Medication Dispensing Errors in Community Pharmacies: A Nationwide Study

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The available literature concerning medication dispensing errors provides relatively few studies that focus on community-based pharmacies. This paper presents the results of a nationwide, observation-based study of dispensing errors. Although community-based pharmacies were the primary focus, a small number of health-system pharmacies were also included. Investigators collected information concerning the frequency and type of errors and near errors as well as data regarding a number of task and environmental factors previously correlated with dispensing errors. A total of 5,784 prescriptions were inspected, revealing 91 errors (1.57%) and 74 near errors (1.28%). Errors were categorized as either content (41.76%) or labeling (58.24%) errors. Results are consistent with findings in the available literature. In particular, lighting levels, type of inspection system used (e.g., bar code product verification), number of available employees, and the arrangement of drug stock were significantly associated with both types of errors.

INTRODUCTION

Errors associated with dispensing prescriptions are committed everyday in pharmacies around the country. However, more unsettling, is the simple fact that the available literature has yet to produce a reliable estimate of the expected rate at which these errors occur. Observational studies, conducted in a variety of pharmacies, have produced a wide range of findings. Flynn, Barker, Gibson, Pearson, Berger and Smith surveyed the available literature and reported observation-based error rates ranging from 1% to 24% (1999).

Currently, little research has been conducted that specifically focuses on dispensing errors in the community-based pharmacy setting. Additionally, relatively few studies have collected data in multiple locations. Much of the available research regarding dispensing errors has been conducted in single pharmacies that are associated with hospitals and medical centers, largely due to convenience. Although the dispensing process may be essentially the same, the validity of extending these findings to community pharmacies has yet to be tested. The processes used to fill prescriptions typically include: (a) entering the patient and prescription information into a computer system, (b) generating a vial label, (c) retrieving the medication, (d) counting the number of units required, (e) packaging and labeling, (f) inspecting the final product, and (g) dispensing the order to the patient. One important difference between the hospital outpatient pharmacy setting and community pharmacies is the work environment. One can reasonably assume that community pharmacy staff are subjected to more distractions and interruptions than in the hospital setting by virtue of selling a wide variety of healthcare and miscellaneous items.

The objective of this paper is to summarize the preliminary results of a nationwide, observational study of dispensing errors occurring in community-based and health-system pharmacies. The authors are seeking to determine a realistic estimate of the national error rate for the types of pharmacies studied. Additionally, this research seeks to gather information regarding the frequency of specific error types, rather than reporting an overall error rate. Finally, the effects of semi-automated dispensing systems on errors, the identification of relationships between errors, and environmental and system design variables were explored. Lighting levels, sound levels, type of inspection system used (e.g., bar code product verification), and arrangement of drug stock were of particular interest.

A wide range of independent variables have been investigated, yet only a relatively small number of variables have consistently produced significant effects when associated with medication dispensing errors. Interruptions and distractions were found to significantly affect the pharmacy's overall error rate (Flynn et al., 1999). Grasha, A. and Schell, K. investigated psychological variables including perceived workload, stress and field dependence with a simulated task in a laboratory setting (2001). An important environmental variable that has been correlated with dispensing errors is the level of illumination (Buchanan, T., Barker, K., Gibson, J., Jiang, B. and Pearson, R., 1991). In addition, ambient sounds have been investigated as a potential influencing factor (Flynn, E., Barker, K., Gibson, J., Pearson, R., Smith, L. and Berger, B., 1996).

METHODOLOGY

Variables. A universally accepted taxonomy for dispensing errors does not exist. Therefore, with respect to this research the authors used definitions of error types consistent with that found in Flynn et al. (1999). An error was defined as any deviation from the interpretable prescription on new orders. If the investigator could not determine with 100% confidence what the prescriber had ordered, the prescription was excluded from the study. Consequently, only dispensing related errors were considered.

With respect to the refill and will call orders inspected in this study, an error was defined as any deviation from the prescription label on the vial (i.e., label errors were not evaluated on these types of prescriptions). Data was also collected regarding near-errors, which are defined as errors observed during the filling process that were discovered and corrected by the pharmacy staff, without feedback from the investigators, prior to dispensing to customers.

Errors observed during the study were categorized into two major groups: content and labeling errors. Content errors included dispensing an incorrect drug (e.g., ibuprofen instead of cimetidine), incorrect form (e.g., sustained release product instead of a standard release tablet), an incorrect quantity (e.g., 30 tablets instead of 60), and an incorrect strength (e.g., 10 mg instead of 30 mg) . Labeling errors simply consisted of printing a label with either incorrect instructions, including omitting a portion of the doctor's directions for use of the medication, or incorrect information (e.g., prescribing doctor's name). Information was also collected regarding the circumstances under which the errors and near errors were committed and detected.

Researchers collected information concerning the following independent variables, which are consistent with findings in the available literature. The lighting level associated with the prescription filling workstations, the prescription inspection area, the patient-counseling counter, and the drug storage area was measured. The system for inspecting prescriptions was recorded (i.e., bar code systems versus manual systems). The researcher also noted the number of available pharmacists and technicians, the system of drug stock storage, and the type of pharmacy (i.e., an independent store or associated with a major chain or health-care system).

Participants. Fifty pharmacies were randomly selected from within six cities : Chicago, Dallas/Fort Worth, Los Angeles, Philadelphia, Seattle and Tampa Bay/Clearwater/St. Petersburg. Approximately half of the pharmacies were in the chain pharmacy category, a fourth were independent pharmacies, and the remaining fourth were health-system pharmacies (e.g., hospital or managed care). A letter of invitation to participate in the study was sent to the pharmacy managers, and personal contact was made until 50 pharmacies agreed to participate.

Equipment. Lighting levels were measured at all work stations and in the drug storage areas using a Sper Scientific light meter (840021). Sound levels were recorded for common sources of sound using a Sper Scientific sound meter (840005).

Procedure. An un-disguised observer technique was employed for data collection. This technique has been widely used and highly regarded as a practical and valid technique for data collection in the pharmacy setting (Barker and Allan, 1995). Data was collected between June 2000 and April 2001 by three investigators, all of whom are registered pharmacists with advanced research training and Ph.D. degrees.

Every prescription filled while the investigator was present was inspected. Additionally, a sample of will-call prescriptions (filled before the arrival of the investigator and waiting to be picked up) were inspected. Investigators compared the physician's written order to the contents and label of each new prescription (patient presented a new prescription to the pharmacy staff). Any deviations from the prescribed order were noted as errors. All errors were confirmed and then corrected by an available pharmacist before the prescription was dispensed to a patient.

Investigators observed a minimum of 100 prescriptions at each location. However, if more than 100 prescriptions were filled during a single day, the additional observations were captured. Thus, the number of observations varies at each location.

Lighting and sound levels were measured upon arrival of the investigator at the pharmacy in order to allow the staff to adjust to having the observer in the area. Additional data regarding the prescription filling system and pharmacy design were collected at this time as well.

RESULTS

Statistical Analysis. This section discusses the findings as well as the statistical analyses performed on the data. A total of 5,784 prescriptions were inspected, revealing 91 errors. Therefore, the overall error rate was calculated to be 1.57%. A total of 74 near-errors were detected. New prescriptions had an error rate of 3.2% (63 errors out of 1,965 observations), which was higher than refill (0.7%) and will-call (1.1%) prescriptions. Table 1 presents the error data stratified by type of pharmacy.

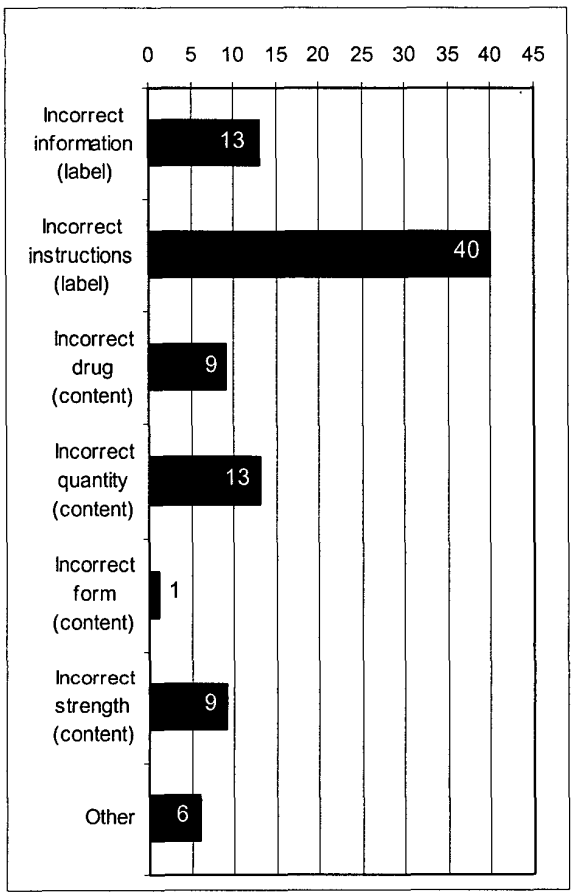
Table 1.

Type	Pharmacies	Errors	Near-Errors	Prescriptions
Chain	26	43	58	3,068
Health-system	9	21	7	1,136
Independent	15	27	9	1,580
Totals	**50**	**91**	**74**	**5,784**

Fifty-three percent of the total prescriptions were inspected in chain stores, 27% in independent locations and 20% in health-system pharmacies. The associated error rates were 1.4% (43 errors), 1.9% (21 errors), and 1.7% (27 errors) respectively for chain, health-system and independent pharmacies. The majority (61.21%) of all mistakes (i.e., errors and near errors combined) were observed in chain pharmacies. Interestingly, chain stores also had a significantly higher rate of near errors, i.e., the staff caught more errors unprompted by investigators ($X^2 = 16.653$, df = 2, p = .000).

Labeling errors (i.e., incorrect information or instructions) accounted for the majority (58.2%) of all errors. The most common type of error was incorrect instructions (44.0%). Figure 1 depicts the observed errors by type.

Figure 1.



Background Sound Levels. The ambient noise levels of each pharmacy were recorded and analyzed using a chi-squared test. A significantly lower percentage of the mistakes (errors and near errors combined) were detected by pharmacy staff when the sound levels were above 75 dbA (X^2 = 6.682, df = 1, p = .010). When the ambient noise was a result of radio or television, which was the case 83% of the time, a significantly higher proportion (54%) of the errors were detected (X^2 = 27.423, df = 1, p = .000).

Lighting Levels. The lighting levels associated with various work areas were analyzed. A chi-squared test revealed that 68% of the content errors occurred in pharmacies with a lighting level below 94 foot-candles in the prescription filling area (X^2 = 5.577, df = 1, p = .018). A significantly lower number of near errors were associated with lighting levels above 94 foot-candles in the prescription filling area (X^2 = 6.641, df = 1, p = .010).

As a result of data mining, an illumination level of 94 foot-candles was suggested as a breakpoint for significance testing. With respect to near-errors, a one-way ANOVA on lighting found a significant main effect (f(1, 164, .05) = 8.04, p = .005). In fact, near errors were associated with a level 15 foot-candles brighter.

A one-way ANOVA on the lighting levels associated with the work area for inspecting prescriptions showed a significant main effect (f(1, 87, .05) = 9.93, p = .002). A chi-squared test showed that 73% of the content errors were committed in pharmacies with a lighting level below 94 foot-candles in the inspection area (X^2 = 6.397, df = 1, p = .011). A t-test confirmed the average lighting level was significantly different when both labeling (t = 2.36, p = .022) and content (t = -2.13, p = .040) errors occurred. A significant difference was found between the number of near errors occurring above and below 94 foot-candles (X^2 = 5.699, df = 1, p = .017). Specifically, errors were found 35% of the time in pharmacies with inspection area lighting levels below 94 foot-candles and 54% when the level was above. The average lighting level associated with near errors was 13.58 foot-candles brighter than the average associated with errors. A one-way ANOVA found this difference to be significant (f(1, 161, .05) = 8.07, p = .005). Further, with respect to near errors, a one-way ANOVA found lighting levels during computer order entry was significantly (11.44 foot-candles) brighter (f(1, 164, .05) = 5.31, p = .022).

Inspection System. The inspection systems were analyzed using a chi-squared test. Interestingly, this test revealed that 77% of the content errors occurred when prescriptions were only manually inspected (X^2 = 14.451, df = 2, p = .001). Eight chain pharmacies used a bar code product verification system to inspect filled prescriptions. A significant difference was found between the number of near errors associated with the type of inspection system (X^2 = 17.975, df = 2, p = .000). The completely manual systems found 25% of the errors while bar code systems found 62%.

The type of label used at each pharmacy could impact the inspection task. Pharmacies that used a dot matrix printer to prepare labels found 20% of the total mistakes (i.e., the near errors). However, 55% were found in pharmacies that used either a laser or thermal printer. This difference was found to be highly significant (X^2 = 15.784, df = 1, p = .000).

Number of Employees Available. The number of available employees was analyzed as (a) pharmacists, (b) technicians and (c) the combined number of employees. The number of pharmacists was categorized as one, two, or more than two. A chi-squared test found that 79% of the content errors occurred when only one pharmacist was available (X^2 = 5.6997, df = 1, p = .017). With respect to the number of technicians available, a chi-squared test revealed that over half (57%) of the content errors occurred when only one technician was available. Finally, when the total number of available

employees (i.e., pharmacists and technicians combined) was examined, a chi-squared test showed that 60% of the content errors and 33% of the labeling errors occurred when two or less employees were available ($X^2 = 8.288$, df = 3, p = .040). With respect to error detection, a significant difference was found between the number of employees available ($X^2 = 10.827$, df = 3, p = .013). Forty-eight percent of the mistakes were found when two or less employees were available compared to 67% found when four where available.

Patient Bins. Using a chi-squared test, the availability of bins to hold all of the prescriptions for an individual patient was found to have a significant effect on the percentage of mistakes caught by pharmacy staff (i.e., near errors). Thirty-five percent of mistakes were detected when bins where not available, however this increased to 55% when they were available ($X^2 = 4.863$, df = 1, p = .027).

Drug Stock Storage. A pharmacy's drug stock was classified into one of two systems: stocked with space in between items or tightly packed onto the shelves. A chi-squared test determined that 2/3 of the content errors were committed in pharmacies where the drug stock was packed tightly on the shelves ($X^2 = 3.9116$, df = 1, p = .048).

Drug Arrangement. The arrangement of drug stock in each pharmacy was categorized based on whether brand name drugs were separated from their generic counterparts, and if the drug stock was grouped by form (e.g., tablets separated from ointments, eye drops, etc.). Although drug arrangement had no significant effect associated with errors committed, the percentage of mistakes detected by pharmacy staff was significantly higher when the drugs where stored alphabetically regardless of form ($X^2 = 10.613$, df = 3, p = .014).

DISCUSSION

The results of the error analysis are generally consistent with those reported in the existing literature. With respect to this study, the overall error rate was closer to the lower bound of the range reported by Flynn et al. (1999). Content errors were associated with lighting levels in filling and inspection areas below 94 foot-candles. This level is noticeably less than the 146 foot-candles tested by Buchanan et al. and associated with a significant decrease in dispensing error rates using a manual inspection system (1991). This suggests that lower lighting level standards may be acceptable in bar code product verification systems. The data associated with the errors and near errors would suggest that a lighting level brighter than 94 foot-candles significantly affects the overall dispensing accuracy.

Potential limitations. Pharmacies that agreed to participate in this study may have felt they would have a low error rate. The error rate determined in this study may therefore represent the most accurate pharmacies. Further, the presence of the observer as well as the feedback regarding errors committed may have influenced the error rates. Efforts to minimize the influence of the observer on the pharmacy staff included training the observers to be unobtrusive and nonjudgmental, but it is difficult to eliminate all effects of the observer.

Variables with a significant relationship to errors that merit further study include lighting levels at filling and inspection areas, effects of music on performance in prescription-filling operations, inspection systems, and staffing levels. Research is needed to investigate the impact of staffing levels and workload on pharmacy error rates. The results of this study suggest that accuracy is linked to the number of available employees for medication dispensing tasks.

CONCLUSION

Dispensing errors are a nation-wide problem, occurring at a rate of 2 errors for every 100 prescriptions filled. This translates to over 60 million errors on 3 billion prescriptions filled each year in the U.S. (Ukens, 2000). Additional research to refine the variables associated with errors in this study should be performed to test error prevention measures.

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