

Comparing the Use of SNOMED CT and ICD10 for Coding Clinical Conditions to Implement Laboratory Guidelines

Mobin YASINI^{a,1}, Vahid EBRAHIMINIA^b, Catherine DUCLOS^a, Alain VENOT^a and Jean-Baptiste LAMY^a

^a *Université Paris 13, Sorbonne Paris Cité, Laboratoire d'informatique médicale et bioinformatique (LIM&BIO, EA 3969), UFR SMBH, Bobigny, France*

^b *Université Paris 12, UFR de Médecine, Créteil, France; AP-HP, Groupe Hospitalier Mondor, Direction du Système d'Information*

Abstract. Laboratory medicine is responsible for an important part of hospital expenditure. Providing appropriate decision support to laboratory test requesters at the point of care is one of the main incentives for implementing laboratory guidelines, which can improve medical care. Laboratory guidelines developed by local experts in the Parisian region and two national guidelines for dyslipidemia were analyzed to extract test ordering recommendations. Clinical conditions which can be a trigger to order or not to order laboratory tests were extracted and mapped with ICD10 and SNOMED CT: 43.1% of clinical conditions were matched by ICD10 whereas SNOMED CT covered 80.1% of these conditions. For the non-mapped conditions, the main problem was found to be the ambiguity of the terms used in the guidelines. Ordinal characteristics of some clinical conditions and using terms more specific than SNOMED CT were other causes of mapping failure. Applying consistent and explicit concepts in the development of guidelines would lead to better implementation. By resolving the guideline ambiguity, SNOMED CT is a good choice and covers almost all of the clinical conditions in laboratory guidelines which are needed to implement in a Clinical Decision Support System.

Keywords. Guideline implementation, Clinical Decision Support System, Laboratory Guideline, SNOMED CT, ICD10

Introduction

Clinical practice guidelines recommend effective interventions and discourage inappropriate or unnecessary acts; they disseminate best practice, improve health outcomes, and reduce expenses by offering better cost-effectiveness [1–3]. However, guideline recommendations are often not followed by physicians [4] for various reasons including lack of awareness of the content of guidelines and lack of familiarity or disagreement with these recommendations [5]. Furthermore, the appropriate

¹ Corresponding Author. Mobin Yasini MD, MSc; Laboratoire d'Informatique Médicale et Bioinformatique (LIM&BIO), University of Paris 13, UFR Santé, Médecine, Biologie Humaine, 74 rue Marcel Cachin, 93017 Bobigny, France; Email: ninomobin@yahoo.fr; Phone: +33148388542

guideline information may be difficult to obtain at the point of care. Computerized interfaces have been reported to facilitate access to laboratory guidelines [6]; however exploiting the computerized decision support systems (CDSSs) is the most promising way to improve the implementation of practice guidelines and provide the right information at the point of care [7–9].

Laboratory tests play an important role in a large number of medical decisions concerning admission, medication, and discharge [10]. However, overuse or underuse of laboratory tests is currently common raising the issue of the appropriateness of test ordering. The expert panels of Assistance Publique – Hôpitaux de Paris (AP-HP), the public hospital system of the city of Paris and its suburbs, and the largest European academic hospital system, have formulated evidence-based laboratory guidelines for reducing errors concerning test ordering, sample collection and handling procedures for some common laboratory tests. Furthermore, national evidence-based clinical practice guidelines provided by the French national health authority (HAS) and French Drugs and Health Products Safety Agency (ANSM), contain statements concerning laboratory medicine. AP-HP has decided to implement the prescription rules contained in these guidelines in its information system to rationalize test ordering behavior of physicians. We hypothesized that the successful implementation of these guidelines requires the information to be structured and coded. We studied these laboratory guidelines and two national guidelines addressing dyslipidemia to extract the conditions included. The main aim of this study was to assess the extent to which the clinical conditions included in these guidelines could be mapped to the most widely used coding systems (ICD10 and SNOMED CT). We determined if these coding systems are sufficient to map these clinical conditions or if a new coding system is required for the successful implementation of these guidelines.

1. Materials and Methods

We analyzed thirty evidence-based laboratory guidelines produced by the expert panels of the AP-HP and two national guidelines for dyslipidemia. These guidelines include recommendations in various fields of laboratory medicine, including biochemistry, microbiology, immunoglobulin analysis and cardiac markers.

These guidelines were written by different panels and covered different topics. As a result, they were highly heterogeneous in structure. We examined the data, line by line, in each guideline and broke it down into recommendations. We were interested in implementation of the prescription rules; therefore we concentrated on the recommendations for test ordering (including prescription and re-prescription of the laboratory tests). These recommendations were extracted and listed. For each recommendation, one or more clinical situations were considered. For example for the prescription rule “Iterative ordering for anti-neutrophil cytoplasmic antibody (ANCA) is indicated three to six months after the former order”, two clinical situations could be imagined: 1) The clinician requests ANCA before the limit of the time interval indicated (3 months). 2) It has been over 6 months since the last test, and ANCA has not yet been reordered. In the first situation the system should send a message reminding the requester of the recommended time interval for reordering ANCA with the purpose of preventing the overuse of test ordering. In the second situation, the system should remind the physician in charge that he may have forgotten to reorder ANCA within 6 months. The purpose of this reminder is preventing the underuse of the

test. We then analyzed each clinical situation and extracted the conditions used to make a test-ordering decision. For example, the conditions for reordering a lipid profile analysis may be a change in dietary habits, the administration of a particular drug, a cardiovascular event, or weight gain. These conditions were then categorized into clinical and non-clinical conditions. Clinical conditions included patient signs and symptoms, pathologies and physiological states. Non clinical conditions included other types of conditions including age, sex, habits, medications, laboratory test results, etc. In the next step, two of the authors (MY and VE), both medical doctors working in medical informatics, independently matched clinical conditions with ICD10 and SNOMED CT codes. Discordances were then discussed to obtain a consensus between them. We evaluated to what extent these clinical conditions could be mapped to ICD10 and SNOMED CT. A possible need for a new coding system to map more clinical conditions and the reasons for which these coding systems, used worldwide, were unsatisfactory were then discussed.

Cohen's kappa coefficient of concordance was used to assess agreement between the two raters before consensus decisions were made. McNemar's test was used to compare the proportions of ICD10 mappable conditions and SNOMED CT mappable conditions.

2. Results

We extracted 335 conditions for 201 test ordering rules: 188 conditions were categorized as clinical conditions (56.1%); the remaining 147 conditions concerned medication, demographic factors, family history, habits, laboratory tests, and other procedures. Clinical conditions were mapped to ICD10 and SNOMED CT by our two medical experts. We applied the formula for Cohen's Kappa after their independent evaluations and we got $k=0.81$ for ICD10 mapping and $k=0.84$ for SNOMED CT mapping. Cohen's kappa coefficient measures the agreement between two raters and kappa above 0.8 indicates almost unanimous mapping results. Discordant instances were then discussed by reviewing the mappings to obtain a consensus. After the consensus, 81 clinical conditions (43.1%) were directly mapped to ICD10 and 152 (80.1%) were mapped to SNOMED CT. Thus, SNOMED CT has a greater capacity than ICD10 for mapping the clinical conditions found in laboratory guidelines ($p < 10^{-6}$). The conditions mapped to SNOMED CT included all of the clinical conditions mapped to ICD10. The presence of qualifier values in the SNOMED CT concepts (for example "suspected", "primary", "history of", etc.) was the key for covering more clinical conditions. When a condition is not mappable, the relevant test ordering rule cannot be implemented in the computerized decision support system. We tried to identify the characteristics of the remaining 36 conditions that could not be mapped with SNOMED CT to assess whether a new coding system capable of mapping all these conditions is required. The main obstacle for mapping was the ambiguity of the terms used in the guidelines (77.8%). This ambiguity was in some cases in the meaning of the conditions, for example "*evocative context of measles*" is insufficiently precise. It may refer to rashes, lymphadenopathy, or other signs and symptoms. Ambiguity can also be caused by using words for clinical problems which are too general, for example "*personal history of genetic disorders of muscle*" includes a very wide range of diseases (muscular dystrophies, congenital myopathies, storage myopathies, periodic paralysis, etc.) and needs to be broken down into specific disorders. Words with ambiguous

meaning in the state of clinical problems lead also to ambiguous conditions, for example in “*persistence of infectious syndrome*” the time period for considering persistence is not defined. Conditions in which an ordinal characteristic of a clinical problem is mentioned accounted for 13.9% of non-mapped conditions. The examples are “*First spontaneous venous thrombosis*” or “*Third spontaneous miscarriage*”. Finally, 8.3% of the non-mapped conditions were caused by words being more specific than compatible with SNOMED CT, for example “*pauci secreting plasmocytoma*”.

These observations indicate that the major problem is associated with guideline development rather than the choice of SNOMED CT or other types of coding system for implementing clinical guideline conditions.

3. Discussion

This study presents an analysis of laboratory guidelines to assess the feasibility of implementing their test ordering rules in a clinical decision support system. In particular, we considered the appropriate nomenclature for coding clinical conditions included in these guidelines. Clinical conditions were extracted and mapped to ICD10 and SNOMED CT. The proportion of clinical conditions that could be mapped to SNOMED CT was significantly higher than the proportion of conditions mappable with ICD10. However, some clinical conditions included in the laboratory guidelines could not be mapped with SNOMED CT. Our analysis of these non-mapped conditions indicated that the problem was due to guideline deficiencies, and particularly guideline ambiguity.

We decided to map the clinical conditions with ICD10 and SNOMED CT codes because ICD10 is the most widely used system to code clinical diagnosis in hospitals both in France and worldwide and SNOMED CT is considered to be the most comprehensive, multilingual clinical healthcare terminology in the world. We only mapped clinical conditions because our planned guideline-based CDSS is only designed for clinical reminders. For this purpose, it is less important to map the action part of a recommendation and the reminder can be presented as free text. However, if the system is used to evaluate the care delivered, actions also need to be defined in a code-based way.

Our study shows that SNOMED CT could match 77.8% of the total number of extracted clinical conditions. This is in line with the coverage reported in other studies [11,12]. Automating guidelines with CDSSs requires explicit definitions of many important information elements contained in the guidelines [13]. We found that some of the clinical conditions mentioned in the laboratory guidelines were ambiguous. This corroborates the results of other studies which report that guidelines often use vague terms or overly general concepts that require more rigorous definition [14,15]. The results of our study of guidelines in the field of the laboratory medicine are likely to be generalized to other clinical guidelines in other fields because most of the guidelines are formulated as unstructured textual documents. The multiaxial nature of SNOMED allows adequate structuring of information and its good coverage fits to the needs of coding in other clinical fields including drug contraindications [16]. Guideline development in parallel with its implementation by a CDSS provides better results in developing computer interpretable guidelines which leads to improve the quality of the decision support system [17]. For guidelines that have already been formulated, regular

revision and timely updates should be systematically included in the guideline development process [1].

4. Conclusion

There is a consensus that guideline delivery systems need to be integrated with electronic health records via CDSS to be most effective. Coding clinical conditions in laboratory guidelines using ICD10 and SNOMED CT draws attention to the importance of consistent and explicit concepts when developing a guideline. Using general and ambiguous terms in guidelines make their implementation difficult. If guideline ambiguity is resolved, SNOMED CT covers almost all of the clinical conditions in laboratory guidelines and can be used to implement a CDSS. However, the few missing conditions need to be added to reach an optimized system.

References

- [1] Oosterhuis WP, Bruns DE, Watine J, Sandberg S, Horvath AR. Evidence-based guidelines in laboratory medicine: principles and methods. *Clin Chem* 2004; 50(5):806–18.
- [2] Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. *BMJ* 1999; 318(7182):527–30.
- [3] Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* 1993; 342(8883):1317–22.
- [4] Grimshaw J, Eccles M, Tetroe J. Implementing clinical guidelines: current evidence and future implications. *J Contin Educ Health Prof* 2004; 24 Suppl 1:S31–37.
- [5] Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999; 282(15):1458–65.
- [6] Yasini M, Duclos C, Lamy J-B, Venot A. Facilitating access to laboratory guidelines by modeling their contents and designing a computerized user interface. *Stud Health Technol Inform* 2011; 169:487–91.
- [7] Shojania KG, Jennings A, Mayhew A, Ramsay C, Eccles M, Grimshaw J. Effect of point-of-care computer reminders on physician behaviour: a systematic review. *CMAJ* 2010; 182(5):E216–225.
- [8] Shiffman RN, Liaw Y, Brandt CA, Corb GJ. Computer-based guideline implementation systems: a systematic review of functionality and effectiveness. *J Am Med Inform Assoc* 1999; 6(2):104–14.
- [9] Garg AX, Adhikari NKJ, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. *JAMA* 2005; 293(10):1223–38.
- [10] Forsman RW. Why is the laboratory an afterthought for managed care organizations? *Clin Chem* 1996; 42(5):813–6.
- [11] Ahmadian L, Cornet R, de Keizer NF. Facilitating pre-operative assessment guidelines representation using SNOMED CT. *J Biomed Inform* 2010; 43(6):883–90.
- [12] Kim HY, Cho IS, Lee JH, Kim JH, Sim DH, Kim Y. Matching between the concepts of knowledge representation for a hypertension guideline and SNOMED CT. *AMIA Annu Symp Proc* 2008;1005.
- [13] Tierney WM, Overhage JM, Takesue BY, Harris LE, Murray MD, Vargo DL, et al. Computerizing guidelines to improve care and patient outcomes: the example of heart failure. *J Am Med Inform Assoc* 1995; 2(5):316–22.
- [14] Codish S, Shiffman RN. A model of ambiguity and vagueness in clinical practice guideline recommendations. *AMIA Annu Symp Proc* 2005; 146–50.
- [15] Ohno-Machado L, Gennari JH, Murphy SN, Jain NL, Tu SW, Oliver DE, et al. The guideline interchange format: a model for representing guidelines. *J Am Med Inform Assoc* 1998; 5(4):357–72.
- [16] Liu JH, Milstein C, Séné B, Venot A. Object-oriented modeling and terminologies for drug contraindications. *Methods Inf Med* 1998; 37(1):45–52.
- [17] Goud R, Hasman A, Strijbis A-M, Peek N. A parallel guideline development and formalization strategy to improve the quality of clinical practice guidelines. *Int J Med Inf* 2009; 78(8):513–20.