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Medication error rates have long been a subject of interest among the pharmaceutical, nursing, and medical professions. The basic purpose of medication error studies has been to discover the quantity and type of errors which exist, thus enabling the investigator to evaluate the relative safety of various drug distribution systems as well as to subsequently make appropriate recommendations.

A medication error study was conducted at a 500 bed general medical and surgical hospital which utilized a ward stock drug distribution system. Different types of errors and error rates were presented and discussed.

Altogether 2, 418 medications were reviewed, and a total of 195 patients were included in the study. Four wards were involved, which utilized approximately 37% of the hospital's medications. The

reported total medication error rate for these wards ranged from 1:2.8 (35.4%) to 1:5.9 (16.9%). The method selected as being the most appropriate manner in which to express the total error rate revealed an error rate of 1:5.5 (18.03%).

In addition to determining several medication error rates, eight auxiliary goals were sought. Included in these auxiliary goals was the determination of a Medication Card error rate which ranged from 1:13.2 (7.6%) to 1:18.2 (5.5%). It was also found that nurses made significantly more errors when they were unaware that a medication error study was being conducted (disguised observer technique) than when they were told that they were being observed for medication errors (direct observer technique).

The results of this study should be of benefit to hospital pharmacists who wish to initiate changes in their drug distribution system.

Medication Error Rates in a Hospital with a Ward Stock Distribution System

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INTRODUCTION AND STATEMENT OF THE PROBLEM

The medication distribution system is an extremely important factor in the management of any hospital. This factor may affect, among other things, the financial condition of the hospital, the responsibilities and obligations of professional personnel such as nurses and pharmacists, the duties of non-professional personnel, and, ultimately, the welfare of the patient. This project concerned itself primarily with the latter aspect as it relates to medication errors. Such an important factor deserves close observation in order to ascertain whether or not any system utilizes its resources and personnel efficiently and effectively, while providing a safe and reliable means of distributing medications. In order to improve any system, the system must first be observed and evaluated, giving consideration both to its beneficial and detrimental properties. These properties can then be utilized in evaluating and recommending potential changes in the system.

Medication errors are a vital concern to the pharmaceutical, nursing, and medical professions, and a literature review provides evidence of these concerns (3, 8, 11).

Review of Literature

Despite the sincere concern of the pharmaceutical, nursing and medical professions regarding the reduction of medication errors, literature on this subject has been greatly limited in the past. Hospitals have been reluctant to publicize errors, and the fear of consequences has prevented adequate reporting of errors by individuals involved (19).

Early medication error studies relied solely upon reports by nurses of errors already committed. Many hospitals still rely upon such "incident" reports as data for medication error studies. As pointed out on one such form, an incident may be defined as follows:

> An incident is any happening which is not consistent with the routine operation of the hospital or the routine care of a particular patient. It may be an accident or a situation which might result in an accident (13, p. 46).

Error rates based upon this type of data have traditionally been low, indicating that few errors have occurred. One such report revealed that only 90 medication errors had occurred over a period of one year in the particular hospital (7). The most frequently reported type of error in the above study was "wrong medication given". Upon analyzing the causes of such errors, it was discovered that in over 50% of these instances the nurse in charge either did not transcribe Doctors' Orders correctly or did not make out the

Medication Card properly.

In another study, in a "large" hospital, 360 medication errors were reported in a 12 month period (19). The largest percent of these errors were those involving wrong time (46%). Wrong drug errors were 26%, wrong dosage errors were 16%, and wrong patient errors were 12%.

Incident reports are utilized in calculating hospital accident rates. In one hospital, 128 accidents occurred over a seven month period, and four of these accidents involved medication errors (14). Thus, three percent of the accidents involved medication errors. In another study, 614 total accidents occurred, five of which involved wrong medication or treatment (approximately 0.8%). In the latter study, it was admitted that more medication errors probably should have been reported.

> There probably was some under-reporting of medication errors, since failure to administer a medication is as much an error as administering the wrong drug or an incorrect dose of a drug. Medication errors are potentially one of the most dangerous types of patient accidents (15, p. 679).

The critical incident technique is similar to the aforementioned "incident report" technique in that the results are still dependent upon the reporting of the "incident" by nurses. The critical incident technique, as described by Flanagan, is a method utilized in helping to solve practical problems, whereby human behavior is directly

observed and described (9, 17). The incidents are "descriptions of directly observable complex human activity", which may be considered "critical" if descriptive of a segment of behavior relevant to a stated objective (17). The critical incident technique was employed by Safren and Chapanis in a study in an 1100 bed hospital (17, 18). Nursing personnel, in this study, were requested to fill out a questionnaire regarding medication errors or near errors as they were made or witnessed. In order to encourage participation "without fear of recrimination", nurses were to remain anonymous.

The questionnaire listed types of errors and circumstances surrounding errors. Questions were designed which could usually be answered by making a check mark or writing a word under the appropriate type of error or circumstance. The questionnaire functioned both as a means of collecting and categorizing the data.

The following results were reported:

> Over a period of seven months, 178 medication incidents were recorded. These are the raw data which form the substance of this study. Seventy-five per cent (133) of the incidents were obtained by the questionnaire and the remainder (45) by the usual incident form sent to the director of nursing service. Of the total number, 80 per cent (143) are medication errors and 20 per cent (35) are near errors (17, p. 32).

All 178 medication incidents and their immediate cause(s) were tabulated. The errors were distributed as follows (18, p. 53):

Error or Near Error Involving	Number
Wrong patient	36
Wrong dose	36
Extra dose	36
Omission	31
Wrong drug	23
Wrong time	14
Improper Route	2
Total	178

A vast majority (approximately 90%) of the reasons given for the occurrence of such incidents involved only five categories: (1) failure to follow required checking procedures (e. g. checking Medication Card against patient's name at bedside); (2) misreading or misunderstanding written communication; (3) transcription errors; (4) Medication Cards misfiled; (5) calculational errors (17).

Data obtained from incident reports, as well as incident questionnaires, suffer from the fact that nurses must report the errors. Therefore, the nurse involved must (1) recognize that an error (or near error) has occurred, and (2) be motivated to report the error (or near error) (17).

Prior to Barker's studies, all medication error studies had relied solely upon self-report methods. "Such methods are completely reliant upon (1) someone being aware that an error has occurred, and (2) their willingness to report it" (3). Barker recognized that errors may occur which are unknown to the nurse(s)

involved, and, thus, he classified errors as being known or unknown:

> All medication errors may be classified in two categories with respect to the problem of detecting them: (1) known errors (someone is aware of them, though they may not be reported), and (2) unknown errors. The distinction is important to emphasize the point that achieving 100 percent reporting of known errors may mean the detection of only a fraction of all the errors which have actually occurred (5, p. 360).

Cognizant of the weaknesses of self-report methods, Barker, in 1962, designed a disguised observer technique aimed at discovering a more reliable error rate (4, 5). In using this technique, "a hospital pharmacy intern was presented to the nurses as being required to observe the administration of medications as part of his internship program" (4). The pharmacy intern(s) gathered information which was later utilized to determine an error rate. Preparation and administration of a total of 572 medications were observed, and altogether 93 errors were discovered. Distribution of these errors was as follows:

Type of Error	Frequency	Percent
Omission	35	37
Unordered Drug	17	18
Underdose	12	13
Extra Drug	9	10
Wrong Time (early or late by 30 minutes)	9	10
Overdose	7	8
Wrong Dosage Form	4	4
Total	93	100

A table was also presented which illustrated the number of medication errors observed per nurse. Nine nurses were observed during Barker's 1962 study, and these nurses made errors in giving "18.4 per cent of the doses they administered during the observation" (4).

> The error ratio for the safest nurse was 1:13, for the average nurse approximately 1:6 and for the nurse making the greatest proportion of errors it was between 1:3 and 1:4 (4, p. 102).

Based on these 93 errors, it was projected that 51,200 medication errors occurred in the study hospital during a one year period.

> Of the 51,200 medication errors estimated to have occurred in the hospital studied, only 36 (0.07 per cent) were reported on Incident Reports. Therefore, it is recommended that such accident report forms no longer be considered as source material for an estimate of the number of errors which have occurred in a hospital over a given time (4, p. 96).

Five other conclusions dispersed throughout Barker's 1962 study are: (1) Self-report methods of detecting medication errors are of little value in determining the actual error incidence; (2) apparently the vast majority of medication errors are unknown even to the person committing them; (3) approximately 29 percent of nurses can probably be expected not to report medication errors of any kind in any way; (4) since the death rate obviously did not begin to approach the error rate, it is concluded that the vast majority of medication errors do not result in death; and (5) no significant

difference was found on comparison of error rates for all first days of observation (on each nurse) with all second days of observation. This seemed to indicate that the presence of the observer had little if any effect on the error rate of the individual nurse (4).

Barker also tested an "Anonymous Report" method in an attempt to determine "whether such an anonymous report would detect errors not detected by other means". Barker had very unsatisfactory results with this particular method as there were only six anonymous reports turned in during the seven months that they were available. Also, Barker found that 40% of the nurses objected to any kind of "anonymous error report" (4).

Basically, Barker tested three methods of detecting errors in his 1962 study: (1) observation, (2) self-report, and (3) study of existing records.

> Of the methods tested, the disguised observation method as used in this study is recommended as the best method presently available for estimating the total number of medication errors occurring in hospitals (4, p. 96).

In 1964, Barker again used the disguised observer technique to detect medication error rates. Error rates were determined for both a control (ward stock distribution system) and an experimental (centralized unit-dose distribution system) method of distributing drugs. The observers were both faculty members of the University of Arkansas School of Pharmacy.

> The nurses being observed were told (by the observers) that the purpose of the observation was to collect accurate information concerning the number, amount, and timing of medications given during the control and experimental periods in order to indicate whether the periods differed significantly in these respects. They were also told the results would be used for accounting purposes to determine the true cost of each dose administered under the control and experimental systems (2, p. 609).

The reason the technique was successful "was that the average nurse is (and was) simply too busy to stop and converse with an observer and, thus, get more than a fleeting glimpse of his notes"(2).

The results of Barker's 1964 study are presented below (2, p. 609):

	Control Period (1,238 total doses 192 observation hours)	Experimental Period (1,121 total doses 192 observation hours)
Omission	81	3
Wrong Dose	27	4
Extra Dose	21	7
Unordered Drug	52	4
Wrong Dose Form	8	2
Wrong Time (early or late by more than 30 minutes)	22	61
Total	211	81

In calculating the error rate, Barker defined the term "opportunities for error" as being the "total number of doses administered by the nurse plus the total times she was supposed to administer a dose but didn't (her omission errors)"(2).

Barker concluded from his 1964 study that "the true average error rate for the existing system is probably between 9 and 17

percent, while that for the experimental system lies between 4 and 7 percent" (2).

Several other approaches have been made toward establishment of medication error rates. One study was reported in 1965 which may be referred to as a retrospective study.

> A chart was made from the patient's prescription sheet showing which drugs should have been given each day. This was compared with the ward sister's drug book in which an entry is made each time a drug is administered (21, p. 370).

The results of this retrospective study were as follows:

Total number of prescription readings	8610
Total number of errors	100
Errors of omission	80
Errors of commission	15
Apparent errors of transcription	5

Based on the total number of errors, the error rate was apparently 1:86.1 (1.2%). This study suffered from two main drawbacks: (1) only five patients were involved (over a 3 month period); (2) it was difficult to determine whether the errors were actually errors of administration or drug-book entry errors (21).

Barker's disguised observer technique appears to be more reliable than such retrospective studies, since the disguised observer records what he actually saw given rather than what the nurse recorded that she had given to the patient. Conversely, the advantage of the retrospective technique is that the nurse is not influenced

by the presence of an observer.

Observational techniques were reviewed in a 1965 issue of Nursing Research.

> Of course, any research in which a human scientist faces an equally human subject necessitates both observation and participation. To some degree, therefore, most human behavioral research involves participant observation whether the scientist is aware of and in self-conscious control of the method or not. As used here, however, participant observation refers to some deliberate expansion of either or both "participation" with, or "observation" of human research subjects (16, p. 37).

The participant role is best minimized in order to decrease the influence of the observer upon the observed. Complete observation, however, is very difficult to accomplish. Ideally a "complete observer" role would produce more accurate results; however, as pointed out in Nursing Research:

> Short of concealed one-way viewing mirrors (which would of course eliminate "participation" completely) or situations involving large crowds, opportunities for implementing the complete observer role are rare (16, p. 37).

In order to better understand some of the specifics of Barker's studies, the following example is given to illustrate the method used in determining the number of errors committed.

> As a resident in hospital pharmacy in a state university teaching hospital, one of the authors (knb) was required to observe nurses administer drugs to patients. One day he observed a nurse carry two hypodermic syringes into a room with four patients. One syringe was filled with

> Papaverine and the other contained Procaine Penicillin G. She then gave each injection to the wrong patient by mistake (3, p. 16).

Barker went on to explain:

> The definition of a medication error used in this study was constructed so that the results would reflect the dimensions of the errors problem from the patient's (and physician's) point of view. Thus, errors were identified in terms of what happened to the patient, regardless of how it happened or who-or-what caused it to happen. If the drug switching error described above had occurred, in this study, four errors would have been counted because, from the viewpoint of the two patients involved, each received an unordered drug and each failed to receive the correct drug (3, p. 16).

In a recent journal, Barker discussed his observational technique and some of its limitations.

> Errors were defined in general as "deviations from the physician's order on the patient's chart", and identified by comparing the physician's order with the notes taken by an observer on the nursing floor (1, p. 324).

Two limitations were pointed out by Barker: (1) the effect of the observer upon the performance of the observed; (2) the skill of the observers and their ability to detect errors (1).

Despite these, and other limitations, some type of disguised observer technique appears to be the best method, to date, of determining the medication error rate in a hospital. Regardless of which technique is employed in measuring them, errors, nevertheless, do occur. When they occur, not only the patient but also the hospital and its personnel may suffer.

> If any place should be safe, and any environment a protected one, a hospital is certainly that place. Yet accidents do happen to patients in hospitals, despite the best efforts of everyone concerned. And, when they do, they may not only result in injuries to the patient and anxiety for his family, but also bring in their wake the possibility of unfavorable publicity about the hospital, and hostility within the community toward members of both the medical and nursing professions (15, p. 679).

Fulton stated that:

> There is not a medication error that can be defended. Every nurse likes to think that she has a reason for making her medication error, but I would not care to see her upon a witness stand trying to present that theory to a group of laymen; they will never buy it (10, p. 22).

Several medication error studies have been presented, but it appears that additional data may be beneficial. Based on the literature, it also appears that the first step involves the detection and identification of such errors (5).

Goals of Study

The primary goal of this study was to determine various medication error rates in a large (400 to 500 bed) hospital utilizing a ward stock drug distribution system. Both preparation and administration of medications were observed by pharmacy personnel on each of the wards selected for observation. Information gathered during such observation was compared to Doctors' Orders so that various medication error rates could be determined.

In addition to the determination of medication error rates, an

attempt was made to collect other data which would be of benefit to the interpretation of such error rates. An attempt was also made to discriminate between error rates on different types of wards, and at different times of administration. In order to accomplish these objectives, the following eight auxiliary goals were pursued: (1) determination of the number of potential errors which were prevented either by pharmacy or patient intervention (condition "N" errors); (2) separation of medications and medication errors according to pharmacological category in order to determine the potential "seriousness" of the errors committed; (3) determination of a Medication Card error rate; (4) determination of a Continuing Medication and Treatment Record error rate; (5) determination of the difference in error rates when nurses were aware that they were being observed for medication errors as opposed to when nurses were provided with another reason for pharmacy observation (namely, that such observation was merely an extension of the clinical pharmacy training program); (6) determination of the difference between medical and surgical ward medication error rates; (7) determination of the difference between 9 A. M. and 1 P. M. medication error rates; and (8) observation (and subsequent discussion) of any other pertinent discrepancies which were related to the preparation and/or administration of medications.

METHODS

Description of Ward Stock Distribution System

The study hospital was a 400 to 500 bed general medical and surgical hospital. Prior to initiating this study, a clinical pharmacy training program had been introduced to certain wards in the hospital. At the time of the study, some wards were accustomed to the presence of pharmacy observers (going on medical rounds, reviewing charts, etcetera). In addition to the clinical pharmacy program, pharmacy personnel in the study hospital were basically involved in two more roles. One role found the pharmacist filling prescriptions for patients leaving the hospital. The other role involved the supplying of drugs to wards for inpatient use by means of a ward stock drug distribution system.

Ward stock drug distribution involves primarily the following ten steps:

(1) Drugs are prepackaged in convenient quantities and properly labeled by Pharmacy Service.

(2) Nursing Service prepares the Pharmacy Order (refer to Appendix A for abbreviated form).[1/]

1/ Forms are abbreviated only where necessary in order to protect the identity of the study hospital.

(3) When received in the pharmacy, the Pharmacy Order is filled by pharmacy personnel and then delivered to the ward by a pharmacy technician.

(4) The drugs are placed in ward medicine cabinets by nursing personnel.

(5) Ward clerks check Doctors' Orders and transcribe these to Medication Cards and to the Continuing Medication and Treatment Record (refer to Appendix B for abbreviated form).[2/]

(6) Transcriptions are verified and initialed by nurses.

(7) Medication Cards are placed in a rack where they are arranged according to the anticipated time of administration. Prior to the time of administration, the appropriate Medication Cards are selected from the rack.

(8) Medications are placed into paper cups (souffle cups) from the ward's stock bottles according to the information on Medication Cards. These paper cups, the Medication Cards, and medications are arranged in the medication tray (in the study hospital this was a tray with 24 positions--four rows of six).

(9) At the time of administration, the prepared medication

2/ Forms are abbreviated only where necessary in order to protect the identity of the study hospital.

tray is taken to patients' rooms and medications are administered to patients by nurses.

(10) After administration, nurses record the medications that were given to each patient in the appropriate patient's chart (on the Continuining Medication and Treatment Record).

Nursing function is more completely described by a section from the study hospital's Nursing Procedures (refer to Appendix C for abbreviated section).[3/]

Studies A Through F

Selection and Description of Wards

Ideally, all wards in the hospital should have been observed, twenty-four hours per day, for an extended period of time. However, limitations with regard to time, personnel, and finances prevented such extensive coverage. In order to maximize the potential benefits from the study, wards were selected which used large quantities of drugs. Selection of "high-use" wards was accomplished by (1) reviewing previous Pharmacy Orders, and (2) determining the relative usage by each ward (Table 1 indicates the relative usage by the wards which were selected).

3/ Forms were abbreviated only where necessary in order to protect the identity of the study hospital.

Table 1. Description of wards, circumstances and dates observed.[a/]

Study	Number of Beds	Type of Ward	Relative Drug Usage (%)	Awareness	Dates Studied
A	30	Surgical	6.2	Unaware	10/13/69--10/19/69 11/24/69--11/25/69
B	66	Medical	7.2	Unaware	10/13/69--10/19/69 11/25/69--11/26/69
C	57	Surgical	10.0	Aware Initially	12/01/69--12/07/69
D	60	Medical	13.2	Aware Initially	12/01/69--12/08/69
E	66	Medical	7.2	Aware Secondarily	1/19/70-- 1/25/70
F	30	Surgical	6.2	Aware Secondarily	1/24/70-- 1/30/70

[a/] Key

Relative Drug Usage = The approximate percent of the hospital's drugs that were distributed to the particular ward.

Awareness = A description of the information the nurses were given regarding the purpose of pharmacy observations. Three possibilities existed (unaware, aware initally, and aware secondarily).

Unaware = Nurses were not aware that a medication error study was being conducted (i.e., the nurses were told that the observations were merely an extension of the established clinical pharmacy program).

Aware Initially = Nurses were told immediately that observers were looking for medication errors.

Aware Secondarily = The nurses originally observed in studies A and B were now informed of the actual purpose of the observations and observed again.

Although the use of drugs on the tuberculosis ward was relatively high (13.7%), it was elected not to study this ward due to the lack of variability with respect to the type of drugs used. It was felt that routine usage, primarily of one class of drugs, would not produce an error rate which could justifiably be compared to error rates established on other wards.

Wards which were participating in the clinical pharmacy program were desirable for inclusion in at least part of the study. Nurses on these wards were accustomed to pharmacists going on rounds with other medical personnel; consequently, these nurses could be observed while "unaware" that data were being collected for a medication error study. One other factor which entered into the selection of appropriate wards was whether the ward was a surgical or a medical ward.

With regard to the above considerations, four wards were eventually selected which seemed to best meet all of these requirements. Collectively, based on Pharmacy Orders, these four wards ordered approximately 37% of the hospital's drugs. Two of these wards (one medical and one surgical) were participating in the clinical pharmacy program. Two wards were medical wards, and the other two were surgical wards. These four wards were involved in six studies designed to fulfill the primary and auxiliary goals of the

project. The six studies were designated as studies A, B, C, D, E, and F.

Studies A Through F

Dates, Times, Personnel

Drugs in the study hospital were administered according to the following schedule:

Interval	Interpretation	Administration Time(s) A. M.	P. M.
qd	every day	9[a]	
q4h	every four hours	1, 5, 9	1, 5, 9
q6h	every six hours	1, 7	1, 7
bid	twice per day	9	6
tid	three times per day	9	1, 6
qid	four times per day	9	1, 6, 9

[a] Exception - some wards administered "Digoxin qd" at 1 p. m.

Based on the above schedule, it appeared that a large quantity of data may be collected by observing medications scheduled to be given at 9 A. M. and 1 P. M. since all of the common drug intervals involved at least one of these two administration times. Very few injectable drugs were given at such scheduled times (many were "prn" or "as needed"); consequently, the vast majority of drugs which appeared in this study were tablets and capsules. Potential

errors involving intravenous solutions and their additives were eliminated from the study since the method of drug distribution does not necessarily affect the preparation and administration of intravenous solutions.

During week days, data were collected by pharmacy interns (the Author plus three more interns). On Saturdays and Sundays, the Author, one pharmacy intern, and two pharmacy students collected data. Altogether, four pharmacy students were involved, as two were available Saturdays while the other two were available Sundays. Interest in hospital pharmacy was the primary basis for selection of students. Preparation and administration of medications for each medication round seldom took more than one hour; therefore, there was ample time for these students to observe nursing activities, review patient's charts, discuss clinical pharmacy, and ask questions regarding pharmaceutical practices in this particular hospital.

Table 1 described studies A through F with regard to the wards that were observed, the circumstances surrounding their observation, and the dates on which the observations occurred. Each of the six studies was intended to last one week. Studies A and B, however, were extended by two days in order to obtain additional data. Dates were chosen which were convenient both to nursing personnel and to pharmacy student observers.

Introduction of Project to Pharmacy and Nursing Personnel

Approximately, one week prior to collection of data, the following letter (along with the forms mentioned in the letter) was sent to each of the four pharmacy students involved with the project. Copies of this letter were also presented to the three pharmacy interns at the study hospital.

Letter to Pharmacy Observers

> Thank you for your willingness to participate in this project. Without your help, collection of sufficient data would approach the impossible.
>
> Enclosed you will find a copy of the introduction to this project along with a brief explanation of the proposed methodology. Also you will find copies of the letters of introduction which will be presented to medication nurses at appropriate times. Please keep in mind the fact that during the first week of observation nurses are not to be told that observers are looking for medication errors. Supposedly, observers are present merely to investigate the usefulness of nurses' medication rounds as a tool in the education of clinical pharmacy interns and as a source of practical education for senior pharmacy students interested in hospital pharmacy.
>
> Enclosed you will also find three of the forms which will be utilized in the project as a means of collecting and recording data. For now, merely try to become familiar with these forms. They will become less complicated as you gain experience with this observational technique.

Upon arriving at the hospital, the method of collecting data was

reviewed in more detail. The letter, along with this verbal explanation, followed by a few practice observations, served as the primary means by which pharmacy observers were introduced to the project.

The fact that medication errors were to be studied was revealed only to a select number of hospital personnel.

The procedures and goals of this study were thoroughly discussed with personnel from nursing education. The project was then presented to, and approved by, the Chief of Nursing Service at the study hospital. After obtaining approval of the head nurse on each of the wards involved, the following letter was presented to the nurses concerned with studies A and B.

Letter to Nurses Involved With Studies A and B

> Pharmacy, as you are most likely aware, is beginning to assume a more active role in patient care than has traditionally been the case. Evidence of this new role has shown up in this hospital by the fact that pharmacy interns have been going on rounds with doctors on your wards. Such rounds are part of the Clinical Pharmacy program.
>
> Going on rounds with medication nurses is an approach to Clinical Pharmacy which, perhaps, should be explored. By observing the drugs administered, routes employed, etc., even for one week, the interns could gain a tremendous amount of insight into nursing problems and seek potential areas in which pharmacists could be of assistance to nursing personnel.
>
> Going on such rounds would also be a beneficial educational tool for pharmacy students. These students are interested in nursing activities, hospital terminology,

drug identification, etc.

With your permission and cooperation, one week of observation will be available for such an educational program. Observers will be present to watch the preparation and administration of medications scheduled to be given at 9 A. M. and 1 P. M. No more than two observers will be present at any one time.

The names of nurses will NOT be recorded, so nurses should try to prepare and administer drugs the same as they would if these observers were not present. In order to help maintain a typical atmosphere, observers will minimize their conversation with the nurses.

You are requested to deposit discontinued Medication Cards in a special receptacle which will be placed on your ward in a convenient location. Please deposit these cards as soon as the drug is discontinued or as soon as the patient is discharged. As usual, you should continue to tear the cards, but please do not tear them completely apart.

Your cooperation would be greatly appreciated since the success of this project depends entirely upon your willingness to participate. Thank you.

Several weeks after studies A and B were completed, but prior to commencement of studies C, D, E, and F, the following letter was presented to nurses involved with these four studies:

Letter to Nurses Involved With Studies C, D, E, and F

Many hospitals have become involved with various methods of determining medication errors. With your cooperation and permission, a medication error rate will be determined on your ward by use of a direct observer technique. It is important that you know that the identity of nurses will neither be recorded nor

revealed to anyone, and observers will not even know at the time of administration what drugs the doctor has ordered; consequently, on the spot interruptions will not occur. In order to make conditions as close to natural as possible, conversation between observers and nurses should be held to a minimum.

The purpose of determining medication errors is not a malicious one. The main purpose is to identify the types of errors that occur, where they occur, and ultimately, from this information, perhaps, how they could be reduced. Therefore, it is important for nurses to prepare and administer medications the same as they would if there were no observers present.

The study will be conducted for only one week. Pharmacy interns and students will observe the preparation and administration of medications scheduled to be given at 9 A.M. and 1 P.M. No more than two observers will be present at any one time.

You are requested to deposit the discontinued Medication Cards in a special receptacle which will be placed on your ward in a convenient location. Please deposit these cards as soon as the drug is discontinued or as soon as the patient is discharged. As usual, you should continue to tear the cards, but please do not tear them completely apart.

Your cooperation would be greatly appreciated since the success of this project depends entirely upon your willingness to participate. Thank you.

Errors Defined

Medication errors may be defined in many different ways. In general, however, Barker's definitions were relied upon in this study (4). The primary deviation from Barker's definitions involved the importance granted to "time" errors. Some error rates attached

no importance to time, other error rates counted one hour time errors, and still other error rates counted one-half hour time errors. This allowed for a great deal of flexibility with regard to time errors. Other than time errors, six types of errors were recognized which were abbreviated as follows: U = Unordered Drug Given, E = Extra Dose Given, O = Omission, D = Wrong Dosage, F = Wrong Dosage Form or Route, A = Incorrect Administration. The definitions used in this study are shown in Table 2.

Forms and Procedures for Collection of Data

Collection and tabulation of data were accomplished by use of five forms. Two forms were necessary to record the preparation of medications. In these two forms, an "activity" was defined as being "each time that a drug was taken from a medication bottle and placed in a souffle cup". One observer would record the name of the drug placed in the souffle cup (on Form 1) while the other observer would record the "position" in the medication tray in which the drug was placed (on Form 2). Positions were numbered consecutively from left to right, top to bottom, such that position one was in the top left corner while position twenty-four was in the bottom right corner. In order to be more certain that both observers were recording information about the same drug, the observer watching the "position" in which the drug was placed would also record the

Table 2. Definition of errors.

1. Unordered Drug Given = medication given that had either (a) never been ordered for the patient to whom it was given, or (b) been discontinued for at least one day prior to administration.

2. Extra Dose Given = dose given at the scheduled time as well as time(s) when not ordered; does not include giving a medication to make up for a dosage that was previously omitted.

3. Omission = dose not given at the scheduled time and still not given by the end of the next scheduled rounds; does not include dosage missed due to patient absence, patient refusal, late Doctors' Orders, or lack of the medication ordered (e.g., it was not counted as omission if pharmacy did not stock the drug).

4. Wrong Dosage = dose given that was either 5% above or below the correct dosage (as determined by quantity X strength = dosage).

5. Wrong Dosage Form or Route = any dosage form which is not included in the generally accepted interpretation of Doctors' Orders. Included would be giving by mouth a drug ordered to be given intramuscularly (4).

6. Incorrect Administration = not giving the drug in the manner prescribed by the doctor (e.g., not giving a drug with milk or orange juice, or giving a drug within one-half hour of food when Doctors' Orders specifically stated that the drug was not to be given with food).

7. Wrong Time (prn medications are not included)

   t^a = time was off more than 30 minutes but less than one hour from the scheduled time.

   t^b = time was off by one hour or more but the drug was given at least by the end of the next scheduled rounds; does not include medications missed because of patient's absence, etc.

Table 2. Continued.

t^c =	drug was given at the wrong time but this was an excused error in that delay was due to: (1) patient's absence at the scheduled time, (2) prior patient refusal, (3) Doctors' Orders being written too late, (4) lack of the necessary medication, or any other excused time discrepancy. (t^c was not counted as an error but was merely an observation).

dosage form of each drug observed. The quantity of drug placed in each souffle cup was recorded by both observers as another such dual check. At the time of administration, only one observer was required. This observer used Form 3. There are twenty-four numbers shown on Form 3. Each number represents a position in the medication tray. Beside each of these numbers were recorded the patient's name and the time at which the medications in the corresponding souffle cup were administered. Time was recorded to the nearest five minutes. Each patient's social security number was also recorded on the form as a means of helping to locate the patient's chart from the records room. At the end of each study, the patient's names were arranged alphabetically according to the patient's last name and then consecutively assigned a number. Form 4 was utilized to record Doctors' Orders, which were transferred from the patient's chart. This information was recorded some time after the preparation and administration data had been recorded. Form 5 provided a means of comparing the preparation and administration data (i.e., medication given) with data from Doctors' Orders (i.e., medication ordered). Medication errors were then extracted from Form 5 and error rates were subsequently calculated. The five forms used for collection of data are shown in Appendix D.

Methods of Calculating the Error Rate

Seven methods of calculating the error rate are shown in Table 3. Method one expresses the error rate in terms of the specific type of error being considered. Methods two, three, and four express the error rate in terms of decreasing emphasis upon time errors. Methods five, six, and seven express the error rate in terms of decreasing emphasis upon time errors, while also excluding the possibility for more than one error to be made per medication given. Previous methods of expressing the error rate did not allow as much flexibility with regard to time errors. Also, previous error rates implied that more than one error could potentially be created for only one "opportunity for error". For example, wrong strength and wrong time for one medication could lead to two errors per one "opportunity for error". Methods five, six, and seven eliminated the latter possibility by allowing only one error per one potential medication given.

Collection of Auxiliary Data

Besides obtaining data leading toward the determination of medication error rates, eight other types of data were collected in order to approach the previously-mentioned auxiliary goals. The first of these was referred to as data involving condition "N".

Table 3. Methods of calculating error rates.[a/]

Method Number	Description of Method (Formula)
1	$\frac{\text{Each Type of Error (e.g., U, E, O, etc.)}}{\text{TPM}}$
2	$\frac{\text{Total Errors}}{\text{TPM}}$
3	$\frac{\text{Total Errors} - t^a}{\text{TPM}}$
4	$\frac{\text{Total Errors} - (t^a + t^b)}{\text{TPM}}$
5	$\frac{X}{\text{TPM}}$
6	$\frac{Y}{\text{TPM}}$
7	$\frac{Z}{\text{TPM}}$

[a/] Key

TPM = Total Potential Medications = Medications Given + Omissions (Analogous to Barker's "Opportunity for Error").

For Method Number 1: U = Unordered Drug Given; E = Extra Dose Given; O = Omission; D = Wrong Dosage; F = Wrong Dosage Form or Route; A = Administration Error; t^a = time error which was over 30 minutes but less than one hour from the scheduled time; t^b = time error in which the drug was one hour or more away from the scheduled time; t^c = excused time error.

Total Errors = The summation of all errors exclusive of excused time errors (t^c).

For Method Number 5: X = Total number of medications containing at least one error (includes all errors except t^c).

For Method Number 6: Y = Total number of medications containing at least one error (without counting t^a or t^c).

For Method Number 7: Z = Total number of medications containing at least one error without regard to time errors at all.

Condition "N" was defined as any situation in which the nurse committed herself to a medication error (any of the types of errors described previously), but either the patient or the pharmacy observer stopped the nurse from administering the medication. Data on condition "N" were necessary since it was the opinion of the Author that pharmacy observers should stop medication errors when possible, and yet, the Author strongly felt that once the nurse had handed the wrong medication to a patient, she had, indeed, committed herself to an error.

The second type of auxiliary data required the classification of medications into "serious" and "other" drugs[4/] as originally described by Barker (3), and utilized by the University of Kentucky (12). Using Barker's general scheme as a guideline, the following list was developed which divided the "serious" from the "other" medications according to the pharmacological category in which each medication appeared.

4/ The term "serious" drugs in this case refers to the usual seriousness of the condition being treated and thus reflects the potential "seriousness" of medication errors involving such drugs.

HFS No.[a]	Pharmacological Category	Serious	Other
4:00	Antihistamine Drugs		x
8:00	Anti-infective Agents	x	
12:00	Autonomic Drugs		x
20:00	Blood Formation and Coagulation	x	
24:00	Cardiovascular Drugs	x	
28:00	Central Nervous System Drugs	x	
36:00	Diagnostic Agents		x
40:00	Electrolytic Caloric and Water Balance	x	
44:00	Enzymes		x
48:00	Expectorants and Cough Preparations		x
52:00	Eye, Ear, Nose, and Throat		x
56:00	Gastrointestinal Drugs		x
68:00	Hormones and Synthetic Substitutes	x	
86:00	Spasmolytics	x	
88:00	Vitamins		x
92:00	Unclassified		x

[a] Hospital Formulary Service Number.

Although the above classification has its drawbacks, it does provide a relative indication as to the "seriousness" of the drugs involved, and, thus, a relative indication as to the seriousness of the error committed. According to this list, then, each medication and each medication error was classified as being either "serious" or "other".

The third type of auxiliary data concerned the determination of a Medication Card error rate. During each study, nurses were requested to deposit discontinued Medication Cards in a box placed on the ward. These cards were collected for several weeks following the termination of each study in order to be able to obtain as many cards as possible for the study. Later, these cards were compared

with Doctors' Orders so as to determine an error rate.

The fourth type of auxiliary data was obtained by photographing discrepancies between Doctors' Orders and nurses' Continuing Medication and Treatment record. Only discrepancies involving drugs were photographed.

The fifth type of auxiliary data involved a comparison of error rates for studies A and B (unaware) with error rates for studies C and D (aware initially) with error rates for studies E and F (aware secondarily). This comparison was necessary in order to determine the relative importance of nursing awareness (of the purpose of the pharmacy observations) upon the magnitude of the error rate. Aware was compared with unaware, and aware initially was compared with aware secondarily.

The sixth type of data involved a comparison of error rates for studies A, C, and F (surgical wards) with the error rates for studies B, D, and E (medical wards).

The seventh type of auxiliary data involved a comparison of error rates for all 9 A. M. medication rounds with the error rates for all 1 P. M. medication rounds.

Error rates were recorded for each study (A through F) based on the error rate for each particular round (Appendix E, part 1). Error rates were expressed as a percentage (Errors $\div$ Total Potential Medication X 100) and then a normalizing transformation

was performed (6, 20) (angular transformation) followed by an analysis of variance (Appendix E, parts 2, 3, 4). Auxiliary data five, six, and seven were then extracted from such analyses.

The eighth type of auxiliary data resulted from the expansion of any pertinent notes recorded on data sheets by pharmacy observers. Several observations were made which were not directly related to any of the above types of data. Observers were requested to record such observations either on the back or in the margins of the data sheets.

Hence, data were collected and tabulated leading to the calculation of several different error rates. In addition, eight auxiliary types of data were collected, reviewed, and are discussed in the results section of this report.

RESULTS AND DISCUSSION

General Statement

Nurses were, in general, very cooperative with respect to this study. No nurse refused to participate, although many were, understandably, nervous. Nervousness was noticeably lessened by the second or third medication round according to reports from pharmacy observers.

The effect that the presence of pharmacy observers had upon the error rate was difficult to assess. At least two factors appeared to be important possible effects: (1) the nurse was more careful when being observed resulting in an observed error rate which was lower than the actual error rate, (2) the nurse was nervous when being observed, and, possibly made more errors resulting in an observed error rate which was higher than the actual error rate.

Essentially, all medications were prepared and administered by Registered Nurses. Two LPNs (Licensed Practical Nurses) did prepare and administer some of the medications in studies B and E, and nursing students did prepare some of the medications in study C. Since a vast majority of the medications were, however, prepared and administered by Registered Nurses, there was no attempt made to categorize the errors committed by each type of nurse.

Collection and Tabulation of Data

Data were collected for 195 patients representing 2,418 Total Potential Medications (i.e., medications given plus omissions, abbreviated TPMs). Table 4 reveals the number of patients, TPMs, as well as number and types of errors for each of the studies A through F. The total errors (i.e., the summation of all errors exclusive of the excused time "errors") and the number of medications with at least one error are also presented in Table 4.

Error Rates

Seven different types of error rates were proposed in Table 3. Based on data presented above, error rates were calculated for this particular study (Table 5). Total errors divided by Total Potential Medications (i.e., method two) was the method which most closely resembled Barker's method. As can be seen in Table 5, this error rate was 1:2.8 (35.4%). However, 48.5% of these errors were one-half hour time errors (t^a). Based on this method, the other types of errors were distributed as follows: unordered drug given = 9.1%, extra dose given = 0.8%, omission = 26.3%, dosage error = 7.3%, form error = 0.7%, administration error = 3.7%, t^b errors = 3.5% (i.e., time was off one hour or more).

A casual observation of the data revealed that one-half hour

Table 4. Distribution of errors[a/]

Study	No. Pt.	TPM	U	E	O	D	F	A	t^a	t^b	t^c	T.E.	X	Y	Z
A	29	341	20	2	38	16	0	3	176	4	5	259	249	83	79
B	71	731	37	0	81	19	0	4	121	2	1	264	261	143	141
C	33	353	10	1	21	11	6	9	4	3	1	65	63	60	57
D	20	321	5	1	23	4	0	1	0	0	0	34	34	34	34
E	24	422	2	2	52	8	0	8	30	5	1	107	106	77	72
F	18	250	4	1	10	4	0	7	84	16	6	126	123	39	26
Total	195	2418	78	7	225	62	6	32	415	30	14	855	836	436	409

[a/] Key

No. Pt. = Number of patients in the particular study.

TPM = Total Potential Medications (Medications Given + Omissions).

U = Unordered Drug Given; E = Extra Dose Given; O = Omission;

D = Dosage Error; F = Wrong Dosage Form or Route; A = Administration Error;

t^a = time error which was over 30 minutes but less than one hour from the scheduled time; t^b = time error in which the drug was given one hour or more away from the scheduled time; t^c = excused time error; T.E. = Total Errors = the summation of all errors exclusive of excused time errors (t^c).

X = Total number of medications containing at least one error (all errors were included except t^c).

Y = Total number of medications containing at least one error without counting t^a or t^c.

Z = Total number of medications containing at least one error without counting time errors at all.

Table 5. Error rates for studies A through F.

METHOD	STUDY						
	A	B	C	D	E	F	Total
1. U / TPM	20/341 = 1/17	37/731 = 1/20	10/353 = 1/35	5/321 = 1/64	2/422 = 1/211	4/250 = 1/62	78/2418 = 1/31
E / TPM	2/341 = 1/171	0/731 = 0	1/353 = 1/353	1/321 = 1/321	2/422 = 1/211	1/250 = 1/250	7/2418 = 1/345
O / TPM	38/341 = 1/9.0	81/731 = 1/8.1	21/353 = 1/17	23/321 = 1/14	52/422 = 1/8.1	10/250 = 1/25	225/2418 = 1/11
D / TPM	16/341 = 1/21	19/731 = 1/58	11/353 = 1/32	4/321 = 1/80	8/422 = 1/53	4/250 = 1/62	62/2418 = 1/39
F / TPM	0/341 = 0	0/731 = 0	6/353 = 1/59	0/321 = 0	0/422 = 0	0/250 = 0	6/2418 = 1/403
A / TPM	3/341 = 1/114	4/731 = 1/183	9/353 = 1/39	1/321 = 1/321	8/422 = 1/53	7/250 = 1/36	32/2418 = 1/76
t^a / TPM	176/341 = 1/1.9	121/731 = 1/6.0	4/353 = 1/88	0/321 = 0	30/422 = 1/14	84/250 = 1/3.0	415/2418 = 1/5.8
t^b / TPM	4/341 = 1/85	2/731 = 1/366	3/353 = 1/118	0/321 = 0	5/422 = 1/84	16/250 = 1/16	30/2418 = 1/81

Table 5. Error rates for studies A through F (cont.).

METHOD	STUDY						
	A	B	C	D	E	F	Total
$\frac{t^c}{TPM}$	$\frac{5}{341} = \frac{1}{68}$	$\frac{1}{731} = \frac{1}{731}$	$\frac{1}{353} = \frac{1}{353}$	$\frac{0}{321} = 0$	$\frac{1}{422} = \frac{1}{422}$	$\frac{6}{250} = \frac{1}{42}$	$\frac{14}{2418} = \frac{1}{173}$
2. $\frac{T.E.}{TPM}$	$\frac{259}{341} = \frac{1}{1.3}$	$\frac{264}{731} = \frac{1}{2.8}$	$\frac{65}{353} = \frac{1}{5.4}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{107}{422} = \frac{1}{3.9}$	$\frac{126}{250} = \frac{1}{2.0}$	$\frac{855}{2418} = \frac{1}{2.8}$
3. $\frac{T.E. - t^a}{TPM}$	$\frac{83}{341} = \frac{1}{4.1}$	$\frac{143}{731} = \frac{1}{5.1}$	$\frac{61}{353} = \frac{1}{5.8}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{77}{422} = \frac{1}{5.5}$	$\frac{42}{250} = \frac{1}{6.0}$	$\frac{440}{2418} = \frac{1}{5.5}$
4. $\frac{T.E. - (t^a + t^b)}{TPM}$	$\frac{79}{341} = \frac{1}{4.3}$	$\frac{141}{731} = \frac{1}{5.2}$	$\frac{58}{353} = \frac{1}{6.1}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{72}{422} = \frac{1}{5.9}$	$\frac{26}{250} = \frac{1}{9.6}$	$\frac{410}{2418} = \frac{1}{5.9}$
5. $\frac{X}{TPM}$	$\frac{249}{341} = \frac{1}{1.4}$	$\frac{261}{731} = \frac{1}{2.8}$	$\frac{63}{353} = \frac{1}{5.6}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{106}{422} = \frac{1}{4.0}$	$\frac{123}{250} = \frac{1}{2.0}$	$\frac{836}{2418} = \frac{1}{2.9}$
6. $\frac{Y}{TPM}$	$\frac{83}{341} = \frac{1}{4.1}$	$\frac{143}{731} = \frac{1}{5.1}$	$\frac{60}{353} = \frac{1}{5.0}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{77}{422} = \frac{1}{5.5}$	$\frac{39}{250} = \frac{1}{6.4}$	$\frac{436}{2418} = \frac{1}{5.5}$
7. $\frac{Z}{TPM}$	$\frac{79}{341} = \frac{1}{4.3}$	$\frac{141}{731} = \frac{1}{5.2}$	$\frac{57}{353} = \frac{1}{6.2}$	$\frac{34}{321} = \frac{1}{9.4}$	$\frac{72}{422} = \frac{1}{5.9}$	$\frac{26}{250} = \frac{1}{9.6}$	$\frac{409}{2418} = \frac{1}{5.9}$

time errors were unevenly distributed among the wards studied, which indicated that method two did not provide a representative view of the hospital's error rate. In fact, the majority (62.7%) of these errors were observed on the same ward (i.e., study A, with 176, and study F, with 84). In contrast, only 28.6% of the Total Potential Medications were from studies A and F. Therefore, over 60% of the one-half hour time errors were observed on a ward which contributed less than 30% of the TPMs. This information, coupled with the fact that one ward (study D) produced no time errors at all, leads to the conclusion that it would be unfair to state that the total hospital error rate was 1:2.8 (35.4%). Indeed, the error rate, based on method two, ranged from 1:1.3 or 76% (study A) to 1:9.4 or 10.6% (study D).

By excluding these one-half hour time errors (t^a), method three was obtained. The error rate then became 1:5.5 (18.2%). The errors, using method three, were distributed as follows: unordered drug given = 17.7%, extra dose given = 1.6%, omission = 51.1%, dosage errors = 14.1%, form errors = 1.4%, administration errors = 7.3%, and t^b errors (i.e., time off by one hour or more) = 6.8%. Method three appears to be an improvement over method two since the error rate using method three did not vary as much from ward to ward as did the error rate using method two.

Method six not only eliminated one-half hour time errors, but it

also allowed for only one possible error per one Total Potential Medication. Only four errors were counted in method three which were not counted in method six; consequently, the error rate remained essentially unchanged (i.e., 436:2418 = 1:5.5 = 18.03%) from the 18.2% error rate calculated by using method three. However, method six was selected by the Author as the most appropriate manner in which to express the total error rate.

Auxiliary Data

Condition "N" Errors

Condition "N" errors (those errors in which the nurse committed herself to an error but either the patient or the pharmacy observer stopped the mistake before the medication was actually administered) were only observed in studies C and D and accounted for a total of eight medication errors. These were distributed as follows: three unordered drugs given, one extra dose given, and four omission errors. Examples of these "conditions" are presented below:

Case 1: On December 2, 1969, at 9:30 A.M., a nurse in study C handed patient 103 one 100mg Dilantin capsule. The patient refused to take the capsule stating that he had not previously been taking that particular medication. Reviewing the orders led to the discovery

that patient 104 (in the same room as patient 103) was to have received the Dilantin. Had it not been for an observant patient, an unordered drug would have been given to patient 103, and an omission error would have been reported for patient 104.

Case 2: On December 6, 1969, at 1:25 P.M., a nurse in study D handed patient 136, two Digoxin 0.25mg tablets, one 200mg Quinidine Sulfate tablet, and 10cc of 10% Potassium Chloride syrup. The patient put these medicines to his mouth at which time the pharmacy observer (the Author) noticed that the name on the patient's wrist band was not the name that the nurse had called out upon entering the room. The pharmacy observer asked the patient to wait before taking his medications, and the situation was quietly discussed with the nurse. It was discovered that the patient had misunderstood the nurse when she called out "his" name. Patient 135 (same room as patient 136) should have received the above-mentioned medications. Consequently, the nurse "committed" herself to three omission errors for patient 135. She also committed herself to two unordered drugs given and one extra dose given (since one Digoxin had actually been ordered for each patient) with respect to patient 136.

Condition "N", as it turned out, contributed very little, quantitatively, to this study. The study would have been essentially unaltered by deleting consideration of this particular auxiliary goal; however, the Author felt that the potential seriousness of the drugs

involved, in such cases as mentioned above, warranted the inclusion of such data.

"Serious" Versus "Other" Errors

Medication errors and Total Potential Medications (TPMs) were classified by pharmacological category for each of the studies A through F. For purposes of comparison among studies, the total number of errors (exclusive of time errors) was shown in Table 6 with the appropriate HFS (Hospital Formulary Service) number for each study. In addition, the total number of "serious" and "other" errors was compared to the number of "serious" and "other" TPMs for each study.

The medication errors and TPMs were also separated according to pharmacological category (HFS number) for the total study (Table 7). The Total Potential Medications (TPMs), number of omissions, number of commissions (i.e., all errors exclusive of omissions and time errors), total of omissions and commissions, as well as t^a and t^b time errors were all separated according to the percent "serious" and percent "other". The technique employed in Tables 6 and 7 was developed by Barker (3), and recently utilized by researchers at the University of Kentucky (12).

In Barker's study, the three most frequently observed drug error categories were (1) Central Nervous System (CNS),

Table 6. Medication errors and total potential medications by pharmacological category (serious versus other errors).

Pharmacological Category (by HFS)	Number of Errors and % of Total Errors (Not Counting Time Errors) For Each of Studies A-F																	
HFS	Study A			Study B			Study C			Study D			Study E			Study F		
Number	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O
4:00	1		1.3	0			1		1.7	0			0			0		
8:00	17	21.5		21	14.9		2	3.4		0			6	8.3		2	7.7	
12:00	1		1.3	0			6		10.3	0			1		1.4	0		
20:00	6	7.6		5	3.5		10	17.3		3	8.8		8	11.1		4	15.4	
24:00	15	19.0		13	9.2		2	3.4		8	23.5		3	4.2		0		
28:00	3	3.8		25	17.7		9	15.5		1	2.9		20	27.8		0		
36:00	0			0			0			0			0			0		
40:00	1	1.3		14	9.9		4	6.9		15	44.2		3	4.2		0		
44:00	0			0			0			0			0			0		
48:00	1		1.3	9		6.4	3		5.2	2		5.9	10		13.9	3		11.5
52:00	2		2.5	0			0			0			1		1.4	0		
56:00	16		20.2	33		23.4	6		10.3	1		2.9	10		13.9	14		54.0
68:00	7	8.9		6	4.3		7	12.1		1	2.9		2	2.8		0		
86:00	3	3.8		0			6	10.3		2	5.9		0			0		
88:00	6		7.6	14		9.9	2		3.4	1		2.9	6		8.3	2		7.7
92:00	0			1		0.7	0			0			2		2.8	1		3.8
Total	79	65.8	34.2	141	59.6	40.4	58	69.0	31.0	34	88.2	11.8	72	58.3	41.7	26	23.0	77.0

Errors	Study A	Study B	Study C	Study D	Study E	Study F	Total
Number Serious	52	84	40	30	42	6	254
Number Other	27	57	18	4	30	20	156
TPM							
Number Serious	229	446	250	242	258	105	1530
Number Other	112	285	103	79	164	145	888

Table 7. Medication errors and TPM by pharmacological category (total).

HFS Number	Number of Errors and % of Total Errors[a/]									Time Errors						TPM		
	Omission			Commission			Total			t^a			t^b					
	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O	No.	%S	%O
4:00	1		0.4	1		0.5	2		0.5	6		1.4	0			36		1.5
8:00	28	12.4		20	10.8		48	11.7		51	12.2		6	21.4		242	10.0	
12:00	6		2.7	2		1.1	8		2.0	3		0.7	0			30		1.2
20:00	11	4.9		25	13.5		36	8.8		21	5.0		2	7.1		142	5.9	
24:00	23	10.4		18	9.7		41	10.0		32	7.7		3	10.7		230	9.5	
28:00	38	16.9		20	10.8		58	14.1		83	19.9		7	25.0		529	21.9	
36:00	0			0			0			0			0			1		0
40:00	20	8.9		17	9.2		37	9.0		29	7.0		0			241	10.0	
44:00	0			0			0			0			0			1		0
48:00	20		8.9	8		4.3	28		6.8	7		1.7	1		3.6	96		4.0
52:00	3		1.3	0			3		0.7	4		1.0	1		3.6	12		0.5
56:00	43		19.1	37		20.0	80		19.5	83		19.9	4		14.3	356		14.7
68:00	15	6.7		8	4.3		23	5.6		13	3.1		0			93	3.9	
86:00	1	0.4		10	5.4		11	2.7		14	3.4		1	3.6		53	2.2	
88:00	13		5.8	18		9.7	31		7.6	70		16.8	3		10.7	343		14.2
92:00	3		1.3	1		0.5	4		1.0	1		0.2	0			13		0.5
Total	225	60.5	39.5	185	63.8	36.2	410	61.9	38.1	417	58.3	41.7	28	67.9	32.1	2418	63.4	36.6

[a/]Not counting time errors.

(2) Anti-infective, and (3) Gastrointestional (GI) drugs, respectively. Barker's results indicated that approximately 70% of all medication errors could be considered as involving serious drugs. The University of Kentucky study revealed that the two most frequently observed "serious" drug error categories involved (1) CNS (23.2%), and (2) Anti-infectives (18.5%), while the two most frequently observed "other" drug error categories involved (1) GI (24.4%), and (2) Expectorants and Cough Preparations (10.8%). Results at the University of Kentucky indicated that 59.1% of the errors involved "serious" drugs.

In the present study, the two most frequently observed "serious" drug categories were (1) CNS, and (2) Anti-infectives, while the most frequently observed "other" drug category was that of GI drugs. Of the drugs given, 63.4% were categorized as being "serious". Of the errors committed (exclusive of time errors), 61.9% were categorized as being involved with "serious" drugs. It is interesting to note that 67.9% of the time errors which differed from the scheduled time by one hour or more (t^b time errors) involved "serious" drugs.

The number of TPMs which were classified as being "serious" was 1530, while the "other" TPMs totaled 888. Not counting time errors, the total "serious" errors numbered 254, while the "other" errors numbered 156. The ratio of "serious" errors to "serious"

TPM was 254:1530 or 1:6 (16.6%). The "other" errors to "other" TPM ratio was 156:888 or 1:5.7 (17.6%). Seriousness of the error was only indirectly measured as a function of the potential seriousness of the drug involved. The ultimate seriousness of the error would vary from patient-to-patient and from condition-to-condition.

Two additional ratios may be helpful. The total serious errors (exclusive of time errors) to TPM ratio was 254:2418 or 1:9.5 (10.5%). The serious errors (exclusive of time errors) plus the serious t^b errors (i.e., time errors one hour or more away from the scheduled time) was divided by the TPM to obtain a ratio of 273:2418 or 1:8.9 (11.3%). The last ratio expresses the error rate in terms of the errors involving serious drugs with time errors being counted when they were at least one hour away from the scheduled time.

Medication Card Errors

Altogether 237 Medication Cards were compared with Doctors' Orders to establish a Medication Card error rate. Three different error rates were calculated:

1. The number of errors per number of Medication Cards.
2. The number of Medication Cards with at least one error per total number of Medication Cards.

3. The number of errors involving "serious" drugs per total number of Medication Cards.

With this information in mind, Table 8 was developed. Depending upon the method utilized the medication card error rate ranged from 1:13.2 (7.6%)to 1:18.2 (5.5%).

Continuing Medication and Treatment Record Errors

There were 23 photographed cases of discrepancies existing between Doctors' Orders and the Continuing Medication and Treatment Record. Twenty patients were involved and a total of twenty-eight discrepancies were observed. These discrepancies were distributed as follows: 9 were unordered drugs given (4 of these involved an incorrect or unobserved "discontinue" date), 8 were interval errors, 7 were dosage errors, 3 were errors of omission, and 1 was a dosage form error. Four of these cases are discussed below:

Figures 1 and 2: An "unordered drug given" discrepancy was shown in the photograph. There was no written order for either of the drugs found in the Continuing Medication and Treatment Record. The only drug order was for Milk of Magnesia, while the Continuing Medication and Treatment Record showed that both Orinase and Chloral Hydrate had been ordered.

Figures 3 and 4: A photographed "interval" discrepancy was

Table 8. Medication card errors.[a/]

Study	No. of cards	Number and Types of Errors: Administration S	Administration O	Dosage S	Dosage O	Route S	Route O	Wrong Drug S	Wrong Drug O	Error Rates: No. M	No. N	No. O
A	36			1	1	1				3:36	3:36	2:36
B	35									0	0	0
C	28	2		2	1					5:28	4:28	4:28
D	78	1								1:78	1:78	1:78
E	47	1	1	1	2			2	1	8:47	7:47	4:47
F	13	1								1:13	1:13	1:13
Total	237	5	1	4	4	1	0	2	1			

Error Rate Totals

Method Used	Rate	Reduced Rate
M	18:237	1:13.2
N	16:237	1:14.8
O	13:237	1:18.2

[a/] Key

s = Medication card errors involving "serious" drugs
o = Medication card errors involving "other" drugs

Administration Medication Card Error = Wrong or incomplete directions as to usage (e.g., writing "MOM 30cc qd" when Doctors' Orders read "MOM 30cc qd prn constipation")

Error Rate Methods:
M = Number of Errors:Number of Cards
N = Number of Cards with at least one error on them:Number of Cards
O = Number of errors involving "serious" drugs:Number of Cards

shown. Here a doctor clearly wrote "tid" for Potassium Chloride while the Continuing Medication and Treatment Record stated "qid" for Potassium Chloride.

Figures 5 and 6: A dosage discrepancy was illustrated in this case. The doctor wanted 30 cc Milk of Magnesia and 10 cc Cascara while the Continuing Medication and Treatment Record indicated 30 cc Milk of Magnesia and 5 cc Cascara.

Figures 7, 8, 9, and 10: This was an example of an "unordered drug" being given, due to an incorrectly interpreted discontinue (DC) date. Here the doctor only wanted Valium to be given three times daily for five days, yet, almost two weeks later the doctor had to request that Valium be discontinued. Ironically, in response to this request the Continuing Medication and Treatment Record indicated that Valium was not only to be continued, but also it was now to be given at bedtime. It was not until after five more days that Valium was, eventually, discontinued.

A reliable error rate was not determined for Continuing Medication and Treatment Records as not all such records were reviewed as closely as for these twenty patients. These were cases which "caught the Author's eye" as data were being collected from Doctors' Orders; consequently, these cases were not necessarily representative. Despite this fact, an "estimated" error rate was determined by dividing the number of discrepancies (28) into the total number of

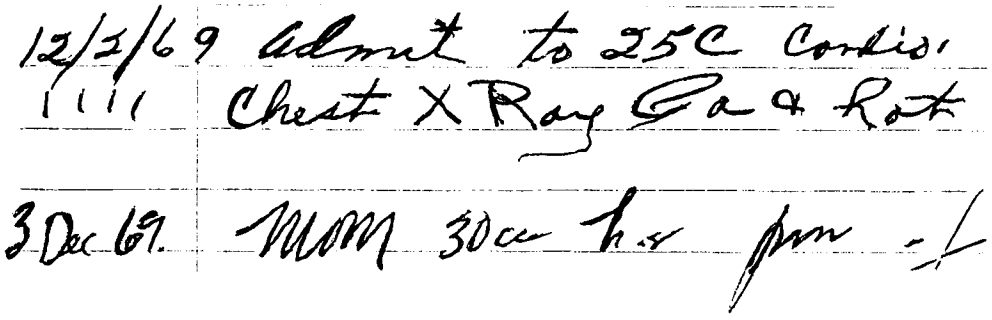

Figure 1. Doctors' Orders.

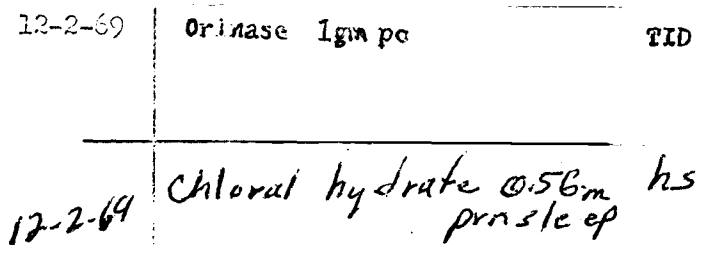

Figure 2. Continuing Medication and Treatment Record.

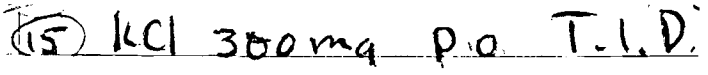

Figure 3. Doctors' Orders.

Potassium Chloride 300 Mg m PO QID

Figure 4. Continuing Medication and Treatment Record.

MOM 30cc } daily prn
Cascara 10cc }

Figure 5. Doctors' Orders.

1/29/70	MOM 30cc Cascara 5cc qd

Figure 6. Continuing Medication and Treatment Record.

9-30-69 Valium 5mg Po TID x 5 days

Figure 7. Doctors' Orders.

9-30-69	Valium 5mg P.O. Tid
Last Dose	10/13/69

Figure 8. Continuing Medication and Treatment Record.

10-13-69 D/C Valium

Figure 9. Doctors' Orders.

10-13-69 Valium 5mg po tid s H.S.

Figure 10. Continuing Medication and Treatment Record.

entries made in the Continuing Medication and Treatment Record for these 20 patients (239). This resulted in an estimated error rate of 1:8.2 (11.7%). Of the 28 discrepancies, four were considered by the Author to be due somewhat to a poorly written Doctors' Order. By subtracting these four "physician-caused" discrepancies from the total number of discrepancies, an error rate of 1:10 (10%) was established. The actual error rate, whether it be lower or higher than the above estimates, is, in any case, apparently too high when one considers that this is the permanent official document concerning the medications which were actually administered to patients by Nursing Service.

"Awareness" Effect on Error Rates

In studies A and B, nurses were "unaware" of the actual purpose of pharmacy observations. A total of 100 patients were involved with these two studies. In studies C and D, nurses were initially aware of the fact that a medication error study was being conducted. A total of 53 patients were involved with these two studies. Studies E and F involved the two wards that were originally observed in studies A and B; however, in studies E and F, nurses were now informed that a medication error study was being conducted (aware secondarily). A total of 42 patients were included in these two studies.

An error rate (based on method six) was calculated for each round, for each study. This rate (a proportion) was expressed as a percentage (number of errors ÷ TPM x 100) and then a normalizing transformation (arcsin or angular transformation) was performed (6, 20). An analysis of variance (F ratio) was then computed. It was found that at the 5% level there was a significant difference between error rates on wards that were aware (15.6%) and wards that were unaware (21.1%). However, there was no such significant difference between wards that were aware initially and wards that were aware secondarily. Data and corresponding statistical analyses are shown in Appendix E.

These data appear to imply that nurses are more cautious (and, thus, make fewer errors) when they know that they are being observed for medication errors as opposed to when nurses feel that they are being observed for other reasons. The disguised observer technique (unaware) revealed an error rate which was significantly higher than the "direct" observer technique (aware).

Surgical Versus Medical Ward Error Rates

Another goal of this study was to find if there was a statistically significant difference between the error rates of surgical and medical wards. In Barker's studies, it was found that there were "no significant differences in the number of errors made on different

services" (4). However, it was suggested that such differences may be found in studies involving larger samples.

Studies A, C, and F were involved with surgical wards, and a total of 80 patients were included. Studies B, D, and E were involved with medical wards, and 115 patients were included in these three studies.

Based on an analysis similar to that used for auxiliary data five (Appendix E), it was found that no significant difference existed between error rates on medical and surgical wards in the study hospital.

9 A.M. Versus 1 P.M. Medication Error Rates

Medication error rates (based on method six) were determined for all 9 A.M. and 1 P.M. medication rounds. An analysis similar to that used for auxiliary data five and six (Appendix E) revealed no significant differences between the error rates for these two medication administration times.

Perhaps, this was because both 9 A.M. and 1 P.M. were extremely busy times on most wards. As pointed out previously, most medication time intervals call for medications to be given at either or both of these times. In order to determine the degree to which workload influences error rates, it appears that more administration times would have to be included such that busy and

"non-busy" administration times could be compared.

Other Observations

Other observations were concerned primarily with "pouring" techniques. For instance, many nurses "poured" toward the label of liquid medications. Some nurses did not clean off the lips of liquid bottles after preparing medications. Several nurses delivered liquid medications through a dropper by holding said dropper at a 45^{o} angle.

Such practices were observed many times, but no attempt was made to quantify their existence. Two situations deserve further discussion. One involved the storage of unused half tablets, and the other involved incorrect labeling and a subsequent dosage error.

One nurse had a particularly bad habit of storing unused one-half tablets of Digoxin in a corner of the medicine cabinet. Later, she would use the remaining one-half tablet for another order. Such practices were in direct violation of hospital and nursing policy, as well as being extremely dangerous and unsanitary (also no economic factors warranted such practices when giving Digoxin).

An error involving a doctor, a pharmicist, and a nurse occurred in study E. The drug was Mandelamine Suspension 100mg per ml. The doctor wrote for 100mg of Mandelamine Suspension which led to a complaint from nurses that this dose was difficult to administer.

The bottle was returned to pharmacy along with the aforementioned complaint. In pharmacy the bottle was relabeled, incorrectly, to read 1000mg per ml. In the meantime, a pharmacist on the ward questioned the efficacy of such a low dosage of Mandelamine. The doctor, realizing that 100mg of Mandelamine was a subtherapeutic dosage, changed the order to 1000mg of Mandelamine Suspension. The incorrectly labeled bottle was observed on the ward by a pharmacist. The pharmacist relabeled the bottle to read 100mg per ml. At this point in time the correct volume of Mandelamine Suspension was 10ml. The particular nurse on medication rounds reglected to read the change in dosage and change in labeling and proceeded to give the one ml dosage as before. The error was later pointed out to the nurse so that the patient could begin proper therapy.

SUMMARY AND CONCLUSIONS

Medication error rates have long been a subject of interest to the pharmaceutical, nursing and medical professions. The main purpose of such studies has been to discover the quantity and types of errors which may exist, thus enabling investigators to evaluate the relative safety of various drug distribution systems as well as to make appropriate recommendations for improvement of such systems.

A study was designed to determine the medication error rate in a hospital utilizing a ward stock drug distribution system. Pharmacy personnel collected data by accompanying nurses on medication rounds. Data were then compared to Doctors' Orders as to what drugs should have been given, to whom, at what time interval, etcetera. The study included 195 patients, and altogether 2,418 Total Potential Medications were reviewed.

The primary goal of this project was to determine various medication error rates for the study hospital. Seven different methods of calculating the error rate were proposed and subsequent error rates were calculated. Depending upon the method utilized, the error rate (for the total of all studies) ranged from 1:2.8 (35.4%) to 1:5.9 (16.9%). The method chosen as being most appropriate (method six) revealed an error rate of 1:5.5 (18.03%).

Distribution of errors for the 1:2.8 (35.4%) error rate was: one-half hour time errors = 48.5%, omission errors = 26.3%, unordered drug given = 9.1%, dosage errors = 7.3%, administration errors = 3.7%, one hour time errors = 3.5%, extra dose errors = 0.8%, and dosage form errors = 0.7%.

One-half hour time errors, however, were very unevenly distributed among the wards studied. Exclusion of one-half hour time errors produced an error rate of 1:5.5 or approximately 18%. Distribution of errors for the 1:5.5 error rate was: omission errors = 51.1%, unordered drug given = 17.7%, dosage errors = 14.1%, administration errors = 7.3%, one hour time errors = 6.8%, extra dose errors = 1.6%, and dosage form errors = 1.4%.

In addition to the primary goal, eight auxiliary goals were sought: (1) condition "N" errors (those errors in which the nurse committed herself to an error but either the patient or the pharmacy observer stopped the mistake before the medication was actually administered) occurred with only 8 medications out of a total of 2418 Total Potential Medications; consequently, this situation contributed very little to the study; (2) "serious" versus "other" errors - the two most frequently observed "serious" drug categories were Central Nervous System drugs and Anti-infectives, while the most frequently observed "other" drug category was that of Gastrointestinal drugs; (3) the Medication Card error rate ranged from 5.5% to 7.6%;

(4) an "estimated" Continuing Medication and Treatment Record error rate ranged from 10% to 11.7%; (5) a statistically significant decrease in error rate occurred when nurses were aware that a medication error study was being conducted as opposed to nurses who were unaware of the actual purpose of the observation; thus, disguised observer techniques do, indeed, appear to reveal higher error rates than do direct observer techniques; (6) no significant difference in error rates between medical and surgical wards could be detected; (7) no significant difference in 9 A.M. and 1 P.M. medication error rates could be detected; and (8) several drug preparation (i.e., pouring) technique weaknesses were noted.

On the basis of the aforementioned data, it appears that the drug distribution system being utilized by the study hospital needs to be reviewed and revised in hopes of decreasing the error rate. In view of the reported medication error rate, it would seem that appropriate personnel at the study hospital should first determine if the present drug distribution system is adequate. If it is felt that an error rate of 1:5.5 (18.03%) is not acceptable, perhaps other drug distribution systems should be investigated.

Interpretation of Doctors' Orders appears to be a potential reason for errors (as evidenced by the reported Medication Card error rate and the estimated Continuing Medication and Treatment Record error rate). Other studies have shown that error rates can

be reduced by use of a unit-dose drug distribution system (2, 12), which utilized pharmacists in the interpretation of Doctors' Orders. Perhaps, the information provided by this study may be of benefit in initiating such changes.

BIBLIOGRAPHY

1. Barker, Kenneth N. "The Effects of an Experimental Medication System on Medication Errors and Costs". American Journal of Hospital Pharmacy. 26:324. June, 1969.

2. Barker, Kenneth N. and William M. Heller. "The Development of a Centralized Unit-Dose Dispensing System for U. A. M. C., part VI, The Pilot Study - medication errors and drug losses". American Journal of Hospital Pharmacy. 21:609. December, 1964.

3. Barker, Kenneth N., W. W. Kimbrough and W. M. Heller. A Study of Medication Errors in a Hospital. University of Arkansas, Fayetteville, Arkansas, November, 1966.

4. Barker, Kenneth N. and Warren E. McConnell. "How to Detect Medication Errors". The Modern Hospital. 99: 95-106. July, 1962.

5. Barker, Kenneth N. and Warren E. McConnell. "The Problems of Detecting Medication Errors in Hospitals". American Journal of Hospital Pharmacy. 19:360. August, 1962.

6. Batson, H. C. An Introduction to Statistics in the Medical Sciences. Dept. of Public Health, University of Illinois, College of Medicine, Chicago, Ill. p. 22-37. 1956.

7. Byrne, Ann K. "Errors in Giving Medication". American Journal of Nursing. 53:829. July, 1953.

8. Faddis, M. O. "Eliminating Errors in Medication". American Journal of Nursing. 39:1217. November, 1939.

9. Flanagan, J. C. "The Critical Incident Technique". Psychol. Bull. 51:327. July, 1954.

10. Fulton, Jack J. "Medical-Legal Forum Medication Errors". Hospital Forum. 4:22. September, 1961.

11. Hartley, Herbert. "Medication Errors in Hospitals". Northwest Magazine. 68:239-242. March, 1969.

12. Hynniman, C. E. et al. "A Comparison of Medication Errors under the University of Kentucky Unit Dose System and traditional drug distribution systems in four hospitals". American Journal of Hospital Pharmacy. 27:803. October, 1970.

13. (Incident Report Form). Hospitals. 32:46. August, 1958.

14. Lauterstein, R. and L. Mustoe. "Accidents Involve People". Nursing Outlook. 8:96. February, 1960.

15. Parrish, H. M., T. P. Weil and B. Wolfsen. "Accidents to Patients can be Prevented". American Journal of Nursing. 58:679. 1958.

16. Pearsall, Marion. "Participant Observation as Role and Method in Behavioral Research". Nursing Research. 14:37. Winter, 1965.

17. Safren, Miriam A. and Alphonse Chapanis. "A Critical Incident Study of Hospital Medication Errors". Part One. Hospitals. 34:32. May 1, 1960.

18. Safren, Miriam A. and Alphonse Chapanis. "A Critical Incident Study of Hospital Medication Errors". Part Two. Hospitals. 34:53. May 16, 1960.

19. Schlessberg, Eli. "16 Safeguards Against Medication Errors". Hospitals. 32:62. October 1, 1958.

20. Snedecor, George W. and William G. Cochran. Statistical Methods. Sixth Edition. The Iowa State University Press. Ames, Iowa. p. 327-328, 563, 569-571. 1967.

21. Vere, D. W. "Errors of Complex Prescribing". Lancet. 1:370-373. February, 1965.

APPENDICES

APPENDIX A

PHARMACY ORDER

ISSUE TO:

LINE NO.	ITEMS	QUANTITY ORDERED	QUANTITY DISPENSED
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
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20			
21			
22			

ORDERED BY (*Signature*) DATE

PHARMACIST FILLING ORDER DATE

RECEIVED BY DATE

APPENDIX B

YEAR:		MONTH(S):														
DATE	MEDICATION AND TREATMENT *(A nurse will initial each entry to verify that it has been correctly transcribed. SEE REVERSE SIDE FOR IDENTIFICATION OF INITIALS.)*	TOUR	DATE													
			NURSES' INITIALS													
		N														
		D														
		E														
		N														
		D														
		E														
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Enter in space below: PATIENT IDENTIFICATION – TREATING FACILITY – WARD NO. – DATE

MEDICAL RECORD

CONTINUING MEDICATION AND TREATMENT

APPENDIX C

Nursing Procedure - MEDICATIONS

Preparation and Administration of Medications

Note: This procedure is supplemented by and is to be used in conjunction with the procedure on Control of Alcoholics and Narcotics, and the Charting Procedure.

GENERAL RULES:

1. The professional nurse is responsible for the actual (or the supervision of instructed Practical Nurses assigned) preparation, administration, and recording of all medications, except those given by doctors. In the case of doctors administering medications, entry on the Nursing Observations will so note. (Nursing Assistants may administer retention enemas, suppositories or medicated baths, but the nurse must prepare the solution to be given.)

2. Special care must be exercised to assure identity of the patient. If in doubt, ask the patient to give his name, and check the identification bracelet.

3. Orders for medications are to be written by the doctor before a drug is given. The dose order must be specific. At night, if the O. D. orders a drug via phone, the chart will be sent immediately to him for written order, and the nurse will NOT administer the medication until the written order is checked.

4. Orders written by the clinical clerk must be countersigned by the ward doctor before the orders can be accepted.

5. Medications will be given by the nurse who prepared them, with the exception of the I. V. or other medications prepared for the doctor to give.

6. Medication Cards must be checked routinely each shift against entries on the Continuing Medication and Treatment Record or Doctors' Order sheet to assure there is a card for each medication order. Head Nurses or their designates

will be held responsible for assuring that all orders are current AND accurate.

7. Trays of medications must be under direct supervision of the nurse until ALL medications have been given.

8. ANY medication left at the bedside requires a written order "at bedside", must be labeled, and must be checked daily. The following medications usually are "at bedside" orders: PAS, PZA, INH, Trecator, and Cycloserine; antacids; nitroglycerin tablets; cough medicine; ointments for use for skin conditions; and salt and soda rinses and gargles.

9. The medication cabinet is to be locked when not in use and the key kept in the possession of the nurse at all times. Keys are not to be released to anyone other than the registered or practical nurse specifically designed responsibility for preparing and administering medications.

10. Nurses must be continuously aware of inherent dangers of habit formation and untoward reactions in the use of drugs.

11. Condition or state of medication must be observed carefully for signs of adulteration or deterioration. If in doubt, return medication to Pharmacy for replacement.

12. Assure adequate supply of all drugs in daily use is available for 48-hour and week-end/holiday periods.

13. NEVER take stock bottles of medications to the bedside.

14. Return all empty bottles and vials to Pharmacy (except solution vials such as streptomycin). Do not use pharmacy bottles for any other purpose.

15. DO NOT transfer contents of partially empty bottles into any other container.

16. Drug containers are to be returned to Pharmacy when labels are soiled or illegible. Ward personnel are NOT to re-label drug containers.

17. Samples, etc., of drugs which physicians wish administered to patients must be sent to Pharmacy for regulation packaging and labeling.

18. Bedside Medications: the following guide lines are suggested:

    a. A patient is judged to be capable of assuming responsibility for self-administration of medication.

    b. The physician must write and sign an order specifically stating that the patient will administer to himself the prescribed medication.

    c. The physician will arrange to provide for adequate instruction and orientation of the patient regarding his responsibility for self-administration of medication. The nurse will assure herself that this has been done and the patient understands his instructions.

    d. The Pharmacy will, on the individual prescription of the physician, dispense to the patient--through the ward nurse--the medication in properly labeled containers.

    e. The patient's medical record, including the nurses' notes, will show that the patient is a participant in the plan.

19. On admission of patient, medications for self-administration will be impounded and stored.

20. Medications requiring special preparation, such as pulverizing tablets for administration via tube feeding, will be prepared by Pharmacy on request.

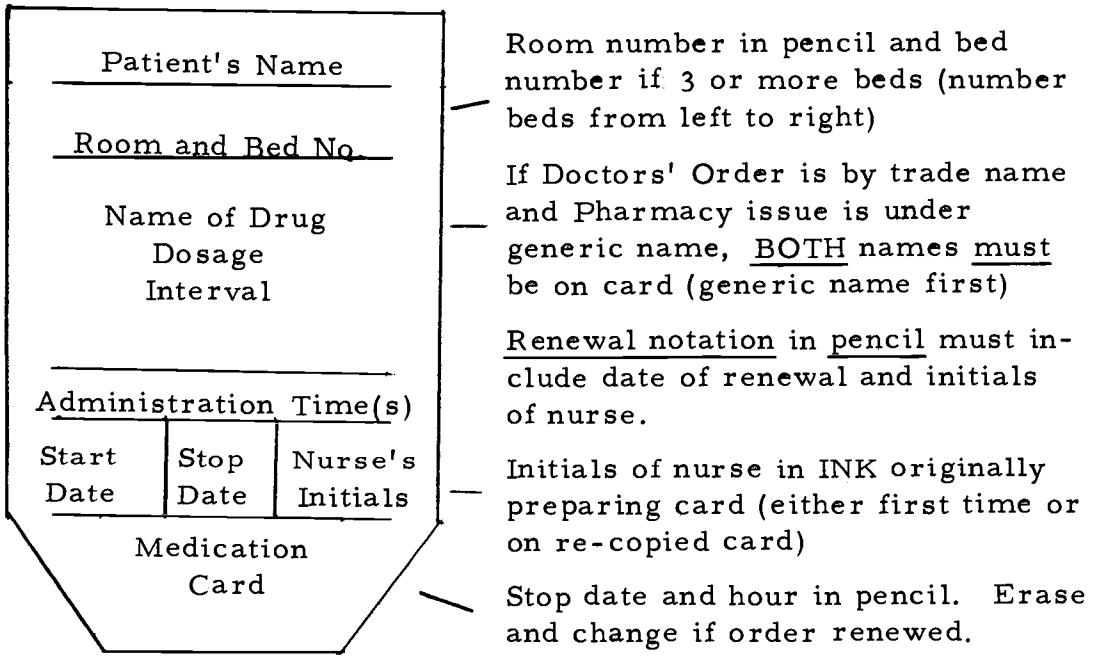
21. Antibiotics require a specific "stop-date" order. Any not ordered with a specific stop-date will automatically be stopped in 7 days. Nurses are to remind the doctors of the impending expiration of the 7 day period.

22. The nurse who checks the doctor's order will also verify the accuracy of the entry by the ward clerk on the medication card, and (in case of continuing medications) the entry on the Continuing Medication and Treatment Record; when necessary, the nurse will carry out the entire procedure. PRN orders or other medication orders--such as non-stabilized dosages--will be noted on the Nursing Plan card and, when administered, charted on the Nursing Notes Record until such time as they may be entered on the Continuing Medication and Treatment Record.

23. Medication Cards will be prepared on ALL medications (stat, single, narcotic, PRN, continuing, whether to be dispensed from Nurses' Office or Dressing Room) AT THE TIME the orders are checked.

a. When soiled cards are re-copied, the original order must be re-checked on the Doctors' Order form... do not re-copy from the old card.

b. Except for indicated pencil entries and written initials in ink, cards will be typed or printed clearly in ink.



Appendix C (Continued)

PROCEDURE	KEY POINTS
A. Checking Orders	
1. Make check mark & enter initials in appropriate space following order.	Medications are not to be given without written order. Check mark indicates you are working on the order; the initials indicate you have completed the orders.
2. Prepare Medication Card for each ordered medication, entering complete information as illustrated on previous page. If medications are ordered as a unit, may be entered on one medication card. Write initials in ink.	Nurse who checks order, must prepare card & enter her initials on card verifying accuracy of order.
3. Following preparation of card, RECHECK against doctor's order to verify accuracy of drug, dose, and frequency.	
4. Transcribe orders for any continuing medications onto the Continuing Medication & Treatment record.	Stat/one-time medication, or medications with non-stabilized dosage are not entered on Continuing Medication & Treatment Record. Neither are PRN orders, until frequency of administration indicates entry.
5. Note any PRN or non-stabilized-dosage orders on Nursing Plan Card, as indicated in Charting Procedure.	
6. If order is STAT or one-time only: a. When checking STAT or one-time only, enter time and initial beside the check mark on Doctor's Order Sheet. b. Chart administration of drug on Nurses' Notes. c. Destroy card immediately after giving medication.	
7. Narcotic/Alcoholic orders: a. Place "N" in RED pencil in lower right corner of medication card and maintain card in Kardex on top of patient's Nursing Plan.	Review & carefully adhere to procedure for Control of Narcotics and Alcohol. Complete Narcotic Order must be re-written each 72 hours.

PROCEDURE	KEY POINTS
Checking Orders (cont.)	
8. Place medication cards (other than STAT/one-time & narcotic) in appropriate pocket of Medication Card Rack. . .or, if indicated, in Medication Card file in Dressing Room.	Medication cards are to be arranged alphabetically in Card Rack.
9. If order is renewed: - nurse checking renewal order will erase date & time in "stop" space on Medication Card; enter new date & time, will enter "Renewed. . .", note her initials and date as illustrated on Page 70.	The nurse making renewal note will be held responsible for assuring renewed order is identical with medication card.
B. Preparation of Medications	
1. Select appropriate cards from rack.	
2. Review cards to be sure "stop" date has not been reached. As indicated, check cards against Continuing Medication & Treatment Record and/or Doctors' Orders to assure order has not been changed or discontinued.	
3. Locate correct medication & check with medication card.	If there are two bottles of same drug, be sure to use one bottle completely before opening second.
4. READ LABEL: - a. BEFORE removing bottle from shelf. b. BEFORE pouring medication. c. When returning bottle to shelf.	Verify unusual or questionable drug or dosage. If in doubt, do NOT prepare or give drug until you check with head nurse, supervisor or doctor.
5. Pour medications, observing precautions to assure accuracy. a. Use medicine glass or clear plastic for liquid medications such as Tr. Belladonna, Potassium Iodide, etc., which are prone to absorb in paper cups. b. Use measuring device indicated. (Minim glass for minims, dropper for drops, etc.) c. Add water immediately to those medicines requiring dilution, to avoid loss by evaporation.	Refrain from talking while pouring medications. Read literature accompanying (or Formulary information on) new or unfamiliar drugs. Pour Away from the label.

PROCEDURE	KEY POINTS
d. Hold glass on level with eye when measuring liquids. e. Check for abnormal appearance or odor of medication.	NEVER POUR DRUG BACK INTO BOTTLE.
6. Place medicine glass (cup) in back of corresponding medicine card on tray.	In mixing drugs such as ACTH, pencillin, etc., which will be used for continuing doses, the nurse mixing the drug MUST place an adhesive label, carrying her initials and date, and clearly indicating the strength of dosage per cc, on the bottle.
7. Wipe off bottle and re-cap.	
8. Re-read label and replace bottle in proper location on shelf.	IMPERATIVE that the nurse use caution in noting required dilution on certain drugs (Streptomycin & Streptomycin Sulfate appear identical yet require different dilutions to achieve correct dosage).
9. LOCK the medication cabinet and remove keys from lock.	READ DIRECTIONS CAREFULLY.
C. Administration of Medications	
1. Take tray of medications & cards, and administer medications to patients, using following precautions to assure accuracy: - a. Check identification tag. b. Ask patient his name (or if you know him, address him by name). c. Make necessary explanatory remarks.	The nurse who prepares the medicines MUST administer and chart them. BE SURE of your identification of the patient. Literature accompanying drugs (or Formulary) will often give information about expected reactions. Simple explanations will often spare the patient anxiety.
2. Wait until you have actually observed the patient take the medication.	Medications are NOT to be left at bedside except on written order. If such order is written, notation to the effect should be on Medication Card, with entry on Continuing Medication & Treatment Record, and on Nursing Plan.
D. Charting Medications	REFER TO PROCEDURE ON "CHARTING"
USE MEDICATION CARDS AS VERIFICATION and: 1. Record on Nursing Notes: - a. All narcotics/alcoholics. b. All STAT/single dose medications.	Charting of narcotics/alcoholics require full signature of nurse directly under narcotic.

PROCEDURE	KEY POINTS
c. PRNs which are not on Continuing Medication & Treatment Record. d. Notations concerning omitted or held medicines, unusual observations, etc.	
2. Record on Continuing Medication & Treatment Record your initials in correct date block for each medication listed on the CM&T Record and administered. Make other appropriate entries for "held" or omitted doses, etc.	Initials are not, under any circumstances to be entered until AFTER administration of medicines.

E. Action in case of Error in Medication Procedure

Failure to immediately report discovery of an error (whether discovered by nurse making error or someone else) is considered a serious omission of professional duty. All nurses are held strictly responsible for prompt action in such cases.

1. Immediately take emergency action if such is indicated and if you KNOW what action to take (e.g., irrigate eye if wrong medication has been used.) EXTREME CAUTION MUST BE EXERCISED BY NURSE IN DECIDING ON ACTION PRIOR TO DOCTOR'S EXAMINATION AND ORDER. RESTRICT TO SIMPLE FIRST AID.

2. Notify doctor.

3. Notify head nurse and/or supervisor.

4. Assist in follow-up treatment of patient.

5. Record all pertinent information, including who was notified and action taken on "Nurses Notes."

6. Prepare "Special Incidents Involving a Beneficiary" form.

F. Action in case of Suspected Error in Drug Issued by Pharmacy

1. If stock supply of drug appears to be other than as labeled (or if, on administration, patient complains of usual medication "being different. . .") DO NOT TAKE A CHANCE.

2. If drug has been given follow procedure for "Error in Medication Procedure" as above.

3. In any case, whether or not drug has been given, seal bottle and assure that it is turned over to appropriate officials for investigation. (Never destroy remaining portion of suspected drug.)

4. Prepare MEMO addressed to Chief, Nursing Service, setting forth complete details.

G. Any medication to be administered through the I.V. tubing of an established intravenous solution WILL ALWAYS BE GIVEN BY THE PHYSICIAN CONCERNED. Nurses may add medication to a bottle of intravenous solution, and can prepare medication for the doctor to insert through the I.V. tubing, provided that the order is written for the correct dosage, and it has been determined that the drug is appropriate for intravenous use. Charting should indicate who prepared and who administered the medication.

APPENDIX D

FORM 1

PREPARATION OF MEDICATIONS FOR ADMINISTRATION
(DRUG)

Ward
Date
Time

Activity	Drug	Quantity	Strength (if more than one is stocked)
1			
2			
3			
4			
5			

FORM 2

PREPARATION OF MEDICATIONS FOR ADMINISTRATION
(POSITION)

Ward
Date
Time

Activity	Form	Position	Quantity
1			
2			
3			
4			
5			

FORM 3

ADMINISTRATION OF MEDICATION

Ward
Date

Position (in tray)	Patient's Name	S.S. Number	Time A.M.	Time P.M.
1				
2				
3				
4				
5				

FORM 4

DOCTORS' ORDERS

DATE	DRUG	DOSAGE FORM	DOSE	INTERVAL	ROUTE	STOP

FORM 5

DETERMINATION OF TYPE OF ERROR

MEDICATION GIVEN											MEDICATION ORDERED								TYPE OF ERROR									
Med. No.	Pt. No.	Study	Date	Drug	Strength	Form	Quantity	Route	Time A.M.	Time P.M.	Drug	Strength	Form	Quantity	Route	Interval	Time A.M.	Time P.M.	U	E	O	D	F	A	t^a	t^b	t^c	t

APPENDIX E
(Part 1 - Data Table and Angular Transformation)
Statistical Analysis for Auxiliary Data (5, 6, 7)

Study A (Unaware, Surgical)

9 a.m. (n = 8)			1 p.m. (n = 9)		
Rate	%	Angle	Rate	%	Angle
8:26	30.77	33.69	9:15	60.00	50.77
3:25	12.00	20.27	2:14	14.29	22.20
3:24	12.50	20.70	3:16	18.75	25.66
0:14[a/]	1.79	7.69	4:14	28.57	32.31
4:14	28.57	32.31	3:14	21.43	27.60
8:25	32.00	34.45	2:16	12.50	20.70
9:26	34.62	36.04	5:14	35.71	36.70
12:40	30.00	33.21	3:17	17.65	24.84
			5:27	18.52	25.49
Sum of Angles =		218.36			266.27
Sum of Squares =		6666.0394			8576.7103

Study B (Unaware, Medical)

9 a.m. (n = 8)			1 p.m. (n = 8)		
Rate	%	Angle	Rate	%	Angle
7:27	25.93	30.61	9:41	21.95	27.94
4:28	14.29	22.20	11:38	28.95	32.55
17:69	24.64	29.76	1:18	5.56	13.64
11:45	24.44	29.63	6:40	15.00	22.79
11:38	28.95	32.55	9:27	33.33	35.26
19:86	22.09	28.03	13:39	33.33	35.26
12:89	13.48	21.56	1:47	2.13	8.39
10:84	11.90	20.18	2:15	13.33	21.41
Sum of Angles =		214.52			197.24
Sum of Squares =		5910.6560			5664.7192

Study C (Aware Initially, Surgical)

9 a.m. (n = 7)			1 p.m. (n = 7)		
Rate	%	Angle	Rate	%	Angle
9:51	17.65	24.84	2:22	9.09	17.55
5:38	13.16	21.27	3:18	16.67	24.10
7:35	20.00	26.56	1:16	6.25	14.48
8:40	20.00	26.56	1:17	5.88	14.04
4:37	10.81	19.20	2:14	14.29	22.20
1:2	50.00	45.00	2:16	12.50	20.70
13:41	31.71	33.83	2:6	33.33	35.26
Sum of Angles =		197.26			148.33
Sum of Squares =		6018.4146			3460.2021

Study D (Aware Initially, Medical)

9 a.m. (n = 7)			1 p.m. (n = 6)		
Rate	%	Angle	Rate	%	Angle
6:26	23.08	28.72	0:17[a/]	1.47	6.97
4:21	19.05	25.88	2:18	11.11	19.47
2:25	8.00	16.43	1:19	5.26	13.26
2:18	11.11	19.47	6:32	18.75	25.66
5:30	16.67	24.09	0:27[a/]	0.93	5.53
3:27	11.11	19.47	0:26[a/]	0.96	5.62
3:35	8.57	17.02			
Sum of Angles =		151.08			76.51
Sum of Squares =		3392.7280			1324.0903

Study E (Aware Secondarily, Medical)

9 a.m. (n = 5)			1 p.m. (n = 7)		
Rate	%	Angle	Rate	%	Angle
8:39	20.51	26.93	3:27	11.11	19.47
7:42	16.67	24.09	5:31	16.13	23.68
7:46	15.22	22.97	1:26	3.85	11.32
9:51	17.65	24.84	8:32	25.00	30.00
10:47	21.28	27.48	3:23	13.04	21.17
			7:30	23.33	28.88
			9:28	32.14	34.53
Sum of Angles =		126.31			169.05
Sum of Squares =		3205.3499			4442.5099

Study F (Aware Secondarily, Surgical)

9 a.m. (n = 6)			1 p.m. (n = 7)		
Rate	%	Angle	Rate	%	Angle
3:24	12.50	20.70	0:11[a/]	2.27	8.66
3:25	12.00	20.27	2:14	14.29	22.21
2:32	6.25	14.48	0:10[a/]	2.50	9.10
2:29	6.90	15.23	4:9	44.44	41.80
4:27	14.81	22.64	1:9	11.11	19.47
3:34	8.82	17.28	3:12	25.00	30.00
			12:14	85.71	67.80
Sum of Angles =		110.60			199.04
Sum of Squares =		2092.1542			8274.2506

[a/] When n is less than 50, a zero proportion should be counted as 1/4n before transforming to angles (i.e., 0:14 = 1:(4)(14) = 1:56 = 1.79%). [20]

APPENDIX E
(Part 2 - Tabulation of Transformed Data)

	Unaware^{+}		Aware Initially^{-}		Aware Secondarily^{-+}		
	9 a.m.$^{+}$	1 p.m.$^{-}$	9 a.m.$^{+}$	1 p.m.$^{-}$	9 a.m.$^{+}$	1 p.m.$^{-}$	Total
- Medical (n = 41)	214.52	197.24	151.08	76.51	126.31	169.05	934.71
n	8	8	7	6	5	7	41
+ Surgical (n = 44)	218.36	266.27	197.26	148.33	110.60	199.04	1139.86
n	8	9	7	7	6	7	44
Sum =	432.88	463.51	348.34	224.84	236.91	368.09	2074.57
n =	16	17	14	13	11	14	85
Sum =	896.39		573.18		605.00		
n =	33		27		25		
Sum =			1178.18				
n =			52				

Sum of 9 a.m. Medications = 1018.13 with n = 41
Sum of 1 p.m. Medications = 1056.44 with n = 44

APPENDIX E
(Part 3 - Sample Calculation of Sums Squared)

General Formula (for corrected sums squared)

$$\frac{(\text{Sum of } y)^2}{n_y} + \frac{(\text{Sum of } x)^2}{n_x} - \frac{(\text{Sum of } x + \text{Sum of } y)^2}{n_{x+y}}$$

For example

Surgical Service Medication Errors (y) versus Medical Service Medication Errors (x), following angular transformation.

$$\frac{(1139.86)^2}{44} + \frac{(934.71)^2}{41} - \frac{(2074.57)^2}{85} =$$

$$\frac{1299280.8196}{44} + \frac{873682.7841}{41} - \frac{4303840.6849}{85} =$$

$$29529.1095 + 21309.3362 - 50633.4198 = 205.0259$$

APPENDIX E
(Part 4 - Analysis of Variance of Transformed Data)

Sources of Variance Main Effects	df[a/]	SS[a/]	MS[a/]	F[a/]	Sign. Diff. (5%)[a/]
Surgical vs. Medical	1	205.0259	205.0259	2.2457	No
9 a.m. vs. 1 p.m.	1	14.3557	14.3557	0.1572	No
Aware (initially and secondarily) vs. Unaware	1	409.9074	409.9074	4.4898	Yes
Aware initially vs. Aware secondarily	1	114.5877	114.5877	1.2551	No
Total	(4)	(743.8767)			
Interactions					
Ward X Time	1	146.8937	146.8937		
Ward X (Unaware Plus Aware)	1	14.4165	14.4165		
Time X (Unaware Plus Aware)	1	26.3879	26.3879		
Ward X (Aware Initially Plus Aware Secondarily)	1	206.8815	206.8815		
Time X (Aware Initially Plus Aware Secondarily)	1	520.6317	520.6317		
Total (First Order Interactions)	(5)	(915.2113)			
Higher Order Interactions	2	70.6355			
Within Groups	73	6664.6812	91.2970		
Total	84	8394.4047			

[a/] df = degrees of freedom, SS = sums squared, MS = mean of squares, F = F ratio, Sign. Diff. (5%) = Difference is significant at the 5% level (With 1 and 73 degrees of freedom, the F ratio must be greater than 3.974 in order to be significant at the 5% level).[(20)]

F = MS/Within Groups MS