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ORIGINAL PAPER

Effectiveness of Implementation of a New Drug Storage Label and Error-Reducing Process on the Accuracy of Drug Dispensing

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Abstract This study evaluated the effectiveness of implementation of an improved storage label and an error-reducing process on the incidence of drug-dispensing errors. A total of 27 pharmacists (11 male and 16 female) were included. Questionnaires were distributed to pharmacists to measure their degree of satisfaction with the format and content of the labels. The questionnaires were completed before and one month after implementation of new label. Pharmacists were also requested to follow a new error-reducing dispensing process by circling the following items on the new storage label: drug name, appearance, packaging, dose, and formulation. The pharmacists' degrees of satisfaction increased significantly after implementation of the new label with respect to these questionnaire items: all label format items, edition appropriateness, use of capital fonts to distinguish similar drug names, reminder images to help with drug differentiation, and complete label information. The outpatient monthly drug-dispensing error rate was significantly decreased.

Keywords Storage label · Drug dispensing · Error-reducing process · Drug-dispensing errors

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Introduction

Medication errors are one of the most frequent causes of adverse events in healthcare. Human error is often the immediate cause of medication errors [1]. The drug-use process commonly involves errors in prescription, dispensing, delivery, and monitoring; these mistakes account for approximately 14% of total patient mortality [2]. Dispensing errors are one of the most common. In a British hospital, 178 drug-dispensing errors occurred among 1 million processed prescriptions, which equates to an incidence rate of 0.018%. The incidence rate increased to 0.04% when the process was not double-checked and decreased to 0.01% when it was double-checked [3]. Therefore, an operating environment with security checks and strict procedures are essential to prevent or reduce drug-dispensing errors. Published data indicates that across the Australian public hospital system each year 140,000 hospital admissions are related to the consequences of inappropriate use of medicines [4]. It is estimated that 1–2% of inpatients are affected as a result of medication errors. Only the most serious and immediate errors are obviously identified from their outcomes. Dean suggested that we need to develop a culture in which we are more willing to talk about our errors and to learn from these mistakes [5]. Once identified, the cause of the error should be established so that changes can be made in practice [5]. With preventative strategies in place, error rates may be reduced [6].

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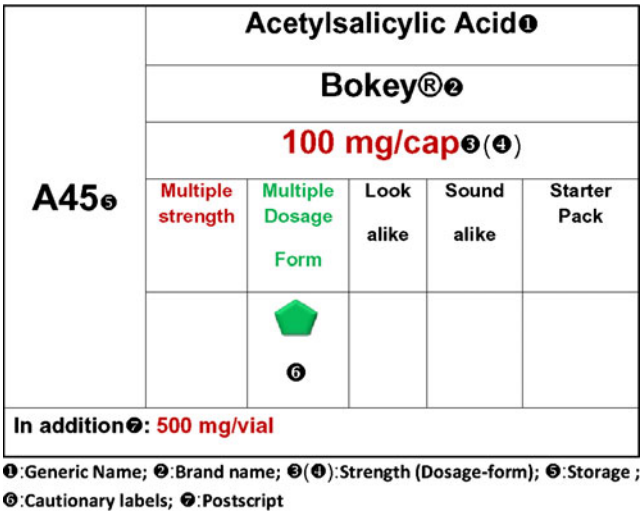

Fig. 1 Design of the new storage label

The objective of this study was to examine the effectiveness of improvements in the drug-dispensing system to decrease the incidence of errors. Theoretically, pharmacists who dispense drugs must follow the principle "read three times and verify five items." "Read three times" means that the drug name should be read first before the drug is dispensed to confirm that the correct drug is being dispensed, then again when the drug is taken from the shelf to verify that the proper drug is selected, and finally after the drug is dispensed and before it is returned to the shelf to verify that the correct drug was dispensed. "Verify five items" means that patient name, drug name (generic name and brand name), quantity, dosage form and administration frequency must be checked. Pharmacists also need to increase their awareness of high-risk drugs and drugs with similar names and appearance/packaging, multiple strengths, and multiple dosage forms. The limited time available for dispensing, the limited amount of drug information available and the large variety of drugs kept in the typical pharmacy, however, make it difficult to avoid errors. The aim of this study was to evaluate the effectiveness of implementation of an improved storage label containing more drug information (Fig. 1) and a new error-reducing process on the incidence of drug-dispensing errors. The study also evaluated pharmacists' degree of satisfaction with these newly-introduced measures.

Methods

Participants

The participants in this study were selected from all the pharmacists responsible for drug dispensing at a teaching hospital in southern Taiwan.

Inclusion and exclusion criteria

Only pharmacists whose primary responsibility was drug dispensing and who completed their probation period were included in the study. Newly appointed pharmacists who had not completed their probation were excluded from the study.

Study design and methods

A questionnaire with a rating scale of 1 to 5 (1 = not satisfied, 2 = mildly satisfied, 3 = moderately satisfied, 4 = severely satisfied, 5 = extremely satisfied) was distributed to pharmacists to measure their degree of satisfaction with the format and content of the current storage labels (Fig. 2) used for drug dispensing. The pharmacists were also encouraged to indicate their desired storage label format in a "Comments" section. The survey questions were developed based on the particular function of the labels in a practical setting. The results from this survey were used as the basis for designing the new storage label. When the new storage label was ready for implementation, five drug-dispensing pharmacists with at least 3 years working experience were randomly selected to examine its validity by completing the survey. The pharmacists were required to verify that the content and the format of the storage label met the objective of improving drug dispensing quality. The design of the new storage label was modified in accordance with the feedback received from these pharmacists. The final version of the new storage label was then implemented in outpatient and inpatient pharmacies (Fig. 1). The old label (Fig. 2) showed only the shelf storage location, the chemical name, commercial name and dose of the drug. The new label included additional information relating to multiple dosage forms of the drug as well as cautionary labels alerting the dispenser to other drugs that may be similar in appearance.

At the same time, pharmacists were requested to follow a new error-reducing dispensing process. Pharmacists needed to circle the essential items on the prescription requiring verification on the new storage label, including drug generic/brand name, strength, dosage form, appearance, and packaging before placing the medication into the

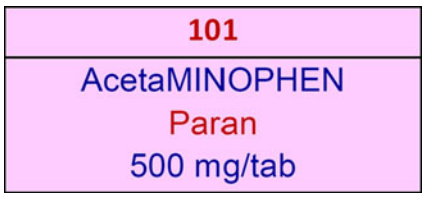

Fig. 2 A sample of the old storage label

medication bag (Fig. 3). This provided documentation for possibly double-checking the information in the future. This process may also assist auditors to perform a dispensing quality audit if necessary. One month after implementation of the new storage label and error-reducing process, the degree of satisfaction of the pharmacists were evaluated and the drug-dispensing error rates were analyzed. The questionnaire used to evaluate degree of satisfaction focused on three features: the format and content of the new storage label, and the extent to which these features improved drug-dispensing quality. The drug-dispensing error rate after implementation was compared with the rate before implementation to determine whether there were any statistically significant differences.

Statistical analysis

The Wilcoxon Signed Rank test was used to determine the difference between the average degree of satisfaction before and after implementation of the new storage label. The drug-dispensing error rate before and after implementation was evaluated using the McNemar test. The average degree of satisfaction is displayed as mean ± standard deviation and drug-dispensing errors are displayed as a number (percentage). All statistical assessments were two-sided and evaluated at the 0.05 level of significance. Statistical analyses were performed using SPSS 15.0 statistics software (SPSS Inc, Chicago, IL, USA)

Results

The participants in this study included all the pharmacists responsible for drug dispensing at a teaching hospital in southern Taiwan. However, pharmacists who had not passed 2 months of their probation period were excluded from participation. A total of 27 pharmacists (11 male and 16 female) were included in the study. Most pharmacists were aged between 26 and 39 years (74%), achieved undergraduate education (78%) and had more than 5 years of experience in drug dispensing (26%) (Table 1).

The pharmacists' degrees of satisfaction relating to the following questionnaire items increased significantly ($P<0.05$) after implementation of the new storage label: edition appropriateness (3.63±0.84 vs. 4.11±0.70, $P=0.038$); "similar drug names" are distinguished by capital fonts (3.41±0.93 vs. 4.04±0.65, $P=0.013$); the "reminder images" are helpful for drug differentiation (3.48±0.98 vs. 4.11±0.64, $P=0.009$) and the provided information is complete (3.26±0.90 vs. 4.19±0.68, $P=0.001$). The questionnaire item edition appropriateness related to the practical usefulness of the information on the label. The layout of the printed label was an important factor for the department. Pharmacists preferred that all the important information should be easy to see and read, consistent in color and format and that the printing should be of good quality. All items of dispensing quality, except "helps promote dispensing accuracy" ($P=0.062$) (Table 2) also increased significantly after implementation of the new label. The pharmacists' average degrees of satisfaction with the format, content, and quality improvement of the storage label increased from 3.58, 3.50, and 3.48, respectively, for the old storage label to 4.15, 4.10, and 4.07, respectively, for the new label.

There were no statistically significant differences in degree of satisfaction with the format, content and quality improvement of the new storage label between undergraduate and graduate level pharmacists. Due to the fact that it was not recorded who dispensed the incorrect medication, it is unknown if there was a significant difference in drug-dispensing error rate between undergraduate and graduate level pharmacists. Similarly, there were also no statistically significant differences in the degree of satisfaction with the format and quality improvement of the new storage label between the different age groups (pharmacists <25 years and ≥25 years). However, pharmacists in the age group ≥25 years were more satisfied with the content of the new storage label compared with the age group <25 years (4.2±

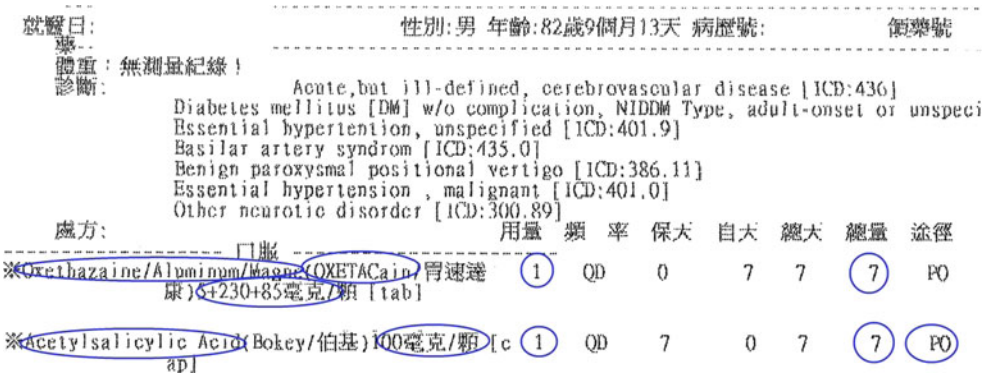
就醫日:　　性別:男 年齡:82歲9個月13天 病歷號:　　領藥號
藥
體重：無測量紀錄！
診斷:
Acute,but ill-defined, cerebrovascular disease [ICD:436]
Diabetes mellitus [DM] w/o complication, NIDDM Type, adult-onset or unspeci
Essential hypertention, unspecified [ICD:401.9]
Basilar artery syndrom [ICD:435.0]
Benign paroxysmal positional vertigo [ICD:386.11]
Essential hypertension , malignant [ICD:401.0]
Other neurotic disorder [ICD:300.89]
處方:　　用量 頻 率 保大 自大 總大 總量 途徑
口服
※Oxethazaine/Aluminum/Magne(OXETACain/胃速達康)5+230+85毫克/顆 [tab]　1 QD 0 7 7 7 PO
※Acetylsalicylic Acid(Bokey/伯基)100毫克/顆 [cap]　1 QD 7 0 7 7 PO

Fig. 3 Implementation of error-proof dispensing process

Table 1 Demographic information of participating pharmacists

Demographics		Number of participants (n=27)
Gender	Male	11 (41%)
	Female	16 (59%)
Age (years)	<25	6 (22%)
	26–39	20 (74%)
	40–64	1 (4%)
Education level	Undergraduate	21 (78%)
	Graduate	6 (22%)
Seniority (years)	< 0.5	4 (15%)
	0.5–<1	6 (21%)
	1–<2	4 (15%)
	2–<3	4 (15%)
	3–<4	1 (4%)
	4–<5	1 (4%)
	≥5	7 (26%)

0.4 vs 3.6±0.4, P=0.010). Again, due to the fact that it was not recorded who dispensed the incorrect medication, it is unknown if there was a significant difference in drug-dispensing error rate between the different age groups.

The outpatient monthly drug-dispensing error rate was calculated as the number of monthly drug-dispensing errors divided by the total number of drug-dispensing incidents × 100. This error rate decreased significantly from 0.019% to 0.009% (P<0.001) after implementation of the new storage label (Table 3).

Discussion

All humans, including healthcare professionals, make mistakes during the course of their careers. To understand why mistakes occur, evaluation of the drug-use system of the particular medical institution, the system's primary organizational structure, and the quality of the professionals involved is required. It has been proposed that errors can be classified as one of two basic categories: (1) slips and (2) mistakes [7]. Slips are defined as negligence and may be due to people being "too busy", "not paying attention", "getting tired" or other reasons. The most common cases of slips were typing an incorrect name on the medicine label. Mistakes were mainly due to the lack of knowledge of the prescription or drugs and/or incorrectly citing references. Grasha and O'Neil identified several factors that may affect the individual's basic cognitive processes and lead to a negative outcome [8]. These factors are 1) excessive workload; 2) personal factors, such as age, decreased sensory perception or poor health, stress, fatigue, or

Table 2 Comparison of survey results between old and new storage labels (n=27)

	Old storage label	New storage label	P-value[a]
Label format			
1. Appropriateness of the entire printed page	3.56±0.75	4.00±0.83	0.038[b]
2. Appropriateness of font and font size of the letters	3.52±0.80	4.00±0.73	0.026[b]
3. Clarity of letters	3.59±0.89	4.56±0.58	<0.001[b]
4. Color appropriateness of the letters	3.63±0.79	4.04±0.65	0.027[b]
5. Background color for identification increment	3.59±0.75	4.15±0.72	0.010[b]
Label content			
1. Edition appropriateness of the entire printed page	3.63±0.84	4.11±0.70	0.038[b]
2. "Similar drug names" are distinguished by capital fonts	3.41±0.93	4.04±0.65	0.013[b]
3. "Warning contents " are distinguished by color	3.70±0.91	4.07±0.68	0.104
4. Helpfulness of the "reminder images" for drug differentiation	3.48±0.98	4.11±0.64	0.009[b]
5. Integrity of the provided information	3.26±0.90	4.19±0.68	0.001[b]
Dispensing quality			
1. Label helps verify important drug information	3.56±0.80	4.22±0.70	0.005[b]
2. Label helps promote dispensing accuracy	3.52±0.80	4.00±0.78	0.062
3. Label helps increase dispensing efficacy	3.44±0.80	3.96±0.81	0.029[b]
4. Label helps provide a better understanding of the drug	3.41±0.93	4.15±0.72	0.007[b]
5. Overall degree of satisfaction with the storage label at outpatient and inpatient pharmacies	3.48±0.80	4.04±0.65	0.024[b]

[a] P-values are based on Wilcoxon Signed Rank test

[b] Indicates a significant difference (P<0.05)

Table 3 Differences in dispensing error rates before and after implementation of the new storage label

	Old storage label (N^a=1,075,878)						New storage label (N^a=1,102,902)					
	Jan.	Feb.	Mar.	Apr.	May	June	July.	Aug.	Sep.	Oct.	Nov.	Dec.
Dispensing error rate (%)												
	0.018	0.020	0.017	0.022	0.015	0.022	0.009	0.009	0.009	0.011	0.011	0.007
Total number of dispensing error incidences												
	204 (0.019%)						104 (0.009%)					
P-value[b]	<0.001[c]											

[a] Total number of dispensing events

[b] P-value is based on McNemar test

[c] Indicates a significant difference ($P<0.05$)

boredom; 3) factors unrelated to the institution, such as similar drug names or packaging by the pharmaceutical industry; 4) work environment, including poor lighting, excessive noise, excessively high or low temperatures, or too many phone calls; 5) unreasonable employee policies or regulations set by the managers of the institution; 6) poor communication; 7) failure to comply with policies or regulations; 8) insufficient knowledge; and 9) lack of a patient medication guide.

In Taiwanese hospitals, there is a high volume of prescriptions in both inpatient and outpatient pharmacies with most hospital pharmacies being extremely busy. To limit patients' waiting time to 15 min or less, the institution usually requests that the drug-dispensing time be kept within this timeframe. In addition to maintaining an inventory of the most commonly prescribed drugs, large hospitals must keep temporarily stocked drugs, drugs procured for specific cases, and even experimental drugs, with the total number of drugs stored often in excess of a thousand. Moreover, new drugs are continually added, stretching the pharmacists' basic drug knowledge to the full. All of these factors increase the chances of drug-dispensing errors. Another common problem is that the drug-dispensing area of the pharmacy tends to be narrow and crowded. The drug storage system is usually designed to contain as many drugs as possible. Often, the storage labels are not easy to read or contain insufficient information. Therefore, some errors did occur. Before implementation of a new drug storage label and error-reducing process, the outpatient monthly drug-dispensing error rate was 0.019% (Table 3). Generally speaking, the rush hour for outpatient pharmacy is from 10 to 12 O'clock in the morning of any weekdays. At the time an average of 3.3 medicines on each of the average of 55 prescriptions was filled by a pharmacist per hour (data not shown). To reduce the error rate, the newly designed label was used to emphasize important information (e.g. drug generic and brand name, strength, dosage form, and quantity) by printing the information in bold or colored letters to improve clarity and minimize confusion, and all of which were to ensure the easier verification of medications by the pharmacists during times of a high prescription volume. In conclusion, although the arbitrary expectation of waiting time less than 15 min and among other difficulties may have potentially increased the dispensing error rate, the implementation of the new label in the study indeed achieved the major goal of reducing dispensing errors significantly under any circumstances (the error rate reduced to 0.009%, $P<0.05$).

Rolland [9] examined the type and severity of dispensing errors reported by pharmacy services and the efforts implemented to reduce overall medication-related errors. Of the dispensing errors reported, 67% were due to selection of the wrong drug and the wrong patient. Therefore, focusing error reduction efforts on methods to improve selection of the correct drug, correct patient and correct dose would likely yield the best results in reducing dispensing errors. These practices should be the standard of care for all patients [9].

Although a storage label containing adequate information may help to reduce the incidence of drug-dispensing errors, the results of one survey showed that between 42% and 46% of pharmacists did not strictly follow the principle "read three times and verify five items" in drug dispensing [1]. Therefore, mistakes are still possible if this basic drug-dispensing principle is not followed by all healthcare personnel. With the traditional process, pharmacists usually read the prescription and then take the medication from the shelf. It is not known whether they are actually following the recommendation "read three times and verify five items". With implementation of the new process, pharmacists were asked firstly to follow the "read three times" policy during the providing stage (taking the medication from the shelf according to the prescription). When placing

the medication into the medication bag, pharmacists were then asked to physically check the prescription by circling or crossing out the names, strength, dosage form, and quantity of the prescribed items. This process thus reinforced the implementation of the new drug-dispensing regulations by pharmacists and facilitated the later spot-check by audit staff. Notably, when compared with the old label, the new label provided considerably more information (Fig. 1) relating to multiple dosage forms and other drugs that are similar in appearance. Although the questionnaire item "Label helps promote dispensing accuracy" did not achieve significantly increased scores (P=0.062, Table 2), which might be due to the fact that most of pharmacists would contribute many factors to dispensing errors and inappropriate labeling was not considered to be the key factor, the dispensing error rates did decreased significantly after implementation of the new storage label (P<0.001, Table 3). Therefore, the new label was indeed useful in achieving the goal of the improvement.

Eventually, the purpose of the new label design was to indicate clearly to pharmacists the potential mistakes that can be made during dispensing. Pharmacists working in busy hospitals are faced with the potentially competing challenges of efficiency and accuracy. The design of an effective drug-dispensing operating process is an important task of the institutional management. The drug storage label must include adequate information and provide appropriate reminders. Effective use of such storage labels, combined with simultaneous adoption of an error-reducing drug-dispensing process, can reduce the drug-dispensing error rate and improve the safety of drug use by patients. This new process may also be useful to assist managers to perform an audit on the quality of dispensing at the institution.

Conclusion

The results from this study showed that the implementation of the new storage label and the error-reducing process was effective in decreasing the overall drug-dispensing error rate and increasing the pharmacists' degree of satisfaction with the storage label design compared to the previous label used.

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