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Dispensing errors in community pharmacy: perceived influence of sociotechnical factors

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Abstract

Objective. This study examined the impact of pharmacists' perceptions of errors in dispensing, errors in communication, delays in prescription processing, efficiency and physical mobility in the pharmacy by practice setting and sociotechnical factors (i.e. pharmacy design, drive through pick-up window services and automated dispensing systems).

Setting. Community pharmacy practice in the USA.

Design. A two-page survey was mailed to a geographically stratified random sample of 1047 community pharmacies. One-way analysis of variance was used to determine the impact of attitudinal items with respect to pharmacy practice setting (e.g. mass merchant, supermarket, chain and independent) and sociotechnical factors. Pharmacy characteristics, pharmacist experience and total dispensing errors were also addressed.

Results. The response rate was 45.0% ($n = 429$). Pharmacists perceived that pharmacy design significantly ($P < 0.05$) contributed to dispensing errors, errors in communication, problems with efficiency and those similar problems were observed for all items relating to drive through window pick-up services. Automated dispensing systems were perceived as less likely ($P < 0.05$) to contribute to dispensing errors, errors in communication, efficiency problems and extra physical movement. Perceived dispensing error rate was 0.057%, and the number of dispensing errors was positively and significantly ($P < 0.001$) correlated with prescription volume. Cognitive errors accounted for ~80% of the dispensing errors.

Conclusions. Perceptions of dispensing errors by pharmacists are influenced by design, drive through pick-up window services, and automated dispensing systems. However, more effort is needed to determine how cognitive processes relate to sociotechnical variables in pharmacy practice and other environments.

Keywords: contextual, dispensing errors, error rate, medication errors, sociotechnical factors

Outpatient prescription medications dispensed in the USA increased from 2.1 billion in 1994 to 3.6 billion in 2005 [1]. Pressures to provide convenient delivery options have required changes in pharmacy workflow, personnel and technical design. Although these changes have facilitated prescription processing and improved patient accessibility to medications, additional risk is presented when sociotechnical (i.e. interaction of the social and technological systems) factors coexist with human factors in an environment where cognitive abilities are necessary to ensure accurate processing and delivery of prescribed medications.

Attention to medication and dispensing errors was heightened in the Institute of Medicine (IOM) report that supports the implementation of safety systems in health care organizations to ensure safe practices at the delivery level [2]. For the purposes of this study, dispensing errors included any inconsistencies or deviations from the prescription order such as dispensing the incorrect drug, dose, dosage form; wrong quantity; inappropriate, incorrect, or inadequate labeling, confusing, or inadequate directions for medication use; incorrect or inappropriate preparation, packaging, or storage or medication prior to dispensing.

Community pharmacists perform tasks that are at times somewhat repetitive, yet require high levels of professional training and optimal performance under considerable time constraints. Mass merchants and supermarkets typically offer one-stop shopping for medications, groceries and other general merchandise, chains offer a more streamlined inventory with greater emphasis on health care products and specialty health care items, and independently owned pharmacies are generally smaller stores offering specialty items and services in health care. Using a system approach [3] depicted in

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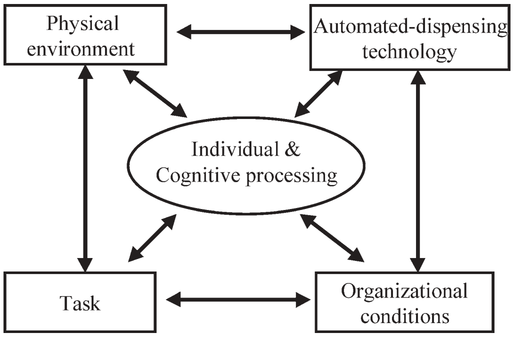

Figure 1. Sociotechnical considerations influencing prescription processing in community pharmacy practice.

Fig. 1, four sociotechnical areas [4] applied to community pharmacy practice are believed to influence cognitive functioning when processing prescriptions. Pharmacy design influences how the organization functions, that is, materials, authority, information and the flow of decision processes [5], which include the physical environment of the work area where prescriptions are processed and information is exchanged during processing. Although pharmacies in the past were designed to be somewhat hidden from public view, the internal environment has evolved into a standardized operation using drive-through pick-up windows and automated dispensing systems to meet patient demands for convenience and efficiency.

Previous studies from community practice describe errors in workflow [6], satisfaction [7, 8] and safety [9, 10]. However, more information is needed to describe how pharmacy design, drive through pick-up window services and automated dispensing systems contribute to perceptions of error in prescription processing in the community setting. Improvements in prescription processing are ongoing especially efforts to distinguish dispensing errors attributed to pharmacy design from errors attributed to cognitive ability. Previous studies also provide evidence that people talking in the background, interruptions and background noise [11, 12] interferes with concentration and may decrease the ability to perform cognitive functions. Other approaches that describe human error and situations that influence patient safety are well documented in the literature [13–16]. For example, human errors in pharmacy dispensing are easily attributed to skill, rule and knowledge framework in which individuals switch among different levels of cognitive control when presented with different situations [17]. Pressures from the internal environment may act as a trigger to create situations in which concentration is easily interrupted [18] thus hampering the ability of the processor to return to the original concentration point. As a result, information processing falters, resulting in concentration gaps and information sorting problems that increase the likelihood of errors in prescription processing. However, more information is needed to assess the contribution of internal design variables to dispensing errors and to determine how design variables and cognitive abilities are viewed when dispensing errors occur.

The purpose of this study is to examine the impact of pharmacists' perceptions of errors in dispensing, errors in communication, delays in prescription processing, efficiency and physical mobility in the pharmacy with respect to practice setting and sociotechnical factors (i.e. pharmacy design, drive through pick-up window services and automated dispensing systems). Other variables such as age, gender, practice experience, prescription volume, number of pharmacies worked, pharmacy configuration, dispensing errors and error attribution were examined to determine the relationship between pharmacy and pharmacist characteristics and dispensing errors.

Methods

Study design

This was a national study that included respondents from community and community pharmacies in the USA. The sample frame was acquired from the Hayes' Independent and Chain Drug Store Guide Database in October 2004. A two-page questionnaire was mailed to a random sample of 1047 geographically stratified (using zip code) pharmacies, with the addressee indicated as 'pharmacist'. An Institutional Review Board located at Ohio State University approved this study.

Instrument development

Instrument development commenced with a literature search covering the sociotechnical areas and medication errors reported in peer-reviewed studies. Literature examined included marketing reports, clinical studies in which medication safety was an issue, and quality and safety studies that appeared in MEDLINE, sociology, information technology and service literature that examined such topics as work interruption, task concentration, workflow design and medication errors.

Instrument validity was assessed through the use of an expert panel selected according to type of experience and convenience. The panel consisting of five pharmacists with community pharmacy practice experience representing different practice settings reviewed existing information in the instrument and the ability of the instrument to provide a realistic representation of the prescription-processing environment. After revisions, this group provided written comments agreeing that the instrument's content was consistent with relevant literature and the study objectives.

The resultant instrument contained a cover letter and two sections. Definitions for dispensing errors and design (e.g. work area, storage and shelving) were provided in the first section, which also contained six items to examine how pharmacy design, drive through pick-up window services, and automated dispensing systems influenced dispensing errors, errors in communication with staff, and prescription processing. Other items addressed efficiency, physical perceptions of distance needed at each juncture and delays in prescription processing. The second section of the instrument contained several items pertaining to demographic and practice site variables such as years of experience and number of pharmacies worked. Other items focused on pharmacy type, configuration of the pharmacy dispensing area (e.g. straight, L-shaped or other) prescription volume, and number of dispensing errors and whether perceptions of dispensing errors were proportionally more cognitive in origin or attributed to pharmacy design.

Survey methods

The instrument was pre-tested using a convenience sample of 20 geographically dispersed pharmacies that existed in a central location where patients have numerous choices for pharmacy services. Using a regional map to locate pharmacies in each of the municipalities, pharmacies were selected both for convenience and for the quota needed to represent each of the pharmacy types (mass merchant, supermarket, chain and independent). To assess face validity, participants were asked to complete the instrument and provide comments using an open-ended format regarding the clarity of the questions, relevance of the questions to practice, and any problems with item clarity or the response format. Nine questionnaires were returned with detailed comments, and appropriate changes were made to improve the instrument with respect to study objectives.

For the main study, respondents were assured that their responses would remain confidential, and a complimentary sample of tea was included in each envelope. Pharmacists were asked to consider past and present pharmacy practice sites, and to indicate their level of agreement with each of the attitudinal items using a five-point Likert-type scale (1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree). Returned questionnaires were tracked to determine response origin and date of delivery. After two weeks another mailing was sent to those stores with non-responding pharmacists. One last mailing was sent after two more weeks to the remaining non-respondents. Data collection ceased four weeks after the final mailing.

From the original sample ($n = 1047$), a total of 431 usable questionnaires were received (41.1%). A large number of questionnaires ($n = 94$ or 8.9%) were returned by the postal service as undeliverable. This high percentage of incorrect or invalid addresses is not uncommon for a dynamic and changing economic market such as community pharmacy. Of the 431 responses obtained, 429 questionnaires were deemed to have a completion rate of >85% yielding a response rate of 45.0%. For the purposes of this study, pharmacists who worked in multiple sites ($n = 23$) or who did not respond to the question eliciting pharmacy type ($n = 8$) were excluded from subsequent analyses.

Data management

Differences among pharmacy practice setting types with respect to pharmacy design, drive through pick-up window services, and automation-dispensing systems were analyzed using one-way analysis of variance. Descriptive analyses and independent *t*-tests were performed for pharmacist demographic and pharmacy characteristic variables. Assumptions of normality, linearity and equal variances between the groups were assessed to ensure appropriate interpretation of statistical analyses. If unequal variances were revealed, differences between the largest and smallest groups were examined and the Dunnett *post hoc* test coupled with descriptive data was used for analysis and interpretation of group differences [19]. All statistical tests were two-tailed, and values of $P < 0.05$ were considered statistically significant. Analyses were completed with SPSS version 11.

As a check for response bias [20], early respondents (selected from March 1 to 15, 2006) were compared with late respondents (selected from April 15 to 30, 2006). A comparison of these two groups showed no statistically significant difference between groups for the items under investigation. In addition, previous studies [21] revealed that lower response rates in homogenous populations do not necessarily imply significant bias.

Results

The majority (65.2%) of respondents was male with a higher proportion of pharmacists (88.3%) reported for independently owned and operated pharmacies than for mass merchant (57.7%) and traditional chain pharmacies (58.4%) (Table 1). The proportion of pharmacists representing mass merchant/supermarket, traditional chains and independent practice was (34.7, 41.7 and 23.6%, respectively). Respondent pharmacists in an independent practice were on average ~10 years older and had ~10 years more experience than pharmacists in the other practice settings. The impact of gender on dispensing errors was non-significant.

A majority of pharmacies had a 'straight' pharmacy configuration for processing prescriptions, usually prescriptions were dropped off at one side and medications were picked up at the other side. The impact of configuration on other aspects of design, drive through pick-up window, and automated dispensing systems was not significant. Chain pharmacies in this sample processed more prescriptions per month compared with mass merchants, supermarkets and independents.

Age was divided into three groups according to computer generated cut points for young (age ≤ 36), middle aged and older pharmacists (age ≥ 52). Significant findings ($P < 0.05$) linking age to perceived errors were revealed for groups representing younger and older pharmacists. The mean number of perceived dispensing errors (mean = 1.94; SD = 1.90) was significantly lower for younger pharmacists than older pharmacists (mean = 3.42; SD = 4.12). Although the number of perceived errors reported by independents was slightly higher compared with errors reported by pharmacists in other settings, differences were not significant. Dispensing errors were distributed equally across shifts and ~80% were attributed to cognitive abilities. The percentages reported in Table 1 represent percentage responses to each question, and may not reflect that actual number of questionnaires received because of missing information on certain responses.

Pharmacists representing mass merchants, supermarkets, chains and independents reported significantly higher than average levels of agreement for items assessing the

Table 1 Characteristics of respondents ($n = 398$)

Characteristics	Mass merchant/ supermarket pharmacy ($n = 138$)	Chain pharmacy ($n = 166$)	Independent ($n = 94$)	*P-value*
Gender, no (%)				
Men	79 (57.7)	97 (58.4)	83 (88.3)	<0.001
Women	58 (42.3)	69 (41.6)	11 (11.7)	
Age, years (range = 21–79), mean (SD)	42.1 (13.2)	41.4 (12.4)	52.1 (10.7)	<0.001
Years experience, mean (SD)	15.8 (12.9)	16.7 (12.8)	28.5 (12.6)	<0.001
Number of pharmacies worked, mean (SD)	10.3 (11.9)	8.9 (12.8)	7.8 (15.7)	0.33
Pharmacy configuration				0.003
Straight	62 (64.5)	76 (55.9)	62 (71.3)	
L-shaped	18 (18.8)	45 (33.1)	10 (11.5)	
Other (circle, arch, square)	16 (16.7)	15 (11.0)	15 (17.2)	
Processed prescriptions, per month				0.009
Mean (SD)	4487 (2438)	5719 (4,398)	4473 (2,352)	
Dispensing errors, per month				0.14
Mean (SD)	2.7 (3.4)	2.4 (2.8)	3.4 (3.7)	
Error attribution, mean (SD)				
Cognitive	85.2 (21.0)	78.1 (27.8)	79.4 (28.7)	0.15
Pharmacy design	12.1 (15.9)	17.0 (21.7)	15.7 (22.2)	0.23

Results based on usable responses.

contribution of pharmacy design to dispensing errors, efficiency and errors in communication. There was general agreement among pharmacists working in a mass merchant, supermarket and chain settings that drive through windows contributed to perceptions of dispensing errors, errors in communication, problems with efficiency, physical mobility in the pharmacy for both pharmacists and staff, and delays in prescription processing (Table 2). *Post hoc* evaluation revealed a much greater impact regarding dispensing errors and more steps in processing for pharmacists in mass merchant and supermarket settings compared with independents. In addition, errors in communication with staff and delays in prescription processing were significantly more pronounced as perceived by pharmacists in mass merchant, supermarket and chain settings relative to independents. *Post hoc* evaluation also revealed differences in efficiency and staff taking more steps in general in a chain pharmacy setting compared with independents. Response patterns obtained from pharmacists regarding automation revealed general agreement that automated dispensing systems were perceived as less likely to contribute to dispensing errors, errors in communication with staff, efficiency concerns, and more steps taken in prescription processing by pharmacists. Results from *post hoc* comparisons revealed the strongest differences between mass merchants and supermarket based pharmacists compared with chains and independents.

When monthly prescription volume was regressed with monthly occurrence of errors, regardless of how errors occurred, a significant positive correlation ($r = 0.404$; $P < 0.001$) was revealed. Results indicate that as prescription volume increased pharmacists were more likely to experience errors in dispensing. This pattern was observed regardless of when errors occurred.

Discussion

Results of this study reveal that perceptions of dispensing errors by pharmacists were influenced by design, drive through pick-up window services, and automated dispensing systems. Given that data collected for this study were representative of pharmacy practice sites in the USA, where the Healthcare Distribution Management Association report [22] revealed a total of 55 382 community pharmacies in the USA of which 28.5% were mass merchandisers/supermarkets, 37.4% were classified as chain pharmacies, and 34.0% were independently owned pharmacies further evaluation of results was possible. First, according to pharmacists' perceptions, there was an agreement that pharmacy design could be more efficient, contributed to dispensing errors, and communication errors with staff. Second, pharmacists perceived that the existence of a drive through pick-up window was reported to cause more travel time when processing prescriptions and was attributed to delays in prescription processing, taking more steps by pharmacists and staff, dispensing errors and errors in communication. Third, pharmacists perceived that automated dispensing systems were reported to reduce errors in dispensing and errors in communication with staff, reduce the number of steps in prescription processing by pharmacists, and were viewed as more efficient in all practice settings. Although it may be possible to attribute errors to shortcomings in experience and problem solving, results

Table 2 Descriptive statistics and impact of design, drive through pick-up window services, and automated dispensing on pharmacy dispensing errors

Items[a]	Design ($n = 397$)				Drive through window ($n = 366$)				Automation ($n = 355$)			
	Mass merchant/ supermarket	Chain	Independent		Mass merchant/ supermarket	Chain	Independent		Mass merchant/ supermarket	Chain	Independent	
	Mean	Mean	Mean	*P*-value	Mean	Mean	Mean	*P*-value	Mean	Mean	Mean	*P*-value
Contributes to dispensing errors	3.4	3.1	3.4	0.03	3.4	3.1	3.0	0.03	2.8	2.5	2.4	0.008
Contributes to errors in communication with staff	3.2	2.9	3.4	0.05	3.4	3.4	3.0	0.01	2.8	2.5	2.5	0.008
Could be more efficient	3.6	3.2	3.4	0.03	4.0	4.0	3.5	0.006	3.0	2.6	2.6	0.003
I take more steps when processing prescriptions	3.4	3.1	3.3	0.22	3.5	3.3	3.0	0.007	2.8	2.5	2.5	0.007
Causes delays in prescription processing	3.6	3.4	3.7	0.17	3.9	3.9	3.2	<0.001	2.6	2.4	2.6	0.14
Causes staff to take more steps when processing prescriptions	3.8	3.8	3.9	0.64	4.1	4.3	3.8	0.003	2.7	2.6	2.6	0.32

[a]Scale: 1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree.

from this study revealed the existence of realistic perceptions that sociotechnical factors can increase the likelihood of dispensing errors. Finally, results from this study suggest that patient safety may be jeopardized when certain elements of the internal environment interfere with cognitive abilities or conflict with human factors.

Medication procurement by patients safely and through a safe network is a global issue that warrants continued research efforts. In the UK, dispensing error rates range from 0.04 to 0.08% for community pharmacy practice [23, 24]. Dispensing errors rates in mail service pharmacies in the USA were reported at 0.075%, with errors attributed to the initial stages of prescription processing (including order entry); no errors were associated with the mechanical stages of product dispensing [25]. In this study, error rates of 0.057% (5.7 errors per 10 000 prescriptions processed) averaged across the three practice settings provided the most conservative estimates. Although this finding translates to one error per 1754 prescriptions, a downward bias is reported to exist depending on the enforcement of reporting procedures and possible repercussion [26]. Under standard procedures that exist for documenting dispensing errors in most large pharmacy operations, pharmacists are required to file an incident report. From these reports, error management protocols are developed for training purposes to understand how errors occur, and how to avoid potential situations in which errors are likely. In addition, pharmacists should share their knowledge and experience with other professionals that include the responsibility to report medication problems back to prescribing physicians [27].

Efforts for process improvement continue to be supported in the UK by the National Health Service through the National Patient Safety Agency (NPSA), which encourages error reporting and safe practices [28]. Besides the Pharmacopeia (USP) and the Institute of Safe Medication Practices (ISMP) Medication Errors Reporting Program (MERP) in the USA [29], the ISMP in Canada is another national voluntary medication incident and 'near miss' reporting program founded for the purpose of sharing the learning experiences from medication errors [30]. As revealed in this study, the probability of making an error increased across the three levels of age, with the stipulation that most pharmacists completed pharmacy school at a relatively young age. However, the results should be interpreted cautiously given the inability to perform this study in a controlled environment, and more research is needed to estimate the threshold for committing dispensing errors with respect to prescription volume and other factors influencing the pharmacy work environment.

Automated dispensing systems were useful in all practice settings examined, especially for the occurrence of repetitive activities and actions [31]. In general, according to pharmacists' perceptions, the use of automated dispensing systems appears to improve overall efficiency and reduce workload effort. In summary, results from this study reveal the potential of sociotechnical factors including design and drive through pick-up window services to trigger a change in cognitive processing that can lead to mistakes occurring from concentration gaps or concentration-point loses, which can be detrimental to human safety. When designing community pharmacies, consideration should be given to activities that will help standardize prescription processing (e.g. automated dispensing systems, batch processing and pre-assignment of responsibilities), streamline cognitive processing, and thereby reduce the chances for workflow interruption.

Patient safety is a universal goal. Although human error is perhaps the largest culprit in the cause of dispensing errors, additional studies are needed to evaluate the potential interaction between sociotechnical variables and cognitive processing, and the impact on medication safety. Perhaps patient needs for convenience are questionable when patient safety may be jeopardized. Nonetheless, one of the keys is to challenge pharmacy practitioners anywhere in the world to create an internal service environment with zero errors in the service delivery process.

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