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Data Quality Assessment of Narrative Medication Error Reports

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Abstract. Medication errors are preventable adverse events or unsafe conditions caused by inappropriate uses of medication. To collect data of patient safety events (PSE) and to analyze the root causes of PSE, reporting systems have been implemented in healthcare settings and patient safety organizations (PSO). However, the poor data quality of reports impedes the reporting and root cause analysis (RCA) of PSE. Incomplete or missing data is the most prevalent problem in event reports. To assess the data quality of PSE reports, we used an adapted taxonomy as the data evaluation model to evaluate the quality of narrative reports collected by a PSO. Sample reports were extracted based on eight error types and scored by experts. Most structured fields in the reports were ignored by reporters. In contrast, the narrative parts of the reports contain rich and valuable information. The evaluation results show that the adapted taxonomy is a promising tool for report quality assessment and improvement.

Keywords. Patient safety, Data quality, Medication error, Reporting system

1. Introduction

Patient safety events (PSE), such as adverse drug events, medication errors, patient falls, pressure injuries, health information technology (HIT) events, and surgical events, threaten the health of patients and lead to economic losses. Medication errors are preventable adverse events or unsafe conditions caused by inappropriate use of medication. To collect PSE data and to analyze root causes of PSE, reporting systems have been implemented in healthcare settings and patient safety organizations (PSO). However, the low data quality of reports impedes the reporting and root cause analysis (RCA) of PSE. Incompleteness or missing of data, is the most prevalent problem in PSE reports. Compared with data quality of PSE reports, dimensions and standards in data quality of electronic health record (EHR) are well discussed, which include completeness, correctness, concordance, plausibility, currency, etc. [1, 2]

Taxonomies and ontologies have been developed to standardize PSE reports, which hold promise to improving data quality and facilitating data sharing among healthcare facilities and PSOs. The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) developed the Taxonomy of Medication Errors which defined standardized concepts, terms and relationships to improve medication error reporting, communicating and shared learning. In 2008, the World Health Organization (WHO) initiated a program for development and implementation of a generalizable

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framework, the Conceptual Framework for the International Classification for Patient Safety (ICPS), and furthermore released a Minimal Information Model for Patient Safety (MIM PS) based on the framework [3].

The purpose of this study is to understand the prevailing PSE taxonomies and ontologies to establish a strategy of data quality assessment for medication error reports. We examined the data quality, especially the completeness of the narrative part of medication error reports and discussed ontology-based solutions for the data quality issues.

2. Methods

2.1. Taxonomy for Narrative Medication Error Reports

We developed a taxonomy that was adapted from the MIM PS and other taxonomies in our previous work [4]. The taxonomy depicted the key elements involved in medication errors, including "Medication", "Indication", "Error Type", "Stage – Error Originating", "Personnel – Error Made By", "Stage – Error Caught", "Personnel – Error Caught", "Outcome", "Intervention", "Causes", and "Contributing Factors".

2.2. Dataset and Sampling

The dataset containing one-year, 3143 medication events was provided by our collaborator PSO. The reports were classified into 20 categories, based on a classification of error type adapted from the NCC MERP [5]. To reduce the human labor, we randomly extracted 63 reports (2%) from each category for further review and annotation.

2.3. Expert Review and Annotation

To assess the data completeness, three domain experts who are familiar with patient safety data and reporting process reviewed and annotated the medication error reports using the previously developed taxonomy [5]. The frequencies of presence (represented by "1") and absence (represented by "0") of the data elements were calculated and illustrated by error types. We summed the numbers to present the scores that reflect the data completeness. Discrepancies were fixed through group discussion.

3. Results

Two groups of taxonomies and classifications for patient safety are identified (Figure 1). In the International Classifications of Diseases (ICD), including ICD-9, ICD-10 and ICD-11, though not specifically developed for patient safety terms, the ICD terms focus on outcomes, for example, the adverse drug reactions (ADR). MedDRA, a taxonomy for adverse events of drugs and other medical productions, was developed based on ICD-9, ICD-9-CM, WHO-ART and FDA COSTART. Another group of the taxonomies focus on the attributes rather than the outcomes. For example, the NCC MERP Taxonomy of Medication Error is the first taxonomy exclusively designed for medication errors, which defines the terms and concepts in medication errors. Based on the JACHO patient safety

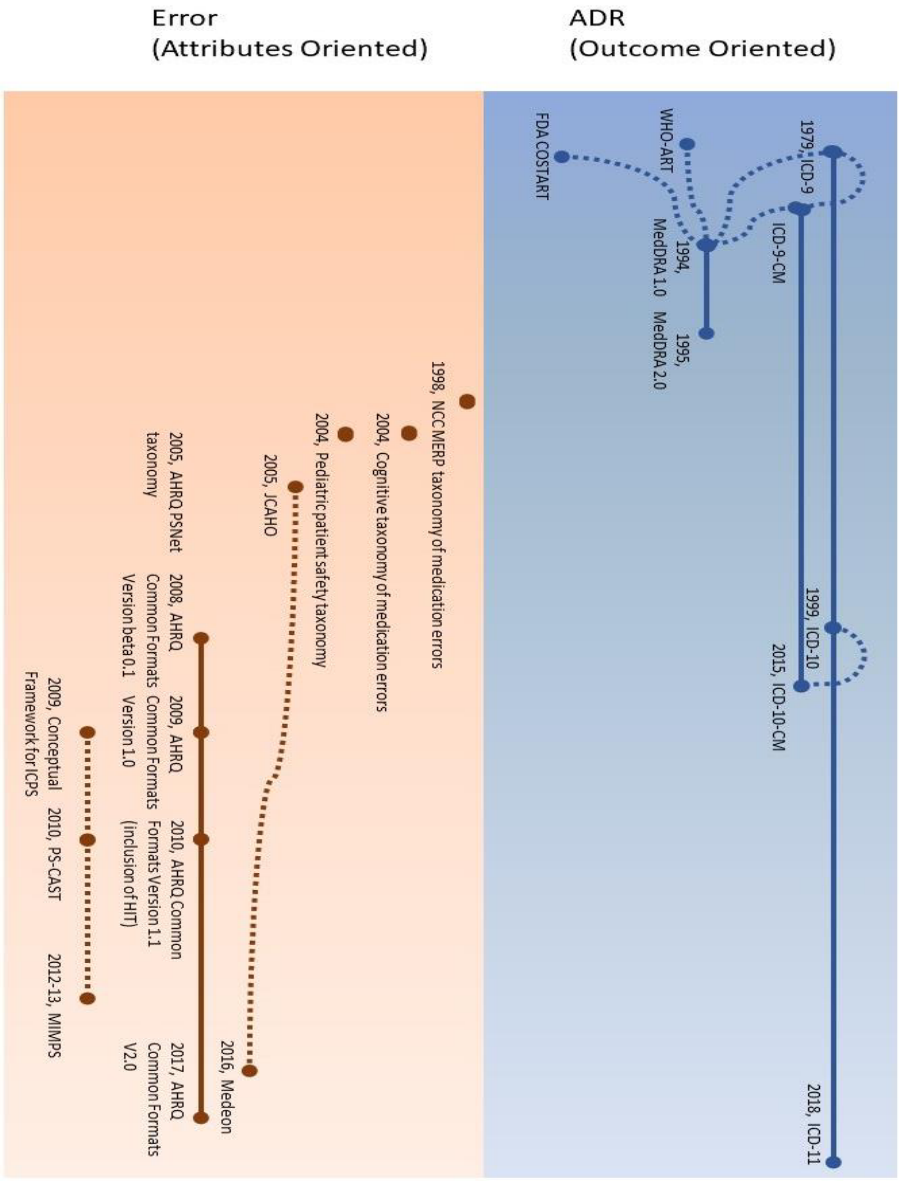

Figure 1. Evolution of taxonomies for patient safety. Solid lines: updates of the same taxonomy; Dotted lines: new taxonomies developed based on existing taxonomies.

event taxonomy, Medeon was developed for both human-understandable use and computer-compatible applications to present patient safety data including medication errors.

The data elements in the taxonomies were extracted and compared in Table 1. The elements shared by most taxonomies are drug information, type of event/error, outcome, cause and intervention. Causes and interventions are categorized in patient level and system level, according to the Instrument to characterize unintentional medication discrepancy (ICUMD) [6].

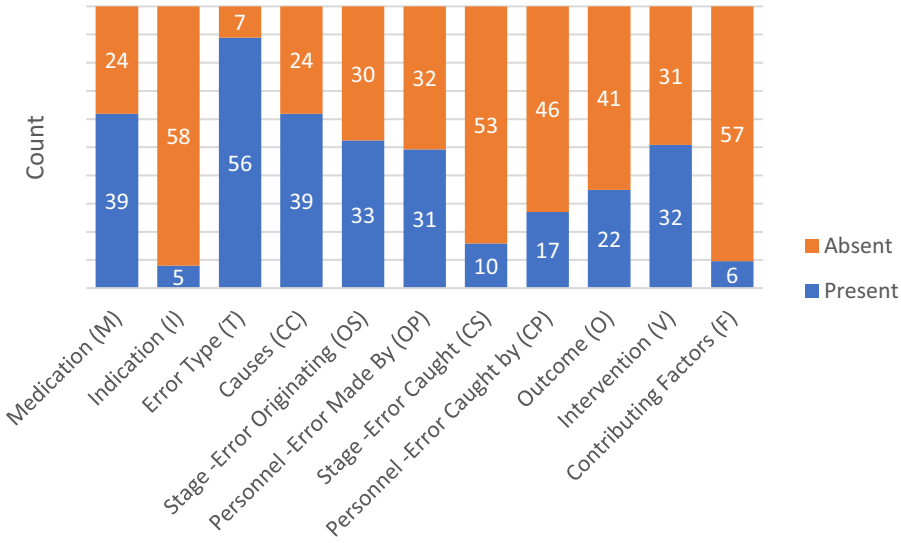

Figure 2. Absence and presence of data element in medication error reports (63 sample reports in the year 2016).

We reviewed and annotated the absence and presence of data elements on 63 (2%) sample reports. As shown in Figure 2, 56 reports contain the information of error types, while only 5 contain the information of indication and 6 contain the information of contributing factors. Meanwhile, information such as error originating stages and personnel is usually implicit, which makes it difficult to perform RCA.

Table 1. Categories and count of items of taxonomies for medication errors.

Notes: APS-Doc: A classification system for drug-related problems in the hospital setting; ICUMD: Instrument to characterize unintentional medication discrepancy; MDT: Medication Discrepancy Tool; NCC MERP: The National Coordinating Council for Medication Error Reporting and Prevention; PCNE: Pharmaceutical Care Network Europe; PI-Doc: Coding system for drug-related problems-interventions document.

Taxonomy, Author and Year	Categories/Domains and Count of Subcategories/Items (number of items in the brackets)
APS-Doc, Hohmann C, et al., 2012	Drug (13), Dosage form/drug strength (4), Dosage (7), Indication (3), Contraindication (1), Drug-drug interaction (3), Adverse drug reaction (2), Administration/Compliance (6), Application (7), Other (2)
ICUMD, Claeys C, et al., 2012	Type (11), Cause – Patient level (7)/System level (11), Interventions – Healthcare professional level (4)/Patient level (4)/Medication level (10)/Other
MDT, Smith JD, Coleman EA, & Min SJ, 2004	Medication discrepancy event description (Unstructured), Causes and contributing factors (19), Resolution (7)
NCC MERP Taxonomy of Medication Errors	The event (5), Patient outcome (4), Product information (5), Type (14), Causes (5), Contributing factors (14)
The PCNE Classification V7.0, PCNE, 2016	Problems (3), Causes (8), Planed interventions (5), Interventions acceptance (2), Status of the DRP (Outcome) (4)
PI-Doc, Schaefer M, 2000	Drug-related problems, Drug related interventions

4. Discussion

Despite the over-average presence rate of "Causes", the information is limited to direct triggers of errors such as choosing wrong medication name or dose in the system when prescribing or drawing incorrect dose of fluids, which are merely root causes. Compared to other data elements, the presence rate of contributing factors in the narrative reports seems quite low, because contributing factors are often not clear to the reporters upon the time of reporting. In many cases of medication errors, contributing factors are not immediately discovered and reported, which leads to the absence of invaluable information in the reports. Another challenge in medication error reporting is the balance between reporting efficiency and data completeness. Despite the information such as medications, indications and patient information that already exists in the EHR, reporters still have to manually fill the information in the reporting systems because the current reporting systems are stand-alone and do not have access to collect data from EHR.

Medication event reporting is a promising and important way of reducing the medication error occurrence and developing the error prevention strategies, especially for the high-alert medications. The Joint Commission in the USA has been collecting and analyzing error reports from accredited hospitals, and issuing alerts and recommendations based on the results of integrated data analysis. Reporting medication events remains a challenging task in clinical settings. medication events have one of the highest rates among all patient safety events. However, reporting medication errors can be time-consuming and labor-intensive. Medication errors may happen at any stage of the medication distribution process in hospitals, starting when a clinician prescribes a medication and ending when the patient takes the medication. Among all the medication error reports, those describing medication errors and near misses, are of high learning value for healthcare facilities to identify error causes and create processes to reduce the risk of errors.

Moreover, multiple personnel are likely to be involved in medication events, such as physicians, pharmacists, nurses, which could make event reporting complicated. The various types of medication event also increase the difficulty of reporting. Since a patient need to receive the right drug, in the right dose, at the right time and in a right way, any compromise during the procedure will lead to different types of errors. The cause of errors varies as well, for example, if a patient receives a wrong dose of drug, it may be due to a wrong prescription by physician, or a wrong administration by nurse. Thus, during medication error reporting, the events may need more elaborated narratives to restore the key information in the events.

To systematically study medication errors, guide the medication error reporting and promote the safe use of medications, it is important to build a taxonomy of medication error reporting. The effectiveness of medication error reporting and analysis of the error reports are highly dependent on quantity and quality of the data collected by medication error reports. NCC MERP Taxonomy of Medication Errors aims to record, track, categorize and analyze the medication errors is regarded as the most adequate medication error taxonomy. To reflect the complexity of medication error and the information need for its reporting, NCC MERP taxonomy has great potential in improving the efficiency and efficacy of medication error reporting if it is integrated in the error reporting system. The annotations on the taxonomy could help establish a knowledge base of medication errors. The knowledge base could make connection among various reports, unveil the healthcare professionals' blindfolds by providing them an integrated view of the events and showing similar cases and potential solutions to the cases under investigation.

Taxonomies such as NCC MERP taxonomy contain terms in high granularity that are useful for collecting rich information. However, clinicians, due to competing priorities, may be reluctant to complete a report with too many details, especially in narrative reports. It remains challenging for researchers to balance the efficiency and quality of reporting when considering the trade-off between richness of information and limited time and labor. Using our minimal information model for data quality assessment of the reports is a promising study for meeting the challenge and finding a solution.

5. Limitations

The sample size was limited. We explored the data quality of medication error reports, which may not necessarily reflect the facts of other PSE subtypes such as patient falls, surgical events, etc.

6. Conclusion

Despite the low data quality, narrative reports contain rich and valuable information. The taxonomy proposed in this study is a promising tool for report quality assessment and improvement, which facilitates the reporting and RCA of PSE.

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References

[1] N.G. Weiskopf and C. Weng, Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research, *J Am Med Inform Assoc* **20** (2013), 144-151.
[2] N.G. Weiskopf, S. Bakken, G. Hripcsak, and C. Weng, A Data Quality Assessment Guideline for Electronic Health Record Data Reuse, *EGEMS (Wash DC)* **5** (2017), 14.
[3] World Alliance For Patient Safety Drafting group, H. Sherman, G. Castro, M. Fletcher, S. on the behalf of the World Alliance for Patient, M. Hatlie, P. Hibbert, R. Jakob, R. Koss, P. Lewalle, J. Loeb, et al., Towards an International Classification for Patient Safety: the conceptual framework, *Int J Qual Health Care* **21** (2009), 2-8.
[4] B. Yao, H. Kang, J. Wang, S. Zhou, and Y. Gong, Toward reporting support and quality assessment for learning from reporting: a necessary data element model for narrative medication error reports, *AMIA Annu Symp Proc* (2018), 1581-1590.
[5] S. Zhou, H. Kang, B. Yao, and Y. Gong, An automated pipeline for analyzing medication event reports in clinical settings, *BMC Med Inform Decis Mak* **18** (2018), 113.
[6] C. Claeys, J. Neve, P.M. Tulkens, and A. Spinewine, Content validity and inter-rater reliability of an instrument to characterize unintentional medication discrepancies, *Drugs Aging* **29** (2012), 577-591.