ABSTRACT

Introduction: Errors are a byproduct of human information processing or cognitive functioning. Although everyone is disposed to an error while performing various activities, individual differences in cognitive abilities can lead to various types and rates of errors committed in similar situations. Human errors are one of the most important challenges in work environments, including health care systems, wherein such errors are abundantly occurring. Errors in the delivery of correct medications due to the resemblance in appearance and name are thus one of the cognitive errors that come about in health care systems. The main purpose of this systematic review was to evaluate evidence and approaches recently practiced to reduce medication errors caused by the use of look-alike-sound-alike (LASA) medications.

Material and Methods: The study was conducted on August 30, 2018, through searches in the databases of PubMed and Embase, all available years, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) instructions. The searches were done in the titles or abstracts of the articles using the intended terms and the Medical Subject Headings (MeSH) index in combination. These studies were selected based on the inclusion and exclusion criteria and then categorized based on the type of interventions and outputs. Finally, the data were analyzed descriptively.

Results: The research designs and methods varied widely among the studies. There were also discrepancies in the number of participants, number of tests, type of medications, and test conditions. The approaches examined in these studies were tall-man lettering, color-coding, label background variations, and use of signs and symbols. Accordingly, 11 studies had utilized tall-man lettering and the most important reported in all articles were "error rate" and "response times". As well, a wide range of medication names had been tested. It should be noted that medication errors have different dimensions, but the errors caused by the look-alike-sound-alike (LASA) medications and the effect of tall-man lettering of medication name were only investigated in the present study. Laboratory studies in this respect have shown that tall-man lettering contributes to mitigating the rate of errors, which might be due to the better legibility of labels, but evaluations in real work environments are needed to reinforce this conclusion. There is also insufficient evidence to support color-coding, as well as several other approaches such as use of signs and symbols. Because of the novelty of the studies in this field, no uniform mechanism has been so far introduced.

Conclusion: errors have different dimensions, but the errors caused by the look-alike-sound-alike (LASA) medications and the effect of tall-man lettering of medication name were only investigated in the present study. Laboratory studies in this respect have shown that tall-man lettering contributes to mitigating the rate of errors, which might be due to the better legibility of labels, but evaluations in real work environments are needed to reinforce this conclusion. There is also insufficient evidence to support color-coding, as well as several other approaches such as use of signs and symbols. Because of the novelty of the studies in this field, no uniform mechanism has been so far introduced.

Keywords: Cognitive error, LASA, Tall Man Lettering, Color coding
1. INTRODUCTION

Individual differences in human cognitive abilities determine the type and the rate of errors committed in different situations. Some of the most challenging human errors that frequently in health care systems are cognitive ones such as medication errors associated with look-alike-sound-alike (LASA) medications (1, 2). As estimated by the American Food and Drug Administration (FDA), more than 20% of the errors in delivering correct medications to patients are due to cognitive errors induced by confusing packaging and similar labels with look-alike medication names (3, 6). Therefore, clear labeling of medications is an important aspect of drug safety, which is critical for health care professionals. Numerous measures have been so far proposed for enhancing the legibility of the labels and reducing the error rate of the LASA medications. A technical solution in this respect is to use a closed loop system with a barcode technology. However, this method is not widely implemented. Moreover, the FDA and the European Medicine Agency (EMA) guidelines have not provided conclusive procedures on how to prevent medication errors caused by similar drugs. Tall-man lettering and color-coding approaches are thus regarded as potential solutions. The main objective of tall-man lettering is to maximize the difference between two medication names alike via capitalizing sections of the names. Color-coding in anesthesia is also exploited to differentiate between classes of materials as described in the ISO 26825 standards. In addition, there are methods to improve the design of labels and their use is claimed to boost patient safety. The main purpose of this systematic review was to evaluate evidence and approaches that have recently taken to minimize medication errors, including labeling for LASA medications.

2. MATERIALS AND METHODS

The present systematic review surveyed the primary labels on medication containers. It was conducted on August 30, 2018, for all available years, through searches in the databases of PubMed and Embase, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) instructions. Accordingly, the searches were done in the titles or abstracts of the articles via the intended terms and the Medical Subject Headings (MeSH) index in combination. There were also some inclusion and exclusion criteria. Accordingly, the studies applying methods for lessening medication errors caused by similar labeling and focusing on the legibility of the primary labels by health care professionals or consumers were included in this review. The articles were also categorized based on the type of interventions (viz. tall-man lettering and color-coding) and the type of outputs. In most of the selected studies, error rate and response time had been also used. Finally, all the data were extracted, but due to the wide variety of the design of the included studies, it was not possible to perform a meta-analysis. Accordingly, the data were analyzed descriptively (7).

3. Results and Discussion

The literature search resulted in a total number of 256 studies. After applying the inclusion and exclusion criteria, 19 articles remained and 17 studies were included in this systematic review upon further examinations. The research design and methods varied widely, including the number of participants, number of tests, type of medications, and test conditions. Tall-man lettering, color-coding, label background variations, and use of signs and symbols were the approaches tested in this study. Accordingly, a total number of 11 studies had used tall-man lettering and the most significant results reported in all articles were “error rate” and “response time”. Among other methods used to improve the texts in studies, bolded tall-man letters had achieved the best results. Moreover, eye movement experiments had disclosed that the time required to stabilize eyes on medication packages with tall-man lettering was significantly less than those in which the letters had been written in lower cases. Two experiments had correspondingly tested color-coding. Other laboratory studies had further reflected on contrasting backgrounds on the ampoules. The name of the medications had been thus printed either directly on the glass or on a white label affixed to it. The time required for the participants to identify the information on the vial (namely, the text directly printed on the glass) had been significantly longer than that for the new white labels. The correct reading score had been also higher for the ampoules with a white label than the ones with the text directly printed on the glass. Furthermore, the results of a study had shown that cognitive errors would be reduced if the same spelling had been exercised for a medication name produced in different companies. This systematic literature review found evidence from laboratory-based studies that tall-man lettering could
contribute to a better legibility of medication labels and indicate a lower error rate. There were also only few studies assessing color-coding or other approaches such as the use of signs and symbols. Of note, high mental workload in health care could reduce accuracy and thus increase cognitive errors. Most studies had similarly evaluated response time. This criterion could provide general information about the analysis of the text by individuals on the medication label under high mental and physical workload. Moreover, the response time depended on the participants’ knowledge of the purpose of tall-man lettering, suggesting that training might be required for optimum use of the tall-man lettering policy, which could lead to a higher level of medication safety and reduce cognitive errors. However, it remains challenging to evaluate the specific involvement of one factor, like tall-man lettering, as medication administration is a process wherein many factors can be contributing. There were few studies available for color-coding system and the slight evidence in this respect had proposed that its ineffectiveness in mitigating the risk of look-alike medication errors. In addition, the prevalence of congenital color vision deficiency was one of the limiting this method. More importantly, evidence had demonstrated that health care professionals would exclusively rely on the color of the labels, and do not read them, which in turn causes errors. These documents logically illustrated problems of implementing the color-coding system in practice. This review study had a number of limitations. First, medication errors could have different dimensions and the ones only caused by LASA medications as well as the effects of medication names were investigated in this study. Second, the novelty of the articles in this field prevented a comprehensive review and comparison.

4. CONCLUSION
Laboratory studies demonstrate that tall-man lettering contributes to reduced rates of errors, which may be due to better legibility of medication labels, but real-world assessments are required to reinforce this conclusion. There is also insufficient evidence to support color-coding and few other methods such as use of signs and symbols have been so far tested.

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