

Nursing diagnoses and outcomes related to the circulatory-system terms (INCP®) represented in an ontology*

DIAGNÓSTICOS E RESULTADOS DE ENFERMAGEM RELACIONADOS AOS TERMOS DO SISTEMA CIRCULATÓRIO - CIPE® REPRESENTADOS EM UMA ONTOLOGIA

DIAGNÓSTICOS Y RESULTADOS DE ENFERMERÍA RELACIONADOS A LOS TÉRMINOS DEL SISTEMA CIRCULATORIO - CIPE® REPRESENTADOS EN UNA ONTOLOGIA

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ABSTRACT

The aim of the present study was to develop titles of Nursing Diagnoses and Outcomes (ND/NO) through the relationship between the terms of the Focus axis, limited to the Circulatory System Process, and the terms of other ICNP® axes and to integrate these terms into an ontology. Titles were developed linking 17 terms of the focus axis, which were evaluated by expert nurses in five Brazilian cities. Titles whose use concordance was above 0.80 were included in the ontology. In total, 89 titles for ND/NO were supported in the literature, and 19 were not supported; 37 were assessed as eligible for use in healthcare practice and were included in the ontology. The construction of ND/NO titles based on the ICNP® and using a formal representation of knowledge is a task that requires deepening concepts used for nursing and adequate classification revisions. The elaborated titles will facilitate the composition of diagnostics that are more consistent with practice.

DESCRIPTORS

Nursing diagnosis
Classification
Cardiovascular system
Vocabulary controlled
Nursing process

RESUMO

O objetivo do estudo foi elaborar títulos de Diagnósticos e Resultados de Enfermagem (DE/RE) por meio da relação entre os termos do Processo do Sistema Circulatório do eixo Foco e termos de outros eixos da CIPE® e integrá-los em uma ontologia. Foram construídos títulos relacionando 17 termos do eixo Foco, os quais foram avaliados por enfermeiros especialistas de cinco cidades brasileiras. Incluíram-se na ontologia os títulos cuja concordância de uso foi acima de 0,80. Foram elaborados 89 títulos de DE/RE sustentados pela literatura e 19 não sustentados; 37 foram avaliados como passíveis de utilização na prática assistencial e incluídos na ontologia. A construção de títulos de DE/RE com base na CIPE® e utilizando uma representação formal de conhecimento é um trabalho que exige aprofundamento de conceitos utilizados pela enfermagem e adequação às revisões da classificação. Os títulos elaborados facilitarão a composição de diagnósticos mais coerentes com a prática.

DESCRIPTORIOS

Diagnóstico de enfermagem
Classificação
Sistema cardiovascular
Vocabulário controlado
Processos de enfermagem

RESUMEN

El objetivo del estudio fue elaborar títulos de diagnósticos y resultados de enfermería (DE/RE), utilizando la relación entre los términos del Proceso del sistema circulatorio del eje central, y términos de otras líneas de la CIPE® e integrarlas en una ontología. Fueron construidos títulos haciendo el enlace de 17 términos del eje central, los cuales fueron evaluados por enfermeras especialistas de cinco ciudades brasileñas. Se incluyeron en la ontología los títulos cuya concordancia de uso fue superior a 0,80. Fueron elaborados 89 títulos de DE/RE sostenidos por la literatura y 19 sin apoyo sostenido, 37 fueron evaluados como posibles ítems para su utilización en la práctica asistencial e incluidos en la ontología. La construcción de los títulos de DE/RE sobre la base de la CIPE® y utilizando una representación formal del conocimiento es una tarea que requiere una mayor profundización de los conceptos utilizados por la enfermería y adecuación a las diversas revisiones de la clasificación. Los títulos elaborados facilitarán la composición de diagnósticos más coherentes con la práctica.

DESCRIPTORIOS

Diagnóstico de enfermería
Clasificación
Sistema cardiovascular
Vocabulario controlado
Procesos de enfermería

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INTRODUCTION

O The Nursing Process (NP) is an instrument that allows for organizing thoughts for planning and decision-making, as well as providing resources for the registration and evaluation of the care provided. In Brazil, the Federal Nursing Council presented the NP in five phases through Resolution no. 358/2009: data collection, nursing diagnostics, planning, implementation, and evaluation of care⁽¹⁾.

For nursing care based on NP to be visible in information systems, it is necessary for the knowledge to be represented through a standardized language. The mechanisms of knowledge representation in the field of computer science facilitate the implementation of computable structures; the field of information science enables the elaboration of languages that allow the retrieval and organization of informational content; and in the field of terminology, it is possible to systematize concepts and consistent definitions⁽²⁾.

Currently, several classification systems are compatible with computer systems that describe nursing care, including the International Classification for Nursing Practice (ICNP[®])⁽³⁾. Because this system is a multi-axial classification of terms represented in a seven-axis model (i.e., Focus, Judgment, Means, Time, Location, Client, and Action), it allows for combining the terms belonging to the axes and for composing titles called Nursing Diagnoses (ND), Interventions, and Outcomes.

The ICNP[®] defines ND as a consequence of nurses' actions related to human needs, organized to produce results⁽⁴⁾. Understood as a nominal category, ND is an expression that represents the health situations influenced by nursing actions⁽⁵⁾. In developing the ND, the nurse performs actions and prescribes treatment to obtain an expected Nursing Outcome (NO). When the Nursing Intervention (NI) ends, the NO is obtained, defined by ICNP[®] as a diagnosis changed over time⁽⁴⁾.

The nominal composition of the ND or NO follows a generic guide of association and restriction: it must include a term from the Focus axis and one or more terms from the Judgment axis; the terms from other axes, except for the Action axis, used in the composition of Interventions are used if a greater specificity is required in the declaration⁽⁴⁾.

Due to the many combinations of terms between the ICNP[®] axes, inconsistencies may occur in elaborating the ND or NO⁽⁶⁾. Thus, the use of this classification does not ensure that the nurse correctly names the ND or NO. This problem is recognized by the International Council of Nurses (ICN), which included a knowledge representation feature after ICNP[®] version 1.0—more specifically, ontology.

Ontology is defined as a formal, explicit specification of a shared conceptualization⁽⁷⁾. It is a manifestation of the understanding of a domain (in this case, nursing) that is common and shared between the members of a community that represent this domain (in this case, nurses)⁽⁸⁾. An ontology is used to improve communication between people, between people and machines, and between machines, and it enables interoperability between computer systems through unifying languages. Ontologies can be maintained and reused⁽⁸⁾.

The ICN clarifies that the ICNP[®] ontology can define and combine the relationships between terms, which is a form of support necessary to avoid ambiguities and inconsistencies in the elaboration of ND, NO, and NI⁽⁴⁾. These relationships are constructed based on pre-established rules of association and restriction, and in the case of ICNP[®], they are essential for elaborating ND/NO titles and reuse of the ontology.

Although there is an effort within the ICN to minimize inconsistencies by constructing catalogs, the problem remains even when the ND/NOs in a class of ICNP[®] are compared with the ND/NOs in other classification systems.

Studies that used the NANDA International to propose an ND set for clients who require nursing care related to the circulatory system, employed terms of other ICNP[®] subclasses in the nominal composition of ND, such as Pain (subclass, Perception; class, Nervous System Process) and Urinary Output (class, Urinary System Process)⁽⁹⁻¹⁰⁾.

The aim of the present study was to elaborate ND/NO titles from rules of association between terms of the Focus axis, Process class, Body Process subclass, Circulatory System Process subclass, and terms of other axes that compose the ICNP[®] (except for those that compose the Action axis) and to represent these terms in an ontology. This work is the result of a Master's thesis that is available at http://www.biblioteca.pucpr.br/tede/tde_busca/arquivo.php?codArquivo=1950, and the present investigation is part of two research projects that, among other goals, suggests constructing a Brazilian ontology.

METHOD

The present study was developed in three stages: the combination of terms in the Circulatory System Process class from the Focus axis and other ICNP[®] axes (except for the Action axis) to compose possible ND/NO titles for the Circulatory System Process, the evaluation of the titles by expert nurses, and the inclusion of the valid titles in an ontology.

The first stage consisted of a descriptive documentary study. To this end, versions 1.0, 1.1, and 2.0 of ICNP[®] were

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used. Three different versions were used because at the stage of data collection, only version 1.0 had been translated into Portuguese; moreover, versions 1.1 and 2.0 included new terms and definition changes, as well as modifications of the classification hierarchy.

Version 2.0 of ICNP® had 19 atomic terms in the Focus axis that defined the Circulatory System Process. Of these, the following 17 were selected: Arrhythmia, Bradycardia, Tachycardia, Hypertension, Hypotension, Bleeding, Hemorrhage, Hematoma, Menorrhagia, Deep Vein Thrombosis, Shock, Anaphylactic Shock, Cardiogenic Shock, Hypovolemic Shock, Neurogenic Shock, Septic Shock, and Vasogenic Shock. The following two terms were excluded: Cardiac Process because it is a term only used to compose the class at the top of the hierarchy; and Menorrhagia because it is a specific term for women's health, which would determine the inclusion of experts in that domain.

Next, a conceptual analysis of each selected term was conducted. This analysis involved revising each concept in search of a better description of the pathophysiology and clinical classification using the ICNP® versions, bibliographies related to the Circulatory System, Portuguese dictionaries, and technical dictionaries. This process was necessary because the term in the ICNP® is often reduced or limited to a certain type of client (e.g., Bradycardia and Tachycardia are parameters limited to adults). Therefore, the references were used to expand the definition and to provide a thorough description of the pathophysiological characteristics.

The terms were then organized in a worksheet that related the term, the definition offered by ICNP®, a brief description of the pathophysiology, and possible evidence to associate terms capable of nominally composing ND or NO. From this worksheet, the legal limits of nursing were verified using the perspective of nursing actions and interventions listed in regulations and legislation from the Federal Nursing Council.

After this process, the ND/NO titles were elaborated according to ISO 18.104/2003⁽¹¹⁾. The 17 terms of the Focus axis were related to each of the terms in the Judgment axis by restricting combinations and using concept analysis as a base and by asking the following questions: Does the Focus term have a Judgment? If yes, then which Judgment is consistent and coherent? This first set of combinations was used to find the combination of each term with terms from the other axes, thereby reducing inconsistencies based on the following questions: Does the ND/NO require a complimentary term? If yes, then which terms from the Means, Time, Location, and Client axes are consistent and coherent for this arrangement?

The final set of combinations was the basis for the collection tool in the second stage. To organize the

instrument, the ND and NO were placed in a single list because some titles can consist of both diagnostics and results. The titles were divided into two categories: titles whose composition was supported by the literature, meaning there was a definition of the ND/NO title in nursing publications or in the description of concepts; and titles whose composition was not supported by the literature, that is, descriptions of these compositions were not found in the literature, but the compositions were utilized in nursing practice.

The second stage consisted of an exploratory and descriptive field study, the sample of which consisted of 15 nurses from hospitals with nursing services that used classification systems and the Nursing Care Systematization with NP application for a period exceeding five years.

To increase the representativeness of the practices in Brazil, these nurses were selected from five different cities: São Paulo-SP, Porto Alegre-RS, Belo Horizonte-MG, João Pessoa-PB, and Florianópolis-SC. These locations were chosen because they have graduate nursing programs with lines of research including classification systems, particularly the ICNP®.

The criteria for including nurses were as follows: having at least two years of experience in the field of adult healthcare; having a graduate nursing program in their respective city as a reference; or having a publication in the specific area within the previous three years. Nurses who were dedicated to direct patient care for less than six hours per day were excluded.

The selection of experts followed these steps: a) an e-mail with a cover letter was sent to six professors at the graduate nursing programs in the cities listed above, requesting the appointment of three nurses; b) an e-mail containing a cover letter, an invitation to participate, a consent form, and an assessment form with guidelines for completion was sent to the nursing experts who were recommended.

Due to the lack of recommendations within the collection period, the city of Florianópolis had no representatives and thus was replaced by Curitiba-PR. Of the number selected, eight professionals responded to the form completely, three did not respond, and four replied with incomplete forms. The form was resent to the latter group, with a request for completion. However, three of these individuals did not return the form. Consequently, the total number of evaluators was nine professionals.

The ND/NO titles were sent to the nursing experts. For the titles supported in the literature, the experts were asked to indicate whether the diagnosis/outcome was used in their professional practice. For the titles that were not described in the literature, the experts were asked to indicate whether these titles could be

used in their practice. If the answer was negative, then an explanation was requested as an optional item.

The data were calculated with the Concordance Index (CI), using the formula $CI = C / (NC + C)$, where NC=non concordance and C=concordance⁽¹²⁾. The titles with indices above 0.80 were considered possible statements used in professional practice. The reasons for non-use were categorized and discussed.

The third stage was characterized as a development study. The ND/NO titles that obtained a CI above 0.80 were included in an ontology, following a method⁽¹³⁾ whose steps, in general, are as follows: establish the domain and extension of the ontology; verify the conditions for reusing other ontologies; list the important terms; define the classes and hierarchies between the classes; define the properties between the classes; and define the restrictions between the classes.

The ontology was constructed using the ontology editor *Protégé* 3.4.1 (Available at: <<http://protege.cim3.net/download/old-releases/3.4.1/full/>>), represented in the OWL language, which allowed the ontology to be integrated into an information system. The inference machine Pellet was used (Available at: <http://clarkparsia.com/pellet/>), which is a reasoning mechanism provided by *Protégé* that can automatically verify the constructed classification for coherence with the properties of the ontology and consistency in the hierarchical structure.

The project that generated this study was approved by the Research Ethics Committee at the Pontifical Catholic University of Paraná (Pontificia Universidade Católica do Paraná - PUCPR) under number 3309/2009.

RESULTS

In the first stage, 89 ND/NO titles were composed; several were supported by the literature or by the ICNP® concept, whereas 19 were not supported. Certain terms from the Focus axis, when combined with terms from other axes, were classified in both lists.

For example, when the ICNP® definition of Arrhythmia was a *variation of the normal rhythm of arterial contraction (...)*⁽⁴⁾, the nurse could obtain evidence of such changes by evaluating the electrocardiogram and could associate terms from the Judgment axis, composing two possible ND/NOs: Initial Arrhythmia or Current Arrhythmia. However, when verifying possibilities for association with terms in the *Frequent Time* axis, which is defined as *the rate of repetition is high during a period of time: 7-9*⁽⁴⁾, the professional was faced with establishing an incompatible time interval, which could determine a possible association but was not consistent with the ICNP® definition because establishment of the arrhythmia period is associated with the length of the sinus cycle⁽¹⁴⁾.

In the second stage, there was agreement from the experts regarding the use of 31 titles supported by the literature (35%) and six unsupported titles (32%) in healthcare practice, totaling 37 ND/NOs with a concordance of use and 71 without concordance. The Diagnosis and Outcome titles evaluated as candidates for use in healthcare practice, with their respective CIs, are listed in Tables 1 and 2.

Table 1 – Diagnosis and Outcome titles supported in the literature, with their respective concordance indices for use in healthcare practice.

Nursing Diagnosis and/or Outcome	Concordance Index
Risk for Arrhythmia	0.88
Chronic Arrhythmia	
Chronic Bradycardia	
Current Anaphylactic Shock	
Current Cardiogenic Shock	
Current Hypovolemic Shock	
Current Neurogenic Shock	
Current Shock	
Current Septic Shock	
Current Vasogenic Shock	
Current Hematoma	0,89
Risk for Anaphylactic Shock	
Risk for Neurogenic Shock	
Risk for Vasogenic Shock	
Risk for Hemorrhage	
Risk for Tachycardia	
Bleeding with Decreased level	
Bleeding due to Duration of surgery	
Improved Deep Vein Thrombosis	
Current Deep Vein Thrombosis	
Risk for Bradycardia	
Risk for Shock	
Risk for Cardiogenic Shock	
Risk for Hypovolemic shock	
Risk for Hematoma	
Risk for Hypertension	1,0
Risk for Hypotension	
Risk for Bleeding	
Risk for Deep Vein Thrombosis	
Bleeding with Increased Level	
Current Bleeding	

Table 2 – Diagnosis and Outcome titles not supported in the literature, with their respective concordance indices for use in healthcare practice.

Nursing Diagnosis and/or Outcome	Concordance Index
Acute Arrhythmia	
Frequent Arrhythmia	
Intermittent Arrhythmia	
Acute Bradycardia	0,89
Acute Tachycardia	
Acute Hypotension	1,00

In the third stage, the inclusion, organization, and presentation of the ontology of the valid ND/NO titles occurred according to the hierarchical model of ICNP® 2.0, thereby yielding the following results: The scope of the ontology was defined as the Circulatory System Process, and there was reuse of the ontology proposed for Brazil(6). The 37 ND/NO titles were listed. The terms that comprised the ND/NO titles for the Circulatory System Process were considered subclasses of the Focus class, which had the Axis class as a superclass (Figure 1). All the ND/NO titles were considered subclasses of the Diagnostic Circulatory System Process class, which is a subclass of the Nursing Diagnostic class and has two subclasses: Circulatory System Process and Impaired Vascular System Process.

The properties of the utilized classes were *hasFocus*, *hasJudgment*, *hasLocation*, *hasMeans*, *hasClient*, and *hasTime*. The restrictions for each title were created for each individual class, with a scientific basis, to avoid constructing inconsistent titles.

Figure 2 presents an example of restrictions of the *Acute arrhythmia* class, with which it is possible to make the following inferences: *hasClient* only *Individual*, *hasFocus* only *Arrhythmia*, *hasJudgment* only *Current*, *hasTime* only *Acute*, and *hasMeans* some *drug* or *dialysis technique*.

DISCUSSION

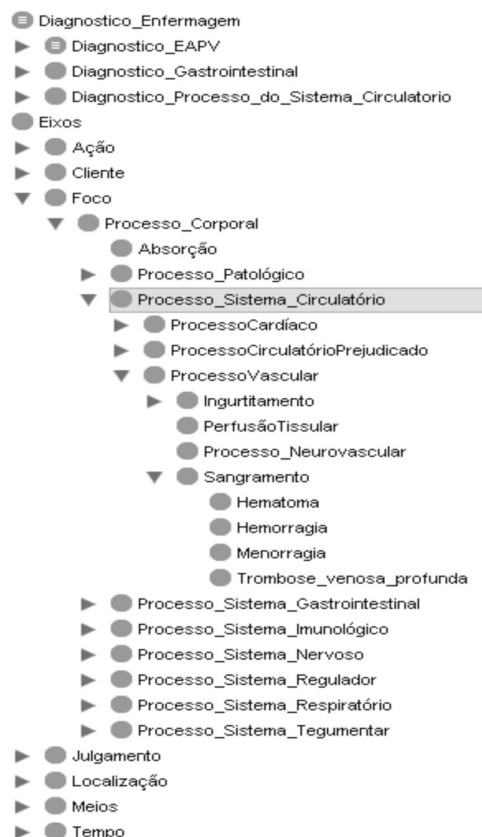


Figure 1 – Example of the Superclasses and Subclasses (Protégé Interface).

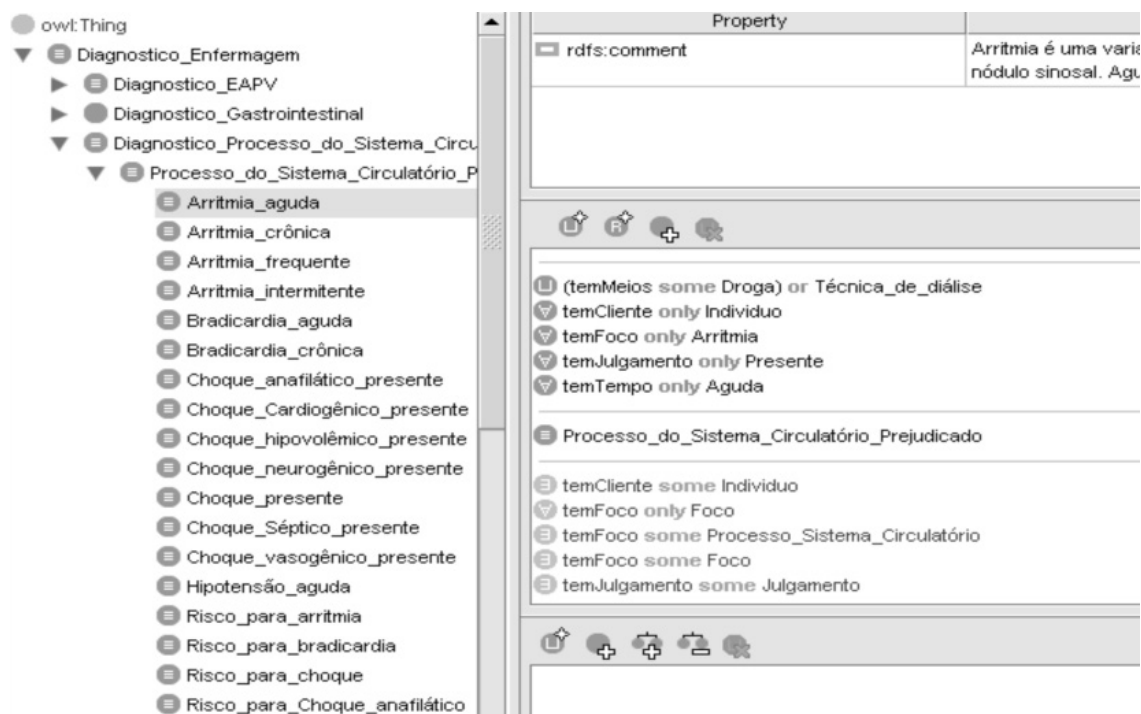


Figure 2 - Restrictions of the *Acute arrhythmia* class.

Of the 31 titles whose composition was supported by the literature and evaluated by nursing experts for use in health-care practice, 35.5% obtained a CI of 1.00 (Table 1). In this category, the presence of 48% of the titles in the Risk context was highlighted, and the percentage was 82% in the group that exhibited a CI of 1.00. This result is related to the fact that professionals are increasingly concerned with preventive intervention measures.

The compositions of 58 ND/NO titles were supported in the literature but did not obtain agreement from experts regarding their use in practice. Because the explanation was optional, the reasons that these titles were not used was not obtained for eight titles. A lack of scientifically based explanations was observed although the completion instructions requested a reference that supported the disagreement. The main reasons for non-concordance were as follows: a) refusal of ND, understood as NO; b) refusal of the judgment, means, or time offered to the focus; c) failure to understand the composition of the title or how to respond; d) use of the focus term alone, without combining it with a judgment; e) wording of the title differently than offered; and f) use of the broader term that was superior to the hierarchical subclass.

This result displayed limitations, given the understanding of the concept of NO applied to ICNP®, although the instrument for collecting the definition was present in the guidelines provided to the participants. For example, for the Diagnosis *initiated cardiogenic shock*, the Outcome *interrupted cardiogenic shock* was expected as one of the possibilities. The professionals who did not use this reasoning had difficulty composing the referred focus with the judgment *interrupted* and generating comments such as, *I do not understand this statement, or, The interrupted term does not apply to a diagnosis*.

This fact can be explained by two circumstances. The first regards a limitation resulting from the form given to the experts, which did not separate the ND from the NO, thereby creating the belief that if these categories were displayed in different spreadsheets, the understanding of the titles' use by the experts would be better and would minimize the problem related to the concept.

The second circumstance is directly related to the definition of NO. For the ICNP®, the NO is one measure or status of a diagnosis after the NI, i.e., they are changes in the diagnosis in response to the interventions, which are evaluated at different timepoints. In this view, the NO can be used as an expected result, meaning what is desired, and as a result that has been achieved and became effective after the intervention⁽¹⁵⁾. Nurses who use NANDA International⁽¹⁶⁾ use the concept of outcome as a description of a client's state, behaviors, perceptions, or⁽¹⁷⁾ aftercare. The results of the nurses' actions are measured by indicators, using a scale from 1 to 5⁽¹⁵⁾, and the NO is not viewed as a modified ND.

Regarding the reasons for not accepting the judgment, means, or time offered for the focus, and using the focus in

isolation, some experts limited themselves to the presence of the sign and/or symptom that directed the focus but did not provide a judgment. The following comment exemplifies the situation: *I think, in these cases, we are 'forced' to include a judgment term*.

Establishing diagnoses using a classification system is a skill that must be learned and reinforced by using the NP practice. Insufficient theoretical knowledge about taxonomies was reported as the most important cause for difficulty in the practical application of ND by nurses in a university hospital in São Paulo⁽¹⁷⁾.

Certain nurses, by using a reduction of the title differently than was provided, justified the non-concordance by stating that the other axes were factors related to composing the rationale of the diagnosis decision. For example, an expert stated, in relation to the term of the time axis *duration of surgery*, [...] *in our practice, we use the factor related to all diagnoses, which makes me have this type of reflection*.

Other nurses suggest the necessity of including the related factor and the defining characteristics in ICNP®, similar to the perspective of NANDA International⁽¹⁶⁾. Although this step is not one of the purposes of classification, the ICNP® does contemplate the definition of certain terms that minimize the requirement stated by the experts. An example is the term Bleeding, whose concept in the ICNP®⁽⁴⁾ includes an association with the destruction of blood vessels, rupture of the outer skin or internal organs, or spaces between tissues.

In total, 14 ND/NOs whose composition was not supported by the literature also did not obtain an evaluation of use in practice. The main reasons from the nurses were similar to those offered for the titles with descriptions supported by the literature. However, in this set, it was perceived that the experts had difficulty establishing the temporality of the focuses or did not have sufficient knowledge to use this temporality more appropriately.

From the perspective and the context of accuracy in the nursing diagnosis process, experts can reach different diagnostic conclusions regarding the same set of patient data, which is a situation that is present in other clinical settings, not only nursing diagnosis⁽¹⁸⁾. This fact can support the argument that some of the titles, even those supported by the literature, have not reached a CI above 0.80; and other titles, although there is no evidence in the literature, are used in practice. This argument is combined with the discussion that the clinical reasoning used to define diagnoses is a complex and dynamic mental process, which occurs in identifying situations and actions necessary for care, and that the difficulties in establishing diagnoses are related, among other factors, to the degree of knowledge required to observe normal manifestations or behavioral changes⁽¹⁹⁾.

A study conducted in different clinics of the Lauro Wanderly Hospital /UFPB exposed a set of 257 ND/NOs from ICNP®, with their respective nursing interventions, categorized by Basic Human Needs⁽²⁰⁾. When these

findings were compared with the results from the present study, terms from *Circulatory System Process* were identified in the requirement for Vascular Regulation, with only Bleeding (current) and Risk for Bleeding being common to the titles presented in this manuscript, out of the 21 proposed diagnostic statements⁽²⁰⁾.

Although not only ND/NOs that are based on the ICNP[®] are used, five titles were identified in the lists of an information system database to support the implementation of the NP developed by the Brazilian Nursing Association⁽²¹⁾ and to verify the presence of the ND Risk of Shock and Risk of Bleeding in the diagnoses proposed by NANDA International⁽¹⁶⁾.

Regarding the inclusion of statements in the proposed Brazilian ontology⁽⁶⁾, this procedure followed the above-described method and was consistent after applying the Pellet inference mechanism, resulting in a coherent classification with the developed structure.

The construction of ontologies is a necessarily interdisciplinary process that requires constant revisions and enables the development of a shared vision of a knowledge domain⁽²²⁾. The challenge lies in organizing

the specific domain of knowledge in a coherent manner and in improving the reasoning power of machines to support the decision-making of the various participants in the process⁽²²⁾.

CONCLUSION

This study involved 17 terms from a single ICNP[®] subclass and presented 37 ND/NO titles evaluated as feasible for use in healthcare practice and that subsequently can be employed to form terminology subsets.

The construction of ND/NO titles based on the ICNP[®] is a task that requires further understanding of the concepts used in nursing theory and practice, as well as an adjustment to the constant reviews of the classification. It is believed that the titles that were presented in the present study and that are available in an ontology will facilitate the performance and learning of professional nurses and nursing students, thereby yielding diagnoses that are more coherent with professional practice.

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