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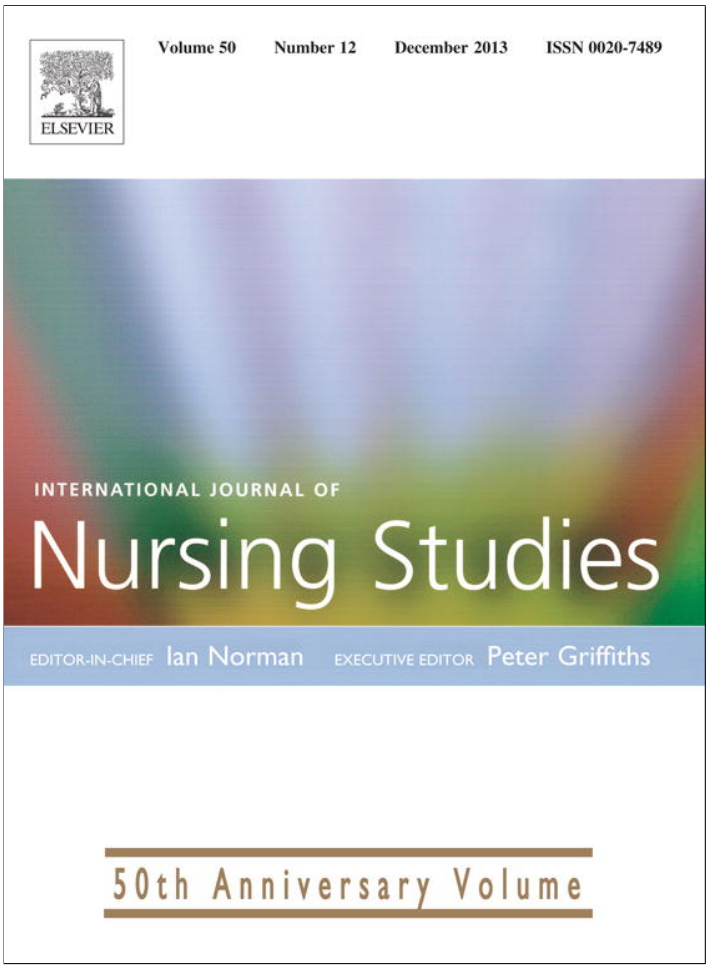

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What patients' problems do nurses e-chart? Longitudinal study to evaluate the usability of an interface terminology

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ABSTRACT

Background: The nurses' ability to document patient's status, problems and progress is an important issue in patients' safety. Nursing terminologies are intended to support nursing practice but as any other clinical tool, they should be evaluated to assure quality and warrant effective written communication among clinicians.
Objectives: This study was aimed to evaluate the usability of the diagnosis axis of an interface terminology by assessing its completeness and the frequency of use of its concepts.
Design: Observational, longitudinal, multicentre study.
Setting: A total of 8 hospitals representing 162 acute medical–surgical, obstetric and mental health nursing wards, step-down units and home in-patient units were included.
Participants: Overall, 246,400 electronic care plans were studied; 53.5% from male patients; 14.6% paediatrics and 33.7% from patients elder than 70 years old. Most were admitted due to cardiocirculatory, respiratory, digestive or musculoskeletal conditions (50.5%), other acute medical or surgical disorders (29.8%) and obstetrics (19.3%).
Methods: The main outcome measures were: the use of nursing diagnoses from the interface terminology evaluated and their accumulated frequency, analysed over a 3-year retrospective review of the electronic nursing care plans. The analysis of data included descriptive statistics with a confidence level of 95% for confidence intervals.
Results: Most of the diagnostic concepts from the interface terminology were used (92.3%) by nurses to illustrate patients' problems in the electronic care plans. Their frequency of use widely varied, from some very frequent diagnoses like *Risk for haemorrhage* (51.4%; CI 95%: 51.25–51.65) or *Acute pain* (49.6%; CI: 49.49–49.88) to others used only in exceptional cases like *Faecal impaction* or *Extravasation*. The first nursing diagnosis related to family or caregiver emerges in the 32nd place of the ranking.
Conclusions: Results for outcome measures oriented that the diagnosis axis of this interface terminology meets the usability criterion of completeness when assessing for the use of its concepts in the acute care setting.

What is already known about the topic?

- The use of different nursing controlled vocabularies has been reported in the literature to cover nursing diagnosis, interventions and outcomes in a variety of settings.
- The ATIC terminology is a nursing interface vocabulary to support nurses' entry of patient-related information into the electronic health records.
- Formal evaluation methods of clinical controlled vocabularies have been defined, but usability studies on terminologies in the practice settings are scarce.

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What this paper adds

- Most of the diagnostic concepts of the ATIC terminology are used in the electronic nursing care planning.
- Risk for haemorrhage, acute pain and fear are the most frequently documented nursing diagnoses in the hospital in-patient population.
- The diagnosis axis of the ATIC terminology meets the usability criterion of completeness.

1. Introduction

The need for meeting efficiency outcomes in the healthcare systems, while assuring the quality of care, has challenged hospitals to implement major organisational changes and has placed nurses under growing pressure to demonstrate their contribution and influence on quality and cost, in terms of health problems they resolve or prevent and health outcomes in patients. Acute hospitals increasingly tend to concentrate only the most seriously ill groups of patients, frequently with multiple advanced major chronic diseases, oncologic diagnoses or catastrophic conditions, that require intensive and proficient nursing care and expert on-going vigilance to prevent, promptly detect and manage potential complications (Despins et al., 2009; James et al., 2010).

Nurses working in acute care settings play a pivotal role in patient safety (Burhans and Alligood, 2010; Clarke and Aiken, 2005; Feng et al., 2008). There is strong evidence demonstrating that careful monitoring of the patient status, early recognition of deterioration and accurate decision-making contribute to reduce the incidence of adverse events, serious complications and short and long-term disabilities (Armitage et al., 2007; Institutes of Medicine, 2004; Thornlow et al., 2009). According to Levinson (2010), lack of adequate assessment of the patient's status, inadequate monitoring of the patient's progress and poor communication among clinicians account for almost 70% of preventable adverse events in the hospital setting. It is also acknowledged, that the nurses' ability to report and document patient's status, problems and progress is an important issue in patients' safety (Saranto and Kinnuen, 2009). Thus, accurate nursing documentation may help in increasing the efficiency of clinical and management decision-making, in a context of growing demands of information along with the widespread of the use of the electronic health records for all care sites. Electronic health record systems are expected to increase patient safety, reduce medical errors, improve efficiency and reduce costs (Trent Rosenbloom et al., 2006).

2. Background

Several authors have addressed the use of nursing diagnoses to represent patients' problems in charting the care planning in patient records, to reflect the nurses' judgements on patient' status (Bernhart-Just et al., 2010; Müller-Staub et al., 2006). Most of the nursing literature covering this issue focuses on the concept of nursing diagnosis as described by the North American Nursing Diagnosis Association (NANDA): *A nursing diagnosis is a clinical judgement about individual, family or community responses to actual or potential health problems/life processes. Nursing diagnoses provide the basis for the selection of nursing interventions to achieve outcomes for which the nurse is accountable* (North American Nursing Diagnosis Association, 1990). Over time, this concept has been widely debated by scholars and confronted to the concepts "patient problem" or "nursing problem", but it seems that agreement exists in defining its essential components, including that: (1) it is a nursing judgement on a patient (or group) actual or potential health problems, (2) represented by a concise statement, (3) based on the analysis of objective and subjective assessment data, (4) for which the nurse can prescribe care (Hogston, 1997; Lützén and Tishelman, 1996).

Many authors around the world use the NANDA International (NANDA_I) nursing diagnoses to describe what do nurses document in the patient records and also, to explain how nurses systematise care planning for different patient populations. Some of them focus on a single nursing diagnosis in a single profile of patients (Costa et al., 2010; Martins et al., 2010), while others describe frequent nursing diagnoses in a single group of patients (Bisca and Marques, 2010; da Silva et al., 2008; Neves-Inácio et al., 2010), but only a few have explored

Nursing Minimum Data Set	A set of standardised nursing data to collect essential uniform nursing information across different settings.
Controlled vocabulary	A set of terms and their definitions that represent concepts in a knowledge base of a discipline.
Standardized language	A collection of terms with definitions, usually specific to a discipline, for use in information systems and databases.
Reference terminology	A terminology that may include different expressions representing the same concept. It is oriented to enable data conversion among different language schemes.
Classification	A language system, specific to a discipline, in which concepts are rigorously defined and hierarchically related. Classifications features include concept abstraction and orientation to concept aggregation and synthesis, for data retrieval and analysis.
Taxonomy	A method of systematic ordering, distinguishing and grouping concepts within a subject field according to rules or presumed natural relationships.
Interface terminology	A conceptual system, based on close to natural language terms, intended to ease users' entry of data and information into computer programs. It is also named "entry terminology", "application terminology" and "colloquial terminology".

Fig. 1. Glossary of terms.

Code	**10000074**	
Concept label	**AGGRESSIVENESS**	
Synonym	**Aggressive behaviour**	
Definition	*State in which the care beneficiary shows a*: **behavioural response of incitement and attack, verbal and/or physical, due to a stressful situation, loss of control, emotional disorganization, emotional overflow or intolerance to frustration**.	
Additional information	Aggressiveness should be considered an acute situational, reactive, adaptation response. When it develops as a usual behavioural pattern, it should be labelled as *chronic aggressiveness*. Clinical manifestations of aggressiveness may include verbal manifestations (shouting, verbal abuse, profanity, threats), physical manifestations towards self (self-hitting, self-dropping to the ground, self-biting), towards others (beating, kicking, punching, pushing) or towards objects (messing, breaking glasses or other objects, throwing objects against the walls or the floor). Aggressiveness is not a synonym of *Violence*. An aggressive behaviour does not entail the intentionality of causing harm, while violence involves this intentionality.	
Concept dissection	Focus: **Aggressive behaviour**	Potentiality: **Actual**
	Judgment: **Implicit**	Location: **Not applicable**
	Onset: **Acute**	Subject: **Individual**
Concept roots	Dimension: **Being Conscious** *	Component: **Adaptive** *
Concept development	Related nursing scientific production: **Profuse**	
	Type of designs: **Category 3** **	
	Areas of disciplinary interest: **(1)** Medical-surgical Nursing, **(2)** Maternal-Child and Paediatric Nursing, **(3)** Family and Community Nursing, **(4)** Mental Health Nursing and **(5)** Other areas of disciplinary interest.	
Terminological features	Compositionality: **Simple**	Mapped to ICNP***: **Perfect match**
	Granularity: **Low**	Mapped to NANDA_I: **Best match** (Violence)
Translation	Catalan: ***Agressivitat***	Italian: ***Agressività***
	Spanish: ***Agresividad***	Portuguese: ***Agressividade***
	French: ***Agressivité***	Russian: ***Агрессивность***
Selected References (Sample)	Bowers L, Crowder M. **Nursing staff numbers and their relationship to conflict and containment rates on psychiatric wards-a cross sectional time series poisson regression study**. Int J Nurs Stud. 2012 49(1):15-20. doi:10.1016/j.ijnurstu.2011.07.005. Stewart D et al. **Inpatient verbal aggression: content, targets and patient characteristics.** J Psychiatr Ment Health Nurs. 2012, doi: 10.1111/j.1365-2850.2012.01905.x. Rittenmeyer L. **Assessment of risk for in-hospital suicide and aggression in high-dependency care environments.** Crit Care Nurs Clin North Am. 2012 24(1):41-51. Browne G et al. **Children with behavioural/mental health disorders and school mental health nurses in Australia**. J Child Adolesc Psychiatr Nurs. 2012; 25(1):17-24. Hardin D. **Strategies for nurse leaders to address aggressive and violent events**. J Nurs Adm. 2012; 42(1):5-8. Lamontagne C. **Intimidation: a concept analysis.** Nurs Forum. 2010 45(1):54-65. Sidora-Arcoleo K, et al. **Differential effects of a nurse home-visiting intervention on physically aggressive behaviour in children.** J Pediatr Nurs. 2010 25(1):35-45. Chae SM, Covington CY. **Biobehavioural outcomes in adolescents and young adults prenatally exposed to cocaine: evidence from animal models.** Biol Res Nurs. 2009 10(4):318-30. Delaney KR. **Reducing reactive aggression by lowering coping demands and boosting regulation: five key staff behaviours.** J Child Adolesc Psychiatr Nurs. 2009 22(4):211-9. Hage S et al. **Aggressive behaviour in adolescent psychiatric settings: what are risk factors, possible interventions and implications for nursing practice? A literature review.** J Psychiatr Ment Health Nurs. 2009 16(7):661-9. Nau J et al. **The De-Escalating Aggressive Behaviour Scale: development and psychometric testing.** J Adv Nurs. 2009 65(9):1956-64. Tenneij NH et al. **The correspondence between the Staff Observation Aggression Scale-Revised and two other indicators for aggressive incidents.** Arch Psychiatr Nurs. 2009 23(4):283-8. Duxbury J et al. **The Management of Aggression and Violence Attitude Scale (MAVAS): a cross-national comparative study.** J Adv Nurs. 2008 62(5):596-606.	

Fig. 2. Sample concept from the diagnosis axis of the ATIC Terminology. **Dimensions* and *components* in the diagnosis axis of the ATIC terminology derive from an interpretative conceptualization of the metaparadigm concept "*Individual*" (for further information, see reference Juvé-Udina, 2012b). ***Types of designs* refer to the following categories of types of research studies, published in the scientific literature. Category 1 includes case studies, case series,

whether the NANDA_I nursing diagnoses properly address any nursing judgement on a patient's actual or potential health problem for which the nurse is accountable, within a general in-patient population (Giménez-Maroto and Serrano-Gallardo, 2009; Olaogun et al., 2011). The NANDA_I taxonomy has also been used, during the last decades, as an entry terminology in the electronic health records (Bernhart-Just et al., 2009; Klehr et al., 2009; Müller-Staub, 2009), because this classification system is the most known and researched nursing diagnoses vocabulary (Anderson et al., 2009; Müller-Staub et al., 2007). Fig. 1 contents a glossary of controlled vocabularies related terms.

Nursing classifications are language systems in which nursing concepts are comprehensively and rigorously defined and hierarchically related. These systems have an important role in data retrieval and statistical evaluations of nursing care, but they tend to confine terms to an abstract level that are unnatural to nurses in the practice settings. The use of nursing controlled vocabularies is necessary for representing nursing phenomena and actions in the health information systems, but as stated by Bakken et al. (2000), "*no single existing terminology can serve all purposes equally well; the level of granularity of data required for decision support is very different than that required for billing or for examining disease patterns in a population over time*". Similarly, with regard to direct patient care, there is increasing evidence showing that existing classification systems, such as the NANDA_I classification, are not able to represent the kind of nursing data commonly recorded in patients' charts in sufficient detail. Paans et al. (2010) observed that "*nurses tend to use a more descriptive approach in documenting than a diagnoses-based approach*" and pointed that "*records containing several accurate diagnosis also contained inaccurate ones*". Giménez-Maroto and Serrano-Gallardo (2009) found several inaccuracies in the nursing diagnostic process when analysing the use of the NANDA_I taxonomy in the hospital setting; Varsi and Ruland (2009) concluded that the NANDA_I nursing diagnoses only partially cover patients' problems identified by nurses in the oncology clinical setting; and Frauenfelder et al. (2011) described similar results for psychiatric and mental health in-patients.

In 1999, Moen et al. recommended: "*Nurses should pursue the development of formal terminologies to complement the existing classification systems*". Interface terminologies may fill this gap, playing a complementary, practice-oriented role.

An interface terminology is a controlled vocabulary; a conceptual system based on the natural language that the professionals use in their daily practice and subsequently revised for theoretical refinement. In the healthcare literature, it has been defined as a "*systematic collection of health care related terms that supports clinicians' entry of patient-related information into computer programs (...). Such terminologies provide the translation from clinician's own natural language expressions into the more structured representations required by application programs*" (Trent Rosenbloom et al., 2006).

This article focuses on a nursing interface terminology termed ATIC. The name of this vocabulary is based on six key concepts: Architecture, Terminology, Interface, Information, Nursing (*Infermeria*) and Knowledge (*Coneixement*), yielding the acronym ATIC in the Catalan spelling. The ATIC terminology is designed as a nursing concept-oriented, interface controlled vocabulary. The terminology is structured in three main axes: (1) assessment, (2) diagnosis and (3) interventions, and several complementary axes, to represent the patients' health status, problems, situations and responses for which nurses are accountable, the interventions and actions they perform, the clinical findings they assess and the outcomes they evaluate.

Terms (labels) and concepts (meanings) in this terminology are based on the study of the natural language that nurses use in their daily practice and then, they are revised for theoretical refinement. Fig. 2 shows a sample concept of this terminology.

The philosophical and theoretical background of the ATIC terminology has recently been published (Juvé-Udina, 2012a). The structure of the terminology has been evaluated for inductive validity, based on an interpretative conceptualisation of the metaparadigm constructs (Juvé-Udina, 2012b,c) and the nursing process, including the meaning of the concept *Nursing Diagnosis:* "*A nursing diagnosis is a clinical judgement – or the conclusion of several judgements – on the health status of an individual (or group), and the actual or potential consequences and reactions within the different dimensions of the individual and their integrality, in the context of their environment and particular experience and, within the scope of professional nursing accountability, including shared responsibility with the care beneficiaries and with other healthcare providers*" (Juvé-Udina, 2012b,d).

The ATIC terminology has also been tested for face validity, content validity and criterion validity (Juvé-Udina, 2012e,f; Juvé-Udina et al., 2012).

Nursing controlled vocabularies have to be systematically assessed in order to assure patient' safety, quality of care, as well as to ease the identification of the patient status and progress and to warrant an effective inter-professional communication. Several criteria to evaluate clinical vocabularies have been described in the literature (Bakken et al., 2000; Müller-Staub et al., 2007; Trent Rosenbloom et al., 2008), but to determine to what extent a terminology performs in the real world, usability has to be measured.

The usability of a terminology refers to the ease using a vocabulary. Usability evaluation "*focuses on how well an interface terminology performs when used to complete sample, representative real-world tasks*" (Trent Rosenbloom et al., 2006). Usability evaluation metrics may include: (1) Completeness – the proportion of task that a user can

reviews and concept analysis. Category 2 includes quantitative descriptive designs, validation studies, and qualitative designs. Category 3 includes analytical designs, controlled trials, meta-analysis and qualitative meta-synthesis. These categories are inclusive, that is, the higher contains the former. (For further information locate reference Juvé-Udina, 2012f). ***ICNP = *International Classification for Nursing Practice* from the International Council of Nurses.

perform successfully using the terminology; (2) Correctness – accuracy of performance compared to a gold standard; (3) Efficiency – effort required to complete a task using the terminology, and (4) User' satisfaction (Trent Rosenbloom et al., 2008).

This article focuses on the evaluation of the usability of the ATIC terminology, measuring the completeness of its diagnosis axis. The research questions posed are:

What is the proportion of ATIC diagnoses used by nurses to represent their judgements on patients' status?

What is the proportion of nursing judgements on the patients' status that can be represented using the ATIC diagnoses? Or are there diagnostic concepts missed?

What is the frequency of use of each nursing diagnosis?

3. The study

3.1. Goals

The primary purpose of this study is to evaluate the usability of the diagnosis axis of the ATIC terminology to represent the nurses' judgements on patients' status in the hospital setting, by assessing its completeness and identifying the frequency of use of each nursing diagnosis.

3.2. Design

The study applied a descriptive, longitudinal design, based on a three-year (2009–2011) retrospective evaluation of data, collected from the electronic nursing records of patients admitted to a public hospital ward or step-down unit.

3.3. Sample and setting

Nursing electronic records from all elder, adult and paediatric patients admitted to a ward or intermediate care unit were considered eligible for the study. Critical care episodes were excluded because the nursing documentation was not computer-based. Because of the predominant descriptive focus of the study, no sample size calculation was performed.

The nursing electronic documentation from a large metropolitan tertiary centre (≥500 beds), one urban university hospital and one community hospital was studied in 2009. One urban university facility and another community hospital were added to the study in 2010. Finally, in 2011, two more large metropolitan tertiary hospitals and a third urban teaching centre were included.

Adult in-patient units were defined as nursing wards caring for patients over 18 years old, including: (1) step-down units, (2) medical wards (≥80% of patients admitted for health conditions that require medical diagnostic or therapeutic interventions), (3) surgical units (≥80% of patients admitted for health conditions that require any surgical procedure, including all surgical specialties and organ transplants; but excluding one-day surgical wards and major ambulatory surgery units), (4) combined medical–surgical wards, (5) obstetrics (≥80% of patients admitted for ante-partum, labour, delivery and post-partum, including baby-mother combined units), (6) mixed acuity units (≥80% of patients admitted for health conditions that require progressive care, from intensive to acute, such as a burns unit) and (7) in-patient home units (patients requiring continuity of care at home for short-term, complex nursing interventions). Paediatric units, caring for patients under 18 years old, applied the same criteria, except for the case of obstetric care. Finally, psychiatry and acute mental health wards included adult in-patient with acute psychiatric disorders, behavioural-health in-patient wards (such as eating disorders or substance abuse) and combined psychiatric unit types.

3.4. Data collection

At the outset of this study, the ATIC terminology contained 527 concepts to illustrate patients' problems: 369 actual problems (70%) and 158 risk problems (30%).

The electronic health record system implemented in the hospitals included in this study runs the software Gacela Care® (Oesía, Madrid, Spain) integrated into the platform SAP® (Systems, Applications & Products -SAP-, Waldorff, Germany).

Using a blinded data retrieval system to protect data confidentiality, patients' problems documented by nurses in the electronic care plans were obtained. The nursing diagnoses were searched in the nursing care planning section of the electronic health records. No other parts of the system were accessed.

Personal data were neither accessed, except for illustrating some general sample features. Data were obtained using *Standardised Query Language* queries, searching for the number of care episodes containing actual and potential nursing diagnoses of the ATIC terminology documented in the care planning section of the electronic health records. A care episode consists of all related services for one in-patient from admission to discharge. Each care episode is identified in the electronic health record by a number. Each admission of a patient represents a new care episode.

The main outcome measures were: the use of every diagnostic concept from the ATIC terminology expressed as a dichotomous variable, the requests from nurses to add a new diagnostic concept and the frequency of use of each diagnosis, according to the nursing electronic charting.

Considering the different patients' profile building a theoretical hospital in-patient population, the frequency of use of the nursing diagnoses concepts was categorised as: Extremely high frequency of use (>50% of overall cases), very high (20–50%), high (10–20%), moderate (5–10%), low (1–5%), very low (0.1–0.99%), extremely low (0.01–0.09%), exceptional cases (<0.01%), and null (0.000%).

Nurses in the wards were invited to communicate to the author via e-mail or selected key informants in each facility participating, any patient's problem that they could not represent using the ATIC diagnoses.

Permissions for the study were obtained from the Institutional Executive Board in the context of the development of the author's doctoral program. Ethical issues related to anonymity and data confidentiality were assured, since the retrieval system had been previously blinded, according to the current regulations in the

country. Ethics committee approval to conduct the research was obtained.

3.5. Data analysis

Retrieved data were processed onto an Excel spreadsheet (Microsoft Excel, Redmond VA, 2007) and revised to identify potential processing errors and to control for inconsistencies. The data analyses were performed using the statistical functions of SPSS v16. Depending on the properties of the data, frequencies in percentages, means and standard error of the population were calculated for description. Significance testing included p-value < 0.05 to determine the differences among the 2009, 2010 and 2011 populations studied.

It is acknowledged that the p-value is dependent on statistical power, effect size and sample size (Hayat, 2010). Considering the sample size in this study, it could be expected that statistically significant differences would be found due to this mathematical property of the p value. Assuming that although statistically significant, these differences would not be clinically relevant, the analysis of the main outcomes was performed aggregated. Confidence intervals were calculated for a confidence level of 95%, considering the confidence level as a function of the level of significance. Confidence intervals estimate the size of the true difference in the target population, providing the accuracy of the estimation, a plausible range for this true value and addressing both clinical and statistical significance (American Psychological Association, 2010; Sedgwick, 2012).

4. Findings

4.1. Sample

The final analysis included 246,400 in-patient care episodes (nursing e-care plans) from eight hospitals accounting for 130 nursing wards (82.3% medical and/or surgical units, 13.7% paediatric and obstetrics wards and 3.8% acute mental health wards), 23 step-down units (87% adult and 13% paediatrics intermediate care) and 9 home in-patient units (5.5%). Gender distribution in the final sample was 53.5% for male patients and 46.5% female. Age distribution, health conditions for admission and further information of the study groups is presented in Table 1.

4.2. Usability results

Main outcome measure analysis resulted in 92.3% diagnostic concepts of the ATIC terminology ($N = 486$) used in the electronic nursing care planning, while 41 (7.7%)

Table 1
Sample features.

Sample and setting	2009_N	%	2010_N	%	2011_N	%	Total_N	%	p value
Community hospitals	1	*	2	*	2	*	2	*	0.38
Urban teaching facilities	1	*	2	*	3	*	3	*	0.74
Metropolitan tertiary centres	1	*	1	*	3	*	3	*	0.13
Hospitals (total)	3	*	5	*	8	*	8	*	0.06
Medical/surgical wards	25	65.7	42	67.7	107	66.0	107	66.0	0.14
Medical/surgical step-down units	3 (8)	7.9	6	9.6	20	12.3	20	12.3	0.20
Paediatric wards	3 (8)	7.9	4	6.4	11	6.8	11	6.8	0.14
Paediatric step-down units	0 (0)	0.0	0	0.0	3	1.8	3	1.8	0.42
Obstetric wards	3 (8)	7.9	4	6.4	7	4.3	7	4.3	0.06
Home in-patient units	3 (8)	7.9	4	6.4	9	5.5	9	5.5	0.10
Mental health/psychiatric wards	1 (3)	2.6	2	3.2	5	3.0	5	3.0	0.15
Wards (total)	38	*	62	*	162	*	162	*	0.14
Nursing e-records	44,776	*	73,106	*	128,518	*	246,400	*	0.07
Sample description									
Gender (Male)	24,313	54.3	38,550	52.7	69,015	53.7	131,878	53.5	0.07
Paediatric (0–18 years)	7725	17.2	10,476	14.3	17,992	13.9	36,193	14.6	0.05
Adult (19–69 years)	20,574	45.9	37,840	51.8	68,757	53.5	127,171	51.6	0.09
Elder (≥70 years)	16,477	36.8	24,790	33.9	41,769	32.5	83,036	33.7	0.06
Surgical in-patients	13,970	31.2	23,637	32.3	47,295	36.8	84,902	34.4	0.10
Health conditions for admission									
Cardiocirculatory	6925	15.5	11,259	15.4	19,451	15.1	37,635	15.3	0.07
Respiratory	6678	14.9	9276	12.7	17,667	13.7	33,621	13.6	0.07
Digestive	4827	10.8	8430	11.5	13,896	10.8	27,153	11.0	0.07
Musculoskeletal	5425	12.1	7748	10.6	12,996	10.1	26,169	10.6	0.06
Obstetrics	4696	10.5	8078	11.0	12,741	9.9	25,515	10.4	0.06
Healthy newborn	4534	10.1	6869	9.4	10,450	8.1	21,853	8.9	0.05
Infectious	3241	7.2	5556	7.6	9273	7.2	18,070	7.3	0.07
Nephrourinary	2941	6.6	5191	7.1	9389	7.3	17,521	7.1	0.09
Nervous system	2586	5.8	4437	6.1	7978	6.2	15,001	6.1	0.08
Reproductive	867	1.9	1784	2.4	3738	2.9	6389	2.6	0.12
Head and neck	663	1.5	1644	2.2	3601	2.8	5908	2.4	0.15
Haematology and immunology	672	1.5	1423	1.9	2966	2.3	5061	2.1	0.13
Nutrition and metabolism	389	0.9	650	0.9	1678	1.3	2717	1.1	0.14
Cutaneous	119	0.3	276	0.4	1528	1.2	1923	0.8	0.28
Mental health	126	0.3	233	0.3	777	0.6	1136	0.4	0.20
Ophthalmology	87	0.2	252	0.3	389	0.3	728	0.3	0.10
Total	44,776		73,106		128,518		246,400		0.07

diagnoses were never included in a patient care plan during the period of the study.

Risk for haemorrhage (51.4%; CI 95%: 51.25–51.65), *acute pain* (49.6%; CI: 49.49–49.88) and *Fear* (41.2%; CI 95%: 41.02–41.44) were the most frequently used nursing diagnoses in the in-patient population studied.

Fig. 3 contains sample nursing diagnosis labels selected by nurses to reflect their judgements in the patient electronic care planning documentation, categorised in relation to their frequency of use.

Ranking the top-50 patients' problems e-charted, 42% were actual problems and 58% risk nursing diagnoses. In this top-50 list, only one diagnosis was concerned to other beneficiary than the patient (Table 2).

From 47 nursing diagnoses in the ATIC terminology concerning family, parents or caregivers, 19 were never used (40.4%). In the general analysis, *Parental fear* (6.9%; CI 95%: 6.80–7.00), *Risk for ineffective family coping* (1.9%; CI 95%: 1.91–2.02) and *Risk for family situational claudication* (1.8%; CI 95%: 1.82–1.93) were the most frequently used

Frequency	ACTUAL PROBLEMS	RISK PROBLEMS
Extremely high (> 50%)		Risk for haemorrhage
Very high (20-50%)	Acute pain	Risk for infection
	Fear	Risk for thromboembolic event
	Physiological anxiety	Risk for urinary retention
	Surgical wound	Risk for nutritional deficit
High (10-20%)	Ineffective airway cleaning	Risk for decreased cardiac output syndrome
	____	Risk for impaired adaptation to a new health status
	____	Risk for atelectasis
	____	Risk for arrhythmia
Moderate (5-10%)	Hypoxemia	Risk for hypothermia
	Clean wound	Risk for ineffective breastfeeding
	Fever	Risk for mucositis
	Fatigue	Risk for unintended self-harm
Low (1-5%)	Clean surgical wound	Risk for falling
	Urinary and faecal incontinence	Risk for dehydration
	Peripheral oedema	Risk for disuse syndrome
	Physical frailty	Risk for ineffective family coping
Very Low (0.1-0.99%)	Activity intolerance	Risk for hyponatremia
	Dyspnoea	Risk for hypercalcemia
	Faecal incontinence	Risk for anxious-depressive syndrome
	Self-care deficit: feeding	Risk for complicated uterine dynamics
Extremely low (0.01-0.09)	Hypothermia	Risk for respiratory depression
	Cachexia	Risk for ineffective parental coping
	Newborn jaundice	Risk for ineffective airway cleaning
	Chronic low self-esteem	Risk for autonomous dysreflexia
Exceptional cases (< 0.01%)	Extravasation	Risk for corneal abrasion
	Complicated parental grieving	Risk for post-traumatic syndrome
	Parental hopelessness	Risk for caregiver situational low self-esteem
	Faecal impaction	Risk for impaired family dynamics
Never used	Corneal abrasion	Risk for hyperphosphatemia
	Chronic sorrow	Risk for family chronic low self-esteem
	Caregiver hopelessness	Risk for infiltration
	Parental uncertainty anxiety	Risk for self-exclusion

Fig. 3. Sample ATIC nursing diagnoses categorised according to the frequency of use.

Table 2
Rank of the most frequent patients' problems e-charted.

	Nursing diagnoses	%	Mean	SEP	CI_LL	CI_UL
1	Risk for haemorrhage	51.4	42,220	0.10	51.25	51.65
2	Acute pain	49.6	40,773	0.10	49.49	49.88
3	Fear	41.2	33,822	0.10	41.02	41.41
4	Risk for ineffective management of therapeutic regimen	40.4	33,166	0.10	40.22	40.61
5	Physiological anxiety	38.8	31,863	0.10	38.64	39.02
6	Risk for thromboembolic event	35.4	29,111	0.10	35.28	35.66
7	Surgical wound	32.1	26,349	0.09	31.92	32.29
8	Risk for urinary retention	27.9	22,897	0.09	27.72	28.08
9	Risk for nutritional deficit	27.7	22,775	0.09	27.58	27.93
10	Risk for postoperative infection	26.7	21,937	0.09	26.56	26.91
11	Risk for hyper/hypoglycaemia	22.6	18,543	0.08	22.43	22.76
12	Risk for constipation	21.7	17,863	0.08	21.61	21.93
13	Risk for infection	20.3	16,602	0.08	20.07	20.39
14	Risk for paralytic ileum	18.2	14,967	0.08	18.09	18.39
15	Risk for impaired adaptation to a new health status	17.5	14,398	0.08	17.39	17.69
16	Risk for hydro-electrolyte disturbances	15.6	12,811	0.07	15.47	15.76
17	Risk for atelectasis	13.6	11,227	0.07	13.55	13.82
18	Risk for arrhythmia	10.3	8492	0.06	10.23	10.47
19	Ineffective airway clearance	10.2	8432	0.06	10.16	10.40
20	Risk for decreased cardiac output syndrome	10.1	8295	0.06	9.99	10.23
21	Hypoxaemia	9.6	7898	0.06	9.51	9.74
22	Risk for food intake intolerance	9.4	7763	0.06	9.35	9.58
23	Risk for postoperative hypothermia	9.0	7447	0.06	8.96	9.19
24	Risk for ineffective breastfeeding	8.9	7339	0.06	8.83	9.06
25	Clean wound	8.5	7001	0.06	8.42	8.64
26	Risk for mucositis	8.4	6931	0.06	8.34	8.56
27	Newborn physiological immaturity	8.3	6882	0.06	8.28	8.50
28	Fever	8.2	6755	0.06	8.12	8.34
29	Fatigue	7.5	6219	0.05	7.47	7.68
30	Functional impotence	7.5	6210	0.05	7.46	7.67
31	Chest pain	7.2	5916	0.05	7.11	7.31
32	Parental fear	6.9	5666	0.05	6.80	7.01
33	Risk for compartment syndrome	6.7	5564	0.05	6.68	6.88
34	Perineal pain	6.7	5560	0.05	6.68	6.87
35	Uterine cramping	6.7	5539	0.05	6.65	6.85
36	Risk for respiratory failure	5.5	4519	0.05	5.42	5.60
37	Risk for unintended self-harm	5.4	4499	0.05	5.39	5.57
38	Risk for sepsis	4.2	3464	0.04	4.14	4.30
39	Risk for falling	4.1	3386	0.04	4.05	4.20
40	Risk for dehydration	3.8	3151	0.04	3.76	3.91
41	Clean surgical wound	3.7	3032	0.04	3.62	3.77
42	Risk for disuse syndrome	3.7	3024	0.04	3.61	3.76
43	Risk for myocardial ischaemia recurrence/progression	3.6	3020	0.04	3.61	3.75
44	Risk for respiratory failure recurrence/progression	3.5	2935	0.04	3.50	3.65
45	Bleeding	3.4	2789	0.04	3.33	3.47
46	Leisure activities deficit	3.3	2775	0.04	3.31	3.45
47	Urinary and faecal incontinence	3.3	2750	0.04	3.28	3.42
48	Peripheral oedema	3.0	2510	0.03	2.99	3.13
49	Abdominal pain	3.0	2483	0.03	2.96	3.09
50	Medium risk for pressure sores	2.9	2370	0.03	2.82	2.95

SEP, Standard error of the population; CI_LL, confidence interval: lower limit (5th percentile); CI_UL, confidence interval: upper limit (95th percentile).

diagnoses for other nursing care beneficiaries included in the patients' care plans.

The frequency of use of the ATIC nursing diagnoses distributed as follows: only one diagnosis fell into the *extremely high* frequency category; 12 problems (2.2%) and 7 (1.3%) diagnostic concepts corresponded to the *very high* and *high* frequency of use respectively; 17 problems (3.2%) were found to be used with a *moderate* frequency; 89 labels (16.8%) fell into the *low* frequency of use category; 125 nursing problems (23.7%) were used in a *very low* frequency; 111 diagnoses (21.0%) were *extremely low* used in nurses e-charts and finally, 124 concepts (23.5%) were used in *exceptional cases*.

When observing the granularity of the nursing diagnostic concepts, aggregating results from very specific terms to general related ones, differences were identified in the frequency outcome measure. Thus, when aggregating all the acute pain-related nursing diagnosis labels to the *Acute pain* diagnostic concept, the frequency almost doubled, from 49.6% to 80.4% of in-patient population studied suffering this problem according to the nursing electronic documentation. The same effect was observed when aggregating results for *Risk for infection* related labels (20.3–53.4%), *Risk for self-concept disturbance* associated diagnoses (1.5–3.1%) or *Ulcer* detailed concepts (0.2–3.7%).

Finally, during the period of the study, requests to add diagnostic concepts from nurses were not received. Twelve requests from different nurses to clarify a diagnostic concept ($N = 3$) or to ask for opinion on differential diagnosis ($N = 9$) were attended.

5. Discussion

This study was designed to evaluate the usability of the diagnosis axis of an interface terminology by assessing its completeness and the frequency of use of its concepts in the acute care setting.

Based on a large dataset, the results presented seem to support that the diagnosis axis of the ATIC terminology meets the usability criterion of completeness: 92.3% of the diagnostic concepts were used with a variety of frequencies and ward nurses could represent their judgements on patients' status, since no requests for new diagnostic concepts were received.

In the study, sample distribution data, in terms of age, gender and conditions for admission, were consistent with available in-patient population statistics from different European healthcare systems official websites (Ministerio de Sanidad and Política Social, 2009; National Health and Service, 2011) and with data from previous studies published in the international nursing literature (Goosen et al., 2001; Sermeus et al., 2008).

In the absence of published research on other nursing interface terminologies to compare, studies using NANDA_I nursing diagnoses have been addressed, because as previously explained, NANDA_I is a classification system but it has been used for long as an interface terminology (Bernhart-Just et al., 2009; Klehr et al., 2009; Müller-Staub, 2009).

To the author's knowledge, only a few studies assessing the usability of other nursing diagnosis controlled terminologies in relatively large acute care populations have been published. These studies describe the expressions used by nurses to represent patients' problems in the acute care setting (Thoroddsen and Thorsteinsson, 2002), the more prevalent NANDA_I nursing diagnosis (Almeida et al., 2008; Goosen et al., 2001; Olaogun et al., 2011), or how nursing specialty knowledge was demonstrated in nursing records by use of standardised nursing languages, including the NANDA_I diagnoses (Thoroddsen et al., 2010).

The findings presented by these authors are moderately consistent with the ones in this evaluation. Several reasons may explain the differences and inconsistencies. First, conceptually classifications, nursing minimum data sets and interface terminologies serve different purposes (Marin et al., 2000). Second, the educational background of nurses and their context of practice may be substantially different in terms of the use of the nursing diagnosis and their frequency and accuracy. Third, all these studies use cross-sectional designs. Their results represent prevalence data contrasting with the longitudinal data from individual care episodes in the ATIC analysis. Longitudinal designs tracks participants' behaviour while using a language system over an extended period of time and they may be especially useful for evaluating controlled vocabularies, since they allow to observe how usage may vary (Shneiderman and Plaisant, 2006).

The reports referred studying general in-patient populations, using the NANDA_I classification, show extensive use of nursing diagnoses as documented in patient records. Thoroddsen and Thorsteinsson (2002) and Olaogun et al. (2011) also identify patient problems not represented by NANDA_I. They cited "missed" diagnostic concepts like *Risk for dehydration*, *Headache*, *Risk for decubitus ulcer or Heart-burn*, which are represented in the ATIC terminology and have been used by nurses in this study.

The fact is that probably, these diagnoses that nurses miss in the NANDA_I classification are detailed concepts embedded in more abstract and non-specific NANDA_I diagnostic concepts. For example, *Headache* may be matched to the diagnosis *Acute pain*; *Risk for dehydration* may be aggregated into the concept *Risk for fluid volume deficit*, and so on. This is what refers the "granularity effect" of a controlled vocabulary which is further discussed in Section 5.1.

Recently, several analysis on the frequency of patients' problems in focussed groups of diagnoses or selected acute populations have also been published. A study from Tannen et al. (2012) offered cross-sectional data on care problems related to oral intake. Our findings are consistent when comparing for nausea, vomiting, swallowing problems, and risk for nutritional deficit. Frequency results in our study are also consistent with the relevant nursing diagnoses and health problems with absolute consensus described by Speksnijder et al. (2011) in haematology-oncology patients, except for the problem *Risk for multiorgan toxicity*, that was one the most frequent diagnosis used in our study for this in-patient population and it was not mentioned in these authors' work. Similarly, many of the nursing phenomena in in-patient psychiatry identified by Frauenfelder et al. (2011), that the authors classify as not located among the NANDA_I labels and definitions, are observed in our study, although at the lowest levels of frequency of use because psychiatric in-patients represents a minor proportion in the overall acute in-patient population.

Moderate consistency is also observed when reviewing the results of a frequency analysis of nursing diagnoses in surgical orthopaedic patients (da Silva et al., 2008).

Little coincidence exist when observing the findings of the study from Scherb et al. (2011) that described the most frequent NANDA_I nursing diagnoses of hospitalised older adults with heart failure, but it should be taken into account that these authors found considerable variation across the hospitals in the ten most frequent nursing diagnoses identified. Our results also show discrepancy when contrasted to the results presented by Head et al. (2011) on the most frequent nursing diagnoses for hospitalised older adult with pneumonia.

These considerations about the similarities and differences among studies should be interpreted with caution, since the reports refer to selected in-patient groups and most of them use cross-sectional designs, in contrast with the general in-patient approach and the longitudinal design in this ATIC evaluation.

5.1. Implications for practice and future research

Nursing classifications necessarily tend to confine concepts to an abstract level in order to aggregate and synthesise. Both classifications and nursing minimum data sets are expected to present aggregated data of the diagnostic concepts, while interface terminologies may include concepts detailed to different levels of granularity, form general to very specific ones, because "*the need for granularity varies depending on the needs of the users; at the point of care, specific concepts may be needed, for research or management purposes less granularity will suffice*" (Bakken et al., 2000; Sewell and Thede, 2010).

The presented study was not intended to analyse the granularity effect; only sample diagnoses were observed and a minimum basic descriptive analysis was performed. Wieteck et al. (2008) pointed out some issues with regard to the granularity effect, when discussing the results of a mapping procedure applied to two nursing controlled vocabularies, demonstrating that "*finer granularity of the nursing diagnoses contributes to the increase in expressiveness and clarity*". These suggest that further research should be conducted to properly evaluate this effect in any nursing language system.

The heterogeneous grades of consistency previously found when discussing the results, may be related to the fact that concept granularity is not considered and also that, standardised nursing languages have been reported to lack alignment of terms being used by nurses in the clinical setting (Carrington, 2012).

A relationship may also exist with the hypothesis that the nurses' clinical expertise may play a role in the final judgements stated and documented.

The content of nursing documentation has been closely associated with nurses' professional expertise (Wang et al., 2011). It could be hypothesised that, the proportion of risk nursing diagnosis and the specificity of the diagnosis labels used could be indirect indicators of the nurses' clinical expertise: advancing to what is going to happen to a patient correlates with the results of previous studies where, prevention and early recognition of deterioration was considered to require a very high clinical competence threshold (Juvé-Udina et al., 2008; Reischman and Yarandi, 2002; Thompson et al., 2008) while contributing to patients' safety (McDonell et al., 2013). It might be possible that, novice nurses are more symptom-focussed, they need to use a greater number of diagnoses and more general concepts to explain a situation while, expert nurses are more focussed on the problem-outcome dyad, being able to synthesise and accurately identify specific diagnoses and outcomes to be managed and prevented. As explained by Reischman and Yarandi (2002): "*The expert nurse processes cues with highly relevant fine-tuned patterns of knowledge. These patterns of knowledge are perceived as one unit of information*".

Some studies have included the average number of nursing diagnoses identified by nurses in the patients' care plans (da Silva et al., 2008; Morales-Asencio et al., 2009; Thoroddsen et al., 2011). Describing how many nursing diagnoses does a patient' care plan contain should not be considered as an indicator of nursing intensity, patient' complexity or severity of the situation, at least until more evidence is produced on the relationship between nursing diagnoses and nursing clinical expertise.

It has been suggested in the literature, that nurses refer that standardised nursing languages reduce the individualised approach of nursing care and documentation, because these vocabularies are not able to reflect subtle changes in patient' status, and they may foster inaccuracies in patients' information in reporting clinical events (Carrington, 2012; Lee et al., 2002). The presence of diagnoses categorised in this study as very low, extremely low frequency and exceptional cases are probably needed in interface terminologies to ease nurses' individualisation of the patient care plan. This fact should be considered one of the main differences between interface terminologies and classifications or other types of nursing controlled vocabularies. Accordingly, the use of this type of diagnoses may be indicators of accuracy and clinical expertise, although this statement cannot be proven with such a design presented. There might also be taken into account, that some of these diagnoses are expected to be exceptionally used, because they may represent a failure to prevent deterioration, adverse events or negative outcomes. This is the case for some exceptionally used diagnoses identified in this study like *Faecal impaction*, *Extravasation* or *Complicated grieving*.

It is not feasible to think that only expert nurses will work in a hospital (Benner et al., 2009). Assuming that the nurses' clinical expertise in the hospital staffing distributes on a Gaus' bell, controlled terminologies should probably include this consideration to serve equally to competent and proficient nurses, while guiding the clinical judgement learning process of novice and advanced beginner nurses.

In this same sense, proficient and expert nurses are probably working with the concept of a *main nursing diagnosis*. Their previous experiences with similar cases and advanced reasoning skills enhance them to integrate the overall information captured when caring for the patient, relating and ruling out cues that lead them to effectively diagnose what is happening to a patient, what should be done to manage it and to prevent further complications or avoid adverse end points, altogether expressed as a single nursing diagnosis with multiple interventions to achieve the desired health outcomes. The patterns of knowledge and reasoning processes of such proficient nurses probably does not match with a simplistic linear way of representing the nursing process, where each diagnosis is conceived independent from the whole situation (Tanner, 2000). But, further research is needed to clarify this and other considerations on nursing diagnoses, including the evaluation of the differences among novice and expert nurses' use of nursing diagnoses and the development of the meaning of the concept *Main nursing diagnosis* to evaluate whether it make sense for the nursing community or not. *Main nursing diagnosis* should be the term used to illustrate the problem that is the major cause of the patient need for nursing care, but to the author's knowledge, no concept analysis or other types of designs about this topic have been published in the literature.

6. Limitations

Overall, this study has some limitations that should be mentioned; those inherent to a descriptive, retrospective design and others as follow.

First, the data were gleaned from nursing electronic documentation from 162 in-patient wards that differ in the conditions of the patients, patient-to-staff ratio, nurses' educational background and professional experience, and nurses' skills in both the diagnostic reasoning process and the use of the electronic health record system. These factors might have influenced the accuracy of the results. Some previous studies showed that no statistically significant differences were observed in the hospitals included in this analysis when assessing for the practice environment, using the Nursing Work Index (Juvé-Udina et al., 2007) and when evaluating the nurses' clinical expertise levels distribution, from novice to expert (Juvé-Udina, 2007). These evidences could be taken into account when considering the findings presented.

Second, nurses' knowledge and previous experience in the use of nursing controlled vocabularies were not considered in this essay. In a recent survey conducted in the United States, the results indicated that a large proportion of respondent nurses had no experience with or knowledge of any nursing controlled vocabulary, being the NANDA_I framework "*the most recognisable with over 1/3 of respondents reporting that they had used it in nursing school, but not since*" (Schwiran and Thede, 2011). Similarly, in a qualitative inquiry conducted in Madrid (Spain), participants stated that the issue was not only the knowledge of the nurse in the clinical practice but those who "impose" the use of nursing language systems, who actually did not know how to implement these vocabularies in practice (Cachón-Pérez et al., 2012). Lack of knowledge and substantial complexity of the vocabularies employed, expressed by difficulties to use them because of lacking alignment with close-to-natural clinical language, have been reported in the literature as important issues to be considered in nursing language systems research (Carrington, 2012; Paganin et al., 2008).

Third, despite the large sample size and the multicenter approach, only electronic documentation from patients in public hospitals was studied. Testing the usability of the diagnosis axis of the ATIC terminology in private hospitals and in other health care settings is probably needed. In this same sense, international studies might also be needed, because the literature describes several culturally relevant issues on the use of nursing controlled vocabularies across countries (Thoroddsen and Thorsteinsson, 2002; Lai et al., 2013).

Forth, the population studied included intermediate care units but excluded critical care wards. Equally, the sample included healthy newborns which are not expected to present acute health problems. These data should be kept in mind when interpreting the results.

Fifth, no data about how long the diagnoses did exist during the care episodes were gathered. It might be interesting, as suggested by Tannen et al. (2012), to include this information in future studies. In this same sense, patient days were not controlled. The *patient day* is a unit of measurement defined as "*one day in hospital of a particular patient*" (Goosen et al., 2001) and it may offer valuable information to assess future results.

Sixth, no requests for other diagnostic concepts were received from nurses. The method used to collect nurses' requests for patient's problems that they could not represent using the ATIC diagnoses may have resulted insufficient and may have unwillingly introduced potential bias in the findings. This limitation could not be eliminated due to the need for protecting the right to autonomy and the voluntary character of participation, but alternative methods should be considered in future studies.

Completeness is one of the criteria to assess usability of a controlled vocabulary, but usability should also be evaluated measuring, accuracy, efficiency and satisfaction. The evaluation of these metric properties might result more effective in identifying nurses' needs for other diagnostic concepts to represent the patients' problems they diagnose in the acute care setting.

7. Conclusions

The findings of this study are expected to contribute to reach some of the orientations of the *Nursing informatics research agenda for 2008–2018*, which encourages the identification of the information needs of interdisciplinary researchers, the emphasis on effectiveness studies in real world settings and the use of innovative evaluation methodologies that attend to human–computer interface factors (Bakken et al., 2008).

The results presented herein contribute to demonstrate that the diagnosis axis of the ATIC terminology meets the usability criterion of completeness. The findings reported also show longitudinal data on the frequency of use of the ATIC nursing diagnoses, in the acute care setting, that may lead to obtain a more accurate understanding of the value and the usage patterns of this interface terminology.

Nursing interface terminologies are not intended to substitute the existing classification systems but to complement them, while at the same time, to meet the needs of nurses in the practice settings, to concisely represent their judgements on the patients' status and progress.

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