



University of
Salford
MANCHESTER

Embedding nursing interventions into the World Health Organization's International Classification of Health Interventions (ICHI)

Fortune, N, Hardiker, NR and Strudwick, G

<http://dx.doi.org/10.1093/jamia/ocw173>

Title	Embedding nursing interventions into the World Health Organization's International Classification of Health Interventions (ICHI)
Authors	Fortune, N, Hardiker, NR and Strudwick, G
Publication title	Journal of The American Medical Informatics Association
Publisher	Elsevier
Type	Article
USIR URL	This version is available at: http://usir.salford.ac.uk/id/eprint/40873/
Published Date	2017

USIR is a digital collection of the research output of the University of Salford. Where copyright permits, full text material held in the repository is made freely available online and can be read, downloaded and copied for non-commercial private study or research purposes. Please check the manuscript for any further copyright restrictions.

For more information, including our policy and submission procedure, please contact the Repository Team at: library-research@salford.ac.uk.

Embedding Nursing Interventions into the World Health Organization's International Classification of Health Interventions (ICHI)

Corresponding author

Nicola Fortune
National Centre for Classification in Health, Faculty of Health Sciences
The University of Sydney
PO Box 170, Lidcombe NSW 1825
AUSTRALIA
E-mail: nicola.fortune@sydney.edu.au
Tel: 0401 643 483

Nicholas Hardiker
School of Nursing, Midwifery, Social Work & Social Sciences
University of Salford
Salford, United Kingdom

Gillian Strudwick
Lawrence S. Bloomberg Faculty of Nursing
University of Toronto
Toronto, Canada

Keywords: Classification, Nursing Informatics, Data Aggregation, Terminology, World Health Organization

Word count, excluding title page, abstract, references, figures and tables: 3910

ABSTRACT

Objective: The International Classification of Health Interventions (ICHI) is currently being developed. ICHI seeks to span all sectors of the health system. Our objective was to test the draft classification's coverage of interventions commonly delivered by nurses, and propose changes to improve the utility and reliability of the classification for aggregating and analyzing data on nursing interventions.

Materials and methods: A two-phase content mapping method was used: (1) three coders independently applied the classification to a data set comprising 100 high-frequency nursing interventions; (2) the coders reached consensus for each intervention and identified reasons for initial discrepancies.

Results: A consensus code was found for 80 of the 100 source terms: for 34% of these the code was semantically equivalent to the source term, and for 64% it was broader. Issues that contributed to discrepancies in Phase 1 coding results included concepts in source terms not captured by the classification, ambiguities in source terms, and uncertainty of semantic matching between 'action' concepts in source terms and classification codes.

Discussion: While the classification generally provides good coverage of nursing interventions, there remain a number of content gaps and granularity issues. Further development of definitions and coding guidance is needed to ensure consistency of application.

Conclusion: This study has produced a set of proposals concerning changes needed to improve the classification. The novel method described here will inform future health terminology and classification content coverage studies.

BACKGROUND AND SIGNIFICANCE

Health terminologies and classifications are fundamental to the infrastructure of health information systems.[1-3] International standard classifications provide a foundation for collecting, aggregating, analyzing, and comparing health-related statistical data. Terminologies are essential for health information capture, storage, retrieval, translation, and communication. Classifications and terminologies play complementary roles in supporting the full spectrum of information needs in health care provision, quality improvement, financing, planning, policy, and research; consistency among different schemes is crucial in order for these tools to efficiently support the functioning of the health systems they are intended to serve.

A new international health classification is currently under development. The World Health Organization's International Classification of Health Interventions (ICHI) seeks to span interventions across all sectors of the health system, including acute care, primary care, rehabilitation, assistance with functioning, and public health.[4] Once finalized, the classification will join the long-established International Classification of Diseases (ICD) and the International Classification of Functioning, Disability and Health (ICF) as a Reference Classification within the World Health Organization's Family of International Classifications.

Nurses represent the largest health workforce group globally.[5] They play an essential role in the delivery of health services, and account for a significant proportion of health system expenditure. It is crucial, therefore, that nursing interventions are comprehensively covered in ICHI. The inclusion of nursing interventions within a broader international statistical classification has the potential to promote the visibility of nursing activity in health information

systems. Conversely, failure to adequately capture nursing interventions could pose a risk to the relevance of that classification as an international standard.

Here we describe a study conducted to test the coverage of nursing interventions in ICHI, and to identify issues that should be addressed to improve the utility and reliability of the classification for aggregating and analyzing data on nursing interventions. The novel method employed will inform future health terminology and classification content coverage studies.

International Classification of Health Interventions

The International Organization for Standardization defines a classification as an ‘exhaustive set of mutually exclusive categories to aggregate data at a pre-prescribed level of specialization for a specific purpose’.[6] It is a characteristic of statistical classifications that detailed concepts are grouped into categories to facilitate statistical study, and the coding system reflects this (often hierarchical) grouping structure.[7, 8] In this way classifications differ from terminologies, in which terms represent individual concept entities.[9] Uses of statistical classifications include data capture (e.g., in surveys or administrative data systems), relating pre-existing information from disparate sources, meaningful aggregation of data for analysis, and presentation of statistical information.[10]

The Alpha 2015 version of the International Classification of Health Interventions (ICHI) contains over 5,800 intervention codes. ‘Health intervention’ in ICHI is defined as ‘an act performed for, with or on behalf of a person or a population whose purpose is to improve, assess or modify health, functioning or health conditions’.[4] Interventions are described using three axes, each of which comprises a list of descriptive categories:

- Target — the entity on which the Action is carried out ([633 categories grouped into 114 'Target Groups'](#))
- Action — the deed done by an actor to the Target ([130 categories grouped into 4 'Action Types'](#))
- Means — the processes and methods by which the Action is carried out ([59 categories grouped into 6 'Means Types'](#))

Each intervention has a title and a unique 7-digit code denoting Target, Action and Means ([Box 1](#)). ICHI is neutral as to the profession of the person delivering the intervention, and why and where the intervention is delivered. The classification is divided into three broad sections, based on Target: Interventions on body systems and functions ([4,423 codes](#)), Interventions on activities and participation domains ([848 codes](#)), and Interventions to improve the environment and health-related behaviour ([598 codes](#)). The tri-axial structure of the classification provides flexibility for aggregating and analyzing data. As a Reference Classification within the WHO Family of International Classifications, ICHI must be capable of meeting the needs of different and varied users, and must provide a stable basis for the compilation of internationally consistent data to enable comparison within and between different countries and health care settings, and over time.[11]

Box 1: Examples of intervention codes in ICHI

ITA AI AF *Blood pressure monitoring*

- Target: Blood pressure function (ITA)
- Action: Monitoring (AI)
- Means: Percutaneous transluminal/Transparietal intraluminal access (AF)

PZA DA AJ *Intracavity administration of nutritional substance*

- Target: Whole body (PZA)
- Action: Alimentation (DA)
- Means: Combined approach, percutaneous and endoscopic per orifice (AJ)

International Classification for Nursing Practice

The International Classification for Nursing Practice (ICNP) has been developed by the International Council of Nurses as an agreed terminology for international nursing practice to enable nursing data generation and comparison.[12] ICNP ‘provides a dictionary of terms and expressive relationships that nurses can use to describe and report their practice in a systematic way’,[12] with the resulting information used to support care and decision-making, and to inform nursing education, research, and health policy. The main elements of ICNP include nursing interventions, nursing diagnoses and nursing-sensitive patient outcome statements. ICNP is used in numerous clinical settings around the world, including across entire healthcare administrative regions, such as the Matosinhos region in northern Portugal, where the data set used in this study originated.

The ICNP is a ‘related classification’ within the WHO Family of International Classifications. The International Council of Nurses has been working in partnership with the ICHI Development Project team, using ICNP content as a basis for enhancing coverage of nursing interventions in ICHI.

Evaluating Classification Content Coverage

'Mapping', or linking content between health terminologies and classification schemes, is a technique widely used for various clinical, administrative and epidemiological purposes. These include migrating information from one system to another without loss of meaning, enabling data collected for one purpose to be reused for another purpose, and conducting longitudinal analysis of data.[8, 13-16] Mapping is also used as a method for testing the validity of a terminology or classification scheme, and to identify gaps in coverage.[17-23]

Typically, terms in a 'source' scheme are used to evaluate the content of the 'target' scheme under study. The absence of a term or category in the target scheme that is a match for a source term indicates a coverage gap in the target. The type of semantic relationship between concepts matched across source and target schemes is usually recorded. For instance, Hardiker and colleagues classify matches as exact, broader or narrower (describing the target term in relation to the source term).[24] Other studies have designated semantic relationships as equivalent, more general, less general, mismatch, or overlapping,[22] broader, narrower, or imprecise,[25] and complete or partial.[23, 26] The quality of mappings may be evaluated in terms of their clinical relevance or usefulness, having regard to information lost when a specific source term is matched to a broader target term—this can affect whether information expressed in terms of the target scheme will be fit for particular use cases.[26] The ISO technical report 'Health informatics—Principles of mapping between terminological systems', states that 'any loss or gain of meaning must be made explicit'.[19]

Content coverage studies often use a source scheme without considering how its content relates to on-the-ground information needs, for instance, the frequency of use of terms

in clinical practice. In this study, we avoid this pitfall by using a set of data reflecting the top 100 nursing interventions actually delivered, and recorded, in hospitals and health centres in a particular region over a 12 month period; thus the source terms are high frequency, or commonly delivered nursing interventions. The data set is based on the ICNP, and so the content mapped is framed within the context of an established international terminology.

METHODS

Coverage of nursing interventions in the Alpha 2015 draft of ICHI was evaluated using a content mapping approach, with semantic matching of source and target terms. This study took the 100 nursing interventions (translated into English) most commonly delivered in hospitals and health centres in the Matosinhos region of Portugal (as recorded between 1 September 2012 and 31 August 2013) as the source terminology. The data set is based on clinical data routinely captured using a national adaptation of the ICNP. The use of the anonymous, aggregate data for this study was authorized by Unidade Local de Saúde de Matosinhos. No ethical approval was required.

A two-phase mapping activity was undertaken by three coders (NF, NH and GS), who used ICHI Alpha 2015 to code the source terminology. All coders were familiar with the purpose and structure of both ICHI and ICNP; NF and NH have particular expertise in the application of ICHI and ICNP, respectively.

Phase 1. Independent Coding

Following an agreed protocol, the three coders independently assigned ICHI codes to intervention terms in the source terminology. If a matching ICHI intervention code was not

found, appropriate ICHI Target, Action and Means categories were recorded, where available. Issues arising during the coding process were noted (e.g., concepts in the source term not captured by the ICHI code).

Phase 2. Discussion and Consensus

The coders discussed Phase 1 results and, where possible, assigned a consensus ICHI code for each source term. Reasons for discrepancies in codes assigned during Phase 1 were recorded (e.g., differing interpretation of source term meaning). The semantic relationship of the consensus ICHI code to the source term ('equivalent to', 'broader than', or 'narrower than') was recorded separately for the three ICHI axes.

Data Analysis

Based on Phase 1 (independent coding), percentages of two-way and three-way inter-coder agreement were calculated. Quantitative analyses of data from Phase 2 (discussion and consensus) included calculating the percentage of source terms for which a consensus ICHI code was found and, of these, the percentage for which the ICHI code was equivalent, broader or narrower on each of Target, Action and Means.

Descriptive analyses of the ICHI-coded source terms were conducted to explore the utility of the classification axes for summarizing the data set.

Based on notes recorded during Phases 1 and 2, qualitative analyses were conducted to examine reasons for discrepancies in codes assigned during Phase 1, and other issues arising during the coding process. Results were used to develop proposals for changes to the draft classification aimed at improving its coverage of nursing-relevant content.

RESULTS

Inter-coder Agreement

During Phase 1 (independent coding) the same ICHI code was assigned by all three coders for 14% of source terms, and by two out of three coders for 38% of source terms. Two out of three coders found no ICHI code for 11% of source terms, and for 2% all three coders found no ICHI code. For the remaining 35% there was no commonality of result among the three coders. Some examples are given in Table 1.

Table 1: Examples of Phase 1 coding results

Source term (ranking in top 100)	Coding result
Assessing pain (3rd)	All three coders chose ICHI code AVA AA ZZ 'Assessment of pain'
Motivating patient for self-feeding (19th)	Two coders chose ICHI code SMF RC FA 'Emotional support for eating' One coder chose ICHI code SMF PH ZZ 'Training in eating'
Positioning patient (9th)	Three coders each chose a different ICHI code: SIB RA FA 'Performing the task of changing and maintaining body position' SIC RA FA 'Performing the task of changing body position' PZA LD AH 'Positioning of the body'
Planning visit (41st)	All three coders found no appropriate ICHI code

Consensus Coding

The purpose of Phase 2 (discussion and consensus) was to discuss Phase 1 results and explore reasons for discrepancies between the three coders, assign a consensus ICHI code for each source term, and record the semantic relationship of the consensus code to the source term as 'equivalent to', 'broader than', or 'narrower than' on each ICHI axis. Discussion among the coders resulted in a consensus ICHI code. A consensus code was found for 80 of the 100 source terms. For the remaining 20 a code was not assigned: in 9 cases the source term was unclear; in 11 cases no appropriate code was available.

Considering the semantic relationship of ICHI codes to source terms, 34% were judged to be equivalent on both Target and Action axes, 64% were broader on the Target axis (including 12% also broader on the Action axis), and 2% were narrower on the Target axis. Table 2 presents examples of these different types of semantic relationship.

Table 2: Examples of equivalent, broader Target, broader Action, and narrower Target matches

Source term	ICHI code title	Relationship
Monitoring blood pressure	Blood pressure monitoring	Equivalent
Assisting the patient to self toileting	Practical support with toileting	Equivalent
Monitoring heart rate	Cardiac monitoring	Broader–Target
Assisting the patient to oral hygiene care	Practical support with caring for body parts	Broader–Target
Monitoring height	Body measurement of whole body	Broader–Target & Action
Motivating patient for self turning	Emotional support for changing body position	Broader–Target & Action
Assisting the patient to self hygiene	Practical support with washing	Narrower–Target

Specifying the semantic relationship between codes and source terms on the Means axis proved difficult because most of the source terms did not articulate a ‘means’ (e.g., the source term ‘Oral hygiene care’ does not indicate how the care is provided). For the 80 source terms coded, 8 had a Means category indicating a specific approach (‘Per Orifice/Transorifice’ (3 source terms), ‘Percutaneous transluminal/Transparietal intraluminal access’ (1), ‘External’ (3), ‘Combined approach, percutaneous and endoscopic per orifice’ (1)) and the remaining 72 had a very broad or residual Means category (‘Facilitator – human’ (29), ‘Unspecified approach’ (7), or ‘Intervention using other method, without approach or not otherwise specified’ (36)).

Fifty-seven different ICHI codes were assigned to the 80 coded source terms. Of these, 47 were matched to a single source term, and seven were matched to either two or three source terms. There were three ICHI codes that were each matched to six different source terms (Table 3).

Table 3: Examples of a single ICHI code matched to multiple source terms

Source terms	Matched ICHI code
Surveying signs of pressure ulcer Surveying surgical wound Surveying pressure ulcer Surveying traumatic wound Assessing wound Surveying venous ulcer	LZZ AA ZZ 'Assessment of skin and subcutaneous cell tissue, not elsewhere classified'
Pressure ulcer care Maceration care Surgical wound care Traumatic wound care Wound care Venous ulcer care	LZZ SY ZZ 'Therapeutic intervention of skin and subcutaneous cell tissue, not elsewhere classified'
Motivating for adherence to therapeutic regime Motivating for adherence to immunization regime Motivating health seeking behaviour Motivating for adherence to medication regime Motivating for health service use Motivating for breast self surveillance	SMH RC FA 'Emotional support for looking after one's health'

Analysis of the Coded Data

The three classification axes can be used to group, analyse, and make summary statements about the coded data. Among the 80 coded source terms, the most common ICHI Target was 'Skin and subcutaneous cell tissue, not otherwise specified' (18% of coded source terms), followed by 'Whole body' (8%), and 'Looking after one's health' (8%) (Figure 1). Altogether,

there were 37 different ICHI Target categories in the coded data, 22 of which were uniquely associated with a single source term.

(Insert Figure 1 here)

Figure 1: Most frequently occurring Target categories among source terms for which an ICHI code was found

The coded data were also analyzed by Action and Means. There were 19 different ICHI Action categories, 8 of which were associated with a single source term. The most common Action categories were 'Emotional support' (19% of coded source terms), 'Assessment' (15%), 'Monitoring' (13%), and 'Practical support' (13%). For 45% of coded source terms the Means was 'Intervention using other method, without approach or not otherwise specified', and for 36% Means was 'Facilitator – human'.

Reasons for Coding Discrepancies

Issues identified as contributing to coding discrepancies in Phase 1 results were of five broad types:

- 1) *Concepts in source terms not adequately captured by ICHI.* For example, the concept of risk, as in the source terms 'Assessing risk for falls' and 'Assessing risk for pressure ulcer', is not captured by ICHI axis categories. There is an ICHI Action 'Assessment', but no Target that relates to 'Risk'.
- 2) *Ambiguities in source terms.* Some terms could not be coded because it was unclear what the intervention actually entailed, for example 'Environmental safety management' and 'Supervising adherence to immunization regime'. Definitions were not available in the source terminology.

3) *Difficulty choosing between similar ICHI code titles.* For example, for the source term 'Positioning patient' a different ICHI code was chosen by each of the coders: 'Performing the task of changing and maintaining body position', 'Performing the task of changing body position', and 'Positioning of the body'. The first two of these are hierarchically related, as the Target 'Changing body position' is a child category of 'Changing and maintaining body position', but this relationship is not clear from the code structure.

4) *Difficulty determining type of Target.* It was sometimes difficult to decide whether the target of a source term should be regarded as an 'activity' or a 'health-related behaviour'. For example, for 'Motivating for healthy eating pattern' either of the ICHI Targets 'Eating' (activity) or 'Diet' (behaviour) could apply. Similarly, for 'Assisting the patient to oral hygiene care' either 'Caring for body parts' (activity) or 'Oral health behaviours' (behaviour) could apply.

5) *Uncertainty of semantic matching between 'action' concepts in source terms and ICHI.* For example, the 14 source terms with the word 'surveying' in their title (e.g., 'Surveying surgical wound', 'Surveying urine') were variously matched to ICHI codes with the Action categories 'Assessment', 'Monitoring', 'Identification', 'Other therapeutic action', and 'Other managing action'. Other concepts were more consistently interpreted, for instance 'assisting' was usually interpreted to have equivalent meaning to the ICHI Action 'Practical support'.

DISCUSSION

The two-phase coding process applied here was well-suited to the primary objectives of this study: to test the coverage of nursing interventions in the draft International Classification of

Health Interventions and to identify coding-related issues that indicate changes needed to improve the utility and reliability of ICHI.

The relatively low level of inter-coder agreement (Phase 1) may in part reflect the stage of the classification's development, as well as the coders' different levels of familiarity with it. It can be expected that coding reliability will improve once coding guidelines are available and definitions for intervention codes and axis categories are more developed; [7, 15, 23] further reliability testing will then be required. More importantly for this study, the independent coding followed by discussion among the three coders produced valuable insights into reasons for coding discrepancies that will inform both further refinement of the content and structure of the classification, and development of coding rules and training materials.

Use of a source terminology comprising high frequency nursing interventions and based on an international nursing terminology, ICNP, is a particular strength of this study. For a statistical classification it is essential that commonly delivered interventions can be captured, represented, and grouped in a way that meets the information needs of potential users.

Classification Coverage and Representation of Nursing Interventions

The overall result of the consensus coding (Phase 2) shows that ICHI provides good coverage of commonly delivered nursing interventions—there were only 11 source terms (11%) for which an appropriate code was missing from the classification, indicating a relatively small coverage gap.

Although there was a high proportion of 'broader' matches (on the Target axis or both Target and Action axes), there were only three ICHI codes into which several source terms were 'bundled', with 48 ICHI codes uniquely matched to a single source term. This indicates that, on

the whole, ICHI was able to capture differences between interventions as represented in the source terminology.

It is characteristic of statistical classifications that detailed concepts are grouped together into categories.[7] In this study there were seven ICHI codes that grouped together two or three source terms, and three codes that each grouped six source terms. However, the grouping of entities in a new and developing classification such as ICHI should be carefully considered and tested against empirical data (e.g., data relating to other important variables, such as cost). It is also essential to draw on the expert knowledge of relevant stakeholders (e.g., clinicians, researchers, health care administrators, and policy makers) to ensure the classification is able to capture important distinctions and resulting data can support key information needs, for example in quality monitoring or health care funding.[10, 26, 27]

In light of this, the ~~three~~ ICHI codes into which several source terms were bundled (Table 3)—‘Assessment of skin and subcutaneous cell tissue, not elsewhere classified’, ‘Emotional support for looking after one’s health’, and ‘Therapeutic intervention of skin and subcutaneous cell tissue, not elsewhere classified’—indicate particular areas of the classification that deserve further examination, ~~to determine whether the level of detail is sufficient to meet user needs.~~ Two of these codes—‘Assessment of skin and subcutaneous cell tissue, not elsewhere classified’ and ‘Therapeutic intervention of skin and subcutaneous cell tissue’—were used for source terms describing a range of wound-related interventions; this may be a content area in need of expansion to ensure that the level of detail is sufficient to meet user needs. Future studies employing statistical approaches will be required to evaluate whether the classification provides adequate discrimination between categories.

Use of the Classification to Group and Summarise Nursing Intervention Data

Descriptive analyses of the coded data have demonstrated use of ICHI's tri-axial structure to summarise ~~nursing interventions~~ data on interventions delivered by nurses in terms of the types of actions performed and the types of targets towards which these actions are directed.

The analyses show clearly which targets and actions were most common across the 100 interventions. Summarising data in this way may reveal patterns in nursing activity and provide a basis for making comparisons between different healthcare settings or over time. Use of ICHI to code interventions data within a broader health information system would make it possible to explore relationships between intervention target, action and means and other variables, such as clinical specialty or characteristics of the patient population.

The fact that 37 different Targets and 19 different Actions were represented across the 80 coded source terms suggests that these two axes provide a useful basis for discriminating between different types of interventions. The Means axis appears less useful in this regard, with most of the ICHI codes assigned having a non-specific or very general Means. There may be potential to further develop the Means axis of ICHI by adding new categories to reflect important distinctions between interventions in terms of how they are delivered.

Use of Results to Improve ICHI

Together, the coverage gaps identified and the coding issues that emerged from the qualitative analysis have provided a basis for developing a set of proposals concerning changes needed to improve ICHI's utility and reliability.

The proposed changes include addition of new axis categories and intervention codes, modifications to the titles and definitions of axis categories and intervention codes, and

addition or modification of inclusion/exclusion terms. The intent of these changes is to fill content gaps, remove ambiguities, and make it easier for users to identify the appropriate code. A recommendation to thoroughly review the representation of wound-related interventions has been made, as fifteen of the 100 source terms were wound-related, and these were not well catered for by ICHI.

In addition to specific proposals, several issues have been identified for further consideration, including representation of concepts that are not adequately captured in ICHI, such as 'risk', and clarification of the distinction between 'activity' and 'behaviour' Target types to remove confusion and ensure consistent application of codes.

Limitations

This study used the Alpha 2015 draft of ICHI. Because of the relatively early stage of its development, comprehensive coding guidelines are not yet available and definitions for intervention codes and axis categories are still under development. More formal evaluation of coding reliability will be needed in future, once coding guidance and other infrastructure to support consistent use of the classification (such as an index and training materials) have been developed.[8]

Because of the source data used in this study, the scope of our content analysis was restricted to the 100 nursing interventions most commonly delivered in hospitals and health centres in a particular geographic region. ~~As ICHI is intended for international use much~~ Broader testing will be needed before the classification is finalised, to ensure coverage of the full range of nursing interventions and to test its applicability of the classification in a wide variety of health care contexts in different countries, including in low resource settings.[11]

Use of a source data set based on an existing terminology may be seen as both a strength and a limitation of this study. It is likely that ICHI will most often be applied to data captured using a terminology, rather than for direct data capture in clinical contexts, so use of this type of data to test ICHI's content coverage seems appropriate. However, using data expressed through an existing terminology does limit evaluation of content coverage to that allowed by the source terminology; some distinctions between different interventions will already have been obscured or lost because they are not captured by the terminology. Thus, evaluation of ICHI's content coverage using more detailed information sources, such as patient records, would be a valuable complement to this study.

Commented [NF1]: Could delete this first bit if you think this is all a bit long-winded.

CONCLUSIONS

The International Classification of Health Interventions promises to be of value in supporting integrated approaches to collecting, reporting and comparing statistical information on activity across different components of health systems. ICHI will function as a common framework within which to conduct analyses and relate information from disparate sources. It is essential to take the opportunity at this stage of its development to ensure that the classification provides comprehensive coverage of nursing interventions, at a level of detail sufficient to meet stakeholder information needs.

This study represents an important contribution to the development of the classification. The results indicate that the ~~current~~ ICHI Alpha 2015 version has good coverage of nursing interventions, but there remain a number of specific content gaps and granularity issues to be addressed. The findings also point to the need for further development of

definitions and coding guidance to ensure consistency of application. Use of the axes underpinning the classification to analyze the coded data has demonstrated the utility of the unique tri-axial structure of ICHI for grouping, summarising and comparing data on health interventions.

The two-phase coding procedure proved an effective means of evaluating classification coverage and identifying gaps, while also exploring reasons for coding discrepancies that shed light on broader conceptual and definitional issues. Use of a set of data reflecting commonly performed nursing interventions, represented using a pre-existing international standardised terminology, strengthens the significance of these findings by focusing the analysis on high frequency interventions that account for significant healthcare time and cost resources. The study offers an important methodological contribution by demonstrating a novel approach to health classification content analysis and development.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Paulino de Sousa and Unidade Local de Saúde de Matosinhos for making the data available for this study.

COMPETING INTERESTS

None

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

AUTHOR CONTRIBUTIONS

Each of the authors certifies that they have contributed substantially to the drafting and revision of the paper.

REFERENCES

- 1 Chute CG, Cohn SP, Campbell JR. A framework for comprehensive health terminology systems in the United States. *J Am Med Inform Assoc* 1998;5(6):503-510.
- 2 Coiera E. *Guide to Health Informatics* 3rd ed. Boca Raton, Fla: CRC Press/Taylor & Francis Group 2015.
- 3 Giannangelo K, ed. *Healthcare code sets, clinical terminologies, and classification systems* 3rd ed. American Health Information Management Association 2015.
- 4 WHO ICHI Development Project. *International Classification of Health Interventions. ICHI Alpha 2015*. Geneva: WHO 2015. <http://sydney.edu.au/health-sciences/ncch/resources.shtml>. Accessed September 10, 2016.
- 5 World Health Organization. *World health statistics*. Geneva: WHO 2015.
- 6 International Organization for Standardization. *ISO 17115:2007(en) Health informatics—Vocabulary for terminological systems*. International Organization for Standardization 2007.
- 7 World Health Organization. *International statistical classification of diseases and related health problems. 10th revision. Volume 2: Instruction manual* 5th ed. Geneva: WHO 2016.
- 8 Bramley M. A framework for evaluating health classifications. *HIM J* 2006;34(3):71-83.
- 9 Brown PJB. The difference between clinical terminologies and statistical classifications – semantic versus extensional definitions. In: Overhage JM, ed. *Proceedings of the 2000 AMIA Fall Symposium*. Philadelphia: Hanley & Belfus; 2000: 975.
- 10 Hoffmann E, Chamie M. Standard statistical classifications: basic principles. *Stat J UN Econ Comm Eur* 2002;19(4):223-241.

- 11 Madden R, Sykes C, Ustun B. *World Health Organization Family of International Classifications: definition, scope and purpose*. Geneva: WHO 2007.
- 12 International Council of Nurses. *International Classification for Nursing Practice* <http://www.icn.ch/what-we-do/international-classification-for-nursing-practice-icnpr/>. Accessed September 10, 2016.
- 13 Barrows Jr. RC, Cimino JJ, Clayton PD. Mapping clinically useful terminology to a controlled medical vocabulary. In: *Proceedings of the Annual Symposium on Computer Application in Medical Care*. American Medical Informatics Association 1994:211-215.
- 14 Giannangelo K, Fenton S. Mapping: creating the terminology and classification connection. Poster P2-2. In: *WHO – Family of International Classifications Network Meeting*. Tokyo, Japan: WHO 2005.
- 15 Imel M, Giannangelo K, Levy B. Essentials for mapping from a clinical terminology. In: *IFHRO Congress & AHIMA Convention Proceedings*. The American Health Information Management Association 2004.
- 16 Sun JY, Sun Y. A system for automated lexical mapping. *J Am Med Inform Assoc* 2006;13(3):334-343.
- 17 Hardiker NR, Rector AL. Structural validation of nursing terminologies. *J Am Med Inform Assoc* 2001;8(3):212-221.
- 18 Harris MR, Langford LH, Miller H, *et al*. Harmonizing and extending standards from a domain-specific and bottom-up approach: an example from development through use in clinical applications. *J Am Med Inform Assoc* 2015;22:545-552.

- 19 International Organization for Standardization. *ISO/TR 12300 Health informatics — Principles of mapping between terminological systems*. International Organization for Standardization 2014.
- 20 Ivory CH. Mapping perinatal nursing process measurement concepts to standardized terminologies. *Comput Inform Nurs* 2016;34(7):313-321.
- 21 Juve Udina M-E, Gonzalez Samartino M, Matud Calvo C. Mapping the diagnosis axis of an interface terminology to the NANDA international taxonomy. *ISRN Nurs* 2012;2012:676905.
- 22 Park HA, Lundberg C, Coenen A, *et al*. Mapping ICNP Version 1 concepts to SNOMED CT. *Stud Health Technol Inform* 2010;160(Pt 2):1109-1113.
- 23 Hyun S, Park HA. Cross-mapping the ICNP with NANDA, HHCC, Omaha System and NIC for unified nursing language system development. *Int Nurs Rev* 2002;49(2):99-110.
- 24 Hardiker NR, Sermeus W, Jansen K. Challenges associated with the secondary use of nursing data. *Stud Health Technol Inform* 2014;201:290-297.
- 25 Vikstrom A, Skaner Y, Strender L-E, *et al*. Mapping the categories of the Swedish primary health care version of ICD-10 to SNOMED CT concepts: rule development and intercoder reliability in a mapping trial. *BMC Med Inform Decis Mak* 2007;7(1):9.
- 26 Dhombres F, Bodenreider O. Interoperability between phenotypes in research and healthcare terminologies—Investigating partial mappings between HPO and SNOMED CT. *J Biomed Semantics* 2016;7:3.
- 27 Salvador-Carulla L, Dimitrov H, Weber G, *et al*. *DESDE-LTC: Evaluation and classification of services for long term care in Europe*. Spain: Psicost and Catalunya Caixa 2011.