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Systemized Nomenclature of Medicine Clinical Terms for the structured expression of perioperative medication management recommendations

Mehrdad Rafiei, Ph.D.,

Postdoctoral Fellow, Institute for Health Informatics, University of Minnesota, Minneapolis, MN

David Pieczkiewicz, Ph.D.,

Assistant Clinical Professor and Director of Graduate Studies, Institute for Health Informatics, University of Minnesota, Minneapolis, MN

Saif Khairat, Ph.D., M.S.,

Assistant Clinical Professor, Institute for Health Informatics, University of Minnesota, Minneapolis, MN

Bonnie L. Westra, Ph.D., RN, FAAN, FACMI, and

Associate Professor, Institute for Health Informatics and School of Nursing, University of Minnesota

Terrence Adam, M.D., Ph.D.

Associate Professor, Institute for Health Informatics and College of Pharmacy, University of Minnesota

With an aging U.S. population,¹ there has been progressive growth in the number of surgeries, surgery-related costs, and complications of surgery.^{2–5} At least 50% of patients undergoing surgery take medications on a regular basis,⁶ and as many as 44% take medications in preparation for surgery.⁷ Furthermore, half of general surgical patients take medications unrelated to surgery and are thus at increased risk for postoperative complications relative to patients taking no medications.⁶

Recommendations for perioperative medication management (PMM)—decisions on stopping or continuing a patient's active medications during a preoperative physical examination—are largely provider specific, nonstandard, and written in free-text format. In the study described in this article, we aimed to evaluate the use of standard medical terminology instead of the free-text format for conveying PMM recommendations.

The *Informatics Interchange* column gives readers an opportunity to share their experiences with information technology in pharmacy. *AJHP* readers are invited to submit their experiences and pertinent lessons-learned related to pharmacy informatics. Topics should focus on the use of information technology in the medication-use process, informatics pearls, informatics education and research, and information technology management. Readers are invited to submit their ideas or articles for the column to ajhp@ashp.org or *ASHP*, c/o Allie Woods at 7272 Wisconsin Avenue, Bethesda, MD 20814 (301-657-3000).

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PMM challenges

Managing a patient's active medications during the perioperative period is a complex clinical problem. The state of the underlying disease, the risk of withdrawing medications, the patient's response to stresses of surgery, the patient's comorbidities, and drug–anesthesia interactions are all factors that the provider needs to consider in making each medication recommendation.^{8,9} While the surgical procedural burden in the United States is increasing, some providers feel that they are inadequately trained to perform preoperative evaluations because, until recently, most of the perioperative literature was published in a variety of specialty journals. Only in the last few years has more information appeared in the general medical literature.¹⁰ It has been shown that good medication management can improve postoperative outcomes¹¹ and plays a key part in successful and safe transitions of care^{12–14} and in the prevention of adverse drug events.¹⁵

Detailed clinical guidelines on PMM recommendations are lacking, resulting in clinical practice variations and a variety of provider-specific evaluation methods, which, in turn, create management problems due to practice variation. Besides the paucity of randomized clinical trials in the area of PMM, information on perioperative medication use is mostly recorded in a nonstandard, unstructured free-text format, making the measurement and assessment of clinical outcomes challenging using electronic data in medical records. Unstructured free-text data are not amenable to effective indexing, aggregation, searching, and analysis in electronic health record (EHR) systems. The meaningful use of EHR data aims to establish the effective use and exchange of healthcare information in order to support better decision-making and more effective processes. The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009¹⁶ outlines improvement of health outcomes and reduced costs as other potential benefits of EHR systems.^{17,18}

Background

Reference terminology development and use are becoming important aspects of health informatics.^{19,20} The Systemized Nomenclature of Medicine Clinical Terms (SNOMED CT) is a comprehensive clinical terminology that provides a consistent way to index, store,

retrieve, and aggregate clinical data across disparate specialties and healthcare facilities,²¹ thereby reducing variability in data capture and encoding.²² The structure of SNOMED CT is a hierarchy of concepts and relationships that link concepts together.²³ Support for multiple levels of granularity allows the use of SNOMED CT to represent clinical data at varying levels of detail appropriate to a range of different uses.²³ The January 2013 release of SNOMED CT included more than 297,000 active concepts and more than 890,000 logically defined relationships to enable consistency of data documentation, retrieval, and analysis. These numbers suggest roughly 39 trillion ($2^{297,000} \times 890,000$) possible combinations of concepts and relationships.

Medication therapy management

Medication therapy management (MTM)²⁴ encompasses a distinct group of services performed by the pharmacist that “optimize therapeutic outcomes for individual patients.”¹⁴ MTM services are distinct from medication dispensing and focus on patient-centered care.²⁵ Proper documentation of MTM services includes facilitating communication between the pharmacist and other healthcare professionals regarding recommendations intended to resolve or monitor actual or potential medication-related problems.²⁴ Like PMM, MTM entails a set of medication management recommendations, albeit a substantially broader set. In 2006, two pharmacy organizations—the Pharmacist Services Technical Advisory Coalition²⁶ and the Pharmacy e-Health Information Technology (e-HIT) Collaborative²⁷—submitted MTM-related definitions for proposed SNOMED CT codes to the National Library of Medicine (NLM).²⁸ Of the submitted set of proposed codes, 228 were approved for inclusion and were incorporated into the March 2013 release of the U.S. edition of SNOMED CT.

The development of standardized structured terminology will be useful in better understanding the clinical work and associated clinical decisions in PMM. Such a system can enhance clinical documentation, data aggregation and integration, interpractice communication, comparative effectiveness research, data exchange, and quality measures.^{18,29} Standardized healthcare terminologies are essential in the development of EHR information and in facilitating quality, safety, and outcomes research. In this article, we describe the validation of MTM concepts in the context of PMM through a project to determine whether MTM concepts can sufficiently express medication management recommendations in the context of surgical planning.

The project was submitted for approval by the institutional review board at the study site and, as a quality-improvement initiative, deemed to be exempt from review.

Objectives

Our objectives were to (1) validate the use of SNOMED CT concepts to express PMM recommendations, (2) identify any gaps in SNOMED CT in the context of PMM recommendations, and (3) determine the need for and, as appropriate, propose new PMM concepts to be added to SNOMED CT.

Study design

A descriptive study using secondary EHR data was conducted to validate the use of SNOMED CT concepts to express PMM recommendations. We manually extracted PMM recommendations from the electronic records of 100 randomly selected patients who had undergone a preoperative medical examination during the period August 1, 2010–July 31, 2012. PMM had been performed for all the patients, and PMM recommendations were documented in the patients' records. We defined "medication" to refer to all prescription and over-the-counter drugs, supplements, and herbal products. Unlike other terminology validation studies in which the terminology to be validated existed prior to validation,^{30–32} our study attempted to validate the use of concepts from one domain of healthcare (pharmacy) in another domain (medicine).

Setting

The study was conducted at the general internal medicine preoperative clinic at the Veterans Affairs Medical Center (VAMC) in Minneapolis, Minnesota. At the time of the study, the clinic comprised 10 primary care providers, with an approximately 90% adult male and 10% adult female patient population. Providers and other clinicians at the Minneapolis VAMC use the enterprisewide Veterans Health Information Systems and Technology Architecture (VistA) EHR system for documentation of clinical care.

Development of standardized terminology

In order to introduce terminology tools applicable to perioperative medicine, we found it necessary to establish a foundation upon which to conduct our validation study by defining data elements (medication-related concepts) and use of data (medication management recommendations). We determined that the necessary steps in building this foundation involved

- Operational tasks—collecting medication recommendations, vetting the set of recommendations through domain experts, and cross-mapping recommendations to concepts in SNOMED CT, and
- Validation tasks—aggregating PMM-related concepts deemed to represent "matches" with existing SNOMED CT concepts and verifying the validity of the mappings with domain experts.

After the removal of duplicate terms, reconciliation of synonyms, and disambiguation of terms by a domain expert in perioperative medicine, a distilled list of PMM recommendations was produced. Our sample records revealed five medication management recommendations: (1) stop medication, (2) take medication, (3) adjust medication dose, (4) start new medication, and (5) change to a different medication. Recommendations were further refined to more specific temporal subclasses (e.g., "Stop [medication] five days before surgery.").

To cross-map the recommendations, we downloaded the latest release of SNOMED CT, U.S. edition (released March 31, 2013), from the NLM website³³ to conduct a manual search of

MTM concepts. The team was informed by a NLM staff member that concepts in this version could not be searched with the latest SNOMED CT browser,³⁴ the usual medium of concept searching. Hence, we conducted a manual search of the release files using the following keyword terms and phrases: *medication, drug, prescription, supplement, herb, over-the-counter, dose, stop, discontinue, start, initiate, continue, recommend, stop/discontinue medication/drug, and start/continue medication/drug.*

Validation tasks

All semantically equivalent SNOMED CT synonym candidates were organized by medication category (prescription medications, herbal products, over-the-counter medications, and dietary supplements). The rationale for subdividing was the recognition that PMM recommendations are conveyed in “category-agnostic” language. For example, the recommendation “Hold fish oil for seven days before surgery” does not contain any explicit information about the category of medicine to which fish oil belongs (i.e., herbal products). This meant that for every PMM concept evaluated, we collected several synonym candidates in SNOMED CT.

To verify the validity of the mappings, we enrolled two domain experts in internal medicine to review and score each mapping as a match or a nonmatch. The interrater reliability statistic (Cohen’s kappa) was then calculated for the two raters’ scorings. The kappa statistic tests interrater independence, with the extent of concordance ranging from chance alone ($\kappa = 0$) to complete agreement ($\kappa = 1$). Landis and Koch³⁵ offered the following interpretation of the degree of agreement indicated by ranges of possible κ values: 0.0–0.2, slight; 0.21–0.4, fair; 0.41–0.6, moderate; 0.61–0.8, substantial; and 0.81–1.00, almost perfect.

We compiled lists of all the PMM concepts and the corresponding synonym candidates in a two-column text file format, with PMM concepts in the first column and synonym candidates in the second column. We then showed this list to two domain experts in internal medicine, who were asked to consider each PMM concept and score each synonym candidate as a match or a nonmatch.

Results

After manually searching the release files, collecting all medication management recommendations, and removing duplicates and resolving ambiguities, a total of 11 unique recommendations were aggregated from the records of the sample population. The recommendations (and corresponding frequency of mention in the release files) were as follows:

1. “Hold for a.m. surgery” ($n = 45$).
2. “Hold for p.m. surgery” ($n = 9$).
3. “Hold perioperatively” ($n = 17$).
4. “Hold for [number of hours/days/weeks] prior to surgery” ($n = 159$).

5. “Hold for [number of hours/days/weeks] preoperatively and [number of hours/days/weeks] postoperatively” ($n = 16$).
6. “Take a.m. of surgery” ($n = 164$).
7. “Take p.m. of surgery” ($n = 3$).
8. “Take perioperatively” ($n = 13$).
9. “Take 30–60 minutes before surgery” ($n = 7$).
10. “Take a reduced dose [number of hours/days/weeks] before surgery” ($n = 8$).
11. “Take a varied dose [number of hours/days/weeks] before or after surgery” ($n = 1$).

A search of SNOMED CT yielded 47 concepts that were deemed by a domain expert to be synonym candidates for the 11 PMM recommendations listed above. For each PMM recommendation, the number of synonym candidates ranged from a minimum of 1 to a maximum of 5. In addition to prescription drug-specific mappings, equivalent mappings exist for herbal products, over-the-counter medications, and supplements in SNOMED CT.

After collecting data on match/nonmatch scoring of each proposed SNOMED CT term by the two domain experts, we calculated κ for interrater agreement as 0.77 (substantial agreement). Since there was no natural ordering of the data, we believe the κ value accurately reflects the reliability of the mappings.

Discussion

We conducted a study to validate the use of structured terminology concepts in pharmacy to express clinical procedures. By manually extracting, examining, and vetting MTM concepts in SNOMED CT, we were able to show that they can be used to code PMM recommendations with sufficient clarity. The application of existing machine-interpretable concepts from one domain (pharmacy) in another domain (perioperative medicine) was shown to be sufficiently reliable.

As computerized healthcare systems become more knowledge intensive and the representation of medical knowledge in a format that is computable as well as human readable becomes more necessary, we need to find ways to start expressing clinical thoughts in standardized medical terminologies. SNOMED CT has proven to be an excellent mechanism by which we can accomplish this task.

We have proposed the possible use of SNOMED CT concepts in the “notes” section of the VistA EHR system used to document perioperative physical examinations, with the goals of enhancing decision support capability for clinicians and providing error-free data transmission across disparate facilities, potentially enhancing patient safety.

The project described here had some notable limitations. It was a single-site study with a specific patient population, and the evaluated medication recommendations were limited in clinical context to the perioperative period. Also, with our small sample size, all possible

medication management recommendations were not captured; however, we are confident that the recommendations captured were representative of those typically made for patients at the study site. Moreover, without access to a working SNOMED CT browser, we were unable to validate the placement of the MTM concepts in the SNOMED CT hierarchy.

Future directions

In our validation project, the methodology for expert assessment of cross-mappings did not allow for “partial match” scorings due to the fact that SNOMED CT concepts lacked time representation (e.g., one hour before, two hours after) typical of PMM concepts. For example, while the SNOMED CT expression “recommendation to discontinue prescription medication” (SNOMED CT concept identifier, 4781000124108) was deemed to have a matching PMM synonym, that expression does not convey a timeline (i.e., it does not specify for how long the medication is to be stopped). In this context, a simple instruction to “discontinue” without a corresponding instruction to restart the discontinued medication after surgery might be problematic; in some cases, the stop recommendation would need to be tethered to a start/restart expression. This example illustrates one of the core problems in clinical care transitions—the need for systems to provide some sort of HIT-driven memory to help manage appropriate continuity—and the importance of continued research and investigation in this area.

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