

Research and Theory

An evaluation of SNOMED CT® in the domain of complex chronic conditions

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Abstract

Objective: To determine the content coverage in SNOMED CT® to represent the multidisciplinary terms and concepts in the domain for complex chronic conditions.

Methods: An evaluation of the coverage of multidisciplinary health factors in SNOMED CT® for the complex and chronic condition, multiple chemical sensitivity (MCS) is conducted in the study. The methodology included a retrospective audit of patient charts and feedback from multidisciplinary clinicians in the creation of a controlled vocabulary used in the generation of patient profiles for MCS. Clinicians and experts in the field reviewed and tested the vocabulary for its usefulness (scope, specificity and structure) by re-coding three patient profiles using the vocabulary. Cohen's kappa analysis was conducted to determine inter-rater reliability. Cronbach's alpha analysis was conducted to determine the internal reliability of the survey questionnaire.

Results: One hundred patient charts and nine clinicians from varying health disciplines participated in the study. SNOMED CT® was shown to capture nearly 82% of the concepts spanning multidisciplinary areas of health focus. The nutrition area of health focus had the highest level of exact matches. Furthermore, post-coordination was applied in an attempt to improve coverage of concepts to 75% (of 45 terms) of the missing terms in SNOMED CT®. Seventy-five percent (n=9) of the clinicians agreed on the overall usefulness of the vocabulary.

Conclusions: SNOMED CT® had a reasonable coverage of the multidisciplinary health concepts required to describe a complex and chronic condition. Standardizing the multidisciplinary vocabulary with reference tag to a widely used reference terminology, such as SNOMED CT® to discuss the terms and concepts used may improve the understanding across disciplines and communities of practice. Overall, based on the availability of concepts in SNOMED CT® and the feedback from clinicians, the approach looks promising and should be further explored.

Keywords

multidisciplinary, chronic care management, standardized clinical vocabulary, SNOMED CT®

Introduction

In a report by Statistics Canada, at least 5% of Canadians have symptoms that cannot be medically explained [1, 2]. These include conditions such as multiple chemical sensitivity (MCS), fibromyalgia (FM), chronic pain syndrome, and chronic fatigue syndrome (CFS). Patients with these conditions occupy a disproportionate amount of physician time [3], and it has been argued that they constitute the most common disorders seen in primary care [4, 5]. Multidisciplinary care teams have come to the forefront as an effective management strategy for these conditions. The variety and recurring nature of symptoms in patients with complex chronic illness has led to the belief that management may benefit from the insights of different bodies of knowledge, such as medicine, nursing, occupational therapy, psychology, and nutrition [6, 7]. Studies have shown the consequences of poor communication among multidisciplinary care providers resulting in poor care experiences for patients, repetitive medical tests and medical errors [8–12]. Studies have also discussed the need to identify methods to improve communication among care providers in the care of these complex conditions [12, 13]. The challenges of enabling shared communication in these conditions are related to the limited, unstructured and poorly categorized knowledge that exists in the medical records [14]. There is also a significant amount of knowledge that exists as tacit knowledge among experts [15]. Furthermore, these conditions can be viewed as emerging knowledge systems with new knowledge of the conditions continuing to build among groups of experts [16, 17]. Building knowledge in silos and in unstructured format makes it challenging to share or integrate knowledge of these conditions in a common domain. Consequently, there is growing interest in the literature to explore the model of building communication bridges in emerging or complex knowledge systems that can be understood and shared by knowledge communities at the design phase itself [16]. This will allow the collaborative knowledge to grow in a consistent and semantically operable manner.

Key clinical documents, such as patient profile documents or problem lists and discharge summaries for these conditions, will contain patient information generated by multiple disciplines of care. As outlined by Hays et al. [18], the patient profile document for patients with complex conditions goes beyond the traditional problem lists and contains terminologies contributed by multiple disciplines under areas such as social barriers, education, psychosocial stressors which may impact the therapy selection. Standardization of the clinical vocabulary used in the key clinical documentation can be viewed as a way of enabling semantically

interoperable exchange of information among multiple care providers [19, 20]. SNOMED CT® or Systematized Nomenclature of Medicine [21] has gained attention in the recent years as an effective platform for standardization of vocabulary used in the representation of complex disease concepts. SNOMED CT® is a comprehensive, multilingual, controlled clinical reference terminology, with comprehensive coverage of diseases, clinical findings, etiologies, procedures, living organisms, and outcomes used for recording clinical data. SNOMED CT's intellectual property rights were transferred to the SNOMED SDO® in the formal creation of the IHTSDO. Studies have explored the breadth of SNOMED CT® coverage in representing various complex clinical concepts and areas of medicine [22–27]. Asbeh et al. [23] applied SNOMED CT® to develop a consistent and minimal diagnosis set for developmental disorders and found SNOMED CT® to provide coverage up to 85.7% of the terms required to organize the terminologies. In a study by Elkin et al. [24], the ability of SNOMED CT® to represent common problem lists in the Mayo Clinic was evaluated. SNOMED CT® was able to represent 92.3% of the terms used in the medical problem lists. According to the authors of this study, improvements to synonymy and adding missing modifiers could lead to greater coverage of common problem statements. A few others have discussed the standardization of clinical vocabulary used in clinical documentation using SNOMED CT® and studied the impact in improving patient care processes. A study by Elevitch [25], discussed the improvement in safety standards by using a reference vocabulary in anaesthesia care. A study by Paterson [19] explored the enhancement of semantic interoperability of clinical documents for chronic conditions, such as chronic kidney disease, hypertension and diabetes. The study by Paterson generated a semantically interoperable discharge summary as a boundary object by creating a standardization platform for the vocabulary used in the document from reference vocabularies, such as SNOMED CT® and UMLS. There is no research to date that explores the availability of content coverage in SNOMED CT® to represent multidisciplinary vocabulary that is essential in the categorization of complex chronic health conditions.

The research presented in this paper is part of a larger study exploring the benefits of using the concept of boundary objects to enhance communication among care providers in collaborative care management [28]. Towards this effort, the content coverage of the multidisciplinary vocabulary in SNOMED CT® for a complex health condition, multiple chemical sensitivity is explored in this paper. Multiple chemical sensitivity (MCS) is a complex chronic medical condition which affects multiple body systems with the patients exhibit-

ing a wide range of symptoms from physical to psychological [29, 30]. It is the hypothesis of this work that showing the availability of multidisciplinary concepts for one complex condition can generate a similar expectation of available terms for other chronic conditions which require comprehensive factors as outlined in the work of Hays et al. [18].

Methodology

Setting

A convenience sample of 100 patient charts and nine multidisciplinary clinicians was selected from the Nova Scotia Environmental Health Centre (NSEHC), a treatment facility for individuals with chronic conditions, such as multiple chemical sensitivity, chronic fatigue syndrome and fibromyalgia [30]. Members of the multidisciplinary team include a physician, nurse, psychologist, psychotherapist, physiotherapist, rehabilitation coordinator and a dietician.

Participants

The study included a retrospective review of 100 charts of patients of the NSEHC with a diagnosis of MCS [29]. Health record information of the last 100 newly enrolled patients who gave their consent to participate were used in the study. The sample size was considered sufficient to account for the variability in the profile information of patients and to explore all possible multidisciplinary concepts and terminologies that may typically exist in the domain of patient profile categorization.

The multidisciplinary team of clinicians of the NSEHC engaged in the care of patients with MCS also participated in the study by evaluating and testing the vocabulary for accuracy and completeness [31].

Ethical considerations

The study received ethical approval from the Capital District Health Authority Board of Ethics.

Procedure and data analysis

Exploration of multidisciplinary terminologies in SNOMED CT®

Retrieval of concepts and terms used to categorize patient profile

In this study, 100 patient charts with a diagnosis of MCS were audited to retrieve concepts and terminol-

ogies used to categorize the profile of patients. The concepts were manually extracted from the patient charts and maintained in a database for subsequent analysis. The extracted terminologies were grouped under the categories of medical, nursing, psychosocial, physiotherapy and rehabilitation areas of health focus to match the health care disciplines that were involved in the assessment and treatment of patients at the Centre. The extracted vocabulary was reviewed by two clinicians from each health disciplines to ensure that all the concepts and terminologies that had been retrieved were relevant to the patient profile information for MCS. The percentage of occurrence of concepts in the 100 patient charts was compiled and grouped under the multidisciplinary areas of health focus.

Mapping of terms to SNOMED CT®

The extracted data were mapped to SNOMED CT® version 0907 [21] through a manual review process. The manual mapping was done using SNOMED CT® browsers, CLINICLUE version 2006.2.0030 [32].

String-based mapping was used to compare the strings for concept names from source terms to SNOMED CT®. Two string-based mapping techniques were used.

1. *Normalized term matching*: In this technique, the following steps are done before comparing the string. Removal of attributes and punctuations, removal of stop words, remove case sensitivity, word order. Finally, the remaining words are sorted into alphabetical order.
2. *Expanded term matching*: The expanded term matching process aims to expand the abbreviation of any term to its full form. If the term is not matched in the normalized term matching, the expanded term matching will be performed.

The accuracy of the semantic representation of the mapped expressions was reviewed by two clinicians from each healthcare discipline that was involved in the study. For the disciplines which did not have two representatives, the medical director reviewed the concepts. The terms were grouped as exact, synonym or no match terms.

Testing of the vocabulary

A vocabulary of mapped terms from SNOMED CT® was created in the profile domain for the chronic condition, MCS. The multidisciplinary clinicians of the NSEHC reviewed the information and provided feedback on the accuracy of the clinical terms and identified missing terminology of relevance whenever

possible. A search for the missing terminologies identified by clinicians was made using the SNOMED CT® browser, CLINICLUE to find exact match or synonyms when possible.

A representative sample of charts that was considered a prototypical representation of the patient population was selected by a physician at the Centre. The patient charts selected for the re-coding were not selected from the 100 charts used to compile the controlled vocabulary. The selection was validated by another member of the care team, a physician who assigned a rating from 0 to 10 to express agreement or disagreement for the selection of the patient profile for re-coding. A total of three patient charts were selected for the re-coding process.

The clinicians who agreed to participate in the study were randomly assigned to coding group A and coding group B. Each coding group was comprised of a physician, a nurse, a physiotherapist, a rehabilitation coordinator, a dietician, and a psychologist (psychotherapist).

A web-based form containing the terminologies from the controlled vocabulary was created to help the clinicians re-code the patient profiles. The clinicians had access to a tutorial to assist with the process of re-coding. The clinicians printed the re-coded profiles once completed and provided the printed profiles to the researcher. Each source terminology in the web-based form had a link to the term as it exists in SNOMED CT®. This provided an opportunity for the clinician to view the parent concepts, the concept ID, synonyms and alternatives for the source term in order to decide the best option for a match of concept in SNOMED CT® to best capture the intended clinical meaning, in other words a *1: Many* mapping approach was used. The clinicians also had an opportunity to identify missing terminologies or concepts in the vocabulary that existed in the source vocabulary.

Cohen's kappa [33] was used to analyze the inter-rater reliability of the coding disciplines with the same area of health focus, such as a psychologist and psychotherapist for the area of psychosocial factors. The kappa score was also used to determine the reliability in the number of terms identified as missing terms in the new vocabulary.

The vocabulary was further revised based on the feedback from the clinicians.

Evaluation of the vocabulary

A survey questionnaire consisting of seven items of 5-point Likert scales was used to capture the feedback from the multidisciplinary clinicians on the usefulness of the vocabulary.

Description of the concepts captured under these categories is provided below:

- **Scope:** Is the vocabulary capable of representing all of the concepts found in the complete patient record? Does the vocabulary have the terms necessary to represent the full range of health? Does the vocabulary encompass the terminology used to describe the procedures performed by care providers? Does the vocabulary use terms that are commonly used by care providers?
- **Specificity:** Is the vocabulary specific enough to accurately represent the many aspects of health care reality? Is there minimal loss of clinical detail when data are encoded in the vocabulary?
- **Useability:** Does the vocabulary meet the needs of a range of end users?

Post-coordination mapping

In this research, a very preliminary effort was made to apply post-coordination for missing terms [34]. If an extracted term or concept did not have a representation in pre-coordinated concepts in SNOMED CT®, post-coordination was applied. The first step in post-coordination process was to see if it was possible to compose using SNOMED CT® qualifiers. When this was not possible, post-coordination was done using the steps outlined in the Technical Reference Guide of SNOMED CT®. This algorithm consists of three steps. The source term is first broken into atomic terms. This step included normalization of the term, expansion and breaking text into separate words. Each atomic term is then mapped to a concept in SNOMED CT®. The atomic term mapping is based on a longest string match. Following this step, the relationship is found between the SNOMED CT® concepts by matching relationship patterns.

Data analysis

- Chart audit and interview format (MCS clinicians) were used to identify recurring themes and key terminologies used in the categorization of MCS patients.
- Cohen's kappa [33] statistic was employed to determine consistency among the two categories of raters, the researcher and the clinicians for the 'no match' or the 'missing terms' grouping.
- Cronbach's alpha [35] analysis was conducted to determine the internal reliability of the seven item survey questionnaire.

Results

A total of 512 terms and concepts relating to categorization of patient profiles were identified through the

manual chart audit process. The chart audit terms were reviewed by experts, the multidisciplinary clinicians involved in the care of MCS patients. [Table 1](#) shows a sample of the distribution of the occurrences of the clinical terms under various health care disciplines of focus retrieved in the chart audit process and grouped as top third, middle third and bottom third.

In the top one-third consortium, symptoms in the various body systems included blood and gland symptoms (fatigue); nervous system symptoms, such as light-headedness, cold fingertips, cold extremities and irritability; eye symptoms (eye irritation, itchy eyes) and nose symptoms (sinus congestion). Along with symptoms in the body systems, such as pain (multiple body systems), non-restorative sleep (nervous system), poor memory (nervous system) and food sensitivity and bloating (stomach and bowel), there is a manifestation of other determinants of health, such as psychosocial factors (non-assertiveness, self criticism and overly accommodative) and rehabilitation factors, such as not working, work related and financial stressors that add to the patient profile. [Table 1](#) shows the examples of a few top categories retrieved from the patient charts grouped under the areas of health focus.

The clinical vocabulary identified from the chart review was mapped to SNOMED CT® to identify the exact matches, synonyms and no matches. Out of the 512 clinical terms that were identified in the chart audit process as relevant to categorization of MCS, there were a total of 422 concepts (82%) found in SNOMED CT® through the manual string matching technique. About 5% of the 422 concepts required the use of expanded term matching approach. Some examples include source terms, such as CFS expanded to chronic fatigue syndrome, IBS for irritable bowel syndrome and low BP for low blood pressure. The remaining terms were mapped using the normalized string

matching technique. The percentage of exact matches and synonyms or closely related words found in the various health care disciplines is as shown in [Figure 1](#). The number of exact matches in nutrition and psychosocial focus of care were 61% and 57%, respectively while medical, physical and rehabilitation disciplines had 57%, 69%, and 55% of closely related terms in SNOMED CT®.

[Tables 2](#) and [3](#) show instances of source terms grouped by areas of health focus with their corresponding terms mapped in SNOMED CT®. The Table also includes the SNOMED CT ID for these mapped terms and their corresponding parent concepts. These terms were selected by clinicians as accurate representation for the sources terms.

Nine clinicians of the NSEHC representing various health care disciplines: physicians, nurses, psychologist, psychotherapist, dietician, physiotherapist and rehabilitation coordinator reviewed the controlled vocabulary for its accuracy and completeness [\[31\]](#). A high Cohen's kappa score of 0.95 was obtained indicating excellent agreement among the raters for the missing concepts or no match terms in SNOMED CT® between the clinicians and the researcher.

Among the terms that were missing in the vocabulary were those of relative importance to the condition of MCS. Although alternate terms were found, the experts were not in agreement with the accuracy or completeness of these terms in capturing the intended meaning as used in the charts. [Table 4](#) shows instances of such terminologies. Post-coordination [\[22\]](#) applied to these terms are also presented. For 75% (45 terms) of the terms with direct relation to MCS, post-coordination was possible with some level of complexity with a few attribute value pairs required for the process.

Table 1. Sample of multidimensional health factors that contribute towards an MCS patient profile grouped by the frequency of occurrence in the 100 patient charts

Sample of frequently used terms (n=100)	Area of health focus	Frequency of occurrence
Fatigue	Medical, physical	96%
Light-headedness	Medical	93%
Sinus congestion	Medical	89%
Light sensitivity	Medical	89%
Food sensitivity	Nutrition	75%
Poor memory/concentration	Nursing	75%
Pain	Nursing	73%
Poor balance	Physical	72%
Withdrawn	Psychosocial	65%
Bloating	Nutrition	63%
Not working	Rehabilitation	60%
Childhood abuse	Psychosocial	52%
Schooling problems	Rehabilitation	45%

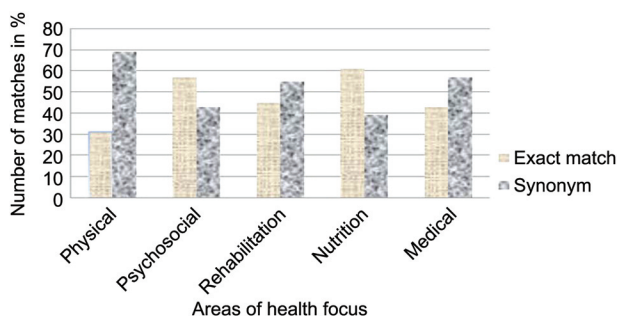


Figure 1. Percentage of exact matches and synonyms found in SNOMED CT® for the chart audit terms grouped under the relevant areas of health care focus.

The multidisciplinary clinicians answered a survey questionnaire following the re-coding of the profiles.

The participating clinicians in the re-coding process completed their evaluation of the vocabulary using a 7-item 5-point Likert scale that measured the usefulness of the vocabulary under an overall category and under sub-categories of scope, specificity and structure.

As seen in Figure 2, there was a high percentage of agreement on the overall usefulness of the vocabulary among the clinicians. The sub-categories also had an

overall high level of agreement with the question on the use of terms familiar to the clinicians under the scope category getting the maximum level of agreement from the clinicians. Clinicians tended to be more neutral and leaning towards disagreement on questions related to structure and specificity of the vocabulary on questions related to the full coverage of concepts to represent the medical condition.

Cronbach's alpha analysis was conducted to determine the internal reliability of the survey questionnaire. A good level of agreement was obtained with an alpha score of 0.84.

Discussion

Schoen et al. [8] reviewed the challenges in the health system related to chronic conditions in the UK, USA and Canada. Conflicting clinical documentation from health professionals about the medical condition, repeat medical tests, and medical errors were among some of the patient experiences reported. Studies have also explored errors in coding practices among clinicians dealing with chronic conditions, such as diabetes [36]. There is an identified need in the domain of chronic conditions to develop structured and semantically operable clinical information.

Table 2. Standardization of multidisciplinary terminologies using SNOMED CT®

Discipline of care	Source terms	Terms from SNOMED CT® SNOMED CT ID, parent concept and synonyms
Medical	• Fatigue, tired, low energy	Fatigue – 84229001 (finding) Parents: energy and stamina finding General problem and/or complaint (finding)
	• Cold extremities	Cold extremities (finding) – 15336001 Parent: temperature change at anatomical site (finding)
	• Fibromyalgia, FM, myalgia encephalitis	Fibromyositis – 24693007 (disorder) Synonyms: fibromyalgia, myofascial pain syndrome Parent: myositis
Nutrition	• Bloating, feeling bloated	Bloating symptom (finding) 248490000 Parent: finding reported by subject or history provider (finding) Swollen abdomen (finding)
	• Food sensitivity, food intolerance, sensitivity to food	Propensity to adverse reactions to food 418471000 Parent: propensity to adverse reaction to substance (disorder) Synonym: food sensitivity
Psychosocial	• Withdraw, withdrawn	Withdrawn (finding) 247755007 Parent: finding of level of interest (finding)
	• Childhood abuse, trauma in childhood related to abuse	Victim of child abuse (finding) 397940009 Synonym – child abuse
	• Feels angry, anger, angry	Feeling angry (finding) 75408008 Parent: mood finding Synonym: anger

Table 3. Standardization of multidisciplinary terminologies using SNOMED CT®

Discipline of care	Source terms	Terms from SNOMED CT®
Nursing	• Clutter in house, clutter	Cluttered living space (finding) 424661000 Parent: finding of characteristics of home environment (finding)
Physiotherapy	• Low energy, lack of energy, very tired	Fatigue (finding) 22496004 Parent: energy or stamina finding (finding)
	• Poor balance, balance impairment, balance	Poor balance (finding) 249985001 Parent: finding of general balance (finding) Impairment of balance (finding)
Rehabilitation	• Out of work	Unemployed (finding) 73438004 Parent: social context (finding) Stopped work (finding) Synonym: out of work, without employment
	• Schooling problems	School problem (finding) 161155000 Parent: social problem finding Synonym: school difficulties

Table 4. Post co-ordination of missing terms in SNOMED CT®

Source terms on MCS	Normalized term	Post co-ordination
Multiple chemical sensitivity (disorder)	Chemical; multiple; sensitivity	281867008 Multisystem Disorder : {47429007 associated with = 35209006 sensitivity : 410658008 triggered by = 441900009 chemical 276339004 environment }
Heightened sensitivity to environment (clinical finding)	Environment; heightened; sensitivity	35209006 sensitivity : {37135001 tolerance related finding =260365005 heightened : 44190009 triggered by = 276339004 environment }

There is an even greater concern around the burden of lesser known or medically unexplained conditions, such as MCS, CFS, IBS and chronic pain on the health care system [3, 4]. These conditions have unclear etiologies, a lack of standardized treatment strategies and unstructured clinical documentation adding another layer of challenge to the ones encountered for

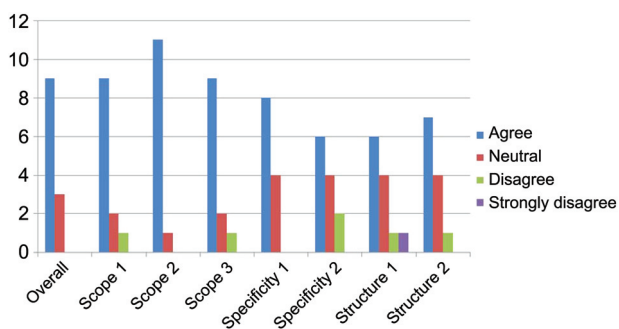


Figure 2. Evaluation of the controlled vocabulary (n=12).

better known chronic conditions, such as diabetes [36]. The patient profile information for these conditions is usually multidimensional and requires the involvement of multiple health care disciplines in the care delivery. The patient information is thus more comprehensive and complex compared to a typical problem list spanning areas, such as psychosocial stressors, rehabilitation, social barriers and education [18]. In this research, a preliminary effort to understand the type of profile characteristics in the domain of a complex health condition has been conducted. The profile characteristics for MCS had a wide range which included medical, psychosocial, nutrition, physical and rehabilitation domains of health focus.

There is a general trend in recent years to standardize the clinical vocabularies for various medical conditions to facilitate semantic interoperability. There has been an identified need for standardization in the domain of complex or emerging knowledge systems, such as

the one discussed in this study [16]. SNOMED CT® is a robust and effective reference terminology that has been shown to be effective as a standardization platform to represent disease concepts [22–27]. However, there is no research to-date that has explored the coverage in the domain of complex conditions, such as MCS that require terminologies spanning multiple areas of health focus.

In this study, the condition MCS was considered to explore the coverage in SNOMED CT® for the multidisciplinary factors that play a role in the categorization of patient profiles. This research is part of a larger study in which the concept of boundary objects is applied to develop a controlled clinical vocabulary and ontology to enable shared understanding among multidisciplinary care providers in the management of complex medical conditions [28].

SNOMED CT® was able to capture a high percentage of the multi-faceted disease concepts that exist in the description of patient profiles for MCS. In this study, there were fairly high percentages of exact matches or synonyms available for clinical terms in the physical, psychosocial, rehabilitation, nutrition and medical areas of health focus. However, a few important terms of direct relevance to the condition of multiple chemical sensitivity, such as ‘multiple chemical sensitivity’, ‘increasing reactivity to chemicals’ and ‘increasing in specific symptoms related to exposures’ were not available in SNOMED CT®. This study has demonstrated some preliminary success in applying post-coordination to capture some of these terms as explored by a few other studies to improve the coverage of terms in SNOMED CT® [22]. However, the post-coordination work done in this study was not reviewed by experts in the domain.

In this research, importance has also been given to the involvement and feedback of experts in the field to ensure the accuracy and completeness of the knowledge developed [31]. In the domain of complex chronic conditions, some additional work with the involvement of experts will be necessary to improve coverage of concepts in SNOMED CT® for application in clinical practice. As seen in this study with the MCS condition, some important concepts of direct relevance to the condition of MCS are not available in SNOMED CT®. This may be true of other complex medical conditions in SNOMED CT® where pre-coordinated concepts may not meet the needs for complete and accurate coverage of clinical terminologies. This further suggests the need for experts in the domain to get involved in the design phases of the standardization itself and in exploring the possibilities for post-coordination techniques to improve coverage of concepts.

Limitations

The study sample for this research was a convenience sample of patient charts and clinicians from the Nova Scotia Environmental Health Centre. While this method of sampling is usually not preferred, it was a reasonable way to test the coverage of multidimensional health concepts related to a complex health condition in SNOMED CT®.

A larger sample size of clinicians from various disciplines and the number of patient profiles for the re-coding process would have offered additional insights and strength to the usefulness of the standardized vocabulary.

This study did not attempt to obtain the feedback of the domain experts to evaluate the accuracy of the post-coordinated terms. The study explored the possibility for applying post-coordination for the missing terms. Given the nature of complexity of conditions, such as MCS, it is important that expert reviewers evaluate the accuracy of post-coordinated terms.

Conclusion

This study has explored the coverage in SNOMED CT® to represent multidisciplinary clinical terminologies and concepts for complex chronic conditions through the evaluation for a complex condition MCS. The importance of involving the feedback of domain experts given the nature of the multidisciplinary vocabulary for these conditions was an integral part of this research. SNOMED CT® was shown to be effective as a reference terminology for the standardization of patient profile concepts for MCS. However, there were a few terms of importance to the MCS condition that were not available in SNOMED CT®. Further involvement of experts in the domain to review such terminologies and post-coordination techniques may improve the coverage of terms in reference terminologies, such as SNOMED CT® in the domain of complex conditions.

Reviewers

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