Nursing diagnoses, outcomes and interventions as measures of patient complexity and nursing care requirement in Intensive Care Unit

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Abstract

Aims. To describe the nursing diagnoses, outcomes and interventions for patients admitted to intensive care units and to assess their possible relation with classical outcomes like length of stay and mortality.

Background. The analysis of nursing diagnosis frequencies may help to estimate the patients' complexity and the need for nursing interventions and can predict hospital outcomes. Nonetheless, few studies were conducted on critical patients.

Design. Prospective cohort observational study.

Methods. Between 15 July–31 October 2013 we collected the above-described nursing parameters of 100 subjects throughout their stay in intensive care. We classified the parameters according to established taxonomies. The independent association between the number of nursing diagnoses and length of stay/mortality was investigated with multiple regressions.

Results. We found an average of 19 diagnoses, 24 outcomes and 60 interventions per patient. Most frequently, the plans of care involved support for self-care deficits or interrupted family processes. They also included strategies to prevent infection, disuse syndrome and impairment of skin integrity. Nineteen nursing diagnoses were significantly related with mortality or length of stay in bivariate analyses. In regression models, the number of such diagnoses explained 29·7% of the variance in length of stay and was an independent predictor of mortality.

Conclusion. In critically ill patients, the analysis of nursing diagnoses, outcomes and interventions confirmed an intense activity in response to a broad spectrum of patient needs. The number of nursing diagnoses allowed to predict patient outcomes.

Keywords: intensive care, nursing, nursing diagnosis, nursing intervention, nursing outcome

Why is this research needed?

- The complexity of nursing practice and its impact on the quality of health care and patient outcomes is seldom described because of poor documentation.
- A uniform and standardized nursing language is advisable to investigate the quality of nursing and its effects on patient outcome.
- The actual contribution of nursing to the overall quality of care in the intensive care setting is still undetermined.

What are the key findings?

- The analysis of nursing diagnoses, interventions and outcomes highlighted the complexity of patients, who required a wide range of intensive nursing activities.
- The number of most critical nursing diagnoses was a good predictor of both length of stay and mortality, better than the APACHE II score or the medical diagnoses.
- Our results are novel, the mostly retrospective previous studies tended to underestimate the patients' complexity and the pursued outcomes, with a possibly inaccurate depiction of nursing in the intensive care setting.

How should the findings be used to influence policy/practice/research/education?

- The systematic collection of standardized nursing data throughout the intensive care stay contributes to an adequate description of patient complexity, nursing workload and impact of nursing on patient outcomes.
- Nursing care in hospitals cannot be evinced from medical diagnoses only, nursing diagnoses can be good predictors of hospital outcomes and costs.
- Despite the unquestionable importance of electronic data systems for gathering and managing extensive nursing information, the actual quality of the collected data should also be of concern.

Introduction

Although the care provided by nurses may have a dramatic impact on the quality of health care and on patient outcomes, nursing activities are often invisible because of documentation practices. Nurses typically collect information in a sparse and heterogeneous manner, so that the documentation is inaccurate and incoherent in general (Paans *et al.* 2010), while the richness and the complexity of nursing practice is rarely captured. The use of a uniform and standardized nursing language could document what nurses really do in clinical practice and may allow better evaluations of the effectiveness of nursing provided to patients. A Nursing Minimum Data Set (NMDS) has been proposed to collect uniform and specific nursing data, comprising diagnoses, interventions and outcomes (Werley *et al.* 1991). 'Nursing diagnosis' (ND) is the accepted and more widely diffused term for naming nurses' clinical judgments concerning human responses to health conditions/life processes, or a vulnerability for that response, by an individual, family, group or community (Herdman 2014). NDs should be recognized as an independent phase of the nursing process and are the premise for decision-making activity, since they offer nurses the opportunity to focus their care on expected nursing outcomes (NOs) and to select specific direct or indirect treatments (nursing interventions, NIs) to achieve them (Moorhead *et al.* 2012, Bulechek *et al.* 2013).

The analysis of ND frequencies provides a measure of the patient's complexity and any related care needs (O'Brien-Pallas *et al.* 1997) and allow us to identify and compare the ND patterns between similar settings, and to analyse the coherence among NDs, NIs and NOs (Müller-Staub *et al.* 2006). These data offer the opportunity for nurse administrators and clinicians to assess the nursing practice, the resources needed and any associated documentation procedures (Head *et al.* 2011).

Unfortunately, while clinical indicators, such as medical diagnoses (MDs) and functional health status, are often used in outcome studies, NDs are rarely considered, primarily because routine, comparable data are seldom collected (O'Brien-Pallas *et al.* 2002). Consequently, the potential relationship between nursing care and patient health outcomes also remains uncertain (Maas & Delaney 2004, Müller-Staub *et al.* 2006, Urquhart *et al.* 2009). Moreover, even if nursing represents the largest segment of hospital costs, the variations in nursing resource consumption cannot be specifically identified and quantified and will therefore continue to be implicitly considered as a fixed cost in hospital reimbursement systems (Knauf *et al.* 2006, Welton *et al.* 2006). Realizing this potential, will require the conversion of current non-standardized, non-uniform and invisible nursing data into visible, standardized and uniform data (O'Brien-Pallas *et al.* 2002).

Background

Critical care nursing deals specifically with human responses to life-threatening problems to ensure that patients and their families receive optimal care at a time in their lives when they are particularly frail. Critically ill patients require complex and continuous assessment, high-intensity interventions and uninterrupted vigilance. Therefore, nurses working in intensive care units (ICU) must have a wide body of knowledge and technical expertise, and a high level of skills in clinical reasoning and decision-making (American Association of Critical-Care Nurses (AACN) n.d.). In their definition of standards of care, the AACN stated that nurses caring for acute and critical patients should identify one or more NDs and use them to develop a plan of care, which reflects current nursing practice. The plan should be developed collaboratively with the healthcare team and involve the patients and their families based on their ability to make decisions about care (AACN 2008). Few studies have identified, using standardized nursing languages, the prevalence and the pattern of NDs (de Carvalho *et al.* 2008, Truppel *et al.* 2009, de Fátima Lucena *et al.* 2010, Paganin *et al.* 2010, Yücel *et al.* 2011, Chianca *et al.* 2012a, Moreira *et al.* 2013, Adejumo & Akolade 2014), NIs (Oliveira & Freitas 2009, Truppel *et al.* 2009, Salgado *et al.* 2012), or NOs (Chianca *et al.* 2012b) in ICU patients; only one study considered the relationships among the three items (Moon 2011).

It has been documented that the number of NDs can reveal the intensity of the need for nursing care and predict hospital outcomes, such as mortality and length of stay (Halloran 1985, Rosenthal *et al.* 1995, O'Brien-Pallas *et al.* 1997, Welton & Halloran 2005). However, to our knowledge, only a few studies have evaluated this influence in ICU patients (Lee *et al.* 2002). The use of a standardized international taxonomy for NDs, NIs and NOs would be a way to demonstrate the effects that nursing involves and what it is that makes effective nursing a specific responsibility of nurses (Bond & Thomas 1993, Hogston 1997).

The study

Aims

The primary aim of this study was to describe the complexity of nursing practice by prospectively examining the pattern and the frequency of diagnoses, outcomes and interventions and the rate of NO actually achieved for ICU patient care. Moreover, we analysed the influence of the number of NDs, which are assumed to be a measure of patient complexity and nursing care requirements, on patient's LOS and mortality in the ICU.

Design and setting

This was a prospective cohort observational study carried out in the Academic Hospital of Trieste in north eastern Italy. This facility is an 866-bed hospital accredited by the Joint Commission International and is divided into two different sites. Depending on their clinical characteristics, critically ill patients can be admitted to the general, cardiovascular or postoperative cardiac surgery ICUs or to the high-dependency unit. To ensure a greater uniformity of patient characteristics and care needs, the study was conducted in the two general ICUs. ICU-A has four beds and admits about 200 patients a year, mainly for postoperative care and exacerbation of chronic pathologies but also for the treatment of acute cardiovascular, respiratory, or metabolic diseases. ICU-B has 13 beds and admits almost 800 patients a year who suffer primarily from acute cardiovascular or respiratory failure, trauma, severe infections, sepsis and major intoxications. According to the hospital policy, the initial assessment and the personalized nursing care plan were carried out early (within a few hours of admission) for all patients admitted to the two facilities and were frequently updated during the patient's stay. No standardized taxonomy was in use for the planning and classification of nursing activities.

Sample/participants

A minimum required sample size of 91 patients was calculated for a multiple regression model that included five predictors to detect a medium anticipated effect size (f^2) of 0·15 with a probability of a type I error of 0·05 and a type II error of 0·2. A convenience sample of 100 consecutively admitted patients was thus recruited. Patients were considered eligible if they were >17 years old and had an ICU-LOS duration of greater than 24 hours. As the study analysed the care planned and provided by nurses during the patients' ICU stay, the data collection ended when the patients either died or were transferred to other wards.

Instruments

The main determinants of the plan of care were encoded using the so-called 'NNN taxonomy' (North American Nursing Diagnosis Association, NANDA (Herdman 2014), Nursing Outcomes Classification, NOC (Moorhead *et al.* 2012), Nursing Interventions Classification, NIC (Bulechek *et al.* 2013)).

Data collection

Four properly trained critical care nurses set ND, NO and NI by consensus, according to the NNN taxonomy on the basis of their daily observations of the actual planned and performed nursing care, which was recorded in the nursing documentation by ICU nurses in the context of clinical practice. During the entire ICU stay, the actual or potential (risk) NDs were selected after the complete assessment of the patients based on Gordon's Functional Health Patterns, respecting definition, defining characteristics (signs and symptoms) and related factors (causative or associated). Each expected NO was derived from the ND and was established according to the patient's potential and also the available resources on the basis of a five-point score (from 1: least desirable to 5: most desirable). The outcomes were considered 'reached' or 'not reached' (achievement of the established NOC score) after having re-evaluated the patient at the time estimate for achievement; the outcome were considered 'not reached' both when the NOC score did not improve (unless maintaining the NOC status was the desired goal) or worsened, and also when patients died or were transferred to other wards without reaching the established outcome. All performed NIs were classified according to standardized NIC taxonomy; since the administration of medications via the intramuscular or subcutaneous route was much rarer than intravenous administration, we unified these data in a single 'parenteral' category.

For enrolled patients, the modality of ICU admission (from the emergency department, ED; from the general ward; or from another ICU) and the main medical diagnosis based on the ICD-10-CM (International Classification of Diseases, 10th Revision) (World Health Organization n.d.) categories were documented, given that these variables can affect the studied outcome (Hillman *et al.* 2002, Godfrey *et al.* 2012). The severity of disease on admission was weighted using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score, which showed predictive validity in ICU patients for both in-hospital LOS and mortality (Knaus *et al.* 1993). Since the patient's age and the presence of comorbidities increased the risks of hospital death and complications (Iezzoni 2013), which can interfere with the effects of the nursing and medical interventions, the level of comorbid medical conditions was calculated using the Charlson Co-Morbidity Index adjusted for age (Charlson *et al.* 1994). The ICU-LOS and the condition at ICU discharge (deceased or living) were also documented.

Ethical considerations

The study was conducted according to the ethical principles stated by the Declaration of Helsinki. Because the nursing planning was a routinely performed procedure for patient care, a formal approval from the Institutional Review Board was not required according to the hospital authorities.

Data analysis

Statistical analysis was performed using the software IBM SPSS Statistics for Windows, Version 22·0 (IBM Corp., Armonk, NY, USA). Continuous variables were displayed as mean (standard deviation, SD) and range. Nominal variables were shown as a number and percentage and were analysed using 2 × 2 contingency tables and Fisher's exact test. One-way analysis of variance (ANOVA) was applied for all comparisons between the subgroups. The differences between means were analysed via unpaired Student's *t*-test or Mann–Whitney's *U*-test, depending on whether the distribution of data was normal or abnormal.

Bivariate association between the number of NDs and other continuous variables was investigated with Pearson's correlation coefficient (r), positive or negative correlation strengths were interpreted as follows: 0-0·30: little (if any), 0·30-0·50: low, 0·50-0·70: moderate, 0·70-0·90: high, 0·90-1: very strong (Hinkle *et al.* 2003).

Multiple linear regression and logistic regression models were used to examine the independent association between the cumulative frequency of ND during the ICU stay and the respective ICU-LOS and ICU mortality. Since the ICU-LOS data had a skewed distribution, logarithmic transformations were performed to obtain a more approximately normal variable. For the logistic regression model, accuracy, positive and negative predictive values (PPV and NPV) were also calculated to determine the ability of inserted predictors to divide patients into categories based on their mortality risk. In addition to NDs, a limited number of predictors were inserted in the regression models (Hosmer *et al.* 2013). For example, age was disregarded because it is already included in the Charlson Co-Morbidity Index. In the final model we included APACHE II score, Charlson Index and those variables significantly related to LOS or mortality in bivariate analyses, i.e. ND number, MD category and modality of ICU admission. Categorical data (MD categories and modality of ICU admission) were transformed to dummy variables. For all tests, an alpha level of $P = 0{\cdot}05$ was set for statistical significance.

Validity and reliability

Before starting the study, agreement in ND, NO and NI selection were evaluated with Cohen k statistics. The four nurses independently assigned ND, NO and NI to a sample of 10 patients. Both intra-observer (ND: k = 0·87-0·98; NO: k = 0·76-0·94; NI: k = 0·65-0·97) and inter-observer (ND: k = 0·78-0·95; NO: k = 0·70-0·89; NI: k = 0·66-0·90) agreements ranged from 'substantial' to 'almost perfect' (Landis & Koch 1977).

Results

Description of the sample

The study started on 15 July and ended on 31 October 2013 after the discharge of the hundredth consecutive enrolled patient. The mean patient age was 65·9 (15) years (range: 23-92), 46 were female; the male and female ages were comparable (males: 64·1 (16) years, range: 26-86; females: 68 (14) years, range: 23-92; $P = 0{\cdot}195$). Thirty-one patients were admitted in ICU-A and 69 entered ICU-B. The patients admitted to ICU-A were older than those in ICU-B ($P = 0{\cdot}014$). ICU-A mainly admitted patients from general wards, whereas ICU-B primarily acquired patients from the ED ($P = 0{\cdot}002$). No significant differences were shown in terms of the severity of clinical conditions, comorbidity, ICU length of stay and ICU mortality.

Nursing diagnoses

Overall, 71 different NDs (27·2% of 261 available in the taxonomy) were selected at least once, 47 (66·2%) were actual diagnoses and 24 (33·8%) were risk diagnoses. The diagnoses were used 1938 times, corresponding to an average of 19·4 (4·2) diagnoses per patient (range: 10–29). When the top 20 most frequently chosen NDs in the two ICUs were compared, 13 were similar and 7 were different (Table 1). ICU-A and ICU-B selected a similar number of NDs per patient (ICU-A: 18·3 (4·0), range: 11-28; ICU-B: 19·9 (4·2), range: 10-29; $P = 0{\cdot}083$). After comparing all selected NDs, 18 diagnoses were chosen with significantly different frequencies (Table 2). No statistically significant differences were shown for the mean number of NDs after grouping the patients according to the modality of ICU admission ($F = 0{\cdot}208$, $P = 0{\cdot}813$) and MD categories ($F = 0{\cdot}721$, $P = 0{\cdot}609$). A significant and weakly positive correlation was observed between the number of selected ND and Charlson Index ($r = 0{\cdot}26$, $P < 0{\cdot}001$), whereas there were no significant correlations with the APACHE II score ($r = 0{\cdot}14$, $P = 0{\cdot}153$), age ($r = -0{\cdot}01$, $P = 0{\cdot}906$) and ICU LOS ($r = 0{\cdot}12$, $P = 0{\cdot}240$).

Nursing outcomes

Starting with each ND, one or more NOs were selected in the study population. Fifty-four different NOs were chosen at least once (11·0% of 490 available in the taxonomy). Overall, the number of selected NOs was 2,397 (average: 24·0 (4·6) NO per patient, range: 14–35). Considering the

Table 1 First 20 nursing diagnoses most frequently selected for the study population. The diagnoses selected only by one ICU are in Italic.

Enrolled population (*N*; %)	ICU-A (*N*; %)	ICU-B (*N*; %)
Bathing/hygiene self-care deficit (100; 100)	Bathing/hygiene self-care deficit (31; 100)	Bathing/hygiene self-care deficit (69; 100)
Risk for infection (95; 95·0)	Risk for disuse syndrome (29; 93·5)	Risk for infection (67; 97·1)
Interrupted family process (93; 93·0)	Risk for infection (28; 90·3)	Interrupted family process (66; 95·7)
Risk for disuse syndrome (86; 86·0)	Interrupted family process (27; 87·1)	Risk for imbalanced fluid volume (63; 91·3)
Risk for impaired skin integrity (80; 80·0)	Risk for falls (27; 87·1)	Risk for impaired skin integrity (59; 85·5)
Risk for imbalanced fluid volume (78; 78·0)	Risk for impaired skin integrity (21; 67·7)	Ineffective airway clearance (59; 85·5)
Ineffective airway clearance (70; 70·0)	Impaired social interaction (20; 64·5)	Risk for disuse syndrome (57; 82·6)
Impaired social interaction (68; 68·0)	Impaired urinary elimination (19; 61·3)	*Impaired oral mucous membrane (56; 81·2)*
Risk for unstable blood glucose (66; 66·0)	*Hyperthermia (16; 51·6)*	Risk for unstable blood glucose (51; 73·9)
Impaired oral mucous membrane (63; 63·0)	*Acute pain (16; 51·6)*	Impaired social interaction (48; 69·6)
Risk for dysfunctional gastrointestinal motility (57; 57·0)	*Disturbed sleep pattern (16; 51·6)*	*Risk for dysfunctional gastrointestinal motility (48; 69·6)*
Risk for falls (51; 51·0)	Risk for imbalanced fluid volume (15; 48·4)	Impaired gas exchange (34; 49·3)
Impaired urinary elimination (48; 48·0)	Risk for unstable blood glucose (15; 48·4)	*Impaired bed mobility (34; 49·3)*
Impaired gas exchange (47; 47·0)	*Ineffective breathing pattern (15; 48·4)*	*Risk for dry eye (34; 49·3)*
Risk for bleeding (46; 46·0)	*Risk for ineffective peripheral tissue perfusion (15; 48·4)*	Risk for bleeding (33; 47·8)
Impaired bed mobility (44; 44·0)	Impaired gas exchange (13; 41·9)	*Risk for electrolyte imbalance (30; 43·5)*
Risk for dry eye (41; 41·0)	Risk for bleeding (13; 41·9)	Impaired urinary elimination (29; 42·0)
Hyperthermia (40; 40·0)	*Deficient fluid volume (13; 41·9)*	*Impaired spontaneous ventilation (28; 40·6)*
Ineffective breathing pattern (39; 39·0)	*Risk for peripheral neurovascular dysfunction (12; 38·7)*	*Risk for ineffective cerebral tissue perfusion (25; 36·2)*
Impaired spontaneous ventilation (38; 38·0)	Ineffective airway clearance (11; 35·5)	Risk for falls (24; 34·8)

Table 2 Nursing diagnoses selected with significantly different frequencies between the two intensive care units (ICUs).

Nursing diagnosis	ICU-A *n*; %	ICU-B *n*; %	Difference RR; *P* value*
Acute pain	16; 51·6%	18; 26·0%	1·978; 0·0215
Anxiety	11; 35·4%	11; 15·9%	2·226; 0·0381
Deficient fluid volume	13; 41·9%	12; 17·3%	2·411; 0·0126
Disturbed sleep pattern	16; 51·6%	12; 17·3%	2·968; 0·0007
Excess fluid volume	0; 0%	17; 24·6%	NV; 0·0012
Impaired oral mucous membrane	7; 22·5%	56; 81·1%	0·278; <0·0001
Ineffective airway clearance	11; 35·4%	59; 85·5%	0·415; <0·0001
Nausea	3; 9·7%	0; 0%	NV; 0·0278
Readiness for enhanced power	6; 19·3%	2; 2·89%	6·677; 0·0103
Risk for dry eye	7; 22·5%	34; 49·2%	0·458; 0·0155
Risk for dysfunctional gastrointestinal motility	9; 29·0%	48; 69·5%	0·417; 0·0002
Risk for electrolyte imbalance	5; 16·1%	30; 43·4%	0·371; 0·0119
Risk for falls	27; 87·0%	24; 34·7%	2·504; <0·0001
Risk for imbalanced fluid volume	15; 48·3%	63; 91·3%	0·53; <0·0001
Risk for ineffective cerebral tissue perfusion	1; 3·2%	25; 36·2%	0·089; 0·0004
Risk for ineffective peripheral tissue perfusion	15; 48·3%	15; 21·7%	2·226; 0·0098
Risk for peripheral neurovascular dysfunction	12; 38·7%	7; 10·1%	3·816; 0·0170
Risk for unstable blood glucose	15; 48·3%	51; 73·9%	0·655; 0·0215

*Fisher's Exact Test.
RR, relative risk.

top 20 most frequently chosen NOs in the two ICUs, 14 were similar and six were different (Table 3). ICU-A selected significantly fewer outcomes per patient (ICU-A: 22·5 (4·5), range: 14-31; ICU-B: 24·7 (4·6), range: 14-35; $P = 0{\cdot}027$). The rate of NO achievement was 72·1% (1728/2397) and was significantly higher for ICU-A (ICU-A: 80·3%; ICU-B: 69·0%; $P < 0{\cdot}001$). The following 10 NOs had a rate of achievement ≥90%: Wound healing: primary intention, Swallowing status and Fatigue level (100%); Self-care, hygiene (93·0%); Risk control: dry eyes (92·7%); Mechanical ventilation weaning response: adult, Nutritional status: nutrient intake (92·3%); Fall prevention behaviour (92·0%); Oral hygiene (90·5%); and Skeletal function (90·0%). A significant but small positive correlation was observed between the number of selected NOs and the Charlson Index ($r = 0{\cdot}25$, $P = 0{\cdot}014$), whereas there were no significant correlations with the APACHE II score ($r = 0{\cdot}13$, $P = 0{\cdot}194$), age ($r = -0{\cdot}05$, $P = 0{\cdot}607$) and ICU-LOS ($r = 0{\cdot}16$, $P = 0{\cdot}122$).

Nursing interventions

Seventy-nine different NIs were listed in nursing care plans (14·3% of 554 available in the taxonomy), totalling 5889 times (average of 59·9 (19·7) NI per patient, range: 20-109). After examining the first 20 most frequently performed NIs by the two ICU, 18 were similar and two were different (Table 4).

The two ICUs implemented a comparable number of NIs per patient (ICU-A: 60·9 (19·8), range: 29-108; ICU-B: 58·0 (19·8), range: 20-109; $P = 0{\cdot}498$). No statistically significant correlation was observed between the number of NIs and the Charlson Index ($r = 0{\cdot}12$, $P = 0{\cdot}240$), APACHE II score ($r = 0{\cdot}02$, $P = 0{\cdot}814$), age ($r = -0{\cdot}02$, $P = 0{\cdot}850$) and ICU LOS ($r = 0{\cdot}06$, $P = 0{\cdot}526$).

NNN connections

We analysed the most frequent connection with NO and NI for the five most commonly selected NDs. The results are reported in Table 5.

Analysis of ICU outcome

Patients both living or deceased at ICU discharge were significantly different in terms of their Apache II scores (living: 18·1 (8·3); deceased: 25·8 (5·6); $P = 0{\cdot}001$), Charlson index (living: 11·8 (9·2); deceased: 23·7 (9·6); $P < 0{\cdot}001$), number of NDs (living: 18·9 (4·0); deceased: 22·5 (4·0); $P = 0{\cdot}002$) and number of NOs (living: 23·6 (4·6); deceased: 26·4 (4·1); $P = 0{\cdot}031$), whereas no difference was found for the number of NIs (living: 58·1 (19·0); deceased: 63·9 (24·4); $P = 0{\cdot}307$) and ICU-LOS (living: 10·3 (11·5); deceased: 10·6 (12·6); $P = 0{\cdot}939$).

Nineteen NDs (26·8%) were significantly related with mortality or LOS (Table 6).

Table 3 First 20 nursing outcomes most frequently selected for the study population. The outcome selected only by one intensive care unit (ICU) are in Italics.

Enrolled population (*N*; %)	ICU-A (*N*; %)	ICU-B (*N*; %)
Medication response (280; 11·7%)	Medication response (67; 10·0%)	Medication response (213; 12·3%)
Tissue integrity: skin & mucous membrane (194; 8·1%)	Tissue integrity: skin & mucous membrane (53; 8·0%)	Tissue integrity: skin & mucous membrane (141; 8·1%)
Electrolyte & acid/base balance (113; 4·7%)	Self-care: hygiene (31; 4·7%)	Electrolyte & acid/base balance (92; 5·3%)
Self-care: hygiene (100; 4·2%)	Risk control: infectious process (27; 4·1%)	Self-care: hygiene (69; 4·0%)
Risk control: infectious process (94; 3·9%)	Family participation in professional care (27; 4·1%)	Risk control: infectious process (67; 3·9%)
Family participation in professional care (92; 3·8%)	Thermoregulation (27; 4·1%)	Family participation in professional care (65; 3·8%)
Thermoregulation (87; 3·6%)	*Fall prevention behaviour (26; 3·9%)*	Risk control: thrombus (63; 3·6%)
Risk control: thrombus (86; 3·6%)	Respiratory status: ventilation (25; 3·8%)	Thermoregulation (60; 3·5%)
Respiratory status: ventilation (77; 3·2%)	Risk control: thrombus (23; 3·5%)	*Respiratory status: airway patency (59; 3·4%)*
Respiratory status: gas exchange (74; 3·1%)	Electrolyte & acid/base balance (21; 3·2%)	Respiratory status: gas exchange (56; 3·2%)
Social interaction skills (70; 2·9%)	Social interaction skills (21; 3·2%)	*Oral hygiene (56; 3·2%)*
Respiratory status: airway patency (70; 2·9%)	*Fluid balance (21; 3·2%)*	*Gastrointestinal function (54; 3·1%)*
Blood glucose level (66; 2·8%)	*Tissue perfusion: peripheral (19; 2·9%)*	Respiratory status: ventilation (52; 3·0%)
Gastrointestinal function (65; 2·7%)	Respiratory status: gas exchange (18; 2·7%)	Blood glucose level (50; 2·9%)
Oral hygiene (63; 2·6%)	*Pain control (17; 2·6%)*	Social interaction skills (49; 2·8%)
Immobility consequences: physiological (62; 2·6%)	Blood glucose level (16; 2·4%)	Immobility consequences: physiological (48; 2·8%)
Fall prevention behaviour (50; 2·1%)	*Sleep (16; 2·4%)*	*Urinary elimination (40; 2·3%)*
Bowel elimination (49; 2·0%)	Bowel elimination (15; 2·3%)	Bowel elimination (34; 2·0%)
Urinary elimination (48; 2·0%)	Immobility consequences: physiological (14; 2·1%)	*Risk control: dry eyes (34; 2·0%)*
Fluid balance (47; 2·0%)	*Mechanical ventilation response: adult (14; 2·1%)*	*Blood loss severity (32; 1·8%)*

A regression model was devised to determine the explanatory factors for the ICU-LOS. The final model explained about 25% of the variance in the ICU-LOS ($P < 0{\cdot}001$). Both the number of NDs predictive for LOS ($\beta = 0{\cdot}297$, $P = 0{\cdot}003$) and the provenience from other ICUs as a modality of ICU admission ($\beta = 0{\cdot}243$, $P = 0{\cdot}024$) contributed significantly to the relation (Table 7).

A logistic regression model was run to ascertain the effects of the same predictors on ICU mortality. The overall relationship between independent and dependent variables was statistically significant ($\chi^2 = 35{\cdot}268$, $P < 0{\cdot}001$). The model explained 66·1% of the variance in ICU mortality and correctly classified 96·0% of cases (PPV: 100%, NPV: 71·4%). Only the number of NDs predictive for death were significant predictors of mortality (Table 8).

Discussion

In a sample of 100 patients consecutively admitted in two general ICUs, we showed that nurses selected an average of 19 NDs, 24 NOs and 60 NIs per patient during the entire ICU stay. The most frequently adopted plans of care regarded support for self-care deficits and interrupted family processes and included strategies to prevent infection, disuse syndrome and impairment of skin integrity. Among the 19 NDs significantly associated with ICU-LOS or mortality, two predicted both outcomes; 11 of them were similar to the NDs identified by AACN as high frequency/high priority (Kuhn 1991).

An analysis of the prevalence of selected diagnoses, outcomes and interventions in the two studied ICUs showed a different pattern of care needs. In particular, 18 NDs were selected a significantly different number of times in the two ICUs; moreover, ICU-A chose fewer outcomes and showed a higher rate of NO achievement than ICU-B. This fact should be related to the fact that ICU-A more frequently admitted patients already hospitalized in general wards due to critical worsening in clinical conditions, while ICU-B had a higher incidence of patients from the ED and from other less-intensive or specialist ICUs. Consequently, even if the two populations had an equal pattern of MDs, a comparable clinical severity and similar comorbidity, the NDs used

Table 4 First 20 nursing interventions most frequently acted for the study population. The interventions acted only by one intensive care unit (ICU) are in Italics.

Enrolled population (*N*; %)	ICU-A (*N*; %)	ICU-B (*N*; %)
Medication administration: parenteral (616; 10·5)	Medication administration: parenteral (187; 9·9)	Medication administration: parenteral (429; 10·7)
Vital signs monitoring (330; 5·6)	Vital signs monitoring (107; 5·7)	Vital signs monitoring (223; 5·6)
Airway management (254; 4·3)	Airway management (79; 4·2)	Airway management (175; 4·4)
Fluid monitoring (203; 3·4)	Fluid monitoring (64; 3·4)	Fluid monitoring (139; 3·5)
Respiratory monitoring (192; 3·3)	Respiratory monitoring (58; 3·1)	Respiratory monitoring (134; 3·3)
Pressure ulcer prevention (150; 2·5)	Electrolyte monitoring (51; 2·7)	Pressure ulcer prevention (100; 2·5)
Electrolyte monitoring (145; 2·5)	Pressure ulcer prevention (50; 2·6)	Positioning (96; 2·4)
Cognitive stimulation (141; 2·4)	Infection protection (50; 2·6)	Electrolyte monitoring (94; 2·3)
Positioning (140; 2·4)	Cognitive stimulation (47; 2·5)	Cognitive stimulation (94; 2·3)
Complex relationship building (139; 2·4)	Complex relationship building (45; 2·4)	Complex relationship building (94; 2·3)
Fluid management (131; 2·2)	Positioning (44; 2·3)	Fluid management (91; 2·3)
Anxiety reduction (129; 2·2)	Venous access device maintenance (43; 2·3)	*Invasive hemodynamic monitoring (90; 2·2)*
Venous access device maintenance (129; 2·2)	Visitation facilitation (43; 2·3)	Anxiety reduction (88; 2·2)
Visitation facilitation (129; 2·2)	Anxiety reduction (41; 2·2)	*Neurologic monitoring (88; 2·2)*
Infection protection (123; 2·1)	Self-care assistance: bathing/hygiene (41; 2·2)	Venous access device maintenance (86; 2·1)
Family involvement promotion (119; 2·0)	Fluid management (40; 2·1)	Visitation facilitation (86; 2·1)
Invasive hemodynamic monitoring (119; 2·0)	Family involvement promotion (37; 2·0)	Family involvement promotion (82; 2·0)
Self-care assistance: bathing/hygiene (119; 2·0)	*Bowel management (33; 1·7)*	Self-care assistance: bathing/hygiene (78; 1·9)
Neurological monitoring (118; 2·0)	*Skin surveillance (32; 1·7)*	Infection protection (73; 1·8)
Family support (104; 1·8)	Family support (31; 1·6)	Family support (73; 1·8)

in the two ICUs described patients with widely differing complexities.

In multivariate analyses, among the explored predictors only the number of NDs showed a statistically significant explanatory capacity for both LOS and mortality in the ICU. This finding may indicate that patients with a higher number of NDs predictive for LOS or death tend to be in a worse general condition and it supports previous non-ICU studies reporting that the number of NDs is predictive for in-hospital deaths and LOS (Rosenthal *et al.* 1992, 1995). We found only one study performed in respiratory ICU, where Lee *et al.* (2002) showed that patients with lower APACHE scores and more NDs had a longer LOS in the ICU. Interestingly, in our study neither the APACHE II score nor any MD category contributed significantly to explaining the variance for both ICU LOS and mortality.

We reviewed the literature on nursing diagnoses, outcome and intervention in the general adult ICU (thus excluding studies that focused on specialist ICUs, such as respiratory, coronary, paediatric, etc.) among studies using standardized nursing languages. We mainly found studies on the prevalence of NDs, while only a few studies examined NOs and NIs. A retrospective study of de Carvalho *et al.* (2008) enrolled 26 patients, to whom ICU nurses attributed an average of five NANDA diagnoses; the most attributed diagnoses were Risk for infection (84·6%), Impaired physical mobility (69·2%) and Risk for aspiration (65·3%). A retrospective study on 150 medical records reported an average of 1·3 NDs per patient and the most common were Impaired tissue integrity and Impaired gas exchange (22%), while all other diagnoses had a prevalence of less than 10% (Paganin *et al.* 2010). Truppel *et al.* (2009) identified 29 NANDA diagnoses and 38 NIC interventions in 20 randomly selected ICU patients. Analysing the data of 991 admissions extracted from a nursing care plans database, de Fátima Lucena *et al.* (2010) reported that 63 different NANDA diagnoses were selected, for a total of 6845 times (6·9 per patient), from which 39,947 NI were prescribed (average of six interventions per diagnosis), the most frequently selected NDs were Bathing/hygiene self-care deficits (98·1% of patients), Risk for infection (95·9%) and Impaired physical mobility (59·3%).

In a prospective study carried out on 44 ICU patients, 28 different NDs were obtained for a total of 1,087 (24·7 per patient); the most frequently selected diagnoses were Bathing and/or hygiene self-care deficit, Risk for infection and Risk for constipation (100%), Risk for impaired skin integrity (98%), Intimate hygiene self-care deficit (93%) and Risk for unstable blood glucose level (80%) (Chianca *et al.* 2012a). The same authors analysed the prescribed

Table 5 Most frequent linkages with nursing outcomes and interventions for the five NDs most frequently selected by nurses in ICU nursing care plans.

Nursing diagnosis	Nursing outcomes	Nursing interventions
Bathing/hygiene self-care deficit	Self-care: hygiene	Bed rest care
		Environmental management: comfort
		Personal well-being
		Self-care assistance: bathing/hygiene
Risk for infection	Risk control: infectious process	Environmental management: safety
		Family involvement promotion
		Infection protection
		Medication administration: enteral
		Medication administration: parenteral
		Phlebotomy: cannulated vessel
		Venous access device maintenance
		Vital signs monitoring
Interrupted family process	Family participation in professional care	Complex relationship building
	Social interaction skills	Family involvement promotion
		Family support
		Visitation facilitation
Risk for disuse syndrome	Immobility consequences: physiological	Body mechanics promotion
	Risk control: thrombus	Bed rest care
	Tissue integrity: skin & mucous membranes	Environmental management: comfort
		Pressure ulcer prevention
Risk for impaired skin integrity	Tissue Integrity: skin & mucous membrane	Bed rest care
		Positioning
		Pressure ulcer prevention
		Skin surveillance

nursing actions in the same population, identifying 124 different actions (2260 in total, 51·4 per patient); after remapping the nursing actions according to the NIC taxonomy, the most prescribed NIs (100%) were Bathing, Oral health maintenance, Respiratory monitoring, Airway management, Positioning and Infection control (Salgado *et al.* 2012).

We found only one study that considered the complete NNN taxonomy in an ICU population. Moon (2011) analysed the electronically archived nursing care plan data of 578 patents admitted to three ICUs (medical, surgical and cardiovascular) over a 2-month period. The author found an average of 3·7 NDs, 4·1 NOs and 6 NIs per patient during the ICU stay. The first five selected NDs were Acute pain, Impaired gas exchange, Ineffective airway clearance, Risk for infection and Ineffective tissue perfusion: pulmonary. Only acute pain showed a prevalence greater than 10% (12·5%). Surprisingly, NDs related to the most easily predicted needs for ICU patients, such as Self-care deficit (e.g. bathing/hygiene), Impaired urinary elimination, or Interrupted family processes, were selected for less than 1% of cases. The author also reported that only 30·6% of NOC scores increased at the last rating over the patient's ICU stay. In our study, a greater rate (72·1%) of expected NOs was reached at ICU discharge, which was probably due to very early initial patient assessment and planning, and to a fairly longer ICU-LOS (average: 10·4 days vs. 2·6 of Moon's study).

In general, it should be noted that the cited studies reported very different results and there are many reasons for these differences. One could be related to the different enrolled populations, however, we searched only for studies that admitted patients from a general ICU, assuming that the case mix of the study reporting joint data from three specialist ICUs (Moon 2001) could be comparable to a general ICU. Even supposing possible differences in the characteristics of enrolled populations, the dissimilarity between the results, such as the reported incidence of NDs, seems unjustifiable.

Another reason could be related to the design of the studies. We noted similarities between studies having a prospective or retrospective design. In many fields of health care, the results of studies based on the retrospective analysis of routinely collected data are controversial (McKee *et al.* 1992, Claster *et al.* 2013, Griffiths *et al.* 2013, Tu *et al.* 2013). One expected limitation in retrospective studies is that nurses may not have documented their work consistently enough, because of contrasts between the time avail-

Table 6 Nursing diagnoses significantly related with Intensive Care Unit length of stay (ICU-LOS) or mortality.

	Mortality *n*/*N* (%)			ICU-LOS (days) *N*; mean (SD)		
Diagnosis	Present	Absent	*P* value*	Present	Absent	*P* value†
Acute pain	1/34 (2·9%)	13/66 (19·7%)	0·031		/	
Decreased intracranial adaptive capacity	7/17 (41·2%)	7/83 (8·4%)	0·002		/	
Disturbed sleep pattern	0/28 (0·0%)	14/72 (19·4%)	0·009		/	
Deficient fluid volume		/		25; 6·2 (6·3)	75; 11·7 (12·6)	0·005
Impaired gas exchange	11/48 (22·9%)	3/52 (5·8%)	0·020		/	
Impaired oral mucous membrane	14/63 (22·2%)	0/37 (0·0%)	0·002	63; 13·0 (13·1)	37; 5·9 (6·3)	<0·0001
Ineffective airway clearance	14/70 (20·0%)	0/30 (0·0%)	0·009	70; 11·9 (12·3)	30; 6·7 (8·9)	0·041
Impaired skin integrity		/		15; 21·5 (18·6)	85; 8·4 (8·7)	0·017
Ineffective peripheral tissue perfusion	6/14 (42·9%)	8/86 (9·3%)	0·004		/	
Risk for bleeding	10/46 (21·7%)	4/54 (7·4%)	0·047		/	
Risk for decreased cardiac tissue perfusion	5/13 (38·5%)	9/87 (10·3%)	0·017		/	
Risk for dry eye	12/41 (29·3%)	2/59 (3·4%)	0·001		/	
Readiness for enhanced power		/		8; 4·9 (1·5)	92; 10·8 (12·0)	<0·0001
Risk for imbalanced fluid volume		/		81; 11·9 (12·4)	19; 3·9 (2·5)	<0·0001
Risk for impaired liver function	4/5 (80·0%)	10/95 (10·6%)	0·001		/	
Risk for ineffective cerebral tissue perfusion	9/26 (34·6%)	5/74 (6·8%)	0·001		/	
Risk for ineffective gastrointestinal perfusion	5/10 (50·0%)	9/90 (10·0%)	0·004		/	
Risk for peripheral neurovascular dysfunction		/		19; 5·5 (5·9)	81; 11·5 (12·3)	0·041
Risk for unstable blood glucose		/		66; 12·3 (13·1)	34; 6·6 (6·4)	0·004

*Fisher's Exact Test.
†Student's *t*-test.
SD, standard deviation.

Table 7 Multiple linear regression of ICU length of stay (LOS) on study variables (R^2 0·254; $P < 0·001$).

Predictor	β	95% CI	*P* value
Apache II	−0·023	−0·011 to 0·009	0·837
Charlson comorbidity index	−0·069	−0·011 to 0·005	0·510
Number of NDs predictive for LOS	0·297	0·028-0·136	0·003
Modality of admission			
From wards	−0·074	−0·250 to 0·134	0·551
From other ICU	0·243	0·030-0·416	0·024
Medical diagnostic category			
Cerebrovascular accident	0·129	−0·075 to 0·371	0·190
Complications of care	−0·061	−0·229 to 0·131	0·588
Constant		0·304-0·837	<0·001

NDs, nursing diagnoses; ICU, Intensive Care Unit.

Table 8 Logistic regression of ICU mortality on study variables (Log likelihood 35·268; R^2 0·661; $P < 0·001$).

Predictor	β	Odds ratio (95% CI)	*P* value
Apache II	0·147	1·159 (0·989-1·358)	0·069
Charlson comorbidity index	0·077	1·080 (0·991-1·176)	0·078
Number of NDs predictive for death	1·049	2·855 (1·536-5·306)	0·001
Modality of admission			
From ED	0·987	2·684 (0·409-17·621)	0·304
Medical diagnostic category			
Cerebrovascular accident	1·684	5·196 (0·511-52·822)	0·164
Constant	−13·184	0·000	<0·001

NDs, nursing diagnoses; ED, emergency department; ICU, Intensive Care Unit.

ability and the choices in prioritization of clinical and documental activities (Maas *et al.* 1990). Moreover, the selection of NDs may have been affected by the nurses' experience in their use and their education and job experience (Onori 2013). A further reason could be related to limitations in electronic databases (e.g. a lack of selectable care plan sets, diagnoses, outcomes or interventions), and the compliance and accuracy of ICU nurses in building or in recording the care plans. Moon (2011) excluded more than 25% of patients from her study because they had no nursing care plans; moreover, ICU nurses were forced to choose from a limited set of pre-template NNN linkages, with many missed NIs or NOs: for example, NIs related to medication, one of the most selected factors in our study, were missing in that system. Conversely, studies like ours that collected data prospectively showed more comparable results. Thus, we think that the results of retrospective studies may underestimate the planned activities and the outcomes pursued by ICU nurses, returning a distorted picture of nursing in the ICU.

Moreover, in most studies NDs were collected only once at patient admission, whereas in others they were recorded during the entire ICU stay. While the consideration of only the NDs collected at admission may allow healthcare providers to have a prognostic tool able to immediately stratify the risk, we think that this picture cannot adequately describe the characteristics of ICU patient conditions. In fact, NDs that are not present at admission (and consequent NOs and NIs) may become evident during the ICU stay and some NDs may resolve faster than others; this variability requires different responses from the system (Head *et al.* 2011) and may modify the prognosis during hospitalization. We believe this is a central problem that warrants future research, since NDs are not as stable as MDs made during hospitalization.

It would be simplistic to affirm that more NDs patients have, the more seriously ill they are, given that the type of diagnosis also plays a role. However, our study showed that certain diagnoses predict mortality and ICU-LOS. Moreover, it can be argued that the overall quantity of NDs is directly related to nursing workload. Therefore, the number of NDs affects the number of needed NIs and the time spent by nurses with patients. It is then an indicator of nursing-resource use (Halloran 1985, Halloran & Kiley 1987, O'Brien-Pallas *et al.* 1997, Bakken *et al.* 2005).

Our findings confirm that nursing is an autonomous component in the clinical pathway of care, emphasizing the concept that NDs may be independent predictors of hospital outcomes and costs (Thoroddsen & Thorsteinsson 2002, Welton & Halloran 2005). The medical diagnosis of patients does not indicate or suggest their nursing needs (namely, their ND pattern) because human needs are not synonymous with diseases (Onori 2013).

Limitations

This study has some limitations. First, there was an absence of randomization in recruiting our study population given that we enrolled a convenience sample of consecutively admitted patients. Second, the ICU nurses projected and realized a personalized nursing care plan for each patient without using standardized or predefined plans; this fact may have limited the comparability of our data with that of other studies. Third, we did not record the time of ND onset and resolution; however, in the case where an ND was resolved but subsequently recurred before ICU discharge, we considered it, and its related outcome and intervention, only once. Fourth, we did not distinguish NOs that were not achieved due to the ineffectiveness of care from any NOs not achieved because of early discharge or death of the patient; this distinction might have caused us to underestimate the rate of NO achievement. Fifth, because of the small sample, our multivariate analyses considered only a limited number of variables that was mainly based on clinical characteristics; future studies with larger sample sizes should include more predictors in their models that potentially influence patient outcomes, like medical and nursing treatments, the nursing skill mix, and organizational variables. These limitations may limit the generalizability of our results.

Conclusion

The real contribution of nursing to the quality of patient care in ICU settings is still undetermined and certainly underestimated. To our knowledge, this is the first prospective study that has identified the prevalence of nursing diagnoses, outcomes and interventions for ICU patient care in a real clinical setting using NNN classifications. The result is a picture of a very intensive activity centred on a broad spectrum of patient needs and not focused on technical aspects alone. Moreover, our data revealed a statistically significant explanatory capacity of NDs to predict both LOS and mortality in the ICU, which was higher than either the severity and comorbidity indexes or the medical diagnostic categories.

The systematic collection of data concerning activities related to the nursing process could allow nursing care provided in the ICU to be measured and would also permit an evaluation of the specific impact of nursing on patient outcomes. Nurses can effectively document their clinical activity by employing a standardized terminology, including diagnoses, outcomes and interventions. Even if the use of electronic data systems offers an unquestionable contribution to collect and manage large volumes of nursing information, the quality of the data should be a major concern for researchers. Further studies should analyse the reasons for which data collected prospectively tend to show a somewhat different picture of nursing in the ICU than when the data are derived from electronic registers.

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Author contributions

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- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

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