DEVELOPING HOSPITAL PHARMACY SERVICES BASED ON
UNIT DOSE DRUG DISTRIBUTION

by

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We accept this thesis as conforming to the
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ABSTRACT

There are many examples in the literature of conventional or traditional drug distribution systems in hospitals which possess many shortcomings with reference to medication errors, the amount of time spent by nursing personnel in medication-related duties, inventory losses, the preparation of intravenous admixtures, and the lack of adequate drug usage records. These deficiencies primarily are due to the pharmacist's minimal influence over the control of the traditional drug distribution systems.

An analysis and evaluation of the present pharmacy services at St. Paul's Hospital, Vancouver, B.C., similarly identified a traditional distribution system subject to many of the aforementioned potential problems. Using information based on existing unit dose systems as reviewed in the literature and data collected from a general questionnaire, new pharmacy services based on unit dose drug distribution are projected for St. Paul's Hospital. The required facilities and personnel for a progressive unit dose drug distribution system, an intravenous (I.V.) admixture preparation service and a drug surveillance program are projected accordingly.

It would appear that a "centralized" approach to implementing unit dose distribution is most appropriate for St. Paul's Hospital's present requirements. This would involve the preparation and distribution of all drugs to nursing units in single dose packages from a central pharmacy area. A similarly centralized intravenous admixture service and a decentralized drug surveillance program also are described. These services commonly feature a greater responsibility being placed with the pharmacy department for
preventing therapy problems such as admixture incompatibilities, drug interactions, adverse drug reactions and inappropriate drug selection.

The effect of the above services on the responsibilities and number of pharmacy and nursing personnel is estimated based on results in similar programs. These changes also reflect extended hours of coverage in each area.

Finally, a potential phasing plan and time schedule for the implementation of the proposed unit dose drug distribution system, I.V. admixture preparation service and drug surveillance program at St. Paul's Hospital is suggested.

Signature of Supervisor.
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INTRODUCTION

The evolution in hospital pharmacy practice within the past decade has been from a primary emphasis on drug distribution to a greater responsibility in the patient-care or clinical environment. This redirection of involvement is the fundamental theme of the majority of hospital or "clinical" pharmacy literature. Kleinmann(1) however, states that "... a hospital must first develop concepts of good pharmaceutical services before it should even consider moving in a progressive direction." Therefore, efficient medication distribution systems are prerequisites to effective participation by pharmacy personnel in the patient-care environment.

The hospital pharmacist's role in the traditional or conventional drug distribution system is limited. In this system the hospital pharmacy department distributes medication by individual prescriptions or as ward or floor stock. In either case issues are by multiple units. After the medications have been distributed the pharmacy has little control over their usage. Barker(2) states that he does "... not believe the hospital pharmacist has a future in the distribution of drugs in hospitals." This is in reference to drug distribution as the physical act of counting, repackaging and transporting of drugs. His expanded responsibility, however, will be to provide the controlling influence over this system. Drug control involves the exertion of a direct restraining or governing influence over the use of drugs(2) and the process by which the ordered dose is made ready for
administration(2,3). Further, the demand to lessen the involvement by nursing personnel in medication related duties and to reduce the possibility of medication errors are basic reasons for intensifying pharmacy's participation in the patient-care areas.

Medication errors have been shown to occur with alarming frequency. In conventional drug distribution systems, these errors are generally considered to occur at a rate of 15 to 18 percent of doses ordered(4). A study by Hynniman and coworkers(4) comparing the frequency of medication errors in four hospitals demonstrated that a rate of 8.3 percent to 20.6 percent could be expected with distribution systems utilizing the prescription order and floor stock concept. Barker and Heller(5) reported a preliminary study before the implementation of an experimental unit dose system showed medication errors occurred at a rate of 8 to 15 percent when wrong time errors were not included. It is quite apparent that with conventional hospital drug distribution methods, approximately one out of every six or seven doses ordered is handled in a manner contrary to physician's instructions(6,7). It is important to realize that errors in the traditional systems are caused by physicians, nurses and pharmacists and that the interpretation of "medication errors" must not mean solely nursing errors. It is also recognized that the statistics reported for medication errors are dependent on different patterns of dosage form utilization, drug doses, times of administration, and medication schedules of the individual hospitals(4) and the specific criteria used to define a medication
error. However, as one hospital administrator has stated, "Even if the vast majority of reported errors are of the less serious variety (i.e., wrong time of administration, omission, wrong dose or extra dose given)*, the risk is too great to tolerate an attitude of unconcern"(7). Progressive trends in hospital pharmacy services, specifically unit dose distribution and drug surveillance programs (reviews of drug usage), are designed to greatly reduce medication errors.

It should be noted that medication errors contributed by nursing personnel cannot be viewed as totally unexpected when one considers the position of the nurse in the present "drug distribution cycle". In the course of assigned nursing duties, she may be expected to interpret physicians' medication orders, select correct drugs from large floor stock supplies, compound difficult and extremely potent pharmaceuticals such as intravenous admixture preparations, and often assume complete responsibility over the drug distribution system during night and weekend periods. In fact, in many hospitals, the proportion of time in which nursing personnel have unsupervised access to the pharmacy department (during evening and night shifts) is substantially greater than the coverage provided by pharmacists during normal day periods (usually eight to ten hours). Several studies have reported that nurses normally spend from 22 to 30 percent of available time in medication related activities(8,9). These duties usually involve the noting of physicians' medication orders, requisitioning drugs from the

* Internal brackets added by author.
pharmacy, preparing doses for administration, transporting drugs, administering of medications and charting. A study on five nursing units in a large university hospital reported that registered nurses spent an alarming 47.3 percent of their time with medication related procedures(10). Again it is recognized that these statistics will vary with individual hospital procedures, policy and personnel assignments. In a multiple dose (traditional) system reported by Riley and coworkers(11) at the Johns Hopkins Hospital, the time spent in medication duties performed by nursing personnel ranged from 29 percent for unit clerks to 30 percent for licensed practical nurses and 40 percent for registered nurses. Two issues are clearly evident here: (1) the large proportion of available nursing time spent in activity which is not patient-care management of professional nursing nature, and (2) the potential for serious adverse consequences when nursing personnel are required to carry out functions for which they are not educated to perform.

Individual approaches to drug distribution, intravenous admixture services and drug surveillance programs have been proposed to realize changes in the roles of pharmacists, nurses, and physicians related to drug therapy. Hospital size, type, management, tradition and personal preferences of pharmacy and nursing will determine the extent to which these systems and responsibilities are implemented(12). This literature survey will review several well-documented examples to describe the results of this progressing trend.
A. Modified Traditional Drug Distribution Systems.

One of the initial attempts to reduce the amount of time delegated to medication activities by nurses was the development of the "Medication Order Supply and Individual Charge System" (MOSAICS). First described by Tucci and Webb at Massachusetts General Hospital(13), this system requires that the pharmacy assumes the responsibility for the stocking, dispensing, and charging of charge medications on each nursing unit. Basically, this is a well-supervised, perpetual inventory ward stock system. The major function of the pharmacists in the MOSAICS is to maintain an active supply of all medications currently being administered on their assigned unit. These decentralized areas are usually composed of three or four nursing units serving from one hundred to two hundred patients. This system has subsequently been described in Canadian hospitals by Greve(14) and Cramp(15) at the Toronto Western Hospital and by Dasko and Greene at the Humber Memorial Hospital(16). In Canada, this acronym refers to "Medication Order Supply and Inventory Control System" since drugs are rarely "charged" to the patient. The advantages of the MOSAICS are:

1. Relieves the nurse of the routine checking of supplies;
2. Reduces the drug inventory on nursing units thereby minimizing storage areas;
3. Delays in drug administration are avoided since routine drugs are available in nursing units.
twenty-four hours per day;

4. Eliminates the practice of crediting unused medications returned to the pharmacy from nursing units;

5. Makes a pharmacist available in the patient-care areas to physicians and nurses to receive and answer drug information requests(13).

Unfortunately, the deficiencies of this system are major. The pharmacist is assigned many duties of a distributive nature which reduce the amount of time he can devote to drug information and surveillance services. MOSAICS does not lend itself well to the efficient utilization of supportive personnel except in prepackaging and transportation functions. Therefore, the staffing requirements to provide this extended coverage by pharmacists may be prohibitive when compared to the benefits which may accrue from this system. However, this method has specified a control responsibility for pharmacists in the patient-care areas. Dr. Elmina M. Price, a nurse-researcher, describing her "ideal" drug distribution systems states:

"If the pharmacist can be better utilized as a resource person in regard to drug therapy while located in a subpharmacy, this would seem to be compatible with nursings' goals. The MOSAIC system appears to accomplish some improvement in this direction"(17).

The concepts of expanded pharmacy control over drugs and reduced nursing involvement in medication activities introduced by MOSAICS are further refined to reduce these disadvantages in the rapid development of the unit dose distribution system.
B. Unit Dose Distribution.

The drug distribution systems described in hospital pharmacy literature within the past decade, almost without exception are based on unit dose packaging. "Unit of use", "single unit packaging" and "unit dose" are terms referred to in unit dose distribution systems. A unit dose may simply be 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"(18). A unit dose drug distribution is, therefore, "... a total system which delivers a pre-calculated, prepared, pre-labeled dose of medication in a ready to administer form for one patient for one specific time period of administration"(19).

The essential features of a unit dose distribution system which differ from the traditional drug distribution method are:

1. All physicians' medication orders are received in the pharmacy as a direct copy (via carbon paper, no-carbon-required paper, or photoduplication) rather than as a transcribed order;

2. All medication orders are recorded in the pharmacy (either manually or electronically) rather than solely on drug administration records maintained by nurses;

3. The great majority of drugs are included in the system so that free floor stocks available to nursing units are greatly restricted;

4. Medications distributed to the nursing units in the unit dose system are limited to quantities for several
hours rather than several days;

5. Nurses are not responsible for any medication preparation since drugs are sent to nursing units from the pharmacy in a ready to use form;

6. Drug doses are clearly identifiable up to the time of administration because of packaging characteristics;

7. Pharmacy receives notification of the fate of all doses distributed whether administered or not.

One of the most significant qualities of unit dose distribution is that it has been shown to be a viable system in many diverse situations. Successful unit dose systems have been reported in very small hospitals (20,21,22,23) where financial support and necessary staffing may be limited. In contrast, unit dose distribution systems have been implemented in very large hospitals and institutions with university affiliation (24,25,26,27) where facilities and staff may be available but the very magnitude of the services to be provided may be substantial. This system has been described in private and community hospitals (28,29,30). Mental (31) and pediatric (32,33) hospitals where services may be more specialized when compared to general, acute care institutions, also have reported the use of unit dose distribution. Finally, the preparation and control of very specialized unit dose pharmaceuticals such as investigational parenteral cancer chemotherapeutic agents has been described (34). In each situation, the hospital has implemented a unit dose distribution system to fulfil its own specific requirements.
Centralized Unit Dose Distribution.

Of the two major unit dose systems, the centralized method has received the most documentation. In this system all physicians' medication orders are received and interpreted in a central pharmacy with unit dose medications being prepared and distributed from that same location. In most centralized systems, nursing personnel are only responsible for noting the physician's orders, administering medications and charting of doses. Nurses are not required to prepare or compound medications prior to administration. Pharmacists or pharmacy supportive personnel interpret physicians' orders and manually or electronically record this order. Several times daily, pharmacy technicians review all active medication orders and prepare individually labeled drug cabinets with unit dose drugs. These drug cabinets containing medications for a specific number of patients (usually one nursing unit) are transported to the patient-care areas on medication carts. Nursing personnel on each unit are then responsible for administering and charting the medication delivered from the pharmacy. These cabinets contain enough doses of each ordered drug to be administered over a two to twenty-four hour period.

One of the initial attempts in centralized unit dose distribution was a pilot study reported at the University of Florida Teaching Hospital(35). The significant features of this project were the use of supportive personnel under pharmacy supervision to prepare medications and the distribution of a short drug monograph, "Pharmacy Notes for Nurses" with each dose.
Soon after the Florida project, reports were published of an extremely comprehensive and detailed system at the University of Arkansas Medical Center(18,36,37,38). This system demonstrated the value of punch cards and electronic data processing equipment to control drug order information and to schedule doses. The data processing equipment and teletype terminals located in the nursing stations also were used to print frequent patient drug summaries for the nursing staff. Unfortunately, the lack of continuing financing resulted in the discontinuation of this experimental system(39).

The first total hospital centralized unit dose system was implemented at the University of Kentucky Medical Center(6). Started in 1965, this program emphasized the value of drug usage data, non-professional personnel and data processing in production methods. These three major studies also identified the need for commercially available unit dose packaged medications.

Decentralized Unit Dose Distribution.

The decentralized system utilizes one or more small pharmacy substations or satellite units located in the patient-care areas of the hospital. These decentralized stations are normally established to serve one complete floor of the hospital or a group of nursing units usually involving from ninety to 145 beds(28,29,40). Complete operation of the satellites is primarily maintained on a one (eight hour) or two shift basis (sixteen hours) requiring one pharmacist and one technician per satellite per shift. It should be noted, however, that a central
pharmacy is still usually required for prepacking, administrative and bulk storage functions. Drug distribution procedures are essentially identical to the centralized unit dose system. The major benefits of improved communication, drug information, and surveillance services anticipated from the decentralized system are the direct result of having the pharmacist and medications in close proximity to the nursing stations and patients.

The prime developmental studies of the decentralized system were reported at the Memorial Hospital of Long Beach in 1961(41), University General Hospitals at the University of Iowa in 1964(42) and the University of Wisconsin Hospitals in 1965(43). An essential feature of the experimental system at the University of Wisconsin is that it was modified in 1967(26) to eliminate pharmacy substations. Mechanical handling of medications was accomplished in a central unit dose dispensary. However, the pharmacists remained in the patient-care areas, supported by a central drug information center, to maintain drug surveillance and information services. This subsequently led to the development of a form of "combination" unit dose system described at the University of Michigan Medical Center in 1969(24) and the Ohio State University Hospitals in 1970(25). The pharmacists are assigned decentralized drug information, surveillance and distribution responsibilities but all doses are prepared and distributed from a central pharmacy.

The unit dose distribution methods -- centralized, decentralized, or "combination" -- offer many improvements for the deficiencies in the traditional distribution system. Slater and Hripko(44) perhaps have
outlined best the potential advantages to pharmacy and nursing in a unit dose distribution system:

1. Pharmacy personnel are freed for increased patient involvement;

2. Decreased pilferage, decreased revenue loss and increased control result;

3. Crediting returned drugs is virtually eliminated;

4. Complete patient medication profile is available in the pharmacy for review to aid physicians and nurses in drug therapy;

5. Unused drugs may be returned and reused since packages have never been opened;

6. Unit-dose packages contain complete identification of drug, lot number and expiration date up to the time of administration to the patient;

7. Pharmacists' time is better utilized;

8. Pharmacy workload activity is more constant throughout the day;

9. A copy of the physician's original order form should eliminate all transcribed orders and refill orders;

10. Exact quantities can be dispensed; nursing errors in pouring liquids and filling syringes should be eliminated;

11. Increasingly complex reconstitution problems for injectables and suspensions pose problems. They can be properly handled in the pharmacy. The pharmacist is more aware than nurses of stability, compatibility, proper reconstitution, vehicles and storage requirements;

12. Inventory management is facilitated by control of dated drugs;

13. Multiple checks for accuracy are possible.
The disadvantages of the unit dose system are few and may be attributed to difficulty in the familiarization with the new system by nursing and pharmacy personnel. Therefore, strict attention to planning and the development of effective policies and procedures is required. The expense of the initial financial investment in pharmacy alterations and equipment(44) which may be substantial would appear, however, to be worthwhile in the long run of operation.

Other Contemporary Features in Drug Distribution.

Several developments related to the unit dose distribution system have been reported recently. Beste(45), Latiolais(46) and Derewicz and Zellers(27) have identified the need for pharmacy to be responsible for the complete drug distribution cycle including the administration of medications to patients. Two approaches have been described. A team of centralized medication administration nurses employed by and under the supervision of the Director of Pharmacy Services is utilized at Providence Hospital, Seattle(45). Secondly, at the Ohio State University Hospitals, nursing personnel deny that the administration of drugs is a symbol of status for any type of nurse(10). The philosophy adopted at this institution is that it "... was a waste of nursing education to allow a registered nurse to function in only this one aspect of patient care when she was prepared to fulfil all the functions of professional nursing"(10). Therefore it was decided to assign the responsibility of all tasks in medication procedures to the pharmacy department and nonprofessional personnel trained and supervised
by pharmacists would administer medications. This latter type of system, however, may require the pharmacy to undertake extensive recruitment, selection, and training programs for pharmacy technicians -- programs which also could be implemented by the nursing department.

The introduction of unit dose packaging has subsequently led to the development of drug dispensing machines. Two examples of these systems are the manual Brewer drug stations(47) and the automated remote "Meditrol" dispensing system(48). These dispensing units located in the patient care areas require nurse, patient and drug identification before they are activated. A record of every transaction is made on a print-out form so that pharmacy control and reduction of inventory losses are major benefits. However, the low quantity of drug orders processed by the machine(48), the limited variety of medications that can be dispensed(47) and malfunctions(48) would appear to limit the usefulness of these units. Beste(45) has stated that Brewer machines were not the answer at Providence Hospital, Seattle. They "... aid in departmental accounting but not accountability" and they place "... additional responsibility for medications on nurses already burdened with a multiplicity of duties"(45).

The unit dose distribution system has identified the value of electronic data processing (E.D.P.) to speed information handling and reduce manual repetitive tasks. Although E.D.P. was initially applied to administrative tasks(49), it also has been reported for such functions as formulary preparation(50,51,52), maintaining narcotic and controlled drug
records(53,54), inventory controls(53,55,56,57) and generating operating and budget reports(56). Recently, however, electronic data processing has been described in the actual drug distribution process, especially the unit dose method. Programming of the unit dose distribution system for E.D.P. is facilitated since pharmacy controls and procedures are much more rigid and explicitly defined compared to the traditional system.

A developmental medication subsystem of a total "Automated Hospital Information System" (AHIS) was reported by Slavin(58) for the Veterans Administration Hospital, Washington D.C. This system was designed for the provision of twenty-four hour per day, "real-time" patient-care data. The input of medication orders to the computer is by way of a programmed keyboard. All medication orders are automatically checked for stop order renewals and hourly medication schedules are generated. The files of this subsystem which have received priority in the study are the medication order, ward medication administration control and the formulary files.

Since 1968, the University Hospital at the University of Saskatchewan has been actively involved in the design of a comprehensive computer-based decentralized unit dose system(59). This project serving 124 beds of the 550-bed hospital by September of 1970 utilized one satellite unit. All input to the computer is through the use of a cathode ray tube display and keyboard. The types of output that can be generated are discharge drug summaries, hourly drug administration lists for the nursing units, daily "P.R.N." lists, narcotic labels, renewal lists and
patient drug profiles(60). This decentralized satellite is in operation for sixteen hours per day and is staffed by one pharmacist and a technician per shift.

An extremely important requirement in the development of a computer-assisted system would appear to be the necessity to clearly evaluate the traditional procedures. The inefficient and non-productive tasks of the conventional system must be eliminated before any attempt is made to utilize electronic data processing methods(61).

The Consequences of Unit Dose Distribution.

Perhaps the major single factor determining the feasibility or success of the implementation of a unit dose drug distribution system is the economic consideration. Frequently, this evaluation is based only upon the cost of a drug in a single unit package, the expenditure for additional equipment and supplies and an increased budget for pharmacy personnel. These variables have been shown to increase(62,63). However, it cannot be assumed that the pharmacy budget is the only factor which determines the cost of the hospital drug distribution system(64).

The nursing component also represents a prime expense in the cost of a drug distribution system. In addition, potential variations in inventory levels, loss due to "shrinkage" and drug deterioration must be evaluated. In summary, the economic results of the unit dose system may only be determined by analyzing the "trade-off" that occurs due to the expected decrease in cost of the nursing component of drug distribution versus the anticipated increase in pharmacy expenditures.
The results of studies published recently refute the claim that unit dose distribution costs more to operate than the traditional system. For example, Slater and Hripko(44) reported an estimated annual saving of $23,168 from the results of a decentralized unit dose project. Their figure was based on savings in nursing labor cost compared to additional expenditures for pharmacy labor and equipment. When the hospital converted to total unit dose, an appended study revealed that the new distribution system contributed significantly to a hospital saving of more than $100,000 per year(65). At the 600-bed Buffalo General Hospital, Yorio and coworkers projected a saving of $0.17 per patient day from a total hospital decentralized unit dose system(30). The cost of nursing personnel activities in this unit dose system were approximately $0.50 per patient lower than the traditional system. In comparison, pharmacy personnel and the standard departmental costs at Buffalo General Hospital were only $0.31 per patient day higher in the unit dose system. At the Memorial Hospital of Long Beach, Smith and Mackewicz(29) determined that total drug distribution costs per patient day increased by $1.59 after the implementation of the PACE (Patient Care Environment) decentralized unit dose system. However, due to an increase in nursing workload and hospital patient days, it was projected that this new system had overcome the need for an additional 17.5 nurses. When this factor was considered, a cost saving of $0.49 per patient day or annual hospital saving of $56,000 could be anticipated(29).

In the centralized unit dose study of 204 beds at Providence Hospital, Beste(45) projected a decrease of 1.5 percent in combined nursing
salaries and pharmacy costs for a total hospital system. This amounted to a reduction of approximately $0.32 per patient day in drug distribution costs. Hynniman(63) has reported on comparable distribution costs of the centralized system at the University of Kentucky Medical Center and four hospitals operating traditional distribution systems. A comparison of the total annual costs of the drug distribution systems showed that the University of Kentucky's was much greater when the other hospitals were adjusted for the number of patient days. However, when factors such as hours of service, drug loss due to wastage, pilferage and deterioration and doses per patient day were considered the unit dose system at the Medical Center compared very favorably to the traditional system.

An important feature of the unit dose distribution system which is not reflected in nursing or pharmacy personnel labor costs is the actual annual drug expenditure. Total drug expenses are erroneously correlated to mean drug usage within a hospital. However, when nursing unit and pharmacy drug inventories and physicians' medication orders are compared to the actual cost of drugs administered to patients or credited returned drugs, a factor known as "shrinkage" (pilferage, wastage and drug deterioration) becomes readily apparent. With reference to this, very few hospitals have any idea of the magnitude of the problem. In a comparison of the actual drug balance with the theoretical balance on nursing units, Barker and Heller(5) reported that annual savings due to elimination of drug losses would have amounted to about seven times the value of the average inventory investment at the University of Arkansas if their experimental system had continued. Hill and coworkers(66) determined that the satellite unit dose system at the Orange County Medical
Center would result in an annual saving of $40,000 from a reduction in inventory loss. A reduction in drug cost of about 36 percent was thought to be due to decreased pilferage and wastage resulting from the use of unit dose packaging and better pharmacy control at the University Hospital in Saskatoon(67). Increased pharmacy control reportedly could have resulted in a reduction in the purchase of diazepam from 54,000 to 16,500 tablets representing a potential cost saving of $1575 at the Western Carolina Center, North Carolina(31). Similarly, Beste(45) noticed an 85 to 90 percent decline in insulin purchases after the implementation of the unit dose distribution system. The potential for increased drug control by the pharmacy department as a result of factors such as pilferage, wastage and drug deterioration should not be underestimated.

The preceding reports of the economic impact of unit dose distribution have primarily considered only the immediate results of the system in the hospitals. However, a report entitled "Study of Health Facilities Construction Costs" by the United Stated General Accounting Office has analyzed the twenty-five year life-cycle cost of the unit dose distribution system(68). In this study, the unit dose system was evaluated against a mechanical dispensing system in which drug dispensing machines are located on each nursing unit and a total ward stock system. Factors such as hospital census, workload, labor costs, drug costs, maintenance and operations, supplies costs, space and construction costs were analyzed from 1971 to 1996. The recommendation of this report
States:

"Based on the results of the life-cycle cost/benefit analysis, the recommended pharmacy system for the reference hospital is the unit dose drug distribution system when savings in nursing time are considered. The analysis indicated that this system has the lowest life-cycle cost of all the systems evaluated in all discount and inflation rate combinations tested plus the benefits of lower dosage error rates and increased patient charting accuracy" (68).

The implementation of a unit dose distribution system and its effect on medication errors has been well-documented. In the comparison of the unit dose system at the University of Kentucky Medical Center with four hospitals operating traditional distribution systems, Hynniman (69) reported an error rate of 3.5 percent in the unit dose system against a rate from 8.3 to 20.6 percent in the traditional systems. The decentralized unit dose study at the University Hospitals, University of Iowa, showed the error rate declined from 2.2 percent in the prior conventional system to 0.5 percent in the new system (70). Similarly during the control period at the University of Arkansas Medical Center an error rate of 31.2 percent was recorded with the traditional system (39). After the implementation of the unit dose system this figure was reduced to 13.4 percent. When "wrong time" and "wrong brand" errors were excluded this unit dose system demonstrated an error rate of 1.9 percent (39). Although the criteria for error in these studies may differ, significant reductions in medication errors have been shown with the unit dose systems. Ideally, the potential for increased patient safety as a result of this factor should be considered to be as important as any economic benefits of the unit dose system.
Unit Dose Distribution in Canada.

The literature reflects that Canadian hospitals have not developed unit dose distribution systems at a rate similar to that in the United States. A major reason for this is the lack of commercially available drugs in single unit packages in Canada. In one study, only 20.8 percent of the drugs administered could have been purchased in unit dose packaging. The computer-based decentralized unit dose system at the University Hospital, University of Saskatchewan, has pioneered the study of unit dose in Canada. Recently, however, several other Canadian unit dose projects have substantiated the benefits claimed by studies in the United States. At the Camp Hill Hospital, Halifax, O'Toole and Kearns evaluated the cost effect of unit dose distribution in a 53-bed extended care area on an eight hour per day and twenty-four hour per day basis. A total daily drug cost saving of $0.39 (materials and labor) for the fifty-three patients served by the twenty-four hour unit dose system was calculated in comparison with a combined traditional-unit dose system. This saving in drug cost was due mainly to a reduction in the quantity of medication at the nursing station. In a unit dose study in an extended care area (33 beds) of the Vancouver General Hospital, a decrease in drug cost per patient day from $0.29 to $0.26 was noted. Between eight and ten hours per day of pharmacy personnel time (pharmacist and technician) were projected to be required to implement this system to a total patient population of 198. A saving of 11.7 hours in nursing time due to the reduction of many medication-related activities could be anticipated if the system
were to be provided to the entire patient population(71). A one-month pilot study on a surgical unit at Sunnybrook Hospital, Toronto, noted a 25 percent reduction ($1.56 to $1.18) in per diem drug costs during the unit dose period compared to the average per diem cost for the preceding twelve months under a total floor stock system(74). A projected saving in total nursing time of 7.6 hours per day for the 22-bed area was calculated for this unit dose system. The authors also state that 60 percent of medication errors which would have been unnoticed in the previous system were prevented by the unit dose system and the pharmacist's input at the floor level.

An important influence in the progress of unit dose distribution in Canada will be the proposed "Study of Unit-Dose Drug Distribution in Canadian Hospitals". In 1970, the Task Force on Operational Efficiency in Hospitals concluded that the present internal drug distribution systems in Canadian hospitals are far from satisfactory, that efforts to find an improved system are long overdue, especially in regard to patient safety and recommended the unit-dose packaging system be introduced in at least five hospitals in Canada(75). The objectives of the multidisciplinary study group analyzing the unit dose distribution system are:

"1. To improve patient safety and reduce medication errors.

2. To reduce the amount of time spent by nurses on routine medication tasks.

3. To improve the utilization of pharmacists through the provision of drug information to the nurse and physician.

4. To compare the costs of pharmacy services under the traditional and unit-dose systems"(76).
The College of Pharmacy, University of Saskatchewan, in conjunction with the Canadian Society of Hospital Pharmacists, has received a National Health Grant to carry out the first phase of this three-year project (77).

In summary, the reports of the unit dose distribution system in Canada and the United States demonstrate that it offers several economic advantages when compared to conventional methods of hospital drug distribution. In addition, the potential for greater control over drugs by the pharmacy department, the lower incidence of medication errors and the reduction in time spent by nursing personnel in medication-related activities indicates that, at present, there is no other reasonable alternative to this method.

C. Intravenous Admixture Preparation.

The preparation of intravenous (I.V.) admixture solutions in hospitals has traditionally been performed by floor nurses, physicians or special I.V. therapy team nurses. The pharmacists' responsibility in this area, however, has been frequently expressed (78, 79). "Few nurses would ever attempt to compound even simple mixtures intended for topical or oral use; yet, today they regularly compound prescriptions for complex, potent drugs intended for intravenous infusion where the drug action is instantaneous" (79). The inefficiencies and hazards of nursing personnel's involvement in these procedures are identical to
the inefficiencies and hazards of their present position in drug
distribution. The amount of time required by nurses to prepare these
solutions, the potential for medication errors and the lack of
knowledge by nurses of factors such as drug stability and compatibility
are valid reasons for pharmacy to assume direct responsibility in
this area.

In a recent study in a 350-bed hospital, 21 percent of
admixtures were compounded incorrectly(80). In this hospital, by
policy, any nurse could prepare to administer any parenteral admixture
except those containing antineoplastic agents. Errors reported included
wrong drug or solution, wrong dosage, unordered drug and incompatible
drugs. The study further reported that 14 percent of the medication
cards were in error and one-third of the medication cards made by ward
clers and not checked by a nurse were in error. The study concluded
by indicating that approximately one-half of the labels on the
admixtures were judged incomplete with regard to information required(80).

The benefits anticipated from a pharmacy-controlled I.V.
admixture service include:

"1. The preparation of parenteral fluids with medication
by the most expert person available in the area of
pharmaceuticals.

2. The elimination of preparing solutions with additives
under poor environmental conditions in heavily
congested nursing units."
3. The accuracy of dosage of additives which can better be assured by the pharmacist than is possible to control in all situations when additives are cared for by physicians and nurses under great pressure of time.

4. The detection of incompatibility of drugs and particulate matter before issue for use.

5. The nurse (and the physician under some circumstances) will gain some time for more appropriate patient-centered activities"(78).

Several approaches have been reviewed in the literature for the implementation of an intravenous admixture service in pharmacy departments. The specific system selected depends to a great extent on the basic drug distribution system in the hospital. For example, in the decentralized unit dose systems of the University of Iowa, University Hospitals(70), Johns Hopkins Hospital(27) and the Buffalo General Hospital(30) intravenous admixture solutions are prepared in the satellite pharmacy units by pharmacy personnel. When the preparation of these solutions is centralized, the involvement of the pharmacy may vary. Holysko and Ravin(81) and Wenger and Kabat(79) have reported services where pharmacists receive the admixture order and prepare the solution. Floor nursing personnel are responsible for administering the solutions. A twenty-four hour centralized pharmacy I.V. service has been reported by Schwarz(82). In this system pharmacists prepare admixture solutions which are administered by an I.V. nursing team. Comprehensive intravenous admixture preparation services have been described by Wuest(83) and Pulliam and Upton(84). In
these systems, an I.V. Therapy Nursing Team under the direct supervision of the pharmacy prepare and administer admixture solutions. Pharmacists interpret the physician's original order, check on drug stability and compatibility problems and make the final check of the solution. The I.V. Therapy Nursing Team is also responsible for the administration of blood and blood products and hyperalimentation solutions. However, few literature reports have dealt specifically with the integration of a unit dose distribution system and an intravenous admixture service. The pharmacy admixture programs are traditionally considered distinct from the other distribution system.

Like the unit dose distribution system, the effect of a pharmacy admixture service on nursing time has been marked. In a 522-bed hospital, Ravin and coworkers(85) estimated the total nursing time saved to be 4000 man-hours from a two year pharmacy admixture service. This resulted in the addition of only one pharmacist to the staff. In a four week study on two nursing units (85 beds), Wenger and Kabat(79) estimated that the nursing time saved by the pharmacy service would have amounted to three full-time nursing positions. The total hospital (300 beds) additive program at St. Francis Hospital, Cincinnati, was estimated to save about 4.7 nursing staff per day as a result of the elimination of intravenous therapy procedures from floor nurses(86).

The literature indicates that no specific admixture service can be considered for all hospitals. The type of program is dependent on factors such as hospital characteristics, pharmacy staffing, budget
and the degree of control desired by the pharmacy. The initial investment of implementing a pharmacy supervised admixture service cannot be considered a serious impediment in view of the potential benefits that may result in savings in nursing time and increased patient safety.

D. Drug Surveillance.

Prospective or "real-time" monitoring of drug selection and use probably is the pharmacists' ultimate contribution to patient care. The identification of the potential hazards in drug therapy such as adverse drug reactions, medication errors, drug hypersensitivity, and irrational drug usage leading to high costs of therapy has prompted this specialized pharmacy service. The magnitude of the problem of drug reactions has been reported by Melmon(87):

"Modern therapeutic agents have contributed favorably to the physician's ability to influence the course of many diseases. Their use has also created a formidable health problem: 18 to 30 percent of all hospitalized patients have a drug reaction(88,89), and the duration of their hospitalization is about doubled as a consequence (88,89,90,91). In addition 3 to 5 percent of all admissions to hospitals are primarily for a drug reaction(88,92), and 30 percent of these patients have a second reaction during their hospital stay. The economic consequences are staggering: one seventh of all hospital days is devoted to the care of drug toxicity, at an estimated yearly cost of $3,000,000,000"(93).

Melmon(87) further states that:

"If most drug reactions resulted from hypersensitivity, idiosyncrasy or the inevitable risk assumed when toxic drugs are used . . ., one could lament the facts, being powerless to change them. However, classic reactions make up less than 20 to 30 percent of drug reactions(91,94); the remaining 70 to 80 percent are predictable. Most of these are preventable without compromise of the
therapeutic benefits of the drug."
The overburdened physician cannot maintain pace with the current explosion of drug information. The nurse, too, is already performing many non-nursing functions which tax her time. The pharmacist is, therefore, the health professional by way of education to assume the responsibility of assembling, evaluating and disseminating drug information to support drug surveillance services within the hospital.

The economic implications of inappropriate or irrational drug therapy has been reported by Roberts and Visconti(95) and Vance(96). In a study of 340 patients to evaluate systematic antimicrobial therapy, Roberts and Visconti showed that nearly 13 percent of the therapies were judged rational, 66 percent irrational and 22 percent questionable (95). The total cost of the antimicrobial drugs in this study amounted to about $18,200, of which 76.8 percent was spent on irrational therapy. In a prospective and retrospective study of the results of drug monitoring at Lion's Gate Hospital, North Vancouver, active drug surveillance resulted in a 48 percent decrease in the mean cost of antimicrobial drugs to the hospital(96). These studies indicate that active drug utilization monitoring may significantly reduce the cost of therapy within hospitals.

Like the intravenous admixture programs, drug surveillance services may be pre-determined by the drug distribution system within the hospital. One of the prime purposes of locating a pharmacist in the patient-care areas of the decentralized and "combination" unit dose
systems is to regularly review drug information requests from medical and nursing personnel. Frequently, however, these pharmacists are still responsible for many drug distribution duties\(^{(24,25,43)}\). Bell and coworkers\(^{(97)}\), however, have described a drug information and surveillance program which is operationally segregated from the drug distribution system at Mercy Hospital, Pittsburgh.

What are the responsibilities of a pharmacist in a drug surveillance program and what information sources and tools are at his disposal? The identification of current drug utilization reviews has corresponded with the development of drug information centers in some hospitals\(^{(98,99,100)}\). Centers such as these are highly desirable to maintain current information from medical and pharmacy journals and to provide basic reference texts on medical and pharmaceutical subjects. The prime source of information on drug utilization within the hospital is the medical chart. To consolidate and review information from the patient chart a variety of forms such as "Pharmaceutical Service Records"\(^{(101)}\), "Patient Drug Summaries"\(^{(97)}\), and "Laboratory Test Summaries"\(^{(97)}\) have been developed. If a potential problem is observed by the pharmacist a "Drug Information Communication Sheet"\(^{(97)}\) may be used to relay this information to the physician. The question, however, of who to monitor and what to monitor is not readily apparent.

Several authors have identified the need to establish specific criteria or priorities for drug surveillance services\(^{(102,103)}\). These are necessary to reduce the amount of time required by the pharmacist to review therapy in uncomplicated medical and surgical patients. A
surveillance program in which such criteria have been used has been provided by the pharmacy department of the Lion's Gate Hospital, North Vancouver, B.C. In addition, drug monitoring is effectively integrated with the distribution system. A drug profile maintained by nursing personnel on the physician's order form is used to initially identify patients for more intensive drug review. Pharmacists then follow-up the case using a detailed drug profile, a drug communication sheet, if necessary, and the medical chart on the ward. In this manner, potential problems such as drug interactions, adverse drug reactions, drug hypersensitivities, and high costs due to irrational therapy may likely be reduced or prevented.

E. A Specific Situation.

An analysis of the literature reflects that there is no established pattern for the complete adaptation of a pharmacy system from one hospital to another. This will depend on factors such as hospital characteristics, staffing, pharmacy and nursing preferences, budget and the sophistication and degree of supervision desired by the pharmacy. However, the need for pharmacy personnel to improve the method of distributing drugs within the hospital, to supervise the preparation of intravenous therapy medication and to provide an active drug surveillance program has been identified. The potential benefits from these services in terms of more efficient utilization of personnel, increased drug control by the pharmacy, reduced nursing time involved in
medication-related activities, rational drug prescribing and increased patient safety are the prime goals of such progressive trends.

St. Paul's Hospital, Vancouver, B.C., would appear presently to be receptive to such progressive pharmacy trends. Several major hospital changes in the planning stages particularly dictate that an opportunity to introduce new programs in drug distribution, drug surveillance, and I.V. admixture is available. The specific future hospital developments which are of particular importance to pharmacy planning are:

1. The hospital is currently assisting in the development of a computer-based purchasing and inventory system. This service will initially cover items presently stocked in the central supply area but it is anticipated that drug inventories will eventually be included;

2. The hospital has been projected as the site to initiate a provincial drug and poison information center(104). This project is intended to provide the required facilities to update the provincial Drug Formulary and poison control card monographs. It is also anticipated that the pharmacy department of the hospital will work closely with the staff of the proposed center to provide for the drug surveillance and information needs of the patients of St. Paul's Hospital;

3. St. Paul's Hospital is currently in the planning stage of a new hospital complex. The first phase,
approximately four years away, will involve the construction of a large base facility to contain the hospital's essential services. The second phase, about seven years away, will include pharmacy services for the new hospital. This stage presently does not specify any details regarding location, facilities or space allowance for the future pharmacy(105). The third phase (which may be included in the second phase) will be the construction of the actual patient tower. The potential involvement of the pharmacy department in these planning stages is obvious.

What information is available that will assist in the projection of progressive pharmacy services at St. Paul's Hospital? How can the current characteristics of the hospital be used to estimate future facility and staff requirements for these services? These questions might best be answered through an analysis of other present progressive pharmacy programs to assist in the design of comparable drug distribution, intravenous admixture and drug surveillance services at St. Paul's Hospital.
The traditional drug distribution methods do not adequately provide necessary drug use controls. Contemporary systems such as unit dose distribution and pharmacy-supervised intravenous admixture programs integrated with an effective drug surveillance or monitoring service offer solutions to the inherent problems in traditional hospital pharmacy services. However, it would be unwise to attempt to implement these programs without an evaluation of existing, similar services. In addition, the present operation of a specific hospital must be analyzed to identify its requirements and adaptability to these modifications. The objectives of the present study are:

1. To project the unit dose distribution, intravenous admixture and drug surveillance services of choice in a specific 575-bed hospital based on existing programs;

2. To project the personnel and facilities required to implement these services; and

3. To recommend a feasible phasing schedule to achieve the proposed services.
EXPERIMENTAL METHODS

A. General

The experimental procedures used in this research were undertaken to accurately project the systems, personnel and facilities required for progressive pharmacy services at St. Paul's Hospital based on unit dose drug distribution. Initially, the characteristics of St. Paul's Hospital were defined and the present Pharmacy Department analyzed with reference to provision of existing services. Secondly, additional information was requested from hospitals identified in the literature which were operating successful unit dose distribution systems. Finally, specific approaches from the literature describing drug distribution, intravenous admixture and surveillance programs were analyzed to determine procedures, personnel and facility requirements.

B. St. Paul's Hospital

A study was undertaken at St. Paul's Hospital to describe the characteristics and services provided by the hospital. In addition, basic statistics of direct importance to the Pharmacy Department were acquired. The organizational and administrative nature of the present Pharmacy Department was evaluated to consider features such as: formulary policies, services within the hospital, facilities, staffing, purchasing and inventory procedures. Appropriate data and statistics were obtained to compare the characteristics of the operation at St. Paul's
Hospital with hospitals described in the literature. The procedures used to facilitate inpatient, ward stock, narcotic and controlled drug and outpatient dispensing were reviewed. The relationship of the I.V. Therapy Service and intravenous admixture preparation to the pharmacy department was considered to identify the method by which a pharmacy-supervised admixture service might be provided. To conclude this evaluation, the drug information, surveillance and educational programs sponsored by the pharmacy department at St. Paul's Hospital were studied. Where possible, interviews with hospital personnel responsible for each service area were conducted. The remainder of information was obtained through interviewing the Director of Pharmacy Services and through personal observation and evaluation of existing systems.

C. General Information Survey

The literature survey identified several hospitals which have implemented progressive unit dose drug distribution systems. Policies and procedures used to achieve the unit dose distribution system in these institutions were usually well documented. However, basic hospital information was required to accurately correlate the literature reports with the analysis of St. Paul's Hospital. Similarly, data such as the pharmacy department staffing patterns, workloads, approximate per patient day pharmacy cost and hours of service which may have been excluded from the literature reports was required. It also was recognized that some time might have passed since the original studies were published.
Therefore, information concerning the present status of these unit dose distribution systems as they might differ from previous reports was desirable. To obtain this additional information, a brief general information questionnaire was mailed to thirteen hospitals operating well-documented unit-dose distribution systems. The hospitals included in the survey were:

1. University Hospitals, University of Wisconsin, Madison.
2. Ohio State University Hospitals, Columbus.
3. University Hospital, University of Michigan, Ann Arbor.
4. Kettering Memorial Hospital, Kettering, Ohio.
5. University Hospital, University of Saskatchewan, Saskatoon.
6. Memorial Hospital of Long Beach, Long Beach, California.
7. Temple University Hospital, Philadelphia.
8. University Hospitals, University of Iowa, Iowa City.
10. St. Joseph's Hospital, St. Paul, Minnesota.
11. University of Florida Teaching Hospital, Gainesville.
12. University of Arkansas Medical Center Hospital, Little Rock.
13. University of Kentucky Medical Center, Lexington.

The questionnaire that was used in this survey is shown in Figure 1. The results were then tabulated and compared to the data obtained from the analysis of St. Paul's Hospital.

D. Literature Approaches

To supplement the information obtained from the general survey, specific approaches to the implementation of unit dose distribution,
FIGURE 1.

QUESTIONNAIRE

HOSPITAL INFORMATION
1. Beds
2. Occupancy rate (1972)
3. Average length of patient stay (1972)
4. Medical and related services

PHARMACY DEPARTMENT
1. Hours of service
2. Staffing:
   a) Number of administrative personnel
   b) Number of staff pharmacists
   c) Number of supportive personnel
3. Approximate departmental budget (1972)
4. Department purchases include (yes or no)
   a) drugs
   b) chemicals
   c) diagnostic products
   d) I.V. solutions
   e) anesthetic gases
   f) other medical and surgical supplies
5. Approximate per patient day pharmacy cost
6. Approximate number of inpatient doses prepared per day
7. A brief summary of the transportation system used by the Pharmacy department
8. A description of the method for handling:
   a) narcotic and controlled drugs
   b) intravenous solutions and additives
   c) inventory procedures
9. A brief outline of any drug information and education programmes that take place in the department.
intravenous admixture and drug surveillance systems were analyzed from the literature. In each hospital, an attempt was made to correlate the facilities, procedures, workload, or staffing pattern with the service provided.

The data and information obtained from the general information survey and the literature identified specific approaches and staff and facility requirements to provide certain unit dose distribution, intravenous admixture and drug surveillance programs. The strengths and weaknesses of individual systems were also identified and commented upon. Finally, using the analysis of the present pharmacy services at St. Paul's Hospital and specific information obtained from other sources, modified drug distribution, intravenous admixture and drug surveillance systems were proposed to introduce these progressive trends.
RESULTS AND DISCUSSION

A. St. Paul's Hospital Analysis

1. Hospital

St. Paul's Hospital, Vancouver, B.C., is a major acute-care referral hospital in the province. Founded in 1894 and administered for many years through its religious affiliation, it is now a government financed and regulated community institution. The hospital provides basic medical and surgical facilities and additional specialty services such as orthopedics, maternity, pediatrics, a renal dialysis unit, neurosurgery and gynecology. St. Paul's Hospital is a teaching site for medical students of the Faculty of Medicine, U.B.C., interns, and residents and has also operated its own nursing school. The hospital has a rated capacity of 621 inpatient beds (575 excluding bassinets). The daily occupancy rate in 1972 was about 89 percent with an average length of patient stay of 10.08 days (excluding newborns).

2. Pharmacy Department

In the administrative organization of St. Paul's Hospital, the Pharmacy Department is supervised by the hospital's Medical Director. The pharmacy is responsible for the purchasing and dispensing of medications to the hospital's inpatients and outpatients, budgeting for anesthetic gases, intravenous solutions, chemicals and diagnostic agents, and providing staff
prescription services. The department operates under the guidelines established by the Pharmacy and Therapeutics Committee and the Director of Pharmacy Services. With respect to medication usage in the hospital, "The members of the Medical Staff shall acquaint themselves with and adhere to the policies regarding drug administration as stated in the Hospital Formulary" (106). Until about 1967, the Director of Pharmacy Services regularly prepared and revised a formulary following the American Hospital Formulary Service classification. At present, there is no specific hospital drug formulary or list. The hospital has, however, adopted the current provincial Drug Formulary, originally developed by the pharmacy department at Lion's Gate Hospital, to serve this purpose. Additional information for prescribing can be found in the pharmacy section of the St. Paul's Hospital Nursing Policy Manual.

The pharmacy department provides daily drug distribution services to the hospital's inpatients and departments. In addition to approximately twenty nursing units which receive ward stock and prescription medications, other areas such as the operating rooms, emergency, out-patient department (O.P.D.), post-anesthetic recovery (P.A.R.), x-ray, central sterile supply, laboratories, dietary, housekeeping, printing, I.V. Therapy, and the power plant receive certain supplies from the pharmacy. A summary of the cost of drug allocations, bed capacities and services of the hospital's nursing units are given in Table I.

The pharmacy department is located on the basement and first floor levels of the hospital and occupies an area of about 1850 sq. ft. The basement level provides storage facilities for most drugs used in the hospital,
<table>
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<tr>
<th>Floor</th>
<th>Nursing Unit</th>
<th>Service</th>
<th>Beds</th>
<th>Inpatient Prescriptions</th>
<th>Ward Stock</th>
<th>Narcotic &amp; Controlled</th>
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<td>262</td>
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<td>5th</td>
<td>5M</td>
<td>Case Room</td>
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<td>275</td>
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<tr>
<td></td>
<td>5W</td>
<td>Renal Unit</td>
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<td>1446</td>
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<td>415</td>
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<td></td>
<td>11</td>
<td>-</td>
<td>44</td>
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<td></td>
</tr>
<tr>
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<td>6S</td>
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<td>19</td>
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<tr>
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<td>6S OBN</td>
<td></td>
<td>35</td>
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<td></td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hospital Total</td>
<td></td>
<td></td>
<td>621</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

security storage for narcotic and controlled drugs, a bulk manufacturing area and ward stock distribution. Inpatient and outpatient dispensing is located on the main floor level. In addition, the administrative and clerical duties of the department are maintained in this area. Standard pharmacy equipment is used for the majority of dispensing and manufacturing procedures. An electronic tablet and capsule counting machine is utilized for ward stock and narcotic drug prepackaging. Annual capital equipment expenditures for other items, however, are usually minimal.

The pharmacy department is staffed by six licenced pharmacists and three supportive personnel who provide daily nine and one-half hour (Monday to Friday) and nine hour (Saturday and Sunday) coverage. The Director of Pharmacy Services is responsible for supervising the daily operation of the department, preparing budget and inventory records, interviewing pharmaceutical sales representatives and establishing pharmacy policy through the Pharmacy and Therapeutics Committee. The job functions of the five staff pharmacists are essentially identical since there is no policy manual specifically detailing individual responsibilities. These pharmacists dispense all inpatient, outpatient and staff prescriptions; receive and distribute narcotic and controlled drug orders to nursing units; and handle drug information requests from medical and nursing personnel. The three supportive staff are responsible for clerical duties, distributing ward stock items to the nursing units, some bulk compounding and restocking pharmacy medication storage areas.

The pharmacy department budget purchases all drugs, chemicals, diagnostic products, intravenous solutions, anesthetic gases and some
surgical supplies used in the hospital. With reference to drugs, the general formulary guideline is followed and no basic drug chemical is purchased under more than one trade name. New drug products must receive approval from the Pharmacy and Therapeutics Committee before they can be used in the hospital. Approximately 1900 items are controlled by the department. St. Paul's Hospital is a member of a twelve hospital lower mainland group purchasing arrangement in which about one hundred drug products are tendered based on the estimated annual consumption of all the hospitals. The hospital also individually contracts to buy other high volume items such as contrast media, intravenous solutions, sensitivity discs, and bacteriological media. The terms of contracts may be specified in either a routine, blanket or standing order. Purchasing records of drugs are maintained under the pharmaceutical manufacturer rather than by individual product. A perpetual inventory is maintained on all narcotic and controlled drugs. All other medications are inventoried by the Director of Pharmacy Services annually. The 1972 pharmacy cost, including salaries, supplies, maintenance, printing, and stationary and drug expenditures was $3.09 per patient day at St. Paul's Hospital.

3. Pharmacy Drug Distribution

A flow chart of the present method of inpatient dispensing is given in Figure 2. St. Paul's Hospital uses the traditional method of drug distribution with both personal prescription and ward stock medications dispensed to the nursing units. All physicians' orders for medications, treatments or laboratory tests are initiated on the
FIGURE 2
PRESENT DRUG DISTRIBUTION SYSTEM AT
ST. PAUL'S HOSPITAL

PHYSICIAN

PHYSICIAN'S ORDER FOR:
- MEDICATION
- TREATMENT
- LABORATORY

ORDER RECEIVED IN PHARMACY
BY PHARMACIST AND SURVEYED
FOR MEDICATIONS TO BE
DISPENSED BY PERSONAL
PRESCRIPTION

COPY OF PHYSICIAN'S ORDER
STAMPED WITH PRESCRIPTION
NUMBER AND LABEL TYPED

PRESCRIPTION FILLED FOR
PATIENT BY PHARMACIST
WITH SIX DAY SUPPLY OF
MEDICATION

PRESCRIPTION PLACED IN
PICK-UP BOX IN APPROPRIATE
NURSING UNIT SECTION

PHARMACY CLERK

PHARMACY CLERK
FOR RECORDING

NURSE

NURSE DETERMINES
IF MEDICATION
REQUIRED FROM
PHARMACY

IF REFILL OF PREVIOUSLY
DISPENSED MEDICATION
REQUIRED NURSE COMPLETES
FORM 33 OR 33A

ORDER RECEIVED IN PHARMACY
BY PHARMACIST AND SURVEYED
FOR MEDICATIONS TO BE
DISPENSED BY PERSONAL
PRESCRIPTION

PRESCRIPTION FILLED FOR
PATIENT BY PHARMACIST
WITH SIX DAY SUPPLY OF
MEDICATION

PRESCRIPTION PLACED IN
PICK-UP BOX IN APPROPRIATE
NURSING UNIT SECTION

FOUR TIMES DAILY PICK-UPS
MADE BY HOSPITAL MESSENGER
AND PRESCRIPTION TRANSPORTED
TO NURSING UNIT

MEDICATION ADMINISTERED TO
PATIENT BY NURSE, CHARTED ON
ADMINISTRATION FORM AND MED. CARD
FILED FOR NEXT DOSE

MEDICATION ADMINISTERED TO
PATIENT BY NURSE, CHARTED ON
ADMINISTRATION FORM AND MED. CARD
FILED FOR NEXT DOSE

DISENTINUED MEDICATIONS
OR DRUGS FROM DISCHARGED
PATIENTS ASSEMBLED BY
NURSE AND RETURNED TO
PHARMACY

MEDICATION ADMINISTERED TO
PATIENT BY NURSE, CHARTED ON
ADMINISTRATION FORM AND MED. CARD
FILED FOR NEXT DOSE

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PATIENTS ASSEMBLED BY
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PATIENT BY NURSE, CHARTED ON
ADMINISTRATION FORM AND MED. CARD
FILED FOR NEXT DOSE

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OR DRUGS FROM DISCHARGED
PATIENTS ASSEMBLED BY
NURSE AND RETURNED TO
PHARMACY

MEDICATION ADMINIST
physician's order form. If a drug is required from the pharmacy, the
direct copy of the order is removed and sent to the pharmacy via the
hospital messenger service. In the pharmacy, the order is interpreted
by a pharmacist and a prescription label is typed. A pharmacist then
fills the prescription with a six day supply of medication. If a refill
of a previously dispensed drug is required then the nurse completes a
transcription of the order on a special form. A hospital messenger
provides delivery service of prescriptions to the nursing units approxi­
mately four times daily. An automatic stop policy exists for narcotic
orders (72 hours) and injectable antibiotics (four days) after which
time a new physician's order is required. All prescriptions are numbered,
priced, and a record of prescription drug allocations to nursing units is
maintained by the pharmacy clerk. After pharmacy hours service is
provided by a well-stocked night drug room. The night nursing supervisors
have access to this room to obtain medications. A record of these
acquisitions is maintained in the drug room. Nursing personnel on the
wards are required to note physicians' orders, requisition prescriptions,
document these orders in the nursing kardex, medication card and
administration record, prepare and administer medications and chart
these drugs.

The nursing units at St. Paul's Hospital have a liberal ward
stock selection. Nursing personnel complete the travelling requisition
book which is then transported to the pharmacy by the messenger service.
Injectable medications, liquids and miscellaneous items are distributed
from the lower pharmacy level by the pharmacy aide while tablets and
capsules are distributed by a pharmacist from the main dispensary area. Ward stock items are transported from the pharmacy by hospital messenger service or nursing unit personnel. Narcotic and controlled drugs are distributed either as ward stock or personal prescription. Nursing units are required to requisition ward stock narcotic or controlled drugs on a special form. These requisitions are received daily by a pharmacist. He is responsible for determining the authenticity of the requisition, numbering the order, preparing a narcotic register, obtaining the required units of the drugs, and distributing these items to the nursing stations. The pharmacist also maintains a perpetual inventory of all narcotic and controlled drugs. Similarly to prescription medications, ward stocks and narcotics and controlled drugs are priced and "charged-out" monthly to nursing units.

St. Paul's Hospital maintains an active Out-Patient Department (O.P.D.). Patients covered under the Department of Indian Affairs or receiving social assistance from several agencies may receive medical care and medications from the O.P.D. In addition, a variety of special clinics such as prenatal, eye, podiatry, orthopedic and pacemaker clinics are regularly held. Prescription transcriptions in triplicate are used to order medications for O.P.D. patients. These patients can receive a maximum of one month's supply of a prescription from the pharmacy at St. Paul's Hospital. The pharmacy department is also responsible for dispensing medications to hospital patients who are being discharged. Again, a maximum of a one month's supply may be dispensed and the patient is required to pay the pharmacy for these drugs when they
are received. Hospital staff personnel may also receive prescription and "over-the-counter" medications from the pharmacy department. The payment for discharge and staff prescriptions is based on the cost of drug plus 30 percent.

St. Paul's Hospital is currently maintaining several clinical research studies. Those programs in which investigational drugs are being used are requested to have them stored and dispensed from the pharmacy department. In addition, the investigator is required to supply a drug protocol and other necessary information pertaining to their use. The involvement of the pharmacy department, however, does not extend beyond the storage and dispensing functions. Approximately four investigational drugs are currently being distributed from the pharmacy.

During normal daily staffing (Monday to Friday), four pharmacists are assigned to dispense inpatient, discharge, staff and O.P.D. prescriptions. An additional pharmacist spends approximately the complete day assigned to narcotic and controlled drug distribution and record maintenance. A summary of the representative daily pharmacy workload is given in Table II. Several observations can be made from this Table with respect to professional allocation of the pharmacists' time. Firstly, of an average daily workload of 215 units (inpatient, discharge, staff, O.P.D., S.A.M.S. prescriptions plus eight units of "over-the-counter" sales) only about 65 percent of this total is composed of St. Paul's Hospital inpatient prescriptions. Secondly, since one
TABLE II.

REPRESENTATIVE DAILY PHARMACY DEPARTMENT

WORKLOAD\(^a\) AT ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>ITEM (UNITS)(^d)</th>
<th>MON</th>
<th>TUES</th>
<th>WED</th>
<th>THUR</th>
<th>FRI</th>
<th>SAT</th>
<th>SUN</th>
<th>AVE.</th>
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<td>142</td>
<td>162</td>
<td>167</td>
<td>125</td>
<td>85</td>
<td>139</td>
</tr>
<tr>
<td>Discharge and Staff(^b) Prescriptions</td>
<td>35</td>
<td>45</td>
<td>34</td>
<td>49</td>
<td>64</td>
<td>39</td>
<td>33</td>
<td>42</td>
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<tr>
<td>Ward Stock</td>
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<td>234</td>
<td>207</td>
<td>205</td>
<td>252</td>
<td>2</td>
<td>2</td>
<td>189</td>
</tr>
<tr>
<td>O.P.D. Prescriptions</td>
<td>15</td>
<td>17</td>
<td>9</td>
<td>30</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>S.A.M.S(^c) Prescriptions</td>
<td>24</td>
<td>14</td>
<td>20</td>
<td>10</td>
<td>14</td>
<td>5</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Narcotics and Controlled Drug Ward Stock</td>
<td>51</td>
<td>57</td>
<td>43</td>
<td>57</td>
<td>59</td>
<td>47</td>
<td>36</td>
<td>50</td>
</tr>
</tbody>
</table>

\(^a\) Averaged daily statistics for the period Feb. 13 to 28, 1973. Hospital occupancy rate during this period 88 to 94 percent.

\(^b\) Excluding an average of eight "over-the-counter" sales per day.

\(^c\) Social Assistance (welfare) prescriptions.

\(^d\) A single unit is one prescription or ward stock container.
pharmacist is assigned narcotic and controlled drug duties, this reduces the daily available pharmacist manpower by 20 percent (during full staff days). The distribution of these drugs and the maintenance of appropriate records is a responsibility that may be delegated to supportive, non-professional personnel. Finally, another pharmacist is responsible for the ward stock distribution of tablets and capsules, although the time required for this daily activity is usually minimal. This analysis of the present staffing, priorities and workload of the pharmacy department is important if additional staff requirements are projected in the design of new pharmacy services.

4. I.V. Therapy Service

An Intravenous Therapy Service under the supervision of the Department of Nursing is employed at St. Paul's Hospital. The I.V. therapy team, staffed by specially trained registered nurses is responsible for doing venopunctures, starting and restarting most intravenous infusions administered in the hospital. This service also takes blood specimens from patients for cross-matching and administers blood and blood products to patients. If problems develop during infusions such as infiltration or phlebitis, members of this team are on-call to investigate. Finally, the I.V. Therapy Service is responsible for preparing and administering all hyperalimentation solutions used in the hospital. Although not under the supervision of the pharmacy department, the proximity to the pharmacy permits nurses of the I.V. Therapy team opportunity of using the resources of the pharmacy to solve problems
which may be pharmaceutical in nature.

Requests for a member of this service to start an infusion with or without additives are not transmitted by the direct copy of the physician’s order used by the pharmacy department. A separate requisition form is used or verbal instructions via the telephone are permitted from the nursing units. Each nursing unit receives a ward stock of the standard intravenous solutions distributed from the I.V. Therapy room. Floor nurses employed in the various patient care areas are permitted to prepare admixture solutions. Regulations specifying the techniques to be followed are covered in the St. Paul's Hospital Nursing Procedure Manual. Floor nurses may only administer intravenous solutions and admixture solutions by way of previously established administration sets. A flow chart of the present intravenous additive and administration system at St. Paul's Hospital is given in Figure 3.

The I.V. Therapy Service is staffed by nursing personnel twenty-four hours per day, seven days a week. The actual number of intravenous admixture solutions prepared and administered per day is unknown since floor nursing personnel prepare most of the admixtures. However, approximately 5000 to 6000 I.V. solutions and solutions with additives are used in the hospital monthly (about 160 to 200 per day). The daily workload of this service varies with respect to the surgical schedule of the hospital. In addition, approximately four patients are usually receiving hyperalimentation solutions at any time prepared by the I.V. Therapy Service. The daily staff schedule requires four I.V. therapists on the day shift, two during the evening and one nurse for the night shift.
FIGURE 3.
PRESENT I.V. THERAPY SYSTEM AT
ST. PAUL'S HOSPITAL
5. Drug Information and Education

Nursing personnel are encouraged to attempt to find information related to the use of drugs from reference sources available at the nursing stations. If the required information cannot be obtained, the pharmacy department is equipped to handle most general information requests. No specific staff member is assigned to research drug information problems. Each patient's direct copy form of the physician's orders contains a drug profile section. The nursing personnel are required to enter new drug orders and indicate discontinued medications before the form is sent to the pharmacy. However, at present, the pharmacy staff does not routinely survey these drug profiles for potential drug therapy problems. The direct copy is essentially only reviewed for medications which are to be dispensed from the pharmacy.

As mentioned previously, St. Paul's Hospital is a teaching center for medical students, interns, and nursing students. The pharmacy department also is actively involved in the education of pharmacy students. Senior-year undergraduate pharmacy students in 1972-73 received an orientation to hospital pharmacy organization and administration during their clerkship in the department. In addition, the hospital also offers a Hospital Pharmacy Residency training program in affiliation with the Faculty of Pharmaceutical Sciences, U.B.C. The residents have studied such areas as the feasibility of satellite pharmacy units at St. Paul's Hospital and the design and evaluation of the direct copy method of physician ordering. Finally, the Director of Pharmacy Services
regularly gives an inservice orientation lecture concerning the pharmacy department to nursing students and new hospital staff personnel.

The preceding evaluation of pharmacy services at St. Paul's Hospital identifies several limitations which are the result of the traditional approach to drug distribution, intravenous admixture preparation and drug use control. Basically these limitations are reflected in the amount of nursing time spent in medication related activities; the lack of controls that can be exerted by the pharmacy over hospital drug supplies; compounding of intravenous admixtures by personnel lacking in adequate information regarding drug compatibilities and stability; and, finally, the limited drug surveillance or monitoring responsibility of the pharmacy department. Therefore, it is recognized through this evaluation that drug distribution, intravenous admixture and drug surveillance services in St. Paul's Hospital are subject to progressive change. It also is recognized that the most feasible direction for change can be achieved through adoption of the best features of such services evaluated in other programs.

B. Literature Evaluation

The survey of the literature clearly establishes that some form of unit dose distribution system gives the pharmacist the opportunity for directing the entire drug distribution cycle. Traditional or
conventional distribution systems, in contrast, force nursing personnel to assume much responsibility in this area. The features of these systems which reflect the pharmacist's lack of control include: the occurrence of medication errors at a rate of 8 to 21 percent (4); nursing personnel spending 22 to 30 percent of available time in medication-related activities (8,9); thousands of dollars in inventory lost through "shrinkage" (31,66); the questionable sterility and accuracy of intravenous admixtures prepared at the nursing stations (80); an incidence of adverse drug reactions of 18 to 30 percent (88, 89); and the hazards and high cost of irrational drug selection (95). The unit dose system, however, offers the pharmacist means to overcome these deficiencies. The drug profile that is maintained for preparing doses permits the pharmacist to rapidly review a patient's entire drug therapy. The preparation of doses in single unit packages by pharmacy technicians precludes the need for nursing personnel to spend time in this activity. Since floor stock supplies are restricted and pharmacy receives notification of the fate of every dose dispensed, inventory controls should be maximized. A pharmacy supervised intravenous admixture service provides for the accurate preparation of these pharmaceuticals in a clean air environment. A continuing drug usage surveillance program can aid in the identification of potential therapy problems such as adverse drug reactions, drug interactions and irrational drug selection. In summary, the efficient development and operation of these services should result in an equitable "trade-off" in economic considerations when the expenditures for equipment and
pharmacy personnel are compared to benefits such as decreased nursing time for medication procedures and increased patient safety.

A projection of a system of choice is difficult to quantitate since factors such as hospital size, services, workload, transportation methods, number of staff, hours of service and pharmacy and nursing preferences vary greatly. However, it is possible to analyze specific features of other programs to assist in the description of such drug distribution, intravenous admixture and drug usage surveillance systems for St. Paul's Hospital based on existing characteristics. The purpose of this study was not to quantitate the significance of the factors or variables in the documented institutions but to consider each variable within the context of a complete system. Accordingly, no statistical analysis of the data was attempted.

C. **General Information Survey**

Eight of the thirteen hospitals which were included in the survey responded by returning a completed questionnaire. Five hospitals have university affiliation while the remainder are private, community institutions. The information from the hospitals responding to the general questionnaire was analyzed according to their specific approach to unit dose distribution, namely, the centralized, decentralized, or "combination" systems. A centralized method was defined as being a system in which all physicians' orders are received and interpreted in a central pharmacy with unit dose medications being prepared and distributed to nursing units from that same location. The decentralized
method utilizes one or more satellite units located in patient-care areas. These pharmacy satellites or substations receive and interpret physicians' orders and prepare and distribute unit dose medications for a specific number of beds or nursing units. A "combination" method was also identified. In this system, pharmacy personnel in the patient-care areas interpret physicians' orders directly from an order book located in the nursing unit. The orders are then communicated to the central pharmacy from which all unit dose medications are distributed. Specific variables in the survey such as hospital characteristics and pharmacy workload were then analyzed. Finally, consideration was given to the staffing pattern of the pharmacy department, hours of service, budget and associated services.

D. Drug Distribution

Unit Dose Systems Analysis.

A summary of the hospital characteristics, services and pharmacy workloads of the centralized unit dose hospitals is given in Table III. The "combination" system hospitals (i.e. University of Michigan, Ohio State University and University of Wisconsin) also are included in this table since the major distribution procedures of this method are centralized. Similar information from the decentralized unit dose hospitals is given in Table IV. The hospitals surveyed are all acute, short-term institutions with general medical and surgical services. Pharmacy unit dose workloads will vary depending on the extent
<table>
<thead>
<tr>
<th>HOSPITAL</th>
<th>SERVICES</th>
<th>BEDS</th>
<th>AVERAGE LENGTH OF PATIENT STAY (DAYS)</th>
<th>% OCCUPANCY RATE</th>
<th>AVERAGE DAILY NUMBER OF INPATIENTS</th>
<th>AVERAGE NUMBER INPATIENT DOSSES PER DAY</th>
<th>AVERAGE NUMBER DOSSES PER PATIENT DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Hospital University of Michigan (Ann Arbor)</td>
<td>General Medical Surgical</td>
<td>1200</td>
<td>11</td>
<td>80</td>
<td>960</td>
<td>7425</td>
<td>7.7(^d)</td>
</tr>
<tr>
<td>University Hospitals Ohio State University (Columbus)</td>
<td>General Specialties</td>
<td>1000</td>
<td>8.1</td>
<td>88</td>
<td>880</td>
<td>3700</td>
<td>4.2(^d)</td>
</tr>
<tr>
<td>University Hospitals University of Wisconsin (Madison)</td>
<td>General Specialties Ped. Hosp.</td>
<td>616</td>
<td>11.5</td>
<td>69.9</td>
<td>430</td>
<td>3100</td>
<td>7.2(^d)</td>
</tr>
<tr>
<td>Shands Teaching Hospital, University of Florida (Gainesville)</td>
<td>Medical Surgical Pediatrics OB/GYN Psychiatry</td>
<td>405</td>
<td>7.3</td>
<td>72.2</td>
<td>292</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>St. Joseph's Hospital (St. Paul, Minn.)</td>
<td>Medical Surgical OB/GYN Psychiatry</td>
<td>429</td>
<td>7.3</td>
<td>76.5</td>
<td>328</td>
<td>2625(^c)</td>
<td>8</td>
</tr>
<tr>
<td>Providence Hospital (Seattle, Wash.)</td>
<td>General</td>
<td>345</td>
<td>7.2</td>
<td>78.9</td>
<td>272</td>
<td>2200(^c)</td>
<td>8.1</td>
</tr>
</tbody>
</table>

\(^a\) Results from questionnaire (p. 37); all information based on 1972 statistics.

\(^b\) Calculated from percent occupancy rate multiplied by hospital bed capacity.

\(^c\) Calculated from average daily number of inpatients multiplied by average number of inpatient doses per patient day.

\(^d\) Calculated from average number inpatient doses per day divided by average daily number of inpatients.
### TABLE IV.
HOSPITAL STATISTICS, SERVICES, AND PHARMACY WORKLOAD OF TWO DECENTRALIZED UNIT DOSE HOSPITALS

<table>
<thead>
<tr>
<th>HOSPITAL</th>
<th>SERVICES</th>
<th>BEDS</th>
<th>AVERAGE LENGTH OF PATIENT STAY (DAYS)</th>
<th>% OCCUPANCY RATE</th>
<th>AVERAGE DAILY NUMBER OF INPATIENTS</th>
<th>AVERAGE NUMBER INPATIENT DOSES PER DAY</th>
<th>AVERAGE NUMBER DOSES PER PATIENT DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temple University Hospital (Philadelphia)</td>
<td>General O.P.D.</td>
<td>586</td>
<td>11.7</td>
<td>76.9</td>
<td>450</td>
<td>3300</td>
<td>7.3c</td>
</tr>
<tr>
<td>Charles F. Kettering Memorial Hospital (Kettering, Ohio)</td>
<td>General</td>
<td>413</td>
<td>7.7</td>
<td>94.5</td>
<td>390</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

---

a Results from questionnaire (p. 37); all information based on 1972 statistics.

b Calculated from percent occupancy rate multiplied by hospital bed capacity.

c Calculated from average number inpatient doses per day divided by average daily number of inpatients.
of floor stock and whether or not items such as narcotic and controlled
drugs and intravenous additive solutions are included in the system.
However, as indicated from the average number of doses prepared per
patient day, workloads are essentially constant irrespective of whether
the centralized or decentralized system is used.

The basic unit dose systems -- centralized, decentralized
and a combined system -- each offer several apparent advantages.
Consolidation of personnel and facilities is the major benefit derived
from a centralized pharmacy system. A greater flexibility in staffing
of pharmacists and supportive personnel could be expected to be
achieved in the centralized operation as opposed to a decentralized
method. The expense of purchasing and operating equipment in prepack-
aging, dispensing, maintaining inventory, and drug monitoring also would
be decreased if utilized at a high capacity in a single location. Also,
in general, delegation of responsibility might be more specifically
defined in a system where information and surveillance functions are
operationally distinct from distributive duties. The mandatory require-
ments, however, are efficient transportation and communication methods.

Improved communication, drug information and surveillance
services are the prime features of decentralized systems. The benefits
anticipated from this operation are the direct result of having the
pharmacist and medications in close proximity to the nursing station and
patient. The major weakness of the decentralized method is the fragmen-
tation of the patient-unit pharmacist's responsibilities. For example,
the time available for dissemination of drug information, consultation with physicians, nurses and patients and drug usage surveillance would likely be decreased due to the distributive duties of the substation's pharmacist and technician. Further considerations which potentially limit the value of a decentralized system upon careful analysis are:

1. If 24 hour per day coverage is not provided from the decentralized units, then a backup central pharmacy must still be operated;

2. If all I.V. solutions and admixture solutions, narcotic and controlled drugs, and other less frequently used medications are not stocked in the satellite pharmacies then distribution must still be provided from a central pharmacy;

3. Inventory records will be more difficult to maintain if large quantities of medications are stored and distributed from several locations;

4. In established hospitals, available space near nursing stations for the location of decentralized units is often minimal. Utility rooms or unused patient rooms (107) far from nursing stations may be employed. However, this practice detracts from the main purpose of decentralization;

5. Renovation costs, expenditures for equipment and hospital space overhead cost may be substantial. Reports of construction and renovation costs for satellite units vary from $2000 (28) to $17,000 (108);

6. Consideration must be given to the legal position of the pharmacist who leaves his decentralized pharmacy unattended to review medical charts or consult with medical and nursing personnel.
The combined centralized-decentralized system is an attempt to achieve the advantages from both systems. The pharmacist is available in the patient-care area for drug monitoring and information communication while at the same time consolidation of pre-packing operations and unit dose preparation by supportive personnel can be maintained in the central pharmacy (24,25,26). The potential limiting features of this system are that pharmacy personnel are required to constantly monitor physicians' order books, input medication orders to the distribution cycle and duplicate the profile or kardex maintained in the central pharmacy for unit dose preparation. In actuality, the pharmacist has many of the same restricting distributive functions as the pharmacist in the strict decentralized operation.

Staffing, hours of service and associated services for the centralized and "combination" systems are given in Table V. It is apparent that no correlation can be made between the staffing patterns of these hospitals and their respective pharmacy unit dose workloads (Table III) or services. A closer comparison, however, can be made in the staff of two similar sized private, community hospitals — one centralized and the other decentralized. The decentralized system of Kettering Memorial Hospital (Table IV) employs eight pharmacists and fifteen supportive personnel while the centralized St. Joseph's Hospital (Table V) utilizes five pharmacists and eleven supportive personnel. The pharmacy department budgets for the hospitals surveyed varied greatly depending on whether or not salaries, expenditures for drugs, solutions, anesthetic gases, diagnostic products and supplies, and hospital overhead were taken into account.
### TABLE V.

**STAFFING, HOURS OF SERVICE AND AUXILIARY PROGRAMS**

*FOR SEVERAL CONTROLIZED AND "COMBINATION" UNIT DOSE HOSPITALS*

<table>
<thead>
<tr>
<th>HOSPITAL</th>
<th>BEDS</th>
<th>STAFFING</th>
<th>HOURS OF SERVICE PER DAY</th>
<th>PHARMACY CONTROLLED INTRAVENOUS ADDITIVE SERVICE</th>
<th>DRUG INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Hospital University of Michigan (Ann Arbor)</td>
<td>1200</td>
<td>9</td>
<td>25</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>University Hospitals Ohio State University (Columbus)</td>
<td>1000</td>
<td>4</td>
<td>31</td>
<td>135&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11</td>
</tr>
<tr>
<td>University Hospitals University of Wisconsin (Madison)</td>
<td>616</td>
<td>5</td>
<td>25</td>
<td>31</td>
<td>15</td>
</tr>
<tr>
<td>Shands Teaching Hospital, University of Florida (Gainesville)</td>
<td>405</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>St. Joseph's Hospital (St. Paul, Minn)</td>
<td>429</td>
<td>1</td>
<td>5</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Providence Hospital, (Seattle, Wash.)</td>
<td>345</td>
<td>4</td>
<td>8</td>
<td>10&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Results from questionnaire (p.37); all information based on 1972 statistics.

<sup>b</sup> Medication administration by pharmacy technicians.

<sup>c</sup> Does not include 31.3 pharmacy positions involved in medication administration.
The 1972 pharmacy budgets of the two hospitals cited above, containing similar expenses, were $1,070,000 (Kettering) and $319,240 (St. Joseph's) as reported in their questionnaire. These two factors -- staffing and budget -- further support the general impression that a centralized system can be operated more economically than the corresponding decentralized unit dose system.

The advantages and limitations described would appear to indicate that the centralized unit dose distribution system offers the greatest efficiency and reduced cost with regard to personnel and facilities. Nevertheless, drug usage surveillance and information services would best be maintained by decentralized or patient-care area pharmacists with no distributive responsibilities.

Based upon the evaluation of the preceding hospital programs, a centralized unit dose medication distribution system is recommended for St. Paul's Hospital. Specifically, with reference to communication and interpretation of physicians' orders, the method described by McConnell and coworkers(35) at the University of Florida and Beste(45) at Providence Hospital are considered preferable to those utilized in the combination systems. In both cases, a direct copy of the physician's order is sent to the central pharmacy where drug orders are then interpreted and recorded manually by pharmacy personnel. This recommendation is also based on the more comparable bed capacities and staff requirements (Table V) of these two hospitals to St. Paul's Hospital. The basic philosophy, however, described in the "combination" systems(26,46,109) also is considered essential. That is, the pharmacist should be available in the patient-care
areas to provide drug information and conduct drug usage surveillance studies.

Proposed Unit Dose Distribution System

(a) Basic System

In the proposed centralized unit dose system at St. Paul's Hospital, all medication orders should be received, interpreted and recorded in the central pharmacy. Similarly, preparation of all unit doses prior to administration should be accomplished centrally. Nursing unit personnel are recommended to administer medications to the patients. This is in contrast to the practices described at the Ohio State University Hospitals(10) and Providence Hospital(45) in which pharmacy technicians or nurses employed by the pharmacy administer medications. Although drug administration is a part of the total "drug distribution cycle", it is felt that this is essentially a nursing procedure to be performed by personnel trained in patient-care management. An extensive drug usage surveillance program and intravenous additive service also should be completely integrated with the centralized drug distribution system. A summary of the present and proposed medication distribution systems of St. Paul's Hospital is given in Table VI.

Table V showed that the pharmacy departments of the majority of hospitals provide twenty-four hour per day service. However, drug distribution services, that is the preparation of unit doses and the cart exchange procedure take place on a more restricted schedule. For example,
TABLE VI.
SUMMARY OF PRESENT AND PROPOSED MEDICATION DISTRIBUTION SYSTEMS AT ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>SERVICE VARIABLE</th>
<th>PRESENT</th>
<th>PROPOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Traditional method of combined individual prescription in multidoses and nursing unit ward stock.</td>
<td>Total pharmacy controlled centralized unit dose distribution system.</td>
</tr>
<tr>
<td>Staff</td>
<td>Nursing personnel responsible for communicating physicians' orders to pharmacy. Individual prescription dispensing by pharmacist. Ward stock distribution by pharmacy aide.</td>
<td>Nursing personnel or pharmacy technician responsible for communicating physicians' orders to pharmacy. All physicians' medication orders recorded by pharmacist. Unit doses prepared by pharmacy technician.</td>
</tr>
<tr>
<td>Hours of Service</td>
<td>Mon.-Fri. 8.00 a.m. - 5.30 p.m. Sat.-Sun. 8.00 a.m. - 5.00 p.m.</td>
<td>Drug distribution service scheduled from 7.00 a.m. - 11.00 p.m. On-call pharmacy resident available 11.00 p.m. - 7.00 a.m. seven days per week.</td>
</tr>
</tbody>
</table>
the interval between the first and last cart deliveries at the University of Michigan Medical Center and the Ohio State University Hospitals is approximately 8½ hours (24,110). Similarly, the interval at the University of Wisconsin Hospitals and the University of Kentucky Medical Center is about twelve hours (26,111). Therefore, while the total pharmacy operation at St. Paul's Hospital is recommended to be twenty-four hours per day, unit dose preparation and distribution procedures should function on a more limited schedule (e.g. sixteen hours).

In the proposed system the term "Drug Distribution Pharmacist" will be used to identify the position responsible for receiving and interpreting all physicians' orders. This pharmacist also would record medication orders on the profile forms and supervise supportive personnel. The term "Drug Distribution Technician" will define the support staff responsible for preparing unit dose medication for administration, transporting medication carts and prepackaging. Finally, "nursing personnel" will refer to registered, practical or student nurses working on a nursing unit delegated to administer medications.

(b) Facilities

The implementation of a unit dose distribution system at St. Paul's Hospital would require renovations to be made to the present pharmacy facilities to accommodate unit dose equipment and storage units. In addition, since the range of products in Canada in unit dose packaging is limited, special packaging materials and equipment must be purchased
to supplement those not commercially available. Comparable figures for the United States indicate that approximately 70 percent of tablets and capsules, 50 percent of liquids and over 40 percent of the injectables can be procured from the pharmaceutical industry in unit dose packages(19). In addition to standard pharmacy dispensing equipment the following items would be required for the centralized unit dose system at St. Paul's Hospital:

- medication carts (approximately 20)
- medication cabinets (approximately 40) with drawers
- tablet and capsule packaging machine
- labeling machine
- oral liquid filling machine and capper
- packaging supplies, Kardexes, cart supplies.

To accommodate the proposed services the pharmacy should have the facilities for receiving, storing, and distributing all drugs, chemicals, internal and external solutions and large volume intravenous fluids required for patient use. Therefore, with reference to space allocation, the physical area of the pharmacy should be separated into the following areas of responsibility (and minimum area required):

- inpatient dispensing (prepackaged unit dose) (1300 sq. ft.)
- outpatient dispensing (if required) (included in above)
- extemporaneous compounding (200 sq. ft.)
- prepackaging and labeling (200 sq. ft.)
- intravenous additive preparation (150 sq. ft.)
- storage
  - bulk drugs (500 sq. ft.)
  - narcotic and controlled drugs (100 sq. ft.)
  - cold storage (150 sq. ft.)
  - barrel storage (1000 sq. ft.)
  - intravenous solutions
- administrative and drug information offices. (450 sq. ft.)
A detailed cost analysis of the implementation of this proposed unit dose system at St. Paul's Hospital will not be attempted since the equipment and renovations required have not been more specifically defined. However, the expenses incurred by other unit dose hospitals are available to estimate the proposed system cost. Medication carts with cabinets and drawers vary from $425 to $600 each(31,44). A strip packaging machine may cost about $3500(112). A labelling machine may cost about $770(31). Oral liquid filling machines vary greatly from $800 to $4000(112). Naturally, the exact cost will depend upon the manufacturer, model and the utility of the item. These equipment expenditures are usually depreciated over a five to ten year period.

(c) Distribution Procedures

Initiation of Physicians' Orders -- A flow chart of the proposed centralized unit dose system at St. Paul's Hospital is given in Figure 4. The direct copy of physicians's orders should be used to initiate all orders into the medication cycle. The form (Appendix I) evaluated by Richards(113) and currently in use at St. Paul's Hospital is recommended to be retained. The drug profile section, however, would not be necessary since a summary of all medications being administered to patients would be maintained by the pharmacists in the unit dose dispensary area. Nursing personnel would be responsible for noting the orders, recording medication orders on a "Medication Administration Record" (Appendix II) such as that used at the University of
FIGURE 4.
PROPOSED UNIT DOSE DISTRIBUTION SYSTEM AT
ST. PAUL'S HOSPITAL

"DRUG INFORMATION
COMMUNICATION FORM"
COMPLETED IF
NECESSARY

"PHARMACY DRUG
SURVEILLANCE RECORD"
INITIATED OR
UPDATED

MEDICAL CHART

PHYSICIAN

NURSE

PHYSICIAN'S ORDER FOR:
- MEDICATION
- TREATMENT
- LABORATORY

DIRECT COPY OF PHYSICIAN'S
ORDER CARRIED FROM NURSING
UNIT TO PHARMACY

ORDER RECEIVED IN CENTRAL
PHARMACY UNIT DOSE
PREPARATION AREA BY
PHARMACIST

PHARMACIST INTERPRETS ORDER
AND ENTERS ORDER INFORMATION
IN PATIENT "MEDICATION
PROFILE WORKSHEET"

MEDICATION ORDERS INITIALLY
SCANNED BY DRUG DISTRIBUTION
PHARMACIST ACCORDING
TO CRITERIA FOR FURTHER
DRUG SURVEILLANCE

"DRUGS NOT GIVEN NOTICE"
CHARTED IN PATIENT'S
"MEDICATION PROFILE
WORKSHEET"

CART CABINETS
RETURNED TO PHARMACY
BY TECHNICIAN

"MEDICATION MEMORANDUM"
COMPLETED AND PLACED IN
PATIENT'S MEDICATION
DRAWER

"DRUGS NOT GIVEN NOTICE"
COMPLETED IF NECESSARY,
AND PLACED IN PATIENT'S
MEDICATION DRAWER

NURSE ADMINISTERS
MEDICATION AND CHARTS
IN PATIENT'S
"MEDICATION
ADMINISTRATION RECORD" AND
SETS TIME FOR NEXT
DOSE

UNIT DOSE MEDICATIONS
PLACED IN PATIENT'S
DRAWER BY PHARMACY
TECHNICIAN

NURSE RECEIVES
UNIT DOSE CART

CARTS RELEASED TO
TECHNICIAN TO TRANSPORT TO
NURSING UNIT ACCORDING TO
STAGGERED SCHEDULE

CART CABINETS
EXCHANGED AT
NURSING STATION
Kentucky Medical Center and setting the tab scheduling device for the next dose of a drug to be administered. All "Medication Administration Records" of patients being served by one medication cabinet should be maintained in the same Kardex or binder. To ensure complete accuracy in this procedure, the standard administration times for the nursing unit would be required to be identical to the schedule maintained in the central pharmacy for unit dose preparation.

The copy of the physician's orders should be transported to the pharmacy by a nursing messenger or by a pharmacy technician during his medication cart delivery period. A drug distribution pharmacist in the inpatient unit dose dispensing area would receive all physicians' orders. This pharmacist would be responsible for interpretation of the orders and, if necessary, clarifying the order with the physician. This clarification would require a notice such as the "Medication Memorandum" (Appendix III) now used at St. Paul's Hospital to be sent to the nursing unit.

Patient Medication Profile — Medication orders should then be transcribed by the drug distribution pharmacist to a "Patient Medication Profile Worksheet". Forms such as those used at the University of Wisconsin Hospitals (Appendix IV) are recommended. Upon the admission of a new patient, a nursing unit would be required to furnish the following information to the pharmacy to be recorded on each profile: patient name, room, nursing unit, allergies, admitting diagnosis or surgical procedures, patient weight and age. The medication order transcription should include the following information:
- drug and dosage form
- dose of drug
- route of administration
- frequency of administration
- time(s) of administration
- PRN reason (if applicable)
- date of order - stop order date
- cart exchange number(s)

The patient's medication orders should be separated on the profiles as to scheduled medications and non-scheduled ("PRN" and non-recurring) orders. All profiles for patients served by one medication cart would be maintained in one Kardex or binder. The patient's profile should then be reviewed by the drug distribution pharmacist according to the criteria established for continuing drug surveillance. These criteria are listed in the discussion of the Drug Surveillance Service (p.104). If more intensive monitoring is necessary, a patient-care area pharmacist would be notified of the particular patient and his drug therapy and he would review the case.

Medication Preparation and Administration -- Standard drug administration schedules at St. Paul's Hospital vary depending on the specific nursing unit. However, it has been estimated that 90 percent of all medications are administered to patients at one or all of the established Q.I.D. times(6). Unit dose preparation and delivery times would subsequently be established with reference to these major medication administration times in the hospital and the degree of control desired by the pharmacy. While the four cabinet exchanges per day system at the University of Kentucky Medical Center(6) is considered excessive, the two cabinet exchanges per
day at the Ohio State University Hospitals(110) and the University of Michigan Medical Center(24) is felt to provide insufficient coverage for new drug orders between delivery times. It is therefore recommended that medication carts be delivered to nursing units three times per day. This is the method presently being used at the University of Wisconsin Hospitals(19).

Three times daily, drug distribution technicians would go through all patients' "Medication Profile Worksheets" to determine doses to be prepared for the particular time interval. All medication cabinets would then be filled with unit dose packaged drugs for a specific length of time. Cart accessories such as alcohol swabs, paper cups, rubber gloves, syringes and needles should be placed in the carts by the pharmacy technicians. Items such as water, milk, juice should be the responsibility of nursing personnel. The medication carts would then be checked by a drug distribution pharmacist and released to be transported to the nursing units by the pharmacy technicians. If a new order is received in the pharmacy and the first dose is to be administered before the next scheduled delivery time, then one dose should be labeled for the patient and delivered by a pharmacy technician to the nursing unit. This drug order would be recorded on the "Medication Profile Worksheet" and if further doses are required they would be handled by the usual distribution procedure.

Regularly during the day, nursing personnel would review the "Medication Administration Records" to determine which medications are to be given at a specified time. After the doses have been given, they would be charted in the administration records which the nurse would carry with
her on the medication cart. If drug is not given a "Drugs Not Given Notice" (Appendix V) such as that used at the University of Kentucky Medical Center would be completed by the nurse and placed in the patient's medication drawer. When the cart is returned to the pharmacy by the technician, this form would be used to chart doses not given in the patient's "Medication Profile Worksheet".

"P.R.N." (as circumstances may require) medications should be placed in a separate section of the patient's medication drawer. If a drug is a scheduled "P.R.N." order then a maximum number of doses would be placed in the drawer to cover the period the cart is on the nursing unit. If the drug is a non-specific "P.R.N." order, only one dose should be placed in the drawer. This is the procedure followed at the Ohio State University Hospitals(110). "P.R.N.s" would be charted in the "Medication Administration Record" as are regularly scheduled drugs.

"Stat" (immediately) medication orders may be telephoned by a nurse to the pharmacy or brought to the pharmacy by a nursing messenger. The drug distribution pharmacist would immediately enter the drug order information into the non-recurring section of the "Medication Profile Worksheet" and prepare the dose. The direct copy of the physician's order should be received in the pharmacy before the dose is sent to the nursing unit. After the drug is given it would then be charted on the "Medication Administration Record" by the nurse.

When a physician discontinues or changes a drug order, the drug distribution pharmacist should enter this date and information in the
"Medication Profile Worksheet". An automatic stop order policy should be in effect for all medications except chronic maintenance therapy (e.g. digitalis, glycosides, insulin). Approximately twenty-four hours before the last dose is scheduled, a "Notice of Automatic Stop Order" (Appendix VI) should be filled out by the pharmacy technician and sent to the nursing unit in the medication cabinet. This is the procedure followed at the University of Kentucky Medical Center (111). The nurse would then place this notice in the patient's chart to bring to the physician's attention.

Associated Distribution Procedures — In a unit dose distribution system, ward stock items available in bulk to nursing units would be greatly restricted. The only items to be included as ward stock should be large volume standard intravenous solutions, topical disinfectants and antiseptic solutions, alcohols, and certain ointments, lotions, and diagnostic items. In addition, each nursing unit would have a supply of drugs to be used in emergency situations. Minimum and maximum levels of each item would be established for the nursing areas at St. Paul's Hospital and automatic replacement of ward stock would be the responsibility of a pharmacy technician.

With reference to the special records and safeguards required, it is proposed that narcotic and controlled drugs should be dispensed separately from the unit dose distribution system. A form such as that in use in the Johns Hopkins Hospital is recommended (114). With this method, an accurate control system is maintained using a twenty-four hour...
pharmacy narcotic disposition and nursing audit record (Appendix VII). A pharmacy technician would be responsible for obtaining disposition records and requisitions and filling and distributing narcotic supplies to the nursing stations. A pharmacist would be responsible for checking orders and maintaining inventory records.

(d) Unit Dose Preparation

Staffing -- Data based on workload or bed capacity for predicting the staffing requirements of a centralized unit dose preparation area is limited. The drug distribution system at the 365-bed University of Kentucky Medical Center requires one pharmacist and three technicians per shift for processing of physicians' orders and the preparation of unit dose cabinets(6). Using this data, it is estimated that two pharmacists and four technicians would be needed each shift in the proposed system at the 621-bed St. Paul's Hospital. However, since it is anticipated the day shift should include two dose preparation periods, approximately five drug distribution technicians would be required during this time with only three technicians needed during the afternoon and evening.

Scheduling -- Using the cost of drug allocations to the nursing units (Table I) as an approximate indicator of drug usage and the bed capacities of these areas, two teams of technicians supervised by one pharmacist each per shift could prepare unit dose medications for the nursing units according to the following scheme:
A proposed medication cart identification plan for St. Paul's Hospital with the appropriate personnel responsible for each medication cart is given in Table VII.
## TABLE VII.

### PROPOSED CART IDENTIFICATION PLAN AND UNIT DOSE PREPARATION RESPONSIBILITY

**FOR ST. PAUL'S HOSPITAL**

<table>
<thead>
<tr>
<th>Floor</th>
<th>Nursing Unit</th>
<th>Service</th>
<th>Beds</th>
<th>Cart Identification</th>
<th>Cart Preparation</th>
<th>Cart Check</th>
<th>Cart Delivery</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>A.M.</td>
<td>P.M.</td>
<td>A.M.</td>
<td>P.M.</td>
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<td>D.1</td>
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<td>I.C.U.</td>
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<td>2-2</td>
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<td>D.1</td>
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<td>B.1</td>
<td>D.1</td>
<td>B</td>
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<tr>
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<td>2SB</td>
<td>Medicine</td>
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<td>D.1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>3M</td>
<td>Surgery</td>
<td>32</td>
<td>3-1</td>
<td>A.1</td>
<td>C.1</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>3N</td>
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<td>32</td>
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<td>C.1</td>
<td>A</td>
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<td>23</td>
<td>3-3</td>
<td>A.1</td>
<td>C.1</td>
<td>A</td>
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<tr>
<td></td>
<td>3E</td>
<td>Surgery</td>
<td>31</td>
<td>3-4</td>
<td>A.1</td>
<td>C.1</td>
<td>A</td>
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<td>3S</td>
<td>Pediatrics</td>
<td>49</td>
<td>3-5</td>
<td>A.1</td>
<td>C.1</td>
<td>A</td>
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<td></td>
<td></td>
<td></td>
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</tr>
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<td>4th</td>
<td>4N</td>
<td>E.E.N.T.</td>
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<td>D.1</td>
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<td>27</td>
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<td>D.1</td>
<td>B</td>
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<td>46</td>
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<td>D.1</td>
<td>B</td>
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<td>Urology</td>
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<td>D.1</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>5N</td>
<td>Case Room</td>
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<td>A.2</td>
<td>C.2</td>
<td>A</td>
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<tr>
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<td>5N</td>
<td>Gynecology</td>
<td>43</td>
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<td>A.2</td>
<td>C.2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>5S</td>
<td>Surgery</td>
<td>41</td>
<td>5-3</td>
<td>A.2</td>
<td>C.2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Nursery</td>
<td>Nursery</td>
<td>11</td>
<td>5-4</td>
<td>A.2</td>
<td>C.2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>5W</td>
<td>Renal Unit</td>
<td>7</td>
<td>5-5</td>
<td>A.2</td>
<td>C.2</td>
<td>A</td>
</tr>
<tr>
<td>Total</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th</td>
<td>6S</td>
<td>Maternity</td>
<td>31</td>
<td>6-1</td>
<td>A.2</td>
<td>C.1</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>6S</td>
<td>O.B. Nursery</td>
<td>35</td>
<td>6-2</td>
<td>A.2</td>
<td>C.2</td>
<td>B</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a The pharmacists are referred to as "A", "B", "C", "D".

b The technicians are indicated by A.1, A.2, A.3, B.1, B.2, C.1, C.2, D.1.

c It is probable that the pharmacists would have some preparation duties.

d The morning would include two unit dose preparation periods.
Accordingly, proposed unit dose medication cart preparation schedules for these teams are given in Figure 5 (day shift) and Figure 6 (afternoon shift). It can be seen from these two Figures that a greater number of technicians would be required during the day shift compared to the afternoon period since the interval between preparation, checking and delivery of each medication cart would be shorter. The drug distribution technicians initially would fill the unit dose cabinets with medications and deliver them to the appropriate nursing units. After these duties had been completed, the technicians would then probably have prepacking, re-stocking and cart maintenance responsibilities. The drug distribution pharmacists would be required to check the medication cabinets after they had been prepared. In some cases they also may have medication preparation duties. During the preparation and delivery procedure, the pharmacists should, at the same time, receive further medication orders and be responsible for updating patients' profiles.

Therefore, the basic preparation and delivery schedule for the proposed drug distribution system at St. Paul's Hospital (assuming standard hospital Q.I.D. administration times of 9.00 a.m. - 1.00 p.m. - 5.00 p.m. - 9.00 p.m.) would be:

<table>
<thead>
<tr>
<th>CABINET EXCHANGE</th>
<th>DELIVERY PERIOD</th>
<th>MEDICATION ADMINISTRATION INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.30 a.m. - 9.00 a.m.</td>
<td>8.30 a.m. - 11.30 a.m.</td>
</tr>
<tr>
<td>2</td>
<td>11.00 a.m. - 11.30 a.m.</td>
<td>11.30 a.m. - 8.30 p.m.</td>
</tr>
<tr>
<td>3</td>
<td>6.30 p.m. - 8.30 p.m.</td>
<td>6.30 p.m. - 9.00 a.m.</td>
</tr>
</tbody>
</table>
FIGURE 5.
UNIT DOSE PREPARATION AND STAFF SCHEDULE FOR DAY SHIFT AT
ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>TECHNICIAN</th>
<th>PHARMACIST</th>
<th>TECHNICIAN</th>
<th>PHARMACIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.00 - 7.30 a.m.</td>
<td>Cart A1</td>
<td>Cart A2</td>
<td>Cart A3</td>
<td>Cart A</td>
</tr>
<tr>
<td>7.30 a.m.</td>
<td>3-1</td>
<td>5-1</td>
<td>5-2</td>
<td>3-4</td>
</tr>
<tr>
<td>7.30 - 8.00</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
<td>Check</td>
</tr>
<tr>
<td>8.00</td>
<td>3-2</td>
<td>5-3</td>
<td>3-3</td>
<td>Carts</td>
</tr>
<tr>
<td>8.30</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
<td>Check</td>
</tr>
<tr>
<td>8.40</td>
<td>Del</td>
<td>Del</td>
<td>Del</td>
<td>Cart</td>
</tr>
<tr>
<td>8.50</td>
<td>Del</td>
<td>Del</td>
<td>Del</td>
<td>Check</td>
</tr>
<tr>
<td>9.00 a.m.</td>
<td>3-4</td>
<td>3-5</td>
<td>5-4</td>
<td>6-1</td>
</tr>
<tr>
<td>9.00 - 9.30 a.m.</td>
<td>UNSCHEDULED TIME</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.30 - 10.00 a.m.</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
</tr>
<tr>
<td>10.00</td>
<td>3-1</td>
<td>5-1</td>
<td>5-2</td>
<td>3-5</td>
</tr>
<tr>
<td>10.30</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
<td>Check</td>
</tr>
<tr>
<td>10.40</td>
<td>Cart</td>
<td>Cart</td>
<td>Cart</td>
<td>Check</td>
</tr>
<tr>
<td>11.00</td>
<td>Del</td>
<td>Del</td>
<td>Del</td>
<td>Cart</td>
</tr>
<tr>
<td>11.10</td>
<td>Del</td>
<td>Del</td>
<td>Del</td>
<td>Cart</td>
</tr>
<tr>
<td>11.20</td>
<td>Del</td>
<td>Del</td>
<td>Del</td>
<td>Check</td>
</tr>
<tr>
<td>11.30 a.m.</td>
<td>3-4</td>
<td>3-5</td>
<td>5-4</td>
<td>6-1</td>
</tr>
<tr>
<td>11.30 - 12.30 p.m.</td>
<td>UNSCHEDULED TIME</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.30 - 1.30 p.m.</td>
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<td>Update Profiles</td>
<td>Prepacking&amp;</td>
<td>Update Profiles</td>
</tr>
<tr>
<td>1.30 - 2.00 p.m.</td>
<td>Cart Maintenance Profiles</td>
<td>Cart Maintenance Profiles</td>
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<tr>
<td>2.00 - 3.00 p.m.</td>
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<td>Update Profiles</td>
<td>Prepacking&amp;</td>
<td>Update Profiles</td>
</tr>
<tr>
<td>3.00 p.m.</td>
<td>Prepacking&amp;</td>
<td>Update Profiles</td>
<td>Prepacking&amp;</td>
<td>Update Profiles</td>
</tr>
</tbody>
</table>

a "Cart", "Check", and "Del" refer, respectively, to the filling of unit dose medication carts by technicians, checking of these carts by a pharmacist and delivery of the cart to the nursing units. The number, e.g., 3-1, refers to the cart assigned to nursing unit "1" on the 3rd floor.

b Unscheduled time refers to meal breaks, coffee breaks, etc.
FIGURE 6.
UNIT DOSE PREPARATION AND STAFF SCHEDULE FOR AFTERNOON SHIFT AT ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>TECHNICIAN</th>
<th>PHARMACIST</th>
<th>TECHNICIAN</th>
<th>PHARMACIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00 - 3.30 p.m.</td>
<td>Cart 3-1</td>
<td>Cart 5-1</td>
<td>Receive Orders 2-1</td>
<td>Receive Orders</td>
</tr>
<tr>
<td>3.30 - 4.00 p.m.</td>
<td>Cart 3-2</td>
<td>Cart 5-2</td>
<td>Check Cart 2-2</td>
<td>Cart 2-4</td>
</tr>
<tr>
<td>4.00 - 4.30 p.m.</td>
<td>Cart 3-3</td>
<td>Cart 5-3</td>
<td>Carts 2-3</td>
<td>Carts</td>
</tr>
<tr>
<td>4.30 - 5.00 p.m.</td>
<td>Cart 3-4</td>
<td>Cart 5-4</td>
<td>Check Cart 4-1</td>
<td>Check Carts</td>
</tr>
<tr>
<td>5.00 - 5.30 p.m.</td>
<td><strong>UN SCHEDULED TIME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.30 - 6.00 p.m.</td>
<td>Cart 3-5</td>
<td>Cart 5-5</td>
<td>Check Cart 4-2</td>
<td>Check Carts</td>
</tr>
<tr>
<td>6.00 - 6.30 p.m.</td>
<td>Cart 6-1</td>
<td>Cart 6-2</td>
<td>Carts 4-3</td>
<td>Carts</td>
</tr>
<tr>
<td>6.30 - 6.40 p.m.</td>
<td>Del 3-1</td>
<td>Del 5-1</td>
<td>Check Del 2-1 2-2</td>
<td>Check Carts</td>
</tr>
<tr>
<td>6.40 - 6.50 p.m.</td>
<td>Del 3-2</td>
<td>Del 5-2</td>
<td>Update Del 2-3</td>
<td>Carts</td>
</tr>
<tr>
<td>6.50 - 7.00 p.m.</td>
<td>Del 3-3</td>
<td>Del 5-3</td>
<td>Update Del 4-1</td>
<td>Cart 4-4</td>
</tr>
<tr>
<td>7.00 - 8.00 p.m.</td>
<td><strong>UN SCHEDULED TIME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00 - 8.10 p.m.</td>
<td>Del 3-4</td>
<td>Del 5-4</td>
<td>Check Del 4-2</td>
<td></td>
</tr>
<tr>
<td>8.10 - 8.20 p.m.</td>
<td>Del 3-5</td>
<td>Del 5-5</td>
<td>Update Del 4-3</td>
<td>Update Profiles</td>
</tr>
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<td>Profiles Del 4-4</td>
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</tr>
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<td>Update Profiles</td>
<td>Prepacking</td>
<td>Update Profiles</td>
</tr>
</tbody>
</table>

"Cart", "Check" and "Del" refer, respectively, to the filling of unit dose medication carts by technicians, checking of these carts by a pharmacist and delivery of the cart to the nursing units. The number, e.g., 3-1, refers to the cart assigned to nursing unit "1" on the 3rd floor.

Unscheduled time refers to meal breaks, coffee breaks, etc.
That is, medication cabinets would be prepared and delivered to the nursing units according to a staggered schedule. The medications in one cabinet would be administered during the interval from the time the cart reached the nursing unit until the next cabinet was exchanged.

(e) Staffing Functions

In summary, the job responsibilities for the personnel involved in the proposed centralized unit dose distribution system at St. Paul's Hospital should be:

**Drug Distribution Pharmacist**
- receives and sorts copies of physicians' orders;
- interprets all orders and enters medication orders into scheduled and non-scheduled areas of patient's "Medication Profile Worksheet";
- scans all medication orders according to criteria for further drug surveillance and notifies patient-care area pharmacist if necessary;
- supervises technicians in prepackaging and in the preparation of unit dose cabinets;
- assists in the preparation of unit dose cabinets;
- checks unit dose cabinets before delivery;
- responsible for extemporaneous compounding and "stat" medications;
- assists in the education programs that are conducted within the pharmacy department.

**Drug Distribution Technician**
- prepares unit dose cabinets;
- transports and exchanges unit dose cabinets and carts on the nursing units;
- carries physicians' orders from the nursing units to the pharmacy;
- responsible for unit dose prepackaging, restocking shelves and cart maintenance.

(f) Comparative Personnel Requirements.

An important consideration in this proposed unit dose distribution system is the comparison of present and future pharmacy and nursing staff requirements. An equitable "trade-off" should occur when the number of anticipated additional pharmacy personnel are compared to potential benefits in decreased nursing time requirements in medication-related activities. A summary of the savings in nursing time from several hospitals after the implementation of unit dose distribution systems is given in Table VIII. The Table also contains the approximate potential nursing time saving if these values are extrapolated to the St. Paul's Hospital capacity of 575 beds. Although this Table contains data from a range of hospitals operating different unit dose systems, it gives an indication of the possible nursing time which may be freed at St. Paul's Hospital as a result of the proposed system. If the total time saved (86.1 hours/day) were expressed in terms of personnel, approximately 10.8 nursing staff (based on eight-hour shifts per person) would be released as a result of decreased medication activities at St. Paul's Hospital.

The discussion of the proposed unit dose distribution system identifies that specific pharmacy personnel would be required for distribution duties only. A summary of the present and proposed staff requirements and hours of service for St. Paul's Hospital is given in Table IX.
### TABLE VIII.

NURSING TIME SAVING OF VARIOUS HOSPITALS AFTER IMPLEMENTATION OF UNIT DOSE AND EXTRAPOLATION TO 575 BEDS.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Unit dose service</th>
<th>Nursing time saved (hrs/day)</th>
<th>Extrapolation to 575 beds.</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Iowa</td>
<td>132 beds</td>
<td>14.5</td>
<td>63.2</td>
<td>Lit 70</td>
</tr>
<tr>
<td>St. Joseph's Hospital</td>
<td>80 beds</td>
<td>5.5</td>
<td>39.5</td>
<td>Lit 115</td>
</tr>
<tr>
<td>Kettering Memorial Hospital</td>
<td>400 beds</td>
<td>35.4</td>
<td>50.8</td>
<td>Lit 44</td>
</tr>
<tr>
<td>Buffalo General Hospital</td>
<td>46-49 patients</td>
<td>4.3</td>
<td>52.1</td>
<td>Lit 30</td>
</tr>
<tr>
<td>Sunnybrook Hospital</td>
<td>22 beds</td>
<td>7.6</td>
<td>198.5</td>
<td>Lit 74</td>
</tr>
<tr>
<td>Temple University Hospital</td>
<td>44-53 patients</td>
<td>9.5a</td>
<td>112.6</td>
<td>Lit 40</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td><strong>86.1 hr/day</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total Personnel</strong></td>
<td></td>
<td></td>
<td><strong>10.8 persons</strong></td>
<td></td>
</tr>
</tbody>
</table>

---

**a** Average time saving in medication activities from nurses, medication nurses, medical students, aides, orderlies, and physicians.

**b** Assuming eight hour shifts per person.
### TABLE IX.

**SUMMARY OF COMPARATIVE PERSONNEL REQUIREMENTS**

**FOR PHARMACY DRUG DISTRIBUTION AT ST. PAUL'S HOSPITAL**

<table>
<thead>
<tr>
<th></th>
<th>PRESENT</th>
<th>PROPOSED b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacists</td>
<td>5</td>
<td>5.6</td>
</tr>
<tr>
<td>Technicians</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.2</td>
</tr>
<tr>
<td>Net Reduction in Nursing Personnel (est.)</td>
<td>--</td>
<td>10.8&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Daily Hours of Service</td>
<td>9.5(or 9)hr</td>
<td>16 hr.</td>
</tr>
</tbody>
</table>

---

a Includes one aide for ward stock, one aide for manufacturing and restocking and one clerical personnel.

b Proposed personnel requirements discussed under unit dose staffing (p. 75) were based on daily needs. To provide weekend coverage these figures have been multiplied by 1.4

c See Table VIII p. 83.
It can be seen from this Table that about a 68 percent increase in hours of active coverage is proposed. To meet this added service an additional 8.8 pharmacy personnel (pharmacists and technicians) would be required. Although this represents a large increase over the current staff, it must be viewed within the context that a potential reduction of 10.8 nursing positions may result with the implementation of the centralized unit dose distribution system. An equitable "trade-off" it appears, may result.

An important feature of these projected services at St. Paul's Hospital with reference to staffing is the proposed provincial Drug and Poison Information Center. In this proposal, hospital pharmacy residency candidates (graduate pharmacists) would provide additional "on-call" service to the information center during evening and night hours(104). It is, therefore, anticipated that this service also would provide back-up "on-call" service for drug distribution, intravenous admixture and drug information systems within the hospital. The net result of this residency involvement would be to assist the pharmacy department in providing twenty-four hours per day, seven days a week service to St. Paul's Hospital.

E. Intravenous (I.V.) Admixture Service

Intravenous Admixture Systems Analysis

Several approaches have been used to implement successful I.V. admixture programs. A basic consideration in the development of
this service is the associated medication distribution system. The centralized and combination unit dose hospitals listed in Table V all provide a central I.V. admixture preparation service. An analysis of these systems as follows indicates the relationship to drug distribution systems and the different approaches which might be used. At the Ohio State University Hospitals, intravenous solutions and admixtures are ordered by nursing personnel using a copy of the physicians' original order(110). Admixture labels are generated by computer and a twelve hour supply of solutions is delivered from the central admixture area to the nursing unit(116). At the University of Michigan Hospital I.V. admixtures are prepared in the central pharmacy upon the receipt of a personal prescription(117). At the University of Florida teaching hospital, the central pharmacy provides intravenous admixture and hyperalimentation solutions on an 8½ hour per day basis(118). In contrast, the experimental decentralized unit dose systems described at the University of Iowa Hospitals(70) and the Johns Hopkins Hospital(27) provide intravenous admixture solutions from the pharmacy substations. In the total hospital unit dose system at the Buffalo General Hospital intravenous admixtures are prepared and dispensed from the six decentralized satellites(30). To provide this service, six bench model laminar air flow hoods were required at a total cost of $3000. The essential feature of these programs is that the nature of the intravenous admixture service is pre-determined by the medication distribution system.

More detailed information specifically related to the
development of an intravenous additive preparation service has been described by Holysko and Ravin (81) and Ravin (119) at the 522-bed St. Joseph Mercy Hospital, Ann Arbor, Michigan, and by Wenger and Kabat (79) at the 1014-bed Minneapolis Veterans Hospital. In these programs, intravenous additive solutions are prepared and dispensed from the central pharmacy upon the receipt of a copy of the physician's order or by a telephone order from the nurse. These services are provided on a ten to twenty-four hour per day basis by the pharmacists. Complete intravenous additive preparation and administration programs have been described by Wuest (83, 86, 120) at the 300-bed St. Francis Hospital, Cincinnati, Ohio, and by Pulliam and Upton (84) at the 427-bed Moses H. Cone Memorial Hospital, Greensboro, North Carolina. In these cases, I.V. therapy nurses under the supervision of the pharmacy departments prepare and administer all I.V. solutions with additives and hyperalimentation fluids. The I.V. therapy team is also responsible for taking blood samples from patients for cross-matching and the administration of blood and blood products. In addition, they may be required to attend cardiac emergencies to do venipunctures and to prepare medications (84). A summary of staff coverage and workload of several hospitals with an intravenous admixture service is given in Table X. The Table indicates that there may be variations in pharmacy service to the admixture program, I.V. therapy nursing teams involved, and differing I.V. admixture workloads.

The types of programs described by Wuest (120) and Pulliam and Upton (84) would appear to be best suited to a proposed St. Paul's
# TABLE X.

**WORKLOAD AND STAFF COVERAGE OF FIVE HOSPITALS WITH PHARMACY INTRAVENOUS ADMIXTURE SERVICE.**

<table>
<thead>
<tr>
<th>HOSPITAL</th>
<th>HOSPITAL BEDS</th>
<th>WORKLOAD OR TOTAL BEDS SERVED</th>
<th>24 HOUR STAFF COVERAGE</th>
<th>24 HOUR STAFF COVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>PHARMACISTS</td>
<td>I.V. THERAPY NURSES</td>
</tr>
<tr>
<td>St. Francis Hospital (Cincinnati, Ohio)</td>
<td>300</td>
<td>300 beds</td>
<td>4&lt;sup&gt;a&lt;/sup&gt; (16 hours/day)</td>
<td>11</td>
</tr>
<tr>
<td>Johns Hopkins Hospital (Baltimore, Md.)</td>
<td>1250</td>
<td>386 beds</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>St. Joseph Mercy Hospital, (Ann Arbor, Mich.)</td>
<td>522</td>
<td>111 admixtures per day</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Moses H. Cone Memorial Hospital (Greensboro, N.C.)</td>
<td>427</td>
<td>42.9 admixtures per day</td>
<td>5&lt;sup&gt;c&lt;/sup&gt; (15 hours/day)</td>
<td>6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Minneapolis Veterans Hospital (Minneapolis Minn.)</td>
<td>1014</td>
<td>85 beds</td>
<td>2.5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup> Represents total number of department pharmacists. Does not include three interns.

<sup>b</sup> Two pharmacists on day shift and one pharmacist thereafter.

<sup>c</sup> Four pharmacists on day shift and one pharmacist during evening. Represents total staff pharmacists.

<sup>d</sup> Includes one part-time nurse.

<sup>e</sup> Projection for total hospital service (preparation only) for 13 hours per day.
Hospital admixture service because they are integrated with the centralized medication distribution system with respect to communication of the physician's order. They are also very comprehensive in that they include a wide range of intravenous therapy procedures. Perhaps a more important feature closely related to the present I.V. service at St. Paul's Hospital is that an additive service of this type permits the pharmacy to exercise control over the preparation of these solutions and, at the same time, utilizes the resources, personnel and experience of the nursing staff on the I.V. therapy team. A summary of the present and proposed I.V. admixture services at St. Paul's Hospital is given in Table XI.

Proposed I.V. Admixture Service

(a) Basic System

A centralized intravenous therapy service such as that described by Wuest(83,88,120) or Pulliam and Upton(84) under the direct supervision of the pharmacy department of St. Paul's Hospital is proposed. The pharmacy should receive, prepare, distribute all new I.V. orders, new and refill I.V. solutions with additives and hyperalimentation fluids. This service would also be responsible for reconstituting parenteral medications and preparing certain unit dose injectable products. The I.V. therapy nursing staff would be on-call for restarting I.V. solutions, checking on problems such as infiltration, taking blood samples for cross-matching, and the administration of blood and blood products. An I.V. therapy nurse also should attend hospital emergency cases to do venopunctures
**TABLE XI.**
SUMMARY OF PRESENT AND PROPOSED INTRAVENOUS ADMIXTURE SYSTEMS AT
ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>SERVICE VARIABLE</th>
<th>PRESENT</th>
<th>PROPOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>Separate I.V. therapy service to perform venopunctures and prepare hyperalimentation solutions.</td>
<td>Pharmacy supervised I.V. solution, admixture, and hyperalimentation preparation in I.V. preparation area. All admixtures to be administered by I.V. therapy nurse.</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td>Initiation of order into system by floor nurse using physician's order form and/or request for I.V. therapy nurse. I.V. therapy nurses perform most I.V. starts and re-starts, prepare and administer hyperalimentation solutions. Floor nurses reconstitute parenterals and prepare admixtures.</td>
<td>Initiation of order into system by pharmacy technician or nurse using direct copy of physician's order. All I.V. therapy orders recorded by pharmacist. All I.V. admixture solutions prepared by I.V. therapy nurse. Pharmacy technician: does mass reconstitution.</td>
</tr>
<tr>
<td><strong>Hours of Service</strong></td>
<td>24 hours per day, seven days per week.</td>
<td>Pharmacy supervision 7.00 a.m.-11.00 p.m. I.V. admixture preparation and administration 24 hours per day. On-call pharmacy resident available 11.00 p.m.-7.00 a.m. seven days per week.</td>
</tr>
</tbody>
</table>
and prepare intravenous admixtures.

The intravenous admixture service should provide twenty-four hours per day coverage. However, the pharmacy staff for this program would be scheduled on a two shift per day basis similar to the proposed unit dose system. Pharmacists could supervise and assist in the preparation of intravenous admixtures during the day and afternoon periods. The intravenous therapy nurses would prepare and administer I.V. solutions over the entire twenty-four hour period. Ravin has reported that at one 522-bed hospital approximately one-third of admixture orders are required between 9.00 a.m. and 11.00 a.m. (119) and 80 percent of solutions ordered are requested between 8.00 a.m. and 5.00 p.m. (85). Pharmacy supervision should therefore be scheduled according to the workload at these periods during the day.

In the proposed system, the term "I.V. Pharmacist" will be used to define the pharmacist who would supervise the preparation of intravenous admixtures. The "I.V. Technician" would be a supportive person responsible for the transportation of standard intravenous solutions to the nursing units, mass reconstitution of injectable medications and maintaining inventories in the I.V. preparation area. The term "I.V. Therapy Nurse" will be used to define a registered nurse responsible for the preparation and administration of intravenous solutions.

(b) Facilities and Budget Considerations

A primary objective of an intravenous admixture service is
to provide for the centralized preparation of intravenous solutions with additives in a controlled environment. Therefore, specialized equipment and facilities would be required to provide a "clean air" setting. Expenditures for equipment and materials, as previously discussed in the unit dose system, will vary depending on the manufacturer and model selected. However, based on the survey by Ravin(121) the following items with their approximate costs are considered essential for this proposed service at St. Paul's Hospital:

- laminar air flow hoods $1500-2000 each
- small refrigerator (1-2 cu. ft.) $100-200
- reconstituting apparatus, syringes, valves, tubing $50
- high intensity lamp $50
- pH meter $200
- work counters, desks $300-600

The number and sizes of the laminar air flow hoods required are normally dependent upon the volume of admixture solutions to be prepared during any given period of time. Ravin(119) has determined theoretically that two four foot air flow hoods should be able to handle approximately 110 admixtures prepared per day at one 522-bed hospital. Using this data, two console model laminar flow hoods and one bench top model are projected to be required at St. Paul's Hospital. The smaller unit would be used for "stat" orders and reconstituting injectable medications. Although not essential, a separate room is highly desirable for an intravenous admixture preparation area. A clean air environment can be more easily maintained when this equipment is segregated from the
noise, traffic and atmosphere of the main pharmacy area. In addition, air conditioning may be required if the laminar flow units are confined to a small room where the heat cannot be dissipated over a sufficiently large area (121).

(c) Distribution Procedure

Initiation of the Physician's Order — A flow chart of the proposed intravenous admixture service is given in Figure 7. The ordering, interpretation and monitoring of intravenous solution orders should be integrated with the proposed centralized unit dose system. The direct copy of the physician's order (Appendix I) would be used to initiate all orders into the medication cycle. This copy could be transported to the central pharmacy by a nursing unit messenger or a pharmacy technician during the unit dose medication deliveries. The drug distribution pharmacist who receives the order would be responsible for interpreting the order or clarification, if necessary, with the physician (Appendix III). The order would then be entered in the patient's "Medication Profile Worksheet" (Appendix IV) and the patient's therapy scanned by the pharmacist according to the criteria established for further drug surveillance (p.104). The drug distribution pharmacist would then prepare an "I.V. Therapy Order Card" such as that used at the Moses H. Cone Memorial Hospital (Appendix VIII) listing the following:

- patient name
- nursing unit
- room
- type and size of I.V. solution
FIGURE 7.
PROPOSED I.V. THERAPY ADMIXTURE SERVICE AT
ST. PAUL'S HOSPITAL

"DRUG INFORMATION
COMMUNICATION FORM"
COMPLETED IF
NECESSARY

"PHARMACY DRUG
SURVEILLANCE RECORD"
INITIATED OR UPDATED

MEDICAL CHART

IF ORDER REQUIRES
CLARIFICATION--
TELEPHONE CONTACT
MADE BY PHARMACIST

NOTIFICATION AND
INFORMATION FROM PROFILE
GIVEN TO PHARMACIST
RESPONSIBLE FOR DRUG
SURVEILLANCE ON
PATIENT'S UNIT

PHYSICIAN

PHYSICIAN'S ORDER FOR:
-MEDICATION
-TREATMENT
-LABORATORY

DIRECT COPY OF PHYSICIAN'S
ORDER CARRIED FROM NURSING
UNIT TO PHARMACY

ORDER RECEIVED IN CENTRAL
PHARMACY UNIT DOSE
PREPARATION AREA BY
PHARMACIST

PHARMACIST INTERPRETS ORDER
AND ENTERS ORDER INFORMATION
IN PATIENT "MEDICATION
PROFILE WORKSHEET"

"MEDICATION MEMORANDUM"
COMPLETED AND ATTACHED
TO "I.V. THERAPY ORDER
CARD"

MEDICATION ORDERS INITIALLY
SCANNED BY DRUG DISTRIBUTION
PHARMACIST ACCORDING TO
CRITERIA FOR FURTHER
DRUG SURVEILLANCE

DRUG DISTRIBUTION
PHARMACIST PREPARES "I.V.
THERAPY ORDER CARD"

"I.V. THERAPY ORDER CARD"
RECEIVED BY PHARMACIST OR
I.V. THERAPY NURSE IN I.V.
PREPARATION AREA

IF STABILITY OR
COMPATIBILITY
PROBLEM

I.V. ADDITIVE ORDER
CHECKED FOR STABILITY AND
COMPATIBILITIES AND LABEL
TIRED

I.V. ADMIXTURE ORDER PREPARED
BY PHARMACIST OR I.V. THERAPY
NURSE

FINAL CHECK OF ADMIXTURE
SOLUTION MADE BY I.V. PHARMACIST

I.V. THERAPY NURSE CHECKS
PHYSICIAN'S ORIGINAL
ORDER

SOLUTION ADMINISTERED TO
PATIENT BY I.V.
THERAPY NURSE

SOLUTION CHARTED IN INTAKE-OUTPUT
FORM AND/or "MEDICATION
ADMINISTRATION
RECORD"

FLOOR NURSE
MONITORS FLOW RATE
AND NOTIFIES I.V.
PREPARATION AREA
IF PROBLEMS
DEVELOP

I.V. THERAPY NURSE TAKES
I.V. ADMIXTURE SOLUTION
TO NURSING UNIT
- additives, amounts
- time required (flow rate)
- prepared by, checked by.

Admixture Preparation and Administration -- The order card would be sent to the I.V. preparation area where it would be received by an I.V. therapy nurse or pharmacist. If no additives are required, an I.V. therapy nurse would proceed to the nursing unit to start a standard solution. If additives are needed, the I.V. pharmacist should review the order for potential stability or compatibility problems and type the required labels. An I.V. therapy nurse would assemble the additives, prepare the solution and attach the label to the bottle. The I.V. pharmacist should then make a final check of the preparation with reference to calculations, labeling, solution clarity and dating and release the admixture to the I.V. therapy nurse. If successive solutions are required then the order card would be filed on a twenty-four hour scheduling rack for when the next solutions would be needed.

The I.V. therapy nurse would take the admixture solution to the nursing unit, check the physician's original order and administer the solution to the patient. The solution should then be charted in the patient's "Medication Administration Record" (Appendix II) and/or intake-output form. The floor nursing staff should be responsible for monitoring the flow rate and notifying the I.V. preparation area if problems develop. After a twenty-four hour period, new physicians' orders should be required for all continuing intravenous therapy solutions. If two or more solutions are to be alternated, then these admixtures could be prepared and delivered about two hours before they are needed by the patient.
Similarly to the proposed unit dose system, a floor nurse may telephone "stat" I.V. therapy orders to the drug distribution pharmacist. However, the direct copy of the physician's order should be received in the pharmacy before the solution is released. As with regular I.V. orders the pharmacist would enter the information in the patient's "Medication Profile Worksheet" and complete the "I.V. Therapy Order Card". In the I.V. preparation area, a label would be typed and the admixture prepared, checked and released to an I.V. therapy nurse to administer to the patient.

(d) Staffing

The personnel required to staff the proposed pharmacy supervised intravenous admixture and administration service at St. Paul's Hospital will be dependent upon the anticipated workload. It has been shown that the workload for this type of service may vary depending on two factors. One, the amount of continuous versus intermittent I.V. therapy used in the hospital(122) and two, the relative proportion of surgical and medical patients in the hospital(79). Intermittent I.V. therapy at St. Paul's Hospital is via I.V. "push" or through the use of a volumetric I.V. administration set (e.g. Volu-TroleR). Surgical and intensive care beds represent approximately 26 percent of the total bed capacity (excluding bassinets). Wenger and Kabat(79) found that medical patients received 0.134 infusions per patient day, while surgical patients averaged 0.423 infusions per patient day on two nursing units in a 1014-bed hospital. Using these figures, approximately 110 infusions would be
administered daily at St. Paul's Hospital. Ravin(119) has found that about 111 admixtures per day were required for patients in a 522-bed hospital. Approximately 122 admixtures would, probably, be prepared at St. Paul's Hospital using this data. An estimation of 110 to 120 admixture infusions per day at St. Paul's Hospital is considered reasonably accurate(123).

Further, Sherrin and coworkers(124) determined theoretically a processing time of 21.1 man-hours per day for 112 new and refill admixture orders in a private community hospital. Actual processing time was 20 man-hours per day which required 3.5 persons for the preparation of intravenous admixture solutions. Using the staff requirements of the hospitals operating I.V. preparation and administration teams given in Table X and extending the bed capacity and workload to that of St. Paul's Hospital this proposed service might be staffed according to the following plan:

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>DAY</th>
<th>EVENING</th>
<th>NIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.V. Therapy Nurses</td>
<td>7</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>I.V. Pharmacist*</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I.V. Technician</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

This schedule would provide twenty-four hour total hospital coverage for the preparation and administration of admixture solutions and related I.V. therapy duties with pharmacy supervision and assistance during the major preparation periods.

* Although "on-call" night coverage by a pharmacy resident is anticipated. See p. 85.
(e) Staffing Functions

In summary, the job responsibilities for the personnel involved in the proposed centralized intravenous admixture and administration service at St. Paul's Hospital should be:

**Drug Distribution Pharmacist** (previously referred to on p. 81)
- receives copy of the physician's orders;
- interprets orders and enters information in patient's "Medication Profile Worksheet";
- scans medication and I.V. therapy orders according to criteria for further drug surveillance and, if necessary, notifies patient-care area pharmacist;
- prepares "I.V. Therapy Order Card".

**I.V. Pharmacist**
- supervises the I.V. preparation area;
- receives the "I.V. Therapy Order Cards";
- checks admixture orders for compatibility and stability problems and, if necessary, notifies patient-care area pharmacist;
- prepares admixture labels;
- assists in the preparation of I.V. admixture and hyperalimentation solutions;
- supervises and assists in the preparation of parenteral unit dose medications;
- assists in the education programs that are conducted within the pharmacy department.

**I.V. Therapy Nurse**
- receives "I.V. Therapy Order Cards";
- prepares, distributes and administers all I.V. admixture and hyperalimentation solutions;
- checks admixture orders for compatibility and stability problems;
- takes blood specimens for cross-match and administers blood and blood products;
- checks on problems such as infiltration and inflammation at the infusion site;
- attends hospital emergency calls.
I.V. Technician
- does mass reconstitution of parenteral medications;
- maintains inventory of solutions and additives in the I.V. preparation area;
- distributes I.V. solutions on ward stock to the nursing units.

(f) Comparative Personnel Requirements

As with the proposed unit dose distribution system, an important consideration in this admixture service will be the present and future pharmacy, I.V. therapy and nursing staff requirements. A summary of the savings in nursing time in several hospitals after the implementation of a centralized I.V. preparation service is given in Table XII. The Table also contains the approximate potential nursing time saving if these values are extended to the St. Paul's Hospital capacity of 575 beds and estimated workload of 120 admixtures. Similarly to the projection of savings in nursing time with the unit dose system, this Table contains hospitals whose data and work measurement may have been calculated by differing criteria. However, it gives an indication of the possible nursing time and personnel (approximately 9.2 persons) which may be freed at St. Paul's Hospital as a result of an intravenous admixture preparation service.

This proposed admixture service projects specific pharmacy and I.V. therapy personnel who would be required to staff this program. A summary of the present and proposed personnel and hours of service for the admixture preparation and administration service at St. Paul's Hospital is given in Table XIII. The Table shows that the projected reduction in
TABLE XII.
NURSING TIME SAVING OF THREE HOSPITALS AFTER
IMPLEMENTATION OF AN I.V. ADMIXTURE PREPARATION SERVICE AND
EXTENSION TO ST. PAUL'S HOSPITAL'S CHARACTERISTICS

<table>
<thead>
<tr>
<th>HOSPITAL</th>
<th>WORKLOAD</th>
<th>NURSING TIME SAVED</th>
<th>EXTENDED TO ST. PAUL'S HOSPITAL</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Joseph Mercy Hospital</td>
<td>26,290 admixtures&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4000 man-hours</td>
<td>2.3 persons&lt;sup&gt;c&lt;/sup&gt;</td>
<td>85</td>
</tr>
<tr>
<td>Minneapolis Veterans' Hospital</td>
<td>22 admixtures per day</td>
<td>3 full-time positions</td>
<td>16.4 persons&lt;sup&gt;d&lt;/sup&gt;</td>
<td>79</td>
</tr>
<tr>
<td>St. Francis Hospital</td>
<td>300 beds</td>
<td>4.7 persons&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.0 persons</td>
<td>86</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>9.2 persons</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Reference indicates 47,800 bottles of solutions were administered over a two-year period. Of these, 55% of the solutions required the aseptic addition of drugs.

<sup>b</sup> Nursing personnel preparation and administration of I.V. solutions.

<sup>c</sup> Calculated to 18.3 hours based on St. Paul's Hospital workload of 120 admixtures. Assume eight hour shifts per person.

<sup>d</sup> Based on approximate St. Paul's Hospital workload of 120 admixtures.
### TABLE XIII.

**SUMMARY OF THE COMPARATIVE PERSONNEL REQUIREMENTS FOR THE I.V. ADMIXTURE SERVICE AT ST. PAUL'S HOSPITAL**

<table>
<thead>
<tr>
<th>Service</th>
<th>Present</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacists</td>
<td>-</td>
<td>2.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>I.V. Therapy Nurses</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Technician</td>
<td>-</td>
<td>1.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Net reduction in flooring</td>
<td>-</td>
<td>9.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>nursing personnel (est.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily hours of service</td>
<td>24 hr.</td>
<td>24 hr.</td>
</tr>
</tbody>
</table>

<sup>a</sup> Includes the I.V. therapy supervisor.

<sup>b</sup> Proposed personnel requirements discussed under I.V. admixture staffing (p.97) were based on daily needs. To provide weekend coverage these figures have been multiplied by 1.4.

<sup>c</sup> See Table XII p. 100.
floor nursing personnel (9.2 persons) due to elimination of admixture preparation duties almost offsets the proposed increase in I.V. therapy nursing personnel (9.8 persons). For pharmacy personnel this would be a new service. Therefore, present and future staff levels are difficult to compare. However, it is anticipated that the 3.2 pharmacy personnel (pharmacists and technicians) that would be required could be equally balanced with the expected economic savings in drug usage and patient safety which would accrue from increased pharmacy supervision.

F. Drug Surveillance Program

Drug Surveillance Systems Analysis

A drug surveillance or monitoring program is an attempt to control the utilization of medication according to concepts of current therapy. This service is ideally achieved when integrated with the drug distribution system. The development of the "combination" and decentralized unit dose systems are specifically designed to meet this objective. Again, an analysis of existing systems presents the alternative approaches which might be taken. At the University of Michigan Medical Center the drug order audit and medication profile record are necessary components of the comprehensive "Medication Chronicle System". The patient unit pharmacist is required to compare new drug orders against the patient's drug history taken upon admission, concurrent medications, laboratory tests and diet and review the cost and rationale for this therapy. In addition, the pharmacist compiles drug experience information which is a periodical review of drug therapy and clinical status. The patient unit pharmacist in
this system, however, still retains distribution duties since he initiates the communication of physicians' orders and acts as a drug supply source.

Bell and coworkers(97) have described an efficient method of delivering drug information through a pharmacy consultation program at a 580-bed hospital. The basis of this drug usage surveillance program is firstly, provision of information concerning a particular patient's drug therapy and secondly, provision of information whether or not it is requested. In this program a drug history is taken by a pharmacist from the patient upon admission and the patient is followed during hospitalization using a "Drug Information Communication Sheet", a "Drug Summary Form", and a "Laboratory Data Summary Form". During this experimental service, five pharmacists were involved in monitoring medical and surgical patients(125). The only criteria for surveillance of a patient was admission to a nursing unit by one of three physicians whose patients were being served by the pharmacy program. The evaluation of the results of this service showed that, "in general, physicians read, accepted and utilized the information provided by pharmacists"(126).

It is felt, however, that consideration should be given to the establishment of more strict criteria for patient monitoring when developing a drug usage surveillance program. The routine evaluation of therapy and laboratory test results in patients with uncomplicated medical or surgical cases yields to the inefficient use of pharmacy personnel. Indeed, the results of the study by Bell and coworkers(126) showed that only about one-quarter of the patients included in the program benefited from the pharmacists' communications. Patients who received more drugs, underwent a variety of
laboratory tests and required longer periods of hospitalization benefited to a greater degree from this information. The establishment of specific, yet flexible, criteria by the pharmacy department and the Pharmacy and Therapeutics Committee with reference to number of drugs, cost of therapy, classes of drugs and unusual incidents should permit an efficient drug usage surveillance program to be provided to the total hospital patient population.

Proposed Drug Surveillance Program

The primary objective of the proposed surveillance service would be to provide for the immediate and continuing drug therapy needs of the patients of St. Paul's Hospital. A summary of the present and proposed drug surveillance services in St. Paul's Hospital is given in Table XIV. As discussed previously, preliminary scanning of drug therapy for all patients should be a function of the centralized drug distribution system. The relationship of the proposed surveillance program to the unit dose distribution system and the I.V. admixture service is shown in Figures 4 and 7. This program would initiate upon receipt of the direct copy of the physicians' orders in the pharmacy. The drug distribution pharmacist would interpret the orders and enter this information on the patient's "Medication Profile Worksheet" (Appendix IV). This pharmacist should then review the complete drug therapy of the patient with reference to the criteria established for more intensive monitoring. Further surveillance may be warranted on the following grounds:

1. Large number of drugs being administered;
2. Cost of drug therapy;
3. The use of expensive antibiotics;
4. The use of drugs in which serious frequent adverse
### TABLE XIV.

**SUMMARY OF PRESENT AND PROPOSED DRUG SURVEILLANCE PROGRAMS AT ST. PAUL'S HOSPITAL**

<table>
<thead>
<tr>
<th>Service Variable</th>
<th>Present</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>No formal drug surveillance program established. Drug profile available to pharmacists on physician's order form.</td>
<td>Formal drug surveillance program with all medication orders reviewed with reference to criteria established for further drug monitoring.</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td>Pharmacist reviews medication orders in course of normal dispensing procedure.</td>
<td>Initial surveillance of all medication and I.V. orders according to established criteria. Further continuing monitoring by patient-care area pharmacist if necessary.</td>
</tr>
<tr>
<td><strong>Hours of service</strong></td>
<td>Regular pharmacy dispensing hours. 8.00 a.m. - 5.30 p.m. (Mon-Fri.) 8.00 a.m. - 5.00 p.m. (Sat-Sun.)</td>
<td>Surveillance service scheduled from 7.00 a.m. - 11.00 p.m. On-call pharmacy resident available 11.00 p.m. - 7.00 a.m. seven days per week.</td>
</tr>
</tbody>
</table>
reactions are known to occur;
5. The administration of unusual doses of a drug;
6. Unusual drug therapy for a particular diagnosis;
7. Upon the report of an adverse drug reaction;
8. The use of chemotherapy in cancer;
9. Patients requiring parenteral hyperalimentation;
10. An indication of possible decreased kidney or liver function (from the medical chart).

Patient-care area pharmacists would be notified by the drug distribution pharmacist of the specific patient and would have the responsibility of continuing the monitoring on the nursing unit. A "Pharmacy Drug Surveillance Form" such as the "Pharmaceutical Service Record (Appendix IX) in use at the Memorial Hospital of Long Beach is recommended as a tool to consolidate information for the pharmacist from the patient's medical chart. Using this document the patient-care pharmacist should be able to monitor information such as drug selection, diagnosis, surgical procedures, laboratory tests and progress. If a specific problem or potential problem is identified then the pharmacist would present this information to the physician verbally or by a "Drug Information Communication Form" such as the "Pharmacy Sheet" (Appendix X) currently available at St. Paul's Hospital. This type of form permits the physician to reply to the pharmacist's comments. This discussion of the proposed drug surveillance program is brief since the full extent of the service would depend on factors such as the criteria (p.104) selected for drug monitoring and the experience and effectiveness of the pharmacists in the patient-care areas.

In addition to the drug usage surveillance service, two associated programs are proposed to be provided at St. Paul's Hospital by
the patient-care area pharmacists. Firstly, a formal adverse drug reaction reporting system should be established. These pharmacists would be responsible for investigating and reporting the circumstances of a suspected adverse drug reaction upon notification by medical or nursing personnel. The drug therapy of patients receiving more intensive surveillance also should be closely evaluated for potential drug reactions. Appropriate statistics should be maintained of actual drug reaction cases. Secondly, it is recommended that drug histories be taken of selected patients upon admission to the hospital. For example, it may be of value to know a history of previous drug usage in patients who will be receiving anesthetics in the hospital. Therefore, if surgical patients were selected, it is estimated that an average of ten or eleven interviews would have to be conducted per day for patients being admitted to one of the major surgical nursing units in St. Paul's Hospital (i.e., 3M, 3E, 3NN, 5S).

(a) Staffing and Facilities

The staff required for the duties in the patient-care areas will likely depend on the strictness of the criteria established for drug surveillance. It was projected by Bohl and coworkers(24) that one pharmacist could be assigned 100 to 125 patients in the distribution and information system at the University of Michigan Medical Center. In the pharmacy consultation program described by Bell and coworkers(125) between 130 and 150 patients were actively monitored at any given time by the five pharmacists. However, as previously indicated, these patients represented...
the inpatient admissions of several physicians. No other criteria were established for surveillance(125). Since only about one-quarter of the patients monitored benefited from the pharmacist's information(126), it is estimated that four pharmacists could provide drug usage surveillance and information at St. Paul's Hospital if more rigid criteria were established. That is, fewer pharmacists would be required if they were utilized efficiently in surveillance of patients whose drug therapy indicated that potential problems may arise. This staff projection has also considered the comparable capacities of the 580-bed Mercy Hospital, Pittsburgh, and the 575-bed St. Paul's Hospital. Each of these four pharmacists could be assigned one of the four main patient-care floors in the hospital to handle the drug information requests of the nursing units on that floor. Further, it is recommended that two of the four patient-care pharmacists be scheduled on the day shift and the other two scheduled on the afternoon and evening shift to extend this surveillance and information service over a greater period of time.

It is not anticipated that this program for the hospital will require substantial expenditures for equipment or facilities. Items such as filing cabinets, shelves and a desk are highly desirable. In addition, the information needs of this service require basic reference texts and journals covering biopharmaceutics, pharmacology, clinical and hospital pharmacy, and therapeutics. With reference to the information sources of the pharmacy department it is anticipated that they will be augmented by the proposed provincial Drug and Poison Information Center(104) at St. Paul's Hospital.
(b) Staffing Functions

The job responsibilities, in summary, for a patient-care pharmacist involved in the proposed decentralized drug surveillance program at St. Paul's Hospital would be:

- to receive notification from the drug distribution pharmacist of patients requiring further drug monitoring;
- to receive notification from the I.V. pharmacist of orders which may have compatibility or stability problems;
- to review the medical charts of the patient and abstract the required data in a "Pharmacy Drug Surveillance Record";
- to survey appropriate reference sources to obtain required information to assist in making recommendations on the drug therapy of the patient and, if necessary, complete a "Drug Information Communication Form" and place it in the medical chart;
- to investigate and maintain records of adverse drug reaction cases;
- to conduct admission drug histories on selected patients;
- to receive and handle drug information requests from the medical and nursing personnel;
- to assist in the education programs that are conducted in the pharmacy department.

(c) Comparative Staff Requirements

It is difficult to analyze the present and future personnel needs in this area because this would be, essentially, a new service. The required 5.6* pharmacists would be additions to the present staff. However, the proposed contribution by the hospital pharmacy residency candidates in "on-call" evening and weekend information service(104) may

* Daily requirement of four pharmacists multiplied by 1.4 for weekend coverage.
potentially reduce the number of additional pharmacists who have been projected. Furthermore, the cost of this staff should be evaluated in terms of the economic benefits which are expected from decreased medication errors, reduction in time spent by nursing personnel for their drug information needs, reduced expenditures due to irrational or inappropriate drug selection and increased patient safety from greater participation by pharmacy personnel in the patient-care environment.

G. Phasing

A feasible phasing plan for the proposed unit dose distribution, intravenous admixture preparation and drug surveillance services at St. Paul's Hospital is difficult to project since many interrelated factors have to be considered. The discussion of these services has indicated some procedures whose implementation relies on the success of the development of related procedures. In a few cases, however, the program may be implemented independent of other services. This phasing plan will not suggest a time schedule for modifications in services, procedures and priorities of the present pharmacy department at St. Paul's Hospital which have been briefly mentioned in the Results and Discussion. These include areas such as: developing a complete drug formulary for the hospital; restricting ward stock selection and quantities to the nursing units; provision for automatic replacement by the pharmacy of these ward stocks; modifications to narcotic and controlled drug distribution; present services to the out-patient department, discharged patients and hospital staff; and greater participation by supportive
personnel in the dispensing process. It is felt that consideration should be given to these policies and procedures before the implementation of the proposed services is attempted.

It is important to note that this projected phasing schedule does not preclude the need for complete discussions, support and approval of the medical staff, nursing personnel, Pharmacy and Therapeutics Committee and any other group who may be directly involved with these proposed pharmacy services at St. Paul's Hospital. A basic plan which could be followed for the phasing operation of each service is:

1. Specification of the service to be provided;
2. A trial study of the service on one or two nursing units;
3. Gradual extension of the service throughout the total hospital;
4. An increase in the hours of coverage from a one shift to a two shift basis for this service.

This phasing plan presupposes that the required equipment and facilities for the specific service would be available at the time they would be required. The projected staff levels should be gradually attained in a manner commensurate with the pharmacy service workload and hours of coverage.

Drug Distribution

Several stages probably would be necessary during the implementation of the proposed centralized unit dose system. Initially, an extensive prepackaging operation should be instituted to speed present dispensing procedures. Since the pharmacy currently receives a direct
copy of the physicians' orders, the development of complete patient profiles should be attempted. High accuracy must be obtained in these records before the unit dose system can be commenced. Secondly, through these profiles it may then be possible to supervise a "stop order" policy with the responsibility for "Notice of Automatic Stop Order" being given to the pharmacy rather than delegated to nursing personnel. The patient profiles also would permit the pharmacy to project the date when the department could automatically replace depleted stocks of dispensed medications without nursing refill requisitions. A stage in which medications are dispensed in increasingly restricted quantities should be attempted before the actual unit dose system is implemented. For example, rather than the present six day supply, medications could be dispensed in three or four day quantities which may subsequently be followed by one or two day supplies. This procedure could give the pharmacy department an indication of workload that could be expected in a centralized unit dose distribution system. The final phase would then be the actual distribution of prescribed medications in single unit packages utilizing the three per day medication cabinet exchange procedure.

Intravenous Admixture Preparation

Since an intravenous therapy nursing team is presently established at St. Paul's Hospital, this service should not be too difficult to implement. The pharmacy department, initially, should attempt to maintain accurate intravenous fluid therapy profiles using the direct copy of the physicians' orders. Secondly, the present I.V. therapy team
should gradually assume responsibility for the preparation of all admixture solutions administered in the hospital using the current ordering procedure. In this stage, the pharmacy department should become more actively involved in the preparation of these pharmaceuticals. Finally, the centralized intravenous admixture service could be implemented using the direct copy of the physicians' orders for the preparation of the "I.V. Therapy Order Cards". In addition, this service would be responsible for the preparation and reconstitution of injectable unit dose medications when the unit dose distribution system is implemented.

Drug Surveillance Program

The drug usage surveillance program should be able to be implemented reasonably independent of the other proposed services. Again, the patient drug profiles which have been previously described would be used to initiate the program. As indicated in the basic plan for phasing (p. l11) the profiles should be maintained, firstly, on patients of one or two nursing units. This would allow the pharmacy department to develop competence and accuracy in these records. Concurrently, specific criteria for more intensive monitoring of drug therapy should be established. As this program develops, these criteria may be broadened to permit drug usage surveillance of a greater number of patients. Finally, the two additional services -- patient drug history interviews and the adverse drug reaction reporting program -- could be initiated. Actually, since they are not dependent on any other services they could be implemented at any time along this phasing schedule.
Suggested Schedule

For the purposes of illustration, a two-year phasing schedule will be projected. Therefore, a summary of a possible phasing plan indicating the interrelationships in the development of the proposed centralized unit dose distribution, intravenous admixture preparation and drug surveillance systems at St. Paul's Hospital is given in Figure 8.
FIGURE 8.

POTENTIAL PHASING SCHEDULE FOR THE PROPOSED PHARMACY SERVICES AT ST. PAUL'S HOSPITAL

<table>
<thead>
<tr>
<th>PROPOSED SERVICE</th>
<th>IMPLEMENTATION</th>
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<tbody>
<tr>
<td></td>
<td>YEAR 1</td>
</tr>
<tr>
<td></td>
<td>Prepackaging Operation</td>
</tr>
<tr>
<td></td>
<td>Patient Drug Profiles</td>
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<tr>
<td></td>
<td>Supervision of Stop Order Policy</td>
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<tr>
<td></td>
<td>Dispensing of Restricted Quantities</td>
</tr>
<tr>
<td></td>
<td>Intravenous Fluid Therapy Patient Profiles</td>
</tr>
<tr>
<td>UNIT DOSE DISTRIBUTION SYSTEM</td>
<td></td>
</tr>
<tr>
<td>INTRAVENOUS ADMIXTURE PREPARATION</td>
<td>I.V. Therapy Team to Prepare all Admixtures</td>
</tr>
<tr>
<td>SERVICE</td>
<td>Pharmacy Supervision of Admixture Preparation</td>
</tr>
<tr>
<td></td>
<td>Patient Drug Profiles</td>
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<tr>
<td></td>
<td>Surveillance criteria</td>
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<tr>
<td></td>
<td>Drug Usage Monitoring in Patient-care Areas</td>
</tr>
<tr>
<td></td>
<td>Adverse Drug Reaction Reporting Program</td>
</tr>
<tr>
<td>DRUG SURVEILLANCE PROGRAM</td>
<td></td>
</tr>
</tbody>
</table>
SUMMARY

The traditional or conventional method of drug distribution within hospitals has been identified as a system over which the pharmacist has very little control. The characteristics of this system which have resulted from the pharmacist's minimal input to drug distribution and drug use control include: the frequent occurrence of medication errors; the large amount of time required by nursing personnel to perform medication-related activities; substantial drug inventories lost through "shrinkage"; the preparation of intravenous admixtures in areas not conducive to aseptic compounding; the occurrence of predictable adverse drug reactions; and the hazards and high cost of inappropriate drug selection. These limitations, singly and in combination, have been demonstrated to be responsible for greatly increasing health care costs as a result of prolonging patient stay in hospitals.

The features of the unit dose distribution system make it possible for the pharmacy department to exercise a greater controlling influence over the use of medications in hospitals and, consequently, reduce the above problems. This system, integrated with progressive hospital trends such as a pharmacy-supervised intravenous admixture preparation service and an active drug use surveillance program also has been shown to assist the pharmacy department in contributing to an improvement in patient care related to drug therapy.

The present study showed that the existing drug distribution system at St. Paul's Hospital possesses some of the identified deficiencies. However, utilizing information obtained from the literature, several proposed modifications to the present pharmacy services could be implemented to closely approximate the above progressive trends. The proposed services that have been recommended at St. Paul's Hospital are:
1. A centralized unit dose distribution system. In this system, most medications would be prepared by pharmacy technicians under the supervision of a pharmacist. Medications would be delivered to nursing units on a three cabinet exchange per day basis;

2. A centralized intravenous admixture preparation and administration service. This service would utilize the present I.V. therapy team at St. Paul's Hospital to prepare and administer all I.V. admixtures ordered in the hospital. The pharmacy department would have supervisory responsibilities;

3. A drug usage surveillance program. This service, integrated with the unit dose distribution system, would utilize patient drug profiles to identify potential drug-related problems. Criteria would be established to indicate patients who may require more detailed drug monitoring by pharmacists in the patient-care areas.

The information obtained from literature sources also projected the anticipated equipment and facilities necessary for the proposed services. In addition, this study used available data from other related programs to project future personnel requirements to implement the services.

Approximately a 68 percent increase over present hours of pharmacy coverage is proposed (from 9.5 to 16 hours per day). In addition, new pharmacy involvement also over extended hours of coverage in intravenous admixture preparation and drug usage surveillance is projected. The effect of the above new and extended services on the number of pharmacy and nursing personnel is summarized in Table XV. The table illustrates several features. Firstly, very little increase in the number of pharmacists is projected to staff the unit dose distribution system. The larger staff in this area would be primarily due to supportive personnel (technicians). Secondly, when a comparison is made between the existing drug distribution system extrapolated to 16 hours per day and the proposed unit dose system a very small difference in personnel is estimated. This indicates that
### TABLE XV.
**SUMMARY OF PROJECTED COMPARATIVE PERSONNEL REQUIREMENTS AS A RESULT OF PROPOSED PHARMACY SERVICES AT ST. PAUL'S HOSPITAL.**

#### A. UNIT DOSE DRUG DISTRIBUTION

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>PRESENT SYSTEM (19.5 HOURS OF SERVICE PER DAY)</th>
<th>PROPOSED SYSTEM (16 HOURS OF COVERAGE PER DAY)</th>
<th>DIFFERENCE</th>
<th>DIFFERENCE IN TOTAL PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHARMACISTS</td>
<td>5 (10)a</td>
<td>5.6</td>
<td>+ 0.6</td>
<td>- 10.8b</td>
</tr>
<tr>
<td>TECHNICIANS</td>
<td>3 (6)a</td>
<td>11.2</td>
<td>+ 8.2</td>
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</tr>
<tr>
<td>SUBTOTAL</td>
<td>8 (16)a</td>
<td>16.8</td>
<td>+ 8.8</td>
<td></td>
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</tbody>
</table>

#### B. I.V. ADMIXTURE PREPARATION SERVICE

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>PRESENT SYSTEM (24 HOURS OF SERVICE PER DAY)</th>
<th>PROPOSED 24 HOUR SYSTEM (16 HOURS OF PHARMACY COVERAGE PER DAY)</th>
<th>DIFFERENCE</th>
<th>DIFFERENCE IN TOTAL PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHARMACISTS</td>
<td>0</td>
<td>2.8</td>
<td>+ 2.8</td>
<td>- 9.2c</td>
</tr>
<tr>
<td>TECHNICIANS</td>
<td>0</td>
<td>1.4</td>
<td>+ 1.4</td>
<td></td>
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<tr>
<td>I.V. THERAPY NURSES</td>
<td>7</td>
<td>16.8</td>
<td>+ 9.8</td>
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<tr>
<td>SUBTOTAL</td>
<td>7</td>
<td>21.0</td>
<td>+ 14.0</td>
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</tr>
</tbody>
</table>

#### C. DRUG SURVEILLANCE PROGRAM

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>PRESENT SYSTEM (16 HOURS OF COVERAGE PER DAY)</th>
<th>PROPOSED SYSTEM (16 HOURS OF COVERAGE PER DAY)</th>
<th>DIFFERENCE</th>
<th>DIFFERENCE IN TOTAL PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHARMACISTS</td>
<td>0</td>
<td>5.6</td>
<td>+ 5.6</td>
<td></td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td>0</td>
<td>5.6</td>
<td>+ 5.6</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>15</td>
<td>43.4</td>
<td>28.4</td>
<td>- 20.0</td>
</tr>
</tbody>
</table>

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* a Present system projected to 16 hour coverage considering present full staff pattern of one shift as 8 hours.
* b From Table VIII, p. 83.
* c From Table XII, p. 100.
the additional personnel required for the proposed system would probably be due to extended hours of service and not specifically to the unit dose system itself. Thirdly, although the projected personnel requirements for the I.V. admixture preparation service and the drug surveillance program appear substantial they must be considered as new or modified services for the pharmacists and I.V. therapy nurses. Therefore, it is difficult to make accurate comparisons in these areas between existing and proposed programs. In addition, the pharmacy department would assume responsibility for delivering all drug items thus relieving this duty from the hospital messenger and transportation services. In summary, the 28.4 personnel difference between existing and proposed pharmacy staffs would be due to a combination of increased hours of service and greater pharmacy responsibilities.

This study has estimated that a potential reduction of about twenty floor nursing personnel may be possible as a result of increased pharmacy responsibilities. It should be recognized that this figure is for illustrative and comparative purposes only. This quantity has been projected from time results of other studies and does not necessarily indicate that a total of twenty individual nursing positions will be released or freed. Many people previously involved in the drug distribution cycle such as registered nurses, student nurses, practical nurses, nurse aides, physicians and medical students will spend less time in medication-related activities when the pharmacy assumes more responsibility in this area. However, considering this reduction in floor nursing personnel as individual positions, a total net increase of only 8.4 persons or approximately 55 percent over present staffing levels are projected to be required at St. Paul's Hospital.

It becomes apparent that the cost of the hospital drug distribution system should not be viewed solely as the cost of the pharmacy component. This
study has indicated that an equitable "trade-off" could occur when the number of anticipated additional pharmacy personnel are compared to the expected benefit in decreased nursing time required in medication-related activities. The potential economic savings from decreased inventory loss and increased patient safety as a result of greater participation by pharmacy personnel in the patient care environment further support the conclusion that these proposed hospital pharmacy services would have a significant positive impact at St. Paul's Hospital.
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111. "The Unit Dose System at The University of Kentucky Medical Center", unpublished information.


116. The Ohio State University Hospitals, Department of Pharmacy, "Admixture Service Policy", 1968.

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118. Shands Teaching Hospital and Clinics, University of Florida, information received on author's questionnaire, Feb. 27, 1973.


123. Murphy, C., Director of I.V. Therapy Service, St. Paul's Hospital, personal communication, 1973.


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### UNIVERSITY HOSPITAL
UNIVERSITY OF KENTUCKY MEDICAL CENTER
Lexington, Kentucky

#### MEDICATION RECORD

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- **Known Allergies:**

- **Today Only:**

---

**STAFF:**

- **Medication:**

| 9 am | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------|----|----|----|---|---|---|---|---|---|---|---|---|---|
|      |    |    |    |   |   |   |   |   |   |   |   |   |   |
MEDICATION MEMORANDUM — ST. PAUL'S HOSPITAL

Ph. #3  PHARMACY DEPARTMENT - ST. PAUL'S HOSPITAL

MEDICATION MEMORANDUM

TO: Ward ___________________  Date ___________________  Time ____________

RE: ______________________  Hospital No. ______________________

PLEASE NOTE: ___________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

Reason for change: Doctor's Request ______________________________________

Clarification Only _______________________________________________________

Action to be taken by the Ward:

Attach to chart as reminder to Doctor _______________________________________

Change Chart, Kardex and Medication Card _________________________________

(This form may be attached to chart for future reference) ___________________  Pharmacist
### APPENDIX IV(a)

**MEDICATION RECORD—UNIVERSITY OF WISCONSIN**

<table>
<thead>
<tr>
<th>ALLERGIES</th>
<th>DIAGNOSIS OR SURGICAL PROCEDURE</th>
<th>WEIGHT</th>
<th>AGE</th>
<th>UNIVERSITY OF WISCONSIN HOSPITALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARGE</td>
<td>START DATE</td>
<td>STOP DATE</td>
<td>TIME</td>
<td>MEDICATION</td>
</tr>
<tr>
<td></td>
<td>DATE</td>
<td>DATE</td>
<td>DATE</td>
<td>DATE</td>
</tr>
</tbody>
</table>

**SCHEDULED MEDICATIONS**

- Date
- Charge
- Start Date
- Stop Date
- Time
- Medication
- Dose
- R

**UNSW-513**

- Room
- Name
- Service
## MEDICATION RECORD—UNIVERSITY OF WISCONSIN

**UNIVERSITY OF WISCONSIN HOSPITALS**

### NON-SCHEDULED MEDICATIONS

<table>
<thead>
<tr>
<th>CHG.</th>
<th>PH</th>
<th>RN</th>
<th>TIME</th>
<th>DATE</th>
<th>NON-RECURRING MEDICATIONS</th>
<th>CHG.</th>
<th>START</th>
<th>STOP</th>
<th>PRN MEDICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

**PHARMACY DEPT. USE ONLY**

<table>
<thead>
<tr>
<th>PHARMACY DEPT. USE ONLY</th>
<th>DATE</th>
<th>DATE</th>
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</table>
# APPENDIX V.

DRUGS NOT GIVEN NOTICE -- UNIVERSITY OF KENTUCKY MEDICAL CENTER

<table>
<thead>
<tr>
<th>DRUGS NOT GIVEN NOTICE</th>
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<tbody>
<tr>
<td>Patient's name</td>
</tr>
<tr>
<td>Room Number</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

- Refused
- NPO
- Discontinued
- Discharged
- Drug Not Ordered
- Incorrect Dosage
- Expired
- Patient Not Available

O.R. O.T. P.T. X-Ray

Drug(s): ______________________
 ______________________
 ______________________
 ______________________
 ______________________

Comments: ______________________
 ______________________
 ______________________

Nurse's Signature

N-34
APPENDIX VI.
NOTICE OF AUTOMATIC STOP ORDER — UNIVERSITY OF KENTUCKY MEDICAL CENTER

<table>
<thead>
<tr>
<th>NOTICE OF AUTOMATIC STOP ORDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>As of midnight</td>
</tr>
<tr>
<td>the following drug(s) will be discontinued automatically unless a new order is written.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient's Name</th>
<th>Room No.</th>
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</thead>
<tbody>
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</tbody>
</table>

Name Date

UH Form PCS14
THE MOSES H. CONE MEMORIAL HOSPITAL
I.V. ORDER CARD

PHARMACY DEPARTMENT
I.V. NO. 1 TIME NEEDED

TYPE
AND SIZE I.V.

ADDITIVES (1)

(2)

(3)

(4)

PREPARED BY: CHECKED BY:

I.V. NO. 2 TIME NEEDED

TYPE
AND SIZE I.V.

ADDITIVES (1)

(2)

(3)

(4)

PREPARED BY: CHECKED BY:

I.V. NO. 3 TIME NEEDED

TYPE
AND SIZE I.V.

ADDITIVES (1)

(2)

(3)

(4)

PREPARED BY: CHECKED BY:

PRESCRIBED BY:

SIGNED BY: DATE

COMMENTS: (Circle Desired Comments)

NEED I.V. NURSE STAT q.6hrs. q.12hrs. OTHERS:

ADD ON SOLUTION q.4hrs. q.8hrs. q.24hrs.

Phar $1
Ph. #1

PHARMACY SHEET
(Not a Permanent Record)

This communication is provided as information only and may or may not be clinically significant. In many cases the physician will already be aware of this information and its implications. In particular, the problems and interpretation of drug interactions are complex and must be viewed in perspective. The term "interaction" is not necessarily synonymous with "incompatibility" or "contraindication". For further clarification, see the reverse side.

Where information has been useful, or if a physician wishes to comment please note this in the space provided.

| Pharmacist | Physician's Comments or Assessment, if any |

Please see reverse side