

# Structured Terminologies in Clinical Information Systems: Implementation through Collaboration

Robert E. HASKELL<sup>a</sup>, Nicholas R. HARDIKER<sup>b</sup>, Tera J. WATKINS<sup>c</sup>, Cynthia B. LUNDBERG<sup>d</sup>, Jane M. BROKEL<sup>e</sup> and Marisa L. WILSON<sup>f</sup>

<sup>a</sup>*Siemens Medical Solutions Health Services, Malvern, PA, USA;*

<sup>b</sup>*The University of Salford, Greater Manchester, UK;*

<sup>c</sup>*Cerner Corporation, Kansas City, MO, USA;*

<sup>d</sup>*CAP SNOMED Terminology Solutions, Northfield, IL, USA;*

<sup>e</sup>*The University of Iowa, Iowa City, IA, USA;*

<sup>f</sup>*The University of Maryland School of Nursing, Baltimore, MD, USA*

**Abstract.** The structure and content of the dialog with a clinical end-user is a critical aspect of clinical information system use, data capture and retrieval, and efficient and effective health care. This dialog is driven ultimately by embedded structures and processes that: a) provide functional models of clinical expression in support of professional practice, and b) determine how structured terminologies ought to populate these models. Based on diverse practical experience, this study identifies challenges to implementing structured clinical terminologies, categorizing them by both stakeholder group and application area. Collaboration across all stakeholders and across a wide range of application areas is identified as a key ingredient to successful terminology implementation and use.

**Keywords.** Clinical Terminology, Clinical Information System, Information Model Use

## 1. Introduction

Structured terminologies are an essential ingredient of operable and interoperable clinical information systems (CIS) [1, 2]. However, their use requires more than simply giving clinical end users direct browser access to large, complex terminologies in their native form [3]. Models of terminology use are necessary to hide the complexity, providing a structured end user dialog to match the mental and operational models of clinical practice held by clinicians, and to capture semantically consistent and interoperable structured data [4]. Models of terminology use define the structures necessary for creating precise, unambiguous, computable and consistent clinical content to drive the system dialog at the point of care, and to collect the resultant structured data necessary for subsequent clinical processing and research [5].

## 2. Objectives

The objective was to identify challenges in and provide recommendations for improving the effective implementation and use of structured terminologies within CIS.

## 3. Materials and Methods

The methodology consisted of several steps. The first step involved defining and developing a basic understanding of stakeholder groups, which are the groups expected to take principal ownership for resolving the challenges, and application areas, which are the areas most likely to have requirements imposed upon them as a result of addressing the challenges.

The second step consisted of a brainstorming and step-wise refinement process to identify and describe challenges for the effective implementation of structured terminologies, based simply on the practical experience of the team members.

The third step consisted of the categorization of challenges according to stakeholder group and application area, to assign responsibility and to understand their impact. It is not the purpose of this paper to describe and analyze the specific challenges. The results that follow reflect only an analysis of this categorization.

#### **4. Results**

A total of 48 implementation challenges were collaboratively identified by a subgroup of the project team. For each of the challenges, two members of the subgroup independently reviewed and allocated them to stakeholder group (content developers, educators, software developers, terminology developers, or terminology managers) and application area (terminology system, model of use, vendor system, or education). It should be noted that the stakeholder groups reflect particular roles that an individual may play, and not specific individuals. The role of end user was discussed as a stakeholder group, but was not included. No attempts were made up front to formally define or refine these organizing concepts (including the model of use). It was assumed that an understanding of roles, responsibilities, scope and boundaries was shared across the project team. As it turned out, this assumption was incorrect. The team was forced to create more concrete definitions post hoc, to establish common understanding and consistency in categorizing terminology use challenges.

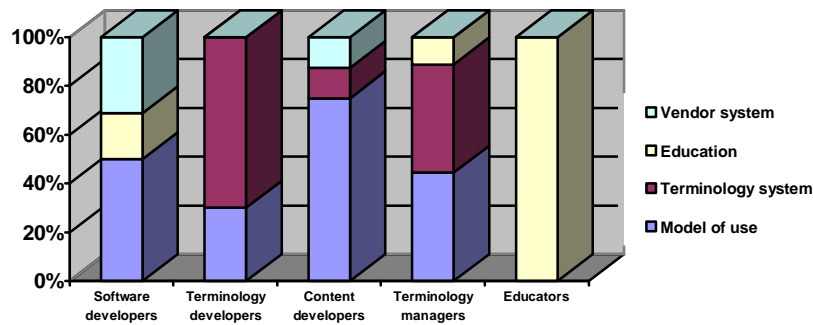
The reviewers allocated the challenges to the same stakeholder group on 30/44 occasions. There was total agreement when allocating challenges to educators. However, for the 14 stakeholder group allocations where reviewers disagreed, there were no consistent patterns, although marginally more disagreements involved software developers. These findings suggest that, while the role of educators in addressing the challenges of terminology use appears to be relatively well-bounded, the role of software developers in particular is less clear.

The reviewers allocated the challenges to the same application area on 31/44 occasions. Of the 13 disagreements, most involved the model of use. This would suggest a lack of clarity in understanding and the role of the model of use.

Consensus was achieved after two rounds in which both reviewers examined differences and worked towards agreement on a uniform allocation for each challenge. In the final allocation, the stakeholder groups deemed responsible for the majority of challenges were software developers (16), followed by terminology developers (10), with terminology managers (9), content developers (8) and educators (5) having lesser responsibility.

The set of challenges imposed requirements in four key application areas: model of use requirements (21), terminology system requirements (12), educational requirements (9) and vendor system requirements (6). The majority of terminology implementation challenges pose requirements on the model of use. Relatively few challenges pose requirements specifically on the vendor system, which deploys the model of use and its associated terminology.

Figure 1 below correlates stakeholder group responsibilities with application area requirements. For each stakeholder group it shows the percentage of challenges organized by application area requirements.



*Figure 1: Correlation of stakeholder group responsibilities with application area requirements*

It is clear from this figure that any one stakeholder group affects multiple application areas and that any one application area is affected by multiple stakeholder groups. Therefore, a solution to terminology use for any one application area is the responsibility of the multiple stakeholder groups that impact that application area, and collaboration across these groups is essential to achieve an effective and coherent solution.

In some respects, the division of responsibility is unsurprising. For example, educators are expected to be responsible for educational requirements. Other results are a little less obvious. For example, while content developers appear to have significant responsibility for model of use requirements, this responsibility is in fact shared across the spectrum of stakeholders (excluding the educators), perhaps indicating a need for greater collaboration. This sharing of responsibility applies, albeit to a lesser extent, to terminology system requirements. While responsibility for vendor system requirements is shared, it is surprising that terminology developers and terminology managers were not identified as also sharing in those requirements.

## 5. Discussion

The purpose of clinical terminology is to structure clinical data for a range of purposes: decision support, quality assurance, information management, sharing data within and between healthcare organizations, etc. [3]. This study has shown that structured terminology use in clinical applications is complex, requiring a multi-stakeholder and multi-application approach to achieve common understanding and to establish effective use. Assumptions, biases, and the multitude of long-standing, endorsed, and competing terminology sources often complicate the learning process and provide multiple implementation paths to a variety of shared goals [6]. Because of the multiple users and uses of the resultant structured data, the task of developing a comprehensive reusable terminology for patient-centered systems is difficult and requires collaboration across many roles within the CIS development team [3]. Otherwise, there is high risk for semantic inconsistency, incomplete data collection, potentially lower validity and consistency of information exchange, and ultimately errors in interpretation [2].

As the synthesis of the various stakeholder group descriptions, responsibilities and challenges matured within the project team, the designation of the outlined challenges became much more diffuse. One person often performs many of the role

responsibilities associated with multiple stakeholder groups, regardless of the primary stakeholder group initially assigned. Therefore, it is necessary to compare and contrast stakeholder group responsibilities for successful CIS implementation, to better understand the need for, and areas of, collaboration.

As illustrated in the application area and stakeholder group chart in figure 1, there are interdependencies between stakeholder groups within and across these application areas. Most importantly, models of use are a direct responsibility of all stakeholders (except perhaps educators). Active collaboration is essential to their development and, consequently, to the deployment and use of structured terminologies. It is also apparent that solutions for other application areas clearly require shared responsibility and collaboration.

## **6. Conclusions**

This study identified 48 challenges associated with the implementation of structured clinical terminologies. However, perhaps more importantly than the identification of challenges per se, this study has shown that collaboration is essential - collaboration between and within stakeholder groups and across application areas. This collaboration has been limited to date, thereby jeopardizing effective terminology integration, and semantic and process interoperability. The domain of clinical terminology and terminology implementation is complex, and is surely beyond any one individual or stakeholder group to understand and implement in isolation.

Clinical terminology is an essential aspect of achieving high-quality, safe and efficient patient-centered care. Proprietary solutions with proprietary data are inevitably limited. Only through broad active participation, across stakeholder groups, and in an atmosphere of mutual trust and respect, can we hope to address some of the significant implementation challenges ahead. This study has provided one model for such collaboration.

## **References**

- [1] Powsner S, Wyatt J, Wright P. Opportunities for and challenges of computerisation. *The Lancet* 1998;352:1617-1622.
- [2] Institute of Medicine. *Key Capabilities of an Electronic Health Record System*. Washington DC: The National Academies Press; 2003.
- [3] Hardiker N, Coenen A, Hovenga E, Sensmeier J, Smith A, Zingo C. Understanding the dialogue between users and formal terminology systems. In: *Proceedings of Nursing Informatics*; Rio de Janeiro; 2003.
- [4] Rector AL. Clinical terminology: Why it is so hard? *Meth Inform Med*. 1999;(38):239-252.
- [5] Hardiker N, Bakken S. Requirements of tools and techniques to support the entry of structured nursing data. In: Fieschi M, Coiera E, Yu-Chan JL (eds). *MEDINFO 2004: Proceedings of the 11th World Congress on Medical Informatics*. Amsterdam: IOS Press; 2004:621-625.
- [6] Hardiker N, Casey A, Coenen A, Konicek D. Mutual Enhancement of Diverse Terminologies. In: Bates D (ed.). *Proceedings of the Annual Symposium of the American Medical Informatics Association*. Philadelphia: Hanley & Belfus, Inc., 2006, 319-323.

**Email address for correspondence:** robert.haskell@siemens.com