An Analysis of the Safety of Medication Ordering Using Typo Correction within an Academic Medical System

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Appl Clin Inform 2021;12:655–663.

Abstract

Objectives Spelling during medication ordering is prone to error, which can contribute to frustration, confusion, and, ultimately, errors. Typo correction can be utilized in an effort to mitigate the effects of misspellings by providing results even when no exact matches can be found. Although, typo correction can be beneficial in some scenarios, safety concerns have been raised when utilizing the functionality for medication ordering. Our primary objective was to analyze the effects of typo correction technology on medication errors within an academic medical system after implementation of the technology. Our secondary objective was to identify and provide additional recommendations to further improve the safety of the functionality.

Methods We analyzed 8 months of post-implementation data obtained from staff-reported medication errors and search query information obtained from the electronic health record. The reports were analyzed by two pharmacists in two phases: retrospective identification of errors occurring as a result of typo correction and prospective identification of potential errors with continued use of the functionality.

Results In retrospective review of 2,603 reported medication-related errors, 26 were identified as potentially involving typo correction as a contributing factor. Six of these orders invoked typo correction, but none of the errors could be attributed to typo correction. In prospective review, a list of 40 error-prone words and terms were identified to be added as stop words and 407 medication synonyms were identified for removal from their associated medication records.

Conclusion Our results indicate, when properly implemented, typo correction does not cause additional medication errors. However, there may be benefit in implementing further precautions for preventing future errors.

Keywords
- electronic health record
- clinical decision support
- medical informatics applications

Background and Significance

Computerized provider order entry (CPOE) has been shown to improve the process of medication ordering and reduce the incidence of medication errors significantly, primarily through its ability to provide clinical decision support (CDS).[1,2] Use of electronic functionalities such as CPOE provides benefits exceeding the support of clinical decision-making at the point of care. Use of electronic health record (EHR) systems and the technologies they provide are also quite valuable as data resources, since they can be used

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received
February 22, 2021
accepted after revision
May 31, 2021

DOI https://doi.org/10.1055/s-0041-1731745.
ISSN 1869-0327.

to track user workflows and activities. This data can provide insight into the impact of modifications to the system itself, as well as context and trends for identification and prevention of errors.[3] However, in some cases, CPOE may facilitate some medication errors, indicating CPOE functionality should be rigorously evaluated for its potential to cause errors.[4]

Medication-related errors, defined as "any preventable event(s) that may cause or lead to inappropriate medication use or patient harm,"[5] are common within the hospital setting. One systematic review found that over half of patients discharged from the hospital setting have experienced a medication error during that stay.[6] Medication errors vary in nature and can occur at multiple steps within the medication use process.[5] Medication ordering, a step within this process, is complex and may be error prone. Medication ordering errors can be attributed to various causes and may even employ a combination of factors, including technological and cognitive aspects, in a single error.[7] In an academic medical center, medication ordering errors are more commonly made by medical residents, especially early in their practice, and when intercepted, are often identified by pharmacists.[8,9]

Medication names and medical terminologies are often intricate and, therefore, prone to misspellings and typos, including when placing medication orders. The reasons for these typographical errors are multifactorial and may be typographic, resulting from slips in finger positioning while typing; cognitive, caused by absence of knowledge; or even phonetic, related to pronunciation errors.[10] It has been shown that misspellings of medication names can limit obtainment of comprehensive results when searching for relevant published literature.[11] Likewise, when exact matches are required, it can be difficult for clinicians utilizing CPOE to accurately locate medications and procedures. In fact, it is estimated nearly 20% of initial order searches do not result in the intended order.[12] As a report from the Food and Drug Administration (FDA) relates, inability to easily locate medications in order searches may lead to prescriber frustration and inefficiencies.[13] This may, in turn, promote ordering of less effective alternatives if the ordering provider cannot find the intended medication. This response and resulting consequences may be due, in part, to uncertainty by the clinician about whether the intended order is truly unavailable or if the medication is available and alternative spellings should be investigated. Additionally, alternative methods for ordering may be employed, such as paper orders, which negate the CDS features available within the electronic system.[14]

Typo correction is one proposed solution to this issue. Typo correction refers to the return of search results even when a typo or misspelling has occurred. The returned results are based on a "close enough" matching of the search term and result. For example, if an individual was searching for "acetaminophen" and instead typed "acetaminophen," typo correction functionality would correct for the substitution of the "e" with "i" in the third position and still include results for "acetaminophen." The technology can correct for various typographical errors such as additions, omissions, or transpositions of letters.[12] Most individuals are familiar with this functionality due to common utilization by online search engines in nonmedical contexts to aid users in returning more relevant, or potentially any, search results. However, it may also return errant results based on other similarly spelled words.

While the use of typo correction for medical ordering is fairly recent, likely due to the perceived potential for errant ordering, it has proven itself to be relevant in other medical contexts. The functionality has performed well when used in parsing big data for health-related information and produces more complete and relevant sets of data.[15] Additionally, evaluation of medical terminology searches indicates spelling correction and other methods of normalizing search terms are useful in obtaining better quality results.[16]

In their February 2018 version, Epic Systems, an EHR vendor based in Verona, Wisconsin implemented typo correction functionality, formerly known by Epic as "fuzzy matching," for order searches as an optional feature facilities could choose to utilize. This functionality within the EHR, was configured to account for multiple types of typographical errors such as a transpositions, omitted characters, or extra letters.[12] Epic's decision to offer this functionality raised concerns regarding the safety of the use of typo correction in clinical ordering, especially with medications. Notably, the Institute for Safe Medication Practices (ISMP), an independent organization recognized as an authority on medication safety information, made the statement in its January 2019 issue of "ISMP Medication Safety Alert! Acute Care" that it "does not believe that fuzzy matching is currently safe for medication ordering."[17] It also claimed "the use of fuzzy matching is a risk not worth taking,"[17] listing the potential for errant ordering of medications look-alike names as a primary concern. In the February 2019 edition, even after Epic modified the functionality for increased safety, ISMP stated, "the potential for medication errors is an unanticipated consequence of electronic health records with enabled fuzzy matching… We still do not think fuzzy matching for medications is wholly safe."[18]

After weighing the risks and benefits of typo correction, Froedtert Health, an academic medical system composed of multiple hospitals and clinics, made the decision to implement typo correction functionality for procedure and medication ordering across the enterprise. As part of this decision, informatics and drug information pharmacists at the medical system performed a prospective evaluation of typo correction functionality during the medication ordering process to identify problematic searches, or search terms and results that might lead to the selection the wrong medication, and took steps to prevent associated ordering errors. Stop words refer to medication names and other terms that when searched within CPOE block the return of inexact matches. An initial list of 51 stop words was generated, guided by the ISMP List of Confused Drug Names, also known as the Look-Alike Sound-Alike (LASA) list, since these medication names have been previously attributed to orthographical medication errors.[19] Synonyms are additional terminology

sometimes added to a medication record to facilitate searching, such as the brand name for a generic medication record. Prospective testing identified five potentially problematic synonyms, which were nonspecific and matched to multiple medication orders, increasing the likelihood of selecting the wrong medication. These synonyms were subsequently removed from their associated medication records. With these modifications in place, the medical system implemented typo correction functionality on June 22, 2019.

Objectives

With the safety of medication ordering being a major concern for implementation of typo correction functionality, the primary objective of our study was to examine the safety of this typo correction functionality for medication ordering within the medical system. Our secondary objective was to identify and provide additional recommendations to further improve the safety of the functionality.

Methods

In our analysis of typo correction functionality within our organization, we took a multifaceted approach utilizing a variety of reports and analysis methods. All data collected for the analysis spanned the time period of June 22, 2019 to February 22, 2020, which represented the period of 8 month immediately following implementation of the functionality. Our approach focused both on retrospectively identifying errors that occurred as a result of typo correction to determine the safety of continuing to utilize the feature with the EHR and prospectively identifying errors that may occur due to use of the functionality to anticipate and prevent future ordering errors from occurring. This prospective identification of potential errors was exploratory and not the result of any previously identified issues.

This study was performed at Froedtert Health, an academic medical system located in southeastern Wisconsin. The system consists of almost 1,000 beds across three hospital locations and more than 40 clinics and health centers.[20] This medical system was selected as the site for this study based upon convenience, with all investigators being employed by and familiar with the ordering workflows within the system. All locations were included as part of this study, since typo correction functionality was implemented simultaneously for CPOE at all sites.

Two pharmacists, both being employees of the medical system and trained and experienced in both clinical practice and informatics, served as the investigators who performed all analysis of the post-implementation data. The first pharmacist was the primary reviewer of the data. The second pharmacist provided secondary review of order information when a medication error due to use of the typo correction functionality was deemed possible by the first pharmacist and as the final reviewer for all recommended changes that were made by the first pharmacist. Ultimately, the process utilized three separate reports, each playing a role in either retrospective or prospective error identification (►Fig. 1).

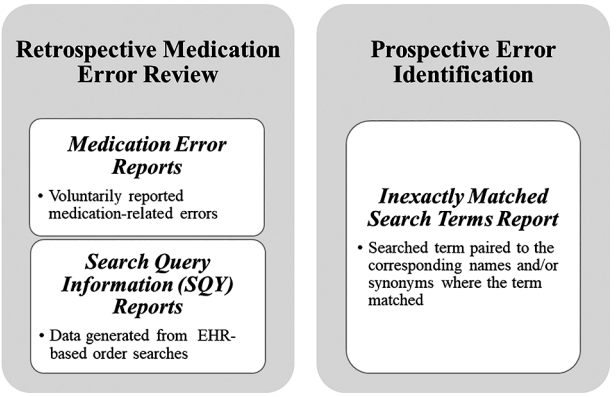

Fig. 1 Report description and role in analysis.

The study was descriptive in nature and, therefore, no statistical analysis was completed. The study did not require oversight by the Internal Review Board (IRB) since all data was de-identified and the project was deemed not to represent human subjects research.

Retrospective Medication Error Review

Investigators worked with Medication Safety pharmacists to generate reports of medication errors logged into the Vizient Safety Intelligence reporting system, the error reporting system utilized by the medical system. This data consisted of all errors that were identified by the medical system's staff members as being a medication error and voluntarily logged into the reporting system during the 8 months following implementation of typo correction. Each of these reported errors were individually evaluated and analyzed for the possibility that typo correction was a contributing factor to the error. The descriptions provided by the user reporting the error were analyzed for the potential role of typo correction in the medication error. Descriptions fitting any of the following criteria were deemed to warrant further evaluation and analysis: medications being ordered for the wrong indication, direct reports of the wrong medication being ordered, or administration of a medication after the order was discontinued, since this could indicate that the original medication order may have been placed in error. In an attempt to capture all reported errors where typo correction was a potential contributing factor, any descriptions in which investigators could not determine if the error fit the criteria were marked for further review. Chart review was completed for each reported error in question to determine ordering information for the medication order involved in the error. Search query reports, as will be described further, were compared with order information to determine if the search in question invoked typo correction functionality.

Reports of search query information stored in the Search Query (SQY) Masterfile, an aspect of Epic's data management structure, were generated from the Epic Clarity database system using SAP Crystal Reports 2013. These reports contained data for the exact search term, if the search invoked typo correction functionality, and if the search results were generated from a cultivated list of provider-specific medication or from the full formulary. In addition, information for

the searching user, date of the search, identifying information for the involved patient and encounter, the top search results, and the selected result were included. Search query reports were exported to Microsoft Excel spreadsheets and analyzed. The data in these reports were cross-referenced with data from other reports, primarily to determine if reported medication errors invoked typo correction and evaluated the search terms used to locate the ordered medication.

Prospective Error Identification

A separate report of inexactly matched user search terms was generated from data stored in the SQY Masterfile and paired with all of the corresponding names and/or synonyms where the term matched. This report was analyzed to identify further opportunities for improving the safety of typo correction functionality within the medical system. Investigators worked with the Epic Technical Support (TS) staff member assigned to the medical system's Willow team to generate the matched terms report corresponding to the 8 months following implementation of typo correction. The report was evaluated to identify potential issues the search term matches may cause during the ordering process. Prospective error identification and subsequent recommendations concerning the addition of further words and terms to the stop words list and removal of synonyms from medication records were primarily based upon analysis of this report.

Results

Retrospective Medication Error Review

To address our primary objective of evaluating the safety of typo correction functionality for medication ordering, we evaluated the 2,603 medication-related errors reported to have occurred across the medical system from June 22, 2019 to February 22, 2020, the 8 months post-implementation of typo correction. Based upon the included description of the error, investigators identified 26 reported errors as potentially involving typo correction as a contributing factor. Of these, typo correction was not invoked in 20 of the searches. In the remaining six orders, typo correction was determined to have been noncontributory to the error (►Fig. 2).

Prospective Error Identification

We addressed our secondary objective, to identify and provide additional recommendations to further improve the safety of the functionality, by identifying additional stop words and error-prone synonyms attached to the medication records. Utilizing the inexactly matched user search term report, investigators identified 40 additional terms for addition to the stop words list because of their potential to lead to selection of the wrong medication during order searches (►Table 1). Each of the identified terms were grouped into the four following categories: Abbreviations and Synonyms, Brand Names, Descriptors, and Over-the-Counter (OTC) Products and Nomenclature. Abbreviations and Synonyms constituted 10 recommendations; Brand Names constituted 17 recommendations; Descriptors constituted four recommendations; and OTC Products and Nomenclature constituted nine recommendations.

Investigators also formulated a list of 407 individual synonyms attached to 895 medication records. The synonyms were the result of a previous nomenclature system utilized by the medical system and manually added to medication records during medication build. Each of these synonyms was a five-character abbreviation for the medication, representing the generic name and formulation of the product. Given the short length of the synonyms, these terms were prone to errant matching, as evidenced in analysis of the search query data. For example, ampicillin injection solution contained a synonym of "AMPII" and amphotericin injection solution contained a synonym of "AMPHI" which, when searched, would match to one another as well as some other terms.

Discussion

Retrospective Medication Error Review

In review of the typo correction, investigators found no evidence for concern over the safety of the functionality, which met our primary objective. Though, six reported medication errors did invoke typo correction during the ordering process, it was determined that the functionality was noncontributory to the error. For example, in one instance, an ordering provider intended to order metoprolol and ordered labetalol instead. The search term used during the search was "LABETOLOL," which is a misspelling that invoked typo correction although clearly the intent is to return labetalol rather than metoprolol. In another instance, a clinician intended to order intravenous (IV) potassium and instead ordered IV furosemide. The clinician had employed "LASIC" as his search term, which was an inexact match to furosemide's brand name Lasix. Again, this search was clearly intended to return Lasix rather than potassium.

Of note, this review of medication errors was a time intensive process that did require a substantial amount of manual review. Since the Centers for Medicare and Medicaid Services (CMS) does recognize medication error reporting and monitoring as a Condition of Participation related to the

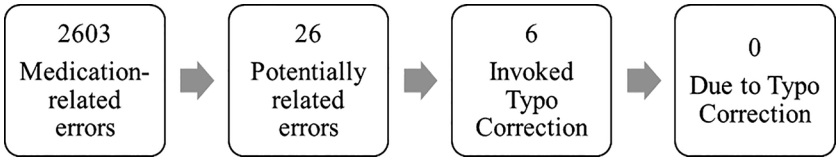

Fig. 2 Retrospective medication error review results.

Table 1 Prospective error identification recommendation stop term[a]

Recommended term for addition	Reasoning
Abbreviations and synonyms	
APAP and/or QPAP	• Abbreviation/synonym for acetaminophen. • As an abbreviation, it matches to multiple short terms, such as for APADAZ, and letter order is important.
CPCR	• Abbreviation for controlled release capsule. • As an abbreviation, it matches to multiple short terms, such as for CPDR, and letter order is important.
CPDR	• Abbreviation for delayed release capsule. • As an abbreviation, it matches to multiple short terms, such as for CPCR, and letter order is important.
IVIG	• Abbreviation/synonym for immune globulin. • As an abbreviation, it matches to multiple short terms, such as for I-Vite, and letter order is important.
RTPA	• Abbreviation/synonym for alteplase. • As an abbreviation, it matches to multiple short terms, such as for tPA, and letter order is important.
SUSP	• Abbreviation for suspension. • As an abbreviation, it matches to multiple short terms, such as for SUSTIVA, and letter order is important.
SUSR	• Abbreviation for sustained release suspension. • As an abbreviation, it matches to multiple short terms, such as for SUSTIVA, and letter order is important.
TBDP	• Abbreviation for disintegrating tablet. • As an abbreviation, it matches to multiple short terms, such as for TDPak, and letter order is important.
TSPA	• Abbreviation for thiotepa, which is not on formulary, so it matches to other medications. • As an abbreviation, it matches to multiple short terms, such as for Xtampza, and letter order is important.
Brand names	
Aria	• Contained in the brand name for golimumab (Simponi Aria). • Matches to common search terms for Breo and Farxiga.
Bentyl	• Brand name for dicyclomine. • Matches to common search terms for Fentanyl.
Biaxin	• Brand name for clarithromycin. • Matches to common search terms for Xifaxan.
Carnitine	• Brand name for levocarnitine. • Matches to common search terms for ranitidine.
DTIC	• Brand name for dacarbazine, which is not on formulary, so it matches to other medications. • As an abbreviation, it matches to multiple short terms and letter order is important.
Humatin	• Abbreviation for paromomycin sulfate, which is not on formulary, so it matches to other medications when searched. • Matches to common search terms for Humulin.
Leustatin	• Brand name for cladribine. • Matches to common search terms for lovastatin.
Kefurox	• Brand name for cefuroxime, not a commonly used brand name. • Matches to misspellings for multiple cephalosporins.
Lopid	• Brand name for gemfibrozil. • Matches to common search terms for clopidogrel, amlodipine, and others.
Loxitane	• Brand name for loxapine. • Matches to common search terms for duloxetine.
Ocufen	• Brand name for flurbiprofen. • Matches to common search terms for fosphenytoin.

(*Continued*)

Table 1 (*Continued*)

Recommended term for addition	Reasoning
Prostin	• Brand name for alprostadil. • Matches to common search terms for Pristiq.
Relador	• Brand name for lidocaine/prilocaine combination. • Matches to common search terms for Relistor and Relizorb.
Repan	• Brand name for paracetamol/butalbital/caffeine combination. • Matches to common search terms for triptans, Relpax, Reglan, propranolol, and ertapenem.
Soma	• Brand name for carisoprodol. • Matches to common search terms for Qsymia and Slow-Mag.
Stadol	• Brand name for butorphanol. • Matches to common search terms for estradiol.
Tambocor	• Brand name for flecainide. • Matches to common search terms for Symbicort.
Descriptors	
Acid	• Common medication descriptor. • Matches to valproic acid and other medications containing “acid.”
Depot	• Descriptor for multiple medications. • Matches to common search terms for “Depakote” and “daptomycin.”
Ortho	• Descriptor for orthopaedic panels and medications. • Matches to common search terms for ophthalmologic medications and orders.
Stool	• Descriptor in OTC products. • Matches to common search terms for Stiolto and sotalol.
OTC products and nomenclature	
Doce	• Contained in brand name for OTC cyanocobalamin. • Short term that matches on multiple short search terms used to search for medications such as doxycycline, Rocephin, and others.
Dram	• Contained in naming for various OTC products, unlikely to be used. • Short term that matches on multiple short search terms.
Forte	• Contained in naming for various OTC products. • Matches to common search terms for Forteo and Florastor.
Itin	• Contained in naming for various OTC products, unlikely to be used. • Short term that matches on multiple short search terms.
OSCO	• Brand name contained in naming for various OTC products, unlikely to be used. • Short term that matches on multiple short search terms.
Soba	• Brand name used in various OTC products. • Matches to common search terms for Tresiba, sugammadex, and others.
Sudanyl	• Brand name for OTC pseudoephedrine. • Matches to common search terms for sufentanil.
THSC	• Brand name contained in naming for various OTC products, unlikely to be used. • Short term that matches on multiple short search terms.
Tums	• Brand name for OTC calcium carbonate. • Short term that matches on multiple short search terms.

Abbreviation: OTC, Over the Counter.
[a]Stop words refer to medication names and other terms that when searched within computerized provider order entry (CPOE) block the return of inexact matches.

provision of pharmaceutical services, it would be reasonable to couple the identification of medication errors due to typo correction with this existing monitoring of reported errors within the hospital setting.[21]

Prospective Error Identification

As our secondary object was to identify additional opportunities to improve typo correction safety, we identified additional stop words and medication synonyms to update. It has been Epic’s recommendation to utilize the ISMP list of LASA medications as a guide when formulating the stop words list. Therefore, the initial list of stop words that we utilized upon implementation of typo correction contained medication names identified using the ISMP list of LASA medications, a list primarily containing generic medication names. Our post-implementation investigation and analysis,

however, identified other terms included in medication nomenclature could be as, if not more, error prone than the generic medication names themselves. For example, abbreviations are typically four letters, which allows for matching to a variety of shorter search terms. Additionally, the ordering of the characters within abbreviations are, by nature, quite important. Therefore, the identification of abbreviations utilized within medication order names and synonyms are important for returning accurate results when utilizing typo correction (►Table 1). Each of the 40 stop words recommended by investigators have since been added to the list of stop words.

The synonyms attached to medication records were also identified as being error prone. Many of these synonyms are abbreviations, which, as previously discussed, can be problematic for typo correction. Additionally, these abbreviation synonyms are often imported from the medication record vendor and therefore are difficult to modify. For synonyms that have been manually added by the organization, these additions were typically made prior to the inception of typo correction without regard to their impact on inexactly matched search results, since typo correction was not available at the time of their addition.

Epic's Updates and Recommendations

Epic has incorporated certain measures to improve the safety of typo correction, some of which became available after the functionality was initially introduced. From its inception, Epic's typo correction functionality has allowed for matching to either order names or synonyms, the latter of which is often a brand name or abbreviation, of more than three characters. Notably, the system does not make any automatic selections for inexactly matched results.[12] Initially, and during the course of our study, the functionality corrected for up to three separate errors within the search term. However, since the completion of our study, updates by Epic have subsequently limited typo correction to only one error.[12] While this modification to the functionality potentially makes many of our updates to the stop words list and synonyms unnecessary, it does not completely invalidate our findings or conclusions and does further decrease the potential for unintended medication order matches.

Additionally, the stop words list initially accommodated up to 100 terms but was expanded to allow for up to 1000 terms.[12] Epic does not supply a list of recommended stop words and instead recommends each facility generates its own list utilizing the IMSP list of LASA medications as a guide.[12] This lack of a predetermined list encourages facilities to consider organizational factors, such as the facility formulary, when creating the stop words list.

Recommendations

Although Epic has limited the use of typo correction to terms greater than three characters in length, our prospective review of potential future errors identified shorter terms, such as those that were four to even six characters in length, tended to have more erroneous matches. For example, terms such as "hydro" and "hydrox" are commonly utilized as search terms. Variations of each of these terms result in multiple corrected matches to a variety of medication products. However, we did note that in these and similar cases, the first letter of the search term was typically correct. Therefore, we recommend the functionality be updated by Epic to require the first letter of a term match in these shorter terms before typo correction may be invoked.

Finally, synonyms are often difficult to update for multiple reasons and may be prone to error. These synonyms must be manually updated in each medication record. This is a time intensive process if many updates are necessary, as was the case in our study. Therefore, since synonyms may be problematic to typo correction by increasing the quantity of shortened terms available for matching, we recommend Epic provide organizations the capability to turn off the functionality for matching to synonyms. Furthermore, since trade names are often listed as synonyms, the capacity to selectively turn off synonym matching for terms other than the trade name could be of even greater benefit.

Limitations

Our analysis of the effects of typo correction on medications errors did present some limitations. The primary limitation of our investigation is our reliance on information from reported errors, which is a manual process during both reporting and analysis, to identify the presence of medication errors. The identification of actual errors was reliant on the error being reported within the error reporting system. This requires that the error has been identified and physically logged within the system, which often may be a time-consuming process. Additionally, the culture of medication error reporting is stronger among some groups of health care providers at the medical system than others, which means ordering providers may be less likely to report errors than other caregivers. Therefore, reporting bias should be considered. We did attempt to mitigate this limitation by doing a more thorough analysis of the data from all search queries, which was not subject to the limitations of manual reporting. However, this expanded analysis only included search query data and could not identify if any actual error resulted from invocation of typo correction functionality.

Since identification of medication errors did require manual review of the descriptions of reported errors, inaccurate descriptions or interpretation of the descriptions may have prevented an actual error from being identified. The impact of this detection bias was somewhat mitigated since all initial review of the data in the reports was assessed and analyzed by the same investigator but should still be considered, since the descriptions of the medication errors were reported by numerous individuals.

Furthermore, the results of our analysis may not be generalizable to all hospitals and health care organizations since typo correction functionality, features, and framework, as described by our study, are features provided within the Epic EHR system. Therefore, organizations utilizing other EHR systems may not have this feature available for use during medication order searches or may not be presented

with the same options for customization if the functionality is available within their EHR systems.

Conclusion

Our analysis indicates typo correction does not provide any additional risk of medication errors with an appropriate implementation plan, which includes an initial review for addition of stop words and removal of error-prone synonyms, a plan for evaluating use of the functionality, and a strategy for updating records based on the results of this review.

In the future, we plan to continue to analyze and monitor the functionality and our modifications to the functionality in the context of safety, as well as other relevant contexts. Future medication safety monitoring will likely utilize a similar approach to that which has been described. Furthermore, since the functionality may provide efficiency and efficacy benefits during the ordering process, we would also like to study these potential benefits of typo correction implementation in the future.

Overall, based on our findings, we believe the risk of implementing of typo correction during the medication ordering process is likely outweighed by the potential benefits it provides in enhancing the efficiency of placing orders and effectiveness in finding the intended medication product in both the inpatient and outpatient contexts.

Clinical Relevance Statement

With the lack of previous literature and research on this topic, our work provides previously undocumented evidence of the safety of typo correction, as well as an example of how the functionality can be implemented and monitored. It is our hope that other health care systems and organizations will be able to utilize our findings to create their own process for implementing and monitoring typo correction features within their own ordering systems, especially in facilities using an Epic EHR for medication ordering. By doing so, these facilities may further enhance the efficiency and safety of the medication ordering process within the clinical setting.

Multiple Choice Questions

1. Which of the following may be increased through the use of typo correction during medication ordering?
   a. Clinician frustration with not being able to find correct medication orders.
   b. Efficiency of finding medication orders.
   c. Number of searches returning no results.
   d. Misspellings of searched medication terms.

   Correct Answer: Typo correction improves clinicians' ability to find medication orders (a) and decreases the number of searches returning no results (c), especially when the search term is misspelled, making those answer choices incorrect. Misspellings of searched medication terms (d) are independent of the use of typo correction and are not increased by its use. The efficiency of finding medication orders (b) is the correct answer, since clinicians will still return results even with misspellings in their search terms, reducing the need for multiple searches.

2. Which of the following will need additional configuration when implementing typo correction?
   a. Medication record names.
   b. Medication record numbers.
   c. Stop words list.
   d. Formulary lists.

   Correct Answer: Medication record names (a) and numbers (b) are usually static and do not need to be configured for implementation of typo correction. In fact, these items may cause additional confusion if they are modified as a part of implementation. The formulary lists (d) are dependent on what medications are preferred by the facility and have no relevance to typo correction. The stop words list (c) is the correct answer, since this list contains the error-prone terms that should not match during searches.

Protection of Human and Animal Subjects

Human and/or animal subjects were not included in the project

Funding

None.

Conflict of Interest

None declared.

Acknowledgments

We would like to acknowledge the contributions of Taylor Mancuso for her help in obtaining medication-related error reports and Greg Harding at Epic Systems for his help providing search query information reports.

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