Original Article

Alignment of ICNP® 2.0 Ontology and a proposed INCP® Brazilian Ontology[1]

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Objective: to align the International Classification for Nursing Practice (ICNP®) Version 2.0 ontology and a proposed INCP® Brazilian Ontology. Method: document-based, exploratory and descriptive study, the empirical basis of which was provided by the ICNP® 2.0 Ontology and the INCP® Brazilian Ontology. The ontology alignment was performed using a computer tool with algorithms to identify correspondences between concepts, which were organized and analyzed according to their presence or absence, their names, and their sibling, parent, and child classes. Results: there were 2,682 concepts present in the ICNP® 2.0 Ontology that were missing in the Brazilian Ontology; 717 concepts present in the Brazilian Ontology were missing in the ICNP® 2.0 Ontology; and there were 215 pairs of matching concepts. Conclusion: it is believed that the correspondences identified in this study might contribute to the interoperability between the representations of nursing practice elements in ICNP®, thus allowing the standardization of nursing records based on this classification system.

Descriptors: Nursing; Vocabulary, Controlled; Artificial Intelligence.

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Introduction

The International Classification for Nursing Practice (ICNP®) consists of a formal terminology formulated by the International Council of Nurses (ICN) and has been included in the World Health Organization Family of International Classifications[1]. The structure of the terms and definitions of ICNP® seeks to provide a formal nursing terminology for the construction of nursing diagnoses, interventions, and results, thus contributing to the systematic documentation of health care[2]. Eight versions of ICNP® were developed from 1996 to 2013; the latest one is known as Version 2013*.

In 2005, to facilitate the management of the ICNP® concepts, the ICN began formulating the terminology versions using an ontology[3]. In computer and information science, an ontology is a formal representation of knowledge[4] based on a formal specification of the worldview accepted by a given community[5]. "Formal" means that the ontology should be machine readable[6].

To contribute to the advancement of ICNP® and concomitantly represent the dimension, diversity, and broadness of nursing practices within the Brazilian Unified Health System, from 1996 to 2000, the Brazilian Nursing Association (*Associação Brasileira de Enfermagem* – ABEn) conducted and elaborated the International Classification of Nursing Practices in Collective Health (*Classificação Internacional das Práticas de Enfermagem em Saúde Coletiva* – CIPESC) project, which resulted in the CIPESC® vocabulary inventory based on the ICNP® *Beta* version, released in 1999[7].

To contribute to the adaptation of the abovementioned inventory to computer-based resources for knowledge representation, in 2007, researchers from the discussion group "Classification Systems for Nursing Practices and Ontologies" ("*Sistemas Classificatórios para as Práticas de Enfermagem e Ontologias*") of the Graduate Program in Health Technology (*Programa de Pós-Graduação em Tecnologia em Saúde* – PPGTS), Pontifical Catholic University of Paraná (*Pontifícia Universidade Católica do Paraná* – PUCPR), began constructing an ontology in Web Ontology Language (OWL)[8]. Initially designated the CIPESC® Ontology, it was based on attempts to adjust the CIPESC® inventory to the various versions of ICNP®[9]**. At the end of the study that resulted in the proposal of the partial development of the Ontology, the group in charge of it

concluded that it described a context different from the context of the ABEn inventory, as it did not correspond to Nursing actions in Collective Health and included results of studies conducted at ICNP® Center – Brazil, Federal University of Paraíba (*Universidade Federal da Paraíba* – UFPB). Therefore, although it was initially based on the inventory, the product was named the INCP® Brazilian Ontology.

ICN took notice of the present study and made ICNP® 2.0 in OWL available to the discussion group in 2011, which was renamed "ICNP® 2.0 Ontology" within the context of this study. In that version, the concepts are hierarchically organized into superclasses, classes, and subclasses.

As a function of the urgent need to establish a unified nursing language for the standardization of records, interoperability between the various representations of nursing practice elements is essential. Interoperability here denotes communication ability, i.e., the exchange of information on entities (concepts and their relations) between different terminologies[10]. Interoperability requires identifying correspondences between the entities in the targeted terminologies[11].

As a function of the various representations of nursing practice elements in the different ICNP® versions and in the proposal for the representation of nursing terms elaborated in Brazil by means of an ontology, the identification of correspondences among all those representations is of paramount importance to enable information sharing and thus to contribute to the unification of the nursing language.

Ontology alignment is one of the techniques that allow the identification of equivalences between concepts and is the process of determining correspondences between entities in different ontologies by means of computer algorithms[12].

Given the above, the aim of this study was to align the ICNP® 2.0 Ontology with the proposed INCP® Brazilian Ontology.

Methods

This work was a document-based, exploratory, and descriptive study, the empirical basis of which was represented by the ICNP® 2.0 Ontology in English and the proposed INCP® Brazilian Ontology in the Brazilian Portuguese language. As human beings were not

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* Available at: http://www.icn.ch/pillarsprograms/international-classification-for-nursing-practice-icnpr/
** This study further consulted three studies from unpublished master dissertations, which complement the article cited as reference #9.

directly or indirectly involved as research subjects, the study was not submitted to review by a research ethics committee.

To perform the alignment, the investigated ontologies should be in the same language. Therefore, the INCP® Brazilian Ontology was translated from Brazilian Portuguese into English, as it included a small number of concepts than the ICNP® 2.0 Ontology.

As the two ontologies are meant to share the same conceptualization, albeit represented in different languages[13], only the concepts in INCP® Brazilian ontology that were also present in ICNP® Version 2.0 were considered for translation.

The process of translation of the INCP® Brazilian Ontology comprised the following steps: a) location of the Brazilian Ontology concepts in the ICNP® Version 2.0 browser in the Brazilian Portuguese language; b) identification of the concepts located in the ICNP® Version 2.0 browser in English based on their codes; and c) replacement of concepts in the Brazilian Ontology located in ICNP® Version 2.0 by concepts in English that were identical to the ones in the ICNP® 2.0 Ontology.

The ICNP® 2.0 Ontology and the INCP® Brazilian Ontology were aligned in an automated manner using the computer tool *Protégé**, the algorithms of which identify correspondences between concepts in ontologies according to their names (expressed in natural language), siblings (classes at the same hierarchical level), parents (superclasses), and children (subclasses), in addition to the concepts present in one ontology but absent from the other[14].

Results

During the translation of the concepts in the INCP® Brazilian Ontology into English, a total of 212 pairs of concepts identical to the ICNP® 2.0 Ontology were found, of which 207 were translated and five did not require translation, as the words were the same in Portuguese and English, to wit, "Normal", "Total, "Regime", "Material", and "Spray".

The results of the ontology alignment were as follows: 2,682 concepts present in the ICNP® 2.0 Ontology were missing in the Brazilian Ontology; 717 concepts present in the Brazilian Ontology were missing in the ICNP® 2.0 Ontology; and 215 pairs of matching concepts, of which 212 exhibited matching names, two exhibited matching siblings (Wound Pain /

Wound-related Pain and Potential / Potential for Increase), and one exhibited matching parents and similar names (Non Normal / Abnormal).

Discussion

The greater number of concepts present in the ICNP® 2.0 Ontology but missing in the Brazilian Ontology of INCP® compared to the number of concepts present in the latter and missing in the former is because the ICNP® 2.0 Ontology represents all the terms in ICNP® Version 2.0[2], while the ICNP® Brazilian Ontology corresponds to a proposed ontology that is still under construction[9].

The 212 pairs of concepts that exhibited matching names were the 212 pairs of identical concepts in the ICNP® 2.0 Ontology and the INCP® Brazilian Ontology found during the translation phase.

However, the fact that concepts exhibit identical names does not necessarily imply that their meanings are also the same[14]. Indeed, the analysis of the definitions of the 212 pairs of aligned concepts showed that they differed in 130 cases.

Most of the definitions of concepts in the proposed INCP® Brazilian Ontology are compatible with the corresponding definitions in ICNP® Version 1.0[9]. Therefore, the large number of concepts with different definitions between the two studied ontologies might be accounted for by the inclusion of novel definitions in ICNP® Version 2.0[2].

In regard to the concepts that exhibited matching siblings, the concept "Wound Pain" in ICNP® 2.0 Ontology is the single subclass of the concept "Cutaneous Pain", while the concept "Wound-related Pain" in INCP® Brazilian Ontology is the single subclass of the concept "Cutaneous Pain". Given that each and every concept in ICNP® 2.0 Ontology is expressed by a preferential term, i.e., the one commonly known by users[2], the concepts "Wound Pain" and "Cutaneous Pain" were found to represent the terms "Wound Pain" and "Cutaneous Pain", respectively, in ICNP® Version 2.0. Therefore, one might infer that the concepts "Wound Pain" in ICNP® 2.0 Ontology and "Wound-related Pain" in INCP® Brazilian Ontology represent the same element, as they correspond to the same hierarchical level, i.e., the single subclass of the concept "Cutaneous Pain".

In regard to the concept "Potential", its preferential expression, i.e., the name commonly known by users[3],

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* Free-access software available at: <http://protege.stanford.edu/download/registered.html>

is the term "Risk" in the ICNP® 2.0 Ontology. However, the concept "Risk" is also included in the ICNP® 2.0 Ontology under the preferential term "Potential for Risk". Thus, to avoid possible confusion between concepts, the concept "Potential" was retained in English in this study because it is considered to be the term known by users.

The analysis of the class structure of the ICNP® 2.0 Ontology showed that the concept "Potential" is a subclass of "Potentiality" and has a sibling named "Actual", whereas the analysis of the class structure of INCP® Brazilian Ontology showed that although the concept "Potential for Increase", which had been identified as corresponding to concept "Potential", is also a subclass of "Potentiality", it has two siblings, namely, "Actual" and "Risk". Therefore, no correspondence was found between the siblings of the concepts "Potential" and "Potential for Increase".

It is worth noting that an algorithm that aligns concepts according to the correspondence between siblings must align all the siblings of the concepts of interest; however, two-thirds of such alignments might provide false positive correspondences[14]. Therefore, one might reasonably consider that the correspondence between the concept "Potential" in the ICNP® 2.0 Ontology and the concept "Potential for Increase" in the INCP® Brazilian Ontology to be such a false-positive instance, as these concepts do not exhibit all matching siblings and thus do not satisfy the results expected from the application of the algorithm.

Therefore, to confirm that there is correspondence between the concepts in the ontologies that represent nursing practice elements, the hierarchical structure to which the concepts belong should be considered independently of the application of computer algorithms.

In regard to the single pair of concepts that exhibit matching parents and similar names, the concept "Non Normal" in the ICNP® 2.0 Ontology is a subclass of "Normality State", which is also the case for the INCP® Brazilian Ontology concept "Abnormal". Therefore, those concepts were aligned because they exhibit matching parents in addition to similar names. It is worth noting that the concept "Non Normal", based on its preferential term, represents the term "Abnormal" in ICNP® Version 2.0 and the concept "Abnormal" in the INCP® Brazilian Ontology.

Conclusion

As the unification of the nursing language is a gradual process requiring countless studies, it is believed that the present study might contribute to the interoperability between the representations of nursing practice elements in ICNP®, thus allowing the standardization of nursing records based on this classification system.

To further contribute to the unification of the nursing language in Brazil, a future study will attempt to include the results of research on the elaboration of the ICNP® terminology subsets conducted at the ICNP® Center of Research and Development, Graduate Nursing Program, Federal University of Paraíba, accredited by ICN, in the INCP® Brazilian Ontology.

Finally, it is worth noting that the identification of correspondences between ontologies that represent nursing practice should not be restricted to the application of computer algorithms but must also consider the definitions of concepts within the specific context of nursing.

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