Identifying Nurses' Concern Concepts about Patient Deterioration Using a Standard Nursing Terminology

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Abstract

[Objectives]—Nurse concerns documented in nursing notes are important predictors of patient risk of deterioration. Using a standard nursing terminology and inputs from subject-matter experts (SMEs), we aimed to identify and define nurse concern concepts and terms about patient deterioration, which can be used to support subsequent automated tasks, such as natural language processing and risk predication.

[Methods]—Group consensus meetings with nurse SMEs were held to identify nursing concerns by grading Clinical Care Classification (CCC) system concepts based on clinical knowledge. Next, a fundamental lexicon was built placing selected CCC concepts into a framework of entities and seed terms to extend CCC granularity.

[Results]—A total of 29 CCC concepts were selected as reflecting nurse concerns. From these, 111 entities and 586 seed terms were generated into a fundamental lexicon. Nursing concern

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concepts differed across settings (intensive care units versus non-intensive care units) and unit types (medicine versus surgery units).

[Conclusions]—The CCC concepts were useful for representing nursing concern as they encompass a nursing-centric conceptual framework and are practical in lexicon construction. It enabled the codification of nursing concerns for deteriorating patients at a standardized conceptual level. The boundary of selected CCC concepts and lexicons were determined by the SMEs. The fundamental lexicon offers more granular terms that can be identified and processed in an automated fashion.

Keywords

Standardized Nursing Terminology; Expression of Concern; Information Storage and Retrieval

1. INTRODUCTION

Nursing records provide information regarding patient condition, support nurse decision making and imply nurses' clinical judgement [1–3]. This data often reflects accumulated experiences of nurses' surrounding the recognition of patient deterioration through the interpretation of patient behavior and physiological signs [4–7].

Nurses expressing concern for patient deterioration through documentation has been highlighted [6–9]. Previous studies used frequency of free text comments by nurses as an indicator of nursing concern for patients and comment frequency was highly associated with increases in cardiac arrest and mortality [10, 11]. Another noteworthy finding from other studies was that nurses' concern for patient deterioration exists before patient decline is evident in physiological data [6, 8, 9]. These findings demonstrate that the extraction of nursing concern from nursing notes could be utilized as an important signal to detect patients at risk of deterioration. However, nursing notes can take on many forms as it reflects nurse's perception of the patient condition and can include a variety of terms and abbreviations. This variability makes it difficult to extract useful information from nursing notes.

An automated text analysis can extract specific data and convert unstructured data into structured data from a corpus comprised of a significant amount of narrative data, and it can be run using multiple methods such as is Natural Language Processing (NLP), data mining, and machine learning. The initial steps to extract specific data often require comprehensive lexicon development which encompasses natural language written in unstructured data.

This paper presents initial steps required to run automated text analyses in the future. Those steps include identifying nurses' concern for their patient and building a foundation for the lexicon. Nursing concern is a difficult phenomenon to define in a standardized format because 'concern' is based on an individual nurse's subjective clinical judgement. To overcome this challenge, we used a standard nursing terminology, the Clinical Care Classification (CCC) system, that contains a conceptual framework which represents nursing practice. Previous studies verified that CCC concepts, 176 nursing diagnoses and 201 nursing interventions categorized into 21 care component classes, highly represent the

nursing process [12–14]. Therefore, using CCC concepts enabled the process of converting abstract nursing concern concepts into objectifiable concepts on which nurses could evaluate and reach consensus. Moreover, the CCC system provides a nursing framework that facilitates linkage to reference terminologies such as SNOMED CT, ICNP (International Classification for Nursing Practice) and other nursing terminologies. This enables concept mapping to the level of granularity closest to that of the actual data [15].

This study had two aims. First, to use the CCC System to identify nursing concerns for deteriorating patients. Second, to identify entity and seed terms to develop a fundamental lexicon for term expansion in order to run a future automated text analysis.

2. MATERIAL AND METHODS

2.1. Identifying nursing concern for patients at risk of deterioration

A total of seven nurse subject-matter experts (SMEs) participated in the identification of nursing concern concepts and development of a fundamental lexicon. Three SMEs performed both the identification of concepts and development of the lexicon. Out of the four remaining SMEs, two participated in one of the processes while the other two participated in the alternative. The SMEs were registered nurses in the United States (U.S.) with clinical experience at academic hospitals across the U.S., Japan, and South Korea. The seven SMEs were selected based on extensive knowledge about and experience in our study units. Furthermore, they have expert knowledge in nursing informatics, including advanced training and research backgrounds related to this field of study.

Five group consensus meetings were held with the SMEs to identify nursing concern concepts. We first conceptualized 'concern' as, "What concepts do nurses document in nursing notes when they believe an inpatient is at risk of deteriorating?". Then, SMEs reviewed and scored the individual CCC diagnosis concepts on a scale from 1–3 (1: High, 2: Moderate, 3: No concern) in the context of six types of clinical units. This was done because different unit types may contain different work flows and patient acuities. Thus, the concern score given for a specific concept may be dependent on these factors [14].

The types of study units were classified between acute care and intensive care. The two acute care unit types were medical (internal medicine, cardiology, gastroenterology, etc.) and surgical. The four intensive care units were medical intensive care unit (MICU), surgical (SICU)/trauma (Trauma ICU), cardiac, and neurological intensive care unit). As our study's purpose was to understand nursing concerns for hospitalized patients, we excluded specialty units, including the emergency and delivery rooms, behavioral/psychiatric, and operating room units, with different workflows than those found in medicine or surgery units.

2.2. Developing a fundamental lexicon

Upon review, the selected CCC concepts appeared verbatim in the study notes very rarely or were completely missing, signaling their abstract and high-level nature as compared to the natural language found in nursing notes. Therefore, we curated CCC concepts at the granularity level of the natural language used in notes. First, we built a terminology set containing CCC core concepts, entities, and seed terms. Each CCC concept was mapped to

an entity, which was then mapped to a seed term (Figure 1). Entities are children of CCC concepts, written at the conceptual level, inheriting the characteristics of their parent-concepts. Seed terms are the actual natural language terms written by nurses in nursing notes and are the children of entities. For example, CCC concept 'cardiovascular alteration' can have multiple entities such as 'tachycardia' and 'bradycardia' etc. which are representative signs and symptoms. And 'tachycardia' can be documented as 'high heart rate', 'HR high', or 'tachy*' in notes which we call seed terms. To generate entities and seed terms, we used the Unified Medical Language System (UMLS) open source tool to link the CCC concepts with related concepts with finer levels of granularity [16]. In addition, clinical experience and domain knowledge [17] were used to break down the standard CCC terminology levels. Specifically, the five SMEs determined the level of granularity for the entities. In addition, they listed the seed terms they used when documenting their practice. During this process, limiting seed term scope to the scope of CCC concepts was set as a parameter. After then, they validated the generated entities and seed terms.

3. RESULTS

3.1. Identifying nursing concern for patients at risk of deterioration

A total of 67 concepts received a score of 1 (most concerning) in at least one-unit setting. Two detailed analyses were conducted. First, we classified settings, ICU (MICU, SICU/ Trauma ICU) versus non-ICU (medicine and surgery units). Second, we classified types of units (medicine versus surgery) across ICUs and non-ICUs. Results indicated that nursing concern concepts differed across the settings and unit types (Figure 2) (Table 1).

In both the ICU and non-ICU settings, all diagnosis concepts classified under the 'cardiac', 'respiratory component', and 'tissue perfusion' components frequently received a grade of 1. The concepts under 'activity' and 'health behavior' were decidedly scored as concerning in non-ICUs, while the concepts under 'bowel/gastric', 'medication', and 'sensory' were concerning in ICUs (Figure 2).

Across all CCC components, nursing concern concepts between medicine units and surgery units, as well as, between ICUs and non-ICUs were similar except for four components (Table 1). More CCC concepts were graded as concerning in surgery as compared to medicine units. Namely, under the Bowel/Gastric component- 'fecal impaction' and 'gastrointestinal alteration', and under the Physical Regulation-'infection', was considered concerning in surgical related ICUs. The CCC concept Urinary Elimination- 'urinary retention', was noted as concerning in both ICUs and non-ICUs, but not in medicine units.

The distribution of each concept's calculated average score from its respective individual scores across all units are shown in Figure 3

The average score threshold for concept inclusion was established in an additional group consensus meeting to finalize the set of CCC Concepts to be used in this study. In order to increase the validity of the average score threshold, the five SMEs that participated in the development of the fundamental lexicon reviewed the list of concept score averages and determined the final list of CCC core concepts based on clinical judgment surrounding

which concepts represented generalized nursing concern across unit types and setting. Based on this review, an average score of 1.37 (range: 1~3) was set as the threshold to finalize the set of CCC concepts to be used in the study (Figure 3).

To avoid missing necessary concepts with an average score over the exclusion threshold, the rest of the excluded concepts were individually reviewed by SMEs to confirm their exclusion. Excluded concepts were those with no relation to nursing concern for patient deterioration or less significant concern for patients and/or setting-specific concepts. The resulting 29 CCC diagnosis core concepts are included in Table 2.

3.2. Developing a fundamental lexicon

The components of a fundamental lexicon, entities, and seed terms are characterized by inheriting the attributes of the concepts. When similar features (i.e., signs and symptoms) are shared across concepts, duplicate entities and seed terms will be generated. For example, CCC core concepts 'blood pressure alteration', 'cardiovascular alteration', and 'cardiac output alteration' share similar signs and symptoms such as 'hypertension' and 'hypotension'. We were able to avoid duplicates by grouping them together in a matrix (see Figure 4).

The matrix simplified the generation of seed terms for unique entities grouped under CCC core concepts. The selected CCC core concepts were grouped into five categories according to characteristic similarity, which allowed them to share common entities. A total of 111 unique entities and 586 unique seed terms were generated (Table 3).

4. DISCUSSION

In this study, we developed a systematic method for identifying nursing concerns documented in nursing notes, which included multiple steps: the definition of nursing concerns using standard terminologies, and the curation of fundamental entities and terms related to nurses' concerns by SMEs. This work is significant in that it uses a standard nursing terminology to demonstrate how its ontology can facilitate the coding of nursing concerns and can be used as a fundamental lexicon to facilitate automated processes, such as machine learning based natural language processing. In addition, we believe our study can be used as a guide for studies focused on the development of fundamental lexicons for additional important clinical concepts such as 'risk of falls', 'pain' etc.

4.1. Usefulness of CCC in identifying nursing concern

Nursing notes are used as a source to extract information [18–20]. However, we were unable to find previous studies using a standard nursing terminology to conceptualize research concepts. In our study, we chose the CCC system because it was developed using nursing documentation and it includes both a framework that organizes nursing clinical documentation (e.g., the CCC care components) and a terminology that represents nursing practice and documentation of that practice. These characteristics enable the CCC conceptual framework to capture subjective descriptors under the higher level CCC concepts. Moreover, this framework can be linked with other terminology standards, making it easy to map concepts to entities and seed terms.

4.2. Different nurses' concerns between clinical settings

Nurses' concerns differed between clinical settings and unit types. Across settings (ICU versus non-ICU), the highest graded concern concepts surrounded patients' physiological condition, such as cardiac or respiratory concerns. However, activity and health behavior issues were rated as a higher concern in non-ICU settings as the focus in these settings shifts towards safe discharge of patients. A comparison of findings between the unit types (medicine versus surgery) demonstrates that nurses identified additional concerns in a surgery unit. Most of these concern concepts are related to patient's recovery after surgery and complication prevention, such as 'infection', 'peripheral alteration', 'urinary elimination', and 'urinary retention'.

The Final 29 CCC core concepts were closely related to patient physiological status and are common indicators of inpatient condition across settings and unit types. These concepts were selected based on their average score. As a result, those scores potentially mask level of importance in particular settings. For example, 'activity intolerance' had an average score of 2 so it was excluded. The scores given by SMEs to this concept were setting dependent, in acute care settings this concept was scored as a 1 and as either 2 or 3 in ICU settings. This indicates that CCC core concepts capture indicators of common conditions for all patients across unit type and patient acuity, however, they do not reflect unit specific nuances. According to these results, future automated information extraction process should include a temporal component and zbe tailored to different settings as we found that nursing concern differs between the ICU and non-ICU and also between medicine and surgery units.

4.3. Initial step of building a lexicon

As human body systems are organically linked, specific symptoms may have various etiologies. While developing entities for the 'fluid volume alteration' CCC core concept, we had to define what we considered indicative of this concept as it can be caused by different clinical issues. It can be due to massive bleeding, or bladder extension from a urinary problem, or hypotension originating from a cardiac issue. Aligned with our study aims, we defined the scope of 'fluid volume alteration' as body fluid loss or overload because fluid volume alteration caused from urinary problems would be captured primarily by the 'urinary elimination alteration' concept, and the cardiogenic abnormal blood pressure would be captured mainly by 'blood pressure alteration' or 'cardiovascular alteration'.

4.4. Practical use in future natural language processing tasks

This work is part of a larger study (CONCERN study) in which we aim to detect nursing concern for patients at risk of deterioration in nursing notes by using NLP and machine learning methods. Subsequent steps include expanding the seed terms to the natural language using data driven approaches including various machine learning methods. Going forward, we will ask the SMEs to separately annotate select nursing concern concepts related to assigned entities in a limited corpus of nursing notes. Ultimately, we will have the ability to control the terms generated outside of a defined range by comparing differences between expanded seed terms generated by automated methods and the terms annotated by nurses. If this is successful, we can run NLP to determine how well our lexicon captured nursing concern from nursing notes.

From the CONCERN study perspective, assigning entities to CCC core concepts is an important step because it will represent the types of concerns in the future NLP program. Entities will be used to tag a nurses' concern while running NLP. From those tagged entities, we can determine what type of nursing concern was annotated by linking entities to their CCC core concepts.

Clinical notes, such as nursing notes, can be used as a communication tool among providers when they share common ground within the context of notes. It can be difficult to coordinate on domain-specific content between providers (e.g., nurses vs. physician) when common ground is lacking [21, 22]. In the same vein, one thing to consider for nursing concern concepts is whether they reflect the "common ground" shared by nurses. Because this is an important goal for future use in practice. As 'concern' is an abstract concept, different nurses may have different interpretations of a concerning concept. However, we believe that the identified CCC core concepts are general enough to represent nursing concern because of the diversity of our SMEs' vast clinical experience in different clinical settings, units studied and across countries. Generalization will be further enhanced by our next processes, including running NLP and additional validation steps by both machines and humans.

We acknowledge several study limitations. The identification of nursing concern using the CCC system may not be generalizable to other hospital settings such as rehabilitation and community hospital settings whose patients may be different than those receiving care in acute care hospitals. In addition, the selection of entities and seed terms was performed by the SMEs based on their clinical knowledge. This selection process may be biased by human factors including education and clinical experience. However, at the same time, the engagement of SMEs is a strength of our study. Their broad clinical knowledge adequately represents inpatient clinical care units and circumstances.

5. CONCLUSIONS

This study establishes the initial step of defining nursing concern using a standard nursing terminology and building a lexicon for future automated text analysis. This study is significant because it demonstrates how an ontology can facilitate the coding of nursing concern into a standardized conceptual framework.

FINANCIAL SUPPORT

REFERENCES

1. Törnvall E, Wilhelmsson S. Nursing documentation for communicating and evaluating care. Journal of clinical nursing 2008;17(16):2116–24 [PubMed: 18710374]
2. Association AN. ANA's Principles for Nursing Documentation Guidance for Registered Nurses. American Nurses Association, 2010.
3. Penoyer DA, Cortelyou-Ward KH, Noblin AM, et al. Use of electronic health record documentation by healthcare workers in an acute care hospital system. Journal of healthcare management 2014;59(2):130–44 [PubMed: 24783371]

4. Cioffi J. Recognition of patients who require emergency assistance: a descriptive study. Heart & Lung: The Journal of Acute and Critical Care 2000;29(4):262–68 [PubMed: 10900063]

5. Cioffi J. Nurses' experiences of making decisions to call emergency assistance to their patients. Journal of advanced nursing 2000;32(1):108–14 [PubMed: 10886441]

6. Odell M, Victor C, Oliver D. Nurses' role in detecting deterioration in ward patients: systematic literature review. Journal of advanced nursing 2009;65(10):1992–2006 [PubMed: 20568317]

7. Kenward G, Hodgetts T. Nurse concern: a predictor of patient deterioration. Nursing times 2002;98(22):38–39

8. Douw G, Schoonhoven L, Holwerda T, van Zanten AR, van Achterberg T, van der Hoeven JG. Nurses' worry or concern and early recognition of deteriorating patients on general wards in acute care hospitals: a systematic review. Critical Care 2015;19(1):230 [PubMed: 25990249]

9. Liaw SY, Scherpbier A, Klainin-Yobas P, Rethans JJ. A review of educational strategies to improve nurses' roles in recognizing and responding to deteriorating patients. International Nursing Review 2011;58(3):296–303 [PubMed: 21848774]

10. Collins SA, Vawdrey DK. "Reading Between the Lines" of Flowsheet Data: Nurses' Optional Documentation Associated with Cardiac Arrest Outcomes. Applied nursing research: ANR 2012;25(4):251 [PubMed: 22079746]

11. Collins SA, Cato K, Albers D, et al. Relationship between nursing documentation and patients' mortality. American Journal of Critical Care 2013;22(4):306–13 [PubMed: 23817819]

12. Capability of Using Clinical Care Classification System to Represent Nursing Practice in Acute Setting in Taiwan NI 2012:11th International Congress on Nursing Informatics, June 23–27, 2012, Montreal, Canada.; 2012 American Medical Informatics Association.

13. Representing critical care data using the clinical care classification AMIA Annual Symposium Proceedings; 2005 American Medical Informatics Association.

14. Feng R-C, Chang P. Usability of the Clinical Care Classification System for Representing Nursing Practice According to Specialty. CIN: Computers, Informatics, Nursing 2015;33(10):448–55

15. Saba V. Clinical Care Classification (CCC) System Version 2.5: User's Guide: Springer Publishing Company, 2012.

16. Medicine USNLo. UMLS Terminology Services. Secondary UMLS Terminology Services 2018 https://uts.nlm.nih.gov/home.html:isessionid=D73B5182D613FC9E5F90797393D9F597.

17. Gundlapalli AV, Divita G, Redd A, et al. Detecting the presence of an indwelling urinary catheter and urinary symptoms in hospitalized patients using natural language processing. Journal of biomedical informatics 2017;71:S39–S45

18. Carrell DS, Cronkite D, Palmer RE, et al. Using natural language processing to identify problem usage of prescription opioids. International journal of medical informatics 2015;84(12):1057–64 [PubMed: 26456569]

19. Hyun S, Johnson SB, Bakken S. Exploring the ability of natural language processing to extract data from nursing narratives. Computers, informatics, nursing: CIN 2009;27(4):215

20. Kudesia V, Strymish J, D'avolio L, Gupta K. Natural language processing to identify Foley catheter-days. Infection Control & Hospital Epidemiology 2012;33(12):1270–72 [PubMed: 23143371]

21. Clark HH, Brennan SE. Grounding in communication. Perspectives on socially shared cognition 1991;13(1991):127–49

22. Describing the clinical communication space through a model of common ground:'you don't know what you don't know' AMIA Annual Symposium proceedings; 2010 American Medical Informatics Association.

HIGHLIGHT

- Nursing concern can be identified by using a standard nursing terminology.

- Nurses concern is dependent upon unit types and settings.

- Engagement with subject-matter experts proved useful to identify nursing concern concepts

- The fundamental lexicon offers granular terms that can be identified and processed in an automated fashion

SUMMARY TABLE

What was already known on the topic

- Nurses concern for their patients is highly related with patient's decline.

- Nursing notes are used as a resource for information extract by multiple automated text analysis methods.

- There is a granularity gap between standard terminology concepts and natural language terms.

What this study added to our knowledge

- Nursing concern can be conceptualized through the use of a standard nursing terminology.

- Nurses concern is dependent upon unit types and settings. As a result, automated information extraction process should be tailored to different settings with their own domains.

- Engagement with subject-matter experts proved useful to identify nursing concern and build a fundamental lexicon representing inpatient clinical care units.
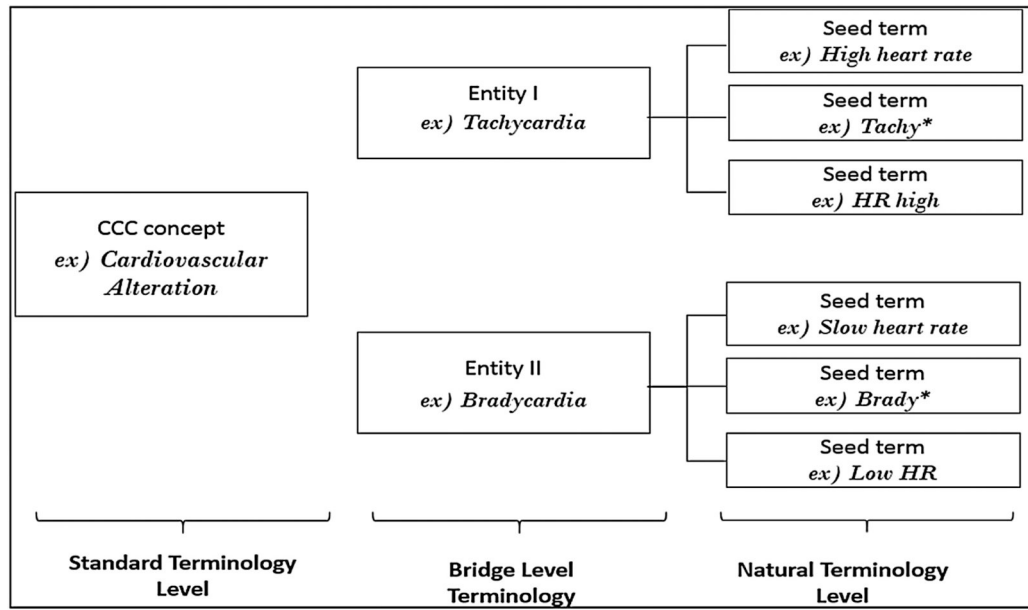
Figure 1.
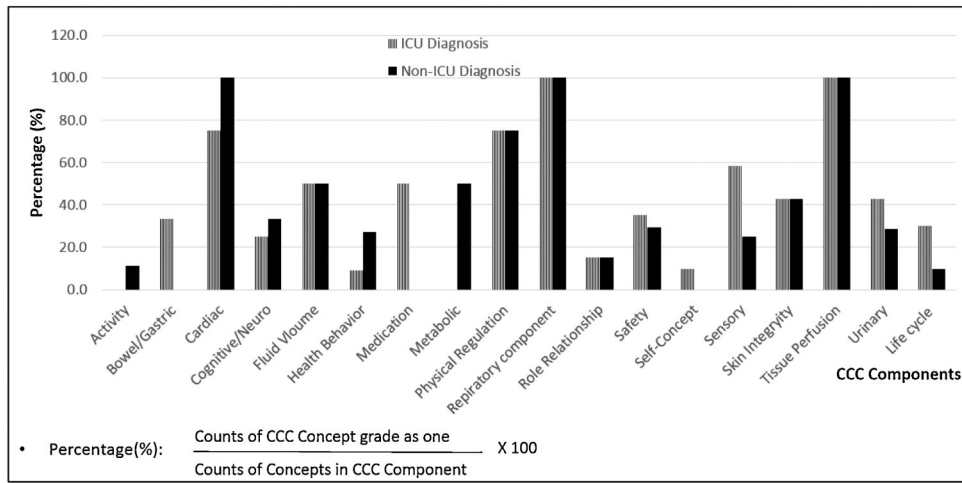Structure of terminology set used in research

Figure 2.
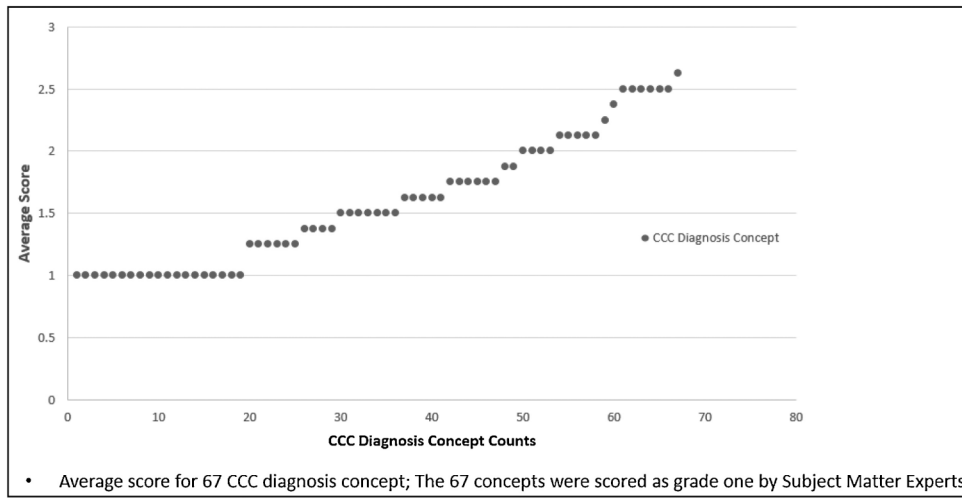Nursing concern scores for CCC concepts stratified by setting

Figure 3.
Distribution of CCC concept counts

Group Type	Entities	Seed Terms (Terms for searching Term Expansion)	CCC Core Concepts		
			Blood Pressure Alteration	Cardiovascular Alteration	Cardiac Output Alteration
Hemodynamic and Respiratory	Abnormal Blood Pressure	abnormal bp; abnormal blood pressure; labile bp; labile bood pressure	Y	Y	Y
	Hypertension	high blood pressure; HTN; high BP; HTN, HT	Y	Y	Y
	Hypotension	low blood pressure; hypo; low BP; HoTN, low bp, low blod pressure	Y	Y	Y
	Abnormal CVP	low CVP, high CVP, abnormal CVP	Y	Y	Y
	Abnormal Arterial line pressure	abnormal arterial pressures, abnormal abp, abnormal aline, high aline pre, aline pressure,high abp, high arterial blood pressure	Y	Y	Y
	Abnormal pulse rate and rhythm	palpate pulse pressure; +1 pedal pulses; +2 pedal pulses; +3 pedal pulses; +1 pulses; +2 pulses; +3 pulses; +0 pulses; diminished pulses; afib,irregular af, irregular a. fib,irregular a. fib,irregular a-fib,hr irregular afib	Y	Y	Y
	arrhythmias	abnormal heart rate; abnormal heart rhythm, rhythm disturbance; dysrhythmia	Y	Y	Y
	Tachycardia	high heart rate; rapid heart rate; tachy; tachycardic; tachy, high heart rate, HR high, tachycardic; PSVT; SVT	Y	Y	Y
	Bradycardia	slow heart rate; brady; low HR; Sinus brady	Y	Y	Y

Figure 4.
Hemodynamic and respiratory section of the entity and seed term matrix

Table 1.

Comparison of Nursing concern CCC concepts Stratified by Medicine and Surgery Unit Type

CCC Component	ICU		Non- ICU	
	Medicine (MICU)	**Surgery (SICU, Trauma ICU)**	**Medicine**	**Surgery**
Bowel/ Gastric	• Diarrhea	• Diarrhea • Fecal Impaction • Gastrointestinal Alteration	–	–
Physical Regulation	• Autonomic Dysreflexia • Hyperthermia • Hypothermia • Thermoregulation Impairment • Intracranial Adaptive Capacity Impairment	• Autonomic Dysreflexia • Hyperthermia • Hypothermia • Thermoregulation Impairment • Intracranial Adaptive Capacity Impairment • Infection	–	–
Skin Integrity	• Latex Allergy Response • Peripheral Alteration	• Latex Allergy Response • Peripheral Alteration • Skin Incision	• Skin Integrity Impairment • Latex Allergy Response	• Skin Integrity Impairment • Latex Allergy Response • Peripheral Alteration
Urinary Elimination	• Urinary Elimination Alteration • Renal Alteration	• Urinary Elimination Alteration • Renal Alteration • Urinary Retention	• Urinary Elimination Alteration	• Urinary Elimination Alteration • Urinary Retention

Abbreviations: MICU: Medical Intensive Care Unit; SICU: Surgical Intensive Care Unit: Trauma ICU, Trauma Intensive Care Unit

Table 2.

Result of Core Concepts count under CCC Components

Average Score	CCC Component (Counts)	CCC Concepts
1.00	Cardiac(3)	Blood Pressure Alteration
		Cardiac Output Alteration
		Cardiovascular Alteration
	Cognitive/Neuro(2)	Confusion
		Cerebral Alteration
	Respiratory(3)	Breathing Pattern Impairment
		Gas Exchange Impairment
		Respiration Alteration
	Role Relationship(2)	Communication Impairment
		Verbal Impairment
	Sensory(2)	Acute Pain
		Visual Alteration
	Safety(2)	Suicide Risk
		Violence Risk
	Fluid Volume(1)	Fluid Volume Deficit
	Tissue Perfusion(1)	Tissue Perfusion Alteration
	Physical Regulation(3)	Hyperthermia
		Hypothermia
		Intracranial Adaptive Capacity Impairment
1.25	Coping(1)	Airway Clearance Impairment
	Physical Regulation(1)	Autonomic Dysreflexia
	Safety(2)	Injury Risk
		Self-mutilation Risk
	Fluid Volume(1)	Fluid Volume Excess
	Urinary Elimination(1)	Urinary Elimination Alteration
1.37	Fluid Volume(1)	Fluid Volume Alteration
	Physical Regulation(1)	Infection
	Skin Integrity(1)	Peripheral Alteration
	Cognitive/Neuro (1)	Thought Processes Alteration

Table 3.

Counts of entities and seed terms under group

Group Type	CCC core concepts	Counts of Entities	Counts of Seed Terms
Hemodynamic and Respiratory	Blood Pressure Alteration	46	201
	Cardiovascular Alteration		
	Cardiac Output Alteration		
	Fluid Volume Deficit		
	Fluid Volume Excess		
	Fluid Volume Alteration		
	Breathing Pattern Impairment		
	Respiration Alteration		
	Gas Exchange Impairment tissue Perfusion Alteration		
	Hypothermia		
	Hyperthermia		
Neurology	Cerebral Alteration	15	111
	Confusion		
	Thought Processes Alteration		
	Autonomic Dysreflexia		
	Intracranial Adaptive Capacity		
	Impairment		
Safety Precaution	Violence Risk	12	96
	Suicide Risk		
	Self-mutilation Risk		
	Injury Risk		
Communication	Verbal Impairment	5	25
	Communication Impairment		
Not Otherwise Grouped	Infection	3	12
	Acute Pain	17	79
	Visual Alteration	1	10
	Peripheral Alteration	6	18
	Urinary Elimination iteration	5	30
	Airway Clearance Impairment	1	4