Developing an Ontology of Intensive Care Unit Orders

By

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Certificate of Approval

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ABSTRACT

This work is the first step towards developing an ontology of Intensive Care Unit (ICU) orders. A dataset, comprised of 625 ICU orders from 34 randomly selected patients of several ICUs at the Oregon Health & Science University (OHSU), previously compiled by Lara Fournier (1), was analyzed to develop the order categories, components, hierarchy, and relationships among the components in the hierarchy. One hundred and fifty nine orders of different categories were randomly selected from the order database to create the ontology of the ICU orders. A commercially available software, MultiTes[1], was used to develop the ontology. The purpose of this project is to develop a tool for the health informaticians who would like to search for information associated with a particular term or element in an order set as to verify its relationships in the hierarchy of the ICU orders and with other elements of a particular order.

[1] Multisystems, Miami, Florida, USA

INTRODUCTION

Background and significance

Disease or treatment related medical information is increasing everyday in any health care domain and has been generating huge medical datasets. The availability of such huge datasets may revolutionize the understanding of diseases and their treatments if these data can be used as a knowledge-base. Such a knowledge-base can be developed through unification of the information. In order to create this unification, the discrete information needs standardized integration through consistent and meaningful representation of the data elements, along with easy accessibility and the ability to share the data. However, the current diversity of representation and organization of medical data in any clinical domain is a barrier to the unification of knowledge. Specifically for this project, the information available in physicians' orders also lacks standard representation and integration.

In any domain, when the amount of information grows, it becomes necessary to formulate a method by which the information can be represented and stored to serve as a knowledge-base for the organizers and the users. With physicians' orders, as the amount of order information has grown, it has become increasingly important to describe and classify order objects in meaningful ways. To develop a schema for meaningful representation of

physicians' order information, the creation of an ontology of the orders may be extremely helpful. Before going into the details of this project, a brief account of ontology in general follows.

What is an ontology?

An ontology is a specification of conceptualization that is designed to be reused across multiple applications and implementations [3, 4, 5, 6]. A specification of a conceptualization is a written, formal description of a set of concepts and relationships in a domain of interest [7]. For example, a database schema is a specification of a conceptualization.

Why develop an ontology?

In recent years, the development of ontologies – explicit formal specifications of the terms in a domain and relations among them [3, 21] – has been moving from the realm of artificial intelligence laboratories to the desktops of domain experts. Many disciplines now develop standardized ontologies so that domain experts can share and annotate information in their fields. Medicine, for example, has produced large, standardized, structured vocabularies such as SNOMED [8] and the semantic network of the Unified Medical language System (UMLS) [9]. Other broad general-purpose ontologies are emerging as well.

One of the more common goals in developing ontologies is *sharing common understanding of the structure of information among people and software agents* [2, 3]. In a given domain, if a standard vocabulary and representation schema is developed for the terms that are commonly used by different groups of similar interest, it is then possible to extract and aggregate information from the sites of these groups to answer user queries or as input data to other applications.

The driving force behind the recent surge in ontology research is *enabling reuse of domain knowledge* [5, 10]. Once an ontology is created using a standardized and structured representation schema, it can be customized for an individual user's needs. This can be done either by integrating several existing ontologies, each describing a portion of a larger domain, thus creating a new more comprehensive ontology, or by modifying an existing general ontology to describe one's domain of interest.

As knowledge is an ever-changing process – especially medical knowledge – another reason for developing an ontology is *to make domain assumptions explicit* [4, 9]. This makes it possible to change these assumptions easily if the knowledge about the domain changes. Explicit specifications of domain knowledge are also useful for new users who must learn what the terms in the domain mean.

A declarative specification is necessary for formal analysis of terms, and is extremely valuable when both attempting to reuse existing ontologies and extending them [8-10]. If such a declarative specification of the terms is available, *analyzing domain knowledge* would then be possible.

All of the above reasons for development of ontologies apply to the development of an order ontology. The ontology of ICU orders would define a common vocabulary for medical informaticians who need to share information in this domain.

MATERIALS AND METHODS

ICU Order Dataset

The ICU order dataset that has been used in this project was originally compiled by Lara Fournier, M.S. [1]. The actual sample of the dataset that was collected and compiled was a subset of orders from randomly selected patients admitted to the Oregon Health & Science University (OHSU) Intensive Care Units (ICUs) during the period of November 1, 2000 through January 31, 2001. Each order in the dataset, having an assigned unique identifier but devoid of patient identifiers, was available for use in this project in a single row of a spreadsheet. For this dataset, a single order was defined as a physician's written instruction(s) in a single line or in multiple lines

grouped together, and separated from the previous and subsequent orders by a new line, white line, bullet and/or number. A total of 625 of such orders were recorded in the dataset.

Selection of orders

The goal of this project was to develop the ontology with at least one-fifth of the available orders in the dataset. Initially, the plan was to choose every fifth order. However, if an order was found to be the same or very similar to another order already entered into the ontology, an adjacent order was chosen instead. Additionally, extra orders were chosen from among the complicated orders to allow exploration of problems with complexity in the ontology. The list of the orders those were used in this project are shown in Appendix A.

The development tool

A commercially available thesaurus construction software – MultiTes, developed and marketed by Multisystems, Miami, Florida, USA, was used for this project [20]. The user (i.e., the ontology builder) first defines the categories and relationships of the ontology. Terms are then inserted, classified with appropriate categories, and relationships are assigned with other terms. In addition, reciprocal relationships are automatically assigned

for each term pair. A screen-shot of the program window with some data components of an ICU order is shown in Figure 1.

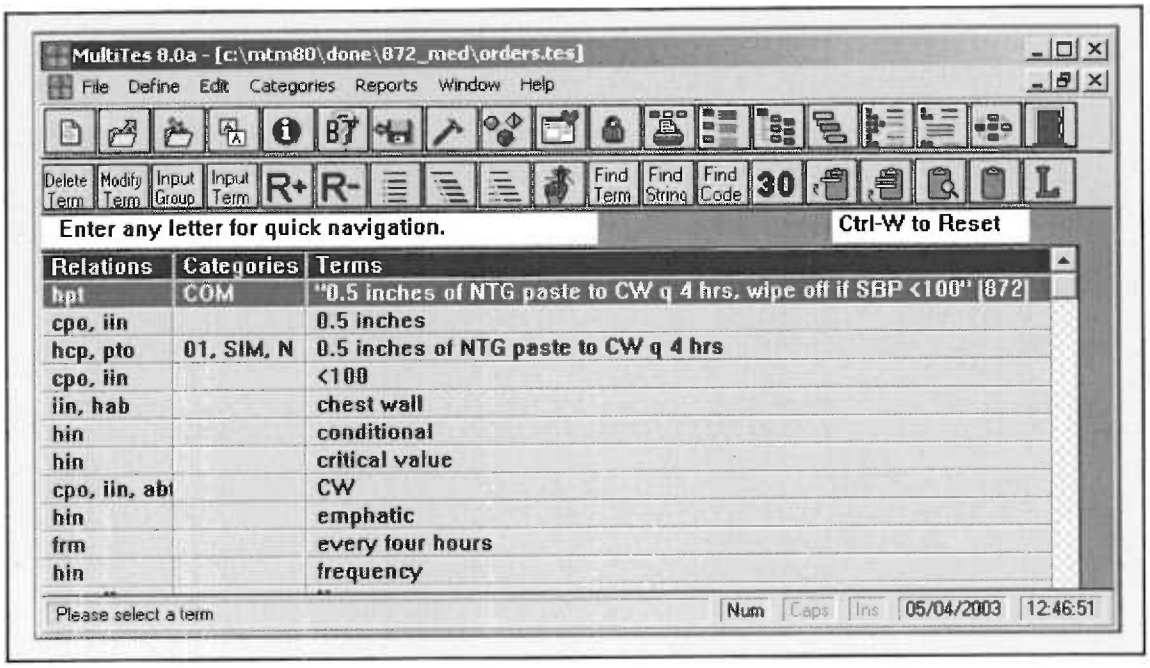

Figure 1. A screen-shot of the MultiTes program window.

The editing ability in this program is very restricted. Relationships, once assigned, cannot be modified. However, an incorrect relationship can be deleted and a new relationship may be assigned to the terms. The program is equipped with tools for searching by term or by category, or for displaying a term record (a term, it's categories and relationships). The program can generate reports in multiple views, such as alphabetical reports, hierarchical reports, or reports with a user-defined alphabetical range of terms. Reports are generated as text files and can be viewed on screen or may be sent to a peripheral device. In addition, the program can also create Hypertext

Markup Language (HTML) files for terms with an alphabetical browsing index.

Methodology of developing the ontology

In an iterative process, orders were entered into MultiTes and assigned relationships and categories of the classifications. A schema was developed and modified in an empirical iterative fashion. Once it appeared that the schema was definitive, the remaining orders were entered into MultiTes following this schema.

RESULTS

The ontology was developed and modified several times during the project. A total of 159 of the 625 available orders, of just over 1/5, were entered into MultiTes following the developed schema. A data disk of the ICU order ontology created is submitted along with this project paper.

The ontology schema

The schema developed in this project is shown in Figure 2. In the rectangles are the terms entered into MultiTes. The classifications are shown as ovals and the relationships are represented by arrows.

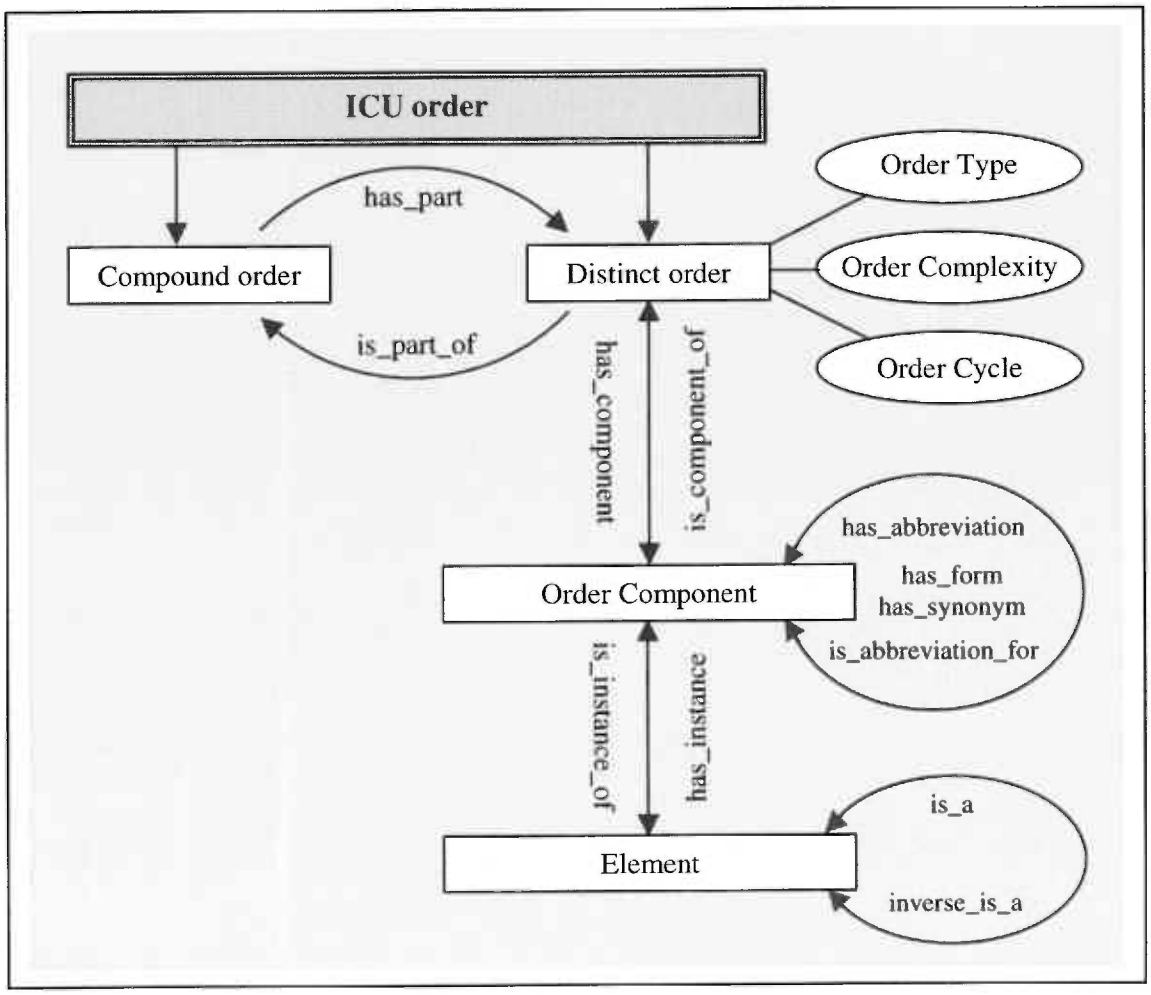

Figure 2. Ontology schema for ICU order ontology project.

Classification of orders

A single ICU order can be either a distinct order or a compound order. A *distinct order* is a straightforward order having one part, i.e. an instruction to carry out a single task, such as a medication administration, performance of a laboratory test or a nursing instruction. Examples of distinct orders are shown in Table 1.

Table 1. Examples of distinct orders.

1	Prednisone 60 mg PNGT q d	[A medication order, simple]
2	Change NS to 70 cc/hr	[An infusion order, modify]
3	Transfuse 2 units PRBC now	[A transfusion order]
4	D/C (L) groin cath	[A procedure order, discontinue]
5	pCXR F/U after thoracocentecis	[An imaging order]
6	CBC at 1800	[A laboratory order]
7	Activity: OOB with assistance	[An activity order]
8	Transfer to 6CVA – Blue	[An ADT order]
9	Diet: 2000 cardiac	[A dietary order]

Table 2. Examples of compound orders.

1	Hold PRBC and transfuse 1 unit FFP now
2	CBC q 6 hrs x 24 hrs then q 8 hrs
3	SSI: CBG q 6 hrs, if CBG = 0-100, 1 amp D50 / 101-200, do nothing / 201-300, 6 units regular insulin SQ / 301-400, 8 units insulin SQ / >401, 10 units regular insulin SQ, Call HO

A *compound order*, on the other hand, has two or more parts. Each part can stand alone as a distinct and separate order. For example, a compound order may be composed of two or more medication or laboratory orders or a mixture of medication, laboratory or imaging orders in a single order as defined in this work. Table 2 shows some examples of compound orders. For the purpose of this ontology project, all compound orders are therefore first divided into two or more distinct orders. For example, the compound

order "*CBC, BMS in am, CXR now*" would be divided into the following distinct orders: (1) *CBC in am,* (2) *BMS in am,* and (3) *CXR now.*

Order categories

A distinct order may be categorized under three broad classifications – the *Order Type* (OC), the *Order Complexity* (XC) and the *Order Cycle* (CC). Each class has several categories. Each category is assigned a unique code for representational purpose in the report.

An *order type category* (Table 3) defines the order roughly in terms of the

Table 3. Order Type Categories (OC)

Code	Order type	Description
01	Medication order	Route independent medication
0101	Infusion order	Intravenous fluid/electrolyte infusion
0102	Transfusion order	Blood or blood product transfusion
011	Other treatment order	Other kind of treatments, e.g. physiotherapy
0111	Dietary order	Diet related order
0112	Activity order	Particular type of movement/exercise
02	Laboratory order	Any laboratory test not subcategorized here
0201	Clinical laboratory order	Cytology, hematology, chemistry etc.
0202	Pathology laboratory order	Biopsy, specimen etc.
03	Imaging order	X-ray, ultrasound, CT etc.
04	Other diagnostic order	Any other diagnostic procedures not listed here
0401	Vital signs	Monitoring vital functions
05	Procedure order	Any surgical/medical procedure
06	Informational order	Information may/not be associated with above
07	ADT	Admission, discharge, transfer
08	Other	Any other order not listed here

system involved in carrying out that order. The order type has 8 categories and several subcategories. However, classifying an order under too narrow a category was not felt to be useful for this project. For example, hematology, chemistry, and microbiology orders were all classified as *clinical laboratory order* (code: 0201), rather than by their more specific types. Similarly, transfusion orders (code: 0102) have not been subdivided by type of transfusion. Table 3 shows the categories of order types and the description of each category.

The *order complexity classification* includes a category for compound order as well as categories for orders which require either domain knowledge or further information about the patient before they can be carried out. A simple order does not require either of these. Table 4 shows the categories of order complexities and their descriptions as have been defined for this ontology.

Table 4. Order Complexity Categories (XC)

Code	Complexity type	Description
SIM	Simple	A single order which can be acted upon without further knowledge
CON	Conditional	A single order that requires further collection of data before being acted upon
REF	Referent	A single order that does not stand alone, but rather requires domain knowledge, such as an order set
COM	Compound	A multi-part order, which can be divided into parts to create more than one distinct orders

Table 5. Order Cycle Categories (CC)

Code	Cycle type	Description
N	New	A complete order having all components; does not require knowledge of a previous order
M	Modify	An incomplete order; changes one or more components of a previous order, requires knowledge of the previous order
P	Partial	An incomplete order; adds components to a previous order and requires knowledge of that previous order
D	Discontinue	An order to discontinue a previous order ; requires knowledge of the previous order

The *order cycle classification* defines whether or not a previous order exists which is added to, modified or discontinued by the current order. The different order cycle categories and their descriptions are shown in Table 5.

Order parts, components, terms and elements

Compound orders may be broken down into two or more distinct orders (Table 6). Each distinct order may then be broken down into components, which are words or phases that form the "building blocks' of an order. A component can be a single word or can be two or more consecutive or separated words. For example, the two words "wipe off", as shown in Table 7, constitute a single component, and in the same order "if" is one component. Symbols, like colon (:) slash (/), and prepositions, such as to, of, etc. were excluded from the terms when not found to be necessary.

An element is the final term in the order ontology. An element describes what each component of an order means or indicates. It is represented as an

"instance of" (reciprocal: "has instance of") relationship for each component of an order. For example, the "q 4 hrs" component of the order shown in the example (Table 7) is an *instance of* **frequency** and the "wipe off" component (Table 7) is an *instance of* an **emphatic** or **act**. When appropriate, elements are further explained by an "is a" (reciprocal: "inverse is a") relationship. For example, Sinemet is *an instance of* **dopaminergic drug** and dopaminergic drug *is a* **medication**.

Table 6. A simplified compound order. The original order is a *compound order*, which has been broken down in two *distinct orders*. Each distinct order is a *part* of the compound order. Terms in the bracket are implied.

Original order:	0.5 inches of NTG paste to CW q 4 hrs, wipe off if SBP <100
Parts:	0.5 inches of NTG paste to CW q 4 hrs Wipe off [NTG paste] if SBP <100 [mm Hg]

Table 7. Components of distinct orders. Note that a component may be a single word, or a phrase. It may also be a numerical value or a mix of number, letter and/or symbol.

Distinct order 1:	*0.5 inches of NTG paste to CW q 4 hrs*
Components:	0.5 inches NTG paste CW q 4 hrs
Distinct order 2:	*wipe off if SBP <100*
Components:	wipe off if SBP <100

Relationships of parts and components

Three types of relationships can be defined in the MultiTes program, namely hierarchical, associative and equivalence relationships. Hierarchical and associative relationships have been defined and used in this ontology.

Hierarchical relationships define the relationships of a term with other terms in a hierarchical fashion. In this project, hierarchical relationships were used to define the relationship of a compound order to its parts and of distinct orders to their components. In addition, the elements have hierarchical relationships with components and may have hierarchical relationships with other elements. The hierarchical relationships are listed in Table 8.

Table 8. Hierarchical Relationships

Label	Relationship		Label	Reciprocal
HPT	has_part		PTO	part_of
HCP	has_component		CPO	component_of
HIS	has_instance		IIN	is_instance_of
ISA	is_a		IIS	inverse_is_a

Table 9. Associative Relationships

Label	Relationship		Label	Reciprocal
SYN	has_synonym		SYN	has_synonym
HAB	has_abbreviation		ABB	is_abbreviation_for
FRM	has_form		FRM	has_form

Associative relationships define the relationship of a component to other representational forms of that component, which may be acronyms,

synonyms or abbreviations. Components and elements are assigned associative relationships whenever appropriate. The associative relationships are listed in Table 9.

For each type of relationship, a *reciprocal* relationship for each term pair is also specified when relationships are being defined. When a term is assigned a relationship in MultiTes, the program automatically assigns the predefined reciprocal relationship to that term. The reciprocal for each type of relationship is listed on the right in Tables 8 and 9.

Ontology report

A representative report of a compound ICU order is shown in Figure 3, which is in alphabetical report format. As shown, the original order has the complexity category of compound (COM) and contains two distinct orders designated using "has part" (HPT) relationships. Each distinct order has been classified by order type (OC), complexity (XC) and cycle (CC). The first distinct order ('0.5 inches of NTG paste to CW q 4 hrs'), as can be discerned from the report, is a *medication* order (OC) of *simple* complexity (XC) with a *new* cycle (CC). It participates in the "has component" (HCP) relationship with four components – 0.5 inches, CW, NTG paste and q 4 hrs. The report also shows the reciprocal relationship this distinct order has with the original order, which is a PTO (part of) relationship.

Alphabetic Report

"0.5 inches of NTG paste to CW q 4 hrs, wipe off if SBP <100" [872]
XC: COM Compound
HPT: 0.5 inches of NTG paste to CW q 4 hrs
wipe [NTG paste] off if SBP <100 [mm Hg]

0.5 inches
CPO: 0.5 inches of NTG paste to CW q 4 hrs
IIN: quantity

0.5 inches of NTG paste to CW q 4 hrs
OC: 01 Medication order
XC: SIM Simple
CC: N New
HCP: 0.5 inches
CW
NTG paste
q 4 hrs
PTO: 0.5 inches of NTG paste to CW q 4 hrs, wipe off if SBP <100 [mm Hg]

<100
CPO: wipe off if SBP <100 [mm Hg]
IIN: critical value

chest wall
IIN: site
HAB: CW

conditional
HIN: if

critical value
HIN: <100

CW
CPO: 0.5 inches of NTG paste to CW q 4 hrs
IIN: site
ABF: chest wall

emphatic
HIN: wipe off

every four hours
FRM: q 4 hrs

frequency
HIN: q 4 hrs

if
CPO: wipe off if SBP <100 [mm Hg]
IIN: conditional

[continued on next page]

medication
HIN: nitroglycerine paste
NTG paste

nitroglycerine paste
IIN: medication
HAB: NTG paste

NTG paste
CPO: 0.5 inches of NTG paste to CW q 4 hrs
IIN: medication
ABF: nitroglycerine paste

q 4 hrs
CPO: 0.5 inches of NTG paste to CW q 4 hrs
IIN: frequency
FRM: every four hours

quantity
HIN: 0.5 inches

SBP
CPO: wipe off if SBP <100 [mm Hg]
IIN: vital sign
ABF: systolic blood pressure

site
HIN: chest wall
CW

systolic blood pressure
HAB: SBP

vital sign
HIN: SBP

wipe [NTG paste] off
CPO: wipe off if SBP <100 [mm Hg]
IIN: emphatic

wipe off if SBP <100 [mm Hg]
OC: 01 Medication order
XC: CON Conditional
CC: D Discontinue
HCP: <100
if
SBP
wipe [NTG paste] off
PTO: 0.5 inches of NTG paste to CW q 4 hrs, wipe off if SBP <100 [mm Hg]

Figure 3 : Alphabetical report of a compound ICU order. The actual order is in quotation as the top entry. Terms are in bold text; categories and relationships are listed below the terms.

As the figure shows, each component of the distinct orders can be adequately described from the report by its hierarchical and/or associative relationships. For example, the term 'NTG paste' is a *component of* (CPO; a reciprocal relationship) the first distinct order; the term (component) is an *abbreviation for* (ABF) nitroglycerine paste, and the term (component) is an *instance of* (IIN) the element medication.

DISCUSSION

The need for a meaningful representation and organization of medical data has been emphasized, especially with the advent of computer technology. Electronic data in a standard or exchangeable format is now available for almost all aspects of medicine with the electronic medical record (EMR) as its core component [11, 12]. This has provided a unique way of archiving, retrieving and verifying medical information [13, 14, 15], as well as making the care delivery easier and less expensive [16, 17]. In recent years, computer-based physician order entry systems (POE) are also being sparsely implemented to help reduce treatment-related morbidity and mortality [18]. ICUs, being one of the most critical areas in the care delivery domain, need an appropriate system to represent and organize the treatment information – specifically the physicians' orders. Yet, there has been no noticeable effort to

systematically organize or archive ICU orders so that they can be used for reference or verification in a time of need. Our effort to develop an ontology of ICU orders may prove helpful in addressing this need.

In this project, we have developed an ontology of 159 ICU orders and their components, selected from a previously compiled ICU order dataset [1]. One limitation of this work is that it is a very limited dataset; so the robustness of the model has not been well tested.

There are, however, certain problems that we encountered during development of the ontology of ICU orders. The software that we used did not perform as one might expect from a commercial product. First of all, most of the steps or operations can only be performed by mouse clicks, as opposed to using the Arrow, Tab or Enter keys, which in a smartly designed program moves the input-output focus to appropriate subsequent steps and greatly enhances the speed of such work. Another frustrating experience was that the program tended to freeze frequently. In addition, we had difficulty storing the data files such that work on the ontology could be tested on or performed from more than one computer. This seriously affected the coordination of the project.

Apart from the technical problems of the software, incompleteness, inconsistency and diversity of the terms used in the orders appeared to be one of the major predicaments. It was noticed that there were many non-

standard terms used in the ICU orders. Many abbreviations or acronyms that were used have no official recognition. Short terms used in the orders varied in their representations, although these were all from the same hospital.

Another issue that has to be considered for any successful health care application is the use of standard vocabulary and format in the orders. The field of Medical Informatics is striving with the standardization of clinical terminologies as well as their systematic organization. The goal is to advance excellence in patient care through the delivery of a dynamic and sustainable, scientifically validated terminology and infrastructure that enables clinicians, researchers and patients to share health care knowledge worldwide, across clinical specialties and sites of care [19]. To make this happen and in order to enhance the service – there is no alternative to using standard vocabulary in any health care application. In the above context, it is crucially important for ICU orders to follow a standard vocabulary. This project foresees that an ontology created from an ICU orders' dataset that was based on standard vocabularies would be of actual interest for users.

CONCLUSION

We have successfully recorded an ontology of orders based on a developed schema from an ICU order dataset. As a first step towards developing the

ontology, we started with a few broad categories, attributes and relationships. As we worked using the developed schema, it became apparent that more categories and relationships were necessary to define the complex orders more efficiently. We also realized that in order to develop a successful ontology of the orders, a thorough knowledge of the domains from which the orders for this project were chosen was also necessary. The project may prove helpful and beneficial to similar subsequent work, and can perform as a model for future work on ontology of physicians' orders.

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APPENDIX A

List of ICU orders used in this project

649 D/C Unasyn [X6]
657 D/C Foley [X7]
716 D/C Fentanyl [Z5]
746 D/C IV Zantac, change to PO 150 mg bid [Z10]
775 Per S.T. recommendations: Diet: puree; thickened liquids, small meals, D/C meal if pt fatigues [BB8]
818 D/C after Heme/Onc sees pt and decides on giving vincristine [CC7]
901 D/C abdominal U/S [GG3]
970 Cx cath tip when D/C 'd [MM8]
1050 D/C (L) groin cath [WW2]
1052 Clarification: Propofol weaned off and D/C 'd per original order on 12/5/00 [WW6]

1163 D/C Insulin drip [AC4]
621 IVF: NS at 100 cc/hr for 1 L total [X1]
622 Labs: ECG, CBC, BMS, pCXR, Troponin at 8 am and 4 pm, HCT q 6 hrs, Blood Cx x 2, urine Cx; Type and cross 2 units of PRBCs [X1]
638 IV F: None [X3]
643 Hytrin 5 mg q hs PO [X3]
654 Change Sinemet to 25/250 PO qid [X6]
674 2 units FFP on admit to MICU [Y1]
681 Transfuse 2 units packed red blood cells now [Y2]
687 Give 1 unit FFP [Y3]
702 See PCA orders [Z1]

714 KCl 40 meq IV over 2 hrs for K = 3.5 [Z5]
717 Ketorolac (Toradol) 30 mg IV q 6 h prn x 48 hrs [Z5]
729 IV: D5 1/2 NS + 20 meq KCl at 100 cc/hr [Z8]
733 Meds: see PCA order [Z8]
738 Mavik 4 mg PO q pm [Z8]
747 Finish current IV bag and hep lock IV [Z10]
760 Encourage PO fluids [BB3]
767 If pressure (PAP) still low after Albumin give LR 250 cc IV x 1 [BB5]
773 Digoxin .25 PO q d via FT [BB8]
806 May give Ativan 2 mg IV pre-op [CC4]

809 Peripheral blood culture, then admin 800 mg ibuprofen PO x 1 [CC5]
814 Cytarabine 40 mg in 5 cc preservative free normal saline - (for Ommaya) to be picked up this am with BBBD chemo [CC5]
824 Prednisone 60 mg PNGT q d [EE4]
840 Ativan 2 mg IV x 1 now [EE12]

841 MSO4 gtt @ 1 mg hr, titrate to sedation/control agitation [EE12]
847 Decrease Prednisone to 40 mg p NGT, starting tomorrow [EE15]
852 Ok to increase NS 125 cc/hr [EE17]
856 change Prednisone 40 mg IV q d [EE17]
872 0.5 inches of NTG paste to CW q 4 hrs, wipe off if SBP < 100 [FF3]
875 Verapamil 240 mg PO q am, 120 mg PO q pm [FF4]

888 Meds: Octreotide 50 mcg/hr gtt [GG1]
891 Tylenol 325-650 mg PO q 4-6 hrs prn [GG1]
893 Labs: now - CBC with diff, CMS, Mg, PO4, ICa, PT, PTT, Type and Cross 2 units [GG1]
900 Decrease Cipro to 500 mg PO q d [GG3]
902 Change Demerol to 25 mg IV q 4-6 hrs prn pain [GG3]
903 CaCO3 1300 mg PO tid - dose 2 hrs between Cipro [GG3]
919 CaGluc 2 amps IV x 1 [GG6]
921 FeSO4 325 mg PO tid [GG6]
927 Azmacort MDI 2 p
928 Serevent MDI 1 puff q am and (prn 1 time per day) [KK1]

933 1 L NS IV [KK3]
943 Dopamine 3 mcg/kg/min IV [KK4]
950 2 g MgSO4 IV [KK6]
954 0.5 mg Ativan IV now [KK6]
958 Change Premarin to 1.875 mg PO q d (Premarin 1.25 + 0.625 = 1.875 mg) [KK10]
963 Clarification of Zofran order - Zofran 4 mg IV q 4-6 hrs prn [MM6]
981 Please thaw 2 units FFP on call to OR [OO2]
982 4 units PRBC on call for OR [OO2]
986 Morphine PCA [OO4]
993 See specific PCA orders from pain service [OO4]

1001 D5 1/2 NS with 20 KCl at TKO [OO11]
1006 Lasix 40 mg PO bid [OO11]
1011 Bacitracin cream to (R) face bid [OO14]
1021 change MSO4 to 1-4 mg IV q 1 hr prn watch for sedation [UU1]
1030 Per Respiratory Eval - Albuterol MDI 2-4 puffs q 4 + prn [UU2]
1034 Per Respiratory Protocol - change Albuterol MDI to prn [UU3]
1057 Zantac 150 mg PO bid or Zantac 50 mg IV q 8 hrs [WW6]
1082 Dopamine gtt - maintain SBP > 140 < 180 [XX1]
1092 Change IV F to D5 W with 60 meq KCl to run at 200 cc/hr [XX2]
1099 Please mix 25 mmoles K3PO4 in 250 cc D5 W + infuse over 5 hrs (50 cc/hr) [XX3]

1105 Solumedrol 1 g IV over 1 hr to begin at 2000 [XX4]
1137 Meds: Insulin gtt per routine [AC1]
1155 Meds: Insulin gtt see protocol [AC4]
1167 MVI PO q d - 1 st today [AC6]

1176 Please change O2 to NC 6 L (rather than face mask). Titrate to keep O2 Sat > 83% oxygen canister so that Pt. may shower [AC7]
1190 D5 NS with 20 KCl/L at 80 cc 1 hr [AE1]
1208 Zofran 4-6 mg IV q 6 hrs prn [AE5]
1213 Colace 100 mg PO bid [AE5]
1230 Meds: Digoxin 0.125 mg PO q d [AF1]
1234 ASA 325 PO q d [AF1]

671 Portable CXR on admit r/o infiltrate [Y1]
691 Abd. Ultrasound for ascites [Y4]
802 CXR: AP/Lat prior to OR [CC2]
846 CBC, BMS, ABG in am, CXR [EE15]
850 Do not need to recheck chest X-ray [EE17]
965 STAT pCXR - FT placement [MM6]
1031 Call H.O. when X-ray done [UU3]
1091 ECHO + EKG to follow please [XX2]
1116 EKG [AB1]
1147 EKG now and in am [AC1]

1160 CXR PA & Lat in AM [AC4]
1194 MRI of head with and without contrast - STAT [AE3]
644 Labs: HCT at 1800 [X3]
690 DIC panel [Y4]
754 am Labs: BMS, CBC with diff, q am start now [BB3]
801 Labs: Draw from neostar - CBC with diff, Comprehensivie Metabolic Panel, LDH, PTT/INR, UA dipstick - 24 hrs for creatinine clearance [CC2]
838 Check ABG 1 hr after wean changes (@ 0745) [EE12]
906 Am CBC with diff, BMS, Mg, Phos, ICa [GG3]
922 Change HCT to q 12 [GG6]
947 Send serum Osmo [KK4]

1028 Blood Cx x 2 [UU2]
1097 1330 Labs - Liver panel, PT, PTT, Amylase, Lipase, CBC with diff, PO4, Mg (if not on Liver Panel), UA with micro, Alk phos, GGT [XX3]
1142 Plz check CBG q 1-2 hrs per Protocol [AC1]
1169 Please send pleural fluid - tube 1: protein, LDH, albumin - tube 2: ???, 3: save for further studies [AC6]
1217 Send HCT now [AE6]
616 Vitals: routine [X1]
635 Activity: OOB with assistance [X3]
673 SCDs [Y1]
710 O2 to keep Sat >= 95% [Z1]
743 Call HO T > 38.5, SBP > 180 < 95, DBP > 110, HR 110 < 50, RR > 30 < 10, UOP < 20 cc/q 4 hrs [Z8]

770 Upper limit SBP 130 [BB5]
819 Vent setting: SIMV/PS PS 10, PEEP 5 rate 17, FiO2 60 % [EE4]

861 Vitals: q 2 hrs [FF1]
884 Activity: Bedrest with bedside commode [GG1]
988 OOB to chair with assistance [OO4]
1056 Clamp NGT once TFs start, check residuals q 3 hrs. Hold TFs for residuals > 150 cc [WW6]
1112 Nursing; IO's, SCDs, HOB at 30 degrees [AB1]
1143 O2 for goal SaO2 89-95 % [AC1]
1181 Vitals: q 1 hr with neuro checks, IO's, SCDs [AE1]
1205 IO's, Foley, SCDs [AE5]

620 Diet: NPO except meds [X1]
731 Diet: sips of clears [Z8]
785 please cont. TF tonight [BB24]
886 Diet: NPO except meds [GG1]
1054 Start Probalance at 10 cc/hr [WW6]
1195 ADAT ([AE3]
613 Admit to MICU [X1]
753 Discharge home today [Z11]
788 Admit 5A [CC1]
955 OK to Tx pt 7CVA [KK6]

1106 Admit 7A Dr.xxx [AB1]
1178 Admit to 7A ICU/Dr.xxx/Neurosurg [AE1]
648 P.T. eval/treat [X6]
857 Psych O.T. to eval for communication board. [EE17]
1125 P.T./O.T. - please eval and treat [AB2]
614 Dx: GI bleed [X1]
634 NKDA [X3]
726 Dx: s/p Gastric Bypass [Z8]
860 Condition: Stable [FF1]
1039 Stable [WW2]

1129 Dx: intracranial hemorrhage [AB2]
1158 Allergy: NKDA [AC4]
1226 Allergies: none [AF1]
626 Inapsine 1/4 - 1/2 cc q 2-4 hrs prn nausea [X1]
668 CMS [Y1]
708 Albuterol nebs q 4 hrs prn [Z1]
762 Sheath out when ACT < 170 [BB3]
779 Begin 3 day calorie count 12/8/00 [BB8]
829 Increase respiration rate to 19 [EE4]
848 Restrain for pt safety, see sheet [EE15]

895 Maintain 2 large bore periph. IVs [GG1]
942 VBG at 1400 [KK4]
975 Decrease FiO2 .50 [MM12]
1013 Wrist extension splint for radial N Palsey [OO14]

1035 C spine cleared [UU3]
1070 CPAP 5 cm x 30 minutes. If tolerates, we will extubate. Page me before extubation [WW12]
1079 Critical [XX1]
1148 Full Code [AC3]
1199 Please cont. pre-op orders [AE4]