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Characteristics That May Help in the Identification of Potentially Confusing Proprietary Drug Names

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Abstract

Purpose: This study aimed to provide a descriptive analysis of characteristics that are common among drug name pairs involved in name confusion medication errors. *Methods:* We evaluated drug name pairs that contained at least one proprietary name from the Institute for Safe Medication Practices (ISMP) List of Confused Drug Names. For each name pair, we analyzed whether the following characteristics were present: (1) the same first letter, (2) a shared letter string of at least 3 letters, and (3) similarity in the number of letters. Additionally, we obtained the combined Phonetic and Orthographic Computer Analysis (POCA) score. *Results:* Ninety-nine percent of the drug name pairs reflected at least one of the 3 characteristics analyzed. Additionally, 75% of the names had a combined POCA score of $\geq$50%. *Conclusions:* This descriptive analysis provides some insight into characteristics that may be associated with name confusion, which should be considered when formulating and evaluating proposed proprietary drug names.

Keywords

drug name confusion, medication error, proprietary name, nonproprietary name, wrong drug

Introduction

A drug name that looks or sounds like another drug name is often cited as a source of confusion that can lead to the use of an incorrect drug.[1] These medication errors can result in serious adverse outcomes. The US Food and Drug Administration (FDA) reviews the proposed proprietary names of drugs and therapeutic biologics submitted by pharmaceutical manufacturers prior to drug approval in order to prevent medication errors related to name confusion.[2,3] If the FDA identifies that a proposed proprietary name looks and/or sounds like an existing drug name such that it could be expected to cause a health care professional or consumer to confuse the two products, then the proposed name may be denied in order to prevent harm resulting from name confusion medication errors. In addition, FDA actively monitors for name confusion medication errors after drug approval, and when necessary, FDA takes regulatory action as appropriate to address name confusion medication errors.

For the purposes of this article, the term *proprietary name* is the name owned by a company for describing its brand of a particular product, and it is sometimes referred to as the brand name or the trademark. Some proprietary names are constructed of a root name and added word(s) or other components that are referred to as the modifier portion of the proprietary name.[i] An example of the *modifier* portion of a proprietary name might include "XR" to signify an extended-release product or "ODT" to signify an orally disintegrating tablet. The modifier portion of a proprietary drug name might consist of letters, numbers, words, a device name, or combination thereof which could be placed at the beginning, middle, or end of a root proprietary drug name. In this article, we describe characteristics of confused drug name pairs that contain at least one proprietary name–involved medication errors. We aim to analyze similar characteristics of drug names within each pair that can inform development and evaluation of proposed proprietary names for drug products.

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Materials and Methods

Identification of Confused Drug Name Pairs

The Institute for Safe Medication Practices (ISMP) published ISMP's List of Confused Drug Names,[4] which includes look-alike and sound-alike name pairs published in the *ISMP Medication Safety Alert!* Acute Care Edition and the *ISMP Medication Safety Alert!* Community/Ambulatory Care Edition. Health care professionals and consumers report medication errors including those that involve confused drug name pairs to ISMP through either the ISMP National Medication Errors Reporting Program (ISMP MERP) or ISMP National Vaccine Errors Reporting Program (ISMP VERP).[4] We used this list to identify the drug name pairs for analysis. We classified each drug name as either a proprietary name or a nonproprietary name and categorized each name pair as proprietary name/proprietary name confusion (when both names were proprietary names), nonproprietary name/nonproprietary name confusion (when both names were nonproprietary names), and proprietary name/nonproprietary name confusion (when one name was a proprietary name and the other name was a nonproprietary name).

Exclusion Criteria

We focused only on proprietary/proprietary and proprietary/nonproprietary name confusion. *Nonproprietary names* of a drug are sometimes referred to as the *generic name* or the *common name*. A nonproprietary name would be those names of a drug that are in the public domain and may be used freely by anyone. Nonproprietary drug names differ in composition to proprietary names because nonproprietary drug names, by design and intent, are similar to nonproprietary names of other drugs that share the same properties so that clinicians and scientists can gain some understanding of the drug's properties from the nonproprietary name. Therefore, given the functional similarity of nonproprietary nomenclature, drug name pairs involving confusion between only nonproprietary names were excluded (n = 99). For similar reasons, we excluded errors involving confusion between drug name pairs containing the same root name (n = 38). Lastly, we did not include in our analysis those drug name pairs involving confusion between identically named products that contain different active ingredients (n = 12) or were different formulations (n = 11). Although the use of identical names can be an important source of error, including these names in a descriptive analysis would not be expected to inform our understanding of what characteristics lead to confusion among two uniquely coined proprietary names. Names that contained symbols (n = 1) were not included since inclusion of a symbol in a name may alter the way it is pronounced. Finally, drug name pairs where both products listed were vaccines (n = 11) were excluded because certain characteristics of vaccine nomenclature, labeling, and use may not be applicable to proprietary naming of drug products and thus not inform our understanding of drug name confusion error patterns (see Table 1 for exclusion criteria).

Table 1. Exclusion Criteria.

Reason for Exclusion	Name Pairs Excluded, n	Example
Nonproprietary name/ nonproprietary name confusion	99	clonazepam/lorazepam
Same root name with added modifier	25	Adderall/Adderall XR
Same root name with different modifier	13	Metadate CD/Metadate ER
Same active ingredient in different formulation	11	Abelcet/amphotericin B
Vaccines	11	Adacel/Daptacel
Same proprietary name with different active ingredient	12	Afrin (oxymetazoline)/ Afrin (saline)
International proprietary names	5	Capadex (non-US product)/Kapidex
Names with symbols	1	B & O/Beano

Characteristics of Drug Name Pairs Evaluated

For each name pair, we analyzed the construct of the names to determine which characteristics applied to the name pair and may have contributed to confusion.

The similarity in spelling between drug names plays an important role in drug name confusion and the resulting errors demonstrate that increasing similarity in spelling is positively correlated with confusability.[5] We evaluated the spelling of each name pair to determine whether both names in the pair started with the same first letter. Next, we examined the presence of shared letter strings (group of letters) among the drug names in the pair, as certain research indicates that shared strings of 3 letters are associated with an increased potential for name confusion errors.[5,6] If a shared letter string of at least 3 letters existed between both drug names in the pair, we sought to identify the position of the shared letter string as being located in the prefix, infix, or suffix[ii] and whether the shared letter string was found in the same position for each drug name in the pair. We also examined whether name pairs had multiple shared letter strings in different positions as well.

We also evaluated similarity in the length of the names in each pair by counting the number of letters and then calculating the difference in the number of letters between both names. For those proprietary names that included a modifier component in this analysis, we counted the letters in the modifier along with the root name to provide for the overall length of the name.

Last, to quantify the similarity of the confused names, we used a computerized method to identify the phonological and orthographic similarities between the name pairs. We used FDA's Phonetic and Orthographic Computer Analysis (POCA) for this purpose.[iii] We obtained a combined (phonetic and

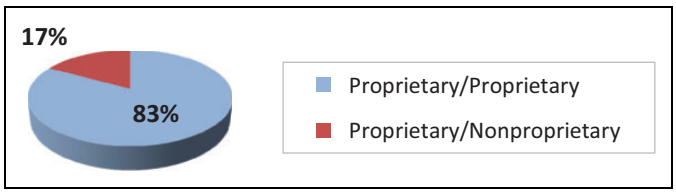

Figure 1. Type of names involved in confusion. Nonproprietary/nonproprietary drug name pairs were excluded from analysis.

orthographic) POCA score for each drug name pair. The drug name pairs were then categorized, based on the combined POCA score, as highly similar (≥70%), moderately similar (≤69% to ≥50%), or low similarity (≤49%).[3]

Results

The ISMP List of Confused Drug Names contains 401 drug name pairs. After applying the exclusion criteria, 224 drug name pairs remained for analysis, which included the following categories: proprietary/proprietary drug name pairs (n = 186, 83%), and proprietary/nonproprietary drug name pairs (n = 38, 17%) (Figure 1).

Of the 224 drug name pairs, 154 (68%) of the drug name pairs started with the same first letter. Overall, the most common letters that the drug name pairs started with were *p* (n = 17), *a* (n = 12), *l* (n = 12), and *z* (n = 12). Table 2 provides detail on the number of drug name pairs that start with the same first letter, by letter, and, for comparison, the list also provides the total number of approved drug names in the United States beginning with each letter (per Drugs@FDA).

Of the 224 drug name pairs, 118 (52%) contained a shared letter string of at least 3 letters. Of these 118 drug name pairs, 7 contained more than one shared letter string. The most frequent shared letter strings were "pro" (n = 6) and "met" (n = 4). The average number of letters in the shared letter strings was 3.6 and ranged from 3 to 6 letters. After evaluating all shared letter strings, we determined that the majority were positioned in the prefix (n = 70, 59%), followed by the suffix (n = 41, 34%), followed by the infix (n = 14, 11%). Because 7 drug name pairs had more than one shared letter string, the total resulted in greater than 100%. Table 3 displays the results of the position of the shared letter strings. Of the drug name pairs with shared letter strings, 95% (n = 113) of drug name pairs had the shared letter string located in the same position (eg, the shared letter string was located in the prefix for both names), while 5% (n = 5) of drug name pairs had the shared letter string located in a different position (eg, the shared letter string was located in the prefix for one name but in the suffix for the other name).

Of the 224 drug name pairs, 206 drug name pairs (91%) had a difference in the number of letters and overall length by two or fewer letters. Eighteen drug name pairs differed in length by 3 to 9 letters. Of note, 16 of these 18 drug name pairs that differed by more than 3 letters shared the same first letter between both names.

Table 2. Drug Name Pairs Starting With the Same First Letter.

Letter	Name Pairs With Same First Letter, n	Approved Drug Names in the United States Beginning With Each Letter, n[a]	Percentage[b]
A	12	618	1.94
B	2	232	0.86
C	10	586	1.71
D	7	479	1.46
E	2	274	0.73
F	7	218	3.21
G	1	130	0.77
H	5	220	2.27
I	1	218	0.46
J	3	23	13.04
K	4	83	4.82
L	12	312	3.85
M	10	426	2.35
N	9	323	2.79
O	3	232	1.29
P	17	650	2.62
Q	0	37	0.00
R	10	203	4.93
S	11	377	2.92
T	10	485	2.06
U	0	62	0.00
V	4	206	1.94
W	0	23	0.00
X	1	45	2.22
Y	1	5	20.00
Z	12	114	10.53

[a]Per Drugs@FDA; information current as of June 27, 2014.
[b]Calculated as (Number of name pairs with same first letter / Total number of names with letter) × 100.

Table 3. Position of Shared Letter Strings.[a]

Location	Name Pairs, n (%)
Prefix	70 (59)
Infix	14 (11)
Suffix	41 (34)

[a]The following name pairs have more than one shared 3-letter string in more than one position and are counted twice, making the total >100%: Adderall/Inderal, Brethine/Methergine, Granulex/Regranex, midodrine/Midrin, Reprexain/Zyprexa, Sonata/Soriatane, tromethamine/Trophamine.

The majority of drug name pairs (n = 121, 54%) were categorized as moderately similar with a combined POCA score of ≥50% to ≤69%, followed by low similarity with a score ≤49% (n = 56, 25%) followed by highly similar with a score ≥70% (n = 47, 21%) (Table 4). The average combined POCA score was 58% and ranged from 23% to 92%.

Overall, 99% (n = 223) of drug name pairs reflected at least one of the following characteristics: same first letter, presence of a shared letter string of at least 3 letters, or similar length between the names (difference of ≤2 letters). Additionally, 75% of the names had a combined POCA score of ≥50%.

Table 4. Drug Name Pairs by Combined POCA Score.

Similarity (Combined POCA Score)	Name Pairs, n (%)
High (≥70)	47 (21)
Moderate (≥50 to ≤69)	121 (54)
Low (≤49)	56 (25)

Discussion

For the 224 name pairs evaluated, we found 68% of drug name pairs started with the same first letter. Although the most common letters that the drug name pairs started with were *p* (n = 17), *a* (n = 12), *l* (n = 12), and *z* (n = 12), it is important to consider the construct of the entire name when considering confusability with another name rather than focusing solely on the same first letter. Therefore, although selection of infrequently used letters may be prudent, discouraging use of these letters may unnecessarily restrict name possibilities.

Fifty-two percent of drug name pairs contained a shared letter string of at least 3 letters. Additionally, of the drug name pairs with a shared letter string, most shared letter strings were located in the prefix for both names. These findings suggest that similarity in the beginning of the name is a common characteristic shared among drug name pairs with known confusion. Additionally, 91% of the name pairs had the same or similar number of letters (difference of ≤2 letters). We note there were fewer confused drug name pairs with a difference of ≥3 letters between the names. Although the number of letters between these name pairs differed by ≥3 letters, all but 2 of these name pairs shared the same first letter among the pair. These findings suggest that drug names may be less likely to be confused if the names differ by 2 or more letters in length.

We found that the majority of drug name pairs were in the moderate similarity category with a combined POCA score of ≥50%. This finding is interesting and supports FDA's current process for evaluating proposed proprietary names to review names with a combined POCA score ≥50%. This threshold was based on the validation data in which the POCA algorithm met the requirement of matching 75% of the FDA-identified names using the combined score at a threshold of 50%. We do note that 25% of the name pairs had a combined POCA score ≤49%. This finding is surprising because one might expect drug names that are confused to have a higher POCA score. This suggests that additional factors or product characteristics that commonly accompany a drug name on a prescription or order, such as strength, dose, and setting of use, may be contributing to confusion. Although we did not determine if overlapping product characteristics such as strength and dose contributed to the drug name confusion, this would be interesting to research in the future.

FDA's current process for evaluating proposed proprietary names is to review names with a combined POCA score ≥50%. Our research shows that other important characteristics to consider among the names with a POCA score ≥50% include the presence of the same first letter, presence of shared letter string of at least 3 letters, and similarity in the number of letters between the names. Considering these characteristics when evaluating the suitability of proposed proprietary name could inform a risk-based approach to evaluating a prospective name against a large pool of potentially similar and confusable drug names.

Although this approach may provide for certain efficiencies when analyzing a proprietary name candidate against a pool of already identified potentially similar names, considering these characteristics alone in an analysis would not be sufficient to reasonably predict or measure the confusability of a pair of drug names. There are other methods described in literature that have been validated to measure similarity between drug names and can form the basis for sensitive and specific tests of the potential for errors with look- and sound-alike names.[4,5,7] Drug name attributes were included as an independent variable in a recent analysis that showed a significant association between drug name confusion error rates observed in the real world and those observed in laboratory-based tests. Notable drug name attributes included the length or number of letters in the drug name, the bigram frequency, and the orthographic and phonological similarities. Drug name length and similarity were positively correlated with real-world error rates, and similarity was statistically significant.[8] Levenshtein distance, or the number of edit operations (eg, substitutions, insertions, deletions) needed to transform one word into another, is another measure of orthographic similarity that has been shown to accurately predict drug name confusion.[5,7]

Our analysis of these drug name pairs that have resulted in errors provides some qualitative data that adds to these literature findings, however our research does have some limitations. First, we did not determine whether overlapping product characteristics such as strength, dose, route of administration, etc, contributed to the drug products being confused. Additionally, we did not research all drug name pairs to determine whether the error was related to look-alike confusion, sound-alike confusion, or both look-alike and sound-alike name confusion. The scope of our evaluation relied on the drug name pairs identified on ISMP's List of Confused Drug Names, which was last updated in 2015. Nearly half of the drug name pairs were excluded from the analysis, which limits the generalizability of the results to understand the causes of error related to name confusion. However, as the considerations in developing and evaluating proprietary names are different from those considerations presented when formulating nonproprietary names, this descriptive evaluation can help to inform our understanding of proprietary name confusion factors.

The design of this study was a descriptive analysis focused on only the proprietary name of the products, and therefore the analysis does not describe other important factors that may have contributed to the name confusion beyond the name which could be important considerations when assessing the potential confusability of a proprietary name candidate. It is likely that drug name confusion is caused by a combination of

factors including similarities in its intended use, dosage form, strength, dose and the use of the product in the usual clinical practice setting. Lastly, this descriptive analysis did not include a cohort of drug name pairs that have not been confused. Although the majority of the confused drug name pairs share the same first letter, are similar in length and share a letter string of at least 3 letters, we are unable to conclude whether these characteristics are unique to confused drug names. Further research into this aspect could help inform our understanding and the predictability of proprietary name confusion.

Conclusions

In summary, we found that the beginning of the drug name may play a significant role in contributing to confusion between drug names. We found that a majority of the confused drug name pairs included in the analysis started with the same first letter and more than half contained a shared letter string of at least 3 letters in the prefix of both names. Additionally, similar lengths of the names may also contribute to drug name confusion. We also found that 75% of the drug name pairs had a combined POCA score of $\geq$50%. It is possible that these characteristics may play a significant role in leading to confusion between the drug names. Considering these characteristics when evaluating the suitability of proposed proprietary name could inform a risk-based approach to evaluating a prospective name against a large pool of potentially similar and confusable drug names, thus potentially making the identification of confusing drug names more efficient. It may also be useful to manufactures to consider these findings when formulating and evaluating proprietary names in order to coin names that minimize the risk of look-alike or sound-alike drug name confusion that can lead to medication errors.

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Author Note

The views expressed in this manuscript represent the opinions of the authors and do not necessarily represent the views of the US Food and Drug Administration.

Declaration of Conflicting Interests

No potential conflicts were declared.

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Notes

i. A *modifier* is a portion of the proprietary name. Some proprietary names are constructed of a root name and added word(s) or other components that are referred to as the modifier portion of the proprietary name. The modifier portion of a proprietary drug name might be a letter, number, word, device name, or combination of letters, numbers, and words attached to the beginning, middle, or end of a root proprietary drug name.

ii. Although there may be variations for common use of the terms *prefix*, *infix*, and *suffix*, in this article, the term *prefix* refers to a group of letters that appear in the beginning of the proprietary name wherein the first letter of the name is part of the group, *infix* refers to a group of letters that appears in the middle of the proprietary name that does not include the first or last letter of the name, and *suffix* refers to a group of letters that appears at the end of the proprietary name wherein the last letter of the name is part of the group.

iii. POCA is a system designed by FDA. As part of the name similarity assessment, POCA is used to evaluate proposed names via a phonetic and orthographic algorithm. The proposed proprietary name is converted into its phonemic representation before it runs through the phonetic algorithm. Likewise, an orthographic algorithm exists that operates in a similar fashion. POCA is publicly available by requesting the system from FDA.

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