A Study of the Quality of Prescriptions Issued In a Busy Pediatric Emergency Room

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THE THERAPEUTIC EFFECTIVENESS of a drug is partly related to adequate levels in the blood and to the length of time these levels are maintained. For children, the adequacy of blood levels depends on the following factors:

- The taste of the compound and thus its acceptability by the child.
- The amount of drug administered per dose, which often depends on the particular household measure used *(1)*. In most cases, the physician calculates dosage on the basis of body weight or age, or both. However, the capacity of the home measuring device—usually a teaspoon—may vary greatly.
- The frequency of administration or the interval between doses ordered by the physician. Unfortunately, the more doses ordered per day, the less the compliance *(2)*.
- Patient compliance, which is related to such factors as the number of other concurrent medications ordered *(3)*, the physician-patient relationship *(4,5)*, the parents' perception of the severity of the illness, and social, demographic, and physiological variables such as sex, adolescence, number of siblings, home care, and restriction of activity *(5,6)*.

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- The patient's or parent's interpretation of the physician's instructions on the prescription label may constitute an additional factor associated with compliance. Arnhold and associates *(7)* reported that in a survey of the parents of 104 pediatric patients in a prepaid group practice, they found that 49 (47 percent) had learned to give medicine by adhering to the instructions on the prescription label. The same authors, however, also noted that although 95 percent of the parents stated that they understood the instructions, only 75 percent complied and, in fact, only 18 of 66 parents never forgot to administer a dose.

The rates of compliance with physicians' instructions have been reported to range from 10 to 60 percent, when measured objectively by urinary excretion of drugs such as INH, PAS, and penicillin *(8–10)*. Factors affecting compliance may include vague or nonspecific directions on the prescription label. An example is the familiar "qid" instruction that places the responsibility on the patient or the parent for determining the interval between 4 doses within a 24-hour period. Another method of ordering 4 doses of medicine over a 24-hour period is "q6h"; this method requires that 1 dose be given late at night, and parents are understandably reluctant to awaken a sick child in order to administer this dose. If the parents do comply, a semi-awake and irritable child may refuse the medicine.

Briefly, then, it seems that failure to achieve adequate drug levels in outpatient children often may occur because a parent, with no professional training, must administer medication to an ill and often negativistic and irritable child by means of an inaccurate measuring device, often in the middle of the night, and frequently without sufficiently clear instructions on the prescription label.

If parents are expected to administer medicine accurately and reliably, the physician must make his instructions clear and specific, including the specific hours of medication or the time interval between doses, or both. Physicians in busy urban emergency rooms or in busy private offices, however, of necessity write prescriptions quickly and succinctly. Unfortunately, many of these prescriptions may be incomplete, inadequate in directions, or even confusing.

To determine the extent to which this situation may prevail, we evaluated the quality of prescriptions written by pediatric house staff in a pediatric emergency room of a large urban teaching hospital during two of the busiest months of 1973, January and February. During these months, each physician examined an average of two to four patients an hour, depending on the severity of the illness. Of course, the registered hospital pharmacists who filled the prescriptions were also particularly busy at this time.

Study Methods

The study covered 32 weekdays during the 2 months and included all physicians and pharmacists who worked from 8 am to 4 pm on weekdays in two emergency areas. The physicians scheduled to work in these areas consisted of 2 second-year residents, 6 first-year residents, and 10 interns. Copies of the patients' medical records written by these physicians and the prescription slips filled at the hospital pharmacy were collected daily for evaluation.

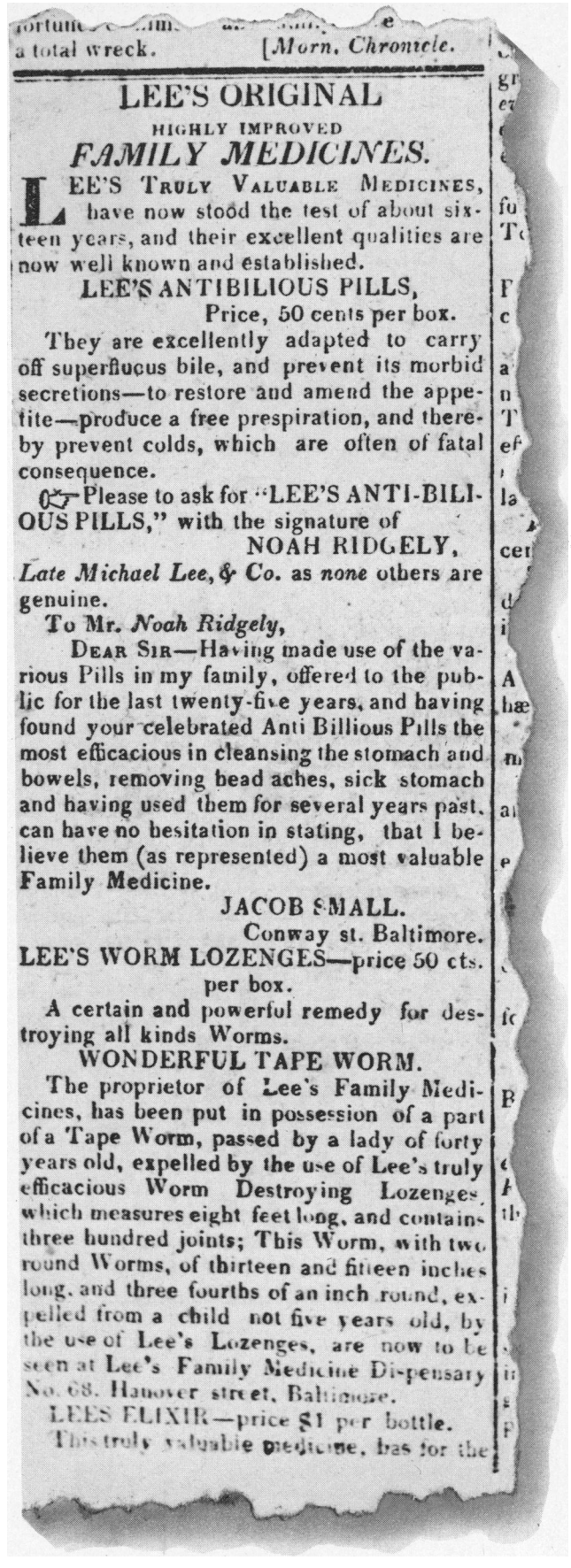
The quality of prescribing was evaluated in terms of proportions of prescriptions in which any of the following specifications deviated from the standards of acceptable prescribing, as formulated by the director of the pediatric ambulatory services (W.A.W.):

Quantity
Dosage
Time interval between doses or specific hours to be given.
Specific instructions

The pharmacists' accuracy in monitoring the specifications was evaluated by the same set of standards. The standards were based on recommendations in current texts on pediatric therapy *(11,12)* and the following specific considerations to insure accuracy and compliance:

1. The prescription should state not only the dose frequency, such as "tid" or "qid," but also either the specific hours judged to be most convenient for parents to give the medication or the specific interval between doses.

2. The amount of drug per dose should be administered in convenient household devices, such as measuring spoons; for example, "¼ tsp." was not acceptable because of the varying sizes of teaspoons used for meals as well as the difficulty of accurately estimating this small amount. (Ideally, parents should be given a calibrated medicine tube.)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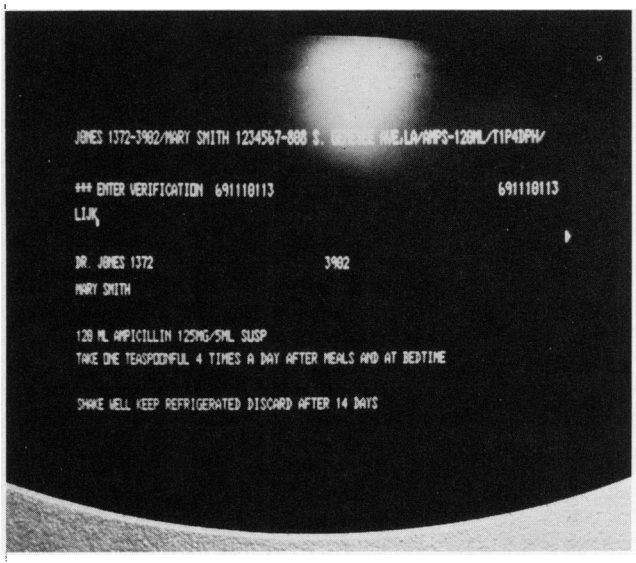

Most human error can be eliminated if the computer is programed correctly and if the physician monitors the prescription.

3. Instructions should be stated clearly and specifically; for example, "1 tsp. q6h day and night" (or "waken for medication"), "give medication after meals only," "refrigerate," "shake well."

First, the prescriptions were matched with the patients' medical records, and then one of us (B.P.), independent of the pediatric emergency room, evaluated the appropriateness of the drug prescribed for the condition or disease diagnosed for each patient. A research pharmacist and a research nurse then evaluated each prescription for accuracy of quantity, dosage, interval between doses or hours to be given, and instructions according to the criteria in the protocol. The protocol consisted of the 70 most frequently prescribed drugs in pediatric emergency rooms, and only prescriptions for these drugs were evaluated. The evaluators followed the protocol as closely as possible, except when dose quantities had to be calculated on the basis of age and weight. In such instances, when the total prescribed quantity of a drug did not deviate from the calculated quantity by more than 1 day's prescribed dosage, it was not considered a wrong-quantity error.

The evaluators recorded the patient's hospital registration number, date, age, sex, race, weight, physician, pharmacist, diagnosis or condition, and drug prescribed. They also noted whether each drug was correct or incorrect according to the diagnosis and the prescription specifications, as well as the accuracy of the pharmacist's changes, additions, or deletions.

To distinguish between omissions and errors in the specifications, we defined an omission rate as the proportion or percentage of prescriptions lacking a required specification in relation to the total number of prescriptions requiring that specification. On the other hand, because errors can be detected only when given specifications can be compared with the established criteria, we defined an error rate for a particular specification as the proportion of prescriptions with errors in that specification.

Results

During the 32 days of the study, 4,364 prescriptions were written for 2,403 patients by 18 physicians and filled by 9 pharmacists; 2,213 of the prescriptions were for drugs listed in the protocol and therefore eligible for evaluation of quality. Of the eligible prescriptions, only 110 or 5 percent contained no errors or omissions (according to the preceding definitions) in the specifications and were considered to be complete.

The proportion of prescriptions that were incomplete because a physician omitted a specification ranged from 25 to 95 percent as follows:

Specification	*Number of prescriptions requiring specification*	*Specification omitted*	
		Number	*Percent*
Quantity	2,209	549	24.9
Dosage	2,133	752	35.3
Interval	2,200	751	34.1
Hours	1,095	1,036	94.6
Instructions	1,461	556	38.1

The physician, in effect, relegated completion of the prescription to the pharmacist. The pharmacist then had the option of completing the prescription to the best of his ability, with inadequate knowledge of the patient's diagnosis or condition, or to make a time-consuming telephone call to the physician for further instructions.

Table 1. Frequency of errors in prescriptions written by interns and residents in a pediatric emergency room of an urban hospital, by type of specification

Specification	*Residents*			*Interns*			*Significance*
	Number prescriptions	*Number errors*	*Percent errors*	*Number prescriptions*	*Number errors*	*Percent errors*	
Quantity	545	115	21.1	1,115	188	16.9	P<.05
Dosage	624	207	33.2	757	268	35.4	NS
Interval	644	348	54.0	805	329	40.9	P<.01
Hours	15	10	66.7	44	10	22.7	P<.01
Instructions	310	73	23.5	595	152	25.5	NS

NOTE: NS indicates not statistically significant.

Table 2. Changes made in prescriptions by pharmacists, according to correct or incorrect specifications by physicians in pediatric emergency room

Physicians' specifications	Number prescriptions	No change		Corrected		Changed incorrectly		Percent errors
		Number	Percent	Number	Percent	Number	Percent	
Quantity								
Correct	1,357	1,099	81.0	213	15.7	45	3.3	$\frac{290}{1,660} = 17.5$
Incorrect	303	214	70.6	58	19.1	31	10.2	
Dosage								
Correct	906	856	94.5	24	2.6	26	2.9	$\frac{478}{1,381} = 34.6$
Incorrect	475	429	90.3	23	4.8	23	4.8	
Interval								
Correct	772	765	99.1	4	0.5	3	0.4	$\frac{669}{1,449} = 46.2$
Incorrect	677	657	97.0	11	1.6	9	1.3	
Hours								
Correct	39	39	100.0	0	0.0	0	0.0	$\frac{20}{59} = 33.9$
Incorrect	20	20	100.0	0	0.0	0	0.0	
Instruction								
Correct	680	666	97.9	12	1.8	2	0.3	$\frac{226}{905} = 25.0$
Incorrect	225	223	99.1	1	0.4	1	0.4	

[1]Pharmacists' errors include "no change on physician's errors," "incorrect changes on physicians' correct specifications," and "incorrect changes on physicians' errors."

As shown in the following table, among the prescriptions containing specifications the highest percentage of errors occurred in the specification of interval between doses. However, the number of incorrectly calculated dosages based on the patient's body weight or age represented a more serious deficiency. More than one-third of the prescriptions with dosage specified contained an error.

Specification	Number of prescriptions with specification	Specification incorrect	
		Number	Percent
Quantity	1,660	303	18.3
Dosage	1,381	475	34.4
Interval	1,449	677	46.7
Hours	59	20	33.9
Instructions	905	225	24.9

An additional 12 to 14 months of pediatric training appeared to have no influence on the ability of the prescription writers to calculate dosage or to estimate quantity (table 1). The residents made as many mistakes in dosages and instructions as the interns who had graduated relatively recently. The residents also made more errors in quantity and timing.

Did the pharmacists, also working under pressure to fill a large number of prescriptions as quickly as possible, monitor the dose, quantity, or time interval? Of 303 prescriptions which called for incorrect quantities of drugs, the pharmacists failed to make any changes in 214 or 70.6 percent and actually made incorrect changes in 31 or 10.2 percent (table 2). Of 475 prescriptions with incorrect dosages, the pharmacists made changes in only 46 or 9.6 percent; however, half of these changes were also incorrect. Of 906 prescriptions containing correct dosages, the pharmacists changed 26 or 2.9 percent incorrectly.

The pharmacists were of little assistance in correcting the interval instructions or in adding helpful supplemental information to the instructions, and they were of no assistance in specifying hours for drug administration. The data presented earlier regarding omission of specifications from prescriptions indicated that the emergency room physicians we evaluated usually failed to specify hours of administration, and for one-third of the prescriptions they failed to indicate any time interval between doses. The responsibility for maintaining a 24-hour blood level of the prescribed drug was therefore left to the patient. Furthermore, by their omissions, the physicians left the daily dosage and the quantity to be dispensed to the pharmacists' judgment. The ages of the patients did not seem to influence the proportion of these prescription errors.

Although prescription errors were more frequent for the relatively innocuous decongestant drugs (usually antihistamine or ephedrine derivatives), a significantly high number of errors was seen in prescriptions for antibiotics, for which the total daily dosage based on body weight is important to maintain therapeutic levels (table 3).

Discussion and Conclusions

Our data indicate that with the many distractions and large numbers of patients characteristic of pediatric emergency rooms, physicians may tend to write prescriptions concisely with a minimum of specific instructions, to miscalculate dosages, and to omit supplemental directions that might improve the compliance of patients. The pharmacists, when filling a large number of prescriptions under similar conditions, may fail to monitor the prescriptions adequately or to add helpful supplemental instructions. The results of other studies indicate that pharmacists rarely decrease the amount of medication prescribed by physicians, even when the large quantity ordered invites potential misuse or suicide *(13)*. Of the prescriptions written in our emergency room during the study period, at least 90 percent contained one or more undetected errors. If

Table 3. Frequency of errors in prescription specifications, according to major drug groups prescribed by physicians in pediatric emergency room

Drugs	Quantity			Dosage			Interval			Specific instructions		
	Number prescriptions	Incorrect		Number prescriptions	Incorrect		Number prescriptions	Incorrect		Number prescriptions	Incorrect	
		Number	Percent		Number	Percent		Number	Percent		Number	Percent
Antibiotics ...	632	122	19.3	453	125	27.6	470	128	27.2	562	17	3.0
Decongestants and expectorants	644	136	21.1	658	264	40.1	658	420	63.8	177	160	90.4
Antitussives .	183	3	1.6	53	10	18.9	52	15	28.8	15	2	13.3
Ointments ...	32	3	9.4	11	1	9.1	53	25	47.2	46	0	0.0
Antiparasitics	25	5	20.0	17	2	11.8	15	11	73.3	12	6	50.0
Others	144	34	23.1	189	73	38.6	201	78	38.8	93	40	43.0
Total .	1,660	303	18.3	1,381	475	34.4	1,449	677	46.7	905	225	24.9

the rate of total compliance of our patient population is similar to the average rate reported, about 33 percent *(14)*, the chance of a patient's receiving sufficient medication to maintain a therapeutic blood level is about 1 in 30.

To improve the quality of prescriptions, there is a need for some kind of error-monitoring system that does not interfere with the physician-patient relationship and does not significantly increase the time needed to process a patient in the emergency room or the prescription in the pharmacy. The system may be physician based, pharmacist based, or computer based.

Physician-based system. A factor to be considered in patient compliance is the patient's interpretation of the directions on the prescription label. For example, the physician must specify time interval between doses, realistic measures (not a fraction of a teaspoon), and the exact length of time the drug is to be given. Apparently many recent medical school graduates do not realize that the patient's interpretation of the label may influence the outcome of treatment.

As mentioned earlier, Arnhold and associates *(7)* reported that of 104 parents 47 percent learned to give medications by following the instructions on the labels. Galloway and Eby *(15)* reported that 60 to 70 percent of 1,543 patients interpreted prescription labels erroneously, and that neither socioeconomic status nor ethnicity influenced the rate of error. Stewart and Cluff *(16)* reported an error rate of 25 to 59 percent among ambulatory adults who were self-administering medications.

For medical undergraduates, departments of pharmacology should devote more attention to the art of writing explicit and comprehensible prescriptions and of calculating pediatric doses correctly, based on body weight or surface area. Our data indicate that the deficiency in teaching this art may be widespread because our staff members were graduates of many medical schools. As part of pharmacological instruction, both the medical student and the pharmacist should be taught effective techniques for instructing parents to administer medications to their children (or to themselves). The patient or the parent must understand the importance of using the medicine correctly, as well as the effect and possible side effects of the drug which should be reported to the physician; such knowledge can be imparted with intelligible, written instructions.

The physician may use preprinted prescriptions for frequently-used drugs and merely add the calculated measure of the drug to be administered and his signature. Because preprinted prescriptions contain all necessary supplemental instructions or cautions, prescribing is largely mechanical for the physician—he is relieved of writing detailed instructions and thus saves time. The limitation of preprinted prescriptions, however, is that calculation of dosage based on weight or surface area remains liable to a high rate of error. Unfortunately, our data indicate that experience does not improve the physicians' performance—pediatric residents were no more accurate in calculating dosage than were interns. Consequently, any personal addition to a preprinted prescription may detract from its accuracy.

Pharmacist-based system. This method is based on the premise that the physician may be considered an expert in the choice of treatment or specific medication for a given disease or condition and that the pharmacist is a specialist in drug dosage, vehicle or form (liquid or pill), drug effects and side effects, and techniques of administration (teaspoon or dropper). The physician prescribes only the specific drug and the length of time it is to be given. The pharmacist completes the prescription by calculating the dose, the time interval, the form of the drug, the quantity required, and any supplemental information useful to the patient. Thus, the completion of a prescription and the responsibility for its administration are shared by the physician and the pharmacist. If the physician is willing to reveal the patient's condition or disease to the pharmacist, the

pharmacist will be more likely to take greater interest in the care of the patient. However, the need to keep a particular diagnosis confidential must be considered, because few pharmacies have the facilities for confidential discussions between patients and pharmacists.

From our experience, physicians are not yet ready to accept the pharmacist in a "partnership" role, because the physicians insist on completing every prescription. Our data also indicate that pharmacists are not infallible, and some pharmacists may not wish to assume this role because of personal or medicolegal reasons.

The pharmacist may work cooperatively with the physician in a clinical setting *(17–19)*, especially an emergency room. In this setting, the pharmacist could enhance the physician's efficiency by obtaining the patient's history of past and present medications, known drug allergies, and even social problems that may interfere with filling or refilling prescriptions—for example, lack of finances or transportation. The pharmacist provides the physician with current information on dose, side effects, and incompatibilities of drugs, as well as the available forms of drugs most suited to the age of the patient (drops for infants, pills or capsules for older children). The pharmacist reinforces or supplements the physician's instructions for proper administration of medicine and explains to the parent or patient the side effects which may occur. Mattar and associates *(18)* reported that full compliance was raised to 51 percent in a group of patients counseled by personnel in a hospital outpatient clinic in contrast to 8.5 percent compliance in a concurrent control group who went to neighborhood drugstores for counseling. Before a prescription is sent from the clinic area, the pharmacist may monitor it for strength of drug, dosage, quantity, legibility, signature, and narcotic number if required.

For maximum effectiveness, the pharmacist should supply written auxillary instructions to reinforce the oral description, because patients often forget oral instructions, fail to listen, or may be confused by the concurrent use of several medicines *(2)*. Thus, the pharmacist must know the vocabulary level as well as the idiom of the population served in order to provide written instructions at an appropriate reading level *(20)*. This approach affords an excellent educational opportunity for pharmacy students in that it provides a first-hand demonstration of the clinical use of a wide range of drugs and also promotes a personal relationship with patients.

The pharmacist-based system is limited by the probability that it may increase the time required as well as the cost for the visit. Furthermore, a consulting room is needed for privacy *(19)*, and such space may not be available.

Computer-based system. A computer system can reduce the factor of human error. It requires a considerable investment in equipment, including a terminal with a typewriter and monitor in the emergency room and a computer and typewriter or printer terminal in the pharmacy.

After the physician selects the appropriate drug, he types into the emergency room terminal an appropriate code for the drug, the patient's identification information and weight or surface area, or both, and length of time the drug is to be administered. The computer is programed to calculate the correct dosage, the appropriate time interval between doses, the vehicle or form of the drug appropriate for the patient, and the exact total quantity required. The computer relays this information to the pharmacy typewriter with detailed instructions, in language comprehensible to the patient, on how the medicine should be taken. The typewriter then prints the complete label for the medication. The completed prescription may then be recalled and displayed on the emergency room monitor for the physician's approval. The computer can be programed further to display, upon the physician's request, the drug's side effects, incompatibilities, and unit cost.

The pharmacist follows the instructions generated by the computer for vehicle and quantity and attaches the computer-printed label to the medicine container. These relatively uncomplicated tasks could be performed by a pharmacist's assistant, and the pharmacist could have more time for direct patient contact.

If the computer is programed correctly and if the physician monitors each prescription, most human error should be eliminated. Every prescription so issued should be correct in dosage and comprehensible to the patient. The following are other advantages of a computer system *(21)*. The prescription is legible. Drug incompatibilities, excessive doses, and issue of excessive or insufficient quantities may be eliminated. Exact quantities are issued—a factor that is valuable to the physician in determining at a subsequent visit whether the parent has complied in administering appropriate quantities of medication to the child. The computer may remind the physician of precautionary laboratory determinations required with certain drugs (CBC, urinalysis, SGOT), as well as the clinical conditions that interfere with excretion, absorption, or metabolism of the drug. Furthermore, this information is supplied immediately. Finally, if a storage system is added, quality control is available. The computer provides the director of the outpatient department and the chief pharmacist with daily or weekly records of the type and amount of each drug prescribed. These records provide data for surveillance of excessively dangerous or inappropriate drugs, and they indicate the quantity of various drugs which the pharmacist must order each week to keep his supplies stocked adquately.

Limitations of the computer approach include the attitude of both physician and pharmacist; some feel that they are working for a computer rather than vice versa *(21)* and are unwilling to delegate their roles in spite of the insured accuracy of the prescriptions. Also, the computer can be programed only for standard recommended doses. If the patient's problem dictates

larger or smaller doses, the physician must write a prescription in full or type special instructions into the emergency room terminal which are transmitted on-line to the pharmacy typewriter.

The availability and versatility of computer processing indicates that this system might best eliminate the human error inherent in the writing and monitoring of emergeny room prescriptions. The cost of filling prescriptions may be increased, but both physicians' and pharmacists' effectiveness in patient care should be enhanced. The system provides further pharmacological training for the physician, alerting him to potentially severe adverse drug reactions from the medications he prescribes. Finally, compliance in taking medicine may be increased over the expected 33 percent if the parent understands more clearly how and when to administer medication to the child.

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SYNOPSIS

WINGERT, WILLIS A. (Los Angeles County-University of Southern California Medical Center), CHAN, LINDA S., STEWART, KATHRYN, LAWRENCE, LENORA, and PORTNOY, BERNARD: *A study of the quality of prescriptions issued in a busy pediatric emergency room. Public Health Reports, Vol. 90, September–October 1975, pp.* 402–408.

An analysis of 2,213 prescriptions written by physicians in a busy, urban pediatric emergency room revealed that only 110 or 5 percent had no errors or omissions of specifications. The quality of the prescriptions was evaluated according to the standards of acceptable prescribing for the following specifications: quantity, dosage, time interval between doses or specific hours to be given, and specific instructions.

The hospital pharmacists, also under pressure, generally failed to monitor the prescriptions adequately—either they did not rectify the physicians' errors or at times they made incorrect changes.

To improve the quality of prescriptions issued under pressure in an emergency room, several courses of actions are recommended:

- **Pharmacology departments of medical schools should place more emphasis on teaching students the art of writing explicit, comprehensible prescriptions;**
- **The physician and pharmacist should work as a team in the interest of providing patients with accurate and detailed prescriptions; or**
- **Both the physician and the pharmacist should delegate the composition of prescriptions to an automated computer system, thereby reducing human error in writing and monitoring prescriptions and allowing both professionals more time for direct contact with patients.**