Development of the System to Objectively Evaluate Similarities of Drug Names

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Abstract

Many accidents and incidents occur in the medical treatment. The medication is related to many of these errors. As one of the factors, the similarity of the names of drugs is pointed out. It was very difficult to study similarity ,because the judgment of similarities was mostly subjective. We developed the system that was able to judge the similarity of the drug names objectively in 2001, and through a psychological experiment, we remodeled this system. As a result, it came to be able to avoid similarity of the new drug's name but also do an psychological examination concerning the similarity in detail..

Keywords:

Drug Name; Medication error; Similarity; Objective evaluation

Introduction

Operational accidents due to mixing up of patients happened in 1999 in Japan have immediately raised national interest about medical accidents. Coincidentally in the U.S., the book titled, "To Error is Human"[1] was published and the president Clinton (at the time) had put up the goal to reduce medication errors into half in five years. These incidents indicate that people all over the world has started to show higher interest in medical accidents. Also what's common throughout the world is that enough researches on human errors in medical field have not been made, due to the closed nature of medical world though human errors must be occurring in this field as well as in other fields.

For the past few years, administrative offices, enterprises and medical institutions in each country have been making many efforts to prevent such accidents from happening. Actually there are many case examples where medication errors or incidents involve drugs, and it is reported that nearly 50% of the incidents involve drugs. Among the errors related to drugs, what is commonly recognized as a problem is the similarities of drug names.

Table1 Case example of similarity problem occurrence (Japan:Two-bites characters)

Stem 1	Stem 2
タキソール	タキソテール
メテナリン	ウテメリン
アルマール	アマリール

These similarities are classified into two types: Look-alike and Sound-alike. Table 1 shows the case of similarity related problems in Japan and Table 2 shows the ones in the U.S.

Table2 Case example of similarity problem occurrence (U.S.:One-bite character)

Stem 1	Stem 2
Lamisil	Lamicel
Accutane	Accolate
Sinequan	Singulair

Traditionally in Japan, prescriptions have been written by hand. But with the spread of order entry system at hospitals or introduction of receipt issuance system at medical clinics, prescriptions now have been issued through such systems; in other words, issuance of prescriptions in printed letters have begun to gain popularity. However on the other hand, at hospital wards most of the instructions are given in a hand writing form, thus the problem of illegibility still remains. In Japan in the past, normally English letters were used for drug names, but today the use of Katakana is on the increase. Katakana is a phonogram, therefore look-alike and sound-alike, attributed similarity problems related to drug names, are almost the same in its characteristic. This is the difference from the U.S. where they have to come up with the measures for each one of them.

The relationship between drug names and human errors was pointed out in the presentations by Tsuchiya [2] and colleagues, at The International Ergonomics Association (IEA 1982). Also in Japan, the studies have been continued led by Tsuchiya and colleagues since then. However, in-depth studies about the "similarities" done today are very few in number, though the cases of "errors" are reported.

In the U.S., there have been audits about drug name similarities by FDA and surveys by private groups, but their methodologies are of subjective nature. In Japan there are systems to check similarities of ethical drug names before their release, but its judgment base is subjective like in the U.S. And since the scope of such checks tends to be limited to the drug names that are within checkers' recollection. Therefore generic drug names less frequently used rarely go through such check process.

There are more and more prescriptions issued by computers these days. Along with this, more than a little of erroneous drug selection are seen when they go through order entry system. There were some cases that such erroneously selected medications were used on patients and resulted in the death of patients. This is due to the fact that normally selecting drugs in the order entry system starts searching drugs using the top letter as an index, and sort and display in Japanese alphabetical order, and users select from that list. With this system, there's a risk that users may select wrong drugs with the same top part. We can say that the similarities of drug names contribute to erroneous selections.

We have developed a system [3] to evaluate similar names of drugs using objective methods, that in the past had been judged subjectively. Since then, psychological researches have been done on the system and studies have been made to identify measures for enhancing its practicality. Here we would like to make a report on the results of our studies.

Development of the system to objectively evaluate similarities of drug names

Drug names in general are made up of three elements: "stem of a word (brand name)," "strength," and "shape of drugs." In developing the system that evaluates similarities objectively, we have focused on the similarities of "stem" out of those three elements. "Stem" parts of drug names on the market were isolated and overlaps were excluded to build a base data. Currently the number of stems accounts to 6,808. Figure 1 shows the distribution of letter length of "stem" parts of ethical drugs in Japan.

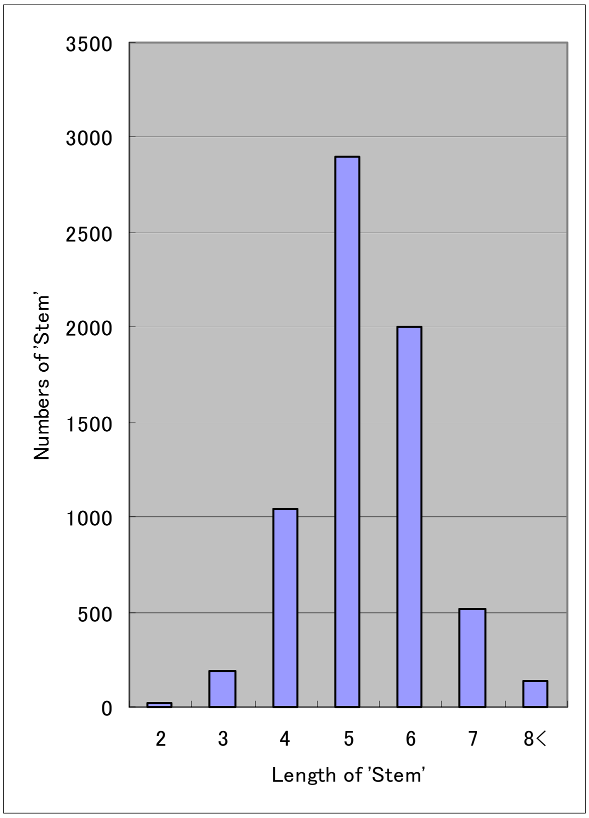

Figure1 Distribution of letter length of 'Stem' in Japan

As indexes to evaluate "stem" similarities objectively, we have used the following 10 indexes of 4 types.

1) Indexes using n-grams method
We have produced characteristic vectors of two stems that are to be compared, and have taken an approach to study similarity level looking at the angle created by such vectors (generally known as cosine). In creating characteristic vectors, we have used n-grams as a guide which is normally used to create characteristics of one word using one vector in evaluating the similarities of documents. We have figured that we can make an index to study similarities of stems by replacing the terms "document" with "stem", and "word" with "character that constitutes stem" used in the n-grams method.

For example, we used two letters located next to each other making up a stem as the base for creating characteristic vector using 1-gram method, and calculated similarity level by cosine (expressed as cos 1). The value becomes 0 if letters that make up each one of comparative two stems are totally different, and becomes 1 if they are completely the same. When comparing ordinary stems, the value will be between 0 and 1, and the value closer to 1 means higher similarity level.

At the initial stage of development, we have calculated three items: one letter unit (cos1), two-letter unit (cos2) and three-letter unit (cos3). But since these three indexes are co-related with each other, we have decided to adopt the first two items as the index. From empirical observation, considering that it is said that pharmacists generally capture the top part and the tail part of drug names, top two letters and two tail letters were used as characteristic vector components to calculate (htco).

And to further study the detailed similarities, top three letters (h3cos1), tail three letters (t3cos1) and top one letter of "stem" were excluded to calculate cosine (eh1cos1).

2) Index based on edit distance
To match two different stems, we have identified distance metric that tells us how many times we have to do editorial basic operations such as "replacement" "insertion" and "deletion" for one of the stems. The edit distance indicates the minimum number of operations required. The index previously mentioned in 1) was the coefficient that was normalized and indicated as 0 with no similarity and 1 with complete identical state. But with this method, edit (タキソール, タキソテール)=1, edit（Lamisil, Lamicel）=2.

3) Difference in stem letter length (dlen)
In judging the similarities, we think the difference in letter length of stems to be compared matters. So we have calculated the letter length of stem and used the difference of the letter length (dlen) as the index.

4) Number of common letters in top/tail letters
As the index to show the commonality of top or tail letters, the number of common letters from the top of "stem" (head) , and the same from the tail (tail) were defined.

Table 3 shows the values of each index for the cases of medication errors occurred in Japan, and table 4 shows the values of each index for some of the combinations, disclosed on the homepage by the U.S. FDA as combinations requiring more attention.

Table 3: Index values from case example of similarity problem occurrence (Japan)

Stem1	Stem2	cos1	cos2	htco	edit
アルマール	アマリール	0.85	0.25	0.75	2
タキソール	タキソテール	0.91	0.67	1	1
メテナリン	ウテメリン	0.75	0.33	0.75	1
アロテック	アテレック	0.80	0.25	0.75	1

Table 4: Index values from case example of similarity problem occurrence (U.S.)

Stem1	Stem2	cos1	cos2	htco	edit
Accutane	Accolate	0.80	0.29	0.75	3
Lamisil	Lamicel	0.76	0.5	0.75	2
Sinequan	Singulair	0.67	0.27	0.5	5
Carbatrol	Carbrital	0.92	0.38	0.75	4

The program was developed using Perl initially for prototype, and then the basic system was built using Visual Basic. And to further bolster the versatility, currently the program is built using File Maker Pro 6.0 plug in application based on C language.

Development of the database to reinforce the system

For 10 indexes that support objective evaluation, drugs already on the market were chosen to come up with the index value between two drug names, and they were put into database. The target drugs were the branded medicines in Japan and in the U.S. In the case of Japanese drugs, the combination counted more than 24 million. Thanks to this effort, when some types of errors were reported, combination of names indicating similar index values and combination of letters with one letter difference (edit=1) were searched easily.

Recently computer based prescription prints are increasing, but still hand written prescriptions are used. To handle this situation, we have developed the system to calculate the indexes, for the letters identified as totally different letters on the computer but tend to be similar when written by hand, regarding them as the same letters. Table 5 shows the case example for it.

Table 5: Example of letters that contains potential similarity problems when hand written

ソ, リ, ン
シ, ツ
ア, ヤ, カ
ル, ノ、 レ

Evaluation of objective index

Table 6 shows the average value of each index calculated by this system regarding the case example of drug preparation accidents (n=257) caused by drug name similarity that Japan Pharmaceutical Association have announced. The data includes errors coming from the similarity of drug efficacy. In such case, the problem does not come from drug name similarity but from location, and the index value turned out to be low.

To verify the adequacy of the index values, we used cos1, htco, and edit obtained through the system to determine the similarity based on the psychological methodology. From the results, it was judged that each index with high values provided similarities. But depending on the drug names, some even with low index values proved similarities. These names included “dot mark of a voiced sound” or “semivoiced sound symbol” or “ー”, which explains that characteristics of some types of letters influence similarity judgments. [4)]

Table 6: Distribution of each index for the similarly named drugs

Index	Ave	Max	Min
cos1	0.63	0.94	0.16
cos2	0.27	0.87	0
htco	0.56	1.00	0
edit	2.58	6	1
dlen	0.45	4	0
head	1.18	4	0
tail	1.34	4	0
ehcos1	0.59	1	0.59
h3cos1	0.55	1	0.55
t3cos1	0.54	1	0.54

Practical application of the system

With the development of this system that provides objective evaluation on similarities of drug names, evaluation on similarities was now enabled to be made in an objective manner using multiple indexes, which had only relied on subjective judgement in the past. And since all the names of the drugs to be used in Japan are registered in the system, similarity problems due to reliance on individual memory has now been resolved by sorting each index in the system for making objective judgments.

In order to prevent the occurrence of problems of similarity in the names between new drugs and existing ones, test operations of this system has been initiated by Japan Pharmaceutical Information Center (JAPIC). As the protocol for the operation, JAPIC will investigate the existing drug names with potential similarity through the system prior to the application to the Ministry of Health, Labor and Welfare by pharmaceutical companies. And the similarity index between new and existing drugs identified by the system, in addition to drug information such as the shape of each drug, strength, efficacy, administration route and so forth will be provided to companies. And various consultations will be offered so that the final decision can be made by the companies concerned. For your reference, similar studies have been initiated by linguists in the U.S. recently, but the system is not yet put to practical use.

Along with the development of the said system, the database has become available that includes indexes obtained from all the possible combinations of existing drug names on the market. The database can be utilized by calculating each index value from combinations of drug names provided by incident reports, and executing the search function to identify the combination of drug names that show higher index values. By doing so, it becomes possible to give warnings to prevent such accidents resulting from similarity problems.

In addition, by changing each index value, we can recognize which index gives more impact on the judgment of similarities. Thus, it was enabled to run the scientific tests in evaluating similarities from psychological as well as cognitive engineering viewpoints.

Conclusion

With the development of this system, it has become possible to evaluate similarities of drug names in an objective manner in Japan(two-bite-characters) and the U.S(one-bite-character). In addition, with the practical use of this system prior to the release of new drugs, the concrete strategy to avoid similarity problems has become available. We are going to keep up with further tests and are planing to develop the system into the one that can automatically judge the similarity by weighting each index.

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