A Compositional Approach to
Nursing Terminology

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The development of standardised vocabularies within nursing has been an important research activity for a number of years. Current representations generally take the form of taxonomic vocabularies. These are seen as important as they provide a structure for retrieving and analysing data from automated systems. However, there is increasing evidence to show that traditional taxonomic vocabularies are unsuitable for capturing detailed clinical data. This paper describes how GRAIL (GALEN Representation and Integration Language) is being used within the TELENURSE project to develop a representation of nursing terminology which is sufficiently expressive for documenting detailed clinical data while retaining the benefits of traditional taxonomic vocabularies.

Introduction

The development of standardised vocabularies to represent nursing terminology and to describe nursing practice has been an important research activity for many years. The development and increasing use of computer-based nursing information systems have further emphasised the importance of this activity. The result has been the emergence of a number of representations.

Problems with traditional taxonomic vocabularies

The majority of the commonly reported standardised nursing vocabularies take the form of taxonomic vocabularies. Taxonomic vocabularies are terminological systems in which concepts are related by hierarchical relations *i.e.* generic 'is-a' relation and partitive 'part-of' relation, and other associative and pragmatic relations[1]. Examples within nursing include the North American Nursing Diagnosis Association Taxonomy I (NANDA), the Nursing Interventions Classification (NIC), the Home Health Care Classification (HHCC) and the Omaha Community System (Omaha).

These representations are seen as important because they provide a structure for retrieving and using nursing data from automated systems[2]. Other reasons cited for organising nursing concepts into taxonomies include: to formalise and expand knowledge about nursing practice, to assist in determining the cost of nursing services, to help to target resources more effectively and to make explicit the role played by nurses in health care[3].

Monohierarchical taxonomic vocabularies that are exhaustive and that guarantee disjunction are seen as useful for statistical evaluation[1]. Thus it could be argued that taxonomic vocabularies have a useful role to play in activities such as data retrieval and data analysis. However there is increasing evidence to show that taxonomic nursing vocabularies are not able to represent the detailed clinical data within patient records[4]. As such they are poorly suited for representing day-to-day nursing care.

One study was carried out to test the feasibility of using the third version of the Systematized Nomenclature of Human and Veterinary Medicine (SNOMED) to represent the terms used by nurses to describe patient problems[5]. It should be noted that SNOMED III contains all of the nursing diagnoses from NANDA. This study found that NANDA terms alone provided matches for only 30% of the patient problems described by nurses in the study. It is clear from these results that NANDA alone does not provides the coverage necessary for nurses to record patient problems (interestingly the inclusion of SNOMED III terms and combinations of SNOMED III terms increased the proportion of matches to 69%).

Another study was carried out to compare the ability of terms from NIC and from the medically-oriented Current Procedural Terminology to represent the clinical terms used by nurses and patients to describe nursing interventions[6]. The results of matching NIC terms to clinical terms used by nurses and patients to describe nursing interventions are given as 'encouraging'. However the examples cited of selected clinical terms and their matching NIC interventions show that comprehensiveness of scope is at the expense of clinical detail. For example, the relatively abstract NIC term 'Hypoglycaemia management' is given as a match for the relatively detailed clinical term 'Fingersticks for blood sugar'. NIC has been criticised previously for being insufficiently fine-grained for capturing differences in practice[4].

One reason concerns the fact that traditional taxonomic vocabularies are constructed by enumerating all of the possible terms that are to be represented; and organising these terms within a hierarchy. In constructing any enumerative scheme, developers must limit the number of concepts to include as the total number of concepts would be unmanageable, both in terms of development and in terms of practical application. As such, enumerative representations tend to be tuned to a single purpose or to a group of closely-related purpose; re-use for other purposes proves very difficult. Indeed HHCC and Omaha have been criticised for lacking the specific vocabulary of acute care and NANDA Taxonomy I has been criticised for not covering all fields of specialty practice[4].

Solutions to problems concerning expressiveness
Linear lists
An alternative approach to the traditional taxonomic vocabulary is the linear list. A linear list is simply a collection of terms relevant to a domain[1]. One study claims that it may be possible to develop a list of standard terms that is capable of representing the universe of terms actually used to record data elements in a patient record[4]. However, there are many outstanding issues arising from this study:

- The study was confined to two specialist fields, Orthopaedics and Thoracic/ Cardiovascular surgery; there is no indication as to how the list of standard terms employed within the study might scale up to include other areas of practice.
- 11 auditors were involved in the study, matching statements from patient records to standard terms in a code book. While the reliability of the auditors, that is the accuracy of term matching, was a consideration within the study, the results given omit any discussion on the degree of detail captured by the standard terms and on the exactness of term matching.
- Within the study term matching was performed manually and it is not clear how this process may be automated, nor how the standard terms might be re-used for other purposes.

Until these issues are resolved, the usefulness in practice of such an approach is questionable.

A compositional approach

Within the GALEN project (Generalised Architecture for Languages, Encyclopedias and Nomenclatures in Medicine) a new approach to representing clinical terminology has been developed in the form of the GALEN Representation And Integration Language (GRAIL)[7].

GRAIL is a terminological language that provides a means of capturing the knowledge that underpins clinical terminology in a formal compositional model from which all and only sensible clinical concepts can be generated[8].

By decomposing complex concepts into primitive concepts, other schemes such as SNOMED attempt to address the problems associated with enumerative representations. However, although SNOMED provides a framework or meta-model for constructing complex clinical concepts, it is impaired by the lack of specific rules for determining which combinations are clinically sensible. Thus it cannot prevent the creation of clinically meaningless concepts; nor is it able to control combinatorial explosion.

A GRAIL model consists of a taxonomy of concepts and a set of rules or 'sanctions' to dictate how these concepts may sensibly be combined. For example, it might be sensible to combine the elementary concepts *Mobilising* and *Ability* to create a composite concept which defines 'Mobility':

(Ability which
refersTo Mobilising).

As they are created, composite concepts are classified automatically in the taxonomy. For example, if the concept *Mobilising* subsumes *Walking*, then the composite concept which defines *ImpairedWalkingAbility* will be subsumed by *ImpairedMobility*.
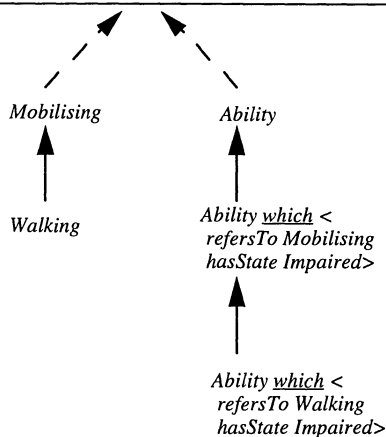
The result is a multiple hierarchy of clinically sensible concepts which are defined to an arbitrary level of detail.

Practical application of GRAIL

The TELENURSE project

The TELENURSE project is an accompanying measure in the European Telematics Application Programme. Its primary aim is to promote consensus among nurses across

Europe around the use of the International Classification of Nursing Practice (ICNP) which is being developed by the International Council of Nurses. Each concept within ICNP is explicitly defined and classified in terms of the generic relation. The alpha version of ICNP has two dimensions: nursing phenomena and nursing interventions. At the time of writing, the ICNP classification of nursing interventions was undergoing change. The remainder of this discussion is therefore restricted to the ICNP classification of nursing phenomena. As the ICNP classification of nursing phenomena is monohierarchical, it may be well-suited for statistical evaluation. However, as an example of a traditional taxonomic vocabulary it is not well-suited to the task of recording day-to-day nursing care. In contrast, the development of GRAIL has been driven in part by the data entry requirements of users of clinical applications.

The use of GRAIL within TELENURSE
The GALEN approach has been applied successfully within other areas[9]; nursing presents new challenges.
There is within nursing a resistance to recording meaningful, concise information concerning the nursing care of patients[10]. This is compounded by a general confusion about the nature of nursing information. In the context of nursing interventions four main origins for this confusion have been identified[3]:

1. The contextual nature of nursing information leading to confusion between intervention (nurse behaviour) and assessment and evaluation (patient behaviour);
2. The use of synonyms *e.g.* action, activity, treatment, order;
3. The lack of conceptualisation of how a number of actions might fit together, resulting in long verbose care plans;
4. Inadequate decision making among nurses in selecting and prioritising interventions.

Within TELENURSE the GALEN approach is being applied in an attempt to overcome the first three of these problems; the final problem requires a change in nursing practice.
An existing GRAIL medical foundation model has been extended to incorporate nursing concepts. This has involved the development of GRAIL definitions for ICNP concepts. For example, the ICNP concept 'Nursing Phenomena' has been explicitly defined in GRAIL as:

Phenomenon which
hasRelevantDomain NursingDomain.

Such definitions restrict the possibility of ambiguity and make explicit any contextual influences.

In GRAIL, any number of unique names for individual concepts is permitted, thus facilitating the controlled use of synonyms:

(Phenomenon which
hasRelevantDomain NursingDomain)
name NursingPhenomenon.

As specific detail is added, GRAIL concepts are classified automatically. The resulting subsumption hierarchy provides a 'bridge' for different levels of abstraction and represents a conceptualisation of how concepts interrelate.

Transforming hope into working achievement

A significant problem with enumerative representations is the fact that any reasoning behind the decisions made during the construction of the scheme is locked inside terms or concept definitions. For example, a nurse may have a clear understanding of the enumerated term 'Able to walk a short distance'. However a computer can have no such understanding and thus cannot utilise the underlying clinical concepts in managing the scheme. A major motivation for the modelling activity within TELENURSE has been the need to ensure that computers will be able to manage the ultimate structure and content of ICNP.

As part of TELENURSE two prototype nursing care management systems are being developed. GALEN technology will make ICNP, in the form of a GRAIL model, available to users of these systems in order to transform the potential benefits of using standardised vocabularies into working achievements.

Summary

A number of well-founded standardised nursing vocabularies have been developed over recent years. The majority of these take the form of taxonomic vocabularies. While such representations may be appropriate for statistical analysis of relatively abstract data, they are unable to capture the detail of day-to-day nursing care. GRAIL provides a mechanism for representing clinical data at any level of detail. Within the TELENURSE project a model built in GRAIL will be used to make ICNP available to users of clinical applications without compromising the operational needs of those users. The result will be a representation of nursing terminology which is sufficiently expressive for documenting highly detailed clinical data; and one which retains the benefits of traditional taxonomic vocabularies.

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