Dispensing errors from look-alike drug trade names

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ABSTRACT

Objectives To improve patient safety, we investigated near-miss dispensing errors in our hospital and evaluated the effectiveness of specific preventive strategies.

Methods The incidence and type of near-miss dispensing errors in a single hospital in Taiwan were identified in 2013. The causes of dispensing errors were analysed by consensus of an expert panel comprising a senior pharmacist on duty, a group leader in the pharmacy and an author. Because alphabetical trade names were routinely used in our pharmacy, they were used for similarity analysis. Trigram-2b and normalised edit distance (NED) were used to calculate orthographic similarity and distance measure, respectively. The correlation between drug-name confusion and dispensing errors was then studied. Preventive strategies, including the introduction of tall man letters, were completed at the end of 2013, and error data were then recollected in 2014. Differences between before and after the interventions were examined by t-test.

Results Before the intervention, look-alike alphabetical names were the main cause of dispensing wrong medicine (134/202, 66.3%). The frequency of near-miss dispensing errors correlated significantly with drug-name similarity ($p<0.01$). After implementation of preventive strategies, dispensing errors due to drug-name confusion were reduced significantly (77/140, 55.0%, $p=0.004$).

Conclusions The frequency of near-miss drug dispensing errors correlated with greater similarity or lower NED scores, and dispensing errors related to drug-name confusion were significantly reduced by our interventions. However, other dispensing errors might need to be investigated in order to prevent them.

INTRODUCTION

Patient safety is the main issue for a healthcare system and risks are largely due to medication errors.[1] A recent study in Australia defined 'human factors' leading to adverse clinical incidents in a broad sense to include 'unsafe acts (including human error and violations), and also other factors, such as individual, organisational, technological, and environmental factors, that might be considered to have an effect on human or system performance'.[2] It reported that the most commonly identified factors contributing to medication-related incidents involve either the organisation (86.5%) or the patient (7.7%).[2] Therefore, these human factors, particularly human error, in non-fatal clinical incidents indicate the need for risk management strategies in healthcare based on an understanding of how and why these incidents occur.[2] The most common medication errors by community and hospital pharmacies are dispensing the wrong drug, strength, form or quantity and labelling drugs with incorrect directions.[3] Confusion of drug names is one of the main causes of medication errors and its contributing factors are look-alike and sound-alike (LASA) drug names, illegible handwriting, incomplete knowledge of drug names, new products, similar packaging or labelling, and similar strengths, dosage, forms and frequency of administration.[4 5] Investigating LASA drug errors would help us to develop better technology and management solutions to limit, or eliminate, errors in hospital wards and outside the hospital.[6] Strategies used to reduce medication errors include e-prescribing and computerised provider order entry with decision support, medication reconciliation, barcode systems, clinical pharmacists in medical settings, medical staff training, package changes to reduce LASA drug confusion, standardisation of labelling, and measurement devices for home administration.[7]

We investigated near-miss dispensing errors from the double-checking report and evaluated the relationship between drug-name confusion and dispensing errors in our pharmacy. Use of tall man (capital) lettering has been reported to be helpful for emphasising the differences between similar products.[8] Therefore we hypothesised that altering the appearance of names on computer screens, prescriptions and shelf labels would decrease dispensing errors related to drug-name confusion.

METHODS

This was a study of a pre–post intervention to reduce near-miss dispensing errors at Tungs' Taichung MetroHarbor Hospital in Taiwan. The first set of data was collected from January to December 2013, and the second set from January to December 2014. At the end of 2013, we introduced several preventive strategies, including tall man lettering, enlargement of drug names and highlighted look-alike drugs on shelf labels. We applied tall man lettering to Glucophage, changing it to GlucoPHAGE for differentiation from Glucobay and GlucoMet. Other drugs, such as JanuMet and Galvus Met, were already provided with tall man letters by the manufacturers. To further prevent confusion between drug pairs such as GlucoMet versus GlucoPHAGE, GlucoMet versus JanuMet and Januvia versus JanuMet, they were placed on separate shelves with highlighted name tags. Drugs with look-alike packaging were also labelled with different colour stickers. We also educated new pharmacists with the list of the look-alike drugs. Tall man lettering was introduced for drugs identified as having the highest risk of confusion and shown on computer screens, shelf labels and prescriptions. Pharmacists, nurses and doctors

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were told about this new format. Differences between before and after interventions were examined by t-test.

Near-miss dispensing errors were reported by the double-checking pharmacists on duty. After dispensing by a pharmacist, the second pharmacist checked the prescription for its content and quantity in the drug package. A third pharmacist double-checked the content before delivery to the patients. If an error occurred, it was registered by handwriting on a drug error report form. The causes of dispensing errors were analysed by the double-checking pharmacist on duty and the group leader in the pharmacy independently. Where there was a discrepancy, a third pharmacist (one of the researchers) made the final decision as to the most likely cause of the error. Categories of dispensing errors followed the framework of Cheung *et al*[6] with some adjustment to our practice flowchart. Since dispensing the wrong drug had been associated with drug-name confusion in Cheung's study, we further investigated the relationship between incidence of dispensing errors and look-alike confusion by pair t-test and χ^2 analysis. Because alphabetical trade names of drugs were routinely used in our pharmacy, they were used for analysis of look-alike drugs. An orthographic similarity measure (Trigram-2b) and orthographic distance measure (normalised edit distance (NED)) were used to examine the lexical similarity or distance between the defined drug pairs. Although the BI-SIM system is used by the US Food and Drug Administration (FDA) for detection of confusable drug names,[9] it requires complicated computer programming which is beyond our capability. Trigram-2b measures computed similarity by breaking words down into three-letter subsequences and then counting the subsequences that occur in both words. For example, Zantac was broken down into z, za, zan, ant, nta and tac, and Zyrtec into z, zy, zyr, yrt, rte and tec. The Dice coefficient was used to

Table 1 Types of dispensing errors in 2013 and 2014

Type of error	2013	2014
Dispensing the wrong quantity	207/478 (43.3)	169/376 (44.9)
Dispensing the wrong drug	202/478 (42.3)	140/376 (37.2)
Look-alike alphabetical drug name	134/202 (66.3)	77/140 (55.0)
Picking-up the next drug	43/202 (21.3)	49/140 (35.0)
Look-alike packaging	24/202 (11.9)	12/140 (8.6)
Stocking the wrong drugs	1/202 (0.5)	2/140 (1.4)
Dispensing the wrong drug strength	42/478 (8.8)	31/376 (8.2)
Dispensing the wrong form	8/478 (1.7)	10/376 (2.7)
Other	19/478 (4.0)	26/376 (6.9)
Total	478/478 (100)	376/376 (100)

Values are n (%).

Table 2 Incidence of most common dispensing errors of look-alike drug pairs

Drug pair	NED	Trigram-2b	2013 errors	2014 errors
Amaryl/Amtrel	0.29	0.33	2	0
Behyd/Bokey	0.67	0.2	6	1
Calcium acetate/calcium citrate	0.53	0.23	3	1
Concor/Cozaar	0.43	0.33	4	1
Concor/Crestor	0.5	0.15	4	0
Cozaar/Hyzaar	0.29	0.33	2	0
Denosin/Diovan	0.5	0.15	4	0
Doxaben/Doxaben XL	0.2	0.82	4	0
Doxaben XL/Lescol XL	0.7	0.11	2	0
Exforge/Exforge HCT	0.27	0.78	4	5
Exforge HCT/Sevikar HCT	0.64	0.18	8	5
Galvus/Galvus Met	0.3	0.75	13	1
Galvus Met/GlucoMet	0.4	0.22	5	7
Glucobay/Glucophage	0.46	0.56	2	4
GlucoMet/Glucophage	0.46	0.56	6	2
GlucoMet/JanuMet	0.78	0.13	3	0
Januvia/JanuMet	0.38	0.57	4	3
Lipanthyl/Lipitor 10 mg	0.5	0.38	2	0
Mirapex 0.25 mg/Mizollen	0.56	0.27	2	0
Sevikar/Sevikar HCT	0.27	0.78	2	4
Zanidip/Zantac	0.5	0.46	3	0
Zantac/Zyrtec	0.43	0.17	5	2
Co-Diovan/Diovan	0.3	0.53	0	2
Pradaxa/Preterax	0.56	0.27	0	1
Lacipil/Lamictal	0.44	0.27	0	2
Tanatril/Trental	0.56	0.13	0	1
Calcium carbonate/calcium citrate	0.53	0.29	0	2
Coaprovel/Co-Diovan	0.5	0.22	0	1
Prednisolone/pseudoephedrine	0.63	0.07	0	1
Voltaren Retard/Vytorin	0.67	0.09	0	2

Look-alike drug pair dispensing errors for 2013 vs 2014: p=0.004 by paired t-test, p<0.001 by χ^2 test.
NED, normalised edit distance.

compute a similarity score between two sets of trigrams: similarity=2C/(B+A), where A is the number of trigrams in Zantac, B the number of trigrams in Zyrtec, and C the number of trigrams that occur in both. Therefore, their similarity score is 2×1/(6+6)=0.167. NED is the total number of edit operations (ie, insertion, deletions and/or transpositions) needed to transform one word into another.[4] To transform 'ambien' into 'amen', one must delete the b and i, so the edit distance between them is 2. NED between ambien and amen is 2/6=0.33; 6 is the maximum possible edit distance between these two words.[4]

RESULTS

After the implementation of preventive measures, the dispensing errors related to drug-name confusion were significantly reduced from 134/202 (66.3%) in 2013 to 77/140 (55.0%) in 2014 (p=0.004). The incidence of dispensing the wrong drug was also reduced from 202/478 (42.3%) in 2013 to 140/376 (37.2%) in 2014 (p<0.001). Near-miss dispensing errors were found in 478 and 376 cases, respectively, from 2013 and 2014, and the incidence was 478/2 170 442 (0.022%) and 376/2 104 369 (0.018%), respectively, based on the total number of drugs dispensed that year. The error types and the causes of dispensing wrong drugs are shown in table 1. After the wrong quantity, the look-alike name was the major cause of dispensing the wrong drugs (134/202). Frequently used drugs in the look-alike group were most associated with the dispensing error (15–22% of the top 150 drugs). The similarity and distance of drug trade names were further analysed by two orthographic methods (Trigram-2b and NED). The frequency of near-miss dispensing errors correlated significantly with greater similarity or lower NED scores (p<0.01, table 2).

DISCUSSION

We found that the most common near-miss dispensing errors (annual incidence range 0.018–0.022%) were the wrong quantity and wrong drugs. The former might be related to memory lapses.[10] Factors such as fatigue, sleep disruption and distraction may interfere with working memory and cause dispensing errors.[11–13] Therefore, it is necessary to avoid distraction in the dispensing area. Dispensing the wrong drugs was the second cause of error in this study. Drug confusion has been attributed to illegible handwriting, incomplete knowledge of drug names, newly available products, dosage forms, frequency of administration, and the failure of manufacturers and regulatory authorities to recognise the potential for error for non-proprietary and brand names.[3 5 14] Among them, LASA drugs are often associated with dispensing errors.[4 5] Our results agree with these findings that the incidence of near-miss dispensing errors correlate with greater similarity or lower NED scores. Since the incidence of near-miss dispensing errors was associated with drug-name confusion, scores of similarity/NED could potentially be used as predictors of dispensing errors. This was confirmed by a recent report of a significant association between real-world wrong drug name confusion error rates (ie, caused by pharmacists and pharmacy technicians) and error rates from laboratory tests of memory and perception (including doctors, nurses, pharmacists and lay people).[15] Although the US FDA and Institute for Safe Medication Practices (ISMP) provided the tall man lettering scheme for LASA drug name pairs, the efficacy of tall man lettering for reducing errors remains inconclusive, as a recent study shows that implementation of tall man lettering did not reduce errors.[16] This suggests that other interventions should be explored to avoid LASA drug errors. The tall man letters recommended in the FDA and ISMP list of drugs is applied mainly to generic names. However, we use trade names for prescription and dispensing in our hospital practice. We also followed the strategy of our neighbouring hospital with a minimum change of drug names to avoid alert fatigue in dispensing. Although our list of look-alike drugs consisted of 22 drug pairs, tall man lettering was applied only to Glucophage.

There are several limitations in this study. First, we only addressed look-alike and not sound-alike drug errors. This was because a non-alphabetical language is used in Taiwan. Second, we analysed all near-miss dispensing errors, and not only tall man lettered drug pairs. In addition to tall man lettering, several other measures were implemented for reducing errors, including enlargement of drug names and highlighting look-alike drugs on shelf labels. Similar strategies have been proposed in the past to prevent name confusion, package confusion and mixed storage. Look-alike drug names can be emphasised by different coloured tall-man lettering to reduce dispensing errors.[8 13 17] A recent literature review also showed that nurses, other health providers and lay people can detect changes in LASA drug pairs more often and more quickly by tall man letters.[18] The authors suggest that attentional allocation to tall man letters is involved with both bottom-up and top-down cognitive systems. The bottom-up attentional system works in a fast and automatic manner regardless of a person's knowledge about the purpose of tall man lettering. The top-down attentional system should require knowledge of the tall man lettering scheme.[18] However, new look-alike drug pairs and other factors also contributed to dispensing errors, and strategies are needed to prevent all of them. In addition, problems with storage of drugs can be improved by storing them in separate locations or in non-alphabetical order, such as by bin number, on shelves, or in automated dispensing devices. These approaches may also be helpful in reducing the rate of dispensing errors but need to be researched further.

What this paper adds

What is already known on this subject

- The most common medication errors by community and hospital pharmacies are dispensing the wrong drug, strength, form or quantity and labelling with incorrect directions.
- The efficacy of tall man lettering for reducing errors remains inconclusive.

What this study adds

- Dispensing errors from look-alike alphabetical drug names can be improved by using tall man lettering, enlarging drug names, and highlighting look-alike drugs on shelf labels.

Contributors H-YT: data collection, writing. C-FW: statistical analysis. Y-LL: data collection, analysing the causes of dispensing errors. K-CJ: discussion, writing. P-LC: computer programming, discussion.

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