Mutual enhancement of diverse terminologies

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Abstract

The purpose of this study was to map the North American Nursing Diagnosis Association (NANDA) nursing diagnoses to the International Classification for Nursing Practice Version 1.0 (ICNP®) and to compare the resulting representations and relationships to those within SNOMED® Clinical Terms (CT). Independent reviewers reached agreement on 25 (i.e. 64%) of the 39 parent-child relationships identified via the mappings between NANDA entities. Other parent-child relationships were more questionable and are in need of further discussion. This work does not seek to promote one terminology over any other. Rather, this collaborative effort has the potential to mutually enhance all three terminologies involved in the study: ICNP®, SNOMED® CT and NANDA. In doing so it provides an example of the type of collaborative effort that is needed to facilitate the development of tools to support interoperability at a global level.

Introduction

The widespread use of an integrated terminology with broad coverage of the entire healthcare domain remains an elusive goal. Despite notable achievements, no single terminology has emerged as a 'standard'. Several decades of sustained effort have resulted in a range of terminologies. At a relatively local level, healthcare may benefit from the existence of a range of terminologies; different specialties and different locations have different needs. However the lack of a common framework prevents a more global view of healthcare.

Two international initiatives have sought to challenge this situation. From a nursing perspective the International Classification for Nursing Practice Version 1.0 (ICNP®) provides a means of mediating between diverse nursing terminologies [1] i.e. it acts as a reference terminology [2]. SNOMED® Clinical Terms (CT) has been developed to fulfill a similar function across a wider healthcare domain [3]. There are obvious similarities between the two terminologies e.g. both terminologies

are underpinned by computable logical ontologies [4]. However, there are important differences e.g. the underlying ontologies differ in scope, in representational form and in hierarchical structure.

In this article we do not attempt to assess the relative worth of each of these terminologies; nor do we provide a comprehensive description of their respective structure and content. Rather, we describe a collaborative effort to mutually enhance both ICNP® and SNOMED® CT by comparing representations of, or mappings from, a third terminology, the North American Nursing Diagnosis Association Nursing Diagnoses (NANDA). As the mappings are used primarily to provide access to the ICNP® and SNOMED® CT hierarchies, their accuracy is not a major concern of this study. Previous related work has focused less on the enhancement of reference terminologies and more on their initial development and application [5].

Background

According to **NANDA**, a nursing diagnosis is defined as 'A clinical judgment about individual, family, or community responses to actual or potential health problems/life processes. A nursing diagnosis provides the basis for selection of nursing interventions to achieve outcomes for which the nurse is accountable.' [6, p 277] A NANDA nursing diagnosis has an associated name or label and an informal definition. For example, 'Acute Pain' has the definition 'Unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage (International Association for the Study of Pain); sudden or slow onset of any intensity from mild to severe with an anticipated or predictable end and a duration of less than 6 months.' [6, p 132] Additional defining characteristics and related or risk factors are used in the diagnostic process.

NANDA's Taxonomy II organises nursing diagnoses into classes and domains [6]. For example 'Acute Pain' is organ-

ised into the class 'Physical Comfort', which in turn falls within the 'Comfort' domain. A separate taxonomy, the NNN Taxonomy, also organises nursing diagnoses into classes and domains, although these differ from those of Taxonomy II [6]. Thus in the NNN Taxonomy, 'Acute Pain' is organised into the class 'Comfort', which falls within the 'Functional' domain.

Both the NANDA and the NNN taxonomies provide an organisational framework for NANDA nursing diagnoses. However, neither taxonomy organises nursing diagnoses among themselves. So for example, 'Death anxiety' does not appear as a child of 'Anxiety', even though this would appear to be an obvious relationship. The only relationship that is specified between nursing diagnoses is the sibling relationship. Thus NANDA is an example of a relatively simple enumerative terminology [5].

Note that the organising classes and domains of Taxonomy II and the NNN Taxonomy have been excluded from this study as (a) they are not mapped into SNOMED® CT (and therefore were not mapped into ICNP®) and (b) their hierarchical relationships are not based on the generic relation, thereby limiting their utility.

ICNP® Version 1.0 is defined as a unified nursing language system [1]. The primary motivation for a unified nursing language system is to be able to communicate and compare nursing data across settings, countries and languages. These data can be used to support clinical decision-making, evaluate nursing care and patient outcomes, develop health policy, and generate knowledge through research.

The International Council of Nurses (ICN) began the work toward an ICNP® in 199l, releasing Version 1.0 in 2005. The definitions of ICNP® have evolved along with the actual development of the terminology. Important to ICNP® development is how ICNP® relates to existing nursing and health care terminology tools. These relationships are also evolving and continue to be a major focus of the development.

ICNP® is more than merely a terminology. It is a resource that can accommodate existing terminologies (through cross-mapping), that can be used to develop local terminologies (as a compositional terminology), and that can identify relationships among entities and terminologies to compare and combine data from different sources (as a reference terminology). ICNP® reflects major reformulations of previous versions aimed at making the classification system technologically more robust while, at the same time, being accessible to the nurse user.

ICNP® Version 1.0 moved beyond a simple multi-axial structure by employing ontological modeling using a description logic approach. Understanding the need for an advanced terminology system for international nursing, Version 1.0 was developed using Web Ontology Language (OWL) within the ontology development environment, Protégé [7]. ICNP® is intended to provide an international standard for nursing and support interoperability across healthcare information systems.

ICNP® is intended to represent the clinical nursing domain, specially nursing diagnoses, interventions, and outcomes. The ICN members (129 countries and affiliate nursing specialty associations) and the ICNP® Programme mechanisms provide an infrastructure for global nursing participation in the ongoing vision of ICNP®. This vision is to serve as an integral part of the global information infrastructure informing health care practice and policy to improve patient care worldwide.

SNOMED® Clinical Terms (SNOMED® CT) is a clinical terminology that seeks to provide clinical content for clinical documentation and reporting; it can be used to code, retrieve, and analyze clinical data. SNOMED® CT is the result of a merger of SNOMED® Reference Terminology (SNOMED® RT) developed by the College of American Pathologists (CAP) and Clinical Terms Version 3 (CTV3) developed by the National Health Service (NHS) of the United Kingdom. The terminology currently comprises over 350,000 entities, 950,000 terms and 1.4 million semantic relationships. Content is organized into a number of hierarchies such as Clinical finding, Procedure or Observable entity, etc. [8]

SNOMED® CT provides a standard for clinical information whereby software applications can use the entities, hierarchies, and relationships as a common reference for data analysis. In this way SNOMED® CT serves as a foundation upon which health care organizations can develop effective analysis applications to conduct outcomes research, evaluate the quality and cost of care and design effective treatment guidelines.

SNOMED® CT provides a system for integrating many different health related entities from multiple classifications via mappings. Currently, SNOMED® CT provides mappings to six nursing terminology systems that are recognized by the American Nurses Association: Clinical Care Classification (CCC), NANDA, Nursing Interventions Classification (NIC), Nursing Outcomes Classification (NOC), Perioperative Nursing Data Set (PNDS), and the Omaha System.

SNOMED® provides mapping resources that allow a crosswalk from SNOMED® CT codes to corresponding codes in other systems. Based upon the philosophy of 'code once, use many times', the SNOMED® CT mapping resources help to minimize the re-entry of data. For example, if clinical care is recorded in a patient record using SNOMED® CT, mapping tables can be used to identify the related code(s) in another terminology. In addition to providing individual cross-maps, a goal of SNOMED® International is to offer convergence across terminologies. Entities from existing nursing classifications converge through their relationships with equivalent SNOMED® CT entities. For example:

SNOMED CT

Administration of medication 18629005

NIC

Medication Administration 2300

The Omaha System

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Medication Administration 33.II

CCC

Medication Administration H24.0

Method

This study involved: 1) mapping from NANDA to ICNP® and 2) validating and comparing the resulting representations with those of SNOMED® CT, focusing on the parent-child relationships identified in the two sets of mappings. This study sets a precedent by working simultaneously across the three different terminologies.

Prior to the study, mappings had been made and approved from all diagnostic entities (n=172) within NANDA to the equivalent entities (or at least to their next nearest match) within SNOMED® CT. As part of this study, a similar process was carried out for ICNP® i.e. tentative mappings were made from all entities in NANDA to the equivalent entities within ICNP®.

In each case, the result was a hierarchy of representations for NANDA entities. Each representation had a unique hierarchy formed of parent-child relationships (i.e. generic relations) among the NANDA entities.

Using ICNP® as the lead terminology (for arbitrary reasons), parent-child relationships between NANDA entities in the ICNP® hierarchy were compared to those within with SNOMED® CT (note that for practical reasons the SNOMED® CT hierarchy was not systematically examined to reveal parent-child relationships that were not present within the ICNP® hierarchy; hence any analysis might be considered unidirectional with ICNP® acting as a 'yardstick'). All parent-child relationships identified were then subjected to independent review by three members of the study team i.e. reviewers were asked to indicated whether they felt that each relationship was valid or not; a second review sought to achieve consensus in cases of disagreement.

Results

The ICNP® hierarchy of parent-child relationships (n=39) between NANDA entities is presented in Table 1. No parent-child relationships existed according to ICNP® between the remaining NANDA entities (n=133). Parent-child relationships (n=16) that also appear within SNOMED® CT are identified in Table 1 in **bold** typeface. Note that entities marked with a caret (^) also appear elsewhere in the hierarchy i.e. they are classified more than once.

*Table 1: Parent-child relationships between NANDA entities according to ICNP® and SNOMED® CT (in **bold**)*

Anxiety
    Death Anxiety
Disturbed Sensory Perception
    Acute Pain
    Chronic Pain

    Nausea
    Perceived Constipation
Disturbed Thought Processes
    Acute Confusion
    Chronic Confusion
Dysfunctional Grieving
    Anticipatory Grieving
Impaired Physical Mobility
    Impaired Bed Mobility
    Impaired Walking
    Impaired Wheelchair Mobility
Impaired Tissue Integrity
    Impaired Skin Integrity
Impaired Urinary Elimination
    Functional Urinary Incontinence
    Reflex Urinary Incontinence
    Stress Urinary Incontinence
    Total Urinary Incontinence
    Urge Urinary Incontinence
    Urinary Retention
Ineffective Breastfeeding
    Interrupted Breastfeeding
Ineffective Coping
    Compromised Family Coping
        Disabled Family Coping
    Defensive Coping
    Ineffective Community Coping
    Ineffective Denial
Ineffective Therapeutic Regimen Management
    Ineffective Community Therapeutic Regimen Management
    Ineffective Family Therapeutic Regimen Management
Ineffective Thermoregulation
    Hyperthermia
    Hypothermia
Post-Trauma Syndrome
    Rape-Trauma Syndrome
        Rape-Trauma Syndrome: Compound Reaction
        Rape-Trauma Syndrome: Silent Reaction
Readiness for Enhanced Coping
    Readiness for Enhanced Community Coping
    Readiness for Enhanced Family Coping^
Readiness for Enhanced Family Processes
    Readiness for Enhanced Family Coping^
Readiness for Enhanced Nutrition
    Readiness for Enhanced Fluid Balance
Risk for Imbalanced Fluid Volume
    Risk for Deficient Fluid Volume
Risk for Injury
    Risk for Perioperative Positioning Injury
Risk for Self-Directed Violence
    Risk for Self-mutilation
    Risk for Suicide

With respect to the independent review, there were few differences between the three reviewers. In the first review, one reviewer rejected 4 relationships that were common to both ICNP® and SNOMED® CT. However they withdrew these rejections in the second review.

Following both reviews:

- all three reviewers rejected one parent-child relationship from the ICNP® hierarchy: 'Anticipatory grieving' as a child of 'Dysfunctional grieving'

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- one reviewer rejected a further 7 relationships from the ICNP® hierarchy and 5 that were common to both ICNP® and SNOMED® CT

- two reviewers continued to question the difference between two entities appearing within a parent-child relationship within the ICNP® hierarchy: 'Compromised Family Coping' and 'Disabled Family Coping'.

Thus one or more reviewers questioned the validity within the ICNP® hierarchy and, in certain cases, also within the SNOMED® CT hierarchy, of a total of 14 parent-child relationships (i.e. 36%), as presented in Table 2.

*Table 2: Questionable parent-child relationships between NANDA entities according to ICNP® and SNOMED® CT (in **bold**)*

Compromised Family Coping
    Disabled Family Coping
Disturbed Sensory Perception
    Acute Pain
    Chronic Pain
    Nausea
Dysfunctional Grieving
    Anticipatory Grieving
Impaired Urinary Elimination
    Functional Urinary Incontinence
    Reflex Urinary Incontinence
    Stress Urinary Incontinence
    Total Urinary Incontinence
    Urge Urinary Incontinence
Ineffective Breastfeeding
    Interrupted Breastfeeding
Ineffective Coping
    Defensive Coping
    Ineffective Denial
Readiness for Enhanced Nutrition
    Readiness for Enhanced Fluid Balance

All three reviewers reached agreement on 25 parent-child relationships between NANDA entities (i.e. 64%), as presented in Table 3.

Discussion and conclusion

The results of this study have the potential to benefit NANDA, ICNP® and SNOMED® CT.

*Table 3: Agreed parent-child relationships between NANDA entities according to ICNP® and SNOMED® CT (in **bold**)*

Anxiety
    Death Anxiety
Disturbed Sensory Perception
    Perceived Constipation
Disturbed Thought Processes
    Acute Confusion
    Chronic Confusion
Impaired Physical Mobility
    Impaired Bed Mobility
    Impaired Walking
    Impaired Wheelchair Mobility

Impaired Tissue Integrity
    Impaired Skin Integrity
Impaired Urinary Elimination
    Urinary Retention
Ineffective Coping
    Compromised Family Coping
    Ineffective Community Coping
Ineffective Therapeutic Regimen Management
    Ineffective Community Therapeutic Regimen Management
    Ineffective Family Therapeutic Regimen Management
Ineffective Thermoregulation
    Hyperthermia
    Hypothermia
Post-Trauma Syndrome
    Rape-Trauma Syndrome
        Rape-Trauma Syndrome: Compound Reaction
        Rape-Trauma Syndrome: Silent Reaction
Readiness for Enhanced Coping
    Readiness for Enhanced Community Coping
    Readiness for Enhanced Family Coping
Readiness for Enhanced Family Processes
    Readiness for Enhanced Family Coping^
Risk for Imbalanced Fluid Volume
    Risk for Deficient Fluid Volume
Risk for Injury
    Risk for Perioperative Positioning Injury
Risk for Self-Directed Violence
    Risk for Self-mutilation
    Risk for Suicide

For NANDA, this study suggests a possible hierarchical ordering for its constituent entities (where, as indicated previously, no such ordering currently exists). Within the limits of the study, this set of hierarchical orderings was validated by one or both of the reference terminologies and subsequently by the reviewers (see Table 3). This study also identifies a number of issues that require clarification. For example within NANDA 'Impaired' appears to be intended as a disturbance rather than as a functional limitation. Also, it is not clear how the following NANDA entities are inter-related:

1. 'Anticipatory grieving' and 'Dysfunctional grieving'

2. 'Ineffective denial' and 'Ineffective coping'

3. 'Enhanced fluid balance' and 'Enhanced nutrition'

4. 'Acute Pain', 'Chronic Pain', 'Nausea' and 'Disturbed sensory perception'

5. 'Compromised family coping' and 'Disabled family coping'.

A discussion of these issues would a) further clarify the intended meaning of problematic entities and b) facilitate consistency in future mapping activities.

For SNOMED® CT the results of this study suggest that five of the existing parent-child relationships (i.e. 31%) between NANDA entities may need re-examining (as shown in **bold** in Table 2) (Note that to repeat this study using SNOMED® CT as the lead might suggest an even greater number of possible parent-child relationships between NANDA entities and therefore possibly a greater number that might require re-examining). It is possible also that 14 potential parent-child

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relationships between NANDA entities may be absent from the SNOMED® CT hierarchy (as shown in normal typeface in Table 3). There are a number of possible reasons for this. For example, the mapping for 'Perceived Constipation' appears within SNOMED® CT as a child of *constipation* rather than as a child of *disturbance of perception*. In a second example, the mapping from 'Ineffective Coping' appears to apply within SNOMED® CT to individuals only, thus excluding coping for family and community. Similarly with the mapping from 'Readiness for Enhanced Coping' which also appears to apply to individuals only. A closer examination of these issues might enhance the existing mappings from NANDA to SNOMED® CT and contribute to a more coherent hierarchical organization.

For ICNP®, there was consensus among all three reviewers on the inaccuracy of one parent-child relationship between NANDA entities: 'Anticipatory grieving' as a child of 'Dysfunctional grieving' (as shown in Table 2). A further 13 parent child relationships between NANDA entities may also need re-examining (as shown also in Table 2). The reasons for this are similar to those for SNOMED® CT. Such a re-examination might contribute to the validation of the tentative set of mappings from NANDA to ICNP® while enhancing the underlying ontology.

Conclusion

There have been several examples over recent years of international collaboration around nursing terminology. One example has been the Nursing Terminology Summit, an invitational think-tank that has met annually in Nashville since 1999 [9]. A further example was the development of the International Standard, ISO 18104 'Health Informatics: Integration of a reference terminology model for nursing' [10].

This study provides a further important practical demonstration of the willingness of the international nursing and nursing informatics community to:

- address commercial sensitivities and overcome differences in intellectual opinion, and

- work together in order to enhance the increasingly sophisticated informational tools needed to achieve global interoperability.

The result has been the development of a practical approach to the mutual enhancement of diverse terminologies.

Acknowledgments

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