THE DEVELOPMENT OF A PARENTERAL ADMIXTURE PROGRAM IN A PEDIATRIC HOSPITAL

by

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ABSTRACT

This endeavor describes the development of a parenteral admixture program in a 175-bed pediatric acute care hospital. It begins with a description of the advantage to the hospital of a parenteral admixture program as compared to conventional floor stock systems. Some examples of other admixture programs are cited along with specific characteristics of programs that could be applicable to any hospital. An outline is presented of the basic steps found in all programs.

A detailed description is given illustrating how the program was actually developed in this hospital. This description includes items such as:

1) how space for the additive center was procured;
2) how a prediction of the workload was arrived at;
3) how the equipment for the center was procured; and
4) how the pilot study was set up.

This is followed by a protocol for the admixture program.

A discussion of data obtained during the development of this program includes:

1) how the I.V. useage rate of each unit was obtained;
2) how the amount of capital loss due to the floor stock I.V. system was determined;

3) the amount of capital and the square feet of storage space tied up by the floor stock systems;

4) the amount of time saved in the hospital by the additive system; and

5) an evaluation of how many personnel in the hospital were required per 100 I.V. solutions used before and after the additive system.

The last chapter discusses the effectiveness of the admixture program based on previously established parameters. Some of the conclusions reached are as follows:

1) The program did save the hospital money through more efficient use of time and equipment.

   a) Capital tied up in floor stock was greatly reduced.

   b) The program reduced the number of man-hours required to operate the I.V. therapy function in the hospital. This freed the nurses more from medication problems and gave them more time for bedside patient care.

   c) Checks were made to insure accuracy and also more care was taken in following established hospital policies regarding parenteral therapy as a result of the program.

   d) Solutions and medications were all labeled properly and uniformly.

I

INTRODUCTION

The trend in hospital pharmacy today has seemed to be to attempt to increase the responsibilities of the pharmacist so that he might reach a point where his long academic training would somewhat equal his responsibilities on the job. The hospital pharmacist today has not been satisfied with the pharmacist's traditional duties and he has set out to become a more clinically involved member of the health team. Some new innovations that have come about in the last decade or so are radiopharmacy, unit dose, clinical pharmacy, and parenteral admixture programs centralized in the pharmacy. A parenteral admixture program is the primary concern of this endeavor.

The first question encountered when a superior was confronted regarding the establishment of a new program was, "Why do you believe such a program to be a valuable asset to the hospital system?" The advantages of such an additive program have been reported by authors such as Brown,[1] Gallelli,[2] Latiolas,[3] Moravec,[4] Ragland,[5] Ravin,[6] Schwartz,[7] Skolaut,[8] and others.

Some of the basic advantages pointed out were:

1. The pharmacy provided a better working environment for preparation of parenteral solutions. The additive

center provided a low traffic area and its staff could work with no interruptions. The nursing station typically provided a high traffic area with the nurse frequently being interrupted while preparing parenteral solutions.

2. The pharmacist, and not the nurse, was trained specifically in such areas as chemistry and drug incompatibility. It always has been the pharmacist's role to prepare and dispense medications. The role of the nurse has been to provide patient care.

3. The additive system has reduced floor stock inventory to a minimum. Therefore the hospital would not have such a large amount of capital investment in parenteral solutions. Also the floor space necessary for storage of the solutions would be reduced.

The literature available clearly indicated that this function should normally be carried out by the pharmacy staff.

There were several examples of parenteral admixture programs in the literature. These ranged widely in complexity and expense. All programs followed basically the same steps in filling an order and most had the same basic equipment.

One such system was that by St. Lukes Medical Center in Phoenix, Arizona.[9] From the following steps one could easily see that their procedure was quite complex and required a good deal of paper work.

1. A direct copy of the physician's order was received

and checked for compatibility and correctness.

2. The order was transferred onto an I.V. transcription record form. This was a preprinted form allowing the pharmacist to merely check off the parameters involved in the order. Items such as type of solution, volume needed, and flow rate were checked. Many other items such as time of administration were usually found on such forms as well.

A disadvantage of this type of form was that it didn't lend itself to a total patient medication profile system since each solution usually had to occupy a separate form. If a profile was maintained a second transcription had to be made onto the profile.

3. A name tag containing the patient's name and room number was then placed on a manilla folder. The I.V. transcription record was placed in the folder with a copy of the physician's order.

4. A four-part I.V. communication tag was prepared for each parenteral admixture needed for the next 24-hour period. These tags were then placed in the patient's folder.

5. An NCR two-part profile card was then prepared for that patient's therapy and this was placed in the patient's folder.

To this point four different types of paperwork had been handled and no order had been filled as yet.

6. If there was a piggyback order a drug and dosage schedule had to be prepared.

7. Upon sending the first I.V. solution to the floor

the four-part form filled out in step number 4 was utilized.

A. The white copy was placed back in the patient's folder.

B. The yellow copy was retained and later counted for daily record purposes.

C. The blue and gold copies which served as labels were placed on the container being sent to the floor.

8. The NCR portion of the profile card was sent to the floor to be placed in the patient's chart.

9. When the first bottle was administered the blue copy of the four-part form was returned to the pharmacy with the following information.

A. When the infusion was started

B. Date

C. Administered by

D. Hour

E. Flow rate

The gold copy remained on the bottle as a label.

10. Information on the blue tag was transcribed onto the patient's profile form when the blue tag was returned to the pharmacy. This served as their charge record for the patient.

11. Another four-part form was completed based on the information received from the blue copy of the previous four-part form. This was utilized for the next solution by placing this form in a time slot. The correct time was

calculated from the information received on the previous blue tag.

This was a fine procedure but it could have been very cumbersome to follow when rushed. If one person failed to send the proper form at the proper time all was lost. Also the procedure would have been very complicated for a new employee to learn.

Another procedure was followed by Ohio State University Hospital.[10] This procedure was one that many institutions would find expensive since special forms were used and the computer was utilized for billing and label typing.

Some innovations used by Ohio State were as follows:

1. The physician's order form was divided into two sections, the left side of the sheet was for routine orders and instructions and the right side was for medication orders. The medication section was divided into blocks of three lines each. The physician was instructed to write one order in each block.

2. The pharmacy received a direct copy of this order. The copy was a pregummed label that could be placed directly onto a patient's medication profile. This eliminated time and possible error in transcription.

One more interesting idea was reported by Klotz.[11] His hospital pharmacy utilized a report sheet filled out by the nursing unit just prior to report at 7 a.m. each morning. This sheet contained the following information: nursing station, date, time, patient's name, type of solu-

tion and additives, flow rate, and amount of fluid remaining in the bottle at that time. This gave the pharmacy an up-to-date report each day on the solutions that were being utilized at that time. This could be checked against the profile in the pharmacy to note discrepancies such as wrong flow rate, etc.

Other procedural type descriptions were available in the literature such as those reported by Ravin,[12,13] Kenna,[14] Paoline[15] and others.[16,17] However, the basic procedures drawn from these programs seemed to indicate the following basic steps in carrying out a parenteral admixture procedure:

1. A form had to be devised to provide the pharmacy with an original copy of the physician's order.

2. Steps had to be taken to insure that the order would be rapidly transported to the pharmacy and that the solution would be rapidly delivered to the nursing unit.

3. A system of storing the orders in an organized manner had to be developed in the pharmacy. This would have to facilitate easy retrieval both by the patient's name or by the time the order was due on the nursing unit.

4. A complete medication profile had to be developed so that a patient's total parenteral therapy and drug therapy could be reviewed in a short time.

5. Equipment had to be purchased to insure a sterile area for the extemporaneous preparation of parenteral solutions and other sterile products.

6. An area had to be designed to house the needed equipment to carry out the program.

7. The pharmacy had to design an adequate billing system to insure than no charges would be lost.

8. Drug compatibility and stability information would have to be collected.

The purpose of this endeavor was to establish a parenteral admixture program in a 175-bed pediatric acute care hospital.

1. The design had to be such that it would operate homogeneously with the unit dose and clinical pharmacy programs already in operation.

2. The system had to include a drug compatibility information file.

3. It had to include a complete patient medication profile.

4. It had to supply all intravenous solutions and all medications added to those solutions whether added to the primary solution or added intermittently.

5. This system had to promote better patient care through solving many problems inherent in the floor stock system of handling parenteral products available at that time.

6. It had to save the hospital money through more efficient use of time and equipment.

As mentioned above, the present system of supplying parenteral solutions to the nursing units was a conventional

floor stock system. The pharmacy merely replaced the solutions at each nursing station on a daily basis as they were used.

This floor stock system had been unable to alleviate several problems that potentially were solvable by an additive system centralized in the pharmacy.

1. All solutions administered by the nurse were not necessarily double checked before they were administered to the patient. It was definitely possible for a nurse to give a solution other than the one ordered by the physician. An additive program would, therefore, provide a double check before the solution left the pharmacy, a third check by the nurse, and a fourth check by our clinical pharmacist at least every 24 hours.

2. Solutions were sometimes not administered at the rate prescribed by the physician. These situations would immediately be noticed under an additive program and corrected if a second solution was needed sooner than the prescribed time or if too much solution remained when the second solution arrived for administration. This would promote closer attention to this problem by the hospital staff.

3. The nursing personnel were not changing administration sets every 24 hours according to hospital policy. The additive system would insure that this would be done by affixing the required sets to the first bottle received by each patient each day.

4. Many intermittent medications, especially antibiotics, presented problems of incompatibility and stability that the nursing staff could not be expected to understand. By utilizing an additive program the pharmacy would become the center of such information.

5. The hospital policy dictated that any child under four years of age was not to receive a solution for I.V. administration larger than 250 cc. in volume. This would easily be controlled by an additive program.

6. Nurses would have more time for actual patient care if the task of I.V. preparation was removed from their realm of responsibility.

7. The central intravenous additive program would remove large volumes of floor stock solutions which take up valuable storage space on the nursing units.

8. It would decrease the amount of lost charges found to exist in the present floor stock system of distribution.

9. It would decrease the financial commitment to inventory through the removal of excess floor stocks.

10. Solutions administered to patients were sometimes improperly labeled or were not labeled at all. The pharmacy would insure that all solutions would be properly and uniformly labeled.

II

PROCEDURE

In order to plan for the establishment of the parenteral program those involved had to be aware of how large the program was going to be when it was completed. It was necessary to know the number of solutions used by each nursing unit on a daily basis. A survey was conducted from November 1, 1972 to December 1, 1972. This was done by recording all floor stock I.V. solutions sent to each nursing unit on a daily basis. The solutions were recorded according to type of solution and volume of solution so that the useage rates of each type of solution could be learned.

From this and a subsequent time study it was found that approximately 4.87 hours per day would be required to staff the program at the useage level that was found to exist. The determination of this data will be discussed in the next chapter.

The program was scheduled to begin with no extra staff and it would continue until the workload necessitated hiring more individuals.

The next problem was that of placement of the physical plant for the additive center. Several areas were considered but it was decided to keep the additive center

within the existing pharmacy area. It was decided that with a small amount of rearrangement there would be ample space for the additive center. The reasons that it was decided to keep the center within the boundaries of the existing pharmacy are as follows:

1. The expense would be less if the additive center was kept in the pharmacy. The hospital would not lose space in any other area to provide for this service.

2. The center would work more homogeneously with other programs in the pharmacy if it was kept in close proximity to those programs.

3. It would be less expensive to staff the additive center if all members of the pharmacy staff worked in the same area.

The additive center was placed in what was part of the pharmacy stock room. This was a clean area and there would be very little traffic to interrupt work in that area.

Since the parenteral solutions were already stocked in the pharmacy they were placed in the additive center. All stock normally occupying that area was moved to other parts of the pharmacy.

Figure 1 is a diagram of the finished additive area in relation to the remainder of the pharmacy.

Before purchasing a laminar flow sterile work area, specifications were drawn that would be suitable for the pharmacy's purposes. The specifications were as follows:

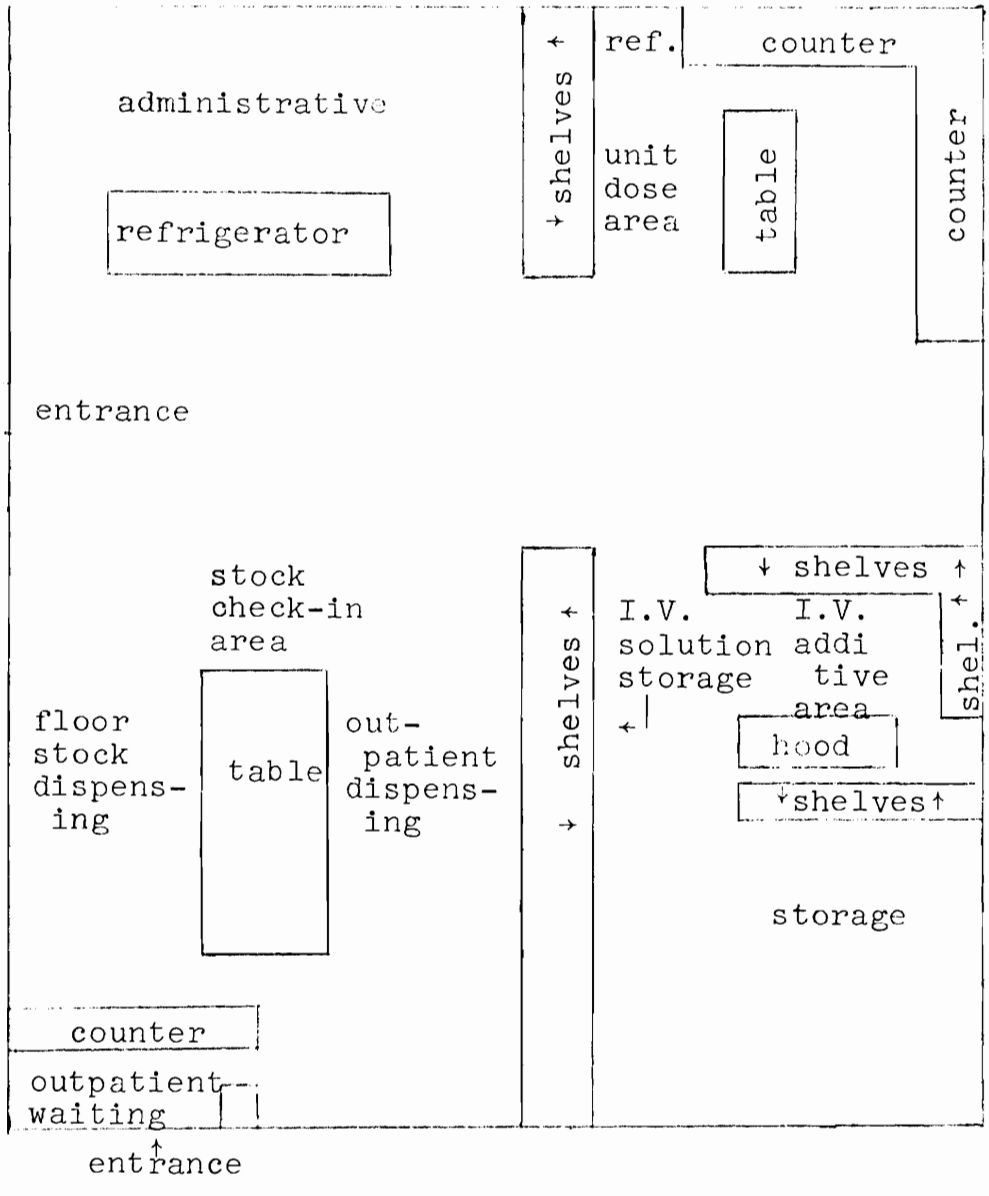

Figure 1. Diagram of Additive Center in Relation to Remainder of Pharmacy Work Areas

Height of work table - - - - - - - - - 30 to 42"

Depth of work table - - - - - - - - - 20 to 24"

Width of work table - - - - - - - - - 60"

Height of work space - - - - - - - - - 35 to 40"

Height of entire unit - - - - - - - - 76"

A horizontal flow unit was chosen for two reasons.

1. Horizontal flow units were less expensive.

2. Vertical flow units required more precise sterile technique since one could not work directly above the object of attention or the laminar air flow past that object would be interrupted.

The laminar flow unit purchased met all the previous specifications set as guidelines.

One nursing unit was decided upon for a pilot study. This unit had the highest useage and the staff seemed the most interested in promoting such a program. While waiting for the laminar flow hood to arrive, a study was done on this unit to determine if the pharmacy staff could accurately project how many solutions a patient would require on a daily basis based on the physician's order. This was done using the procesure designed for the actual pilot study. This procedure is discussed in detail later in this chapter. The procedure was carried out exactly as if the pharmacy was responsible for supplying the I.V. solutions although no solutions were actually sent during this study. A check of the accuracy of these projections was made using the floor stock records of what each patient actually

received.

Doing this study prior to the actual pilot study facilitated perfecting the procedure to a finer degree before it was depended upon to function in actual practice.

Before the arrival of the laminar flow hood it was learned that the hospital planned to open a new semi-intensive care nursing unit. The date set for its opening was very near the date scheduled for the beginning of the pilot study for the parenteral admixture program. Since the staff was hand picked it was decided to do the pilot study on this unit rather than on the unit previously selected.

The pilot study began the same day that the new unit opened. The procedure utilized in carrying out the additive program was as follows:

Parenteral Admixture Procedure Outline

1. The physician has written an order for a parenteral solution.
2. The order was transported to the pharmacy. This was done via messenger service or via nursing staff on the unit.
3. The order was checked for clarity and completeness. It was also checked for any incompatibilities that might exist.
4. The order was transcribed onto the profile sheet (Figure 2). This was kept alphabetically in a file when

1. Patient's Name 2. Patient's Age 3. Nursing Unit

13. Remarks	4. Sets	5. Date	Bottle Number	8. Solution	9. Volume	Time and Flow Rate cc/hr 10.	12. Additives
alternate		6/13	6.n/c	D 5% in Isolyte P	250 cc	50/h runs to 3 pm	none
alternate		6/13	n/c	D 5% 1/2 N.S.	250 cc	50/h finished	KCL 5 meq / 250 cc
		6/13	7. 1	D 5% 1/2 N.S.	250 cc	50/h 11. 3 pm-8 pm	KCL 5 meq / 250 cc
		6/13	2	D 5% in Isolyte P	250 cc	50/h 8 pm-1 am	none
		6/13	3	D 5% 1/2 N.S.	250 cc	50/h 1 am-6 am	KCL 5 meq / 250 cc
		6/14	4	D 5% in Isolyte P	250 cc	50/h 6 am-11 am	none
	2	6/14	5	D 5% 1/2 N.S.	250 cc	50/h 11 am-4 pm	KCL 5 meq / 250 cc

Figure 2. Patient I.V. Profile

Instructions for Patient Profile

(1.) Patient's name. (2.) Patient's age. (3.) Patient's nursing unit. (4.) This column indicated when sets were sent and how many. The number of sets was to be written on the same line as the solution with which the sets were to be utilized. By checking this column other staff members could determine whether sets had been sent for that 24-hour period or not. (5.) This column indicated the date that particular solution was started. (6) N/C meant do not charge for that bottle. This was used when an order was merely written down to indicate the patient had received a bottle from another source such as surgery. It was also used when a physician's order was copied down for future reference. (7.) The numeral in this section indicated that the bottle was sent by the pharmacy and should be charged for. (8.) Indicated the type of solution used. (9.) Indicated the volume of solution used. (10.) Indicated the flow rate prescribed. (11.) Indicated the time span the bottle was to run. (12.) Indicated any additives to the primary bottle. (13.) Clarifying remarks.

not in use.

5. A blue-colored time file card was prepared with the patient's name and nursing unit (Figure 3). This was filed according to the next time a solution was to be prepared. The solutions were prepared and sent to the nursing unit one hour before the solution was to be administered.

   A. Several steps were followed in preparing a solution.

      1). The correct solution was obtained and placed inside the sterile work area in the hood.

      2). All ingredients needed to complete the order were added and a blue-colored metal cap signifying additives was sealed onto the bottle. No blue-capped I.V. solution was to appear on the nursing units or be administered to any patient without a proper pharmacy-prepared label being attached.

      3). A label was properly typed (Figure 4) and affixed upside-down onto the container <u>leaving the manufacturer's solution name visible</u>. It was not possible to have the nurses check the pharmacy's accuracy if they could not read the manufacturer's label. If Dextrose 5% in 0.2% Sodium Chloride was prepared from a different solution such as Dextrose 5% in Sterile Water the amount of sodium chloride added in milliequivalents was noted on the label. This also

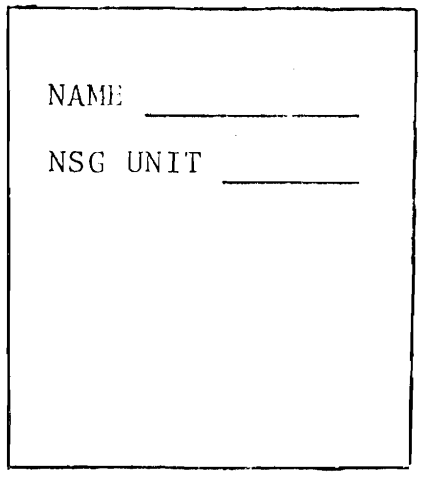

Figure 3. Time File Card

PRIMARY CHILDREN'S HOSPITAL
Salt Lake City, Utah

Name John Doe

Room No. 5 so. Date 7-7-77

Solution Dex. 5% in 0.2% N.S.
250 cc.

Bottle No. _____

Medications KCL 5 meq./250 cc.

(NaCl 8.5 meq. added per 250 cc.
of D 5 W to make D 5 0.2% N.S.)

Run From 10 am To 3 pm

Rate of Flow 50 cc./hr.

Figure 4. I.V. Solution Label

enabled the nursing staff to check the accuracy of the pharmacy (Figure 4).

4). The necessary information was entered on the profile in pencil and the profile was filed alphabetically. The time card was filed according to the time the next solution was needed.

6. An order for a parenteral solution was considered valid until it was changed or discontinued by the physician.

7. All solutions were sent according to age. Any child under four years of age was not to receive a solution containing more than 250 cc. in volume. Children over four years of age could receive up to 500 cc. in any one container.

8. No solution was to be administered for more than 24 hours. At that time it was to be changed whether it was empty or not.

9. Administration sets were sent every 24 hours. The sets were sent with the first solution to be administered during the 7 am to 3:30 pm shift. Specific types of administration sets were provided for each patient. The type of administration set that was sent was dependent upon whether the patient was on gravity drip or on an administration pump. There were also specific sets sent for patients on hyperalimenation solution.

10. When sets or solutions were returned for credit they were lined out with a yellow marker on the profile to indicate they were not to be charged for. Only those

solutions were credited that could be used for other patients. Others were discarded and no credit was given unless it was pharmacy's mistake that it was sent.

11. All persons working in the additive center were to date all containers when they were opened. In the case of reconstituted medications the date, time, and final concentration were entered on the container.
12. The blue-colored additive cap was not to be removed until immediately prior to the use of the solution.
13. Each morning the nurses would fill out an I.V. solution record. This had to be checked each morning in the additive center to keep up-to-date on the actual amount of solution each patient had utilized during the night (Figure 5).
14. The hood was scrubbed each morning and each evening with benzalkonium chloride 1:750. Bacterial growth in the hood was monitored at least monthly by cultures taken by the laboratory.
15. Solutions that were returned unused were periodically checked for sterility by the laboratory. This procedure allowed the staff to check their sterile technique on a regular basis.

Intermittent Additive Procedure

1. The record of intermittently added medications was to be kept on the opposite side of the I.V. solution profile (Figure 6). The medication, strength, route, and signa

To be filled in accurately and sent to the pharmacy at the end of the 7 A.M. nurse's report. This will allow pharmacy to monitor patient I.V.'s for 24 hours. Thank you.

Date: Time:

Nursing Station:

PATIENT NAME	BOTTLE NUMBER	RATE/HOUR	AMT. LEFT

Figure 5. Pharmacy I.V. Solution Record

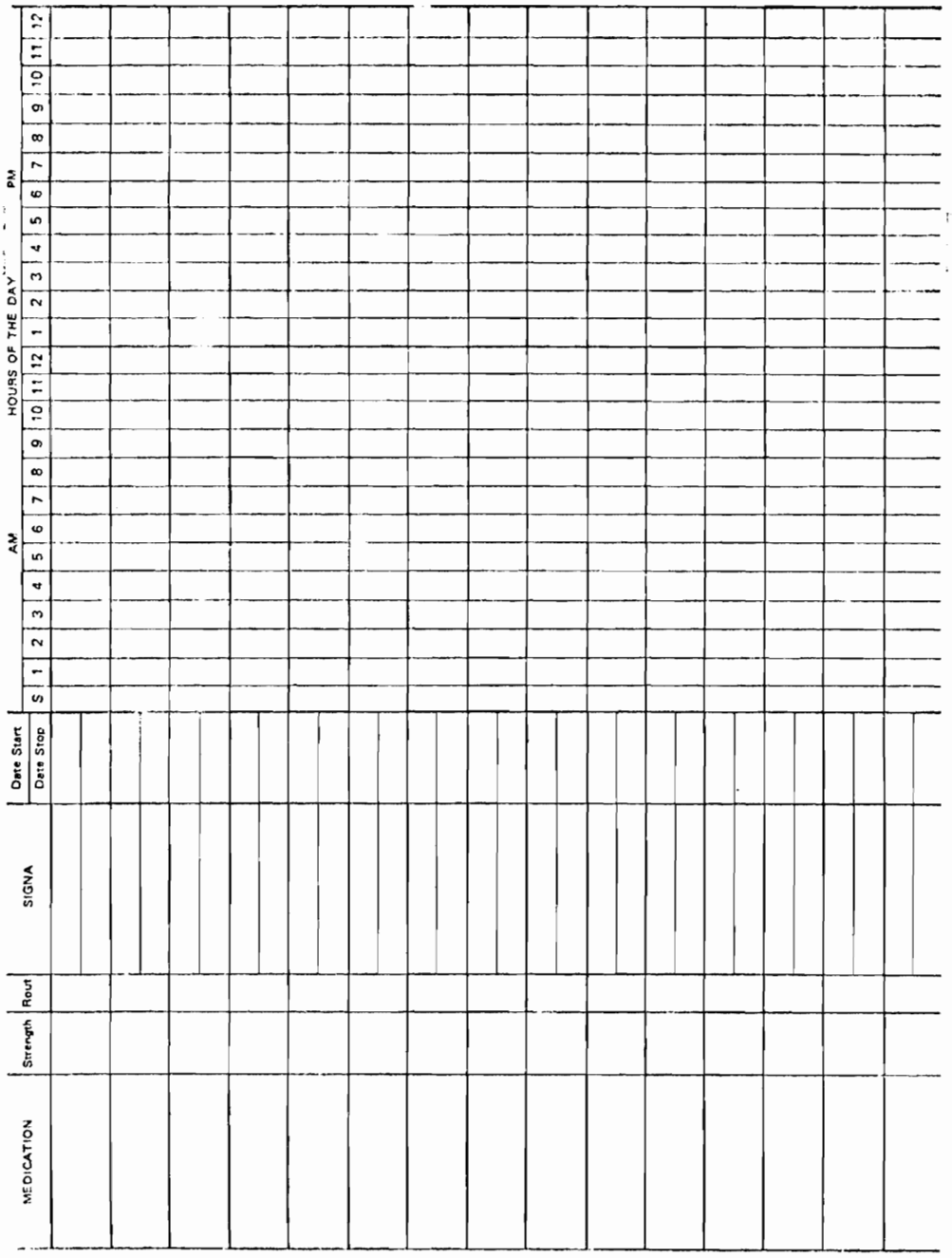

Figure 6. Intermittent Medication Profile

were entered on the profile. The directions for mixing reconstituted medications were placed on the second line under signa. That particular day's date was placed under "S" on the profile. The date started and date to be stopped were placed in their respective blocks. The hours of the day the medication was to be given was indicated by circling the appropriate time blocks across from the medication. As each order was filled the person filling the order would put his initials inside the circle indicating that the order had been filled and by whom.

2. White time file cards were used for intermittent medications. They were filed in the same manner as the blue I.V. solution cards, one hour before the medication was due.
3. Those additives that had long expiration dates were sent for a 24-hour period. Those that had shorter expiration dates were sent only a few minutes before the time for administration. During the evening shift all medications were drawn up for the remainder of the night. These were sent to the floor and stored in the refrigerator.
4. All medications were labeled with the patient's name, room number, medication name, strength, amount, date and time mixed, expiration date, and the amount of solution the medication was to be mixed with in the metriset.
5. Crediting procedures were the same as with I.V. solutions.

Directions for Mixing Hyperalimentation[18-26]

To make 16 bottles:

1. A 1,000 cc. bottle of Sterile Water was used and a portion was discarded to make the volume approximately 921.6 cc.
2. The following ingredients were added: (yields 980 cc.)
   A. 20 cc. of NaCl (3 meq./cc.)
   B. 8.0 cc. of $MgSO_4$ (50%)
   C. 30.4 cc. of K_2PO_4 (2 meq./cc.)
3. A "McGaw" V 1900 series set was added to this bottle. (The tubing was clamped off and the drip chamber depressed before inserting; this drew out the fluid from the air inlet tube of the bottle when the drip chamber was released after insertion into the bottle. This eliminated any drip when the bottle was inverted.) The bottle was then inverted and hung inside the hood.
4. 61.25 cc. of this solution was then added to each of 16 empty evacuated 250 cc. sterile containers.
5. 50 cc. of Fre Amine 8.5% was then added to each bottle, bringing the total volume to 111.25 cc.
6. 130 cc. of dextrose 50% was then added to each bottle, bringing the total volume to 241.25 cc.
7. Each bottle was then shaken to insure that all ingredients were mixed.
8. 5 cc. of calcium gluconate 10% was added to each bottle. This brings the total volume to 246.25 cc.

9. A label was attached upside down on the container (Figure 7). The date prepared was entered in the upper right hand corner stamped in red. The patient's name and the date sent to the floor were added as they were sent to the nursing unit.
10. Another label was added to the top of the container giving final instructions to finish preparation of the solution. This label gave all extra ingredients that were to be added. The reason for leaving out some electrolytes was to give the physician some flexibility in prescribing electrolytes based on the child's needs. The vitamin preparation was left out because it was thought that they would not be stable if stored for any length of time (Figure 8).
11. Two 0.2 micron filters were sent with each bottle of hyperalimentation solution to the nursing unit.
12. The following sets were sent with each hyperalimentation solution:
    A. one pediatric set
    B. one metriset with float
    C. one extension set
13. No more than 24-hour supply was sent at any one time. The solutions and sets were changed every 24 hours.
14. The solutions were stored in the pharmacy for 30 days under refrigeration and then discarded. Each batch was cultured after 7 days in the refrigerator and cultured again when discarded.

Fre Amino Hyperalimentation
(Full Strength)

Supplies 0.884 cal/ml of solution
Each 250 cc contains:

Free Amine 8.5%	50 cc
Dextrose 50%	130 cc
221 Non-protein cal.	meq Sodium
16.57 Protein cal.	meq Potassium
2 meq Magnesium	3.75 meq Phosphate
2.4 meq Calcium	1.25 cc MVI conc.
2.4 meq Gluconate	2 meq Sulfate
6 meq Chloride	8.5 meq Acetate
Protein Equivalent	3.9 gm
Nitrogen Content	0.625 gm

355 Non-protein cal. per 1 gm Nitrogen

Name _____ Date _____

Figure 7. Sample Hyperalimentation Label

THIS BOTTLE CONTAINS:
Na 4.25 meq
K 3.80 meq
TO MAKE THE REGULAR FORMULA ADD:
1) 1.25 cc Na Acetate 3 meq/cc
yielding Na 8 meq total.
2) 1.25 cc K Acetate 3 meq/cc
yielding k 7.55 meq total.
3) 1.25 cc MVI Concentrate.
For any deviation in Na or K
merely change the amount of NaAc
or KAc to be added. For assistance
see formula book on IV table.
PLEASE MAKE NECESSARY ADDITIONS ON
THE IV LABEL.....

Figure 8. Sample Instruction Label

15. The finished solution was considered expired after 24 hours whether refrigerated or not. It was immediately discarded and no credit was given if it was not used.

The pilot study was carried on with no floor stock on the nursing unit during pharmacy hours. During the hours the pharmacy was closed a minimal floor stock was left on the floor with the following sign-out sheet (Figure 9).

PLEASE SIGN OUT FOR ANY SOLUTIONS USED

Dextrose 5% in Isolyte P 250 cc.

patient's name _____

patient's name _____

patient's name _____

Dextrose 5% in 0.2% Sodium Chloride

patient's name _____

patient's name _____

patient's name _____

Dextrose 5% in Water

patient's name _____

patient's name _____

patient's name _____

Figure 9. Sample Floor Stock Sign-Out Sheet

Each morning the floor stock was returned to the pharmacy by the messenger. Any solutions that were used were restocked and the patient for whom it was used was charged

on the I.V. profile.

This procedure forced the nursing staff to rely on the pharmacy during the pharmacy hours. The nursing staff soon realized that the pharmacy could efficiently supply their needs and the system began to run smoothly.

The only extra duty the nurses had to perform when the program began was to fill out the I.V. solution record at 7 a.m. each morning just before the change of shift report (Figure 5). The nurses found that this was no extra duty, in fact, because it merely put into writing what was already being transmitted by word of mouth during report. In fact, they began making two copies, one for the pharmacy and one for the nursing staff.

This meant the nursing staff had been relieved of the responsibility of preparing parenteral solutions and had not been given any extra work to take its place.

After two months the pharmacy expanded its staff slightly and expanded the additive program to another unit.

The expansion in staff required no extra money for the salary budget. Several circumstances enabled the pharmacy to expand its staff without expanding its budget.

The first event that took place was that the nursing philosophy of the hospital changed. The philosophy changed from that of having one medication nurse give all medication to that of each nurse supplying her own patient's total needs. This change in philosophy phased out most of the medication nurse's responsibility and left her with about

four hours per day to take on other duties. When the medication nurse originated she was paid by the pharmacy budget as part of the unit dose program. As soon as she was phased out of her medication duties on the nursing units, the pharmacy began to utilize her as an I.V. technician. She is checked by a pharmacist and performs much the same duties in the pharmacy that she previously performed on the nursing units.

To staff the weekends a student was hired for 16 hours from money not yet utilized in the salary budget.

This staffing has thus far been sufficient to carry the workload in the additive center.

III

DISCUSSION OF DATA

The original survey to determine how many solutions were used per day per unit and what type solutions were used most frequently was carried on from November 1, 1972 to December 1, 1972. This study was carried on throughout the entire hospital.

The average number of patients that month was found to be 112. The lowest number was 75 and the highest number was 144. This compared to the normal yearly average of 108.

The following data represent the results of that study.

Nursing Unit	I.V.'s Total	I.V.'s Avg. Per Day	Sol'n. Most Used	Vol. (cc.)	Amt.
5 W.	235	7.8	D5 0.2 N.S.	500	112
ICU	99	3.3	D5 Isolyte P	250	33
Nursery	84	2.8	D5 Isolyte P	250	54
4 So.	224	7.5	D5 Isolyte P	500	175
4 W.	428	14.3	D5 Isolyte P	250	109

The average total number of I.V. solutions per day was 36.

Approximately 50% of all solutions were found to contain at least one additive.

The average patient on I.V. therapy receives approximately 3 bottles per day. This means that 36 solutions per

day represent about 12 persons on I.V. therapy per day.

It was determined that 7 of those 12 persons received at least one intermittent medication four times daily. It was also determined that 4 of those 7 persons received at least two intermittent medications 4 times daily.

This was determined easily by merely recording how many persons receiving I.V. solutions also received I.V. medications and how many I.V. medications each received via the unit dose program.

It was determined by a time study that the average time spent on an I.V. solution was about 3.6 minutes. This included recording, mixing, and labeling and any time necessary to keep up with changes made on the orders on the unit. To prepare an intermittent medication took about 3.7 minutes. This also included recording, mixing, and labeling.

From the statements made above the following calculations can be made for a 24-hour period:

36 solutions x 3.6 minutes/solution = 129.6 minutes

7 persons x 4 medications/day = 28 medications

4 persons x 4 additional meds/day = 16 meds

28 medications + 16 medications = 44 intermittent meds/day

44 intermittent medications x 3.7 minutes/med = 162.8 minutes

129.6 minutes + 162.8 minutes = 292.4 minutes = 4.87 hours

It took 4.87 hours per day to staff the program at the

workload indicated by these studies. This was all the information necessary to predict the workload on an average daily basis. Messenger time was not calculated since a messenger service already existed under the jurisdiction of the pharmacy.

The next survey done was designed to determine whether revenue was being lost in excessive amounts due to the floor stock system of distributing I.V. solutions in existance at that time.

It was determined that an average of $85.00 per month was lost during 1971 and $73.00 per month during 1972.

This was done by going over old floor stock records for those years. By adding all floor stock charge slips received for a given month and subtracting that total from the total amount of floor stock sent to the floor for that month, the loss was determined.

An inventory was taken to determine how many dollars worth of floor stock was being maintained on each nursing station. A determination of how many square feet was utilized in each area was also made. The results were as follows: (see top of page 33)

The total capital tied up in floor stock was $182.90. The total capital spent in the cost of I.V. solutions for 30 days normal average use was $515.00. Floor stock plus the capital used to keep floor stock maintained for 30 days was then calculated to be $695.90. The average monthly loss for the two months checked was $79.00. This meant

Nursing Unit	$ Volume of Floor Stock	Square Feet of Storage
5 So.	(newly opened unit)	
ICU	$55.50	13.0
5 W.	38.30	8.9
4 W.	49.95	10.5
4 So.	25.45	6.0
Nursery	13.20	3.0

that approximately 11.3% of the money spent on I.V. solutions was lost due to lost charges. This was considered significant.

The total amount of space used on the nursing units for storage of I.V. floor stock was found to be 29.7 sq. ft. No cost per sq. ft. of storage space was available.

A detailed survey was carried on by the nursing staff on a particular nursing unit before the additive program was in operation in that area. It was found that the average time spent by the nurses on this station on I.V. medications was approximately 32 minutes per day. The time spent on I.V. solutions and additives directly to those solutions was found to be approximately 25 minutes per day. Therefore the total time spent on this unit per day on parenteral therapy was approximately 57 minutes. This was compared with another study done on the same nursing unit after the admixture program became fully operable on that unit. The

results of time spent after the program was 6.5 minutes per day on I.V. medications and 5.5 minutes per day on solutions and their additives. The total time spent was found to be 12 minutes per day.

The total number of patients per day on this unit is graphed for each study (Figure 10).

Another study was done to determine the average percent of the total patients on this nursing unit that had parenteral therapy. The average percent of patients receiving parenteral therapy was found to be 20.8% of the total number of patients on that unit.

Total time spent was correlated with the above percent of the total number patients on the nursing unit on a daily basis for each study. The results were as follows:

Time spent/parenteral therapy patient before the admixture program 14.25 minutes.

Time spent/parenteral therapy patient after the admixture program 3.26 minutes.

A survey was taken before and after the parenteral admixture program to determine as completely as possible how many full-time employees were required to handle I.V. solutions. The following is the result of that survey:

	Before	After
Procurement	0.5 hr/day	0.3 hr/day
Nursing	5.0 hr/day	1.0 hr/day
Pharmacy	3.0 hr/day	4.9 hr/day
Totals	8.5 hr/day	6.2 hr/day

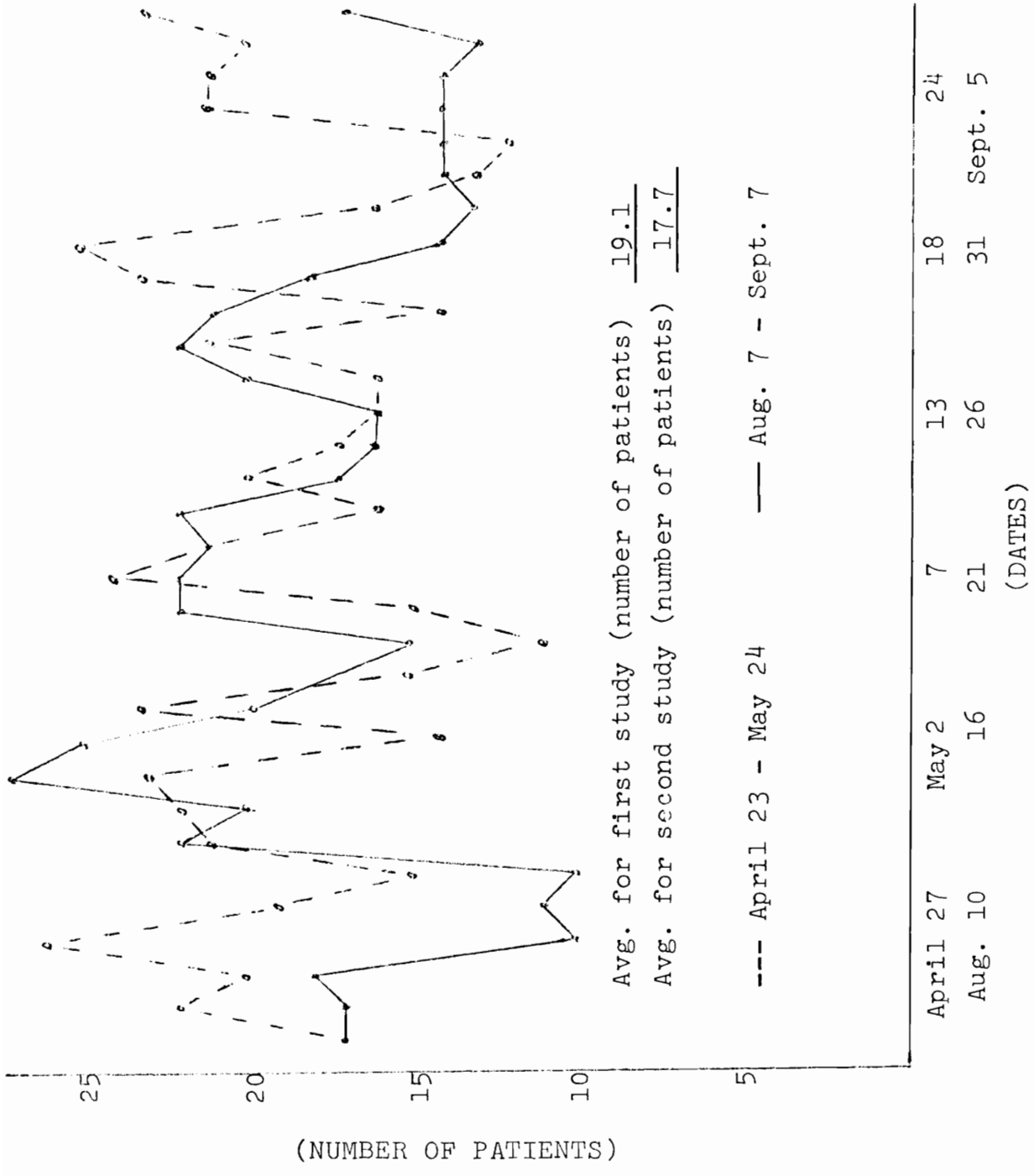

Figure 10 - Comparative Graph of Total Patients per Day

By centralizing the additive program in the pharmacy the number of hours per day required to handle parenteral therapy was decreased.

With all the information gathered above it was determined that the equivalent of one full-time employee was required to handle 170.5 I.V. solutions per 7 days before the admixture and 234.2 I.V. solutions with the admixture program. Another way of expressing this data was to say that 59.2% of one full-time employee was required to handle the work load produced by 100 I.V. solutions per 7 days before the admixture program and 43.1% of one full-time employee was required per 100 solutions with the admixture program.

IV

RESULTS AND CONCLUSIONS

In the first chapter several goals were set for the program to accomplish. It was decided to discuss each of those goals or proposals in this chapter for the purpose of concluding whether or not the program actually accomplished what it was established to do.

1. The parenteral admixture program had to operate homogeneously with the unit dose and clinical pharmacy programs already in operation.

The I.V. additive profile was incorporated into the unit dose profile. The pharmacy then had a complete record of all the patients' medications in three separate sections. The first section was for I.V. solutions and additives directly to those solutions. The second section was for all intermittent medications given I.V. and the third was for all other medications. The pharmacist in charge of unit dose was also in charge of checking the technician filling I.V. solution orders. Therefore he was aware of how both systems were functioning at all times. This pharmacy has dealt with the parenteral admixture program as an extension of the unit dose program.

These two systems together have supplied the clinical pharmacist with a complete drug profile with which she can

doubly insure that the patient is receiving proper therapy in both medications and parenteral solutions.

2. The program had to include a drug incompatibility information file. This file was composed of several drug incompatibility files which were found in the literature at the time the program was developed. Also included was incompatibility information compiled as the result of an extensive literature search by this author. The bibliography contains the sources of this information.[27-59]

3. The admixture program had to include a complete medication profile. This has been accomplished as was pointed out in #1 above.

4. It had to supply all intravenous solutions and all medications added to those solutions whether added to the primary bottle or added intermittently.

The pharmacy now supplies all solutions and I.V. medications to the nursing units on the additive program during the hours the pharmacy is open. Just before closing all I.V. solutions and medications are sent that have been ordered for the remainder of the night. The only times that items were needed from floor stock was on new orders or order changes that occured after the pharmacy closed.

5. The admixture program had to save the hospital money through more efficient use of time and equipment.

The program removed a large volume of floor stock amounting to about $150.00. This also reduced expensive storage space to a minimum.

Since all solutions and I.V. medications were charged for before they left the pharmacy the lost charges were reduced to a minimum. The only source of a lost charge would have been through forgetting to make an entry on the patient's profile. This was checked by two people, making this occurance highly unlikely.

Floor stock was checked daily under the admixture program and answers were sought for any unexplained absence of floor stock. This reduced floor stock loss to a minimum. Since floor stock was actually very minimal under this system, it was a simple task to monitor it's use.

According to a survey taken before and after the admixture program was in operation, the number of man-hours required to operate the parenteral therapy function decreased. This decrease meant that the nurse was then freed from some medication time due to the more efficient program and could then spend more time with bedside patient care.

6. This system had to promote better patient care through solving many problems that the floor stock system could not solve. The rather nebulous term "patient care" was hard to evaluate so the following parameters thought to contribute to patient care were evaluated.

A. All solutions administered prior to the parenteral admixture program were not double checked. Under the additive system the accuracy of the preparation was checked by two

persons before the solution left the pharmacy. A third check took place when the nurse administered the solution.

B. Solutions were sometimes not administered strictly at the rate ordered by the physician. The pharmacy sent solutions to the nursing units at predetermined times calculated according to the flow rate ordered by the physician. If solutions were needed earlier or later than those times a check was made to determine the reason. This insured that the patient was receiving the prescribed amount of solution.

C. Administration sets were sometimes not changed every 24 hours according to hospital policy. The admixture program insured that sets were changed at proper intervals because they were sent by the pharmacy affixed to a container. The patient had to receive a new set at the time that container was used.

D. There were incompatibility and stability problems about which the nursing staff had no information. Since the pharmacy added all the medications and premixed all intermittent medications such problems were screened for before the medications reached the nursing units. Any medications with unusual charac-

teristics were labeled with precautionary labels when necessary.

E. Hospital policy dictated that no child under four years of age was to receive a solution for I.V. administration larger than 250 cc. in volume. Under the old floor stock system this policy was not strictly adhered to. Nurses many times administered 500 cc. solutions to children under four to avoid frequent changing of bottles when the patient was receiving large volumes of solution per hour. Under the new additive system the pharmacy simply sent solutions according to hospital policy. This forced strict adherence to the hospital's policy.

F. Solutions administered to patients were sometimes improperly labeled or not labeled at all. The pharmacy's additive system insured that a proper and uniform label was attached to each solution before leaving the pharmacy. This meant that each nursing unit in the hospital had only one type of label and the information on the label was presented in a uniform manner. This was of advantage to housestaff, attending physicians and nurses working on more than one nursing unit.

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