The Use of Electronic Synoptic Operative Reporting to Improve Operative Reports for Spinal Cord Injury Patients

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I acknowledge that I am the author of this report and that it has not received any previous academic credit at this or any other institution.

Areej Alsulaiman

Executive Summary

Improving the quality of care for patients requires assuring accurate diagnosis and timely, accessible information that enables treatment planning and makes patient care decisions more informed and evidence-based. Traditionally, in the surgical domain, physicians and surgeons document surgical information in a narrative reports. These traditional operative reports collect information in non-standardized format which depends mainly on the surgeon's ability to remember and collect the details of the surgical procedures. The narrative (dictated) operative report can contain redundant, nonessential information and can lack critical information for enhancing the continuing of care for patients. Also, narrative reports limit the use of operative data for secondary purposes such as research or evaluation projects. One solution that has been discussed widely to improve the data quality of operative reporting is the use of the electronic synoptic operative report template. Synoptic reporting allows the use of a structured format when collecting data and enables the capture of discrete data items. Consequently, allocation and reuse of these data can be done quickly and more efficiently. The synoptic template can also represent a potent educational tool, since it reminds clinicians of important steps and details of the occurrence.

The Neurosurgery Division of Dalhousie University, in which the author is performing her internship project, is considered a leader in Canadian surgery and contains many academic programs promoting clinical and research activities. The Spin program is one of the active programs which is provided to promote the care delivery of patients with diseases of the spine.

At present, spinal surgeons and residents of the Neurosurgery division use the traditional narrative reporting to gather information about spinal cord injury operations on patients. Consequently, important details can be missed and redundant information can be collected. In this way, operative reports are likely to be incomplete, and unable to efficiently support the continuity of care for patients and to support research studies and administrative purposes.

The author of the report is participating in a research study that is being conducted in the Neurosurgery department to test if implementing an electronic synoptic operative report for spinal cord injury patients improves the quality of data captured for primary and secondary use. In this research study, participants (Surgical residents) will be recruited to generate operative reports by using the two methods (dictated and Synoptic reporting). Consequently, the narrative (dictated) and synoptic reports will be compared. This study will measure accuracy, conciseness, completeness and reuse. The electronic template that will be used in this research study will be developed to enable the capture of data elements that are considered important to the collection of data based on consensus between investigators.

Moreover, the electronic synoptic operative report template will be built based on Health Level Seven (HL7) clinical statement to enable the collection of discrete data items which is a specific

method to construct electronic templates. Also, a medical vocabulary system called SNOMED CT (Systematized Nomenclature of Medicine -- Clinical Terms statement) will be used as a medical terminology standard to enable the exchange of medical data items between different computer systems.

The author worked in this research project as a research assistant and she completed the following tasks:

1- In the electronic synoptic template there 402 clinical data items that should be encoded to SNOMED CT code values. From these, the author completed the SNOMED CT code values for 396 clinical data items. The remaining six data items were considered uncodable by the research team. The author confirmed that the SNOMED CT code values developed for the clinical data items fit the HL7 clinical statements that are used in developing the sections of the electronic template.

2- A confirmation methodology was developed to confirm some of the SNOMED CT code values with the research team. From the 396 clinical data items that were encoded to SNOMEDCT expressions, 43 were considered as needed to be confirmed with the clinician (*Dr. Sean Christie*). Consequently, the SNOMED CT expressions for 38 data items were confirmed and five were considered as uncodable. As a result, out of the 402 clinical data items provided in the electronic template there are 391 clinical data items that were encoded to SNOMED CT expressions representing 97.26% of the all clinical data items provided in the electronic synoptic template, while 11 data items were considered as uncodable, representing 2.75 % of all clinical data items of the electronic template.

3- The author developed lookup tables containing the SNOMEDCT code values and their descriptions for all clinical data items of the electronic Synoptic template

4- The author conducted a pilot test of the electronic template to test the completeness and usability of the electronic template before providing it to the participant. Results were presented and discussed with the research team and it was found that there is no need to add additional clinical data items to the electronic synoptic operative report template. Also, some issues that were discovered when entering data items were considered when developing the user manual to support participants to efficiently use the electronic template.

5- The author developed a user manual and quick start guide to support participants when using the electronic template.

6- the author could not participate in analyzing the data on accuracy, completeness and reusability of the dictated and synoptic operative reports since there was insufficient time to recruit participants in the study and have them complete the both reports (synoptic and narrative), so the author worked at the modification of the data analysis instruments which will be used in the study to assess the usefulness of the operative reports, (dictated & synoptic). These instruments are; “Completeness and Accuracy Assessments forms” and “Recruitment Questionnaire form”.

Knowledge and experiences, that the author obtained from completing courses of the Health Informatics program have supported the author to effectively complete and perform tasks that have been assigned to her in the internship project. In this paper the author discusses how some Academic courses from the Master of Health Informatics Program enabled her to work in the internship project. These courses are “Health Information Flow And Standards (HINF 6102)”, “Research Method (HINF 6020)”, “Information Systems and Issues (HINF 6110)” and “Nursing Administration and Leadership (NURS 6000)”, which is an elective course,

While the Author was encoding the clinical data items of the electronic template, reviewing the code values with the supervisor (Dr. Grace Paterson), and confirming SNOMED CT code values provided by another previous work, she recognized that there is a tendency for individual users to encode clinical data items differently when using the SNOMED CT system. Therefore, the author searched the literature to explore the issue of the variability of SNOMED CT coding and explored some approaches discussed to enhance the consistency of coding. As a result of this search, the author provides in this paper some approaches recommended in the literature to reduce or overcome the problem of variability of SNOMED CT coding. For example, it is recognized that if it is not feasible to assure the consistency of coding among different coders, it is important to find a method that can algorithmically determine similarities and differences among divergent codes and enable the reconciliations of these differences. Also, it is important to enhance the usability of a complex terminology system like SNOMED CT by developing a logical model that fits users’ needs. Moreover, the importance of standardized guidelines and training sessions was recognized widely in the literature to reduce variability of coding. Also, binding a terminology standard like SNOMED CT with an information reference model like HL7 Reference Information Model (RIM) was recognized as a way to provide coders with a structured way to restrict their coding performance. The use of more than one terminology standard was also recommended as an approach to increase the coverage of coded data and accordingly reducing the need to use post-coordination SNOMED CT expressions, which is a considerable source of variation when encoding data. In fact, all the approaches discussed in the literature were recommended to promote the reliability of SNOMED CT coding. There is no solution that can avoid variations among different coders since the language is inherently complex in its use and control. Individuals have different interests and ways of understanding things as well.

Also the author provides in the report some recommendations derived from her experience in the internship project and these recommendations are presented below:

- The variability of SNOMED CT coding among different coders seems unavoidable, so a crucial task is to enhance the development of a method that algorithmically can detect the similarities and differences among discordant codes.

- A standardized and structured work environment can enhance the reliability of coding. Under controlled circumstances, when coders use the same coding instructions and are exposed to the same training sessions, there will be less coding discrepancy than in more informal situations.
- It is important to promote and encourage the use of more than one terminology standard when encoding data items of a clinical domain. A comprehensive, controlled vocabulary system can support coders to utilize the existence of different terminology standards to allocate the most appropriate code and increase the quality of the coding process
- Guidelines that are released by the International Health Terminology Standards Development Organization (IHTSDO) can effectively help coders learn and understand the concept model of SNOMED CT system, which will support them in the coding process. However, using guidelines or attending train sessions might not be sufficient to promote the quality of the coding process, therefore, exploring examples of real life situations, which describe the coding process that have been taken by other projects from other clinical domains can be very useful in enhancing the quality of coding.
- Changing the traditional way that surgeons use to document operative information can be difficult, therefore it is very important to consider the issue of user satisfaction and adopt methods or approaches to increase the acceptance and avoid resistance of users.

At the end of the report, there are some lessons learned that the author obtained from participating in this project for example:

- The author increased her knowledge about the use of SNOMED CT, an important medical terminology standard that is used to enable the collection, retrieval and exchange of medical data items between different computer systems.
- Also, she learned how to use the SNOMED CT compositional grammar in order to build the post-coordination expressions to represent the required meaning of the intended clinical concepts
- Also, in this project the author increased her knowledge about very important component of the HL7 Clinical Document Architecture; which is the HL7 clinical statement.

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Introduction

It has been discussed that in order to provide patients with high quality care, patients should have access to appropriate and evidence based-health services. This requires that each patient with a health problem should have an accurate diagnosis and timely accessible information that enables treatment planning and makes patient care decisions more informed and evidence-based. Traditionally, in the surgical domain, physicians and surgeons document surgical information in a narrative reports that are free text and descriptive in nature (Urquhart, Grunfeld & Porter, 2009). These traditional operative reports contain non standardized information which depends mainly on the surgeon's ability to remember and collect the details of the surgical procedures (Donahoe et al., 2012). Many researches have discussed the poor quality of information gathered by using these narrative operative reports. It has been found that the traditional way that surgeons use to document an operative procedure can contain redundant, nonessential information. This method also lacks critical information for enhancing the continuing care of patients as well as information vital for treatment planning. The use of this narrative operative report can limit the use of operative data for secondary purposes such as research or evaluation projects (Gur, Gur, & Recabaren, 2012). One solution that has been discussed widely to improve the data quality of operative reporting is the use of the synoptic operative report. Synoptic reporting allows the use of a structured format when collecting data which enables the capturing of discrete data fields. Consequently, allocation and reuse of these data can be done quickly and more efficiently. The capture of structured data can enable the transfer of these data to unlimited number of discrete systems and databases in order to support research activities for clinical and administrative propose (mTuitive Inc., 2005). It has been found that the use of electronic synoptic reports in breast surgery can improve the quality of information collected in the surgical procedures by using a checklist approach and providing surgeons with preselected data items that are considered essential for the care of patients(Gur at el., 2012). It has also been discussed that the synoptic template can represent a potential educational tool, since it reminds clinicians of important steps and details of the occurrence. Consequently, quality control can be optimized (Urquhart, Grunfeld & Porter, 2009)

One successful and promising example that has been discussed widely in the literature is the initiative that was undertaken by The Alberta Cancer Surgery Working Group. A computerized synoptic operative report template (WebSMR) was developed and implemented to improve the quality of data captured in rectal cancer surgery operations. it was found that following the implementation of a web-based synoptic operative report template that collect predetermined and necessary data items, 99% of the required data items were captured while only 45.9% of required data items were capture via the traditional dictated narrative report (Edhemovic, Temple, de Gara & Stuart, 2004). Consequently, it has been recognized that the use of synoptic reporting can be a viable solution to improve the quality of data captured in surgical operations.

There is a research study being conducted in the Neurosurgery Department of Dalhousie University. The aim of this research study is to test if implementing an electronic synoptic operative report for spinal cord injury patients can improve the quality of data captured for primary and secondary use. In this research study the data items of electronic synoptic operative reports will be built based on Health Level 7(HL7) clinical statement to enable the collection of discrete data items, which is a specific method to construct electronic templates. HL7 clinical statement is a health information standard that enables the exchange of information between different computer systems without ambiguity since it acts as common language to exchange clinical data (Benson, 2010, p.152). Also a medical vocabulary system called SNOMED CT (Systematized Nomenclature of Medicine -- Clinical Terms statement) will be used as a medical terminology standard to enable the exchange of clinical data items.

The author of the report worked in this research project as a research assistant. Tasks and responsibilities that have been assigned to the author are presented below:

1. Complete all SNOMED CT code values for all clinical data items of the Electronic Synoptic Operative Report Template and make sure that the SNOMED CT code values fit the HL7 clinical statements used to build the electronic template
2. Develop lookup tables containing the SNOMEDCT code values and their descriptions for all clinical data items of the electronic template as per instructions from the research team
3. Confirm the SNOMEDCT code values with the research team.
4. Test the Electronic template by entering real data to confirm the completeness of the template before providing it to participants.
5. Develop a user manual and quick start Guide to support participants when using the electronic template.
6. Analyzing data for usefulness, usability of an electronic synoptic operative report template for spinal cord injury patients, comparing to the dictated operative reports.

Description of the Organization

The Neurosurgery Department in Halifax was created in January 1948 and was the first neurosurgery service in Atlantic Canada. The department was developed in the Victoria General Hospital (V.G.H.) which was experiencing a considerable growth of medical specialists and departments at that time. At that time many medical education institutions in Canada were inspired by Flexner Report of 1910 (Division of Neurosurgery, 2010, History). The report was a very significant event for medical educations in Canada and United States. It was produced by Abraham Flexner,a secondary school teacher. The report criticized and commented on the situations of medical schools at that time, raising awareness about new medical education methods having higher standards and well defined goals. Many medical institutions in Canada and United State were encouraged to follow the models of the Flexion Report (Olakanmi, n.d.) Victoria General was one of those hospitals influenced by this great initiative. Consequently, the encouraging environment led to the development of many surgical specialty services in Canada, but it should be noted that the establishment of a neurosurgery department in Halifax was more related to the efforts of individual neurosurgeons. Over the past five years, the neurosurgery department has experienced a considerable growth in their academic programs which contain clinical, educational and research activities. Some of the departments' programs include a *Brain tumor Program*, *Cerebrovascular Surgery Program***,** *Robotics Program*, *and Spine Program***.** These academic programs are continually growing which make Halifax Neurosurgery today as one of the most recognized in Canadian neurosurgery (Division of Neurosurgery, 2012, Welcome to Neurosurgery).

The *Spine Program* is one of the Neurosurgery programs that deliver comprehensive care to patients with spinal cord injuries and spinal disorders. The director of the program is Dr. Sean Christie who is one of the neurosurgery faculty members. The goal of the program is to promote the health care services for patients with spinal diseases. This is expected to be done through enhancing the development of a rapid assessment program with a view to reducing the waitlist time, and through the growing of an evidence –based standardized care plan for patients with spinal cord injuries **(**Division of Neurosurgery, 2012, Spine Program**).**

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients, a Research Project

Dr. Sean Christie, who is one of the faculty members of the Neurosurgery Department and the director of the spine program, is conducting a research study with a collaboration with Dr. Grace Paterson (Associate Professor and Acting Director of the medical informatics department of Dalhousie University) to test the usefulness and usability of an electronic synaptic operative report template. This template can be used by surgeons when documenting spinal cord injury operations on patients. At present, spinal surgeons and residents of the Neurosurgery department use the traditional narrative reporting procedures to gather information about spinal cord injury operations on patients. By using this traditional narrative method, important details can be missed and redundant, not essential information can be collected. As a result, the clinical documents are likely to be incomplete and less efficient. They are also less likely to support the continuity of care for patients or to support research studies. They will also lack information required for administrative purposes.

Moreover, collecting the information from numerous number of different patients using the current dictation methods makes it very difficult to reuse the reports and obtain beneficial information and statistics. It has been found that the use of the synoptic operative report can improve the quality of data captured by enabling the gathering of pre-specified items. This can confirm the completeness of the data and by converting the qualitative nature of the narrative operative report to quantative one can support the aggregation of data. Consequently information and knowledge can be generated. Therefore, this study aimed at identifying if the use of electronic synaptic operative report template when collecting information for spinal cord injury patients can improve the quality of the information compared to those documents which are filled out by using the current methods of recall and narrative dictation on reports (Christie & Paterson, 2011).

The Objectives of the Research Project

1. To investigate if using an electronic synoptic template will improve the capture of clinical data on spinal cord injury operations. This includes examining the accuracy, completeness, and conciseness of the data (Christie & Paterson, 2011).
2. To assure that The clinical data that are collected by the electronic synoptic report are suitable to be used for secondary proposes by other research projects, since other research projects like the Rick Hansen Spinal Cord injury Registry (RHSCIR) and the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD) are collecting the same data Items (Christie & Paterson, 2011).

Research Hypothesis

Grace & Sean (2011) states the following

> Our hypothesis is that we can improve the quality of the data for primary and secondary use through implementing an Electronic Template for Spinal Cord Injury Patients. The secondary uses of this data include the Spine Procedure Form for the Rick Hansen Spinal Cord Injury Registry (RHSCIR) and the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD) (p. 3).

Research Plan

This study will be based on previous work done by the same investigators (July 2010- February 2011). At that time, data elements of 15 forms utilized to collect data for the Rick Hansen Spinal Cord Injury Registry (RHSCIR) were expressed by using Health Level 7 International (HL7)

Clinical Statements and vocabulary systems particularly SNOMED CT (Christie & Paterson, 2011).

Therefore, in this study, some of these forms such as the "Procedure" form and expressions developed by the previous work will be considered when building the electronic synoptic template for operative reporting. Also, the Template of this study will be developed to enable the capture of data elements that are considered important, based on consensus between investigators (Christie & Paterson, 2011).

Instruments that will be used for the study are score sheets for completeness, accuracy, and conciseness of the operative reports. Also, a recruitment questionnaire and feedback questionnaire will be used.

Participants will be randomly assigned to Group 1 or Group 2. Group 1 will be requested to complete their operative report by using the traditional dictation method. Following that they will be asked to complete the electronic template for the spinal cord injury patients. In contrast, Group 2 will be asked to complete the template first followed by the dictation. Also, a quick orientation about the synoptic template and its usage will be provided for all participants through a quick start guide and user manual for the template. Participants will be asked to complete a recruitment questionnaire and feedback questionnaire (Christie & Paterson, 2011). For more information about the study design and participants (see Appendix A).

Research Project Team

1. Dr. Sean Christie is a co-investigator in the research study. He is an assistant professor in the Department of Neurosurgery, Dalhousie University. He is also the director of the Spine program, one of the active programs in the Neurosurgery department.
2. Dr. Grace Paterson is a co-investigator in the research study, and she is an associate Professor and acting director in the Medical Informatics Department of Dalhousie University.
3. Ginette Thibault-Halman is research assistance in this research study project. She is currently acting as a research Coordinator in the Spine Program of the Neurosurgery Department.
4. Wilfred Bonney is an HL7expert and he is the one who developed the Synoptic Operative Report for Spinal Cord Injury Template based on HL7 Clinical Statement. He used the Microsoft InfoPath 2010 to develop the Interface of the Template.
5. Areej Alsulaiman, the author, is research assistant and an intern of the Master of Health Informatics Program of Dalhousie University.

Author's Tasks and Responsibilities in The Research Project

1. Complete all SNOMED CT (Systematized Nomenclature of Medicine - Clinical Terms) Code Values to All Clinical Data Items of the Electronic Template:

1.1 Brief introduction to the nature of the first task. All Participants of the study will be asked to fill an electronic synoptic operative report template which contains various sections and some sections contain subsections (See Appendix B). In the electronic template, there are 17 sections. These sections are Patient Information, Surgeon and Anaesthesiologist Information, Procedure Date and Time, Pre-Operative Diagnosis, Post-Operative Diagnosis, Indications, Associated Co-Morbidities, Pre-Operative Clinical Status, Anaesthesia Information, Surgical Procedure, Surgery Description/ Findings, Surgical Drain, Implants, Bone Graft , Adjunct Drugs/Procedures , Intra-Operative Fluid Intake/Output Information, Discharge Disposition, and Author of Operative Report. The data elements of the electronic template are developed to capture data that are important and relevant to the spinal cord injury patients. Most of These data elements are obtained from clinical forms that are used to collect data for the Rick Hansen Spinal Cord Injury Registry (RHSCIR). The RHSCIR is a project that collects, manages and analyzes data on spinal cord injury individuals. Its purpose is to confirm collaboration among researchers, health professionals, services provider and individuals with Spinal Cord Injury (SCI) in order to diminish disabilities and enhance the best quality of life for SCI people. The RHSCIR is active in 31 main rehabilitation and Canadian acute care hospitals across the country (RHSCIR, 2010). The Neurosurgery Department of Dalhousie University is one center where RHSCIR is active. Investigators of this study were involved in a previous project for RHSCIR. In that previous project, data elements in 15 forms that are used to collect data for RHSCIR were expressed using HL7 Clinical Statements and vocabulary systems, especially SNOMED CT. In this study some of these RHSCIR forms are used to design the sections and data elements of the electronic template, especially the procedure and diagnosis forms (See appendix C& D). The Electronic Template has been developed by a member of the project team, Wilfred Bonney, using Microsoft InfoPath 2007. The template has been continually published in a SharePoint environment to enable all the project members to be updated with the latest changes of the electronic template.

Moreover, the electronic Synoptic operative report template was developed based on HL7 clinical statements. HL7 Clinical Statements is one of the core components of the Clinical Document Architecture (CDA). The HL7 Clinical Document Architecture (CDA) is an XML-based mark-up standard that is intended to determine the encoding, structure and semantics of clinical documents to be exchanged by computers(Dolin et al., 2006)(See Appendix E). In the CDA, HL7 Clinical Statements are used as a common pattern to enable the exchange of clinical information between different computer systems (Benson, 2010, p. 152). Time (2010) states the following:

> HL7 defines the clinical statements as an expression of a discrete item of clinical (or clinically related) information that is recorded because of its relevance to the care of a patient. Clinical information is fractal in nature and therefore the extent and detail conveyed in a single statement may vary (p. 152).

Each Clinical statement can contain a number of participants like subjects, author, locations, and performer. Also, a Clinical statement can be any one of the following specializations: a procedure, observation, encounter, or substance administration or supply clinical statement. A Procedure clinical statement can contain expressions that refer to images or specimens that are related to the documented procedure and it is utilized for all invasive procedures like surgical procedures and imagining. Observation clinical statements include a broader range of statements that are related to history, examinations, or tests. Also, Substance Administration or Supply clinical statements can be used to refer to products like medications which are mainly utilized for prescribing, dispensing, or administration of drugs (Benson, 2010, p. 152-153)

As stated before, the electronic template is designed based on the HL7 Clinical statement; Figure (1) shows an HL7 Clinical Statement that is used to design the "Implant" Section of the electronic template. This is a *supply* clinical statement which is commonly used to refer to material or products for medications. In figure 1, The Clinical statement is enclosed by the <Implant Entry> element. This clinical statement provides information about the ***where the*** implant is done and ***what*** device is used to perform the Implant. So as presented in the clinical statements of figure (1), the attribute "*Target Site*" represents information about the *Location* of the implant procedure which in this example is from the "cervical vertebral C4" to "Cervical Vertebral C6" , and the attribute "*Playing Device*" represents information about the *Device* used to perform the implant procedure; in this example, the "Anterior Plate" is the device used to perform the implant procedure. Moreover, in this clinical statement, the SNOMED CT code system is used to encoded the clinical data items ("C4" , "C6", and "Anterior Plate") in order to enable the exchange of these clinical information between different computer systems and achieve the semantic interoperability.

```xml
<ns1:implantSection>
    <ns1:templateId root="2.16.840.1.113883.10.20.7.15"></ns1:templateId>
    <ns1:code codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC" code="55122-6" displayName="SURGICAL OPERATION NOTE IMPLANTS"></ns1:code>
    <ns1:title>Implants</ns1:title>
    <ns1:text></ns1:text>
    <ns1:implantEntry typeCode="DRIV">
        <ns1:supply classCode="SPLY" moodCode="EVN">
            <ns1:templateId root="2.16.840.1.113883.10.20.1.34"></ns1:templateId>
            <ns1:id root="2413773c-2372-4299-bbe6-5b0f60664446"></ns1:id>
            <ns1:statusCode code="completed"></ns1:statusCode>
            <ns1:effectiveTime>
                <ns1:center value=""></ns1:center>
            </ns1:effectiveTime>
            <ns1:targetSiteCode>
                <ns1:qualifier>
                    <ns1:low value="">
                        <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="181824001 | entire C4 vertebra|" displayName="C4" value="" unit="">
                        </ns1:value>
                    </ns1:low>
                    <ns1:high value="">
                        <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="181826004 | C6 vertebra | " displayName="C6" value="" unit="">
                        </ns1:value>
                    </ns1:high>
                </ns1:qualifier>
            </ns1:targetSiteCode>
            <ns1:participant typeCode="DEV">
                <ns1:participantRole classCode="MANU">
                    <ns1:templateId root="2.16.840.1.113883.10.20.1.52"></ns1:templateId>
                    <ns1:playingDevice>
                        <ns1:code codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="271003 | bone plate |+ 255549009 | anterior|" displayName="Anterior Plate">
                        </ns1:code>
                    </ns1:playingDevice>
                </ns1:participantRole>
            </ns1:participant>
        </ns1:supply>
    </ns1:implantEntry>

</ns1:implantSection>
```


Figure 1 : Screen shot of the XML document of the Microsoft InfoPath form shows the Hl7 clinical statement that is used in the Implant section of the electronic synoptic operative template.

Following is figure 2 which shows the *Implant* section of the electronic template when the user chose the "Anterior plate" data item from the list of the Devices ;and the Location form C4 to C6 .

Implants

Device	Location Detail	
	From:	To:
Anterior Plate	C4	C6

Insert item

Figure 2 : Screen shot of electronic synoptic operative report template shows the clinical data items that the users chose which reflects the clinical information included in the HL7 clinical statement of figure 1.

It was stated that in order to effectively enable the exchange of data between different computer systems and confirm the semantic interoperability, it is important to store the data in a common standardized format that support different systems to understand in the same way the data processed. This can be achieved by performing Terminology binding which is the process of developing links between elements of a terminology like SNOMED CT and an information model like HL7 CDA. The basic idea behind the use of an information model Like HL7 CDA is to establish a common framework that states clinical information in a reliable standardized way and to confirm that each entry relates to common meta-data, like the subject, author, location, data/time (Benson, 2010, p. 221-225). While a clinical terminology standard like SNOMED CT is important to enable the collection, retrieval, and reuse of clinical information (Benson, 2010, p. 189). The terminology bindings between the information model like HL7 CDA and the SNOMED CT should be performed in a way that enable data entries of the electronic forms to collect data that fit the purpose of the user, enable valid reusability of data, and assure communication of this information in the same way among different systems (Benson, 2010, p. 221-225).

Therefore in order to confirm the terminology binding between the HL7 CDA and the SNOMED CT, One of the author's tasks in this project is to complete all SNOMED CT code values for all clinical data items of the electronic template. For example, see figure 1 & 2 presented above. Also, the author should confirm the SNOMED CT codes that are provided by the previous work and make sure that these codes fit the HL7 clinical statements used in this project.

1.2 Tools to perform the SNOMED CT coding. The author was provided with Microsoft word documents and PDF documents that have the SNOMED CT code Values and HL7 clinical statements for data elements of the RHSCIR forms. Theses SNOMED CT code values were developed by members of the previous work. Also, the author was provided with three forms that are used by RHSCIR to collect information about spinal cord injury patients; these forms are the procedures, trauma diagnosis, non-trauma diagnosis forms (see appendix C&D). Moreover, the author was enabled to access to a SharePoint server through which she can access and see the electronic template. Consequently she can be updated with any changes and accordingly develop the SNOMED CT codes for data items of the template. Figures from 3 to 7 show the steps that the author follows to get accessed to the electronic template.

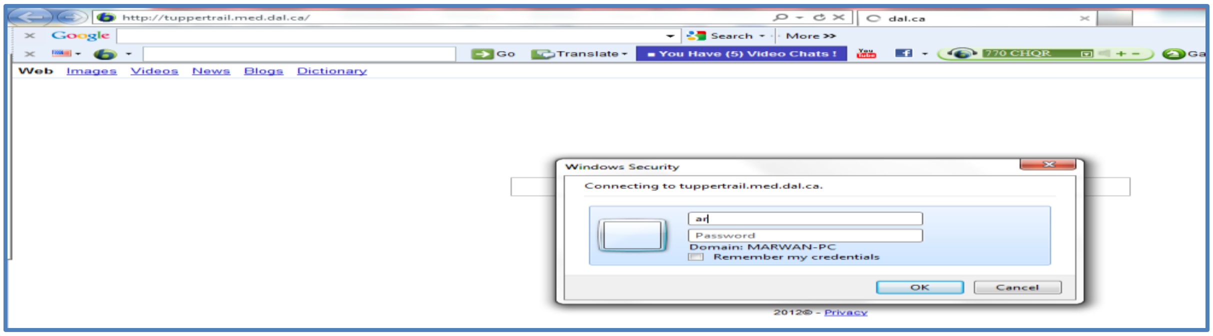


Figure 3 : Screen shot shows that the author is typing the user name and password to login to the SharePoint, after typing "http://tuppertrail.med.dal.ca/" in the toolbar address.

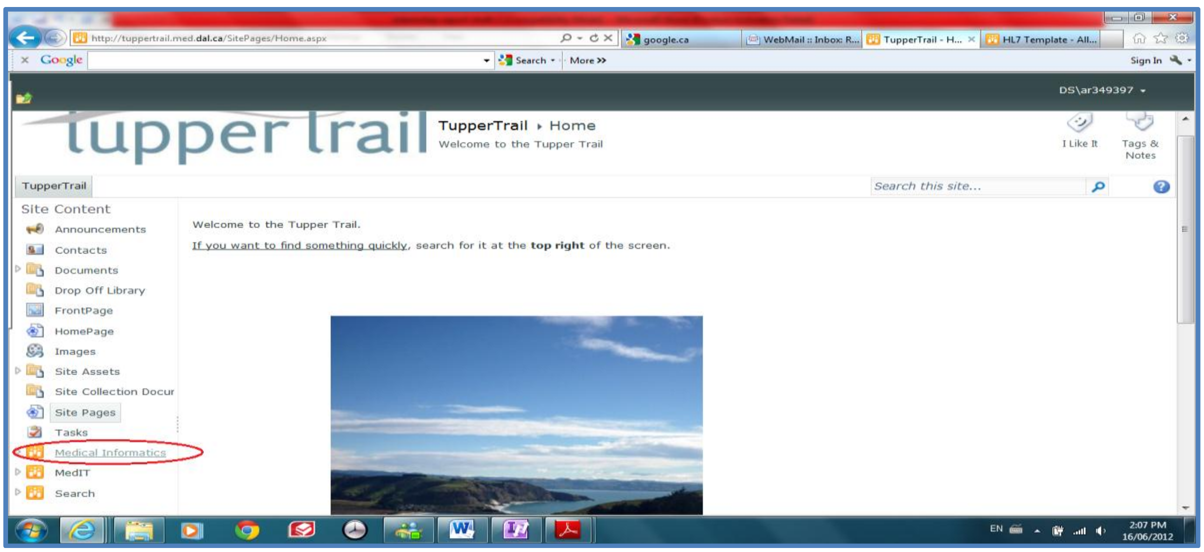


Figure 4 : Screen shot of the SharePoint window shows that the author is choosing "Medical Informatics" form the site content.

Figure 5 : Screen Shot of the SharePoint window shows that author select "HL7 Template" to get accessed to the electronic template.

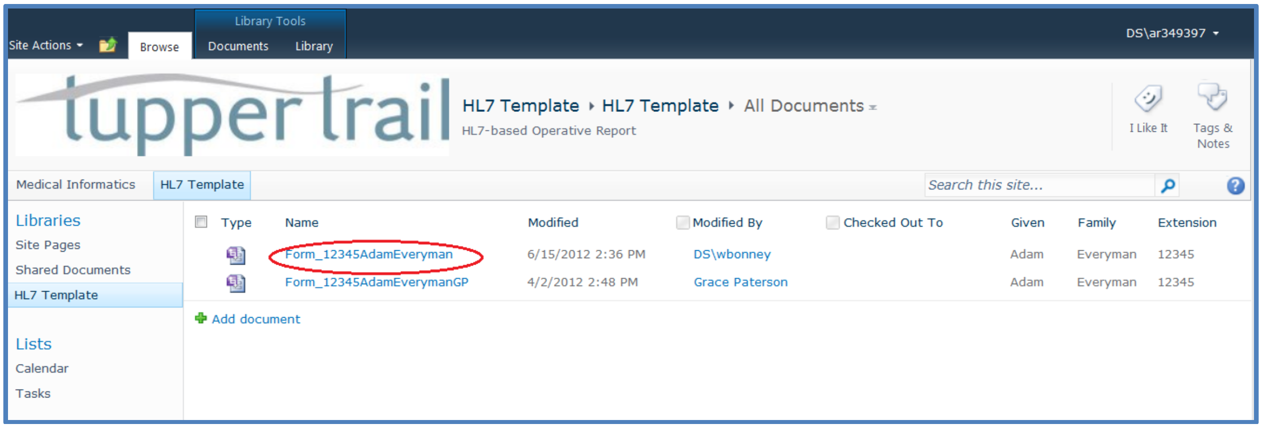


Figure 6 : Screen shot of the SharePoint window shows the author selects the Microsoft Office InfoPath form that is currently updated by the member of the project who is developing the electronic template.

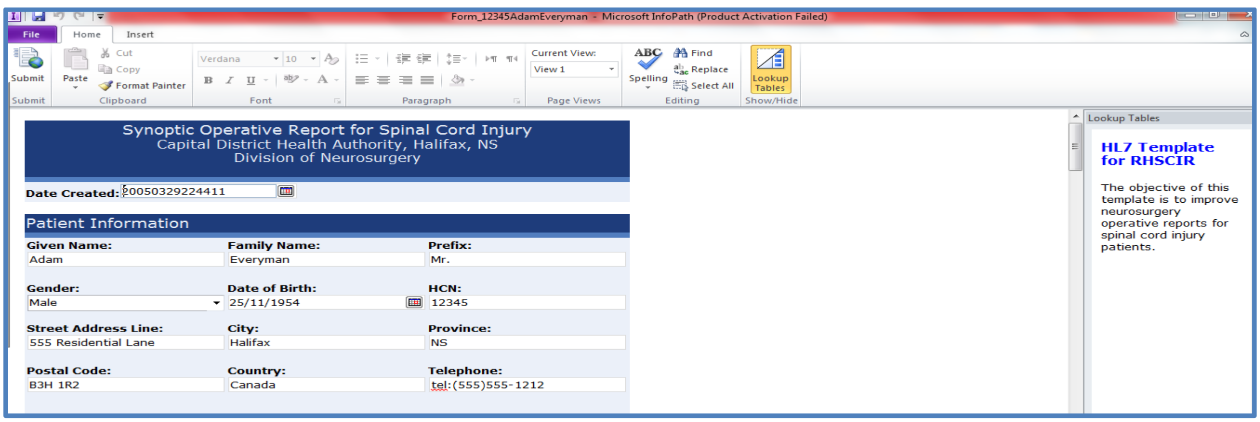


Figure 7 : Screen shot of the Microsoft InfoPath form that was accessed through the SharePoint, and it shows a view of the first part of the electronic synoptic operative report template; through which the author navigates to see sections and data items.

Also, CliniClue Explorer was installed in the author's computer workstation so she can confirm the provided SNOMED CT code values for data elements of the RHSCIR forms which are provided from the previous work, and complete all SNOMED CT code values for all clinical data items of the electronic template. The CliniClue explorer is freeware software that provides easy access to a wide variety of features that enable and support users to search for the intended SNOMED CT codes (CIC, 2011, Features). This Terminology tool is developed by The Clinical Information Consultancy Ltd which is a small independent specialist consultancy that is specialised in the use, representation and communication of clinical information between 1989 and 2011(CIC, 2011, Home).

The interface of CliniClue has many sections. Each section provides a specific feature to support the process of searching for the desirable SNOMED CT concepts or code values (See figure 8).

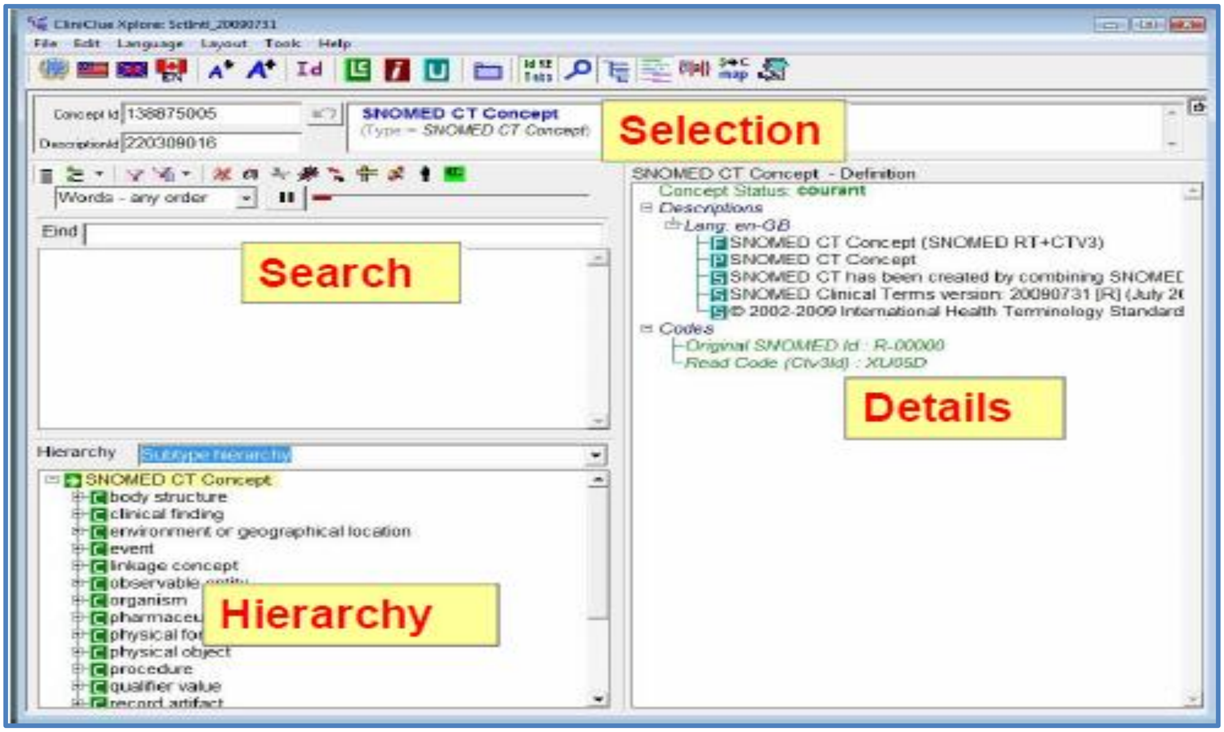


Figure 8 : Shows the main interface of CliniClue browser. Adapted from The Clinical Information Consultancy Ltd (CIC). (2010). Retrieved July 2, 2012, from http://www.hiqa.ie/system/files/workshop_HI_CliniClue_Xplore_SnomedCT_20100131.pdf

Figure 8 represents the main window of the CliniClue tool. This window is divided into frames which can be resized by dragging the splitting lines. It provides different views of the terminology, for example, as presented in figure 8, the **Search** section where the intended concept is entered in the "**find**" data field. The tool will provide all the matched concepts in the large box under the "**find**" data field, through which the users can choose and click on the one of interest; The more words are typed to find the concept of interest, the less matches will appear. Also, Parts of words can be typed instead of whole words to find the intended concept. The SNOMED CT concept that will be chosen from the list will appear in the **Selection** section representing the type of the concept such as "procedure", "clinical finding", or "physical object". The **Detail** section will provide some definitions of the selected concept which help the user to understand the meaning of the concepts and its relationships with other concepts. The **Hierarchy** section provides the Supertype concepts (parents) or the Subtype concepts (children) of the selected concept (Markwell, 2010).

Following is an example of a data item provided in the electronic spinal cord injury template, and it was entered to the CliniClue tool to find the SNOMED CT code value(See figure 9)

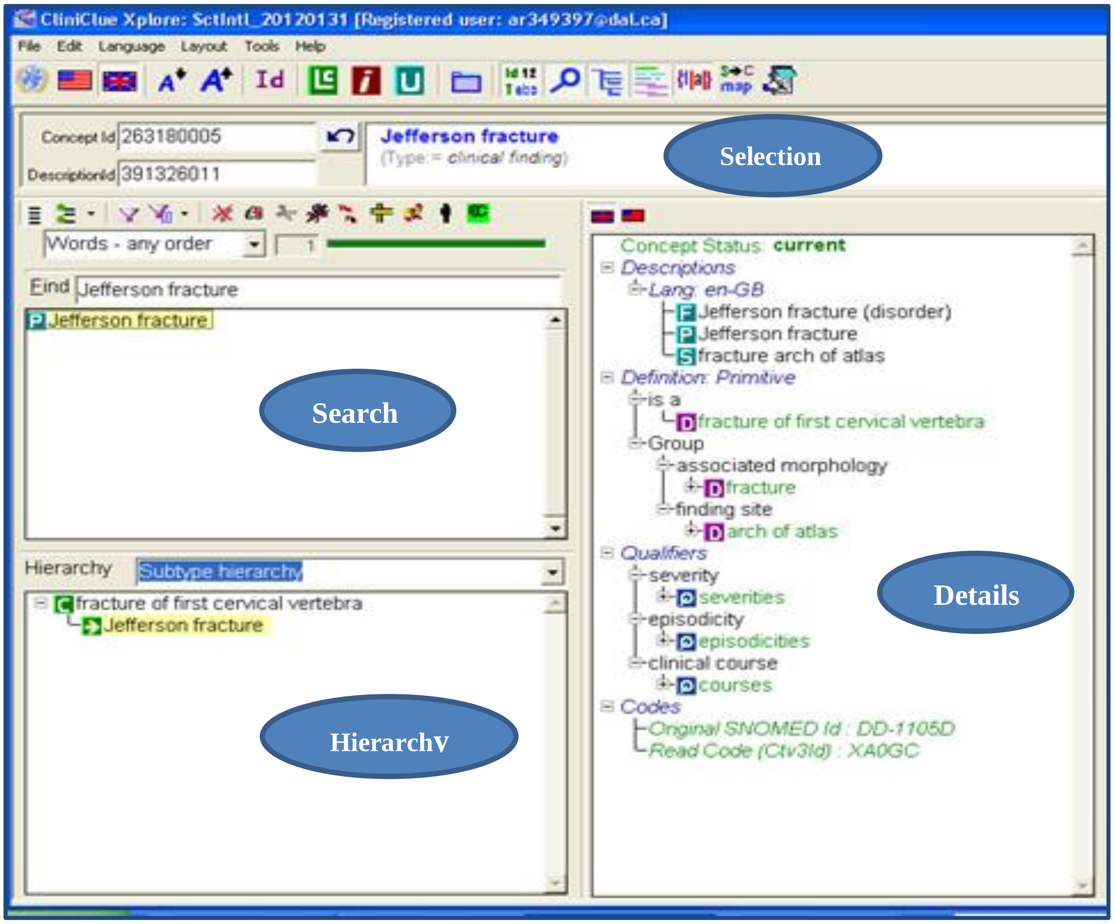


Figure 9 : Screen shot of the CliniClue browser shows entering the clinical data item "Jefferson Fracture" to the CliniClue Xplore browser.

The concept "Jefferson Fracture" is typed in the **Search** data field. All concepts that match the word Jefferson Fracture should be returned. In this example there is only one matched concept which is "Jefferson fracture" , so when the author selects the most matched concept, the type of the concept will appear in the selection field, this example shows that "Jefferson fracture" is a clinical finding. The Concept ID of this concept is presented in the upper left of the window beside the selection area; which is "263180005". Each concept in SNOMED CT has a unique Concept ID has been assigned to it (see appendix F for more information about SNOMEDCT terminology). In the Detail view of the CliniClue interface, there are some descriptions for the concept "Jefferson Fracture" according to its relationships with other concepts. These relationships can be a subtype or attribute relationships. For example, the" *Jefferson Fracture*" is a fracture of first cervical vertebra; this is a subtype relationship; that means Jefferson Fracture is a child concept to the parent concept" *fracture of first cervical vertebra*". While The "Jefferson fraction" has an attribute relationship with the concept "fracture"; the attribute "associated morphology" is used to reflect the relationship between the two concepts "*Jefferson fracture*" and "*fracture*" which are clinical findings.

Also, the hierarchy section can show the subtype relationships in term of hierarchy; so the Jefferson fracture is a subtype of the clinical finding "fracture of first cervical vertebra". All previous features are important to understand the relationship between two concepts in order to choose the most appropriate concept reflecting the required meaning.

1.3 Tasks completed by the author: in the electronic template there are 402 clinical data items, which should be encoded to SNOMED CT code values, under the 13 sections of the Electronic Spinal cord Injury Template, which are used to collect clinical information. These sections are: Surgeon and Anaesthesiologist Information, Pre-Operative Diagnosis including trauma and non-trauma diagnosis, Indication, Associated Co-Morbidities, Pre-Operative Clinical Status, Anaesthesia Information, Surgical Procedure, Surgical Drains, Implant, Bone Graft, Adjunct Drugs/Procedure, Intra-Operative Fluid Intake Output Information, and Discharge Disposition. All these clinical data items were presented in the electronic template as a "pick from list" or in drop down menus (See appendix G for some examples of data items in a section of the template). The author completed the SNOMED CT code expressions for 396 clinical data items. The remaining six data items which could not be coded are provided under the section, "*Pre-Operative Clinical Status*", subsection, *"American Spinal Injury Association (ASIA) Impairment Scale*" (See Appendix B). These data items were considered as uncodable by the research team, since they do not have corresponding SNOMED CT code values. It would be very complicated to encode them by using post-coordination expressions, since each letter (A, B, C, D, and E) used in this subsection refers to a definition to represent the degree of the impairment. Also, these data items were encoded using a local code system (DAL). The DAL code system refers to the Medical Informatics Department of Dalhousie University, and it has a unique number that is globally identified as a reference to this code system. Each concept that is considered uncodable was assigned to a unique number that is derived from the local "DAL" coding system.

Table 1 below represents some examples of SNOMED CT code expressions that are completed and their corresponding clinical data items (display names) in the electronic template.

Display Name	SNOMED CT Expressions
Burst, posterior element disruption(present)	281924004 | burst fracture of thoracic vertebra + 129138001 |disorder of thoracic spine |: 363698007 | finding site | = 280721008|posterior vertebral element|, 408729009 | finding context |= 52101004 | present |
Burst, posterior element disruption(absent)	281924004 | burst fracture of thoracic vertebra + 129138001 |disorder of thoracic spine | : 363698007 | finding site | =

	280721008|posterior vertebral element|, 408729009 | finding context |= 2667000 | absent |
Flexion distraction, Bony	366406001 | range of thoracic spine flexion - finding | +263686003 | bony |
Flexion distraction, ligamentous	366406001 | range of thoracic spine flexion - finding |+ 263126002 | ligament injury |
Hyperextension injury(fracture)	89620005 | hyperextension | + | 125605004 | fracture of bone |
Translational injury(dislocation and fracture), ligamentous	263072001| fracture dislocation of lumbar spine|:363698007 | finding site | =335797003 | ligamentous joint |

Table 1: Shows SNOMEDCT Expressions for some data items in the Trauma Diagnosis list of the electronic template that is under the section “Pre-Operative Diagnosis**”**.

Moreover, Other data Items, like “Patient Information” and “Procedure Date and time” were not considered to be encoded by SNOMED CT. SNOMED CT is developed to encode clinical encounters, not to encoded other type of data , such as names; dates, or numbers. It is possible to express a past medical history with SNOMED CT but not with exact dates (Lee, Lau & Quan, 2010). For example, the following SNOMED CT expression represents a patient has a history of obesity in the past, “414916001 | obesity |*:* 408731000| Temporal context=410513005|In the past|”. In fact, it is not possible to encode the exact date such as of “January 1, 1980. Therefore, data items of these sections will be encoded by using HL7 CDA attributes and data types by another member of the project (Wilfred Bonney).

Below are descriptions of some activities that were undertaken by the author to develop the SNOMED CT code values and expressions for all clinical data items of the electronic template.

1.3.1 Extracting data to be coded: In order to obtain the data to be encoded the author for the most part accessed a SharePoint server to see the electronic template and obtain the clinical data items under each section to be encoded. However she occasionally used RHSCIR forms to obtain data items for sections that were not yet completed at that time. For example, the author used Trauma Diagnosis Form (appendix D) to encode the data elements under the section of Trauma diagnosis because at that time the list of data items for this section were not yet developed in the electronic template. Also, another source that was used to extract the data elements is diagrams provided by the research assistance (Ginette Thibault); these diagrams include some data items that are suggested by Dr. Sean Christie, and they are not included in the RHSCIR forms (see figure 10 below).

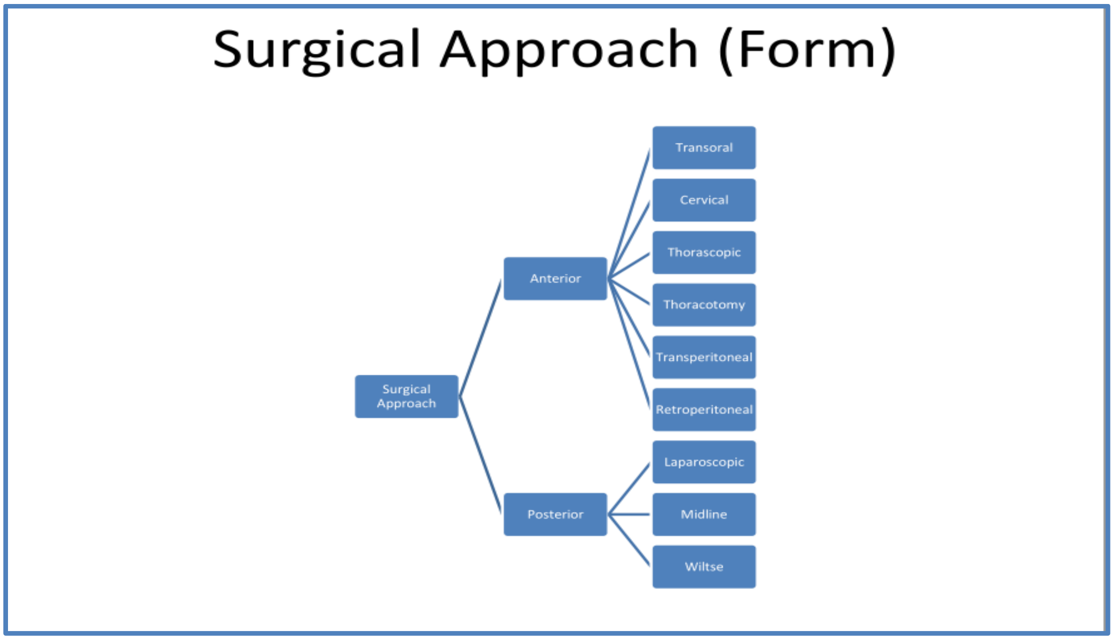


Figure 10 : Shows one example of diagrams provided by the project team to develop data items for the list of "Surgical Approach" filed under the section of Surgical Procedures.

1.3.2 Encoding the data items to SNOMED CT code expressions: As stated before, The Data elements of the forms or data items of sections of the electronic template were encoded to SNOMED CT code values by using CliniClue system. Some data elements can be directly encoded by using a single SNOMED CT concept called pre-coordinated Concept (See Appendix F for more information about SNOMED CT system). For example the clinical concept "Local anaesthesia" is a data item of "Type of Anaesthetic" list which is a subsection of the "Anaesthesia Information" section in the template (See appendix B). The SNOMED CT code value for this data item can be directly generated through the CliniClue system by using a single SNOMED CT concept (pre-coordinated concept). The SNOMED CT code value for the data element "Local anaesthesia" is" 386761002| Local anaesthesia|". In some cases the SNOMED CT code values for some concepts cannot be directly generated or do not reflect the required meaning by using a single concept. In these cases, the Author used SNOMED CT Compositional Grammar to generate SNOMED CT expressions that combine concepts together in order to reflect the required meaning. SNOMED CT expressions that are generated by combining different SNOMED CT concepts are called post-coordinated expressions. The author used some symbols to combine and build relationships between SNOMED CT concepts and generate the required post-coordinated expressions that reflect the same meaning of a data element of the electronic template. Examples of these symbols are "+", ":" , "=" , "( )" "{ }" . For example, the concept "Intra-Operative Urine Output", which is a data element of the "Intra-Operative Fluid Intake Output Information" section, was coded to "277671009 | intraoperative | +

364202003 | measure of urine output|”. This SNOMED CT expression is composed of two concepts, “Intraoperative “ and “measure of Urine output” . The two SNOMED CT concepts were combined by using “+” sign which means that the Observable entity “measure of Urine output” is Intraoperative. Another example is the data element “Inter-body Implant” which is a data item provided in the list of the “Implant ” section; there is no single SNOMED CT code can express the concept “Inter-body Implant”, so the compositional Grammars were used.” Inter-body Implant “is encoded to “16521006 | implantation of spine |: 363704007 | procedure site | = 244539008 | between region joint of vertebral bodies |”. Concerning the previous SNOMED CT code expression, the symbol “ : “ means the proceeding concept uses a refinement to be qualified, and the qualifying expressions always come after the colon, So here the “procedure sit”, which is an attribute commonly used to refine a procedure concept of the SNOMED CT system, is used as a qualifying expression to refine the Procedure ” implantation of spine”. This qualifying expression is of the form “attribute = value”. Moreover, each attribute that is used to perform a refinement consists of an attribute name and an attribute value. The attribute name precedes the value and is separated from it by an equals sign ("="). See Appendix F for more information about the Pre-coordination and post-coordination expressions.

Moreover, the author sometimes used more sophisticated compositional Grammar to express more complex concepts that cannot be found in the SNOMED CT system as a single concept or pre-coordinated concept. For example, the author coded the term” SCIWORA”(Spinal Cord Injury Without Radiologic Abnormality) ,that is provided in the list of “Trauma Diagnosis”, under the Pre-Operative Diagnoses section, to the following SNOMED CT code expressions :

“405754008|cervical spinal cord injury|:42752001|due to|=417746004 trauma|, 246090004 | associated finding | = {118247008|radiologic finding + 263654008 | abnormal|: 408729009 | finding context | =410516002 | known absent | }”.

In this example, more than one attributes was used to refine and qualify the concept “cervical spinal cord injury”. In fact, “DUE TO”, ASSOCIATED FINDING “, and “FINDING CONTEXT” are three attributes used as qualifying expressions to qualify the concept “cervical spinal cord injury”. The attribute “DUE TO” is an attribute that can be used to refine a clinical finding, like “cervical spinal cord injury”, and it relates a clinical finding to its cause. The attribute “ASSOCIATED WITH “is an attribute that can be used to refine a clinical finding; and it is used to confirm that there is an interaction between two concepts; in this example, it indicates that there is a clinically relevant association *between* cervical spinal cord injury and “abnormal” + ” radiologic finding”. The attribute FINDING CONTEXT is an attribute that is used only to indicates the context in which a Clinical finding was recorded ; for example if a clinical finding is known, unknown, present, absent , or uncertain.

So, in the previous example, the author build the SNOMED CT compositional Grammar to indicate that the Spinal cord injury that is due to trauma has associated clinical finding, that is, abnormal radiologic finding which is known as absent. Also, in the previous example the author used the curly braces to indicate that the refinement that is made by using the attribute "finding context" is specified to "abnormal" and "radiologic finding". All the rules to develop the compositional Grammars for SNOMED CT expressions that can be carried in HL7 clinical statements, such as selecting the appropriate attributes to make the needed refinements, were performed by using "SNOMED CT User Guide, January 2012 International Release", released by International Health Terminology Standards Development Organisation (IHTSDO) (IHTSDO, 2012), and "Using SNOMED CT in HL7 Version 3; Implementation Guide, Release 1.5" (HL7 Inc. & IHTSDO, 2008).

1.3.3 Completing the SNOMED CT code values for data items which were not coded by the previous work: Clinical data items of some sections in the electronic Template were not covered and coded by the previous RHSCIR project, so the author developed the SNOMED CT code values or expressions for all data items of these sections. Some of these sections are; Adjunct Drugs/Procedure, Intra-Operative Fluid Intake Output Information, and Pre-Operative Clinical Status. Data elements of some RHSCIR forms, from which the data items of electronic Synoptic were developed, were not completely encoded by the previous work. For example, most of the data items of the Trauma diagnosis Form of the RHSCIR, provided in appendix D, were not encoded to SNOMED CT code values. Consequently, the author completed all the SNOMED CT code values for all data elements of that form.

1.3.4 Searching for synonyms in the literature: In some cases, the author was searching for synonyms or definitions for the clinical terms used in the electronic template which do not have matched SNOMED CT concepts. By using the definitions or synonyms of these items, an appropriate SNOMED CT codes can be found. For example, the clinical term "Morselized Allograft" that is provided in the list of the "Bone Graft" section, cannot be encoded to SNOMED CT code values by using the same words used in the display name. It is possible to code the clinical term ``Allograft``, but there is no SNOMED CT code for the concept "morselized" , so the author searched for synonyms or a definition to this clinical term. It was found in literature that the concept morselization is a process to prepare a graft in which the graft medium bone is cut into small chips (Judas, Figueiredo, Cabrita & Proenca, 2005). Consequently, by entering words of the definition to the CliniClue browser, an appropriate SNOMED CT concept was found which is "bone graft with bone chips". So the concept "Morcelized Allograft" was encoded to "116372002 | allogeneic bone graft | + 288052000 |bone graft with bone chips|". The SNOMED CT expressions that were developed using synonyms or definitions underwent the verification process of SNOMED CT expressions with the research team (task two) described below in this paper.

1.3.5 Confirming the SNOMED CT code values provide by the previous work. One of the tasks that has been assigned to the author is to review and confirm that the SNOMED CT code values provided by the previous work fit the HL7 clinical statements of the electronic template to enable the capture and exchange of these clinical data items.

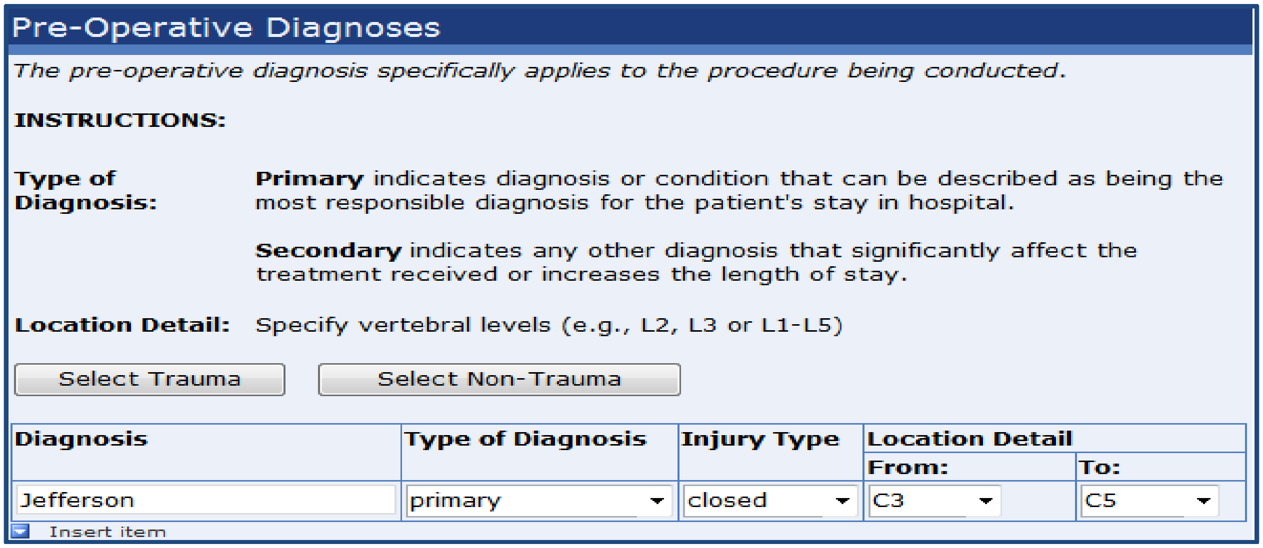
The author had to make changes to some SNOMED CT codes from the previous work and confirm that it matched the attributes of the HL7 clinical statements in which SNOMED CT code expressions should be embedded. For example, the SNOMED CT code values that were developed by the previous work to represent the diagnosis “Jefferson fracture” data item in the RHSCIR form were provided in a combination with the SNOMED CT code that represents the “type of injury”. The SNOMED CT Expressions developed by the previous work is “[263180005|Jefferson fracture|+(423125000|closed fracture|) OR (397181002|open fracture|),42752001|due to|=417746004|trauma|]”. This SNOMED CT expression does not fit the HL7 Clinical statement that is used to develop the “Pre-Operative Diagnosis section” of the electronic template. See figure11 for HL7 Clinical statement used in the electronic template to develop the “Pre-Operative Diagnosis section” and to cover clinical information collected about a diagnosis. This clinical statement is an observation clinical statement that can be used to cover statements about diagnosis (See Appendix E for more information about HL7 clinical statement). In figure 11, according to the attributes that are used in this observation clinical statement, there are four separate SNOMED CT expressions required; the first expressions should reflect the “diagnosis” or the clinical finding; the second expressions should reflect the “type of diagnosis”, Primary or Secondary; the third SNOMED CT expressions should reflect the “type of Injury” (Closed or Opened); and for the location of the diagnosis there should be two separate SNOMED CT Expressions to represent the low and the high value for the intended Location; Therefore sometimes the author would break or make some changes to SNOMED CT code expressions provided by the previous work.

```xml
<ns1:predxEntry>
    <ns1:predxObservation classCode="OBS" moodCode="EVN">
        <ns1:templateId root="2.16.840.1.113883.10.20.1.28"></ns1:templateId>
        <ns1:id root="d11275e7-67ae-11db-bd13-0800200c9a88"></ns1:id>
        <ns1:code codeSystem="2.16.840.1.113883.5.4" code="ASSERTION">
            <ns1:displayName value=""></ns1:displayName>
        </ns1:code>
        <ns1:statusCode code="completed"></ns1:statusCode>
        <ns1:value codeSystemName="SNOMED CT" code="263180005|Jefferson fracture|" displayName="Jefferson fracture">
         </ns1:value>
        <ns1:targetSiteCode>
            <ns1:qualifier>
                <ns1:low value="">
                    <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="181823007 | C3 vertebra | " displayName="C3">
                    </ns1:value>
                </ns1:low>
                <ns1:high value="">
                    <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code=" 181825000 |  C5 vertebra|" displayName="C5">
                    </ns1:value>
                </ns1:high>
            </ns1:qualifier>
        </ns1:targetSiteCode>
        <ns1:diagnosisType codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="63161005|primary|" displayName="primary"></ns1:diagnosisType>
        <ns1:injuryType codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="423125000|closed fracture|" displayName="closed"></ns1:injuryType>
    </ns1:predxObservation>
</ns1:predxEntry>
```


Figure 11 : Screen shot of the XML document of the Microsoft InfoPath form shows an Observation HL7 Clinical Statement that is used in developing the electronic template to Cover Statements about a Diagnosis encounter.

Figure 12 below shows the “Pre-Operative Diagnosis” section of the electronic template when a user picks from the list “Jackson fracture” as diagnosis, “Primary” as type of Diagnosis, “ Open” as Injury Type, and form “ C3” to” C5” to indicates the location of the diagnosis. The clinical data items collected in figure 12 reflect the HL7 clinical statement of figure 11,The SNOMED CT Expressions that are required to be embedded in the HL7 Clinical statement of figure 11 which is used to enable the collection of clinical data items relate to the diagnosis encounter are presented below:

1. "263180005|Jefferson fracture|"
2. 63161005|primary|
3. “423125000|closed fracture”
4. “181823007 | C3 vertebra |”
5. “181825000 | C5 vertebra|”


Pre-Operative Diagnoses

The pre-operative diagnosis specifically applies to the procedure being conducted.

INSTRUCTIONS:

Type of Diagnosis: **Primary** indicates diagnosis or condition that can be described as being the most responsible diagnosis for the patient's stay in hospital.

Secondary indicates any other diagnosis that significantly affect the treatment received or increases the length of stay.

Location Detail: Specify vertebral levels (e.g., L2, L3 or L1-L5)

Select Trauma | Select Non-Trauma

Diagnosis	Type of Diagnosis	Injury Type	Location Detail	
			From:	To:
Jefferson	primary	closed	C3	C5

Insert item

Figure 12 : Screen shot of electronic synoptic operative report template (Microsoft InfoPath form) shows the Pre-Operative Diagnosis Section and the clinical data elements that are chosen in each field.

Also, the author developed the compositional grammars for some of the SNOMED CT code values that were provided by the previous work to represent data items of the electronic template because they were provided as a single concept not in a combination or as post-coordination expressions to represent the required meaning of the data items of the forms. For example, the SNOMED CT code values for the data item "Exploration and restoration of subarachnoid space" from the list in the "Surgical Procedures" Section, were provided from the previous work as single concepts as listed in the table 2 below:

SNOMED CT code value	Code Description
35951006	-subarachnoid space structure
281615006	-Exploration
360323003	- restore - action

Table 2: Shows an example of SNOMED CT code values provided from the previous work as single SNOMED CT Concepts.

So, in these cases the author used the compositional grammars to build the post- coordination expressions that are required to be embedded in the HL7 clinical statement of this section in order to represent the required meaning of data items used in the template. The post-coordination expression that was developed by the author for the SNOMED CT concepts provided in table 2, presented below:

"71388002 | procedure |:363704007 | procedure site | = 35951006 |subarachnoid space structure|, 260686004 | method | = 281615006|exploration| + 360323003 | restore - action |"

1.3.6 Communicating the SNOMED CT code values to the research team, after completing the SNOMED CT code expression for each section, the author communicated the SNOMED CT expressions to the research team using tables developed by Microsoft Word document that contained the SNOMED CT expressions of the encoded data items and the corresponding display names in the electronic template. Also the type of each SNOMEDCT concept used to develop each SNOMED CT code expression is provided in the tables. Tables were sent to the supervisor Dr. Grace Paterson and the HL7 expert, Wilfred Bonney, Who is developing the electronic synoptic template. See appendix H for an example of tables containing the SNOMED CT Expressions for some of the data items of the Non Trauma Diagnosis list of the Pre-Operative Diagnosis section which was sent to the research team.

2. Verification of Some Encoded Data Items

As stated before, some of the clinical data Items that are provided in the Electronic template are encoded to SNOMED CT expressions by using synonyms or by developing post coordination concepts, since it is not possible to encode all data items by using pre-coordination expressions or a single SNOMED CT concept. Therefore, some generated SNOMED CT expressions can have different words than those presented in the electronic template as display names, or, some SNOMED CT expressions become complex and verbose. Consequently this can render uncertainty to the meaning of the intended clinical concepts of the Electronic template. In these cases the author confirmed the codes with the supervisor (DR. Grace Paterson) in order to determine if these codes need further confirmation with the clinician Dr. Sean Christie to assure that they reflect the required meanings. In some cases the supervisor provided some suggestions to change some codes to make them more interoperable, and in some cases, she confirmed the codes as not needing further confirmation; or assigning the codes as needing further confirmation with the clinician(Dr. Sean Christie).

In these cases the author developed a confirmation methodology form to confirm the SNOMED CT codes with the research member Genette Thibault who is directly working with the clinician (Dr. Sean Cristie) and has a sufficient knowledge of the medial concepts presented in the electronic template. The purpose of this process is to obtain confirmation from the research member that the used SNOMED CT expressions reflect the required meaning, so the research member, Genette Thibault, should understand the meaning of the used SNOMED CT concepts. Therefore the author developed a confirmation form to fit this purpose (See appendix I). The confirmation form provide the research member with the display names of the clinical data items that are provided in the electronic template, and the suggested SNOMED CT expressions for the intended display names or concepts, Also, there are some descriptions of the used SNOMED CT concepts in order to support the research member in understanding and confirming the codes. These descriptions are obtained from the CliniClue browser. In the confirmation form the author used the data items "Agree" and "Disagree" to confirm the response of the research member (Genette Thibault). Moreover, in some cases, the research member was provided with two or three candidates of SNOMED CT expressions to represent one specific data item of the electronic template, so she could choose the best candidate to represent the required meaning; for example there are two candidates of SNOMED CT expressions for the data item "Spinal stimulator failure" which is provided in the list of the Indication section. (See appendix I page 19 of the Confirmation Form). Also, in the confirmation meeting the author used a computer that has CliniClue browser installed on it in order to support the confirmation process such as searching for other concepts or looking for definitions or synonyms of some concepts if needed. The confirmation process was completed in a meeting with the research member, Genette Thibault, Also, the supervisor, Dr. Grace Paterson, of the author attended the confirmation meeting. Figure 13 provides an example, of a concept that underwent the confirmation process; the clinical concept " *Interbody Implant*" is a data item provided under the section of " Implant" of the electronic template. The research member, Genette Thibault, who was assigned to confirm the codes with the author, assigned "disagree" to the suggested SNOMED CT expression to that concept, since it represents a different meaning. So in the meeting we found a better SNOMED CT expression to reflect this concept which is "16521006 | implantation of spine | : 363704007 | procedure site | = 244539008 | between region joint of vertebral bodies | ". Also, SNOMED CT expressions that could not be verified by the project member, Genette Thibault, were considered as needing further verification from (Dr. Sean Cristie), so she contacted the clinician about these data items and responses were sent to the author by E-Mails.

In the electronic template there are 402 clinical data items that should be encoded to SNOMED CT code values ; from these, 396 clinical data items were encoded to SNOMED CT expressions; and 43 SNOMED CT expressions of the encoded 396 data items were considered by the author and the supervisor as requiring confirmation. Out of the 43 codes that underwent the confirmation process, five were considered as uncodable data since; they were assigned to "disagree", and the team could not find another possible SNOMED CT code. Some of these data items are presented in the drop down menu of the field of " Positioning" under the section of

"Surgical Procedure" for example, "Jackson Table: Flat" this is considered as a surgical device used in the positioning of patients when performing a surgical procedure. There is no SNOMED CT code or expressions which can be found to represent this device. The author provided the SNOMED CT expressions "86407004 | table |+ 6041008 | flat |" and in the meeting, other code expressions were discussed like "86407004 | table |+ 83578000 | surgical |". However, there were no codes which could be found to represent the required meaning. Consequently, these uncodable data items will be coded to unique numbers by using the local code system "Dal".

4-- Implant Section, Device

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Interbody Implant	120077008 | spinal cord implantation|: 260686004 | method | = 257867005 | insertion - action | ,direct device | = 40388003 | implant |	-spinal cord implantation (Type:= procedure) -method (Type:= linkage concept) -insertion - action (Type:= qualifier value) - direct device (Type:= linkage concept) -implant (Type:= physical object)

Definitions:

- Implant is a biomedical device.

Assessment: I f the codes provided ABOVE REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments: the same problem
we can use Implantation of spine 244539008.
Implantation : Procedure site:- instead of spinal cord ↑ code.
between region Joint of vertebral bodies

Figure 13 : A screen shot of the confirmation form shows an example of a SNOMED CT expression that underwent a confirmation process.

3. Create Lookup Tables for SNOMED CT Codes and Descriptions

The author developed lookup tables containing the SNOMEDCT code values for all clinical data items of the electronic template as per instructions from the research team. These tables were generated by using Microsoft Excel 2010. There are 402 clinic data items presented in the tables with their code values (SNOMED CT or Dal coding system); 391 clinical data items were encoded by using SNOMED CT; while just 11 will be encoded by using the Dal system; In addition, the content and data type of each column in the tables was developed based on a discussion with the supervisor (Dr. Grace Paterson) and consensus among the project members. Also, similar works by other health informatics initiatives were considered when developing the tables, for example, code tables that were developed by the Western Health Information Collaborative for the Western Canada Chronic Disease Management Info-structure Initiative. These tables were developed to describe in details the determined coding sets that will be used for the Chronic Disease Management data elements (WHIC, 2005).

The SNOMEDCT code expressions for clinical data items of each section of the template are provided in a separate excel spreadsheet, so there are 13 spreadsheets for 13 sections of the electronic template. These sections are "*Surgeon and Anesthesiologist Information, Preoperative Diagnoses, Indications, Associated Co-Morbidities, Pre-Operative Clinical Status, Anesthesia Information, Surgical Procedures, Surgical Drains, Implants, Bone Graft, Adjunct Drugs/ Procedures*, *Intra-Operative Fluid Intake Output Information, and Discharge Disposition*. Moreover, lately the author was provided with additional clinical data items to be encoded to SNOMED CT code values. These data items represent information to be gathered about the Adverse Events. The *Adverse Events* section will not be included in the electronic template for this study because of the time constraint, but it will be included in a future study when developing a web-based Electron synoptic operative report template for spinal cord injury patients, so an additional spreadsheet was added for data items and their SNOMED CT code values representing Adverse Events information.

In addition, each spreadsheet in the Excel document has one or more tables; each table represents all possible data items for a data entry or field of a section or of a subsection. For example, in figure 14 and 15, the Excel spreadsheet represents the Implant section which has two fields or data entries in the electronic template (see the *Implant* section in appendix B); consequently, there are two tables in the spreadsheet. The first table contains all possible data items for the "Device" data entry and the second table contains data items for "Location" data entry. In fact the "Location " data field is presented in more than one section in the template for example, Procedure, Indication, and Implant; therefore the table for the location's data items is provided in each spreadsheet(section) that has location filed; and consequently, the total number of data items presented in the excel document is more than ,402, the total number of the clinical data items in the electronic template.

Moreover, in each spreadsheet, each table has seven columns. The first column is “ID” column which contains a unique or identifier number for each data item provided in the electronic template. The second column is “RHSCIR code” which contains the code values that are used by RHSCIR to code data items provided in their forms, since some of the data items in the Electronic template are obtained from the RHSCIR forms. So each data item in those forms   has a code assigned to it, which is a local coding system that is used by The RHSCIR. However there is no RHSCIR codes provided for all data items in the electronic template, since some of these data items were provided by Dr. Sean Christie who is a co-investigator in this study and the director of the Spine Program of the Division of Neurosurgery. In fact, members of the project like Gennete Thibault , who is working as a research assistant in the Spine Program and a member of the project team of this study, is more familiar with the RHSCIR codes so they can be used as a reference to refer to data items of the RHSCIR forms. The third column is   the “SNOMED CT Term” which contains the SNOMED CT concepts that are used to develop each SNOMED CT expression and it contains the type of each concept used. For example, if the used SNOMED CT concept is a clinical finding, procedure, or physical object. Also, the fourth and fifth columns are “Code Code System”, “Code System Name” respectively, which represent the code, and the name of the of the coding system that is used to code the data Items, since there are some data that were coded by using , “DAL”, the local coding system. Also, the sixth column is “SNOMED CT Expressions” which contains the SNOMED CT code values or expression for each data item of the electronic template; and the last column contains the display name of each data item in the concept as it presents in the electronic template.

<table>
<tr><td colspan="7">Section Name: Implant
Subsections : I.Device
II.Location</td></tr>
<tr><td colspan="7">I.Device</td></tr>
<tr><th>ID</th><th>RHSCIR</th><th>SNOMED CT Term</th><th>Code code system</th><th>Code system Name</th><th>Code Values</th><th>DisplayName</th></tr>
<tr><td>423</td><td>NW:1</td><td>bone plate, (physical object)
anterior(Qualifier value)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>271003 | bone plate |+ 255549009 | anterior|</td><td>Anterior Plate</td></tr>
<tr><td>424</td><td></td><td>bone plate(physical object)
posterior(qualifier value)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>271003 | bone plate |+ 255551008| posterior|</td><td>Posterior Plate</td></tr>
<tr><td>425</td><td></td><td>fixation of fracture (Procedure)
Using device (linkage concept)
rods or rectangle with screws (physical object)
procedure site (linkage concept))
lateral mass of atlas (body structure)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>“239279000 | fixation of fracture |: 424226004 | using device | = 257346002 | rods or rectangle with screws |, 363704007 | procedure site | = 40349000 | lateral mass of atlas |”</td><td>Lateral Mass Screw/Rod</td></tr>
<tr><td>426</td><td></td><td>locking screw(physical object)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>257350009 | locking screw |</td><td>Pedicle Screws</td></tr>
<tr><td>427</td><td>NW:3</td><td>fixation of fracture using cannulated screws (procedure)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>239287004 | fixation of fracture using cannulated screws |</td><td>Cannulated Screws</td></tr>
<tr><td>428</td><td>KD:9</td><td>bone wire, device (physical object)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>63112008 | bone wire |</td><td>Wires/Cables</td></tr>
<tr><td>429</td><td></td><td>fixation of fracture using screws(procedure)
procedure site(linkage concept)
facet joint(body structure)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>239283000|fixation of fracture using screws(procedure)| : 363704007 | procedure site | = 81168003 | facet joint |</td><td>Facet screw</td></tr>
<tr><td>430</td><td></td><td>bone screw(physical object)
anterior(qualifier value)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>68183006 | bone screw | + 255549009|anterior|</td><td>Anterior screw/rod fixation.</td></tr>
<tr><td>431</td><td>1SE53XYSL:4</td><td>implantation of spine(procedure)
direct device(linkage concept)</td><td>2.16.840.1.113883.6.96</td><td>SNOMED-CT</td><td>16521006 | implantation of spine | : direct device | =</td><td>Prefabricated Interbody/corpectomy</td></tr>
</table>

Figure 14 : Screenshot of the Microsoft Excel document shows part of the   lookup table for the data items of the device data entry, under the Implant section.

II.Location Detail						
ID	RHSCIR Code	SNOMED CT Terms	Code code system	Code system Name	Code values	DisplayName
437		spinal nerve root C0(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	180999006 | spinal nerve root C0 |	C0
438		c1 vertebra((body structure)	2.16.840.1.113883.6.96	SNOMED-CT	14806007 | c1 vertebra |	C1
439		c2 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181819004 | c2 vertebra |	C2
440		C3 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181823007 | C3 vertebra |	C3
441		C4 vertebra (Body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181824001 | C4 vertebra|	C4
442		C5 vertebra((body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181825000 | C5 vertebra|	C5
443		C6 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181826004 | C6 vertebra |	C6
444		C7 vertebra((body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181827008 | C7 vertebra|	C7
445		C8 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	244655006 | C8 vertebra |	C8
446		T1 vertebra(Body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181828003 |T1 vertebra |	T1
447		T2 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181829006 | T2 vertebra |	T2
448		T3 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181830001 | T3 vertebra |	T3
449		T4 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181831002 | T4 vertebra |	T4
450		T5 vertebra(ody structure)	2.16.840.1.113883.6.96	SNOMED-CT	181832009 | T5 vertebra |	T5
451		T6 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181834005 |T6 vertebra |	T6
452		T7 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181835006 | T7 vertebra |	T7
453		T8 vertebra(ody structure)	2.16.840.1.113883.6.96	SNOMED-CT	181836007 | T8 vertebra |	T8
454		T9 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181837003 | T9 vertebra |	T9
455		entire T10 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181838008 | T10 vertebra |	T10
456		T11 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181839000 | T11 vertebra |	T11
457		T12 vertebra(body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181840003 | T12 vertebra |	T12
458		L1 vertebra (body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181841004 | L1 vertebra |	L1
459		L2 vertebra (body structure)	2.16.840.1.113883.6.96	SNOMED-CT	181842006 | L2 vertebra |	L2

Pre-Operative Clinical Status | Anesthesia Information | Procedure | Surgicla Drains | **Implant** | Bone Graft | Adjunct Di

Figure 15 : Screenshot of the Microsoft Excel document shows Part of the lookup tables for all possible data items of "Location" data entry, under the Implant section.

4. Conducting a Pilot Test of the Electronic Synoptic Operative Report

Another task that has been assigned to the author is to test the electronic Synoptic operative report by entering real clinical data. The author was provided by the research team with four operative reports for four patients that were documented by the traditional dictation method of the Neurosurgery Division of Dalhousie University (see appendix J). These reports do not have identification information referring to the intended patients. These four reports have similar contents, i.e. preoperative diagnosis; post-operative diagnosis, indication, and procedure sections. Consequently, the author's task was to enter the clinical data provided in the dictated operative report to the electronic template. The purpose of this testing process is to check the completeness of the template and identify if there are clinical data items mentioned in the four reports which cannot be captured by the electronic template. Modifications can be made based on the consensus of the research team, before the real study starts. Another purpose of this process is to check the functionality and performance of the electronic template and address any problems which may be encountered when entering the data, so that modification can be made to enhance the usability of the template.

In order to complete this task, the author was requested by the project team to generate tables comparing the clinical data items presented in the dictated operative reports to the corresponding data items of the electronic template that should be captured by the author. The first column should contain paragraphs of the dictated reports and the second column should contain the selected data items by author from the synoptic template corresponding to what is mentioned in the intended paragraph. Consequently, the author developed four tables for the four patients, (see appendix K). The author generated four report views of the synoptic operative template for the four patients after entering the data extracted from the dictated reports, (see Appendix L for the report views for patient 1 & 2). Figures 16 and 17 below show parts of the tables generated for patient 1 &2. In figure 16, the first column refers to the clinical data presented in the dictation report, while the second column refers to the clinical data items that were selected by the author to represent the information in the corresponding paragraphs of the dictation report. For example, the first part, presented in figure 16 for patient #1 contains a clinical sentence that is presented in the dictated operative report under the “Operation” section (See appendix J, Patient # 1), and the second column contains data items that the author selected from electronic synoptic template to represent the data in the corresponding sentence of the dictated operative report. The first part of a data item written in the second column like (Total Discectomy), represent the data item selected from a list of the electronic template, and the data items between brackets represent the section of the electronic template form were the data items were selected. Consequently, the concept” Total Discectomy” was selected from the “Procedure” list under the section of “Surgical Procedures”. In the first column that represents the dictated data, the highlighted data items refer to data items that the author captured in the electronic template, while highlighted and underlined data items refer to data that the author believes should be captured but could not be captured by the electronic template.

Data Items of the Dictated Report	Data Items of the Electronic Template
Operation: C5-C6 ACDF (anterior discectomy with fusion) with allograft and plate	-Total Discectomy (Procedure list, Surgical Procedures) -C5-C6:(location, Surgical Procedures) - fusion, interobody (Procedure list, Surgical Procedures) - Allograft (typed in Bone Graft) - Anterior Cervical Plate (Implant)

Procedure: The patient was transported from the ICU intubated with all the appropriate line, and induced under anaesthesia by Dr. TC. He was positioned supine in the operating table with an inflatable bladder beneath his shoulder blades to allow us to keep his neck in extension	-Previously intubated (Type of Intubation, Anesthesia Information) -General,(Type of Anaesthetic, Anesthesia Information) - Regular bed (Positioning, Surgical Procedures)

The patient was transferred back onto his bed and delivered to Recovery. The patient then delivered back to ICU in stable condition, intubated. There were no intraoperative complications noted. The patient tolerated the procedure well. Blood loss is estimated at approximately 100 mL.	-ICU(Discharge Disposition) -Estimated Blood loss = 100 mL (Intra-Operative Fluid Intake Output Information)

Figure 16 : Shows parts of the table for patient 1 comparing clinical data presented in the dictation report and the corresponding clinical data items of the electronic template filled by the author.

Data Items of the Dictated Report	Data Items of the Electronic Template
Operation(s) Left open-door laminoplasty C3-C6	-Decompression Laminoplasty (Procedure list, Surgical Procedures) -C3-C6 (Location, Surgical Procedure)

Synopsis: This _-year-old gentleman suffered an injury playing football which rendered him tetraplegic. He did show signs of improvement. His MIR scan showed significant stenosis in his cervical region. He was presented with the options of waiting to see the extent of his recovery or early surgical decompression. He did have some anteriod disk herniations, but he did not present with radicular pain. It is felt that the centrol stenosis was the most significant feature, so he was offered a decompressive lamnoplasty. He contemplated this, accepted surgical decompression, and arrangements were made for the following operation.	-Male (Patient Information) - Spinal stenosis (Non trauma Diagnosis) -primary (Type of Diagnosis) -Decompression Laminoplasty (Procedure list, Surgical Procedures)

He was given 1 gram of Kefzol and 10 mg of Decadron. He was then turned prone on the Wilson frame and his head was secured with a Mayfield head clamp and locked to the table. His neck was placed in a slightly flexed posture. A little bit of hair was clipped. We then prepped and draped the skin in the usual sterile fashion. A midline incision was infiltrated with 0.25% Marcaine with 1:200,000 epinephrine.	- Atibiotics (Adjunct Drugs/Procedures) - Wilson frame(Positioning, Surgical Procedures) - Mayfield head rest(Positioning, Surgical Procedures) - Midline(Surgical Approach, Surgical procedure)

Figure 17 : Shows parts of the table for patient 2 comparing clinical data presented in the dictation report and the corresponding clinical data items of the electronic template filled by the author.

After the author entered the selected data items into the electronic template and generated the tables and the operative reports for the four patients, it was presented and discussed with members of the research team (Dr. Grace Paterson, and Wilfred Bonny). Important issues that the author found during performance of this task and the corresponding solutions or responses were discussed in the meeting. For example, there are some clinical data items that were continually mentioned in the dictated forms which the author could not capture using the electronic Template, one example being the clinical concept " Operating Table" which is found in all the dictated forms. The author could not capture this concept since, in the electronic template, the list that represents information about the positioning of patient during a surgical procedure have other options such as "Jackson Table, flat"," Jackson table Sling", "Regular Bed", and "Wilson Frame". Another problem was that there are some devices that were used to perform the surgical procedures that were mentioned in the dictated report but the author could not capture in the electronic template. The device " Timesh Laminplasy plats" were used to perform the Implant procedure for patient 2, but the author could not find this clinical concept in the "Device" list under the section of Implant. There are also specific names of drugs that were presented in the dictation report such as "Kefzol" and "Decardon". In order to reflect this data items in the electronic template the author selected the data Item" Antibiotics" under the list of "Adjunct Drugs/Procedure" since it is not possible to capture the names of the drugs as a pick from list data items. In these cases the author discussed with the team members if there are suitable matched concepts that can be found in electronic template to capture these data. Also, it was discussed whether it is important to add these data items in the lists or not. For example, it was suggested that the "Jackson table, flat " or "Wilson frame" can be a type of an operating table, however, if the participants want to represent the operating table as a different device used rather than the Jackson table, it is possible to enter this information or any details about the surgical procedure in the free text box that is provided under the "Surgery Description/Findings" section. Also, most of the sections in the electronic template, such as Implant, Bone graft, and Adjunct Drugs/Procedures which provided a "pick from list" have an option to allow users to type in an empty field, so a user's can enter the names of devices, drugs, or any important details about the surgical procedure that are not provided in the lists. At the end of the meeting; it was confirmed that there is no need to add additional data items to the lists provided in the electronic template.

In fact, in testing the template, the author found that the dictated report contains more detailed descriptions of the surgical procedures which can be missed using the electronic template. The electronic template however reminds the user to capture information that is considered important to the continuity of care for spinal cord injury patients and for the research purposes. The author found that there was information that was required to be collected by the synoptic report template that was not mentioned in dictated reports. For example, the "Estimated Blood loss" data that should be captured using the electronic template was not included in the dictation report for patient 2. The type of intubation is not mentioned in dictated reports of patients 2 &4, nor was information to fill the section of "Pre-operative Clinical Status" such as Glasgow Coma scale and the American Spinal Injury Association Impairment Scales, included in any of the four dictated reports.

Moreover the author addressed in the meeting another issue related to the usability of the electronic template. It was found that in some of the dictation forms, in some cases a procedure can be performed by using more than one device. This causes a problem because the user is required to enter both devices independently. In the electronic template, in order to select a device used in a surgical procedure a user should use the list, “positioning” data field under the section of “Surgical Procedures”. However, in the “Surgical Procedure” section, in order to represent that two devices are used to perform one procedure, a user is required to select the procedure and fill the other data entries “Location Detail” and “Surgical Approach” two times (see the Surgical Procedure section in appendix B). For example, with patient (2), to perform the surgical procedure “Decompression Laminoplasty” two devices were used; ”Wilson Frame” and “Mayfiled head rest”, so the author filled the data for each data entry under the “Surgical Procedure” section two times to represent the names of the two devices (see Appendix L, report view of patient 2, Surgical Procedure section). It was noticed that filling the information of this section can be very complicated if there are more than two devices, procedures and/or locations involved for one patient. it was discussed and noted by the project member, Wilfred Bonny, who developed the form, that because of the time limitation and the limitation of the Microsoft InfoPath 2007 that was used to develop the electronic template, these problems may not be solved in this project but will be considered in a future study when a web-based electronic synoptic operative report template for Spinal cord injury patients will be developed by the same project investigators. Also, it was decided that these technical problems will be considered when developing the user manual of the electronic template to enable users to use the template efficiently.

All the documentations developed when performing this task were sent to the research team to be considered and reviewed in the future.

5. Developing a User Manual for the Electronic Synoptic Operative Report Template

The author developed a user manual and quick start guide for participants to enable them to effectively use the Electronic Synoptic Operative Report Template for Spinal Cord Injury Patients.

In order to complete this task, the author was provided with a user manual, which was used for a study done by the supervisor, (Dr. Grace Paterson). In this study, the user manual and quick start guide were developed to instruct and guide participates on how to use functions and fill an Electronic Health Record Templates for Chronic Kidney Disease DischargeSummary(Paterson & Soroka, 2005). Also, the author used another resource form the literature that provides instructions on how to develop a user manual for a system, (U.S. Department of Housing and

Urban Development, n.d.). The reference provides informations about the main sections that sould be included in any user manual such as "System overview", "Getting started", "Using the System", and "Special Instructions for Error Correction". There was also information on what should be documented under each of these main sections, for example, the system overview should provide general terms that define the system,the purpose of the system, and who is the responsible organization. The "Using the System" section should decribe the system functions in details. It is stated that each system's function should have a separate section header and identifier number that can be used as a reference to the steps or subsections provided under this function. Also, each function should have detailed narrative descriptions and screen captures on how to perform the intended function. Functions should be organized in a specific way that corresponds to the sequence of the system's functions in order to enable referencing. It was also stated that the user manual shuold be documented in general words without using technical terminology (U.S. Department of Housing and Urban Development, n.d.). A combination of information provided in this reference and the example provided by the supervisor helped the author developed the user manal and quick start guide for the electronic synoptic operative reprot template(See appendix M). The issues that were identified when the authtor was performing the previous task described above (testing the template); were addressed appropriately in the user manual to support users and enhance the usability of the template.

6. Participating in Analyzing the Data on Usefulness and Usability of the Electronic Template

In this research project, the Electronic Synaptic Operative Report Template will be tested to see if it can improve the quality of data captured for the spinal cord injury patients when compared to the dictated (narrative) operative reporting. Participants will be randomly assigned to Group 1 or Group 2. Group 1 will be requested to complete their operative reports by using the traditional dictation method; following that they will be asked to complete the electronic template, while Group 2 will be asked to complete the template first and then use the dictation method. This study aims to collect data on accuracy, completeness and conciseness of synoptic reporting and narrative dictated reporting. The study will also collect data about the suitability of data collected by the two methods (dictated and synoptic) to be reused by Rick Hansen Spinal Cord Injury Registry (RHSCIR) and the Canadian Institute for health information (CIHI), (See Appendix A for more information about the study plan). A task that has been assigned to the author is to participate in analyzing the data by evaluating the accuracy, completeness, conciseness, and reusability of the dictated and synoptic operative reports. In this research study, the accuracy will be measured by assessing the validity of the data items collected in the two methods (dictated and synoptic reporting) to be used as a source for documenting data to (CIHI) or (RHSCIR) by using an accuracy assessment form. This instrument was constructed with three domains, each using a 5-point Likert scale to assign an appropriate point for the intended domain (See Appendix N). The completeness of the operative reports (dictated and synoptic), will be measured by using completeness assessment form which has two section. The first section contains simple data items that should be assigned to either correctly presented or not in the operative reports ; for example, “Date of procedure” or “Pre-operative diagnosis” will be assigned to “yes” or No” based on their inclusion in the (dictated and the synoptic) operative report. So, if a data item is included, it will be graded “1” and if it is omitted it will be graded “0”. The second section of the completeness form has complex data items that are graded based on a 5 point ordinal Likert scale (see appendix N). The conciseness will be measured for the two operative reports also based on 5 point ordinal Likert scale , as follows; “Score of 1” indicates “Dictation or Comments were unnecessarily long with excessive inclusion of extraneous detail or truncated but lacking important elements”, “Score of 2” indicates “Dictation or Comments were relatively concise and inclusive with some extraneous detail included”; and “Score of 3” indicates “Dictation or Comments were concise but inclusive with exclusion of extraneous detail”. The number of words in either synoptic or dictated reports will also be compared. The reusability will be measured by comparing the percentage of concepts that can be encoded to SNOMED CT in dictated and Synoptic reports. Encoded concepts are essential for information reuse in RHSCIR and CIHI Discharge Abstract Database (Paterson & Christie, 2011).

The author did not perform or participate in the data analysis part of the study because she finished her internship and she was not provided with the operative reports that should be filled by participants. It was noted by the project member, Ginette Thibault ,who is responsible for recruiting participants, that there was not sufficient time between the completion date of the electronic template and the end date of the author’s internship to recruit residents and have them complete both reports (synoptic and narrative). Ginette Thibault was provided with the electronic template on July 13th, 2012, and the author finished her internship on July 27, 2012. It was stated that the recruitment process would start in August, 2012. Therefore, during that time, the author was assigned to perform another task that is participating with the supervisor Dr. Grace Paterson in reviewing and updating the instruments mentioned above that will be used in the study to test the usefulness of the synoptic operative report compared to the narrative report. The Instruments that will be used in this study are adopted form another study, (Vergis et al., 2008), and they were provided in the protocol of this study which was submitted to Capital Health Ethics Research Board with Ethics approval submission forms for non-interventional studies (Appendix A). In fact, the study from which the instruments were adopted evaluated only the dictated reporting, having no comparisons between the dictated (Narrative) and the synoptic reporting. Therefore, there are some statements used in these instruments which reflect the dictation reporting and not synoptic reporting. The statements of the Accuracy assessment form (provided in appendix N) were originally developed to evaluate the dictation reporting without considering the synoptic reporting, therefore, the instrument was reviewed and modified to reflect the dictation or the synoptic reporting and to fit the purpose of the study, for example, the statement “Clarity of dictation” was modified to “Clarity of dictation or narrative text entries in the template”. Since the Accuracy Assessment form should assess the validity of the data collected by both operative reports (dictated or synoptic) to be used as source documents for CIHI and RHSCIR, two domains or statements were developed to accommodate this need and to fit the purpose of the study (see the updated Accuracy Assessment form in appendix O). The Completeness Assessment form was also updated. Additional items that should be measured for its inclusion in the operative reports were added to this form, since it was recognized that the Completeness Assessment form missed some components that should be measured for its inclusion in both operative reports. These additional items were obtained from the sections provided in the last version of Synoptic Operative Report Template for Spinal Cord Injury Patients (Appendix B). This made it possible to enable comparisons of these additional components between the synoptic report and the dictated report (see the updated Completeness assessment form in appendix O). Participants in the study will be requested to complete a recruitment questionnaire to examine possible control variables like demographics or computer experience. This instrument also was modified, with more statements included to represent phenomena or variables of interest (see Appendix R). All update instruments were sent to the research member Ginette Thibault who will resubmit the updated instruments to the Capital Health Research Ethics Board to obtain an approval.

Discussion on How the Author’s Work Relates to Health Informatics

The work that the author has completed in the research Project, “Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients”, has a strong relationship with the health informatics filed. Know ledge and experience the author gained from the academic learning in the Health Informatics program have effectively supported the author in understanding the research project and completing tasks assigned to her. In fact, combining the knowledge that has been obtained from the courses with experience that the author went through in the internship project have enriched the author’s knowledge and skills and better prepared her for her future career. Below is a discussion on how the knowledge the author gained from some courses of the Health Informatics program effectively supported her in understanding the research project and completing the assigned tasks.

One of the courses that is provided in the Master of Health Informatics Program, which supported the author in the internship project is, “Health Information Flow And Standards, HINF

6102”. In this course the author learned about an important concept in the field of health informatics, ”semantic interoperability” which enables the exchange of information between different systems or computers without ambiguities. The course presented how this semantic interoperability can be achieved by binding a standard information reference model, like HL7 Reference Information Model, with a terminology standard like SNOMED CT. One of the HL7 Reference information model applications that were discussed in the course is the HL7 Clinical Document Architecture. The author learned about the main components or levels of HL7 CDA, such as header and bodies, and what information is contained in each level to enable standardized representation and exchange of health care information in the electronic word (See Appendix E for more information on HL7 CDA). The HL7 clinical statements, which is one of the main components of the HL7CDA was also discussed in this course. Consequently, the author was capable of understanding the structure of HL7 CDA, which was used to develop the synoptic operative template. This was important, as it enabled the author to allocate the intended HL7 clinical statement which is used to design each section in the template, and to provide the SNOMEDCT code values according to the attributes used to cover clinical information to be encoded in the intended clinical statement. As a result, this interaction or binding between the information reference model, HL7 CDA and the terminology standard, SNOMED CT can enable the semantic interoperability between different computer systems. Also, in this course the author learned about the SNOMED CT system; she learned about the SNOMED CT components like concepts, types of relationships, concepts’ descriptions; and how concepts are related to each other in the SNOMMED CT logical model. Consequently, the author was supported when she was using the CliniClue browser to find the appropriate codes. She could understand the features and functions provided by the browsers, for example, the difference between the concepts’ descriptions provided by the browser such as synonyms, preferred terms, or the fully specific names. She was also capable of selecting the appropriate attributes to do the refinements and develop the post-ordinations expressions (See appendix F for more information About SNOMED CT).

Another course that supported the author in her internship project was the “Research Method, HINF 6020” course. In this course the author learned very important elements of research study i.e. The research question, study design, subjects, measurements and sample size calculations. She learned how to develop a feasible and valid research question that can be generalized to the external populations. She learned how to choose a design of the study that fit the research questions based on the accessible sample. Some examples of study designs that were discussed in the course are cross-sectional studies, cohort studies that are prospective or retrospective, case control, and randomized blinded trial. The advantage and disadvantage of each study design were discussed in the course which enabled the author to think critically about the design of any research study. She also learned how to choose the study subjects and determine the exclusion and inclusion criteria that define the target populations and best fit the research questions.

In fact all the issues and aspects of the research methods that were discussed in the course provided the author with useable knowledge to understand the components of the "synoptic operative report for spinal cord injury patients" research study .The author was not involved in the design of the of the research study because it was done before her involvement in the project, but she was able to effectively understand the components of the study when she read the study protocol (appendix A). She could understand the type of the study design selected in this project which is a cross-over study design. In the crossover study deign, the same group of participants are exposed to two or more different interventions one after the other in a random or specified order. This is different from that of the case –control study design in that in the cross-over study design, each case serves as his or her own control (Newman, Browner, Cummings & Hulley, 2007, p. 119). In fact, this design is more feasible and fits the purpose of the study because it is important in the study to compare between the dictated operative report and the synoptic operative report that is filled by the same person. Each participant should use both methods and serve as the control and the case to enable the comparison between the synoptic and dictated reports. This is important to control the effect of confounders (variables not of interest that can affect the result of the study) when comparing the two operative reports. For example, the work experience, education or the computer skills of participants can have effects on the performance when they are filling the synoptic or dictated report. Consequently, the result would not be precise and the power of the study would be weakened if the comparison made between a dictated operative report and a synoptic operative report that were filled by two different participants. Using the case – control design would threaten the precision of the data collected because in the case –control study, participants in the case group are different from those in the control group. For example, if the control group is using the dictation method and the case group is using the synoptic operative reporting it would be very difficult and more costly to control the confounders and make sure that each participant in one group has an exact match in the another group; Matching sex, skills and work experience between the two groups to reduce the effect of these confounders on the results would be effectively impossible. Moreover, the author leaned that it is vital that instruments of study should be accurate, precise, specific, appropriate, and sensitive. All these features of instruments and strategies to enhance them were discussed in the class and applied in the assignments that were completed in the course. As a result, this helped the author to effectively participate and think critically when she was participating in reviewing and updating the instruments that would be used to collect data to measure the completeness and accuracy of the synoptic operative report and the dictated report. For example, when the author was comparing the Completeness Assessment form used for this study with another instrument used in a similar study (Gur et al., 2012), and considering the sections provided in the electronic template, it was recognized that the completeness form should include more variables when assessing the completeness of the two methods. These variables are important clinical items that present in the Synoptic Operative Report template, but they are not measured in the completeness instrument, so under the support and supervision of Dr. Grace Paterson, these data items were added to the completeness assessment form (See Appendix O)

Also in the Research Method course, it was discussed how to design a questionnaire and interviews, valuable instruments which can be used in a research study to collect the intended data. This supported the author when she was designing and developing the SNOMED CT Confirmation Form (appendix I) described above in this report, since it was important to develop an effective systematic method to enable the author to provide clear and sufficient information to obtain the required responses. In the “Research Method” course the author learned about concepts which supported the author to develop the confirmation form. For example, she learned when to choose open-ended and close ended questions to obtain the intended responses and she learned how to use words effectively to avoid pitfalls when designing questionnaires, all these concepts and more, which were discussed in the course, were considered when the form was designed.

”Information Systems and Issues, HINF 6110” is another course that the author completed in the MHI program. In this course, the author learned about Design, Implementation, Support and Evaluation, which are the general phases of the System Development Life Cycle framework. In fact, activities and components involved to complete each phase were discussed in details in this course. User manuals, such as the one the author developed in this project were discussed in the course as one of activities that should be completed in the “Implementation” phase. In the Implantation phase, documentation is an important step that should be completed after installing a system. This documentation can be system documentation, which provides detailed information about the specifications’ of a system, its internal workings, and the functionality of the system, or a user documentation, that provides visual and written information about an applications system, how to use it and how it works (Hoffer, George & Valacich, 2011, pp. 486-487). The second type of documentation (user documentation) is what the author developed for the Electronic Synoptic Operative Report Template. In fact, the internship project provides a great opportunity for the author to practice developing this important component of the system development life cycle, enabling the author to effectively participate in similar activities in the future work.

The “Information Systems and Issues, HINF 6110” course taught the author how to design electronic forms or reports. Important considerations when designing a form or report were discussed to enhance the creation of an effective design. Some of these considerations are, who is the user, what are their characteristics, what is type of tasks will be performed, and where and when it will be used. Guidelines to enhance the usability of the reports or forms were discussed. These guidelines included, providing meaningful titles, balanced layout, easy navigation, effectively notifying users of errors and more. As a result, this knowledge enabled the author to think critically when testing the Synoptic Operative Report template, (see task four described above in this report). When the author was testing the template she was able to think critically and recognize some issues that can limit the usability of the systems. For example, the issue of filling the information of the "Surgical Procedures" section which was discussed in task number four in this report. In fact, it was recognized that if a procedure has more than one device used in positioning the patient to perform he surgical procedure, a participant should fill the information for the entire field of that procedure twice to represent that two devices were used for patient positioning (See Appendix L , Report View for patient #2; the Surgical Procedure Section) & (See task number 4 described above in this report for more information about this task). So, from the knowledge obtained from the Information Systems and Issues course, the author was capable of critically recognizing and discussing some issues identified concerning the usability of the electronic template with the author's supervisor (Dr. Grace Paterson) and with the template's designer (Wilfred Bonny). It was identified by the electronic synoptic template developer, Wilfred Bonny, that these problems cannot be solved for this research study because of the limitations of the tool used to design the report (Microsoft InfoPath 2007). These usability issues were considered when the author developed the user manual to support users to effectively use the electronic template.

The author also completed an elective course, " Nursing Administration and Leadership, NURS 6000", in this course the author learned about leadership skills which are important for leaders in the health care domain to enable innovations in the health care environment. It was discussed that leaders should have effective interpersonal skills such as listening skills, communications skills and negotiations skills as well as conflict management skills. All these concepts and methods to enhance in these skills were discussed in the course. As a result the author practiced and applied these concepts when communicating with the research team to promote a more healthy working environment and obtain the required responses from the project team.

In conclusion, the knowledge that the author obtained from the courses provided by the Master of Health Informatics program has effectively supported her to perform her tasks in the internship project. More importantly, combining this knowledge with experiences obtained from participating in the "Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients", research project, has strengthened the personality and knowledge of the author and will support her to effectively start her future work life.

Identification of a Health Informatics Problem

Noticeable Variations in SNOMED CT Coding

One of the author's tasks is to provide the SNOMED CT code values for all clinical data items of the electronic template. While performing this task, the author noticed that there is a noticeable tendency by different coders to differently code the clinical concepts when using the SNOMED CT system. In fact, in some cases, the author changed some SNOMED CT code values that were developed by the previous work for example, the clinical term "Dislocation,Occipital-cervical" is a diagnosis that is provided in the Trauma Diagnosis list of the Pre-Operative Diagnosis Section. This concept was coded by a member of the previous work to "44264009|traumatic dislocation of joint of cervical vertebra|:363698007 |finding site|=410731008|joint structure of first cervical vertebra|]". While the author was confirming the codes that were provided by the previous work, she found another appropriate SNOMED CT code by using the CliniClue browser that is " 263014005 | dislocation of atlanto-occipital joint |", which has the same words that are used in the display name of the template and from the author point of view it reflects the required meaning with less words. Both concepts, "44264009|traumatic dislocation of joint of cervical vertebra" and "dislocation of atlanto-occipital joint "are subtypes of the clinical finding "dislocation of joint of spine" but the concept" traumatic dislocation of joint of cervical vertebra "has a hierarchal relationship with the clinical finding "traumatic dislocation of joint". Also, the coder of the previous work used a refinement to encode the data Item" Dislocation, Occipital-cervical"; the attribute "Finding site" was used to represent the site of the clinical fining which is"410731008|joint structure of first cervical vertebra|; while the code that is produced by the author" " 263014005 | dislocation of atlanto-occipital joint |" is defined by the CliniClue system as dislocation of joint of spine and the finding site is "atlanto-occipital joint structure" which is a subtype of the SNOMED CT concept "joint structure of first cervical vertebra" that is used in SNOMED CT expressions that were developed by the other coder. Another possible SNOMED CT code Value that can be used to represent the clinical finding is "263013004 | dislocation of joint of spine: 363698007 | finding site |=31640002 | occipital bone structure |". In fact , as a result of the verification process of SNOMED CT expressions that was done with the research team that is presented in this report, the SNOMED CT code "263014005 | dislocation of atlanto-occipital joint |" ' was considered the best candidate to code the Clinical data Item" Dislocation, Occipital-cervical" . Another example, is the clinical term "Instability "which is a clinical finding provided in the list of the Trauma Diagnosis under the Pre-Operative Diagnosis section. This data item was coded by the previous work to" 202819003|atlanto-occipital instability|+ 202820009|atlantoaxial instability|:42752001|due to|=417746004|trauma|]", and the author changed the code to 202821008 | cervical spine instability |. In fact the author recognized that the two SNOMED CT concepts "atlanto-occipital instability" and "atlantoaxial instability have subtypes (children) relationship with the parents concept"cervical spine instability"; so the author considered that the SNOMED CT concept "cervical spine instability" is better fit since it has the same meaning and it uses the same words that are presented in the synoptic report. Moreover, when the supervisor (Dr. Grace Paterson) of the author was reviewing the author's work, she suggested the author make some changes concerning the code values for some data items. For example, the author coded the clinical term "Diabetes (with end organ damage)", which is a data item in the list of Associated Co-Morbidities section of the electronic template, to "73211009 | diabetes mellitus|: 116676008 | associated morphology |= 37782003 | damage". In fact, using SNOMED CT system there is no code which can refer to damage in a body organ in general because the suggested SNOMED CT concepts by the browser are too specific. For example, the concept "damage" presents embedded in phrases like "damage to pelvic organs or tissues following abortive pregnancy", so the supervisor suggested coding this concept to "73211009 | diabetes mellitus|+74627003 | diabetic complication |". The supervisor believes that this SNOMED CT expression is more intolerable since the diabetic complications leads to organ damage. However, after the verification process with the research member, Ginette Thibault, another best candidate was found to encode the data item "Diabetes (with end organ damage)" which is "73211009 | diabetes mellitus|+ 116223007 | complication | +42796001 | end-stage | ". Moreover, since the Author was extracting the data items to be coded using different resources; the Author couldn't allocate some of the code values for the section "Indications" developed by the previous work, so she encoded the data elements of this section; and after a time the author recognized that this section was a part of the old non-trauma diagnosis form of the RHSCIR which was used by members of the previous work to encode the data. The RHSCIR updated their form and removed data items for Indication from the non-trauma diagnosis form which was used by the author to extract data to be encoded. So, lately, the author found the code values in the resource that has the code values for the non- trauma diagnosis. In fact, when the author compared her work with the previous work, she recognized that there were some variations in encoding some data items. For example, the data Item "intrathecal infusion pump failure" that is presented in the list of the Indication section was encoded by the previous work to "48403009|insertion of infusion pump| = 76797004|failure|: 363698007|finding site| = 72607000|intrathecal route|". While the Author encoded this data item to "48403009|insertion of infusion pump|+72607000 | intrathecal route | :47429007 | associated with | =76797004 | failure |". In fact, the author recognized that different coders can choose different codes to represent the same clinical concept even though they are using the same SNOMED CT terminology browser (CliniClue Browser). It seems that each coder is likely to perceive the concept in a different way and behave differently while navigating the coding system to understand the relationships among concepts. Therefore the author searched the literature to recognize if the variation in SNOMED CT coding is a considerable problem and identified some methods that have been taken by Health informatics professionals and interested parties to enhance the reliability of SNOMED CT code system that can be rendered by the heterogeneity of coding.

The reliability of SNOMED CT coding

It is recognized widely in the literature that SNOMED CT is considered as the most comprehensive and multilingual clinical healthcare terminology that can effectively represent different type of clinical data. The consolidated health Informatics Initiative; that is a collaboration initiative between all federal organizations to seek agreement on health data collection is considered SNOMED CT as the terminology standard for diagnosis, problem lists, anatomy, and procedures (Andrews, Patrick, Richesson, Brown, & Krischer, 2008). Also, it was found that compared to other terminology standards, the coverage of SNOMED CT to represent medical concepts of several medical domains is higher (Chiang et al., 2006). In a study that was evaluating the performance SNOMED CT to be considered as a medical vocabulary for the Computerized Diagnosis and Problem List, it was the found that SNOMED CT system can cover more than 90 % of the medical items of the diagnosis and problem list (Wasserman & Wang, 2003). Also, it is stated that SCT is considered as a key terminology standard for representing clinical data of different domains because it has clinically rich concepts that enable coders to use pre-coordinated concepts or single concepts to reflect the intended clinical items. Also, its potential as expressive and comprehensive terminology appears when it enables coders to use the post-coordinating expressions and generate new concepts and expressions by using the logical model that represent the relationships with other concepts. Consequently, coders can represent more complex concepts and expressions when it is impossible or insufficient to encode a clinical data item with a single SNMED CT concept (Richesson, Andrews, & Krischer, 2006); however, the use of comprehensive and expressive terminology like SNOMED CT system that allow the use of post-coordination expressions can make the encoding process more complex and consequently render the integrity of the data. The flexibility of SNOMED CT that allows the use of post-coordination concepts and combines different concepts to represent the intended meaning can lead to divergent representations by different users (Andrews et al., 2008). Moreover, it is stated that the use of post-coordination expressions when coding clinical data is an area that can lead to great inconsistency, redundancy, and rendering the retrieval of information (Jiang & Chute, 2009). In a study that was developed to evaluate the reliability of SNOMED CT by measuring coding agreement among three physicians using two different SNOMED CT terminology browsers, it was found that the inter- coders reliability, that is if the same codes are assigned to one concept by different Coders, was 44% when coders used one of the browsers and 53% when using the another one. Also, the intra-coder reliability testing , that is if a coder assigns the same code to one concept using different browsers, indicate that a divergent SNOMED-CT codes was generated up to 55% of the time when the two browsers were used by one user to encode the same concept. In fact, the result of the study indicates that the “reliability of SNOMED CT coding is imperfect” (Chiang et al., 2006).

Considerable Solutions to Reduce the Variability of SNOMED CT Coding

It is noted that if the variability of coding is inevitable, an important task is to recognize if multiple representation medical concepts can be comparable. Also, it is stated that it is not important to code concepts in exactly the same format to be equivalent in their meanings and to assure effective retrieval of information. Therefore it was recognized that an area of interest that should be enhanced is to recognize a method that can detect similarities and difference among codes when they are encoded by different coders, especially if it is possible to compare post coordination expressions generated by different coders. As a result, it will be possible for system designers and terminology implementers to realize these similarities and differences and adjust the system to algorithmically determine similarities among equivalent coded concepts and consequently reconcile variant expressions. An approach to accommodate this need was taken by a study that was investigating if the use of the CliniClue transformer Expressions tool can support detecting similarities and differences among separate sets of clinical research concepts that were coded to SNOMED CT by three different expert coding companies. This tool facilitates the transformation of SNOMEDCT expressions to normal form. The general idea of normalization is like cleaning statements of extraneous information in order to allow for comparisons of primitive concepts. In fact, the ultimate goal for this study was to investigate if this SNOMED CT tool can support recognition if the seemingly different coding of the same concepts can be semantically related(Andrews et al., 2008); since it was argued in this study that if the heterogeneity among coders is as inevitable because each coder can utilize or understand the terminology and its structure and rules in different ways. An initial measure of the potential usefulness of a controlled terminology should be based on to what extent users are able to consistently express meaning. That means coding that is computably equivalent should be a reasonable substitute to the consistent syntactic and semantic coding. In fact, the study concluded that for each paired comparisons nearly half of the time the codes of the companies could be related. That means approximately half of the information coded by different coders can be lost and these coded information would not be retrievable. Also, the study failed to algorithmically determine equivalence among concepts that were coded differently and it was stated that the main reason for the lack of comparability among the normal forms of these expressions and the high percentage of unrelated concepts come from the approach that each company had undertaken to code the data, since one company chose a concept from SNOMED CT hierarchy that is not appropriate to represent the intended data items, such as choosing observable entity instead of clinical finding. This gives rise to the major problem of using polyhierarchical terminologies that have complex logical descriptions. The study recognized that heterogeneity among coded data is inescapable and more effort has to be taken to support coders by developing or adopting a model that clearly and effectively presents rules to be used for terminology like SNOMED CT. This new model should be built based on various use cases of the real world scenarios to support users with more efficient references after providing initial training. In the study it is recognized that guiding coders who are not experts in terminology design and common ontological principals is a crucial step needed to promote wider adoption and consistent coding (Andrews et al., 2008).

Moreover, developing guidelines and education programs to support the coding process have been identifies as an approach to respond to the problem of poor quality of data and discrepancies as a result of the coding variations. For example, there was a national study that was done by the Canadian Institute for Health Information (CIHI) to measure the accuracy of the Discharge Abstract Data (DAD). The DAD is an important data holding at CIHI which contains clinical and administrative data based on health care services delivered to patients. This study attempted to measure the reliability of nearly 50 data elements contained in the discharge abstract. Also, one of the main objective of this study was to measure the coding quality of diagnosis and procedures according to the CIHI indicators stated in the Health Indicators Framework, and to measure to what extend diagnoses and procedures are not coded based on CIHI Guidelines so that it will be possible to address coding issues and identify if additional guidelines are needed. At the end of the study, it was identified that there are noticeable discrepancies in the coding of the diagnoses and procedures. Consequently, the analysis of the study and the factors that were identified as reasons for these discrepancies was directed to support the process of developing guidelines and education sessions (Richards, Brown, & Homan, 2001). Many studies, that evaluate the variations of SNOMED CT coding and the tendency of coders to encode differently when using the same terminology browsers have recommended the need for clearer guidelines that are better able to support the coding process of specific context like for clinical research area and to support coders who are originally not expert as a considerable solution to reduce the variability of SNOMED CT coding (Patrick, Richesson, Andrews & Folk, 2008). The adoption of standardized guidelines that fit their needs by health organizations are likely to standardize the coding process and promote the consistency of coding by different coders. It was suggested that under controlled circumstances, when coders are using the same coding instructions and are exposed to the same training sessions, there will be less coding discrepancy than in more natural situations, when different coders are located in different context, motivated by different goals and interests, and not bounded by the same explicit instruction(Andrews et al., 2008). Guidelines like the SNOMED CT User Guide that has been released by the International Health Terminology Standards Development Organization to describe the structure and the hierarchy of the SNOMED CT systems or documents that provide rules of constructing composite SNOMED CT concepts and use the compositional grammars can be adopted by interested parties in order to make the coding process more standardized and consistent.

Moreover, it is recognized that the reliability of SNOMED CT coding is significantly related to the browser used for modeling; in a study that was testing the reliability of SNOMEDCT coding by measuring the inter- coding agreement among different coders when they were using two different SNOMED CT browsers. It was found that the inter-coding agreement was significantly higher among coders when they were using a SNOMED CT browser that has more sophisticated features compared with another SNOMED CT browser that has simple or basic functions (Chiang et al., 2006). The results of the study suggested that the development of terminology browsing tools can support coders to enhance the reliability of SNOMED CT coding. For example, the author of the report was using the CliniClue browser to develop the SNOMED CT expressions for the data items of the synoptic report. The CliniClue system has features to show users the synonyms of the intended concepts or provide the users with attributes that can be used to refine specific concept and accordingly build the composite concepts. For example, in figure 18, the CliniClue browser provides a feature that can support a user to select the appropriate attribute to refine the concept “fracture dislocation of lumbar spine” which is a “clinical finding”. As shown in figure 18 there are four attributes that can be used to refine the concept “ fracture dislocation of lumbar spine”; these attributes are due to, causative agent, finding site, and severity, so if the user wants to represent the location of the clinical finding, he or she should select the attribute “ Finding site” (see figure 19) and accordingly, after clicking on the attribute of interest to make the refinement, a pop up window will appear and provide the user with the possible SNOMED CT concepts to represent the location of the Clinical finding “fracture dislocation of lumbar spine”. In figure 19; there are two body structures provided by the system to represent the location of the clinical finding which are”bone structure of lumbar vertebra” and “lumbar spine joint structure”. Also, the user can type the name or the first latters of the intended location in the search field of the popup window and the system will return the most related matched concepts. Thus, after selecting the most appropriate location, the system will build the post-coordination expressions based on the selections of the user. For example, in figure 20 the user selected “bone structure of lumbar vertebra”; and accordingly the system build the post-coordination expressions. This feature can support coders in the coding process to reduce the tendency to choose inappropriate attributes when building the post-coordination expressions and enhance the consistency of the coding process.

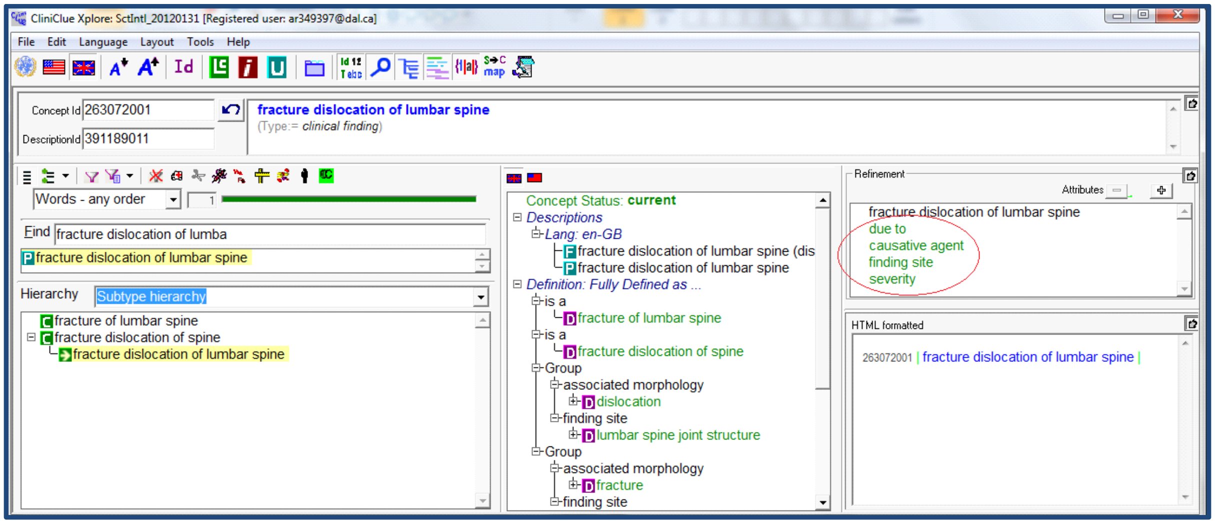


Figure 18 : Screen shot from CliniClue Xplore Browser shows a feature to support users to select the appropriate attribute and build post-coordination expressions-1

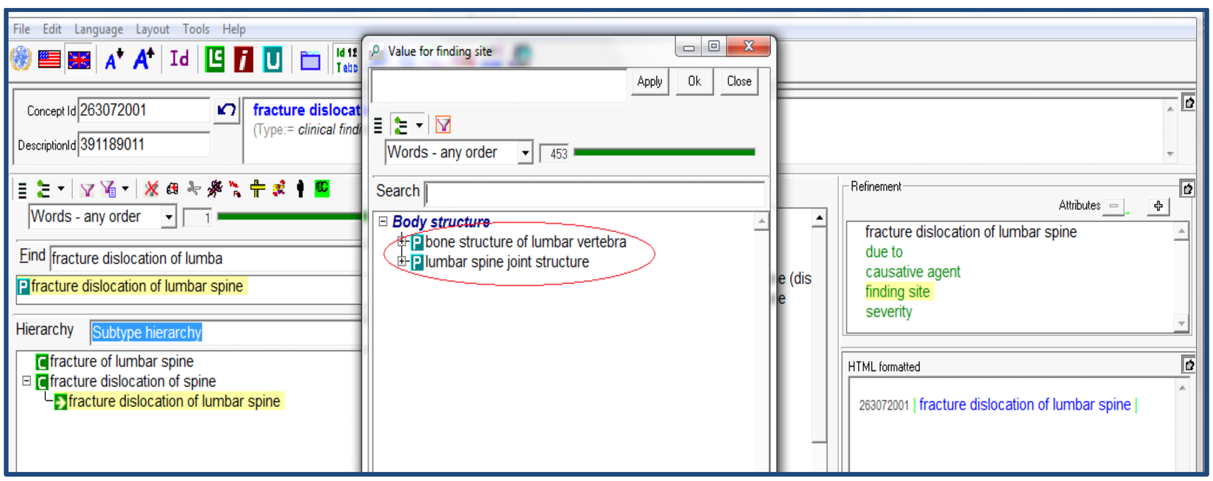


Figure 19 : Screen shot from the CliniClue Xplore browser shows a feature to support users in selecting the appropriate attribute and build post-coordination expressions-2

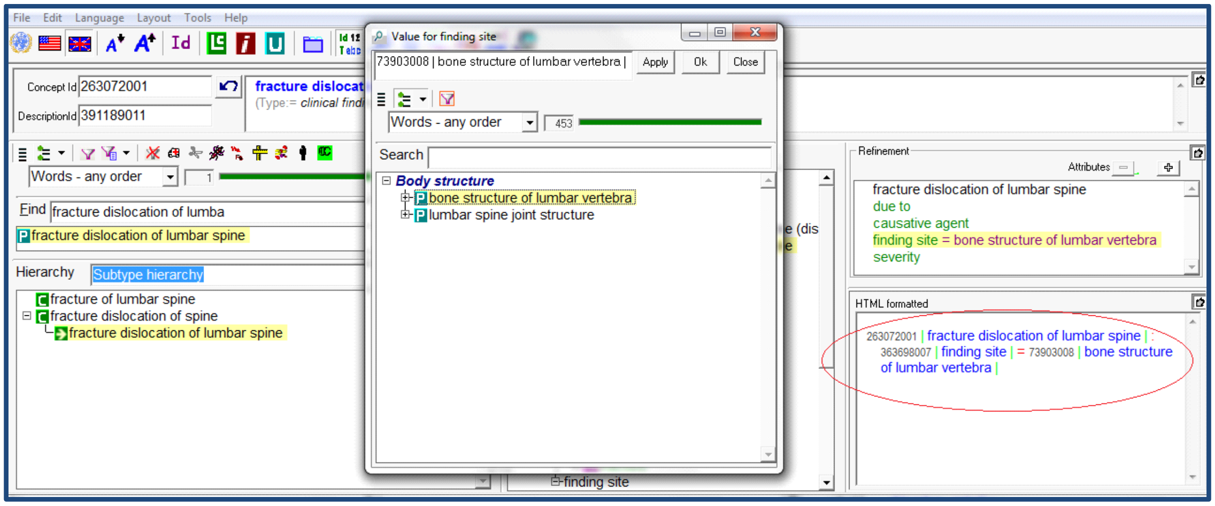


Figure 20 : Screen shot from CliniClue Xplore browser shows a cliniclue feature to support users to select the appropriate attribute and build the post-coordination expressions-3

In addition, it is suggested that In order to enhance the reliability of coding when using a comprehensive and flexible terminology like SNOMED CT that allow the use of post-coordination expressions, it is important to provide coders with syntax and structured format to direct or restrict them in the coding process(Richesson et al., 2006). One approach that has been discussed in the literature which restricts or constrains the use of sophisticated medical terminology like SNOMED CT , that allows the use of post-coordination expressions, is promoting the interaction between an information model like HL7 Reference Information Model(RIM) and a terminology standard like SNOMED CT(Richesson et al., 2006; Elkin, Brown, Lincoln, Hogarth & Rector, 2003). The HL7 RIM specifies the grammars of the clinical massages to assure the semantic interoperability and enables the exchange of information between different computer systems. HL7 RIM uses semantic attributes and data types which become tags in the HL7 XML massages, consequently, providing a standardized messaging framework to collect; exchange, and retrieve data among different computer systems without ambiguity (Benson, 2010, p.108-109). The semantic attributes that are used in HL7 RIM can support coders by constraining their performance when they are coding (Elkin et al., 2003).Also, Clinical Document Architecture (CDA) documents are encoded in Extensible Mark-up Language and their machine processable capabilities are derived from the HL7 RIM and they use the HL7 version 3 (HL7 V3) data types (see appendix E). The RIM and the HL7 V3 data types support a CDA document with an effective mechanism to enable it to incorporate concepts from a standard coding system like SNOMED CT (Dolin et al., 2006).

For example, in this research study in which the author was involved, HL7 clinical statements were used to develop sections of the electronic template. These HL7 clinical statements contain semantic attributes that restrict the use of SNOMED CT codes. For example, the HL7 clinical statement that is used in the procedure section to collect clinical information about a procedure encounter presented in figure 21 uses three attributes to cover information about a procedure; these attribute are “<approachsite>” to represent the name of procedure and the approach that is used to perform the procedure. Also, the attribute “<targetsite>” is used to cover information about the location of the procedure; and “<positioning>” attribute is used to represent the device used in patients’ positioning. Using HL7 clinical statement enhances the reliability of coding since coders do not have to use SNOMED CT attributes to build the post-coordination expressions. For example; the author, when developing the SNOMED CT codes for clinical data items of the Procedure section presented in figure 21; she does not have to use compositional grammars or build post- coordination expressions; single SNOMED CT concepts were developed to be embedded in the attributes of the HL7 Clinical statement; the SNOMED CT code values developed to be embedded in the HL7 clinical statement of figure 21 are presented below:

- 1-283165009 | decompression laminectomy |
- 103388001 | percutaneous approach |
- 181824001 | entire C4 vertebra |
- 181826004 | entire C6 vertebra |
- 441100008 | Mayfield head clamp|


```xml
<ns1:spEntry typeCode="DRIV">
    <ns1:procedure classCode="PROC" moodCode="EVN">
        <ns1:approachSiteCode codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="103388001" displayName="percutaneous"></ns1:approachSiteCode>
        <ns1:code codeSystem="2.16.840.1.113883.6.96" codeSystemName="" code="283165009" displayName="decompression laminectomy"></ns1:code>
        <ns1:targetSiteCode>
            <ns1:qualifier>
                <ns1:low>
                    <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="181824001 | C4 vertebra |" displayName="C4" value="" unit="">
                    </ns1:value>
                </ns1:low>
                <ns1:high>
                    <ns1:value codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="181826004 | C6 vertebra | " displayName="C6" value="" unit="">
                    </ns1:value>
                </ns1:high>
            </ns1:qualifier>
        </ns1:targetSiteCode>
        <ns1:templateId root="2.16.840.1.113883.10.20.1.29"></ns1:templateId>
        <ns1:positioning codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" code="441100008 | Mayfield head clamp|" displayName="Mayfield Head Rest"></ns1:positioning>
    </ns1:procedure>
</ns1:spEntry>
```


Figure 21 : Screenshot of the XML document of the Microsoft InfoPath form (the electronic synoptic template) shows Hl7 Clinical Statement used to develop the procedure section of the electronic template.

In fact, the clinical information that are collected about the procedure encounter in the HL7 clinical statement of figure 21 can be presented by using the SNOMED CT post-coordination expressions as follow

"283165009 | decompression laminectomy |+ 103388001 | percutaneous approach |: 363704007 | procedure site | = 181824001 | entire C4 vertebra | + 181826004 | entire C6 vertebra |, 424226004 | using device | = 441100008 | Mayfield head clamp|".

In the previous example of the SNOMED CT post-coordination expressions, the attribute " "procedure site" was used to indicate the location where the procedure is performed, and the attribute "Direct device" is used to represent the device that is used to perform the procedure. The use of attributes to develop new concepts represents the potential capability of SNOMED CT to cover a wide range of clinical context. However it can render problems in the reliability of coding and the integrity of data, since coders can be exposed to different instructions, guidelines, or training sessions (Andrews et al., 2008). Also, coders can use the wrong SNOMED CT attributes when they are making the refinements to build the post-coordination expressions. For example, considering the previous example of the SNOMED CT post-coordination expressions; a coder can use the attribute "finding site" instead of "Procedure site"; the attribute "finding site" should be used in a different context to represent the location of a clinical finding or a disease. Moreover, there are three different SNOMED CT attributes that can be used to model a device that is associated with a procedure; these attributes are (Direct device, indirect device, and using device). Each one reflects a different meaning and should be used in a different context (IHTSDO, 2012). The use of compositional grammars can be complex and introduce variability in the coding among different coders and the use of a structural Information model like HL7 RIM can support a reduction in the variability of SNOMED CT coding (Andrews et al., 2008; Elkin et al, 2003). In fact, in the design of the Synoptic Operate Report template for spinal cord injury patient, the HL7 CDA which is an application of the HL7 RIM was used and as a result, the process of coding was restricted to specific parts of the clinical context. However, as discussed before, the author noticed that there were noticeable coding variations among different coders. That means this solution may not prevent the variability in coding, but it considerably can reduce the variability that can be generated when coding unstructured data.

Moreover, as discussed above, the use of compositional terminology like SNOMED CT can assure high coverage clinical data to be encoded since it allows coders to develop new concepts and expressions to form binding concepts and qualifier, but also this advantage of using compositional grammar can risk the integrity of data because there is a risk that coders may be unable to code in a reliable and efficient way (Richesson et al., 2006). In a study that was evaluating the performance of SNOMED CT to cover clinical research data, it was found that 80% of the clinical research data items were covered by the SNOMED CT. However, most of these items (83%) were coded by using post coordination. In this study it stated that the use of post-ordination can be difficult and complex and there is a concern about the validity and the reliability of using this standard, since in this study the variability of coding among different coders was not measured. An approach that was suggested by this study to promote more proper method to encode clinical research data is the use of more than one terminology standard (Richesson et al., 2006). The use of more than one terminology standard may reduce the need to use post-coordination when using some compositional terminology like SNOMED CT; and consequently, reduce the variability of coding. There is a study conducted of a large scale vocabulary test by a collaboration between the National Library of Medicine (NLM)and the Agency for Health Care Policy and Research(AHCPR) to examine if the combination of existing controlled vocabularies can provide the best foundation for developing a comprehensive controlled vocabulary of health information systems. In this study a web-based interface linked to Uniform Medical Language system (UMLS) Knowledge source server was designed. The application was designed to allow participants to search terms and concepts in the UMLS Metathesaurus. The UMLS Metathesaurus was developed by the NLM and contains all or part of some 30 vocabularies. For example, there were broad coverage terminologies like SNOMED CT , International Classification of Diseases, Ninth Revision, Clinical Modification (ICD9-CM), and Medical Subject Headings(MeSH); and terminologies of specialized domains like Physician Data Query (PDQ) for Oncology. Also, there were nursing vocabularies like Nursing Interventions Classification. Moreover, most of the items that were submitted by participants to find matched concept of the controlled vocabularies were related to different tasks and specialties. For example, there were data items related to direct patient care, clinical research, public health surveillance, inpatient care, clinical laboratory, and dentistry. In this study it was found that the combination of existing controlled vocabularies can noticeably provide more exact matches than any individual vocabulary in the set (Humphreys, McCray & Cheh, 1997). The author of the report was interested in this solution since she believes if there is more than one vocabulary system used in coding the clinical data items of the Synoptic Operative report, the need to use the post-coordination expressions can be reduced. For example, in the Implant Section of the Synoptic report; there is a Devices subsection (See Appendix B) which includes data items representing devices used in the Implantation procedure. By Using SNOMED CT it was not possible to find an appropriate single SNOMED CT concept, which represents the exact meaning, to encode each device or data item of the Devices subsection, and most of the time the author was using post-coordination expressions. For example, the data item “Lateral mass Screw/Rod” is a device used to perform the Implant procedure for patients. This data item was encoded to the SNOMED CT expression: “239279000 | fixation of fracture |: 424226004 | using device | = 257346002 | rods or rectangle with screws |, 363704007 | procedure site | = 40349000 | lateral mass of atlas |”. Also another example is the data item “Facet screw” that was encoded to “ 239283000|fixation of fracture using screws(procedure)| : 363704007 | procedure site | = 81168003 | facet joint |”. The use of post-coordination expressions can introduce variability in the coding process. Therefore it was recognized that using more than one terminology standard can reduce the need to use the SNOMED CT post-coordination expressions. For example, promoting the use of a terminology standard to encode medical devices like Universal Medical

Device Nomenclature System (UMDNS), which is a comprehensive coding system for medical device which has been adopted officially in many countries (ECRI, 2012), can be an approach to reduce using SNOMED CT post-coordination expressions to code medical device, consequently enhancing the reliability of the Coding process.

In Conclusion

The author recognized that there is a tendency for different coders to differently encode clinical data items when using the SNOMED CT system. Therefore, the author searched the literature to explore the issue of variability of SNOMED CT coding and identify some solutions or methods used by interested parties to enhance the consistency of coding. After searching the literature, The author found that that SNOMED CT is considered as the most comprehensive clinical healthcare terminology that can effectively represent different types of clinical domains like diagnosis, problem list, anatomy, and procedures, and The potential of SNOMED CT appears in its expressiveness and flexibility when it allows coders to use the post-coordination expressions, so coders can generate new concepts and express more complex clinical context when it is not feasible to use a single concept. However this advantage leads to the introduction of variability of coding among different coders. Also, the author identified some approaches that were discussed in the literature to deal with the problem of variability of SNOMED CT coding and enhance the reliability of coding. For example, it is recognized that if it is not feasible to assure the consistent syntactic and semantic coding among different coders. Thus an important task is to find a method that can algorithmically determine similarities and differences among divergent codes and enable the reconciliations of these differences. Also, it was recognized that a complex terminology like SNOMD CT which has complex logical descriptions, can be confusing when used by coders who are not experts in terminology design and common ontological principals. So it is important to enhance the usability of these terminology models by developing a logical model that fits users` needs, which should be based on different use cases from the real world. Also, developing guidelines and training sessions was recognized widely in the literature as an important activity to reduce variability of coding which should be based on continuous evaluations of the quality and performance of the coding. Moreover the use of more sophisticated terminology browser that has improved features and binding a structured Information model like HL7 RIM and a terminology standard like SNOMED CT can be considerable approaches to direct coders and enhance the consistency of SNOMED CT coding. Also, using more than terminology standard can contribute to reducing the variability of coding, since it can reduce the need to use post-coordination concepts of SNOMED CT. In fact, all the approaches that were discussed in the literature were recommended to enhance the reliability of SNOMED C coding. There is no solution that can eliminate variations among different coders and it is stated that coding differences are to be expected and may be inescapable since the Language is inherently complex in its use and control. Individuals have different interests and ways of understanding things (Andrews et al., 2008). However ; more approaches and methods should be identified and adopted to enhance the consistency of coding and achieve the ultimate goal of using a data standard which is confirming consistent and accurate communication of data across different users. Otherwise it would not be a standard (Andrews, Richesson & Krischer, 2007).

Conclusion

This project research is conducted to test if the utility of the electronic synoptic operative report template can improve the quality of data gathered in the operative reporting for spinal cord injury patients. In this research study synoptic and narrative (dictated) operative reports will be compared by assessing the completeness, accuracy, conciseness and the reusability of both operative reports (dictated and narrative).

The electronic synoptic operative report for the spinal cord injury patients was developed based on the HL7 clinical statements that provide a standardized way to communicate data and enable the exchange of information between different computer systems without ambiguity. Also SNOMED CT vocabulary system was used to encode all clinical data items of the electronic template to enable the collection, exchange and retrieval of clinical data item of the template with different computer systems.

The author of the report worked in this research project as a research assistant; tasks that were completed by the author are presented below:

- In the electronic template there are 402 clinical data items provided as "pick from the lists" or in drop down menus in different sections of the electronic template ; The author completed the SNOMED CT code expressions for 396 clinical data items, and the author confirmed that the SNOMED CT codes fit the HL7 clinical statements that are used to develop the sections of the template; Also, the author developed a confirmation form to confirm the SNOMED CT code expressions that are complex or have some ambiguity with the research members. There were 43 SNOMED CT code expressions that were considered as needing verification with the clinician, Dr. Sean Christie. 38 code values were confirmed and five were considered to be uncodable. Consequently, out of the 402 clinical data items presented in the electronic template there are 391 clinical data items that were encoded to SNOMED CT expressions representing 97.26% of the all clinical data items presented in the template. While 11 data items were considered uncodable representing 2.75 % of all clinical data items of the electronic template.

- Also, the author developed lookup tables containing the SNOMEDCT code values and their descriptions for clinical data items of the electronic template as per instructions from the research team,

- The author tested the completeness and usability of the electronic template by entering data items provided in real dictation reports and the results were provided to the research team. It was suggested that there is no need to add additional clinical data items to the lists provided of the electronic template, and issues concerning the usability of the template were considered when developing the user manual.
- The author developed the user manual and quick start guide to support participant using the template efficiently,
- Also, the author participated in reviewing and updating the instruments that will be used to test the usefulness and reusability of both operative reports (dictated and operative).
- Moreover, the author could not participate in analyzing the data on accuracy, completeness and reusability of the dictated and synoptic operative reports, since there were not sufficient time to recruit participants in the study and have them complete the both reports (synoptic and narrative). The Synoptic Operative Report was installed in the Neurosurgery for use on July 15, 2012, and recruiting of participants will start in August 2012. Consequently the author worked in another task, i.e. the modification of the data analysis instruments that will be used in the study to assess the usefulness of the operative reports (dictated & synoptic). These instruments are; "Completeness and Accuracy Assessments forms" and "Recruitment Questionnaire form".

While the Author was encoding the clinical data items of the electronic template and confirming the code values provided by the previous work , she recognized that there is a tendency to differently encode clinical data items when using the SNOMED CT system by different coders; Therefore, the author searched the literature to explore the issue of variability of SNOMED CT coding and identify some solutions or methods discussed to enhance the consistency of coding. It is recognized that if it is not feasible to assure the consistency of coding among different coders, an important task is to find a method that can algorithmically determine similarities and differences among divergent codes and enable the reconciliations of these differences. Also, it was recognized that it is important to enhance the usability of a complex terminology system like SNOMED CT by developing a logical model that fits users' needs. The importance of standardized guidelines and training sessions was recognized widely in the literature to reduce variability of coding, Also binding a terminology standard like SNOMED CT with an information reference model like HL7 RIM was recognized as a way to provide coders with a structured way to restrict or control their coding performance. Also the use of more than one terminology standard was recommended as approaches to increase the coverage of coded data, consequently, it would become possible to reduce the need to use post-coordination SNOED CT concepts. In fact, all the approaches that were discussed in the literature were recommended to promote the reliability of SNOMED C coding. There is no solution discussed that can avoid variations among different coders and it is stated that coding differences are to be expected and may be inescapable.

Recommendations

- However the great efforts that have been made by terminology systems designers and implementers to promote the reliability of SNOMED CT coding,; the variability of SNOMED CT coding among different coders seems unavoidable. Therefore a crucial task is to enhance the development of a method that can algorithmically detect the similarities and differences among discordant codes and accordingly, reconcile these differences to confirm the retrieval of information. Since it was recognized that a major issue in information retrieval is the reconciliation of such differences.
- Standardized and structured work environment can enhance the reliability of coding. Since it was mentioned that under controlled circumstances, when coders using the same coding instructions, and are exposed to the same training sessions, there will be less coding discrepancy than in more natural situations (Andrews et al., 2008). Interested clinical domains should standardize their training sessions and provided consistent guidelines and tools that fit the requirements of their clinical context. Consequently, coders will be motivated and directed by the same instructions and goals.
- It is important to promote and encourage the use of more than one terminology standard when encoding data items of a clinical domain; a comprehensive controlled vocabularies system can support coders utilizing the existence of different terminology standards to allocate the most appropriate code and increase the quality of the coding process. Therefore it is very important to promote the combination of different terminology standards like SNOMED CT, UMDNS which is a standard international nomenclature and coding system for medical devices, The International Classification of Diseases and Related Health Problems, 10th revision(ICD-10), and key health information organizations like the National Library of Medicine(NLM), that support health professionals and researchers retrieving and integrating medical information from different sources. As a result it would be possible to enable the development of a national comprehensive health terminology system that combines many existing terminology standards and achieves the system interoperability (Perspectives in Health Information Management, 2005). Also, providing incentives from governments to encourage interested parties to enhance the use of these existing terminology standards can promote the widespread use of theses terminology standards; and consequently this can promote the development of combined existing terminologies (Humphreys et al., 1997).

- Guidelines that are released by the IHTSDO can effectively help coders to understand and learn about the concept model of SNOMED CT system to support them in the coding process. However, using guidelines or attending training sessions might not be sufficient to promote the quality of the coding process. Exploring examples of the real life which describes the coding process that have been taken by other projects form other clinical domains can be very useful to organize the coding process and enhance the quality of the coding. Coders can learn and follow predefined and tested coding framework. As a result this can support coders to distinguish important issues faced by other projects and make their coding process more organized and distinguish important activities that should be undertaken when coding data items. For example, in a study, there is a coding method was described to encoded clinical data items of a palliative care database to SNOMED CT codes (Lee et al., 2010). In this study, activities undertaken to encode the data items were described in details which can be taken as a real example and general approach to follow when coding data items.

- It is very important to enhance the use of an effective tool to document clinical data like the synoptic operative report to enhance the health outcomes for patients. The effectiveness of the synoptic report in collecting predefined data items in a more structured format is widely discussed in the literature to enable the capture and reuse of important information for the care of patients (Hoffer et al, 2012). Moreover, it is recognized that the dictated operative report cannot adequately capture critical information for the care of patients (Donahoe et al., 2012). In fact, when the author was testing the electronic template by entering data from real dictated operative reports, she recognized that there is some clinical information which cannot be found in the dictated reports, for example, the estimated blood loss or the surgical approaches that were taken to perform a procedure. Also, in the dictated operative report allocating information was not easy, since there is no structured way to document the operative information.

- Changing the traditional way that surgeons use to document operative information can be difficult. Therefore, it is important to consider the issue of user satisfaction and adopt methods or approaches to increase the acceptance and avoid resistance of users. Trying to customize the template to the users need is very important. For example, the options of providing unstructured free text to enter data in the electronic report can be valuable in attracting users and making them more compliant with new structures template (Hoffer et al, 2012). However, this can lead to loss of important information which should be captured as discrete data items to enable the exchange and the retrieval of these data between different computer systems. Also, enhancing the usability of the electronic synoptic operative report can play a very important role in promoting surgeons to use the template. For example providing a user-friendly interface that enables users to easily navigate, select or enter data without complication is very important. Also, providing supportive features like real time feedback that can help users to enhance their performance can be very encouraging. For example, in Alberta, a web-based synoptic operative report, WebSMR, was developed to determine and improve the quality of cancer surgery. In this project, it was found that 75% of surgeons were highly satisfied and 80% stated that they would recommend the WESMR to other surgeons. In this web-based template many functions and feature were used to support users to easily navigate and get the tempted quickly completed, and use free text boxes to enter unexpected data (Mack et al., 2009). In fact, users will not use a new IT system without recognizing potential benefits that make the new system clearly overcome the traditional one.

Lessons Learned

The author increased her knowledge about the use of very important medical terminology standards that are needed to enable the collection, retrieval and exchange of medical data items between different computer systems which is SNOMED CT. However, the academic learning provided her with valuable information about this terminology standard needed to support in the coding process. Working with the SNOMED CT system when she was developing the SNOMED CT code values and expressions for the clinical data items of the electronic template, reading the guidelines released by IHTSDO, and exploring examples of SNOMED CT code values and expressions provided in the guidelines were a great opportunity to understand the logical model of the SNOMED CT system and how concepts are related to each other in the SNOMED CT systems. Consequently she became able to combine SNOMED CT concepts according to their relationships in the concept model and provide the appropriate SNOMED CT expressions to represent the required meaning of the intended clinical concept.

Also, she learned how to use the SNOMED CT compositional grammars in order to build the post-coordination expressions to represent the required meaning of the intended clinical concepts, since it is not possible to use a single SNOMED CT concept to encoded clinical data items for all clinical data items of the electronic template.

Also, in this project the author increased her knowledge about of the important component of the HL7 Clinical Document Architecture (CDA), which is the HL7 clinical statement. In the academic learning the author was exposed to the structure and the components of a CDA document and how the clinical statements are presented in the body of the CDA. But working in this project make the author more experienced with the structure of HL7 clinical statements; she was exposed to different types of clinical statements that were used to develop the sections of the electronic template, and she learned how to provide the appropriate SNOMED CT code values that fit the attributes and data types used in the HL7 clinical statements. As a result; the author learned about how to assure the terminology binding which is combining a terminology standard like SNOMED CT , that provides standardized medical words to be exchanged between different systems without ambiguity and an information model like HL7 CDA that provides the syntax of clinical massages (grammars). Consequently, it will be possible to assure the semantic interoperability between different computer systems.

The author leaned how to use CliniClue explore which is a browser used to encode clinical data items to SNOMED CT code values. Working in this project allowed the author to become acquainted with this SNOMED CT browser. She learned how to use different features of the browser to allocate the required SNOMED CT concepts. For example, the author now is able to recognize the relationships between SNOMED CT concepts by using features of the browser that represent descriptions, definitions, synonyms, and the hierarchical relationships between the SNOMED CT concepts, also she leant about a feature in the browser that support her in building post-coordination expressions.

Also, the author leaned how to develop a method to confirm SNOMED CT code values with clinicians. She learned about very important components that can facilitate the confirmation process, for example; providing more than one SNOMED CT expression candidate to encode a specific data item; descriptions of SNOMED CT concepts used to encode the intended data items, and synonyms of SNOMED CT concepts used to encode data items are important components to be included to enhance the verification process and choose the most appropriate code values. The content of the confirmation form can be changed according the purpose of the study and the forms that were developed in this project can be modified for another study in the future.

Also, the author learned how to develop documentation to clearly and effectively communicate the SNOMED CT Code values to members of the project or to other interested individuals as instructions to SNOMED CT codes. From working with the project team and from exploring examples of tables developed by other projects to document and communicate code values; the author recognized important data elements that should be included when developing tables representing the code values for clinical data items. As a result, current and future users can understand and use data provided in these tables.

Also, from working in this project the author learned how to develop a user manual and quick start guide which are very important components that should be provided with a new system to support the user in effectively understanding and using the system.

Moreover, from working in this project the author recognized and learned about instruments that can be used to assess the quality of the operative reports and this can support the author in a future study. These instruments are structured assessment and a global quality rating scale which are adopted for another study to develop instruments used in this project to assess the accuracy, conciseness, and completeness of the operative reports (dictated & synoptic).

The References

Andrews, J. E., Richesson, R. L., & Krischer, J. (2007). Variation of SNOMED CT coding of clinical research concepts among coding experts. *Journal of the American Medical Informatics Association : JAMIA, 14*(4), 497-506. doi:10.1197/jamia.M2372

Andrews, J. E., Patrick, T. B., Richesson, R. L., Brown, H., & Krischer, J. P. (2008). Comparing heterogeneous SNOMED CT coding of clinical research concepts by examining normalized expressions. *Journal of Biomedical Informatics, 41*(6), 1062-1069. doi:10.1016/j.jbi.2008.01.010

Benson, T.Using SNOMED CT and HL7 together. *Principles of health interoperability HL7 and SNOMED CT* (pp. 221-225). New York: Springer London Dordrecht Hiedelberg.

Benson, T. (2010). Clinical document architecture. *Principles of health interoperability HL7 and SNOMED CT* (pp. 152-153). New York: Springer London Dordrecht Hiedelberg.

Benson, T. (2010). The HL7 V3 RIM. *Principles of health interoperability HL7 and SNOMED CT* (pp. 108-109). New York: Springer London Dordrecht Hiedelberg.

Benson, T. (2010). SNOMED CT. *Principles of health interoperability HL7 and SNOMED CT* (pp. 189). New York: Springer London Dordrecht Hiedelberg.

Chiang, M. F., Hwang, J. C., Yu, A. C., Casper, D. S., Cimino, J. J., & Starren, J. B. (2006). Reliability of SNOMED-CT coding by three physicians using two terminology browsers. *AMIA ...Annual Symposium Proceedings / AMIA Symposium.AMIA Symposium,* , 131-135.

Division of Neurosurgery. (2010). *History*. Retrieved, 2012, from http://neurosurgery.medicine.dal.ca/history.htm

Division of Neurosurgery. (2012). *Spine program.* Retrieved, 2012, from http://neurosurgery.medicine.dal.ca/spine.htm

Division of Neurosurgery. (2012). *Welcome to neurosurgery.* Retrieved, 2012, from http://neurosurgery.medicine.dal.ca/index.htm

Dolin, R. H., Alschuler, L., Boyer, S., Beebe, C., Behlen, F. M., Biron, P. V., & Shabo Shvo, A. (2006). HL7 clinical document architecture, release 2. *Journal of the American Medical Informatics Association, 13*(1), 30-39. doi:10.1197/jamia.M1888

Donahoe, L., Bennett, S., Temple, W., Hilchie-Pye, A., Dabbs, K., Macintosh, E., & Porter, G. (2012). Completeness of dictated operative reports in breast cancer-the case for synoptic reporting. *Journal of Surgical Oncology, 106*(1), 79-83. doi:10.1002/jso.23031; 10.1002/jso.23031

Edhemovic, I., Temple, W. J., de Gara, C. J., & Stuart, G. C. (2004). The computer synoptic operative report--a leap forward in the science of surgery. *Annals of Surgical Oncology, 11*(10), 941-947. doi:10.1245/ASO.2004.12.045

Elkin, P. L., Brown, S. H., Lincoln, M. J., Hogarth, M., & Rector, A. (2003). A formal representation for messages containing compositional expressions. *International Journal of Medical Informatics, 71*(2-3), 89-102.

Emergency Care Research Institute (ECRI). (2012). *Universal medical device nomenclature system.* Retrieved July, 22, 2012, from https://www.ecri.org/Products/Pages/UMDNS.aspx?sub=Management%20Tools,%20Guidelines,%20Standards,%20and%20Nomenclature

Gur, I., Gur, D., & Recabaren, J. A. (2012). The computerized synoptic operative report: A novel tool in surgical residency education. *Archives of Surgery (Chicago, Ill.: 1960), 147*(1), 71-74. doi:10.1001/archsurg.2011.228

Health Level Seven Incorporation (HL7) & International Health Terminology Standards Development Organization (IHTSDO). (2008). *Using SNOMED CT in HL7 version 3; implementation guide, release 1.5.* Retrieved, 2012, from http://www.ihtsdo.org/fileadmin/user_upload/doc/tig/hl7/TermInfo1.5/terminfo.html#TerminfoAppendRefsGrammar

Hoffer, D. N., Finelli, A., Chow, R., Liu, J., Truong, T., Lane, K., . . . Jewett, M. A. (2012). Structured electronic operative reporting: Comparison with dictation in kidney cancer surgery. *International Journal of Medical Informatics, 81*(3), 182-191. doi:10.1016/j.ijmedinf.2011.11.008

Hoffer, J. A., George, J. F., & Valacich, J. S.,. (2011). Implementation and maintenance. *Modern systems analysis and design* (pp. 486-487). Upper Saddle River, N.J.: Pearson Prentice Hall.

Humphreys, B. L., McCray, A. T., & Cheh, M. L. (1997). Evaluating the coverage of controlled health data terminologies: Report on the results of the NLM/AHCPR large scale vocabulary test. *Journal of the American Medical Informatics Association : JAMIA, 4*(6), 484-500.

International Health Terminology Standards Development Organisation (IHTSDO). (2012). *SNOMED CT user guide january 2012 international release.* Retrieved, 2012, fromhttp://ihtsdo.org/fileadmin/user_upload/doc/download/doc_UserGuide_Current-en-US_INT_20120131.pdf

Jiang, G., & Chute, C. G. (2009). Auditing the semantic completeness of SNOMED CT using formal concept analysis. *Journal of the American Medical Informatics Association, 16*(1), 89-102. doi:10.1197/jamia.M2541

Judas, F., Figueiredo, M. H., Cabrita, A. M., & Proenca, A. (2005). Incorporation of impacted morselized bone allografts in rabbits. *Transplantation Proceedings, 37*(6), 2802-2804. doi:10.1016/j.transproceed.2005.05.043

Lee, D. H., Lau, F. Y., & Quan, H. (2010). A method for encoding clinical datasets with SNOMED CT. *BMC Medical Informatics and Decision Making, 10*, 53. doi:10.1186/1472-6947-10-53

Mack, L. A., Bathe, O. F., Hebert, M. A., Tamano, E., Buie, W. D., Fields, T., & Temple, W. J. (2009). Opening the black box of cancer surgery quality: WebSMR and the alberta experience. *Journal of Surgical Oncology,99*(8), 525-530. doi:10.1002/jso.21266

Markwell, D. (2010). *Viewing SNOMED clinical terms with cliniclue xplore.* Retrieved 2012 from http://www.hiqa.ie/system/files/workshop_HI_CliniClue_Xplore_SnomedCT_20100131.pdf

mTuitive Incorporation. (2005). *White paper synoptic reporting and structured data capture* . Retrieved July 2, 2012, from http://ssr-anapath.googlecode.com/files/SynopticReporting.pdf

Newman, B. T., Browner, W. S., Cummings, S. R., & Hulley, S.B. (2007). Designing cross-sectional and case-control studies. *Designing clinical research* (3rd ed., pp. 119). Philadelphia, PA: Lippincott Williams & Wilkins.

Olakanmi, O. (n.d). *The AMA, NMA, and the flexner report of 1910.* Retrieved July, 2, 2012, from http://www.ama-assn.org/resources/doc/ethics/flexner.pdf

Paterson,G., & Christie, S. (2011). *Utility of synoptic reporting to improve operative reports for spinal cord injury patients.* Unpublished work.

Paterson,G., & Soroka, S. (2005). *Chronic kidney disease Hl7 templates user guide.* Unpublished work.

Patrick, T. B., Richesson, R., Andrews, J. E., & Folk, L. C. (2008). SNOMED CT coding variation and grouping for "other findings" in a longitudinal study on urea cycle disorders. *AMIA ...Annual Symposium Proceedings / AMIA Symposium.AMIA Symposium,* , 11-15.

Perspectives in Health Information Management. (2005). *Coordination of SNOMED-CT and ICD-10: Getting the most out of electronic health record systems.* Retrieved July/25, 2012, fromhttp://perspectives.ahima.org/index.php?option=com_content&view=article&id=141:coordination-of-snomed-ct-and-icd-10-getting-the-most-out-of-electronic-health-record-systems&catid=57:white-paper&Itemid=109

Richards, J., Brown, A., & Homan, C. (2001). The data quality study of the Canadian discharge abstract database. Statistics Canada. Retrieved form http://www.statcan.gc.ca/pub/11-522-x/2001001/session16/6282-eng.pdf

Richesson, R. L., Andrews, J. E., & Krischer, J. P. (2006). Use of SNOMED CT to represent clinical research data: A semantic characterization of data items on case report forms in vasculitis research. *Journal of the American Medical Informatics Association : JAMIA, 13*(5), 536-546. doi:10.1197/jamia.M2093

Rick Hansen Spinal Cord Injury Registry (RHSCIR). (2010). *Registry at a glance.* Retrieved July, 25, 2012, from http://rickhansenregistry.org/en/about-us.html

The Clinical Information Consultancy Ltd (CIC). (2011). *Features of cliniclue xplore.* Retrieved, 2012, from http://www.cliniclue.com/xplore_features

The Clinical Information Consultancy Ltd (CIC). (2011). *Home.* Retrieved, 2012, from http://www1.clininfo.co.uk/

U.S. Department of Housing and Urban Development. (n.d). *User's manual.* Retrieved, 2012, from http://www.google.ca/url?sa=t&rct=j&q=user%E2%80%99s%20manual%20project%20or%20system%20name%20u.s.%20department%20of%20housing%20and%20urban%20development&source=web&cd=1&sqi=2&ved=0CEsQFjAA&url=http%3A%2F%2Fportal.hud.gov%2Fhudportal%2Fdocuments%2Fhuddoc%3Fid%3Ddoc_15160.doc&ei=CDUHULDlGorMrQHi0dzACA&usg=AFQjCNFoEBBVSjGHccbP2IaGC5tVR9nrJw

Urquhart, R., Grunfeld, E. & Porter, G. A. (2009). *Synoptic reporting and the quality of cancer care: A review of evidence and Canadian initiatives.* Retrieved July/7, 2012, fromhttp://www.oncologyex.com/gif/archive/2009/vol8_no1/8_review_1.pdf

Vergis, A., Gillman, L., Minor, S., Taylor, M., & Park, J. (2008). Structured assessment format for evaluating operative reports in general surgery. *American Journal of Surgery*, *195*(1), 24-29. doi:10.1016/j.amjsurg.2007.08.053

Wasserman, H., & Wang, J. (2003). An applied evaluation of SNOMED CT as a clinical vocabulary for the computerized diagnosis and problem list. *AMIA ...Annual Symposium Proceedings / AMIA Symposium.AMIA Symposium*, , 699-703.

Western Health Information Collaborative Chronic (WHIC). (2005). *Western Canada chronic disease managment infostructure intiative: Phase 2: Data standards and HL7 messaging CDM data standards- appendix E code tables.* Retrieved July,25, 2012, from http://www.health.alberta.ca/documents/HISCA-WHIC-CDM-DS-E-Code-Tables.pdf

Appendices

Appendix A

The Protocol for the Research Study which was submitted to Capital Health Ethics Research Board with Ethics Approval Submission Form for Non-Interventional Studies

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients

Sean Christie, MD, FRCSC and Grace Paterson, PhD

Executive Summary

Health data gathered about clinical activities on individual patients is key to learning about what works and why. Currently, spinal surgeons and the residents they train use narrative reporting methods to document spinal cord injury operations on patients. It can be difficult to use the reports from several different patients to get information and statistics about the group as a whole. Furthermore, research studies have demonstrated that the existing, narrative operative record, is not as complete as it could be, and this makes it less useful, both for care of the patient as well as for research and administrative purposes. One solution is to move towards electronic capture of the operative report using an electronic template based on "synoptic methodology". This means that a library of key words and phrases would be created to capture clinically relevant information in a standardized way. Synoptic operative reports represent a significant advance toward ensuring higher quality medical treatment of spinal cord injury patients. They enable the capture of discrete data items and transform a narrative operative report that is qualitative in nature to a qualitative one that can be aggregated to generate information and knowledge. Electronic synoptic operative reports have replaced dictated reports at many institutions because users could demonstrate improvements in reliability, completeness and timeliness with this alternative.

Our hypothesis is that we can improve the quality of data for primary and secondary use through implementing an electronic template for synoptic operative reports for spinal cord injury patients. Success in this project would improve the quality of data, which is already collected for other research projects, such as the Rick Hansen Spinal Cord Injury Registry (RHSCIR), as well as for the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD), which collects health information from institutions across the country.

Surgical residents will be recruited to produce an operative report using both the current method of recall dictation for a narrative report and the proposed method of electronic template. All participants (residents) will be given a recruitment questionnaire and a feedback survey. Participants will be given a quick orientation about the template and its use. We seek to investigate the acquisition of a skill using a *teaching at the time of practice* approach. We will randomly assign participants to two groups. Group 1 will be asked to dictate an operative report followed by template, and Group 2 will be given template followed by dictation. The narrative (dictated) and synoptic reports will then be compared. We will look at accuracy, conciseness, completeness and reuse.

Through improvements at the time of data entry, we believe that synoptic reporting will enhance the transfer of information, which will lead to improvements in the clinical data captured on spinal cord injury operations for secondary use (RHSCIR and CIHI DAD).

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients

SUMMARY OF FUNDS REQUESTED

Personnel	$ 8200	Research Assistant in Health Informatics - $14/hr x 35hr/wk x 16 weeks plus 4% vacation pay IN-KIND SERVICES Research Coordinator - $75/hr x 40 hours = $3000 in-kind services from Neurosurgery Health Informatics Analyst - $800/day x 20 days = $16,000 in-kind services from Health Informatics, Dalhousie University
Materials and Supplies	$ 400	Software (Altova XMLSpy) and printing costs for User Manuals
Other	$ 1,900	Ethics submission fees, knowledge dissemination
TOTAL	$ 10,500	(Plus $19,000 in-kind services)

DETAILED PROPOSAL

Background

The care of patients involves many different individuals who rely on information documented about patient care and management. If the documented information is incomplete, it weakens the ability of the team to carry out informed decision-making. By improving data quality at the time of data capture, we should enable higher data quality for use in patient care and for reuse by healthcare administration and researchers.

The two introductory sentences in Tim Benson's book, Health Interoperability HL7 and SNOMED, state why transformation in healthcare is necessary.

"Healthcare quality improvement is an economic and moral necessity. The transformation, which is needed to improve productivity and effectiveness, will rely on computer interoperability to deliver information when and where required, support soundly-based decision-making, eliminate unnecessary repetition, reduce delays and avoid errors." [1]

Rationale

Electronic templates support the creation of clinical documents that are of higher quality than those produced by the same individual using dictated narrative reporting method [2]. The template serves as a prompt for pertinent information, which could be reused to support information needs of researchers and administrators. Electronic synoptic operative reports are dependent upon predefined templates for individual procedures. Such templates are based on synoptic methodology; the synoptic concept starts with the creation of a library of key words and phrases to show a preferred way to communicate a clinical concept in an operative report. This enables the capture of discrete data items and transforms a narrative operative report that is qualitative in nature to a quantitative one that can be aggregated to generate information and knowledge [3]. The Alberta Cancer Surgery Working Group has developed and implemented a web-based synoptic surgical medical record, Alberta WebSMR. Albertans reported that following the implementation of a rectal cancer template, the synoptic report captured 99% of the required data elements versus 45.9% captured via a dictated narrative report [4]. This showed that the science of surgical technique could be better measured using a synoptic reporting method. The synoptic checklist approach has consistently shown superior results to narrative reports for completeness [5].

The adoption rate for the Alberta WebSMR grew from 13.8% as of May 2007 [6] to 75% as of November 2010 [7]. Although feedback suggests that use of the template is time- saving and user-friendly, the adoption rate indicates some surgeons are reluctant to change practice. A Surgical Synoptic Reporting Tools Project (SSRTP) was phased into Capital Health District Authority (CDHA). It uses a web-based system to enable surgeons to provide comprehensive reports after surgeries on breast and colorectal cancer patients [8]. They have engaged family physicians and provided a sample synoptic renal report on the public CDHA website [9] to help familiarize family physicians with the structured document produced by the synoptic reporting method.

Documents, such as an operative report, are composed of sections and statements within these sections. A particular construct for electronic templates called the Health Level 7 (HL7) Clinical Statement is a standardized form of communication that is understandable by humans and computers. It enables computer interoperability because the health information standard, HL7 Clinical Statement, acts as a common language for exchange of clinical data. The Electronic Template for Spinal Cord Injury Patients is based on the use of HL7 Clinical Statements for expressing discrete data items. In its human-readable form, it is a narrative document.

In this study, residents will be shown how their operative report will be used for secondary purposes, specifically the Spine Procedure Form of the Rick Hansen Spinal Cord Injury Registry (RHSCIR) and the procedures section of the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD). The proposed study will gather data on usefulness, usability and use of an electronic template for Neurosurgery operative reports for spinal cord injury patients. Better capture of data using an electronic template will allow us to extract more complete data for resident feedback for training purposes and for current and future research examining treatment for spinal cord injury patients.

Our hypothesis is that we can improve the quality of the data for primary and secondary use through implementing an Electronic Template for Spinal Cord Injury Patients. The secondary uses of this data include the Spine Procedure Form for the Rick Hansen Spinal Cord Injury Registry (RHSCIR) and the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD).

Subjects

Our study population are those surgical trainees listed on the Neurosurgery House Staff Master Schedule 2011-2012. The inclusion criteria are:

- Trainee is eighteen (18) years or older;
- Trainee is registered as a clerk or resident at Dalhousie University Medical School;
- Trainee is willing to take part in this study, including signing the Consent Form after carefully reading it.

There are no exclusion criteria.

Research Plan

The template for this study will be designed to support data capture of any element that is considered by consensus between the investigators to be pertinent to the data collection. It will be based on prior work done by these investigators between July 2010 and February 2011. At that time, the data elements in 15 forms used for data collection for the RHSCIR were expressed using HL7 Clinical Statements and vocabulary systems, especially SNOMED CT. These forms included the Spine Procedure Form. The template will be implemented using a web interface.

Instruments required for the study will be adapted from instruments used in a previous study [2]. These include the score sheet for completeness of the operative report, recruitment questionnaire and feedback questionnaire.

We use a repeated-measures design, also known as within-subjects design. We seek to investigate the acquisition of a skill using a teaching at the time of practice approach. To account for learning effects, we use a counterbalancing technique. We will randomly assign the participants to Group 1 or Group 2. Group 1 will be asked to complete their operative report using dictation followed by electronic template for spinal cord injury patients, while Group 2 will be given template followed by dictation.

The time required should not exceed 1 hour. The average time needed to dictate an operative report for later transcription is 15 minutes. It may take slightly longer to complete the electronic operative report using a template. The trainees will be familiar with the transcription system from their other rotations. All participants will be given a Quickstart Guide and User Manual for the synoptic template. These information sources provide a quick orientation about the template and its relationship to a library of clinical statements for expressing discrete data items. Each participant will also be asked to complete a recruitment questionnaire examining possible control variables (e.g., demographics, computer experience) and a feedback questionnaire. These instruments will be adapted from a previous study as described above. Consent will be obtained from the patients whose charts will be used to conduct this study. This consent process should not exceed 1 hour and no further patient involvement is required. Residents and patients will be consented by researchers in the Division of Neurosurgery, Department of Surgery, Dalhousie University.

Sample Size

The benefits of the crossover design are the elimination of the between subject variance, a decrease in the sample size needed, and the discovery of possible learning effects. Learning effects occur when participants rely on experiences obtained in the first leg in the study to implicitly improve their performance in the second leg. We control for examiner variance by using the same examiner, an International Medical Graduate enrolled in the Dalhousie Master of Health Informatics program, to score the trainee's operative report produced using either dictation or template method. The scoring instrument will be adapted from a previous study [2]. In the study by Flyer et al [10] significant differences were detected in a non-randomized study of 11 residents. In the study on cases for assessing clinical competence, they predict that a sample of 10 would achieve reliability of 0.8 (Cronbach's alpha) [11].

Feasibility

A similar study was done in 2005-2006 and required the development of an HL7 CDA template for capturing discharge summaries for chronic kidney disease patients [2,12]. This template was designed using Microsoft Office product called Microsoft InfoPath, so should be a feasible task for a research assistant with health informatics skills and knowledge. Methods for assessing the completeness will be based on a scoring sheet for assessment of discharge summaries [2] that is adapted to serve the needs for assessment of synoptic operative reports [13].

References

1. Benson T. Principles of Health Interoperability HL7 and SNOMED. Springer-Verlag London Limited 2010.

2. Paterson G. Boundary Infostructures for Chronic Disease: Constructing Infostructures to Bridge Communities of Practice. VDM Verlag, Germany, 2008.

3. Urquhart R, Grunfeld E, Porter GA. Synoptic reporting and the quality of cancer care: A review of evidence and Canadian initiatives. Oncology Exchange. 2009;8(1):28-31.

4. Edhemovic I, Temple WJ, de Gara CJ, Stuart GCE. The Computer Synoptic Operative Report—A Leap Forward in the Science of Surgery. Annals of Surgical Oncology, 2004;11(10):941–947.

5. Mack LA, Dabbs K, Temple WJ. Synoptic operative record for point of care outcomes: A leap forward in knowledge translation. Journal of Cancer Surgery. 2010:S44-S49

6. Cancer Surgery Alberta. Alberta WebSMR Benefits Evaluation. Cancer Surgery Alberta Quarterly 2008; 1:1-6. Available online at www.cancerboard.ab.ca >

Health Professionals > Cancer Surgery Alberta > Projects, Partnerships & Publications (accessed June 2008).

7. Canada Health Infoway. Innovation in the Adoption of HI. https://secure.coachorg.com/news_&_events/awards_news/alberta_websmr.htm

8. Capital Health--Research Focus on Cancer. Fall 2008 http://www.cdha.nshealth.ca/default.aspx?page=DocumentRender&doc.IdType=document&doc.Id=38094

9. Synoptic Rectal Report. http://www.cdha.nshealth.ca/default.aspx?page=DocumentRender&doc.Id=8192 10. Flyer B, Rubenstein LZ, Robbins AS, Wieland GD, Henry D, Cugalj N. An intervention to improve the hospital discharge summary. J Med Educ. 1988 Jun;63(5):407-9.

11. Wass V, van der Vleuten C. The metric of medical education: The Long Case. Medical Education; 2004;38:1176-1180.

12. Paterson GI, Soroka SD. Formative Evaluation of the Clinical Pragmatic Attributes of Components Chosen for a Boundary Infostructure. In Abidi R, Bath P and Keselj V (eds) Proceedings of iSHIMR 2006: The 11th International Symposium on Health Information Management Research: Advancing Health Information Management and Health Informatics: Issues, Strategies and Tools. Halifax, NS, Canada: Faculty of Computer Science, Dalhousie University, 2006, pp 375-385.

13. Park J, Pillarisetty VG, Brennan MF,Jarnagin WR, D'Angelica MI, DeMatteo RP, Coit DG, Janakos M, Allen PJ. Electronic Synoptic Operative Reporting: Assessing the Reliability and Completeness of Synoptic Reports for Pancreatic Resection. J Am Coll Surg 2010;211:308–315.

Appendix B

The Synoptic Operative Report Template for Spinal Cord Injury Patients

Synoptic Operative Report for Spinal Cord Injury
Capital District Health Authority, Halifax, NS
Division of Neurosurgery

Date Created: 12/07/2012

Patient Information

Given Name:	Family Name:	Prefix:
Adam	Everyman	Mr.
Gender:	**Date of Birth:**	**HCN:**
Male	25/11/1954	12345

Surgeon and Anaesthesiologist Information

Prefix	Given Name	Family Name	Speciality
Dr.	Sean	Christie	Surgeon

Procedure Date and Time

Operative Start Date and Time:	Operative Stop Date and Time:	Decompression of Neural Elements
2012-07-12 13:30	2012-07-12 16:30	2012-07-12 16::00

Pre-Operative Diagnoses

The pre-operative diagnosis specifically applies to the procedure being conducted.

INSTRUCTIONS:

Type of Diagnosis: **Primary** indicates diagnosis or condition that can be described as being the most responsible diagnosis for the patient's stay in hospital.

Secondary indicates any other diagnosis that significantly affect the treatment received or increases the length of stay.

Location Detail: Specify vertebral levels (e.g., L2, L3 or L1-L5)

Diagnosis	Type of Diagnosis	Injury Type	Location Detail	
			From:	To:
Jefferson	primary	closed	C4	C6

Post-Operative Diagnosis

Is the post-operative diagnosis same as pre-operative diagnosis? ○ Yes ○ No

Specify (if any):

Indications

Indication	Location Detail *(If any)* From:	To:
Wound dehiscence	C5	C6

Associated Co-Morbidities

Select the associated co-morbidities:

- [x] Myocardial infarction
- [ ] Congestive heart failure
- [ ] Cerebrovascular disease
- [ ] Chronic pulmonary disease
- [ ] Liver disease (mild)
- [ ] Liver disease (moderate or severe)
- [ ] Diabetes (without end organ damage)
- [ ] Diabetes (with end organ damage)
- [ ] Renal disease (moderate or severe)

Pre-Operative Clinical Status

Glasgow Coma Scale (GCS)

Subscore	Value
Glasgow Coma Scale eye opening subscore	2
Glasgow Coma Scale verbal response subscore	2
Glasgow Coma Scale motor response subscore	3
Total Score	7

- [ ] *Show Definition of Glasgow Coma Scale*

American Spinal Injury Association (ASIA) Impairment Scale

○ A ○ B ○ C ○ D ○ E ● Unknown Neurological Level of Injury: N/A

- [ ] *Show Definition of ASIA Impairment Scale*

ASA Grade (American Society of Anaesthesiologists Physical Status Classification System)

○ ASA physical status class 1 (Normally healthy patient)
● ASA physical status class 2 (Patient with mild systemic disease)
○ ASA physical status class 3 (Patient with severe systemic disease, not incapacitating)
○ ASA physical status class 4 (Patient with incapacitating disease, constant threat to life)
○ ASA physical status class 5 (Moribund patient, < 24-hour life expectancy)

○ Unknown

Anaesthesia Information

Type of Intubation (*Select one*):

○ Awake/Fibreoptic ◉ Laryngoscope ○ Glidescope ○ Nasotracheal Intubation
○ Field Light Wand ○ Asleep Fibreoptic ○ Previously Intubated

Other, specify:

Type of Anaesthetic (*Select one, if more than one, select the most significant*):

◉ General ○ Spinal ○ Epidural ○ Combined general and neuraxial
○ Other nerve block ○ Monitored anaesthesia care ○ Local anaesthesia
○ No anaesthetic ○ Other anaesthetic not monitored by anaesthetist

Surgical Procedures

Procedure	Surgical Approach	Location Detail From:	Location Detail To:	Positioning
decompression lam…	percutaneous	C4	C6	Jackson Table: Flat

Surgery Description/Findings

Describe procedure(s) in details:

Surgical Drains

☑ Lumbar drain
☐ Lumboperitoneal shunt
☐ syringoperitoneal shunt
☐ Syringopleural shunt
☐ Syringosubarachnoid shunt

Implants

Device	Location Detail From:	Location Detail To:

Pedicle Screws	C4	C6

Bone Graft

- [x] Local (Vertebra) Autograft
- [ ] Fibula Autograft
- [ ] Rib Autograft
- [ ] Structural Ilium Autograft
- [ ] Morcelized Ilium Autograft
- [ ] Structural Allograft
- [ ] Morcelized Allograft
- [ ] Synthetic BMP (Bone morphogenic protein)
- [ ] Synthetic Osteoset
- [ ] Synthetic PMMA (polymethylmethacrylate)
- [ ]

Adjunct Drugs/Procedures

- [ ] Traction
- [ ] Halo vest
- [x] Antibiotics
- [ ] Foley catheter
- [ ] Anti-embolic stockings
- [ ] Pneumatic compression hose
- [ ] Hemovac drain
- [ ]

Intra-Operative Fluid Intake Output Information

Estimated Blood Loss: 100 mL

Amount of blood transfused: 450 mL

Amount of IV Fluid Infused: 55 mL

Intra-Operative Urine Output: 100 mL

Other Fluid Output: 50 mL **Name of Other Fluid:** Platelets

Discharge Disposition

○ Ward ○ Stepdown ○ ICU ○ Home ○ Deceased

Other, Specify:

None

Author of Operative Report

Given Name:	Family Name:	Suffix:
Sean	Christie	MD, FRCSC

Appendix C

The Spine Procedure Form of the Rick Hansen Spinal Cord Injury Registry

SPINE PROCEDURE FORM

DRAFT

Date: ____________ **Start Time** *(Incision)*: ________ *(2400 hrs)*
Stop Time *(Closure)*: ________ *(2400 hrs)*

Name of Surgeon: ______________________________ **Estimated Blood Loss:** ____________ **(mls)**

I. Type of Intubation *(Circle one)*: Awake/Fibreoptic Laryngoscope Rapid Sequence Previously Intubated Other, specify ______________

II. Decompression Neural Elements *(Patients with SCI only)*: **Date:** ______________ **Time:** ________ *(2400 hours)*

III. Anaesthetic *(Circle one, if more than more, circle the most significant)*:
General Spinal Epidural Combined general and neuraxial Other nerve block
Monitored anaesthesia care Local No anaesthetic Other anaesthetic not monitored by anaesthetist

IV. Approach *(Circle all that apply)*:
Anterior Thoracoscopic [DA:1] Thoracotomy [LL:2] Thoracoabdominal [LL:3] Transperitoneal [LL:4]
Retroperitoneal [LL:5] Laparoscopic [LL:6] Cervical [LL:7]
Posterior Midline [PF:9] Wiltse [PF:10] Percutaneous [HA:11]

I. Procedures *(circle all that apply)*

Location Detail (most rostral segment to most caudal segment) — **Anterior** / **Posterior**

A. Vertebral Column

1. **Decompression** a) laminectomy [1SC80:1]* b) foraminotomy [1SC80:3] c) laminoplasty [1SC80:4] — Anterior: Not Applicable; Posterior: ________
2. **Corpectomy** [1SC89:1]* ________ ________
3. **Discectomy** a) partial [1SE87:5] b) total [1SE89:3] ________ ________
4. **Fixation** [1SC74:1]* *(Must complete section II)* ________ ________
5. **Fusion** *(Also complete section(s) III +/- II)*
   a) posterolateral UNinstrumented [1SC75:1]* b) interbody [1SC75:2]* c) posterolateral (instrumented) [1SC75:3]* ________ ________
   a) posterolateral UNinstrumented [1SC75:1]* b) interbody [1SC75:2]* c) posterolateral (instrumented) [1SC75:3]* ________ ________
6. **Osteotomy** *(Also complete section(s) III +/- II)*
   a) transverse [1SC80:7] b) PSO (egg shell) [1SC80:8] ________ ________
7. **Vertebroplasty** [1S80:6] ________ ________
8. **Excision tumor**
   a) intradural [1AW87:1] ________ ________
   b) extradural i) intralesional [1AW87:2] ii) marginal [1AW87:3] iii) wide [1AW87:4] ________ ________
9. **Thoracoplasty** [1GV52:6] ________ ________
10. **Suboccipital craniectomy** [1AP72:3]
11. **Transoral odontoid resection** [1SA89:2]
12. **Coccygectomy** [1SF89:4]
13. **Removal of Instrumentation** [1SC55:1]*

B. Drainage/Debridement Irrigation

1. **Insertion shunt** a) lumboperitoneal [1AX52:1] b) syringoperitoneal [1AX52:2]
2. **Insertion subarachnoid catheter** [1AX52:3]
3. **Incision & Drainage wound infection** [1XX52:4]
4. **Incision & Drainage abscess (non-epidural)** [1XX52:5]

Version 1 Page 1 of 2

* *Data Entry Note: Replace SC in code with SA if detail location is C1 Ir C2 or replace with SF if the location detail is Sacrum (S1-S5) or Coccyx (Cx)*

I. Procedures Cont'd *(circle all that apply)*

Location Detail
(most rostral segment to most caudal segment)
Anterior **Posterior**

C. Cord, Nerve or Canal

1. **Excision spinal vascular malformation** [1KZ86:1] ______ ______
2. **Exploration & restoration of subarachnoid space** [1AW72:4] ______ ______
3. **Repair meningocele** [1AW72:1] ______ ______
4. **Release tethered cord** [1AW72:2] ______ ______
5. **Repair dural tear** [1AX80:1] ______ ______
6. **Dural patch** [1AX80:5] ______ ______
7. **Rhizotomy** a) facet [1AW59:1] b) spinal nerve [1AW59:2] ______ ______
8. **DREZ lesion** [1AW59:3] ______ ______

D. Pumps

1. **Replacement/removal/implant of infusion pump** [1AX53:1]
2. **Replacement/removal/implant of IPG (battery)** [1AX53:4]
3. **Insertion of spinal stimulator electrode** [1AX53:2]
4. **Spinal stimulator (complete system) to include pulse generator/receiver** [1AX53:3]

E. Other

1. **Biopsy** a) vertebral [2SC71:1] b) soft tissue [2SH71:2] ______ ______
2. **Other** [1XX99:1]: ______________ ______ ______

II. Implant *(circle all that apply)*

Device	Anterior Placement		Posterior Placement	
1. Anterior Cervical Plate	[NW:1]	______	Not Applicable	
2. Posterior Cervical Rod-Screw System (e.g. Vertex)	Not Applicable		[TC:2]	______
3. Cannulated Screws (e.g. UCSS)	[NW:3A]	______	[NW:3P]	______
4. Prefabricated prosthetic replacement (e.g. cage)	[1SE53XXSL:4A]	______	[1SE53XXSL:4P]	______
5. USS	[TC:5A]	______	[TC:5P]	______
6. Moss Miami/Monarch	[TC:6A]	______	[TC:6P]	______
7. CD Horizon	[TC:7A]	______	[TC:7P]	______
8. Other rod system: ______	[TC:8A]	______	[TC:8P]	______
9. Wires	[KD:9A]	______	[KD:9P]	______
10. Z plate	[NW:10A]	______	[NW:10P]	______
11. Other: ______	[GX:11A]	______	[GX:11P]	______

III. Bone Graft *(circle all that apply)*

1. **Autograft:** a) Local (vertebra) [A:1] b) Fibula [1VQ58:2] c) Rib [1SL58:3]
   d) Structural Ilium [1SQ58:4] e) Morcelized Ilium [1SQ58:5]
2. **Allograft:** a) Structural [K:6] b) Morcelized [K:7]
3. **Synthetic:** a) BMP [N:8] b) Osteoset [N:9] c) PMMA (e.g. cement) [N:10]

Signature of Attending: ______________________ **Dictated:** ☐

Version 1 Page 2 of 2

** Data Entry Note: Replace SC in code with SA if detail location is C1 Ir C2 or replace with SF if the location detail is Sacrum (S1-S5) or Coccyx (Cx)*

Appendix D

Trauma and Non-Trauma Diagnosis Forms of the Rick Hansen Spinal Cord Injury Registry

Diagnoses Form

INSTRUCTIONS

Type

Circle P (Primary) to indicate ***ONE*** *diagnosis or condition that can be described as being the most responsible for the patient's stay in hospital*

Circle S (Secondary) to indicate ***any other diagnoses*** *that significantly affect the treatment received or increase the length of stay*

I. Trauma

Is the injury open or closed? *(Circle one)* Open Closed

** Data Entry Note: If injury is open, replace the last 0 directly before the ":" with 1*

A. Cervical

C0-C2 Trauma		Type (Circle)	Location	Code
Dislocation	Occipital-cervical	P S		S131:TC1
	Complete C1-2	P S		S131:TC18
Occipital condyle #		P S		S02100:TC2*
Arch #	Anterior	P S		S12000:TC4*
	Posterior	P S		S12000:TC3*
Jefferson		P S		S12000:TC5*
Rotary subluxation, fixation		P S		S131:TC6
Instability		P S		M5321:TC7
Hangmans	Undisplaced	P S		S12100:TC9*
	Displaced and angulated	P S		S12100:TC10*
	with dislocated C2-3 facets	P S		S12100:TC11*
Odontoid #	Type II	P S		S12100:TC13*
	Type III	P S		S12100:TC12*
Unclassifiable #, C1		P S		S12000:TC23*
Unclassifiable #, C2		P S		S12100:TC23*

C3-C7 Trauma	Type (Circle)	Location	Code
Posterior arch #	P S		S122X0:TC14*
Anterior wedge compression #	P S		S122X0:TC15*
avulsion flakes,	P S		S130:TC16
Minimally displaced unilateral facet #	P S		S122X0:TC17*
Unilateral facet #/subluxation	P S		S122X0:TC18*
dislocation/subluxati	P S		S131:TC19
Three column burst # without dislocation	P S		S122X0:TC20*
Three column fracture dislocation	P S		S122X0:TC21*
Bilateral facet dislocation	P S		S131:TC22
Unclassifiable #, C3-C7	P S		S122X0:TC23*

Soft Tissue Injury - Cervical	Type (Circle)	Location	Code
Sprain	P S		S134:TC27
Torticollis	P S		M436:TC26
SCIWORA	P S		S141:TC24
Transient paralysis (spinal cord concussion)	P S		S140:TC28
Brachial plexus and/or peripheral nerve injury	P S		T1438:TC25

B. Thoracic

T1-T12 Trauma		Type (Circle)	Location	Code
Compression	< 50 % height loss	P S		S220X0:TTL1*
	>= 50 % height loss	P S		S220X0:TTL2*
Burst		P S		S220X0:TTL3*
Kyphosis (degrees): ________ Amount height loss (mm): ________ Posterior element disruption *(Circle)*: Present Absent				
Flexion distraction	Bony	P S		S220X0:TTL4*
	Ligamentous	P S		S220X0:TTL5*
	Mixed	P S		S220X0:TTL6*
Translational injury (#/dl)	Bony	P S		S220X0:TTL7*
	Ligamentous	P S		S220X0:TTL8*
# Hyperextension injury		P S		S220X0:TTL9*
Isolated posterior	# spinous process	P S		S220X0:TTL10*
	# isolated transverse	P S		S220X0:TTL11*
	# laminar	P S		S220X0:TTL12*
	# facet	P S		S220X0:TTL13*
	# pars	P S		S220X0:TTL14*
Unclassifiable #, T1-T12		P S		S220X0:TTL15*

Soft Tissue Injury - Thoracic	Type (Circle)	Location	Code
Sprain	P S		S233:TTL20
SCIWORA	P S		S241:TTL18
Transient paralysis (spinal cord concussion)	P S		S240:TTL21
Brachial plexus and/or peripheral nerve injury	P S		T1438:TTL19

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C. Lumbar

L1-L5 Trauma		Type (Circle)	Location	Code
Compression	< 50 % height loss	P S		S320X0:TTL1*
	>= 50 % height loss	P S		S320X0:TTL2*
Burst		P S		S320X0:TTL3*
Kyphosis (degrees): ________ Amount height loss (mm): ________ Posterior element disruption *(Circle)*: Present Absent				
Flexion distraction	Bony	P S		S320X0:TTL4*
	Ligamentous	P S		S320X0:TTL5*
	Mixed	P S		S320X0:TTL6*
Translational injury (#/dl)	Bony	P S		S320X0:TTL7*
	Ligamentous	P S		S320X0:TTL8*
# Hyperextension injury		P S		S320X0:TTL9*
Isolated posterior element injury	# spinous process	P S		S320X0:TTL10*
	# isolated transverse	P S		S320X0:TTL11*
	# laminar	P S		S320X0:TTL12*
	# facet	P S		S320X0:TTL13*
	# pars	P S		S320X0:TTL14*
Unclassifiable #, L1-L5		P S		S320X0:TTL15*

Soft Tissue Injury - Lumbar	Type (Circle)	Location	Code
Sprain	P S		S335:TTL20
SCIWORA	P S		S341:TTL18
Transient paralysis (spinal cord concussion)	P S		S340:TTL21
Brachial plexus and/or peripheral nerve injury	P S		T1438:TTL19

D. Other Trauma

Other Trauma		Type (Circle)	Location	Code
Penetrating SCI without significant vertebral column injury	Cervical	P S		S141:TC29
	Thoracic	P S		S241:TTL22
	Lumbar	P S		S341:TTL22
	Cauda Equina	P S		S343:TTL22
Other cervical trauma, specify: ________		P S		XX99:TC30
Other thoracic trauma, specify: ________		P S		XX99:TTL23
Other lumbar trauma, specify: ________		P S		XX99:TTL23
Sacral #		P S		S32100:TTL16*
Ilium involved *(Circle)*: Yes No				
Sprain, Sacrum or Coccyx		P S		S337:TTL20
Coccyx #		P S		S32200:TTL17*
SCIWORA, Cauda Equina		P S		S343:TTL18
Pathological fracture collapsed vertebra (excludes that due to oncology)		P S		M80:TO1
Psychogenic paralysis		P S		F444:TO2
Other trauma, specify		P S		XX99:TO3

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II. Non Trauma

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Does the patient have? Myelopathy ☐ Yes ☐ No Radiculopathy ☐ Yes ☐ No Cauda Equina Syndrome ☐ Yes ☐ No

Oncology	Type (Circle)	Location	Code
Primary malignant tumor of spine	P S		C412:O1
Primary intradural tumor (including Schwannoma)	P S		C720:O2
Metastatic tumor of spine	P S		C79:O3
Primary Site: ____________			
Multiple myeloma	P S		C900:O4
Primary benign tumor of spine (ie Giant Cell)	P S		D16:O5
Pathology *(Required for all oncology diagnoses)* : ____________			

Myelopathy	Type (Circle)	Location	Code
Syringomyelia	P S		G950:M1
Myelopathy of unknown cause	P S		G959:M2
Meningeal cyst, adhesions	P S		G961:M3

Deformity - Major	Type (Circle)	Location	Code
Scheuermann's	P S		M420:DM1
Thoracic kyphosis due to osteoporosis	P S		M40:DM2
Post-traumatic kyphosis (conservative)	P S		M40:DM3
Post-surgical kyphosis	P S		M963:DM4
Kyphosis - other	P S		M402:DM5
Scoliosis	P S		M41:DM6
Scoliosis, degenerative, secondary, acquired	P S		M41:DM7

Deformity - Spondylo	Type (Circle)	Location	Code
Acquired spondylolisthesis	P S		M431:DS1
Acquired spondylolisthesis, Isthmic Grade I	P S		M431:DS2
Acquired spondylolisthesis, Isthmic Grade II	P S		M431:DS3
Acquired spondylolisthesis, Isthmic Grade III	P S		M431:DS4
Acquired spondylolisthesis, Isthmic Grade IV	P S		M431:DS5
Acquired spondylolisthesis, Isthmic, optosis	P S		M431:DS6
Degenerative spondylolisthesis	P S		M431:DS7
Post-traumatic spondylolisthesis (conservative)	P S		M431:DS8
Post-surgical spondylolisthesis	P S		M961:DS9
Spondylolysis without listhesis	P S		M430:DS10
Congenital spondylolisthesis L5-S1	P S		Q762:DS11

Inflammatory Arthropathy	Type (Circle)	Location	Code
Psoriatric arthropathy	P S		M073:A1
Connective tissue disease (SLE, DM etc)	P S		M359:A2
Charcot arthropathy	P S		M146:A3
Ankylosing spondylitis of the spine	P S		M45:A4
Rheumatoid arthritis of spine generalized	P S		M45:A5
RA with cranio-vertebral settling	P S		M45:A6
RA with C1-2 instability	P S		M45:A7
RA with subaxial subluxation	P S		M45:A8
Sacroiliitis	P S		M461:A9

Degenerative	Type (Circle)	Location	Code
Spondylosis	P S		M47:G1
Neck pain NYD	P S		M542:G2
Back pain NYD	P S		M549:G3
Disorders of coccyx	P S		M533:G4
Disc protrusion/displacement	P S		M51:G5
Spinal stenosis	P S		M480:G6

Infections	Type (Circle)	Location	Code
Vertebral Tb (Pott's Disease)	P S		M490:I1
Meningitis	P S		G00:I2
Spinal epidural abscess	P S		G061:I3
Discitis (primary)	P S		M464:I4
Vertebral osteomyelitis	P S		M462:I5

Comorbidity - Other associated conditions	Type (Circle)	Location	Code
Movement disorder (Parkinsons', Chorea)	P S		G25:CO1
Spasticity	P S		M624:CO2
Chronic pain syndrome NYD	P S		R521:CO3
Pain of spinal origin	P S		R521:CO4
Pain of peripheral nerve origin	P S		R521:CO5
Chronic adhesive arachnoiditis	P S		G039:CO6

Comorbidity - Spinal Conditions	Type (Circle)	Location	Code
Spina bifida	P S		Q05:CS1
Diastematomyelia	P S		Q062:CS2
Tethered cord, Chiari	P S		Q068:CS3
Unspecified congenital anomaly of spine	P S		Q769:CS4
Failure of formation	P S		Q76:CS5
Failure of segmentation (excluding cervical spine)	P S		Q76:CS6
Klippel Feil	P S		Q761:CS7
Os odontoidium	P S		M481:CS8
DISH	P S		M481:CS9
OPLL	P S		M488:CS10
Spinal vascular malformation	P S		Q273:CS11

Complications - Neurological	Type (Circle)	Location	Code
Neurological deterioration	P S		G98:PN1

Complications - Local	Type (Circle)	Location	Code
Non union of fracture (conservative)	P S		M84:PL1
Pseudoarthrosis following fusion	P S		M960:PL2
Hemorrhage or wound hematoma (sterile)	P S		T810:PL3
Pre-existing CSF fistula	P S		G960:PL4
Wound dehiscence	P S		T813:PL5
Postop wound infection, superficial	P S		T814:PL6
Postop wound infection, deep	P S		T814:PL7

Complications - Implant or Graft Related	Type (Circle)	Location	Code
Intrathecal infusion pump failure	P S		T851:PI1
Spinal stimulator failure	P S		T851:PI2
Fracture of implant or structural graft	P S		T84:PI3
Complication of implant	P S		T84:PI4
Complication of bone graft	P S		T84:PI5
Pinsite infection	P S		T814:PI6

Miscellaneous	Type (Circle)	Location	Code
Other, specify: ____________	P S		XX99:X1

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Appendix (E)

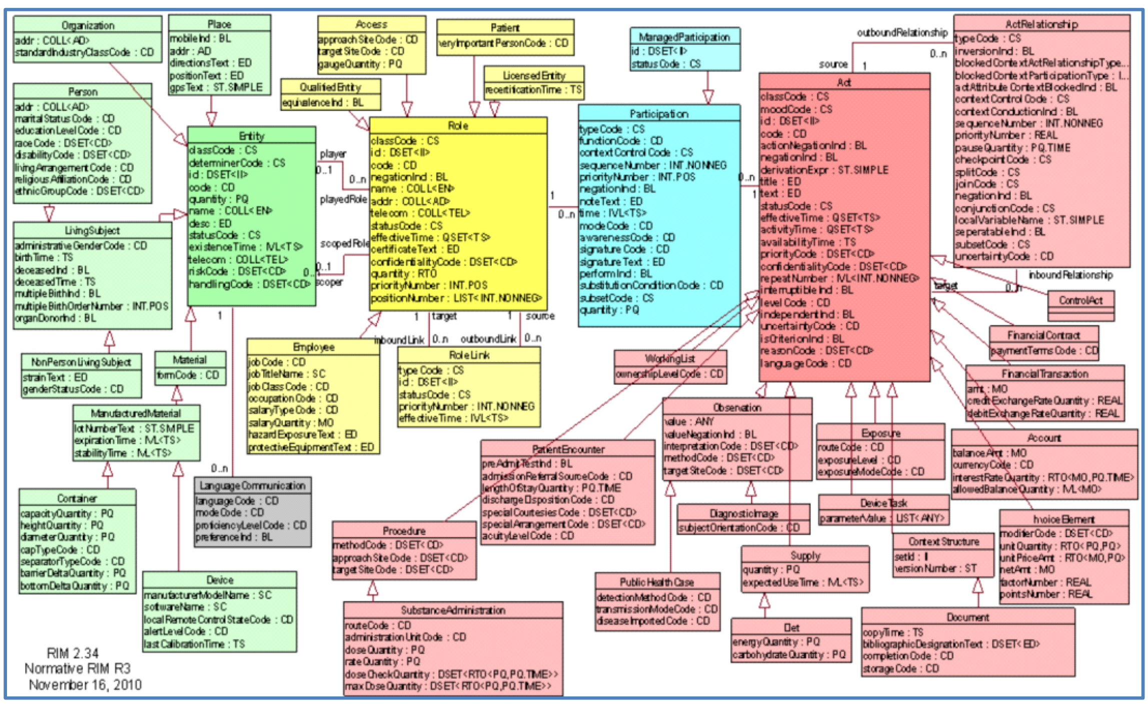
HL7 Clinical Document Architecture

The Health Level Seven (HL7) Clinical Document Architecture (CDA) is an XML-based mark-up standard that is intended to determine the encoding, structure and semantics of clinical documents to be exchanged by computers (Dolin et al., 2006). The CDA makes a clinical document characterized with four features which are Persistence, Stewardship, and Potential for authentication, Context, Wholeness, and Human readability. Moreover, a CDA document is a defined and complete information model which can contain text, sounds, images and other multimedia content. Also, A CDA can include any type of clinical information. Discharge Summary, Imaging Report, and Pathology Report are all examples of typical CDA documents (HL7 International, 2012).

IN 2000, the Clinical Document Architecture (CDA) release 1 was approved as an American National Standards Institute (ANSI) standard from the Health Level 7 Organization; and in 2005 , CDA release 2 was approved as an ANSI standard from HL7, The basic structure of CDA release 2 has not greatly changed from that of release1; a CDA document has a header and a body; the header contains information that identifies and classifies the document which provides information on the encounter, authentication, patients and the involved health providers; while the CDA body provides information about the clinical report. The body is organized into sections that have narrative content which can be encoded by using standard terminology vocabularies like a Systemized Nomenclature of Medicine Clinical Terms (SNOMED CT) (Dolin et al., 2006)

The main difference between CDA release 1 and CDA release 2 is that in release1only the header is derived from the HL7 Reference Information Model (RIM), while the body utilizes different types of human readable non-XML formats like text or images. In CDA release 2 both header and body are fully based on HL7 RIM (Benson, 2010, p.147). HL7 (RIM) defines the XML tags in a CDA document; and it drives the machine processable meaning for the CDA. Also CDA uses HL7 version 3 data types; the RIM and the HL7 V 3 data types provide effective mechanisms to enable the CDA to incorporate concepts from a standard coding system like SNOMED CT(Dolin et al., 2006).

HL7 version 3 is health care standards that are intended to support all health care workflows, and it provides new ways to exchange clinical information according to model driven methodology which generate messages and electronic documents expressed in XML syntax (HL7 International, 2012). The HL7 version 3 uses a Reference Information Model (RIM) that is an essential part of its structure; and the RIM determines the grammar of HL7 version 3 massages, especially, the language's basic building blocks, like nouns , verbs, etc.; also, it determines the allowable relationships and data types. The RIM backbone contains six core classes and it has a number of allowable relationships between them. Also, The RIM determines a set of predetermined attributes for each class which are the only ones permitted in the HL7 massages, and each attribute contain a specified data types. These attributes and data types are used as tags In the HL7 XML massages (Benson, 2010, p.108-109). Figure 1 below shows the HL7 V3 RIM.



Figures 1: shows the HL7 Version 3 Reference Information Model. Adopted from HL7 Standards. (2011). Retrieved July 21, 2012, from http://www.hl7standards.com/blog/2011/05/31/hl7-v3-rim-is-it-really-that-intimidating/

The backbone structure of the RIM consists of three main classes. These classes are Act, Role, and Entity. Also, these three classes can be linked together using three association classes which are ActRelationship, Participation, and RoleLink. In Hl7 version3, any happening is an act and the act is equivalent to the verb in English. Also, each "Act" can have any number of participants; these participations are “Roles” which are played by entities reflecting nouns. The class “ActRelationship” is used to represent a relationship between two “Acts”; from a source Act to a target Act. The “Participation” class determines the involvement of a Role in an Act; and the” Role Link” represents a relationship between two “Roles” which provides a simple mean to link roles together, for example, defining the roles between members of a medical team. Moreover, each of the main classes (Act, Role, and Entry) have a number of other classes linked to it by using a line with an open triangle arrowhead. This is a UML symbol used for specializations; so the class that is pointing is a specialization of the class that the arrowhead is pointing to, that is a generalization (see figure1). For instance, the “Entity” has specialization named as “Living Subject” which has another specialization named “Person”. The Person specialization inherits all the properties (attributes) form both “Entity “and “Living Subject”; while is can add any specific attributes. Also, in the RIM the structural attributes are used to determine what each class in the RIM means when it is used in a massage. For instance, each Act has *classcode* and *modcode*. The *classcode* represents what the type of the act is, such as if it is observation, administration of a drug, or encounter; and the *modcode* represents whether an act happened is a request , goal, or criterion. These structural attributes determine the semantic meaning of each class in the HL7 v3 RIM massages specification (Benson, 2010, p. 109-113).

Major Components of a CDA Document

CDA Header:

The purpose of the CDA header is to eliminate ambiguity and provide defined and structured meta-data about the intended clinical document. Information in the header can be used to find, classify, or retrieve a document and it defines what the type of the intended document is. For example, if it is a discharge summary or procedure report (Benson, 2010, p. 150). Also, information in the header identifies who generated a document, where, when, and what is the reasons for generating this document. For example, information on authentication, the patient, the encounter and the involved providers are stated in the header. In figure 2, the header is located between the <ClinicalDocument> and the <structuredBody> elements (Dolin et al., 2006).

```
<ClinicalDocument>
  ... CDA Header ...
  <structuredBody>
    <section>
      <text>(a.k.a. "narrative block")</text>
      <observation>...</observation>
      <substanceAdministration>
        <supply>...</supply>
      </substanceAdministration>
      <observation>
        <externalObservation>...
        </externalObservation>
      </observation>
    </section>
    <section>
        <section>...</section>
    </section>
  </structuredBody>
</ClinicalDocument>
```

Figure (2) shows the major components of the Clinical Document Architecture. Adapted from HL7 clinical document architecture, release 2. (2006). Retrieved July 21, 2012, from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1380194/

CDA Body

Each CDA has one header and one body. The body contains the clinical reports and it can be a non -XML body or Structured body that is utilized for XML-encoded data. (Benson, 2010, p. 151). Figure 2 represents a structured body that is enclosed by the <structuredBody> elements; also, the Body of the CDA can contain one or more sections. In figure2, it is frequently divided into many document sections (Dolin et al., 2006).

Each section consists of a single human readable narrative block, which is called (section.text); the narrative block of a section is one of the main components of the CDA and it must include the human readable content of the section. The originator of the document must make sure that the narrative block of each section is accurately carrying the meaning of the section and assure that it has human readability (Benson, 2010, p. 151). In figure 2, a CDA section is enclosed by the <section> elements; and the narrative block of a section is enclosed by <text> elements (Dolin et al., 2006).

Moreover, each section of a CDA document can contain one or more entries which are *clinical statements*. These clinical statements are provided in structured formats to be processed by computers and are to be used for exchanging information between different computer systems (Benson, 2010, p. 152). Time (2010) states the following:

> HL7 defines the clinical statements as an expression of a discrete item of clinical (or clinically related) information that is recorded because of its relevance to the care of a patient. Clinical information is fractal in nature and therefore the extent and detail conveyed in a single statement may vary (p. 152).

Each Clinical statement can contain a number of participants like subjects, author, locations, and performers. Also, a Clinical statement can be used to represent a procedure, observation, encounter, or substance administration or supply. A Procedure clinical statement can contain expressions that refer to images or specimens that are related to the documented procedure and it is utilized for all invasive procedures like surgical procedures and imagining. Observational clinical statements include a broader range of statements that are related to history, examinations, or tests. Also, Substance Administration or Supply clinical statements can be used to refer to products like medications which are mainly utilized for prescribing, dispensing, or administration of drugs (Benson, 2010, p. 152-153). In figure 2, there are two <observation> CDA entries (clinical statements) and one <substance Administration> entry (Clinical Statement) which contains one nested <supply> entry (Dolin et al., 2006).

Moreover, clinical statements can include relationships between them in order to represent the structure of clinical information and to represent how different items can relate to each other. For example, there is a relationship which can be used between entries called CAUS. It is used to state that the source caused the target. For example, penicillin (substance administration) caused rash (observation) (Benson, 2010, p.153).

References

Benson, T.(2010). Clinical document architecture. *Principles of health interoperability HL7 and SNOMED CT*. (pp. 147- 153). New York: Springer London Dordrecht Hiedelberg.

Benson, T.(2010). The HL7 V3 RIM. *Principles of health interoperability HL7 and SNOMED CT*. (pp. 108- 113). New York: Springer London Dordrecht Hiedelberg.

Dolin, R. H., Alschuler, L., Boyer, S., Beebe, C., Behlen, F. M., Biron, P. V., & Shabo Shvo, A.(2006). HL7 clinical document architecture, release 2. *Journal of the American Medical Informatics Association*, *13*(1), 30-39. doi:10.1197/jamia.M1888

Health Level Seven (HL7) International. (2012). *Clinical document architecture* (CDA). Retrieved form http://www.hl7.org/about/FAQs/index.cfm

Health Level Seven (HL7) International. (2012). *HL7 Version 3 product suite.* Retrieved from http://www.hl7.org/implement/standards/product_brief.cfm?product_id=186

Appendix F

SNOMED CT (Systematized NOmenclature of MEDicine Clinical Terms)

SNOMED CT is recognized as the most comprehensive and multilingual healthcare terminology in the world. It was developed to meet the requirements of the electronic word so that health care information can be documented and health care providers can retrieve this information (Massey et al., 2009). SNOMED CT improves the recording of Electronic heath record information and can facilitate the exchange of these information across different computer systems; it supports effective access to information required for decision support, analysis, and consistent reporting, and as a result, the quality of patient care will be improved(IHTSDO, 2012).

SNOMED CT is owned and governed by the International Health Terminology Standards Development Organization (IHTSDO) which is a not-for-profit organization. The IHTSDO aims to improve the health of humankind by promoting the development and use of appropriate standardized clinical terminologies, like SNOMED CT; consequently, supporting safe, accurate, and effective communicating of clinical and related health information. In January 2012 eighteen countries were members of IHTSDO and more countries are joining every year (IHTSDO, 2012).

SNOMED CT Components

CONCPTS

SNOMED CT contains more than 311,000 active concepts; each one has a unique meaning and formal logic-based definition. Concepts in SNOMED CT are just clinical ideas which are organized in hierarchies, from the general to the specific. This enables the documentation, retrieval, and aggregation of detailed clinical data at a more general level. Each concept in SNOMED CT has a unique Concept ID that is assigned to it. In addition, each concept has a unique fully specified name (FSN) that is a human readable and each concept is linked to a set of terms (descriptions) which also name the concept in a human readable way (Benson, 2010, p.193, IHTSDO, 2012).

Examples of SNOMED CT concepts include Liver Disease, laryngoscope, Local anesthesia, less-than symbol <, and cervical spine structure.

Descriptions

There are approximately a million English *descriptions* in the International Release of SNOMED CT (IHTSDO, 2012). Each description associates an appropriate human readable term to a concept and it has a unique numeric Description ID. Every concept has at least two associated descriptions; which are the fully specified name (FSN) and a preferred term which is called sometimes the display name for the intended concept. The fully specified name is a phrase that gives a name to a concept which is unique and unambiguous. Also, each FSN contain a suffix (hierarchy tag) that indicated its primary hierarchy of the intended concept (Benson, 2010, p.1195-196); for example; the*" spondylosis (disorder)"* is the fully specified name for the concept "*spondylosis"*.

The preferred term is a general term or word used by health providers to name a concept and it is utilized as a default display term for that concept. The preferred term is often the FSN but without the suffix (hierarchy tag). For example, the preferred term for the concept "*spondylosis*" is "*spondylosis*". Also, a description in SNOMED CT can be presented as a synonym that describes the same clinical idea. , each concept may have multiple synonyms. For example, the concept *spondylosis* has five synonyms which are*: "OA - Osteoarthritis of spine", "OA - Osteoarthritis of the spine", "osteoarthritis of spine", "spondarthropathy", and "spondylarthrosis"*. In SNOMED CT, a synonym must be a clinically considered as alternative to the preferred term as a way of referring to a concept (Benson, 2010, p.196).

Relationships

In SNOMED CT, relationships link each *concept* to other *concepts* that have a related meaning (IHTSDO, 2012).There are more than 1.3million relationships which have been defined in SNOMED CT and this number is continuing to grow. One type of SNOMED CT relationships is the defining relationships which are utilized to define a concept by its relationships with other concepts. These defining relationships can be supertype relationships (parents), which are also called (IS_A) relationships, or attributes relationships (Benson, 2010, p.196). For example, the concept "spondylosis" IS A "arthritis of spine"; it has a parent relationship with the concept arthritis of spine which is directly above the concept " *spondylosis*" in the hierarchy. Also, the attribute relationships are presented in the form of attribute-value pairs, in which each attribute and value in itself is a SNOMED CT concept (Benson, 2010, p.196). For example, the concept "spondylosis" has an attribute relationship with the concept "joint structure of spine" which is expressed as "finding site " = "joint structure of spine ". "Finding site" is the SNOMED CT attribute that is used in this defining relationship.

SNOMED CT is arranged into a set of hierarchies in which concepts are linked by IS_A relationships with their more general parent concepts that are located directly above them in the hierarchy. General concepts are located at the top of the hierarchy, and concepts become gradually specialized at each level down the hierarchy. SNOMED CT structure is different from

Pure tree structure in that each concept can have more than one parent concept. Also, SNOMED CT has 19 top level hierarchy (Benson, 2010, p.193), which are presented in figure 1 below:

· | *Clinical finding* |	· | *Physical force* |
· | *Procedure* |	· | *Event* |
· | *Observable entity* |	· | *Environment or geographical location* |
· | *Body structure* |	· | *Social context* |
· | *Organism* |	· | *Situation with explicit context* |
· | *Substance* |	· | *Staging and scales* |
· | *Pharmaceutical / biologic product* |	· | *Physical object* |
· | *Specimen* |	· | *Qualifier value* |
· | *Special concept* |	· | *Record artifact* |
· | *Linkage concept* |	

Figure 1: shows SNOMED CT top level concepts. Adapted from SNOMED CT user guide january 2012 international release. (2012). Retrieved July 11, 2012, from http://ihtsdo.org/fileadmin/user_upload/doc/download/doc_UserGuide_Current-en-US_INT_20120131.pdf

There are other types of SNOMED CT relationships like qualifying relationships which are not used to define a concept but they are used to modify a meaning of a concept by using post coordination. Also, historical relationships provide an association between the retired or inactive concepts and the current replacement concepts (Benson, 2010, p. 197)

Pre-coordinated and Post-coordinated SNOMED CT Expressions

In some circumstances a single SNOMED CT concept is sufficient to encode the clinical data and represent the required meaning; this is called the use of pre-coordination expressions. An example of Pre-coordination expression is ”52448006 | dementia |”. In the previous example the sequence of digits represent the concept ID, which is a unique identifier to the concept “*dementia*” in SNOMED CT system. Also, the display name that is immediately preceding the concept identifier is optional and it can be any one of the descriptions associated with the concept (IHTSDO, 2008).

In some cases a single SNOMED CT concept is not adequate to express the meaning of a data item. Consequently, it is necessary to generate post-coordination expressions to reflect the required meaning. Following is an example of post-coordination expressions: “217724009|accident caused by blizzard|+297186008|motorcycle accident|” this called a combination post-coordination expression in which two or more concepts are combined by “+ “ symbol to generate new concepts when one concept is not sufficient (IHTSDO, 2008).

Also, there is another type of Post-coordination, which is called the refinement post-coordination, in which concepts are refined by using attributes that are associated with the intended concept in the SNOMED CT concept model. The SNOMED CT concept model is a set of rules that determines how concepts are allowed to be modeled using relationships with other concepts. For example, according to SNOMED CT concept model, a concept that is a subtype of ”clinical finding” can be related to a concept , that is a subtype of the Anatomical or acquired body structure, by using the attribute ”finding site”(Benson, 2010, p. 197-198). Figure 2 below shows attributes that are used to qualify or refine a concept that is a subtype of clinical finding and the allowable values of each attribute.

Defining (Clinical Finding) Attributes	**Allowable Values**
FINDING SITE	Anatomical or acquired body structure
ASSOCIATED MORPHOLOGY	Morphologically abnormal structure
ASSOCIATED WITH	Clinical Finding Procedure Event Organism Substance Physical object Physical force Pharmaceutical / biologic product
CAUSATIVE AGENT	Organism Substance Physical object Physical force Pharmaceutical / biologic product

DUE TO	Clinical Finding Event
AFTER	Clinical Finding Procedure
SEVERITY	Severities
EPISODICITY	Episodicities
INTERPRETS	Observable entity Laboratory procedure Evaluation procedure
HAS INTERPRETATION	Findings values
PATHOLOGICAL PROCESS	Autoimmune Infectious process
HAS DEFINITIONAL MANIFESTATION	Clinical finding

Figure 2 shows attributes that are used to qualify a clinical finding and the allowable values.

The concept model has about 50 attributes that can be associated with different subtype hierarchies in a complex web of relationships (Benson, 2010, p.198). Following is an example of post-coordination expressions in which a refinement is used to qualify a SNOMD CT concept:

16521006 | implantation of spine |: 363704007 | procedure site | = 244539008 | between region joint of vertebral bodies |

In the previous example, the concept "*Implantation of Spine*" is a subtype of the "Procedure hierarchy" ; so in order to qualify this concept ; the attribute "*Procedure site*" is used which is one of the attributes that are used to refine a concept that is a subtype of the procedure hierarchy. In the previous example, the "*procedure site*" attribute is used to indicate the site where the procedure is performed and the value of the "*procedure site* " is " *between region joint of vertebral bodies*" which is a concept that is a subtype of the "Body structure" SNOMED

CT hierarchy. That is one of the allowable values for the ”*Procedure site*” attribute based on the SNOMED CT concept model (Benson, 2010, p 200).

Also, in developing the post-coordination expressions SNOMED CT compositional grammars are usually used. In the previous example, the colon (:) is used as a refinement prefix, which is always between the concept to be qualified and its qualifying expression (refinement). Also, the (=) sign is used as attribute value prefix, which is presented in the previous example, between the attribute “Procedure site and its value” between region joint of vertebral bodies” (HL7 &IHTSDO, 2008). Also, a refinement can consist of one or more attributes, or groups of attributes (Benson, 2010, p.208) as the following example “417746004 | traumatic injury | : 363698007 | finding site | =280721008 | posterior vertebral element |, 47429007 | associated with | = 125605004 | fracture of bone | 363698007 |” In the previous example, the comma (,) is used as attribute separator. There are two attributes used in the previous example, ”*finding site*” and ”*Associated with*” which are used to qualify the concept ” *traumatic injury*” that is a clinical finding .

Moreover, post-coordination expressions can be single level expressions, or they can be nested to any number of detail levels. In the nested expressions each attribute is an expression in itself, and it can be a single level expression or nested (Benson, 2010, p.205). Following is an example of a nested expression:

87628006 | bacterial infectious disease | :
246075003 | causative agent | = 9861002 | streptococcus pneumoniae | ,
363698007 | finding site | = (45653009 | structure of upper lobe of lung | :
272741003 | laterality | = 7771000 | left |).

In the previous example, the attribute *“*causative agent” is used to determine the cause of the infection which is “*streptococcus pneumonia”;* and the nested expression is used to specify the location and the laterality of the disease; so in the previous example, the value of the “finding site “ attribute are presented by using an nested expression instead of a single concept, and the parentheses “()” is used to enclose the nested expression which specifies that “*bacterial infectious disease”* is affecting the “left upper lobe of the lung”. Also the “laterality” is an attribute that is used to refine a concept of the Body Structure hierarchy (HL7 & IHTSDO, 2008).

References

Benson, T.(2010). SNOMED CT. *Principles of Health Interoparability HL7 and SNOMED CT*. (pp. 193-208). New York: Springer London Dordrecht Hiedelberg.

Health Level Seven Incorporation (HL7) & International Health Terminology Standards Development Organisation(IHTSDO). (2008). SNOMED CT compositional grammar. *Using SNOMED CT in HL7 Version 3; implementation guide, release 1.5*. Retrievedfromhttp://www.ihtsdo.org/fileadmin/user_upload/doc/tig/hl7/TermInfo1.5/terminfo.html#TerminfoAppendRefsGrammar

International Health Terminology Standards Development Organisation(IHTSDO). (2008). *Compositional grammar for SNOMED CT expressions in HL7 Version 3.* Retrieved from http://dc317.4shared.com/doc/z2VEdUVz/preview.html

International Health Terminology Standards Development Organisation (IHTSDO). 2012. *About SNOMED CT.* Retrieved from http://www.ihtsdo.org/snomed-ct/snomed-ct0/.

Massey, K. A., Ansermino, J. M., von Dadelszen, P. P., Morris, T. J., Liston, R. M., & Magee, L. A. (2009). What is SNOMED CT® and Why Should the ISSHP Care?. *Hypertension In Pregnancy*, *28*(1), 119-121. doi:10.1080/10641950802601294

Appendix G

Examples of Data Items of Some Sections Provided in the Electronic Synoptic Operative Report Template for Spinal Cord Injury Patients

Insert Item

Code	Name
Cervical (C0-C2) Trauma	
S131:TC1	Occipital-cervical dislocation
S131:TC18	Complete C1-2 dislocation
S02100:TC2	Occipital condyle #
S12000:TC4	Anterior arch #
S12000:TC3	Posterior arch #
S12000:TC5	Jefferson fracture
S131:TC6	Rotary subluxation, fixation
M5321:TC7	Instability
S12100:TC9	Hangmans, undisplaced
S12100:TC10	Hangmans, displaced and angulated
S12100:TC11	Hangmans, with dislocated C2-3 facets
S12100:TC13	Odontoid # Type II
S12100:TC12	Odontoid # Type III
S12000:TC23	Unclassifiable #, C1
S12100:TC23	Unclassifiable #, C2
Cervical (C3-C7) Trauma	
S122X0:TC14	Posterior arch #
S122X0:TC15	Anterior wedge compression #
S130:TC16	Hyperextension, avulsion flakes, traumatic disc
S122X0:TC17	Minimally displaced unilateral facet #
S122X0:TC18	Unilateral facet #/subluxation
S131:TC19	Unilateral facet dislocation/subluxation, no #
S122X0:TC20	Burst # without translation
S122X0:TC21	Three column fracture dislocation
S131:TC22	Bilateral facet dislocation
S122X0:TC23	Unclassifiable #, C3-C7

Figure 1: Screen shot of the Microsoft InfoPath form shows part of the data items provided in the **Trauma Diagnosis** list of the **Pre-Operative Diagnoses** Section of the electronic template.

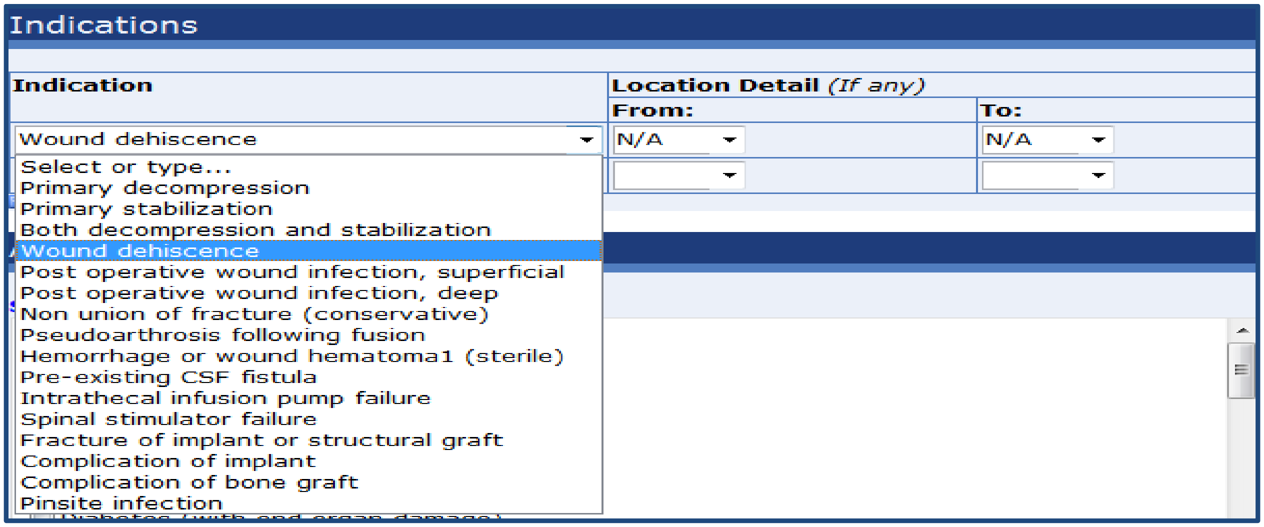


Figure 2: Screen shot of the Microsoft InfoPath form shows the clinical data items provided in the drop down menu of the **Indication** of the electronic template

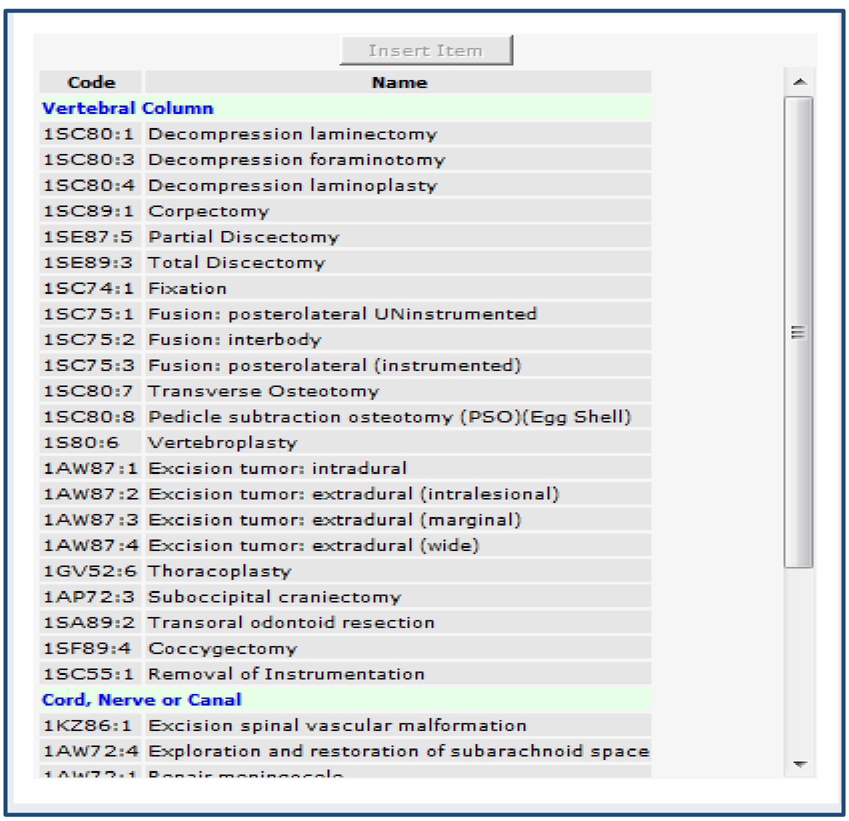


Figure 3: Screen shot of the Microsoft InfoPath form shows the data items provided in the procedure list of the **Surgical Procedures** Section

Appendix H

Example of Some Tables that was Communicated to the Research Team for The SNOMED CT Expressions for Some of Data Items of the Trauma Diagnosis List, Which is Under the Pre-Operative Diagnosis Section

2. Pre-Operative Diagnoses

2.1 Diagnosis:

Trauma diagnosis: A-cervical

SNOMED CT Terms	**Code codeSystem**	**CodeSystem Name**	**SNOMED CT Expressions**	**Display Name**
-Jefferson Fracture(clinical Finding)	2.16.840.1.113 883.6.96	SNOMED-CT	263180005|Jefferson fracture|	Jefferson fracture
-cervical spine instability(clinical Finding)	2.16.840.1.113 883.6.96	SNOMED-CT	202821008 | cervical spine instability |	Instability
- dislocation of atlanto-occipital joint (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	263014005 | dislocation of atlanto-occipital joint |	Dislocation, Occipital-cervical
-dislocation of cervical vertebra (clinical finding) - joint structure of second cervical vertebra(body structure) - dislocation, complete (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	44264009|traumatic dislocation of joint of cervical vertebra|:363698007 |finding site|=79782001|dislocation, complete|	Dislocation, Complete
-fracture of occipital condyle (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	127281000|fracture of occipital condyle|	Occipital condyle
-fracture of first cervical vertebra (clinical finding) - finding site(linkage concept) - structure of anterior arch of atlas (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	207983003|fracture of first cervical vertebra|: 363698007 |finding site|=(35475002|structure of anterior arch of atlas|)	Arch Anterior
-fracture of first cervical vertebra (clinical finding) - finding site (linkage concept) -structure of posterior arch of atlas (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	[207983003|fracture of first cervical vertebra: 363698007 |finding site|= 20561003|structure of posterior arch of atlas	Arch Posterior
-rotatory subluxation of atlantoaxial	2.16.840.1.113	SNOMED-CT	428799009|rotatory subluxation of	Rotary subluxation,

joint (clinical finding) - site of fixation (linkage concept) - structure of atlantoaxial joint (body structure)	883.6.96		atlantoaxial joint|: 246313006|site of fixation|= 62555009|structure of atlantoaxial joint|	fixation
- hangman's fracture (clinical finding) - finding site (linkage concept) -Undisplaced fracture (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	263070009|hangman's fracture|:363698007 | finding site | =307184009 | Undisplaced fracture |	Hangmans, undisplaced
-hangman's fracture (clinical finding) -angulated fracture (body structure) -fracture with displacement (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	263070009|hangman's fracture|:363698007 | finding site | 123735002 | fracture with displacement | +307186006 | angulated fracture |	Hangman’s fracture, Displaced and angulated,
-hangman's fracture (clinical finding) - dislocation of cervical facet joint (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	263070009|hangman's fracture|+314195000|dislocation of cervical facet joint	Hangman’s fracture with dislocated C2-3 facets
-fracture of odontoid process(clinical finding) -Type II (qualifier value) -severity (linkage concept)	2.16.840.1.113 883.6.96	SNOMED-CT	281910003 | fracture of odontoid process |: 258195006|severity|=246112005|Typ e II|	Odontoid #, Type II
-fracture of odontoid process(clinical finding) - Type III(qualifier value) -severity (linkage concept)	2.16.840.1.113 883.6.96	SNOMED-CT	281910003 | fracture of odontoid process |: 258195006|severity|= 258199000 | Type 3 |	Odontoid #, Type III
- fracture of cervical vertebra (clinical finding) -unclassified (qualifier value) - c1 vertebra(body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	125606003 | fracture of cervical spine | +1491000 | unclassified |=363698007|finding site|= 14806007 | c1 vertebra | |	Unclassifiable fracture, C1

- fracture of cervical vertebra (clinical finding) -unclassified (qualifier value) -c2 vertebra(body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	125606003 | fracture of cervical spine | + 1491000 | unclassified |: 363698007|finding site|= 181819004 | c2 vertebra |	Unclassifiable fracture, C2
- fracture of cervical vertebra(clinical finding) - finding site (linkage concept) -structure of posterior arch of atlas (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	125606003 | fracture of cervical spine | : 363698007 | finding site| = 20561003 | structure of posterior arch of atlas |	Posterior arch fracture
-compression fracture of vertebral column (clinical finding), - anterior wedge fracture of vertebra (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	42942008|compression fracture of vertebral column|+307137009|anterior wedge fracture of vertebra|	Anterior wedge compression fracture
-hyperextension (clinical finding) -due to (linkage concept) -traumatic rupture of cervical intervertebral disc (clinical finding) -avulsion – injury (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	89620005 | hyperextension | : 42752001 | due to |= {212455007|traumatic rupture of cervical intervertebral disc| + 284554003 | avulsion - injury |}	Hyperextention, avulsion flakes, traumatic disc Changed
-fracture of bone (clinical finding) -displaced (qualifier value) -finding site(linkage concept) - facet joint(body structure) -laterality(linkage concept) -unilateral(qualifier value)	2.16.840.1.113 883.6.96	SNOMED-CT	125605004|fracture of bone|+ 263739008|displaced|+255605001| minimal|:363698007 | finding site |= 81168003 | facet joint |: 272741003 | laterality | = 66459002 | unilateral |)	Minimally displaced unilateral facet fracture,
- fracture of cervical vertebra (clinical finding) -subluxation complex (vertebral) (clinical finding) -facet joint (body structure) -laterality (linkage concept)- Unilateral (qualifier value)	2.16.840.1.113 883.6.96	SNOMED-CT	203709007 | subluxation complex (vertebral)+ 125606003 | fracture of cervical spine |:363698007 | finding site |=(81168003 | zygapophyseal joint structure | 272741003 | laterality | = 66459002 | unilateral |)	Unilateral facet fracture /subluxation,
-subluxation complex	2.16.840.1.113	SNOMED-CT	203709007 | subluxation complex	Unilateral facet

(vertebral)(clinical finding) - facet joint (body structure) -laterality (linkage concept) -unilateral (qualifier value)	883.6.96		(vertebral) |:363698007 | finding site |=(81168003 | zygapophyseal joint structure | 272741003 | laterality | = 66459002 | unilateral |)	dislocation/subluxation
-burst fracture of cervical vertebra (clinical finding) -Finding site(linkage concept) - undisplaced fracture (body structure)	2.16.840.1.113 883.6.96	SNOMED-CT	281914007 | burst fracture of cervical vertebra | : 36369807|finding site|= 307184009|undisplaced fracture|	Burst fracture without translation
-three column fracture of cervical vertebra (clinical finding) -fracture dislocation of spine (clinical finding)	2.16.840.1.113 883.6.96	SNOMED-CT	281920008|three column fracture of cervical vertebra|+263068000 | fracture dislocation of spine |	Three column fracture dislocation
-traumatic dislocation of joint (clinical finding) -facet joint(Body structure) - bilateral(qualifier value)	2.16.840.1.113 883.6.96	SNOMED-CT	44264009|traumatic dislocation of joint of cervical vertebra|:363698007 | finding site |= (81168003 | facet joint | : 272741003 | laterality | = 51440002 | right and left |)	Bilateral facet dislocation
-fracture of cervical vertebra(clinical finding) -finding context (linkage concept) -unclassified (qualifier value)	2.16.840.1.113 883.6.96	SNOMED-CT	125606003 | fracture of cervical spine | : 408729009 | finding context | =1491000 | unclassified |	Unclassifiable fracture

Soft Tissue Injury -cervical

SNOMED CT Terms	**Code code system**	**Code system Name**	**SNOMED CT Expressions**	**Display Name**
-neck sprain (clinical finding) -traumatic injury (clinical finding)	2.16.840.1.113883. 6.96	SNOMED-CT	209557005|neck sprain|:42752001|due to|= 417746004 | traumatic injury |	Sprain
-traumatic torticollis (clinical finding)	2.16.840.1.113883. 6.96	SNOMED-CT	360444002 | traumatic torticollis |	Torticollis
-cervical spinal cord injury (clinical finding) - trauma (clinical finding)	2.16.840.1.113883. 6.96	SNOMED-CT	405754008|cervical spinal cord injury|:42752001|due to|=417746004 trauma|, 246090004 | associated finding | = (263654008 | abnormal | + 118247008|radiologic finding|,	SCIWORA

-associated finding (linkage concept) -abnormal (qualifier value) - radiologic finding (clinical finding) - known absent (qualifier value)			408729009 | finding context | =410516002 | known absent |)	
-concussion and edema of cervical spinal cord (clinical finding) - trauma (clinical finding)	2.16.840.1.113883.6.96	SNOMED-CT	212356007|concussion and edema of cervical spinal cord|:42752001|due to|=417746004 |trauma|	Transient paralysis (spinal cord concussion)
-injury of brachial plexus (clinical finding) -peripheral nerve injury (clinical finding)	2.16.840.1.113883.6.96	SNOMED-CT	6836001|injury of brachial plexus|+73590005|peripheral nerve injury| ,42752001|due to|= 417746004|trauma|	Brachial plexus and/or peripheral nerve injury

Appendix I

Confirmation Form for Some SNOMEDCT Expressions developed for Data Items of the Electronic Synoptic Operative Report Template

1

Confirmation of SNOMED CT Expressions of the

Synoptic Operative Report Template for Spinal Cord Injury Patients

Table of Content

Confirmation for SNOMED CT Expressions of the Trauma Diagnosis Section

1- Trauma diagnosis; Cervical

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Three column fracture dislocation	281920008|three column fracture of cervical vertebra|+263068000 | fracture dislocation of spine |	-three column fracture of cervical vertebra (Type:= clinical finding) -fracture dislocation of spine (Type:= clinical finding)

Definitions:

- The concept "three column fracture of cervical vertebra" **is a** fracture of cervical spine;
- The concept "fracture dislocation of spine" **is a** "dislocation of joint of spine" and **is a** fracture dislocation of joint.

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree
2. Disagree

Comments:

2-Trauma diagnosis; Cervical:

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Bilateral facet dislocation	44264009|traumatic dislocation of joint of cervical vertebra|:363698007 | finding site |= (81168003 | zygapophyseal joint structure | : 272741003 | laterality | = 51440002 | right and left |)	-traumatic dislocation of joint (Type:= clinical finding) - zygapophyseal joint structure (body structure) - bilateral (Type:= qualifier value)

Definitions:

- intervertebral facet joint **is a** synonym for zygapophyseal joint structure

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

3-Trauma diagnosis; Cervical

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Hyperextention, avulsion flakes, traumatic disc	89620005 | hyperextension | : 42752001 | due to |= {212455007|traumatic rupture of cervical intervertebral disc| + 284554003 | avulsion - injury |}	- hyperextension (Type:= clinical finding) -due to (Type:= linkage concept) -traumatic rupture of cervical intervertebral disc (Type:= clinical finding) -avulsion - injury (Type:= clinical finding)

Definitions:

- Hyperextension **Is a** musculoskeletal finding; and it **Is a** finding of movement
- Traumatic rupture of cervical intervertebral disc **Is a** traumatic disc rupture; and **Is a** subtype of disorder of musculoskeletal system.
- Disorder of musculoskeletal system is a subtype of musculoskeletal finding.
- There is no code exactly matches the concept avulsion flakes.
- avulsion - injury **Is a** wound

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

4- Trauma Diagnosis; cervical

Following there are three candidates for SNOMED CT Expressions. (Please assign **Agree to** the suitable candidate or **disagreement** for all candidates is possible)

A- First Candidate

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Dislocation, Occipital-cervical	44264009|traumatic dislocation of joint of cervical vertebra|:363698007 |finding site|=410731008|joint structure of first cervical vertebra|	-traumatic dislocation of joint of cervical vertebra (clinical finding) -joint structure of first cervical vertebra (body structure)

Definitions:

- traumatic dislocation of joint of cervical vertebra **is a** musculoskeletal disorder of the neck
- traumatic dislocation of joint of cervical vertebra **is a** traumatic dislocation of joint
- traumatic dislocation of joint of cervical vertebra **is an** injury of cervical spine
- traumatic dislocation of joint of cervical vertebra **is a** dislocation of joint of spine

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

____

B- Second Candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Dislocation, Occipital-cervical	263014005 | dislocation of atlanto-occipital joint |	dislocation of atlanto-occipital joint (Type:= *clinical finding*)

Definisions:

- dislocation of atlanto-occipital joint Is a musculoskeletal disorder of the neck
- dislocation of atlanto-occipital join Is an injury of cervical spin
- dislocation of atlanto-occipital joint **Is a** dislocation of joint of spine

Notes: Also,we can use this code values:263014005 | dislocation of atlanto-occipital joint | : 42752001 | due to | = 44264009 | traumatic dislocation of joint of cervical vertebra |)

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

____

C-Third Candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Dislocation, Occipital-cervical	263013004 | dislocation of joint of spine | : 363698007 | finding site | = 31640002 | occipital bone structure |	- spine dislocation (Type:= clinical finding) - finding site (Type:= linkage concept) - Occipital bone structure(body structure)

Definitions:

- spine dislocation **is a** dislocation of joint
- spine dislocation **is a** spinal injury
- Occipital bone structure **is as** neurocranium structure
- Occipital bone structure **is a** structure of flat bone

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

5-Trauma Diagnosis; cervical

Display Name	Codes values	SNOMED CT terms Description
Rotary subluxation, fixation	428799009|rotatory subluxation of atlantoaxial joint|: 246313006|site of fixation|= 62555009|structure of atlantoaxial joint|	rotatory subluxation of atlantoaxial joint (Type:= clinical finding) - site of fixation (Type:= linkage concept) -structure of atlantoaxial joint (Type:= body structure)

Definitions:

- rotatory subluxation of atlantoaxial joint **is a** subluxation of atlantoaxial joint

  (Note) can we use just the first part of the code values; or it is too specific

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

6-Trauma Diagnosis; cervical

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Unilateral facet fracture /subluxation,	203709007 | subluxation complex (vertebral)+ 125606003 | fracture of cervical spine |:363698007 | finding site |=(81168003 | zygapophyseal joint structure | 272741003 | laterality | = 66459002 | unilateral |)	-subluxation complex (vertebral) (Type:= clinical finding) -fracture of cervical vertebra (clinical finding) -facet joint (body structure) -laterality (linkage concept) -unilateral (qualifier value)

Definitions:

- Fracture of cervical vertebra **is a** fracture of vertebral column.
- Fracture of vertebral column **is an** injury of cervical spine.
- subluxation complex (vertebral) **is a** subluxation of joint of spine
- subluxation of joint of spine **is a** dislocation of joint of spine
- dislocation of joint of spine **is a** spinal injury
- facet joint **is a** synonym for zygapophyseal joint structure

9

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

7- Trauma Diagnosis; cervical

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Unilateral facet dislocation/subluxation, no fracture	203709007 | subluxation complex (vertebral): 363698007 | finding site |= 81168003 | zygapophyseal joint structure | 272741003 | laterality | = 66459002 | unilateral |	-subluxation complex (vertebral) (Type:= clinical finding) -facet joint (body structure) -laterality(linkage concept) -unilateral (qualifier value)

Definitions

- subluxation complex (vertebral) **is a** subluxation of joint of spine.
- subluxation of joint of spine **is a** dislocation of joint of spine.
- Therefore we do not need to include codes to represent “dislocation”

Assessment: I f the codes provided ABOVE REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

8- Trauma Diagnosis; cervical

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Burst fracture without translation	281914007 | burst fracture of cervical vertebra | : 363698007 | finding site | = 307184009|undisplaced fracture|	-burst fracture of cervical vertebra (Type:= clinical finding) -undisplaced fracture (Type=body structure)

Definitions:

- burst fracture of cervical vertebra **is a** fracture of cervical spine
- undisplaced fracture **is a** fracture alignments

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

11

9-: Trauma diagnosis-cervical.

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Minimally displaced unilateral facet fracture,	125605004 | fracture of bone | +263739008 | displaced | + 255605001 | minimal | :363698007 | finding site |= (81168003 | facet joint :|272741003 | laterality | = 66459002 | unilateral |)	- fracture (Type:= clinical finding) - displaced (Type:= qualifier value) -minimal (Type: qualifier value) -facet joint (Type:= body structure) - unilateral (Type= qualifier value)

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2-Disagree

Comments:

10- **Trauma Diagnosis, Thoracic**

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Isolated posterior element injury, pars fracture	46651001 | isolated | +417746004 | traumatic injury | : {363698007 | finding site | =280721008 | posterior vertebral element |} + 240221008 | spondylolysis |	-isolated (qualifier value) -traumatic injury (clinical finding) -finding site (linkage concept) -posterior vertebral element (body structure) -spondylolysis (clinical finding)

Definitions:

- Posterior vertebral element is a bone structure of spine.
- Spondylolysis is a synonym for Pars Fracture.
- Spondylolysis is a disorder of spine; and it is a disorder of bone.

Note; so can we just use Spondylolysis instead of traumatic injury and put the finding site.

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

11-Trauma diagnosis, Lumbar

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Burst, posterior element disruption(absent)	281934008 |burst fracture of lumbar vertebra+ : 363698007 | finding site | = 76555007 | disruption | + 280721008|posterior vertebral element|, 408729009 | finding context |= 410516002|known absent|	disruption (Type:= body structure) -burst fracture of lumbar vertebra (Type:= clinical finding) -finding site (Type:= linkage concept) -posterior vertebral element (Type:= body structure) -finding context (Type:= linkage concept) -Known absent (Type:= qualifier value)

Definitions:

- burst fracture of lumbar vertebra is a fracture of lumbar spine
- fracture of lumbar spine is a injury of lumbar spine
- injury of lumbar spine is disorder of lumbar spine.

Assessment: If the codes provided ABOVE REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree   2. Disagree

Comments:

12- Trauma diagnosis, Lumbar

Display Name	SNOMED CT Expressions	SNOMED CT Terms Description
Translational injury(fracture and dislocation), Bony	263072001| fracture dislocation of lumbar spine|+ 263686003 | bony |	fracture dislocation of lumbar spine (Type:= clinical finding) -bony (Type:= qualifier value)

Definitions:

- Fracture dislocation of lumbar spine **is a** fracture of lumbar spine
- Fracture dislocation of lumbar spine **is a** fracture dislocation of spine

Notes: there is no code value for the concept (Translational) in SNOMED CT.

Assessment: I f the codes provided above represent the same meaning of the concepts provided in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

13- Trauma diagnosis, Lumbar

Display Name	SNOMED CT Expressions	SNOMED CT Terms Description
Translational injury(fracture and dislocations), ligamentous	263072001| fracture dislocation of lumbar spine|:363698007 | finding site | = 335797003 | ligamentous joint |	- fracture dislocation of lumbar spine(clinical finding) -finding site (Type:= linkage concept)

		-ligamentous joint (Type:= body structure)

Definitions:

- Fracture dislocation of lumbar spine **is a** fracture of lumbar spine
- Fracture dislocation of lumbar spine **is a** fracture dislocation of spine

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1- Agree 2- Disagree

Comments:

____

14-Trauma diagnosis, other trauma

Display Name	SNOMED CT Expression	SNOMED CT terms Description
SCIWORA, Cauda Equina	90584004 | spinal cord injury | : 363698007 | finding site | = 7173007 | cauda equina structure | , 246090004 | associated finding | = (263654008 | abnormal | + 118247008|radiologic finding|: 408729009 | finding context | =410516002 | known absent |)	SCI - Spinal cord injury (Type:= clinical finding) -trauma (Type:= clinical finding) - associated finding (Type:= linkage concept) -abnormal (Type:= qualifier value) - radiologic finding (Type:= clinical finding)

		-finding context (Type:= linkage concept) - known absent (Type:= qualifier value) -finding site (Type:= linkage concept) -cauda equina structure (Type:= *body structure*)

Notes: SCIWORA (Spinal cord injury without radiologic abnormality)

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS THAT ARE PROVIDED OF THE ELECTRONIC form choose Agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

15-Trauma diagnosis, other trauma

Display Name	SNOMED CT Expression	SNOMED CT terms Description
Penetrating SCI without significant vertebral column injury,thoracic	26738009| spinal cord injury without spinal bone injury|: 53568006 | penetrating |+ 261179002 | thoracic |	-Spinal cord injury without spinal bone injury (clinical finding) -penetrating (qualifier value) -thoracic (qualifier value)

Definitions:

- spinal cord injury without spinal bone injury **is a** spinal cord injury
- spinal cord injury without spinal bone injury **is a** traumatic abnormality

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1- Agree 2-Disagree

Comments:

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Confirmation for SNOMED CT Expressions of the Non-Trauma Diagnosis Section

1-NON-Trauma Diagnosis, Inflammatory Arthropathy:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
RA with cranio-vertebral settling	9631008|rheumatoid arthritis of spine|+445100000 | stenosis of spinal canal at craniovertebral junction |	-rheumatoid arthritis (Type:= *clinical finding*) -stenosis of spinal canal at craniovertebral junction (Type:= *clinical finding*)

Definitions:

- rheumatoid arthritis of spine **is a** spondylitis
- spondylitis **is a** inflammation of specific body organs
- stenosis of spinal canal at craniovertebral junction **is a** spinal stenosis
- spinal stenosis **is a** disorder of spine

Notes: "445100000 | stenosis of spinal canal at craniovertebral junction | " is the only candidate provided by the SNOMED CT system".

Assessment: If the codes provided above represent the same meaning of the concepts provided in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1- Agree 2- Disagree

Comments:

____

Confirmation for SNOMED CT Expressions of the Indications Section

1- Indication

Following there are two candidates of SNOMED CT Expressions for the intended display name. (Please assign **Agree to** the suitable candidate or **disagreement** for all candidates is possible)

A-First candidate:

Display Name	SMONED CT Expressions	SNOMED CT terms Descriptions
Spinal stimulator failure	44503004 | removal of spinal neurostimulator	- removal of spinal neurostimulator (Type:= procedure)

Definitions:

- removal of spinal neurostimulator Is a procedure on an organ
- removal of spinal neurostimulator Is a removal of device from central nervous system.
- The direct devices used is neurostimulator

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

B- Second candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Spinal stimulator failure	76797004 | failure |:255234002 | after | = 3270004 | implantation of neurostimulator in spine |	- failure (clinical finding) -implantation of neurostimulator in spine (Type:= procedure)

Definitions:

- implantation of neurostimulator in spine **is a** implantation of spine
- implantation of neurostimulator in spine **is a** insertion of therapeutic device
- The direct device used is neurostimulator
- neurostimulator **is a** neurological device; and it is a stimulator

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

2- **Indication**

DisplayName	SNOMED CT Expressions	SNOMED CT terms Descriptions
Pinsite infection	213125001 | infected external fixator pin |	- infected external fixator pin (Type:= clinical finding)

Definitions:

- infected external fixator pin **Is a** subtype of bone fixation device infection
- bone fixation device infection **is a** infection of bone
- and bone fixation device infection is a complication of internal fixation device; and it is Associated with insertion of therapeutic device

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

Confirmation for SNOMED CT Expressions of the Associated Co-Morbidities Section

1- Associated Co-Morbidities Section

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Diabetes (without end organ damage)	73211009 | diabetes mellitus|	-diabetes mellitus (Type:= clinical finding)

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

2- Associated Co-Morbidities Section

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Diabetes (with end organ damage)	73211009 | diabetes mellitus|+74627003 | diabetic complication |	-diabetes mellitus (Type:= clinical finding) - diabetic complication (Type:= clinical finding)

Definitions:

- diabetic complication is a disease that is associated with diabetes mellitus.
- There is no SNOMED CT code refers to damage in an body organ in general because the codes are too specific; like "**disorder of digestive organ**" or "**disorder of male genital organ**"

  Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

____

3- **Associated Co-Morbidities Section**

Display Name	SMONED CT Expressions	SNOMED CT terms Descriptions
Metastatic solid malignancy	128462008 |secondary malignant neoplastic disease | :246112005 | severity | = 442452003 | life threatening severity |	- secondary malignant neoplastic disease (Type:= clinical finding) - severity (Type:= linkage concept) - life threatening severity (Type:= qualifier value)

Definitions:

- secondary malignant neoplastic disease **is a** malignant neoplastic disease
- secondary malignant neoplastic disease is with associated morphology neoplasm, metastatic
- life threatening severity is severities.

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

23

Confirmation for SNOMED CT Expressions of the Anesthesia Information Section

1- **Anesthesia Information, Type of Intubation**

Display Name	SMONED CT Expressions	SNOMED CT terms Descriptions
Asleep Fibreoptic	285696003|fiberoptic laryngoscope|	fibreoptic laryngoscope (Type:= physical object)

Note: this examination "fiberoptic laryngoscope"
Done when the patient is a wake; so I could not find a code to represent "Asleep Fibreoptic"

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree
2. Disagree

Comments:

Confirmation for SNOMED CT Expressions of the Surgical Procedure Section

1- Surgical Procedure Section, Vertebral Column

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Corpectomy	239562005 | excision of vertebra |	excision of vertebra (Type:= procedure)

Definitions:

- excision of vertebra **Is a** vertebral column excision.
- The procedure site is bone structure of spine.

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

2-Surgical Procedure Section, Surgical approach:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Wiltse	262292006 | paraspinal approach |	paraspinal approach (Type:= *qualifier value*)

Definitions:

- paraspinal approach is a posterolateral spinal approach.

Notes: the Wiltse approach is called as paraspinal approach in literature, (http://www.ncbi.nlm.nih.gov/pubmed/16456311)

Assessment: I f the codes provided above represent the same meaning of the concepts provided in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

3-Surgical Procedure Section, Positioning:

Display Name	Codes values	SNOMED CT terms Descriptions
Jackson Table: Flat	86407004 | table |+ 6041008 | flat |	table (Type:= physical object) flat (Type:= qualifier value)

Definitions:
The table is a household device.
Note:

- There are other two terms: Jackson Table: Flip and Jackson Table: Sling.
- It is possible to use the "Sling" as qualifier value SNOMED CT concept with the SNOMED CT concept "Table"; however, there is no qualifier value for the term "Flip".

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

4-Surgical Procedure Section, Positioning:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Mayfield head rest	441100008 | Mayfield head clamp |	- Mayfield head clamp (Type:= physical object)

Definitions:

- Mayfield head clamp is a 3 pin head fixation device (physical object).

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree   2. Disagree

Comments:

5-Surgical Procedure Section, Positioning:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Wilson frame	257556004 | surgery+ 257297007 | frame |	-surgery (Type:= qualifier value) -frame (Type:= physical object)

Definitions:

- Frame is a physical object.

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

2. Agree   2. Disagree

Comments:

Confirmation for SNOMED CT Expressions of the Implant Section

1- **Implant Section, Device**

Following there are two candidates for SNOMED CT Expressions. (Please assign **Agree to** the suitable candidate or **disagreement** for all candidates is possible)

A- First candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Lateral Mass Screw/Rod	239283000|fixation of fracture using screws(procedure)| : 363704007 | procedure site | = 181894008 | entire lateral mass of atlas |	-fixation of fracture using screws (Type:= procedure) - procedure site (Type:= linkage concept) - entire lateral mass of atlas (Type:= body structure)

Definitions:

- fixation of fracture using screws **is a** internal fixation of fracture
- the device used is bone screw

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

B-Second candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Lateral Mass Screw/Rod	239279000 | fixation of fracture | : 424226004 | using device | = 257346002 | rods or rectangle with screws | , 363704007 | procedure site | = 40349000 | lateral mass of atlas |	-fixation of fracture (Type:= procedure) -using device (Type:= linkage concept) -rods or rectangle with screws (Type:= physical object) - procedure site (Type:= linkage concept) - lateral mass of atlas (Type:= body structure)

Definitions:

- rods or rectangle with screws **is a** rods or rectangle system

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

2- **Implant Section, Device**

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Pedicle Screws	239283000|fixation of fracture using screws| : 363704007 | procedure site | = 277422007 | entire pedicle of vertebra |	-fixation of fracture using screws (Type:= procedure) - procedure site(Type:= linkage concept) - entire pedicle of vertebra (Type:= body structure)

Assessment: I f the codes provided above represent the same meaning of the concepts provided in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

3- **Implant Section, Device**

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Prefabricated Interbody/corpectomy replacement (e.g. cage)	71967004 | artificial |+ 120077008 | spinal cord implantation|: 260686004 | method | = 257867005 | insertion - action | , direct device | = 257275005 | spinal cage |	-artificial (Type:= qualifier value) -spinal cord implantation (Type:= procedure) -method (Type:= linkage concept) -insertion - action (Type:= qualifier value) - direct device (Type:= linkage concept) - spinal cage (Type:= physical object)

Definitions:

- Replacement is a surgical procedure and it is an implantation

Note:

- If it is important to include replacement: I can use replacement (procedure).
- 360039001 | articulated bone prosthesis | can be used as a device.

Assessment: If the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2.Disagree

Comments:

4-- **Implant Section, Device**

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Interbody Implant	120077008 | spinal cord implantation|: 260686004 | method | = 257867005 | insertion - action | ,direct device | = 40388003 | implant |	-spinal cord implantation (Type:= procedure) -method (Type:= linkage concept) -insertion - action (Type:= qualifier value) - direct device (Type:= linkage concept) -implant (Type:= physical object)

Definitions:

- Implant is a biomedical device.

Assessment: If the codes provided ABOVE REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED IN THE DISPLAY NAMES of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

5-- **Implant Section, Device**

Following there are two candidates of SNOMED CT Expressions for the intended display name. (Please assign **Agree to** the suitable candidate or **disagreement** for all candidates is possible)

A-First Candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Interspinous Process Device	428441009 | insertion of spacer into lumbar interspinous process|	insertion of spacer into lumbar interspinous process (procedure)

Definitions:

- Interspinous Process Device **is an** insertion of therapeutic device
- The direct device used is spacer.

Assessment: I f you the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1.Agree 2.Disagree

Comments:

B-Second Candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Interspinous Process Device	243135003 | spacer |	spacer (Type:= physical object)

Definitions:
Spacer device **is a** biomedical device

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree   2. Disagree

Comments:

Confirmation for SNOMED CT Expressions of the Bone Graft Section

1- **Bone Graft Section**

Display Name	SNOMED CT EXpressions	SNOMED CT terms Descriptions
Morcelized Allograft	116372002 | allogeneic bone graft | + 288052000 |bone graft with bone chips|	-allogeneic bone graft (Type:= procedure) bone graft with bone chips (Type:= procedure)

Definitions:

- allogeneic bone graft Is a allogeneic transplantation
- allogeneic bone graft Is a bone graft
- The direct substance used is a allogeneic bone graft material

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree 2. Disagree

Comments:

2-**Bone Graft Section**

Display Name	SNOMED CT Expressions	SNOMED CT terms Description
Structural Ilium Autograft	116371009 | autogenous bone graft |: 363704007 | procedure site | = 22356005|ilium|	- autogenous bone graft (Type:= procedure) - procedure site (Type:= linkage concept) - ilium (Type:= body structure)

Definitions:

- autogenous bone graft is a bone graft
- the direct substance used is autogenous bone graft material

Note: there is no concept in SNOMED CT represents the term (Structural); however, it can appear embedded in Phrases like (structural grafting of bone to spine using allograft)

Assessment: I f you think the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1. Agree   2. Disagree

Comments:

3-Bone Graft Section

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Synthetic Osteoset	80983001|bone graft|: 116680003 | is a | = 411971004|calcium sulfate bone graft pellet|	- bone graft (Type:= procedure) - is a (Type:= linkage concept) -calcium sulfate bone graft pellet (Type:= pharmaceutical / biologic product)

Definitions:

- OSTEOSET is described as Bone Graft Substitute, which is a patented medical grade calcium sulfate bone graft substitute.(http://www.aportamexico.com/solutions/bioorthopedics/04ingosteosetbonegraftsubstitute.html)

Assessment: I f you the codes provided above REPRESENT THE SAME MEANIMG OF the provided display name of the form choose Agree; otherwise choose disagree; any additional comments can be added.

1- Agree   2-Disagree

Comments:

Confirmation for SNOMED CT Expressions of the Adjunct Drugs/Procedure Section

1- **Adjunct Drugs/Procedure Section**

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
Halo Vest	183187001 | halo brace |	halo brace(physical object)

Definitions:

- halo brace is ahead/neck appliance

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1-Agree 2-Disagree

Comments:

____

2- **Adjunct Drugs/Procedure Section**

Following there are two candidates for SNOMED CT Expressions. (Please assign **Agree to** the suitable candidate or **disagreement** for all candidates is possible)

A-First candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
pneumatic compression hose	443448006 | application of intermittent pneumatic compression device |	application of intermittent pneumatic compression device (Type:= *procedure*)

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Definitions:

- application of intermittent pneumatic compression device **is a** application of device.
- The method is application = action.
- The direct device used is intermittent pneumatic compression stockings.

Assessment: I f you think the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1-Agree 2-Disagree

Comment:

B-Second Candidate:

Display Name	SNOMED CT Expressions	SNOMED CT terms Descriptions
pneumatic compression hose	429289005 | intermittent pneumatic compression therapy |	intermittent pneumatic compression therapy

- intermittent pneumatic compression therapy Is a intermittent compression therapy
- intermittent compression therapy is a physical agent therapy
- intermittent pneumatic compression therapy has intent therapeutic

Assessment: I f the codes provided above REPRESENT THE SAME MEANING OF THE CONCEPTS PROVIDED in the display names of the electronic form ; please choose agree; otherwise choose disagree; any additional comments can be added.

1-Agree 2-Disagree

Comments:

The Use of Electronic Synoptic Operative Reporting to Improve Operative Reports

Pages 146 -157

Appendix (J)

Operative Reports for Four Spinal Cord Injury Patients Documented by the Traditional Dictation Method

Due to the confidential nature of this Appendix, it is excluded from the uploaded DalSpace document.

Appendix K

Tables Comparing Clinical Data Items (In Paragraphs) Of the Dictated Report and the Corresponding Data Items That Can Be Captured By The Electronic Template

Patient 1

Data Elements of the Dictated Report	Data Items of the Synoptic template
Preoperative Diagnosis: C5-C6 Instability	Instability: (diagnosis, Pre-Operative Diagnosis) C5-C6: (location, Pre-Operative Diagnosis)
Postoperative Diagnosis C5-C6 Instability	Instability: (diagnosis) C5-C6:(location)
Operation: C5-C6 ACDF (anterior discectomy with fusion) with allograft and plate	-Total Discectomy: (Procedure list, Surgicla Procedure) -C5-C6:(location, Surgical Procedures) - fusion, interobody(Procedure list, surgical Procedure) - Allograft(typed, Bone Graft) - Anterior Cervical Plate(implant)
Indication: This _-year-old-gentleman presented with a C5-C6 bilateral jumped facet and C5 tetraplegia. He underwent an immediate closed reduction earlier this morning and then underwent an MRI scan, which showed no significant compression at the level of the injury. There was evidence of signal change within the cord. He was brought back for an anterior stabilization procedure.	-Bilateral facet dislocation (Trauma diagnosis list, Pre-operative Diagnosis) -Primary stabilization(indication)

Procedure: The patient was transported from the ICU intubated with all the appropriate line, and induced under anaesthesia by Dr. TC. He was positioned supine in the operating table with an inflatable bladder beneath his shoulder blades to allow us to keep his neck in extension	-Previously intubated (Type of Intubation, Anesthesia Information) -General,(Type of Anaesthetic, Anesthesia Information) - Regular bed(Positioning, surgical procedure)
Eight pounds of traction were applied. After we ensured his pressure points were adequately padded and protected, we then prepped and draped the skin in the usual sterile fashion. A horizontal incision was infiltrated with 0.25% Marcaine and 1:200,000 epinephrine. The skin was sharply incised and cautery brought down through the platysma muscle. There was a large descending anterior vein which was isolated and divided. The platysma was then undermined both rostrally and caudally. We worked lateral to the scrap muscles, medical to the sternocleiomastoid in the deep cervical fascia to explore the carotid sheath	- Traction(Adjunct Drugs/Procedure) -Spinal Nerve Rhizotomy (Procedure list, Surgical Procedure) -percutaneous(Surgical Approach, surgical procedure) -C5-C6 (Location, Surgical procedure).
I then put a marker in the C5-C6 space, and confirmed the location with fluoroscopy. The disk was then incised and the anterior longitudinal ligament was opened over the C5 and C6 vertebrae. There was thick clot beneath the anterior longitudinal ligament superficial to the bone. This was all evacuated and the longus collli muscle was elevated bilaterally.	
Trimline retractors were placed to hold our exposure. The disk was obviously disrupted. This was removed with pituitary ronguers, Kerrison ronguers and cupped curettes. The dura was intact. The posterior longitudinal ligament was torn thorough and thorough. Distractor pins were place in the C5 and C6 and disk space was placed under some distraction	

We did the final decompression under microscopic magnification. There was some bleeding from the left hand side in the epidural space, tried to control with some bipolar cautery. Eventually got it controlled with packing with Instat powder. Once I was satisfied I decorticated the endplates of C5 and C6 with Midas Rex drill. The wound was irrigated out.	- Hemorrhage or wound hematoma1 (sterile), (Indication) -C5-C6(Location, Indication)
I measured and cut and shape pieces of allograft into a wedge and this was tapped into place. Our distraction was removed as was the traction. The graft fit snugly. We did oversize the graft a little bit in order to leave this segment in lordosis, and help prevent further subluxation. One I was satisfied with the appearance of this, I then sized up an Atlantis plate (Medtronic).	- Allograft(is typed in ,Bone Graft) - Anterior Cervical Plate(implant)
This was placed and fixed to spine using fixed angled screws and C6 variable angled screws and C5. Locking mechanisms were engaged. The wound was irrigated out. Retractors were removed. We took another inspection for hemostasis in the muscles. This appeared satisfactory. We irrigated out one more time and then began the closure. The platysma muscle was approximated with 3-0 Vicryl. The skin was closed with 4-0 Monocryl. The wound was sealed with Demabond	- Cannulated Screws(Device, Implant) -C5-C6(location, Implant)
The patient was transferred back onto his bed and delivered to Recovery. The patient then delivered back to ICU in stable condition, intubated. There were no intraoperative complications noted. The patient tolerated the procedure well. Blood loss is estimated at approximately 100 mL.	-ICU(Discharge Disposition) -Estimated Blood loss = 100 mL (Intra-Operative Fluid Intake Output Information)

Patient 2

Data Elements of the Dictated Report	**Data Elements of the Synoptic Report**
Preoperative Diagnosis: Central cord injury	
Operation(s) Left open-door laminoplasty C3-C6	-Decompression Laminoplasty (Procedure list, Surgical Procedure) -C3-C6 (Location, Surgical Procedure)
Synopsis: This _-year-old gentleman suffered an injury playing football which rendered him tetraplegic. He did show signs of improvement. His MIR scan showed significant stenosis in his cervical region. He was presented with the options of waiting to see the extent of his recovery or early surgical decompression. He did have some anteriod disk herniations, but he did not present with radicular pain. It is felt that the centrol stenosis was the most significant feature, so he was offered a decompressive lamnoplasty. He contemplated this, accepted surgical decompression, and arrangements were made for the following operation.	-Male(Patient Information) - Spinal stenosis (Non trauma Diagnosis list) -primary (Type of diagnosis) -Decompression Laminoplasty (Procedure list, Surgical Procedure)
Procedure: Following written informed consent, he was brought to the operating room and placed under general anaesthesia by Dr. TC. After adequate arterial and venous access, a Foley catheter was placed as well as antithromoembolic stockings	-General(type of (Type of Anesthetic, Anesthesia Information) -Foley catheter(Adjunct Drugs/Procedure) - Anti-embolic stochings(Adjunct Drugs/Procedure)

He was given 1 gram of Kefzol and 10 mg of Decadron. He was then turned prone on the Wilson frame and his head was secured with a Mayfield head clamp and locked to the table. His neck was placed in a slightly flexed posture. A little bit of hair was clipped. We then prepped and draped the skin in the usual sterile fashion. A midline incision was infiltrated with 0.25% Marcaine with 1:200,000 epinephrine.	- Atibiotics (Adjunct Drugs/Procedure) - Wilson frame(Positioning, Surgical Procedures) - Mayfield head rest(Positioning, Surgical Procedures) - Midline(Surgical Approach, Surgical procedure)
The skin was sharply incised and cautery brought us down to the subcutaneous tissues. Subperiosteal dissection was performed bilaterally to expose the lamina of C3-C6 bilaterally. On the right hand side 2:37 side, we carried this out just to the medial aspect of the lateral masses and on the left hand side, we took it out to about the lateral 1/3 of the lateral masses. A trough was then drilled with the Midas Rex on the right hand side through the posterior cortex of his lamina lateral mass junction of C3-4-5 and 6. On the right hand side, we drilled through-and-through. The ligamentum flavum was resected. There were some large engorged veins which did bleed a fair amount. Once we were able to open the	-C3-C6 (Location, Surgical Procedure)
Once we were able to open the lamniplasty and hold it in place with Timesh laminplasy plates (Medtronic), we were then able to get better control of the veins and control with bipolar cautery as well as some Instat powder	
Once I was happy with this, the wound was irrigated out with bacitracin-infused normal saline. We did place a Hemovac drain in the epidural space. The muscle and facia were re approximated with 0-Vicryl, 2 and 3-0 Vicryl brought subcutaneous tissues together, staples were used under the skin. The drain was secured with 3-0 Ethilon. His wound was cleansed, sterile dressing was applied.	- Hemovac drain(Adjunct Drugs/Procedure)
The patient tolerated the procedure well; there were no intraoperative complications noted. The patient was turned back supine in his bed. His Mayfield was removed. He was extubated by Dr. TC and delivered to the recovery room in stable condition. Postoperatively, he noted that his "hypersensitivity" had improved.	-patient was delivered to the recovery room in stable condition (Typed in the Discharge Disposition)

Patient 3

Data Elements of the Dictated report	Data Elements of the Synoptic Template
Preoperative Diagnosis: Fracture dislocation T9	-Bony Translational Injury(Trauma Diagnosis list, Pre-Operative Diagnosis) -T9 (Location, Pre-Operative Diagnosis)
ORIF (open reduction internal fixation) T9 fracture with pedicles screws from T6 to T12	-Fixation (Procedure , Surgical Procedure). - T6-T12 (Location Detail, Surgical Procedure). - Pedicle Screws (Device, Implant)
This _-year-old woman was involved in a motor vehicle collision and had a multiple trauma. One of her injuries was a T9 fracture, which had a flexion rotation and translation component. It was an unstable fracture. She had some neurological compromise with strength in her right leg. There was no compressive lesion on the spinal cord on her preoperative imaging. There was evidence, however, of some signal change within the spinal cord at the injured level. Surgical stabilization was recommended to her family. She was intubated and medicated in the ICU. Her mother signed the consent form and arrangements were made for the following operation.	- Female(Patient Information) - Bony Translational Injury(Trauma Diagnosis list) - Flexion distraction, Bony(Trauma Diagnosis list) - She had some neurological compromise with strength in her right leg(is typed in indication) - - signal change within the spinal cord at the injured level(is typed in the indication) - Fixation (Procedure list, Surgical Procedure). - Previously Intubated(Type of Intubation, Anaesthesia Information)
Following written informed consent, she was brought to the operating room and placed under general anaesthesia by Dr. IB. He confirmed placement of the endotracheal tube and placed a triple lumen subclavian central line. A Foley catheter was checked for patency and antithromboembolic stockings were placed. She was slid over supine on the flat portion of the Jackson table. A gram of Kefzol was delivered. She was then sandwiched between the flat portion of the Jackson and the sling, and was then flipped into the prone position. We made sure her pressure points were adequately padded and protected.	- General(Type of Anaesthetic, Anaesthesia Information) - Foley catheter(Adjunct Drugs/Procedure) - Anti-embolic stockings(Adjunct Drugs/Procedure) - Jackson table: Sling(Positioning, Surgical Procedure) - Antibiotics (Adjunct Drugs/Procedure) - A gram of Kefzol was delivered(is typed in Adjunct Drugs/Procedure) - pressure points were adequately padded and protected(is typed in Adjunct Drugs/Procedure)

Once I was happy with her position then skin was prepped and draped in the usual sterile fashion. The C-arm was brought in, we localized the fracture and then in the AP plane cannulated the pedicles of T6 through T12. This was done bilaterally. K-wires were drilled into the pedicles. Once I cannulated all of the vetebra (except for the fractured T9), the C-arm was brought into the lateral position.	- skin was prepped and draped in the usual sterile fashion (is typed in Adjunct Drugs/Procedure) - Fixation (Procedure list , Surgical Procedure). - T6-T12 (Location Detail, Surgical Procedure). - Pedicle Screws (Device, Implant) - Wires(Device, Implant)
The K-wires were advanced into the vertebral bodies. Sequentially the muscle and fascia over the K-wire was dilated. A tap was used to begin our screw hole and then Legacy screws (Medtronic) were placed. I used a longitude system. Once all the screws were inserted, a rod was template out, contoured to prove some improvement in her kyphosis and then delivered rostrally to caudally. This was done bilaterally. I first did the left hand side and tightened down the reduction device in longitude sets and then inserted the sub-screws.	- Legacy screws (Medtronic) were placed(is typed in device, Implant) - Post-surgical kyphosis(non-trauma diagnosis)
I was happy with the position of the instrumentation. The alignment of the spine looked satisfactory on the images. The wounds were irrigated out with bacitracin infused normal saline. She was somewhat thin in this region. I did have to mobilize the muscle and fascia somewhat to get good coverage over the heads of the screws but I think I was able to do that. 2-0 and 3-0 Vicyl brought subcutaneous tissues together and Dermabond was used to seal the skin.	
The patient was then turned back supine on her bed and delivered to the Recovery Room still intubated. Blood loss was estimated at approximately 500 mL. She did receive 2 units of packed red blood cells for haemoglobin of 80. Her perfusion pressure was maintained with a phenylephrine drip during the case. There are no complications noted.	- delivered to the Recovery Room(is typed in the Discharge Disposition) - Estimated Blood Loss:500 ml - Amount of Blood transfused= 250 ML - Perfusion pressure was maintained with a phenylephrine drip during(is typed in Adjunct Drugs/Procedure)

Patient 4

Data elements of the Dictated Report	**Data Elements of the Synoptic Template**
Preoperative Diagnosis: Central cord injury	- Instability(Trauma Diagnosis list, Pre-Operative Diagnosis)
Postoperative Diagnosis: Traumatic disruption C5-6 with central cord injury	- Burst fracture without translation (Trauma Diagnosis list). - C5-C6 (location, Diagnosis)
Operation(s): C5-6 anterior cervical diskectomy and fusion (ACDF) with allograft and plate and posterior cervical laminectomy C4 to 6 and posterior arthrodesis of C3 to 7.	- Partial Discectomy(Procedure list) - Cervical(Surgical Approach) - C5-C6(Location, Surgical Procedure) - Fusion: interbody. - Decompression Laminectomy(Procedure list) - C4-C6 (Location, surgical Procedure)
This _-year-old gentleman suffered a fall and presented to hospital on _____ with symptoms consistent with central cord injury. He had cervical spondylosis and his MRI showed some high signal in his disk at the C5-6 level. He had a previous nonsurgical fusion of C3, 4 and 5. Clinically he showed some improvement in his hand function and his pain and in discussions with him we entertained early versus delayed surgery. As he was having significant neck pain when he mobilized we opted for earlier surgical stabilization with a circumferential approach. He agreed with this and arrangements were made for the following operation.	- Male(Patient Information) - Instability(Trauma Diagnosis list) - Spondylosis(non-trauma Diagnosis list) - high signal in his disk at the C5-6 level(typed in Indication) - previous nonsurgical fusion of C3, 4 and 5(is typed in Indication Section). - Neck Pain NYD(non-trauma diagnosis list).
Following written informed consent, the patient was brought to the operating room and placed under general anaesthesia by Dr. RC. After adequate arterial and venous access, a Foley catheter was placed as well as antithromboembolic stockings. He was positioned on the operating table with his head in a horseshoe headrest and his neck slightly extended. We ensured his pressure points were adequately padded and protected. He received 1 g of Kefzol and 10 mg of Decadron. We then used the C-arm to localize our levels and then prepped and draped the skin in the usual sterile fashion. A horizontal incision was infiltrated with 0.25% Marcaine with 1:200,000 epinephrine. The skin was sharply incised and cautery brought me down through the platsysma	- General(Type of Anaesthetic, Anaesthesia Information) - Foley catheter(Adjunct Drugs/Procedure) - Anti-embolic stockings(Adjunct Drugs/Procedure) - Mayfield head rest(Positioning, Surgical Procedure) - draped the skin in the usual sterile fashion(typed in the Adjunct Drugs/Procedure) -Antibiotics(Adjunct Drugs/Procedure)

The platysma was undermined both rostrally and caudally and then working in the anatomical place between the strap muscles and the sternocleidomastoid I dissected deep until I identified the omohyoid muscle. The superior border of the omohyoid was dissected free so this could be mobilized caudally. Beneath this I could identify the carotid sheath and I worked medially beneath the esophagus and opened up the prevertebral space. Upon entering the prevertebral space the longus colli muscles were considerably edematous and ecchymotic	
The muscles practically approximated themselves in the midline and there was no obvious distinction between the right and left sides. I dissected through this obvious area of trauma and identified the vertebral bodies. There was a fractured fragment off an osteophyte anteriorly off his C5 and I placed a marked in this and obtained my fluoro view, which confirmed that this was the C5-6 disk. I undermined along his colli on both sides until I could place Trimline retractors to hold our exposure. With the Trimline in place I paced distractor pins in C5 and C6 and placed a disk under distraction. The disk was obviously disrupted and I removed most of this with the pituitary rongeur. As I worked dorsally along the disk space, I burned down the edges with the Midas Rex drill. The posterior longitudinal ligament was disrupted at its more central component. It was splayed into two layers containing a disk herniation. This was consistent with a trauma	
As I opened up the second layer of the posterior longitudinal ligament there was a hematoma contained within this ligament which extended up rostrally behind the C5 vertebral body. I removing the ligament I was able to deliver a significant portion of this hematoma down into the disk space and removed it. I then decompressed from nerve root sleeve to nerve root sleeve and once I was happy with this I then obtained hemostasis with dipolar cautery and some FloSeal and then I measured up for a size of graft.	Hemorrhage or wound hematoma 1(sterile) (Indication) C5-C6 (Location , Indication)
The graft was fibular allograft. I cut and shaped this into a wedge. Once I was happy with the hemostasis I tapped this into place. The distraction was removed, the distractor pins were also removed and bone was placed in the bone in the holes. The graft was tested for snugness and fit and I was satisfied with this. I then sized up an Atlantis plate, I placed that used fixed angled screws in C6 and variable angled screws in C5. The locking mechanisms were engaged. The Trimline retractors were removed. I rechecked for hemostasis, I was satisfied with this and we began closure.	-Fibular allograft (is typed in , Bone graft) -Cannulated screws (Device, Implant) Anterior Cervical Plate(implant)

The platysma muscle was reapproximated with 3-0 Vicryl and 4-0 Moncryl was used for the skin. The wound was cleansed and Dermabond was placed. The patient was then slid onto a stretcher and we prepared for the second part of the procedure.	
A Wilson frame was placed on the operating table and the patient was placed in a 3-point Mayfield head clamp. He was then turned prone on the Wilson frame ensuring his pressure point was adequate padded and protected. His neck was slightly flexed. We then prepped and draped the skin in the usual sterile fashion. A midline incision was infiltrated with 0.255 Marcaine with 1:200,000 epinephrines. The skin was sharply incised and cautery brought me down through the subcutaneous tissues. The subcutaneous tissues were quite markedly stained with hemosiderin and were a bit edematous. I performed a subperiosteal dissection to expose the lamina of C3 to C7. The C5-6 facet joints were disrupted, as was the ligementum flavum and interspinous ligament.	- Wilson Frame(Positioning, Procedure) - Mayfield head rest(Positioning, Surgical Procedure) - Midline (surgical approach, Procedure)
The supraspinous ligament was intact. Using the Midas Rex drill with the foot plate I performed laminectomy of C4, 5 and 6. I extended this out the lateral recesses a little bit with a 2 mm Kerrison rongeur. FloSeal was used to obtain hemostasis along the bone edges. Then I took a little bit of lamina off C7 so that I could palpate the pedicales bilaterally and then placed pedicle screws using anatomical landmarks. Lateral mass screws were placed in C 3, 4, 5 and 6 bilateral. The instrumentation set used posteriorly was the Mountaineer set from DePuy.	- FloSeal(typed to (Adjunct Drugs/Procedure) - Pedicle Screws(device, Implant) - Lateral Mass Screw/Rod(device, Implant)
Once I was satisfied with the placement of the screws I decorticated the residual lateral masses, the rods were contoured and held in place with set screws which were locked down in the usual fashion. The bone that we had harvested from the laminectomy was stripped of soft tissue, morselized and placed over the lateral masses bilaterally. I then irrigated out one more time, was satisfied with our hemostasis, but place a drain anyway, and we began the closure.	Morcelized Laminectomy Autograft(is typed in Bone Graft)
The muscle and the fascia were reapproximated with 0 Vicryl, 2-0 and 3-0 Vicryl brought the subcutenous tissues together, and staples were used in the skin. The drain was secured with a 3-0 Ethilon. The patient was then turned back supine on his bed, allowed to emerge from anaesthesia, was extubated by Dr. AL, and delivered to recovery room in stable condition. There were no intraoperative complications. Blood loss was estimated at approximately 500 mL from both operations.	Delivered to the Recovery room (is Typed in the Discharge Disposition)

Appendix L

Report Views of The Synoptic Operative Report Template for patient #1 and Patient #2 based on the Information Extracted from the Dictated Reports in Appendix J.

Report view for Patient # 1

Capital Health

P O Box 9000, Halifax, Nova Scotia, B3K 6A3
Health Information Services, Room 1105

SYNOPTIC OPERATIVE REPORT

Site: Halifax Infirmary
1796 Summer Street
Halifax, NS, B3H 3A7

Date Created: 2012-06-28

PATIENT INFORMATION

Prefix:	**Given Name:**	**Family Name:**
Mr.	Patient_1	Everyman
Gender:	**Date of Birth:**	**HCN:**
Male	19541125	12345

Operative Start Date and Time: 201003290800
Operative Stop Date and Time: 201003291600
Decompression Neural Elements: 2012-06-28

SURGEON AND ANAESTHESIOLOGIST INFORMATION

Prefix	Given	Family	Speciality
Dr.	AB	CD	Neurological Surgery
Mr.	EF	GH	Resident
Dr.	IJ	KL	Anesthesiology

PRE-OPERATIVE DIAGNOSIS

Diagnosis	Type of Diagnosis	Injury Type	Location Detail	
			From:	To:
Instability	primary	closed	C5	C6
Bilateral facet dislocation	primary	closed	C5	C6

POST-OPERATIVE DIAGNOSIS

Same as Pre-operative diagnosis.

SURGICAL INDICATIONS

Indication	Location Detail *(If any)*	
	From:	To:
Primary stabilization	C5	C6
hemorrhage or wound hematoma	C5	C6

SURGICAL DESCRIPTION/FINDINGS

A horizontal incision was infiltrated with 0.25% Marcaine and 1:200,000 epinephrine. The skin was sharply incised and cautery brought down through the platysma muscle. There was a large descending anterior vein which was isolated and divided. The platysma was then undermined both rostrally and caudally. We worked lateral to the scrap muscles, medical to the sternocleiomastoid in the deep cervical fascia to explore the carotid sheath,I then put a marker in the C5-C6 space, and confirmed the location with fluoroscopy. The disk was then incised and the anterior longitudinal ligament was opened over the C5 and C6 vertebrae. There was thick clot beneath the anterior longitudinal ligament superficial to the bone. This was all evacuated and the longus collli muscle was elevated bilaterally.Trimline retractors were placed to hold our exposure. The disk was obviously disrupted. This was removed with pituitary ronguers, Kerrison ronguers and cupped curettes. The dura was intact. The posterior longitudinal ligament was torn thorough and thorough. Distractor pins were place in the C5 and C6 and disk space was placed under some distraction.The disk was obviously disrupted and The disk was obviously disrupted. This was removed with pituitary ronguers, Kerrison ronguers and cupped curettes. The dura was intact. The posterior longitudinal ligament was torn thorough and thorough. There was some bleeding from the left hand side in the epidural space, tried to control with some bipolar cautery. Eventually got it controlled with packing with Instat powder. Once I was satisfied I decorticated the endplates of C5 and C6 with Midas Rex drill. The wound was irrigated out.measured and cut and shape pieces of allograft into a wedge and this was tapped into place. Our distraction was removed as was the traction. The graft fit snugly. We did oversize the graft a little bit in order to leave this segment in lordosis, and help prevent further subluxation. , I then sized up an Atlantis plate (Medtronic). This was placed and fixed to spine using fixed angled screws and C6 variable angled screws and C5. Locking mechanisms were engaged. The wound was irrigated out. Retractors were removed. We took another inspection for hemostatis in the muscles. This appeared satisfactory. We irrigated out one more time and then began the closure. The platysma muscle was reapproximated with 3-0 Vicryl. The skin was closed with 4-0 Monocryl. The wound was sealed with Demabond

PRE-OPERATIVE CLINICAL STATUS

ASA Grade:	ASIA Score:	ASIA Neurological Level:	GCS Total:
Unknown	Unknown	N/A	7

ANAETHESIA INFORMATION

Intubation Type:	Anaesthetic Type:
Previously Intubated	general anesthesia

SURGICAL PROCEDURES

Procedure	Surgical Approach	Location Detail		Positioning
		From:	To:	
Total Discectomy	cervical	C5	C6	Regular bed
Fusion: interbody	cervical	C5	C6	Regular bed

SURGICAL DRAINS AND BONE GRAFTS

Surgical Drains

Bone Graft

- pieces of allograft

IMPLANTS

Device	Location Detail	
	From:	To:
Anterior Cervical Plate	C5	C6
fixation of fracture using cannulated screws	C5	C6

CO-MORBIDITIES AND ADJUNCT DRUGS/PROCEDURES

Co-Morbidities

Adjunct Drugs/Procedures

- Traction

INTRA-OPERATIVE FLUID INTAKE OUTPUT INFORMATION

Estimated Blood Loss: 100 mL
Amount of blood transfused: mL
Amount of IV Fluid Infused: mL
Intra-Operative Urine Output: mL
Name of Other Fluid: **Fluid Output:** **mL**

DISCHARGE DISPOSITION

Disposition:

- ICU

Other:

AUTHOR OF OPERATIVE REPORT

Given: Sean
Family: Christie
Suffix: MD

Attending Staff, Department of Surgery (Neurosurgery)

Report View for Patient # 2

Capital Health

P O Box 9000, Halifax, Nova Scotia, B3K 6A3
Health Information Services, Room 1105

SYNOPTIC OPERATIVE REPORT

Site: Halifax Infirmary
1796 Summer Street
Halifax, NS, B3H 3A7

Date Created: 2012-06-28

PATIENT INFORMATION

Prefix:	Given Name:	Family Name:
Mr.	Ptient_2	aa
Gender:	**Date of Birth:**	**HCN:**
Male	19541125	12345

Operative Start Date and Time: 2012-06-28
Operative Stop Date and Time: 2012-06-28T15:30:00
Decompression Neural Elements: 2012-06-28

SURGEON AND ANAESTHESIOLOGIST INFORMATION

Prefix	Given	Family	Speciality
Dr.	AB	CD	Neurological Surgery
Mr.	EF	GH	Resident
Dr.	IJ	KL	Anesthesiology

PRE-OPERATIVE DIAGNOSIS

Diagnosis	Type of Diagnosis	Injury Type	Location Detail	
			From:	To:
Spinal stenosis	primary	closed	C3	C6

POST-OPERATIVE DIAGNOSIS

Same as Pre-operative diagnosis.

SURGICAL INDICATIONS

Indication	Location Detail *(If any)*	
	From:	To:

SURGICAL DESCRIPTION/FINDINGS

The skin was sharply incised and cautery brought us down to the subcutaneous tissues. Subperiosteal dissection was performed bilaterally to expose the lamina of C3-C6 bilaterally. On the right hand side 2:37 side, we carried this out just to the medial aspect of the lateral masses and on the left hand side, we took it out to about the lateral 1/3 of the lateral masses. A trough was then drilled with the Midas Rex on the right hand side through the posterior cortex of his lamina lateral mass junction of C3-4-5 and 6. On the right hand side, we drilled through-and-through. The ligamentum flavum was resected. There were some large engorged veins which did bleed a fair amount. Once we were able to open the lamniplasty and hold it in place with Timesh laminplasy plates (Medtronic), we were then able to get better control of the veins and control with bipolar cautery as well as some Instat powder; then His wound was cleansed, sterile dressing was applied.The patient tolerated the procedure well; there were no intraoperative complications noted.

PRE-OPERATIVE CLINICAL STATUS

ASA Grade:
Unknown

ASIA Score:
Unknown

ASIA Neurological Level:
N/A

GCS Total:
7

ANAETHESIA INFORMATION

Intubation Type:
Glidescope

Anaesthetic Type:
general anesthesia

SURGICAL PROCEDURES

Procedure	Surgical Approach	Location Detail		Positioning
		From:	To:	
decompression laminectomy	midline	C3	C6	Wilson frame
decompression laminectomy	midline	C3	C6	Mayfield head rest

SURGICAL DRAINS AND BONE GRAFTS

Surgical Drains

Bone Graft

IMPLANTS

Device	Location Detail	
	From:	To:

CO-MORBIDITIES AND ADJUNCT DRUGS/PROCEDURES

Co-Morbidities

Adjunct Drugs/Procedures

- Antibiotics
- Foley catheter
- Anti-embolic stockings
- Hemovac drain

INTRA-OPERATIVE FLUID INTAKE OUTPUT INFORMATION

Estimated Blood Loss: mL
Amount of blood transfused: mL
Amount of IV Fluid Infused: mL
Intra-Operative Urine Output: mL
Name of Other Fluid: **Fluid Output:** **mL**

DISCHARGE DISPOSITION

Disposition:

- None

Other:

the patient was delivered to the recovery room in a stable condition.

AUTHOR OF OPERATIVE REPORT

Given:	**Family:**	**Suffix:**
Sean	Christie	MD

Attending Staff, Department of Surgery (Neurosurgery)

Appendix M

The Quick Start Guide and User Manual for the Electronic Synoptic Operative Report Template

Synoptic Operative Report Template for Spinal Cord Injury Patients

User Guide (Release 1.0)

Instructions for Research Study

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients

Prepared by Areej Alsulaiman, MHI Intern

Investigators

DR. Sean Christie, Assistant Professor, Department of Surgery (Neurosurgery)

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July 2012

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Table of Content

QUICK START GUIDE

GENERAL INFORMATION:

The electronic Synoptic Operative Report for Spinal Cord Injury Template is an application stored on Ginette Thibault-Halman's laptop computer. The application contains Lookup buttons (Select Trauma, Select Non-Trauma; Select Procedure , Insert Item, and Submit Form), Pick form the lists, and drop-down menus; Click on these to activate them.

For additional details or related figures, see the Synoptic Operative report for Spinal Cord Injury Template User Guide.

TO ENTER DATA TO THE SYNOPTIC OPERATIVE REPORT TEMPLATE:

Patient Information: Type in appropriate data in each field; use drop-down menus for sex and dates.

Surgeon and Anaesthesiologist Information: Use drop-down menu and type in data for each field, and use "Insert Item" to add another Data Item

Procedure Date and Time: Use drop-down menu for date and type the time in the same data field.

Pre-Operative Diagnosis: Use lookup buttons and Use drop-down menu; use " Insert Item" to add another Data Item

Post-Operative Diagnosis: Use radio buttons and enter a free text if necessary

Indications: Use drop-down menu or type in data for "Indication" field if necessary; and use "insert Item" to add another data item.

Associated Co-Morbidities: Use checkboxes to pick from the list or type in data field if necessary.

Pre-Operative Clinical Status: Use drop-down menu, Use radio buttons to Pick from the list; and use Checkbox.

Anaesthesia Information: Use radio buttons to Pick from the list, or type in data field if necessary.

Surgical Procedures: Use lookup button "Select Procedure" ; Use drop-down menu; and use " Insert Item" to add another Data Item

Surgery Description and Findings: Enter Surgery description and finding as free text.

Surgical Drains: Use checkboxes to pick from the list or type in data field if necessary.

Implants: Pick from the list, type in data field if necessary; and use" Insert Item" to add another data item

Bone Graft: Use Checkboxes to pick from the list or type in data field if necessary

Adjunct Drugs/Procedures: Use checkboxes to pick from the list or type in data field if necessary

Intra-Operative Fluid Intake Output Information: type in data for each field.

Discharge Disposition: Use Radio Buttons, or or type in data field if necessary.

Author Of Operative Report: Type in appropriate data in each field:

SPECIAL INSTRUCTIONS:

Removing a Row that was Erroneously Inserted: CLICK ON floating button; and use drop down menu.

Removing Entries of a Checkbox List: Click on the check box of the selected data item.

OTHERS

Saving Your Synoptic Operative Template: "Save As" patientHUN.xml (where patientHUN is the patient's hospital unit number)

Viewing Your Synoptic Operative Report Template: Use "*Report View*" in Microsoft Infopath.

SYSTEM OVERVIEW

Our Vision it to improve the continuity of care and enhance health outcomes for patients with Spinal cord Injury through an evidence-based approach to collect data in the synoptic operative report for spinal cord injury patients. Data is entered via a Health Level 7(HL7) Template that is based on the HL7's Clinical Document Architecture (CDA). Also, the Systematised Nomenclature of Medicine Clinical Terms (SNOMED CT) is used in the design of the template as standard clinical terminology enables the exchange of clinical information with different computer systems. Components of the system are templates, standards, terminologies and electronic resources.

The Synoptic Operative report for Spinal Cord Injury patients is developed by the division of Neurosurgery, Dalhousie University, to capture data that are relevant to the care of Spinal cord injury patients based on standards of the synoptic reporting and forms that are used by other projects to collect information about spinal cord injury patients. The template contains 17 sections that collect administrative and clinical information about spinal cord injury patients.

This document instructs you how to produce a Synoptic Operative Report for Spinal Cord Injury. This synoptic operative report is designed to be interoperable with knowledge resources to support learning in context. The templates are accessed via laptop of Neurosurgery research associate, Ginette Thibault-Halman.

One aim of this study is to support you to obtain the skills of using a structured approach to data entry. Your experience with the synoptic operative report template will help to construct the future plan for electronic data management of synoptic operative report of spinal cord injury patients. Take your time to become acquainted with the Synoptic operative template before entering the data.

CONTROL BUTTONS

Button	Function	Context of Use
	Choose the date	Patient Information(Date of Birth);Procedure Date and Time
Insert item	Add another line to a section into which information can be entered	Surgeon and Anaesthesiologist Information; Pre-Operative Diagnosis; Indication; Surgical Procedure; Implants.
Select Trauma	the list of trauma diagnoses appears	Pre-Operative Diagnoses. Select the intended trauma diagnoses form the list; and Use Insert item if you want to add another diagnosis
Select Non-Trauma	the list of non-trauma diagnoses appears	Pre-Operative Diagnoses Select the intended non- trauma diagnoses form the list; and use Insert item if you want to add another diagnosis
Select Procedures	Present the list of surgical procedures	Surgical Procedures. Select a procedure from the list and use Insert item if you want to add another procedure.
Insert Item	Insert a data item selected form a list to the intended section.	Pre-Operative Diagnoses; Surgical Procedure.
×	Close an open list	Pre-Operative Diagnoses; Surgical Procedure.
	Save the template	To save your Form
Submit Form	Submit the form	Submission of the form so it can be populate in a SharePoint environment.

Table 1. Navigation Buttons

GETTING STARTED

The Microsoft InfoPath 2007 form will be opened for you on the Research assistant laptop as presented in figure 1; so you can start filling the form when you are ready.

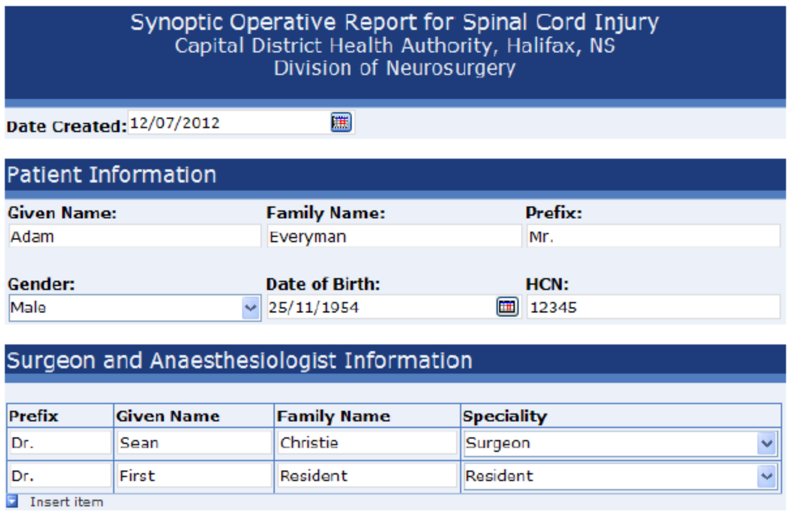

Figure 1: Screenshot Shows the Synoptic Operative Report in Microsoft InfoPath

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DATA ENTRY INTO THE SYNOPTIC OPERATIVE REPORT

1. Date of Data Entry

1.1 Select the date when data was entered into the template using the calendar icon (see figure 2)

Figure 2. Screenshot shows the section used to generate a date of creating the form.

2. Patient Information

Navigate to the *patient information* section of the Synoptic Template (see figure 3)

(Note: This information will automatically be populated from the hospital's admission system once the pilot testing has
been completed)

2.1 Enter the patient's first name in the *Given Name* field.

2.2 Enter the patient's last name in the *Family Name* field.

2.3 Enter the patient title (e.g. Mr.) in the *Prefix* field.

2.4 Select the patient's gender from the *Gender* drop down menu.

2.5 Select the patient's date of birth form the *Date of Birth* drop down menu.

2.6 Enter the patient's Hospital Unit Number for the health card number in the *HCN* field.

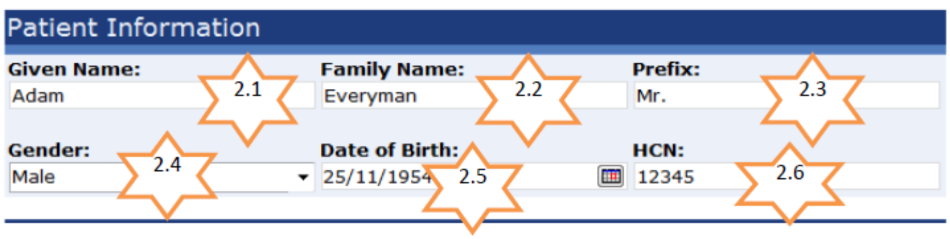

Figure3. Screenshot -- the *Patient Information* section

----

3. Surgeon and Anaesthesiologist Information:

Navigate to *Surgeon and Anaesthesiologist Information* section of the Synoptic Template (See figure 4).

3.1 Enter "Dr." in the *Prefix* field.

3.2 Enter the physician's first name in the *Given Name* field.

3.3 Enter the physician's last name in the *Family Name* field.

3.4 select "surgeon", "anaesthesiologist", "resident" or "surgical assistant" from the drop down menu in the *Specialty* field.

3.5 use "*Insert item*" to add another physician; and repeat steps 1 to 4.

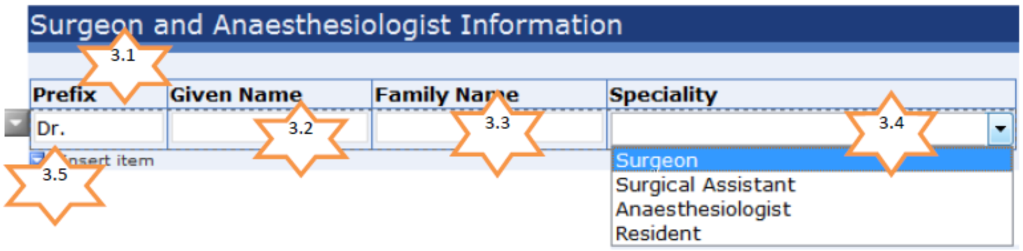

Figure4. Screenshot – the Surgeon and Anaesthesiologist Information Section

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4. Procedure Date and Time

Navigate to *Procedure Date and Time Information* section of the Synoptic Template(See Figure 5)

4.1 Select the operative date from the *Operative Start Date and Time* drop down menu, and type the time in the same filed; after selecting the data see figure 4, for an example.

4.2 Select the operative stop date for the *Operative Stop Date* by clicking on the calendar icon *and* type the operative stop time in the *Time* filed; after selecting the date; see figure 5 for an example.(Notice: the operative stop date and time should be greater than the operative start date and time).

4.3 Optional: select the decompression of neural elements date from the *decompression of neural element drop down menu, and type the time of* decompression of neural elements in the same field after selecting the date; see figure 5, for. an example.

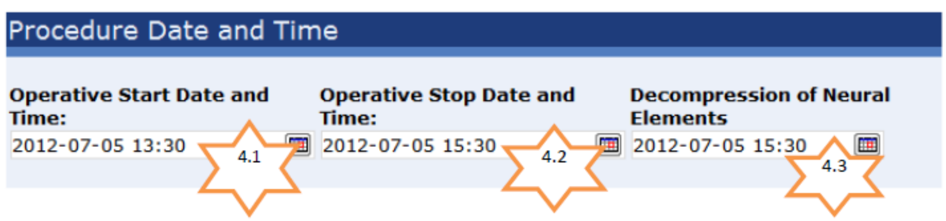

Figure 5: Screenshot – Procedure Data and Time Section

---

5. Pre-Operative Diagnosis:

Navigate to the *Pre-Operative Diagnosis* section of the Synoptic Template (see figure 6)

5.1 click on "*Select Trauma*" button; and the trauma diagnosis list, presented in figure 7 , will pop up on the right corner of the form; Choose diagnosis from the list and click on *Insert Item* button and the *Diagnosis* field will be filled in.

5.2 clicks on "*Select Non-Trauma*" button to see the Non-Trauma list presented in figure 8; Choose diagnosis from the list and click on *Insert Item* button and the *Diagnosis* field will be filled in.

5.3 The *Diagnosis* field will contain the diagnosis that you choose for the Trauma or non-trauma diagnosis lists.

5.4 select the type of diagnosis from the *Type of Diagnosis* drop down menu (primary or secondary).

5.5 select the type of injury from the *Injury Type* drop down menu (open or closed). .

5.6 select the diagnosis location from the *Location Detail* drop down menus; *use " From"* drop down menu to indicate the start point of the diagnosis location; and use "*To"* drop down menu *to* indicate the end point of the diagnosis location.

5.7 Click on *Insert item* button to add another diagnosis; and repeat steps 1-6.

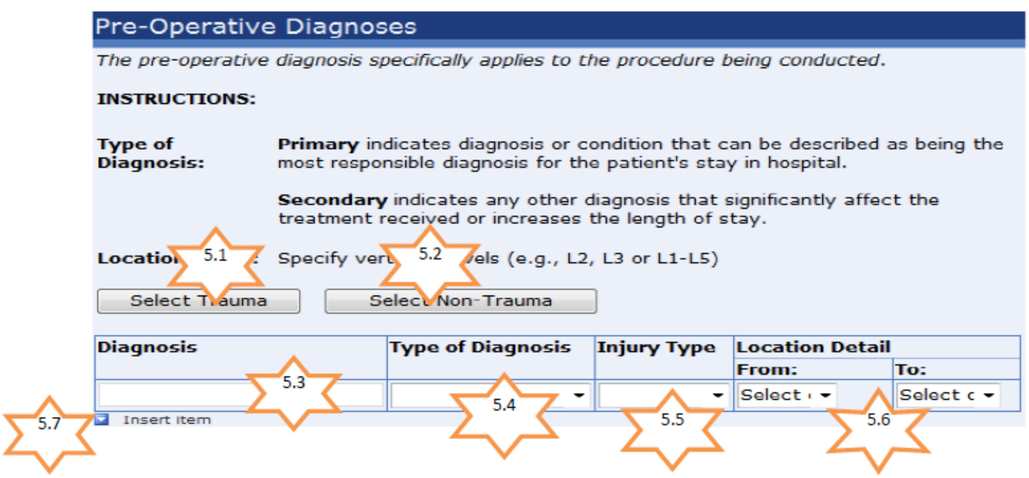

Figure 6. Screenshot –Preoperative Diagnosis Section

5.1 Trauma Diagnosis List:

5.1.1 After performing step 5.1 presented above; the trauma diagnosis list will pop up at the right corner; and you can enlarge the size of list frame by dragging the separating line to see complete data items(see figure 7).

5.1.2 Scroll down the list to see more options for trauma diagnoses.

5.1.3 Click on the intended diagnosis form the list.

5.1.4 Click on *Insert item* button to insert the selected diagnosis to the *Diagnosis* filed mentioned above in step 5.3.

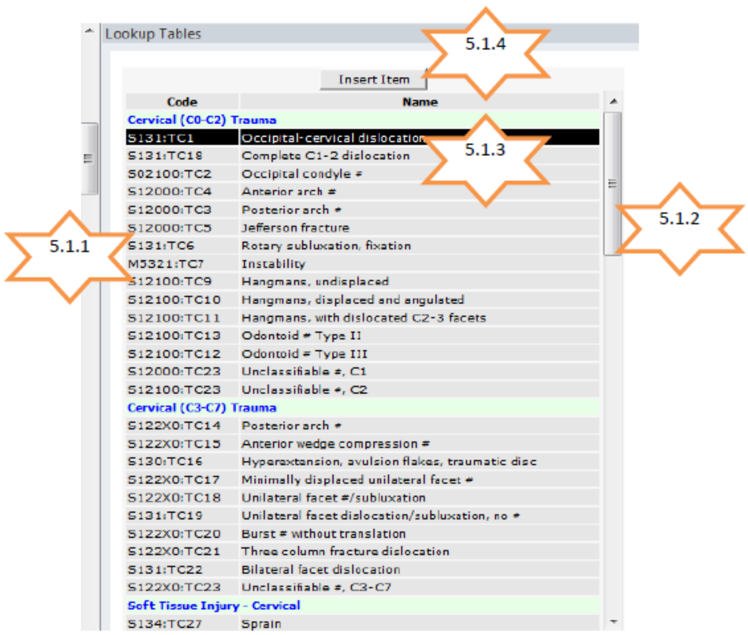

Figure 7. Screenshot – Shows the Trauma Diagnosis List

5.2 Non-Trauma Diagnosis List:

5.2.1 After performing step 5.2 presented above; the non- trauma diagnosis list will pop up in the right corner of the template; and you can enlarge the frame size of the list by dragging the separating line to see complete data items.

5.2.2 Scroll down the list to see more options for non-trauma diagnosis.

5.2.3 Click on the intended diagnosis form the list.

5.2.4 Click on *Insert item* button to insert the selected diagnosis to the *Diagnosis* field mentioned in step 5.3; you can select one diagnosis at a time. See step 5.7 to add another diagnosis.

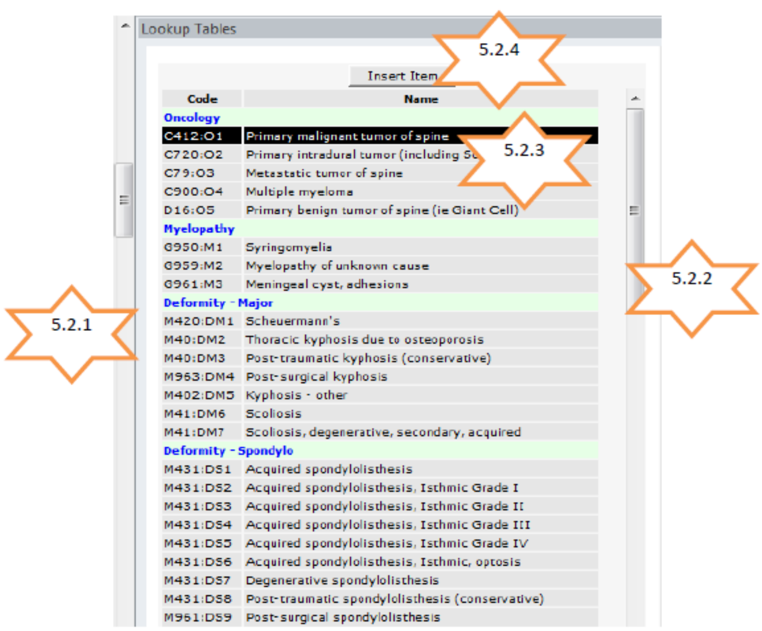

Figure 8. Screenshot – shows the Non -Trauma Diagnosis list

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6. Post-Operating Diagnosis

Navigate to the *Post-Operative Diagnosis* section of the Synoptic Template (See Figure 9)

6.1 use *Yes* or *No* buttons to indicate if the post-operative diagnosis is same as pre-operative diagnosis.

6.2 If No, enter the post-operative diagnosis in the *post-operative diagnosis* field.

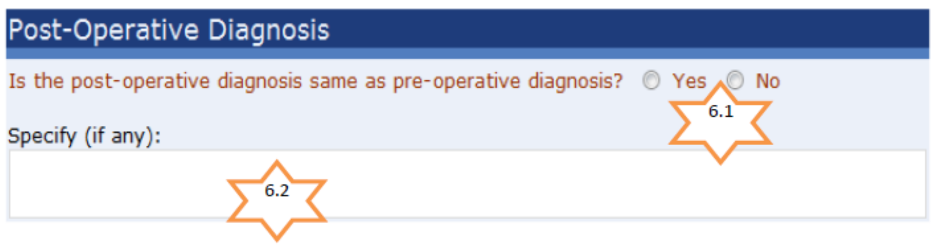

Figure 9. Screenshot – Post-Operative Diagnosis Section

----

7. Indication Information

Navigate to the *Indication* section of the Synoptic Template (see figure 10)

7.1 Select an indication from the *Indication* drop down menu; or you can also type in the *Indication* field.

7.2 Select the Indication location from the *Location Detail drop* down menus*;* use *" From"* drop down to indicate the start point of the indication location; and use "*To"* drop down menu *to* indicate the end point of the indication location.

7.3 Click on *Insert item* button to add another indication, and repeat steps 7.1 & 7. 2.

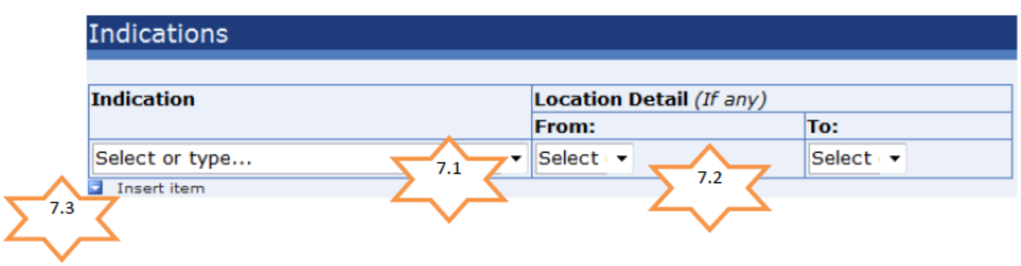

Figure 10. Screenshot –Indication Section

8 .Associated Co-Morbidities Information

Navigate to the *Associated Co-Morbidities* section of the Synoptic Template(See Figure 11)

8.1 Select the associated comorbidity (ies) by clicking on the checkbox(es) in the list.

8.2 If the patient's co-morbidity is not listed, enter it into the empty field at the end of the list; also you can add another line to enter more than one associated comorbidity that are not provided in the list by using the " Enter" key in the key board.

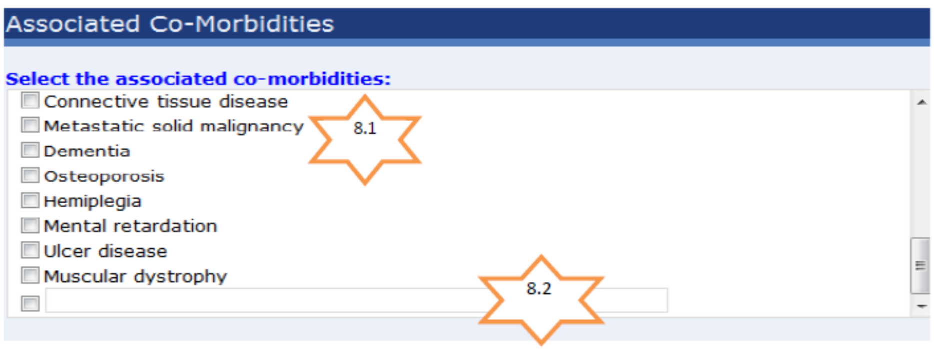

Figure 11. Screenshot–Associated Co-Morbidities Section

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9. Pre-Operative Clinical Status Information

9.1 Glasgow Coma Scale :

Navigate to the Glasgow *Coma Scale subsection* in the *Pre-Operative Clinical Status section* of the Synoptic Operative Report (See figure 12).

Note: If you want to see the scores' definitions for the three parameters (Best Eye Response, Best Verbal Response, Best Motor Response); use the checkbox of the "*Show Definition of Glasgow Coma Scale" data item* to see the

9.1.1 Select the appropriate value for the Glasgow coma scale eye opening subscore from the *Glasgow Coma Scale eye opening subscore* drop down menu.

9.1.2 Select the appropriate value of the Glasgow coma scale verbal response subscore from the *Glasgow Coma Scale verbal response subscore* drop down menu.

9.1.3 Select the appropriate value of the Glasgow coma scale motor response subscore from the *Glasgow Coma Scale motor response subscore* drop down menu.

9.1.4 The system will automatically calculate the values you provide and enter the sum in the *Total Score* field .

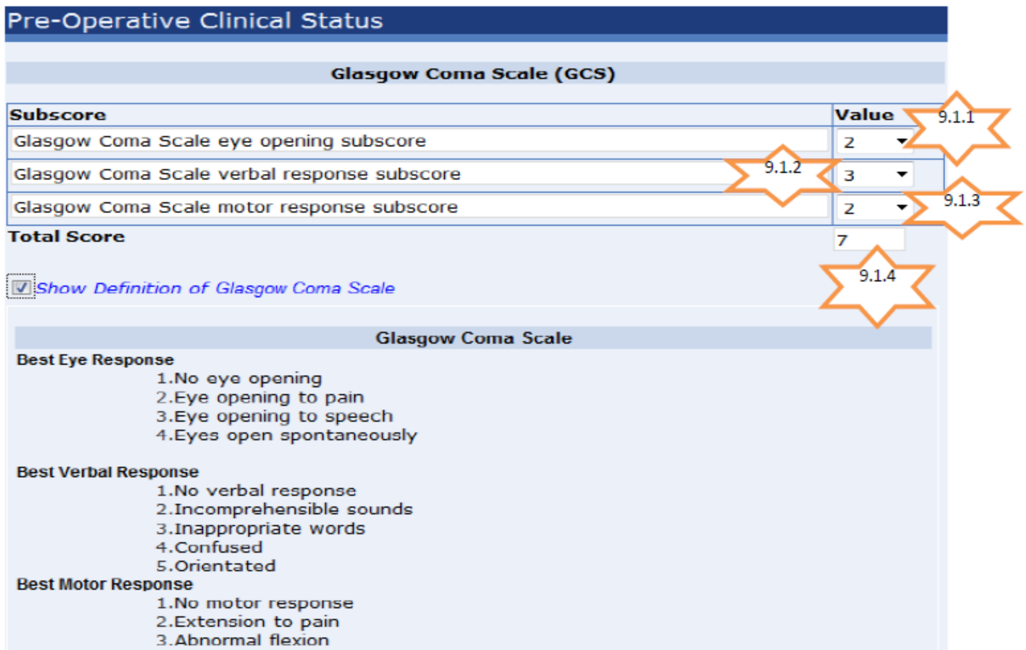

Figure 12. Shows Screenshot of the Pre-Operative Clinical Status Section, Glasgow Coma Scale subsection.

9.2 American Spinal Injury Association (ASIA) Impairment Scale:

Navigate to the *American Spinal Injury Association (ASIA) Impairment Scale* subsection in the *Pre-Operative Clinical Status* section of the synoptic operative report template (see figure 13)

Note: If you want to see the definition of each grade from A to E that are used in the American Spinal Injury association impairment scale; use the check box of the "*show definitions of ASIA Impairment Scale* "

9.2.1 Use radio buttons to select the appropriate grade of American Spinal Injury Association Impairment Scale to represent the patient's functional impairment.

9.2.2 Select the neurological level of injury for patient form the neurological *level of injury* drop down menu.

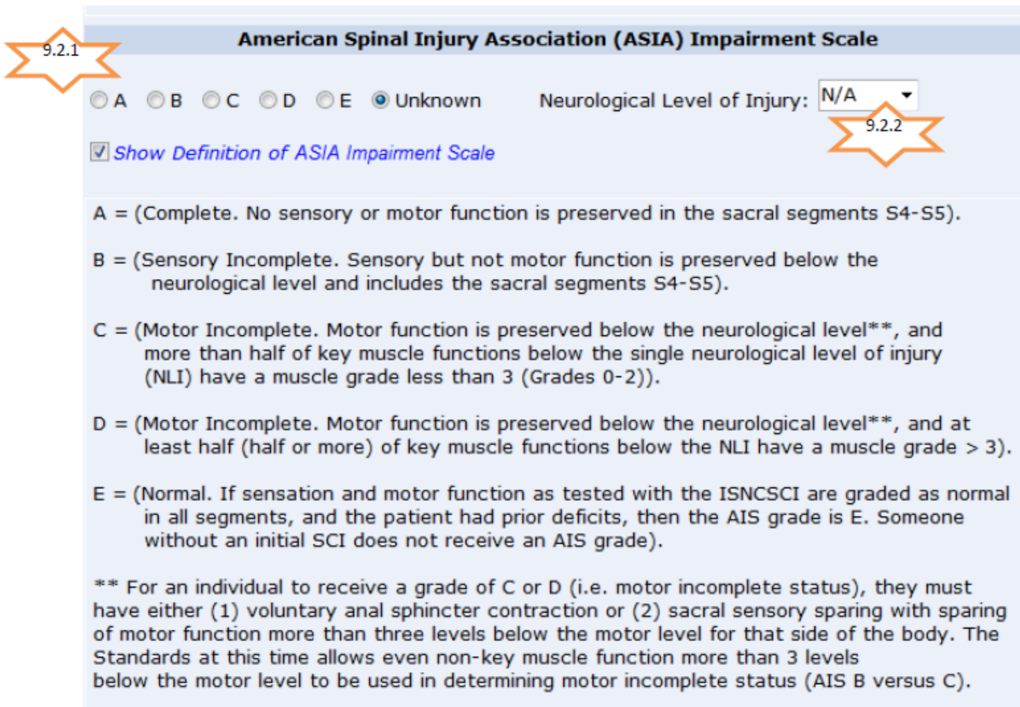

Figure 13 -- Screenshot of the Pre-Operative Clinical Status Section, American Spinal Injury Association Impairment Scale subsection.

9.3 ASA Grade:

Navigate to the American Spinal Injury Association Impairment Scale subsection in the *Pre-Operative Clinical Status section* of the Synoptic Operative Report Template (see figure 14)

9.3.1 Use the checkbox list to select the appropriate ASA grad for patient.

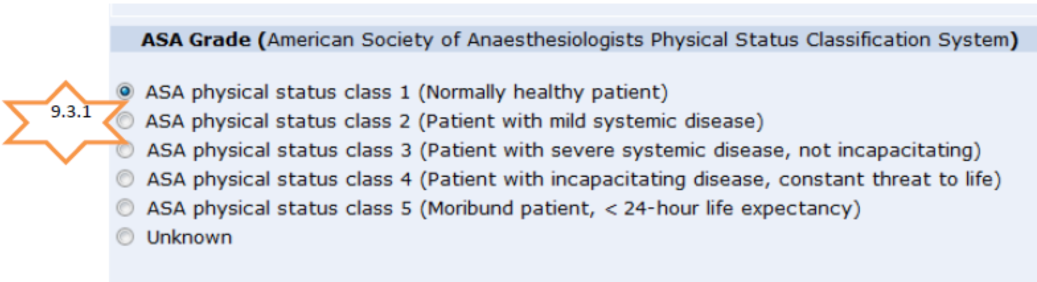

Figure 14: Screenshot of the Pre-Operative Clinical Status Section, ASA Grade Subsection.

---

10. Anaesthesia Information:

Navigate to the *Anaesthesia Information* section of the synoptic operative report template(see figure 15).

10.1 Select the type of Intubation from the list provided in the *Type of Intubation* subsection using the radio \ buttons.

10.2 Also, you can enter the intubation type if it is not provided in the *Type of Intubation* list.

10.3 Select the type of Anaesthetic form the list provided in the *Type of Anaesthetic* subsection by using the radio buttons.

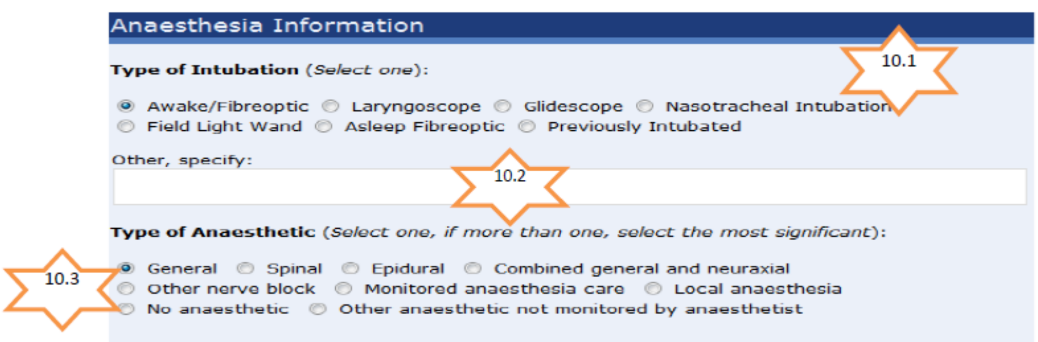

Figure 15 : Screenshot of the Anaesthesia Information Section.

---

11. Surgical Procedure Information:

Navigate to the Surgical Procedure Section of the Synoptic Operative Report Template(see figure 16)

11.1 click on "*Select Procedures*" button ; and the Procedures list presented in figure 17 will pop up on the right corner of the report ; choose a procedure from the list and click on *Insert Item* button and the *Procedure* field will be filled in.

11.2 The *Procedure* filed will contain the surgical procedure that you choose from the procedure list in figure 17.

11.3 select the surgical approach from the *Surgical Approach* drop down menu. Also, in order to add additional surgical approach for the same procedure, in case if there are more than one surgical approach is used to perform a procedure; you must perform the step 1 – 5 for each additional surgical approach(see figure 18 for an example).

11.4 select the procedure location from the *Location Detail drop* down menus; use "*From*" drop down to indicate the start point of the Procedure location; and use "*To*" drop down menu to indicate the end point of the procedure location.

11.5 select the device that is used in positioning the patient from the *Positioning* drop down menu. Also, in order to add additional positioning device for the same procedure, in case if there are more than one positioning device used to perform the procedure, you must perform the step 1 – 5 for each additional positioning device (see figure 19 for an example).

11.6 Click on *Insert item* button to add another surgical procedure; and repeat steps 1-5.

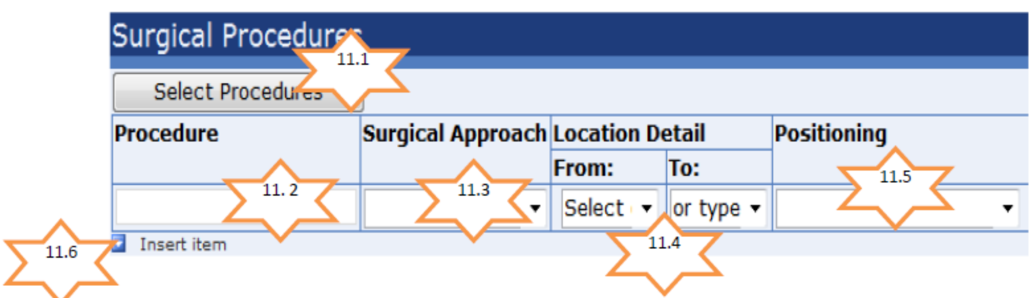

Figure16: Screenshot of the *Surgical Procedures* Section

11.1 The procedure list:

11.1.1 After performing step 11.1 presented above; the procedure list will pop up in the right corner of the template; also, it is important to see complete data items; so you can enlarge the size of list frame by dragging the separating line to the lift(see figure 17).

11.1.2 Scroll down the menu to see more options.

11.1.3 Click on the intended procedure from the list.

11.1.4 You can select one procedure at a time; Click on *Insert item* button to insert the selected procedure to the *Procedure* filed

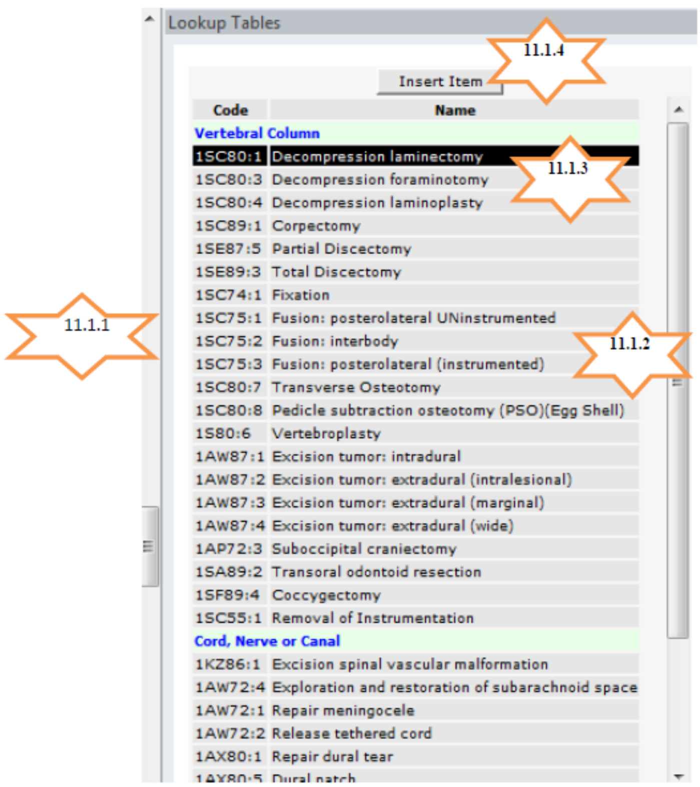

Figure 17: Screenshot of the procedures list

Surgical Procedures

Select Procedures

Procedure	Surgical Approach	Location Detail From:	Location Detail To:	Positioning
Decompression laminectoı	midline	C4	C6	Jackson Table: Flat
Decompression laminectoı	percutaneous	C4	C6	Jackson Table: Flat

Insert item

Figure 18: Screenshot of the *Surgical Procedures* Section shows that there are two surgical approaches used for the same Surgical Procedure.

Surgical Procedures

Select Procedures

Procedure	Surgical Approach	Location Detail From:	Location Detail To:	Positioning
Decompression laminectoı	midline	C4	C6	Mayfield head rest
Decompression laminectoı	midline	C4	C6	Wilson frame

Insert item

Figure 19: Screenshot of the *Surgical Procedures* Section shows that there are two positioning device used for the same surgical procedure.

----

12. Surgery Description/Findings:

Navigate the *Surgery Description/ Findings* section(see figure 20).

12.1 Enter a description of the surgery using free test

Surgery Description/Findings

Describe procedure(s) in details:

12.1

Figure 20: Screenshot of the *Surgery Description/Finding*.

13. Surgical Drains:

Navigate to the Functional Spinal *Procedure* Section of the Spinal Cord Injury Template (see figure 21)

13.1 Select surgical drain (s) by using Checkbox(es).

13.2 Scroll down the list to see a complete list of surgical drains.

13.3 Enter a surgical drain that is not presented in the list in an empty field at the end of the list; multiple entries should be separated by commas.

Note: you can enable another empty field by using " Enter" key in order to enter the name of more than one adjunct drug or procedure that are not provided in the list.

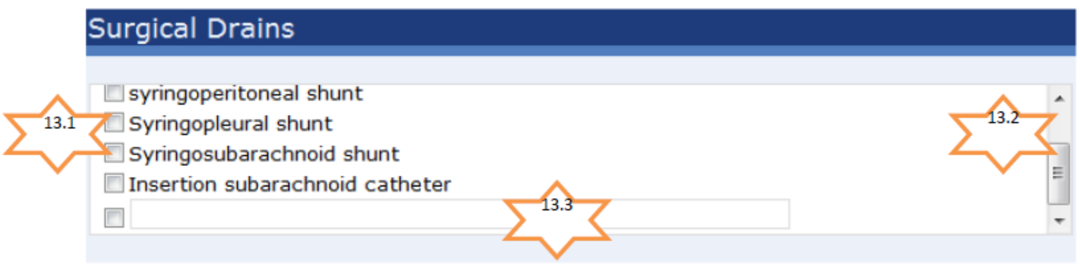

Figure 21: Screenshot of the *Surgical Drain* Section

---

14. Implants Information:

Navigate to the Implant section of the Synoptic Operative Report Template(see figure 22).

14.1 Select an implant device(s) from the *Device* drop down menu.

14.2 Select the location of the Implant from the *Location Detail drop* down menus; use " *From*" drop down to indicate the start point ; and use "*To*" drop down menu *to* indicate the end point.

21.3 Click on *Insert item* button to add another device, and repeat steps 1 and 2.

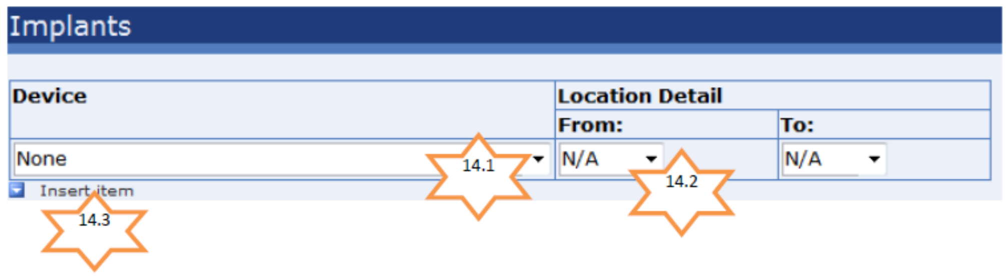

Figure 22: Screenshot of the *Implants* Section

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15. Bone Graft:

Navigate to the *Bone Graft* Section of the Spinal Cord Injury Template (See figure 23)

15.1 Use the ckeckbox(es) to select the type of the *Bone Graft* that was used in the surgical procedure form the *Bone Graft* checkboxes.

15.2 If the bone graft is not in the list, enter it into the blank field at the end of the list; Multiple entries should be separated by commas.

Note: you can enable another empty field by using " Enter" key in order to enter the name of more than one adjunct drug or procedure that are not provided in the list.

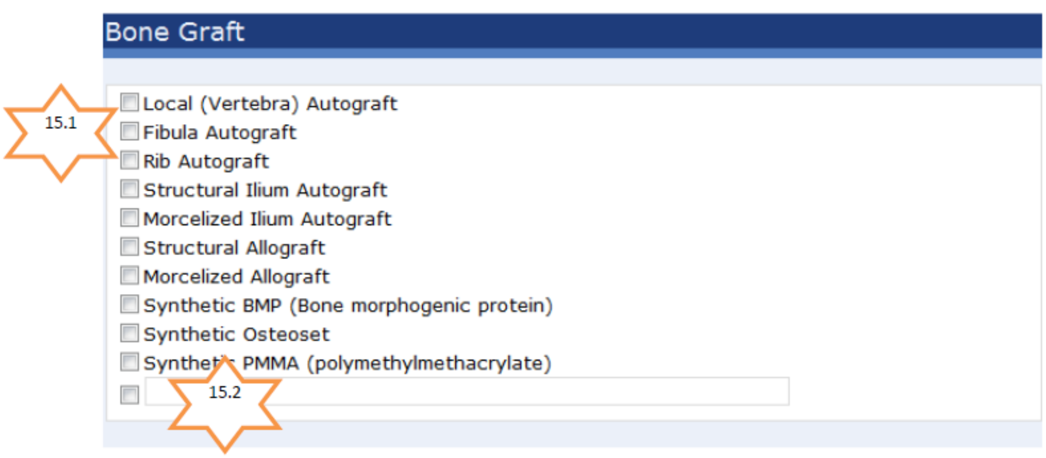

Figure 23: Screenshot of the *Bone Graft* Section

16. Adjunct Drugs/ Procedures

Navigate to the *Adjunct Drugs/Procedures* section of the Synoptic Operative Template(see figure 24).

16.1 Select the adjunct drug s or procedures from the *Adjunct Drugs/Procedures* list by using the Checkbox(es).

16.2 if the name of the intended adjunct drug or procedure is not in the list ; Enter it into the blank field at the end of the list; Also, Multiple entries should be separated by commas.

Note: you can enable another empty field by using " Enter" key in order to enter the name of more than one adjunct drug or procedure that are not provided in the list.

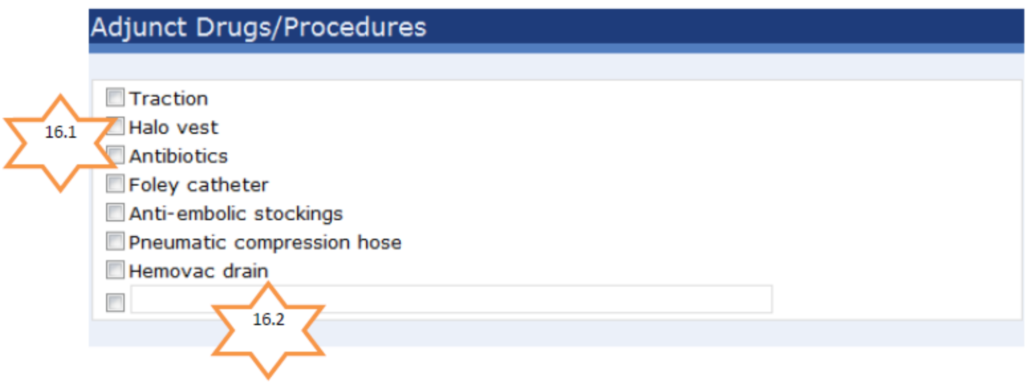

Figure 24. Screenshot of the Adjunct Drugs/ Procedure Section.

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17. Intra-Operative Fluid Intake Output

Navigate to the *Intra-Operative Fluid Intake Output Information* Section of the Synoptic Operative Report Template(see figure 25)

17.1 Enter the value of the estimated blood loss in the *Estimated Blood Loss* field

17.2 Enter the amount of the blood transfused to the patient in the Amount *of blood transfused* field

17.3 Enter the amount of intravenous fluid infused in the *Amount of IV Fluid Infused* field.

17.4 Enter the value of the intra-operative urine output in the Intra-Operative Urine Output field.

17.5 Enter the value of other fluid output in the *Other Fluid Output* field.

17.6 Enter the name of the other fluid that is measured in step 17.5 in the *Name of Other Fluid* field.

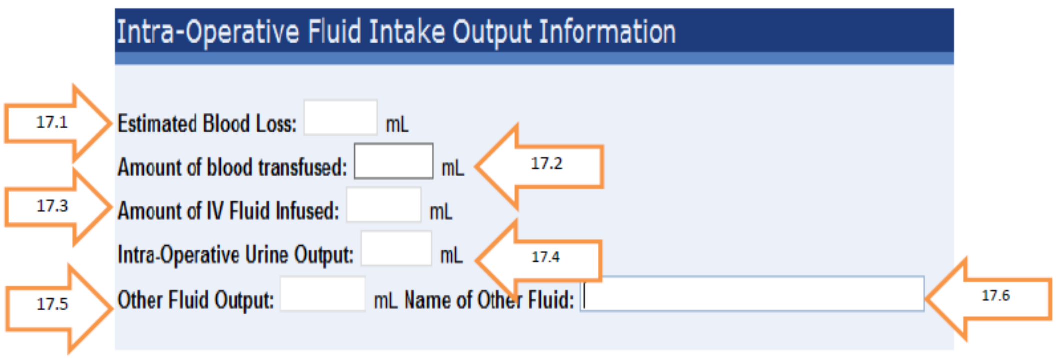

Figure 25: Screenshot of the *Intra-Operative Fluid Intake Output Information* Section.

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18. Discharge Disposition

Navigate to the *Discharge Disposition* Section of the Synoptic Operative Report (see figure 26).

18.1 Choose the Select the Discharge *Disposition* from list.

18.2 If the Discharge Disposition is not in the list, enter it in the box provided.

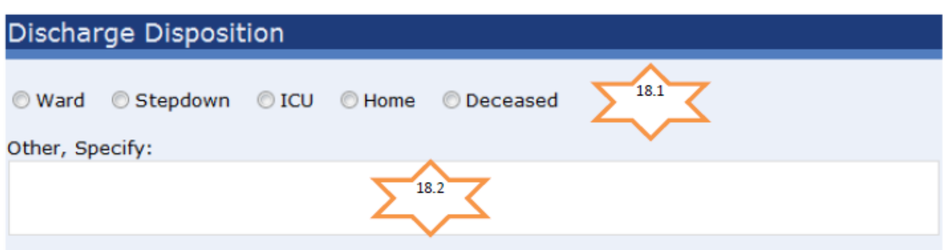

Figure 26 Screenshot of *Discharge Disposition Section.*

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19. Author of Operative Report

Navigate to the *Author on Operative Report* section (see figure 27)

19.1 Enter the authors' name in the *Given Name* filed.

19.2 Enter the author's family name in the *Family Name* field.

19.3 Enter the degree and/or title (e.g. MD, Jr.) in the *suffix* field.

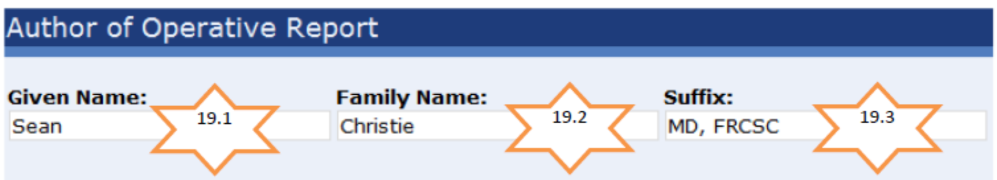

Figure 27 Screenshot of the Author on Operative Report Section.

SPECIAL INSTRUCTIONS

1. Removing a Row Erroneously Inserted:

1.1 Click on the floating button next to the row you would like to remove; and a drop down menu will appear (see
figure 28).

1.2 Select the third option in the drop down menu; for example in the preoperative diagnosis section presented in figure 28; you should select "remove predxentry" to remove a row; consequently, the entire row will be removed .

NOTE: This method for erasing an entry is used whenever there is an entry that needs to be removed from multiple entries.

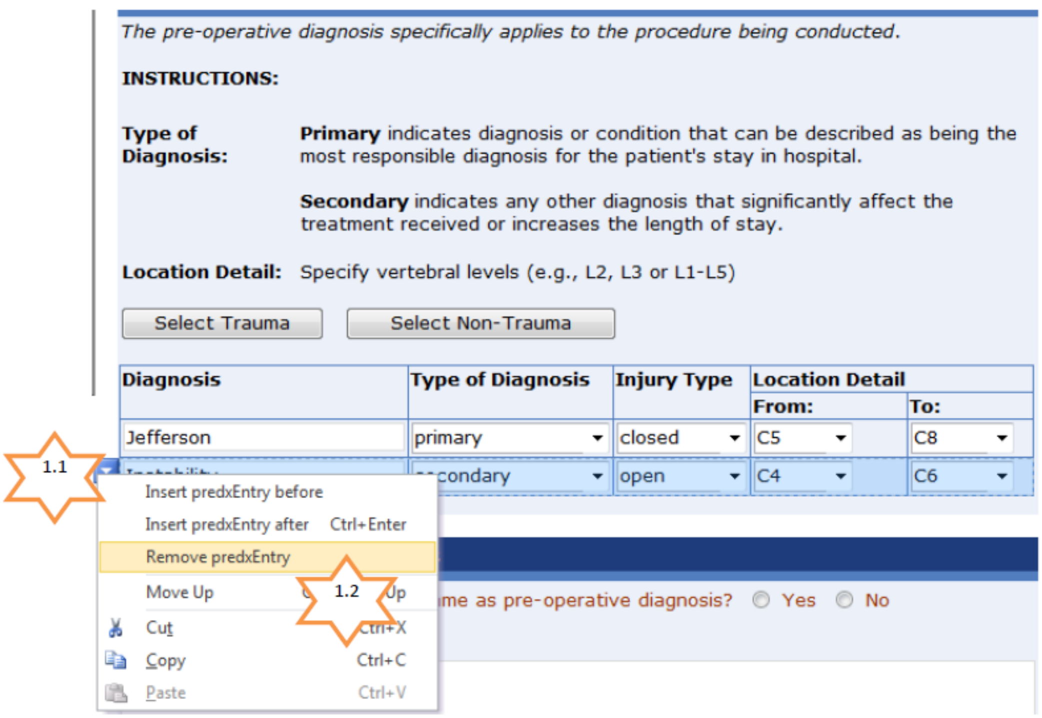

Figure 28: Shows the Removal of a Row in the Diagnosis Section

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2. Removing Entries of a Checkbox List:

2.1 In order to remove an selected data item form a checkbox list, you can click on the check box of the selected data item to be removed(see figure 29).

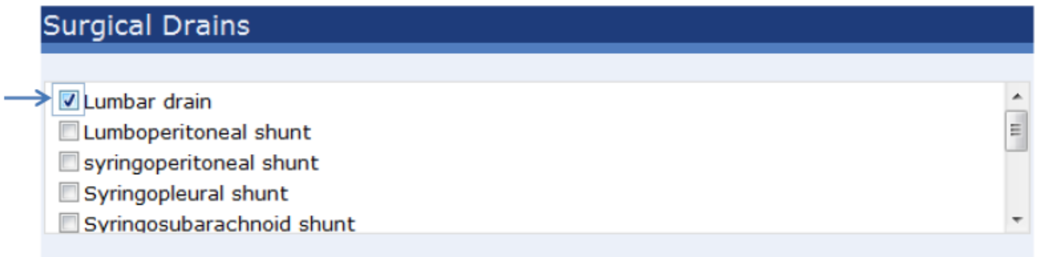

Figure 29: Removing an Entry of a Check Box List

SAVING AND VIEWING YOUR SYNOPTIC OPERATIVE REPORT

1. Saving Your Synoptic Operative Report

1.1 Select "Save as" under the File menu to save your work on the laptop. (See figure 30)

1.2 Save the report As" patientHUN.xml (where patientHUN is the patient's hospital unit number), (See figure 31).

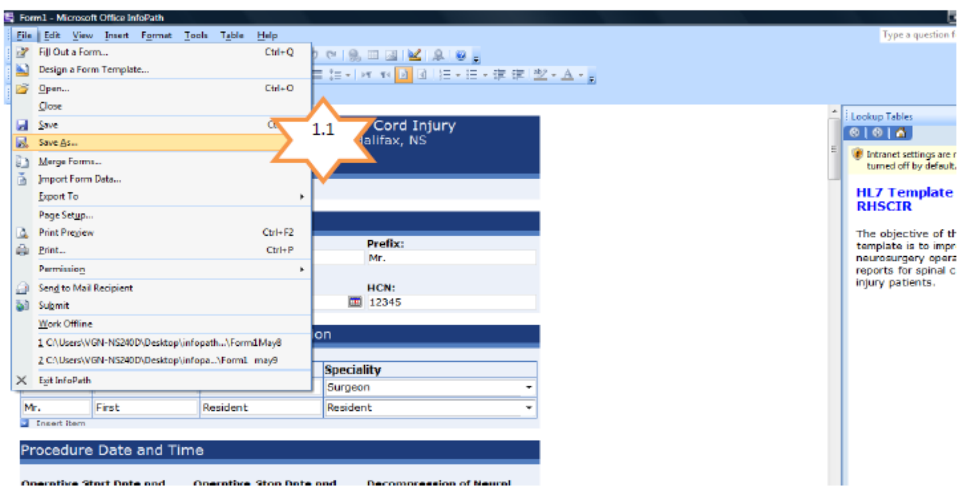

Figure 30: Saving Your Synoptic Operative Report.

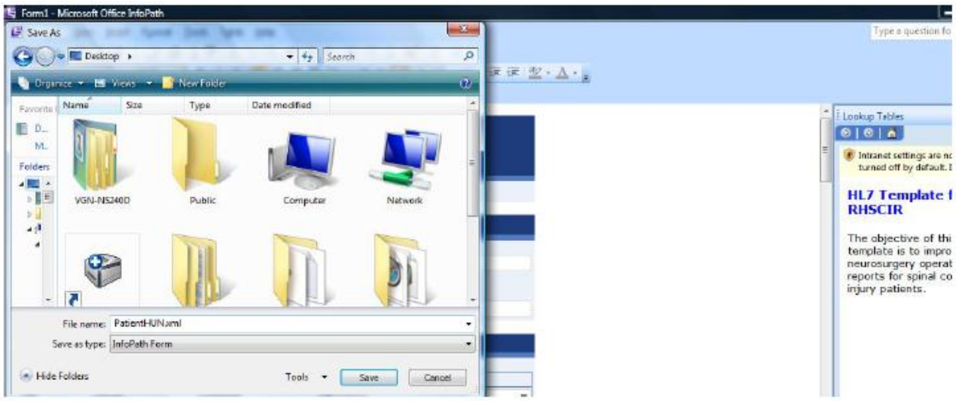

Figure 31: Saving Your Synoptic Operative Report.

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2. Viewing Your Synoptic Operative Report:

2.1 In order to view your Synoptic operative report; Use *Report View* in Microsoft InfoPath (See Figure 32).

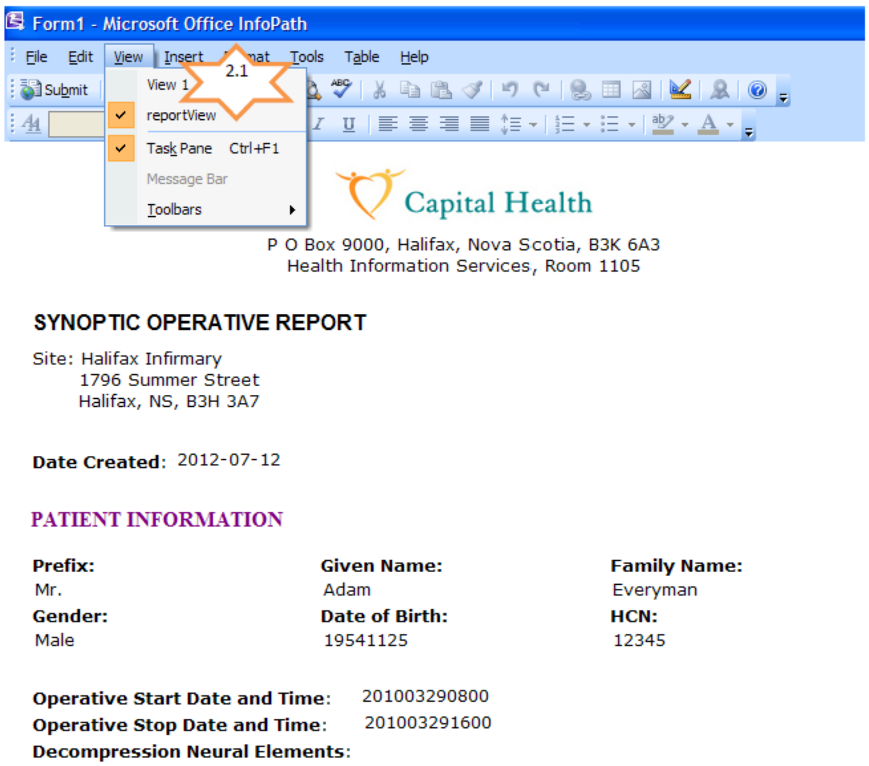

Figure 32: Screenshot of the Microsoft Infopath Shows How to View your Report

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Appendix N

Instruments for Evaluating Accuracy and Completeness of Synoptic Operative Report Template that Were Submitted With the Protocol of the Study "Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients"

Version 1

Updated July 6, 2011

Accuracy Assessment *(Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients)*

Serial No		Candidate's performance in each category				
I	**Clarity of dictation**	○ 1	○ 2	○ 3	○ 4	○ 5
		Description of included steps was vague and unintelligible		Description of included steps was relatively clear and intelligible		Description of included steps was clear and complete
II	**Reproducibility of operative procedure**	○ 1	○ 2	○ 3	○ 4	○ 5
		Recreation of operative events would be impossible from this Operative Report		Reader could recreate events using own knowledge to fill in gaps		Reader has a complete understanding of operation and could recreate procedure step by step
III	**Usability of the Operative Report for Administrative Data**	○ 1	○ 2	○ 3	○ 4	◉ 5
		Major deficiencies in using Operative Report as source document for diagnoses and procedures.		Acceptable Operative Report. Some room for improvement.		Comprehensiveness of coding using number of diagnoses and procedures captured

Completeness Assessment-1 (***Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients)***

Serial No.	Data field	Value available in operative report
1	Date of procedure	Yes No
2	Date of report completion	Yes No
3	Patient identifier	Yes No
4	Name of surgeon	Yes No
5	Name of anesthetist	Yes No
6	Pre-operative diagnosis	Yes No
7	Post-operative diagnosis	Yes No
8	Clinical summary	Yes No
9	Relevant investigation	Yes No
10	Type of Intubation	Yes No
11	Type of anaesthesia	Yes No
12	Patient position	Yes No
13	Type of surgical approach	Yes No
14	Pre-operative clinical status: Glasgow coma scale	Yes No
15	Pre-operative clinical status: ASIA impairment scale	Yes No
16	Pre-operative clinical status: ASA grade	Yes No
17	Estimated blood loss	Yes No
18	Procedures performed (location/type)	Yes No
19	Drainage/debridement (e.g. use of shunt/catheter)	Yes No
20	Implant	Yes No
21	Bone graft	Yes No

Completeness Assessment -2 (***Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients)***

I	**Description of operative indication**	◉ 1	○ 2	○ 3	○ 4	○ 5
		No description of pre-operative course or indication was included		Pre-operative course and indication were described but some detail was lacking or inaccurate		Complete description of pre-operative course and indications for specific procedure performed
III	**Inclusion of operative steps**	○ 1	○ 2	○ 3	○ 4	○ 5
		Incomplete as most important steps were missing		Included most important steps but some detail was missing.		Comprehensive and included all important steps of procedure
IV	**Description of operative findings**	○ 1	○ 2	○ 3	○ 4	○ 5
		Operative findings described were irrelevant or omitted completely		Operative findings were described but some relevant detail was lacking		Operative findings were presented in a relevant and detailed fashion

Appendix O

Instruments for Evaluating Accuracy and Completeness of Synoptic Operative Report Template

Version 2

Updated July 23, 2012

Accuracy Assessment *(*Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients*)*

Item No		Candidate's performance in each category				
1	**Clarity of dictation or narrative text entries in template**	1	2	3	4	5
		Description of included steps was vague and unintelligible		Description of included steps was relatively clear and intelligible		Description of included steps was clear and correct
2	**Reproducibility of operative procedure**	1	2	3	4	5
		Recreation of operative events would be impossible from this Operative Report		Reader could recreate events using own knowledge to fill in gaps		Reader has a complete understanding of operation and could recreate procedure step by step
3	**Usability of the Operative Report for Canadian Institute for Health Information (CIHI) Discharge Abstract Data (DAD)**	1	2	3	4	5
		Major deficiencies in using Operative Report as source document for CIHI DAD diagnoses and procedures.		Operative Report did not sufficiently capture diagnoses and procedures so manual intervention needed to generate CIHI DAD		Conformity of data to CIHI DAD classification and coding systems (ICD-10-CA and CCI) and comprehensive capture of diagnoses and procedures
4	**Usability of the Operative Report for Rick Hansen Spinal Cord Injury Registry (RHSCIR)**	1	2	3	4	5
		Major deficiencies in using Operative Report as source document for RHSCIR		Operative Report did not sufficiently capture data so manual intervention needed to fulfil data requirements of RHSCIR		Conformity of data to RHSCIR classification and coding systems and comprehensive capture of data required for RHSCIR

Completeness Assessment (Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients)

Inclusion of Data Items

<table>
<tr><th>Item No</th><th colspan="4">Data Item</th><th>Inclusion</th></tr>
<tr><td>1</td><td colspan="4">Date report created</td><td>___Yes ___No</td></tr>
<tr><td>2</td><td colspan="4">Date and time of procedure, including Decompression of Neural Elements, where applicable</td><td>___Yes ___No</td></tr>
<tr><td>3</td><td colspan="4">Patient identifier</td><td>___Yes ___No</td></tr>
<tr><td>4</td><td colspan="4">Name of surgeon(s)</td><td>___Yes ___No</td></tr>
<tr><td>5</td><td colspan="4">Name of anesthetist</td><td>___Yes ___No</td></tr>
<tr><td>6</td><td colspan="4">Pre-operative diagnosis</td><td>___Yes ___No</td></tr>
<tr><td>7</td><td colspan="4">Type of diagnosis</td><td>___Yes ___No</td></tr>
<tr><td>8</td><td colspan="4">Diagnosis injury type</td><td>___Yes ___No</td></tr>
<tr><td>9</td><td colspan="4">Diagnosis location</td><td>___Yes ___No</td></tr>
<tr><td>10</td><td colspan="4">Post-operative diagnosis</td><td>___Yes ___No</td></tr>
<tr><td>11</td><td colspan="4">Indication</td><td>___Yes ___No</td></tr>
<tr><td>12</td><td colspan="4">Indication location</td><td>___Yes ___No</td></tr>
<tr><td>13</td><td colspan="4">Associated co-morbidities</td><td>___Yes ___No</td></tr>
<tr><td>14</td><td colspan="4">Pre-operative clinical status: Glasgow coma scale(GCS)</td><td>___Yes ___No</td></tr>
<tr><td>15</td><td colspan="4">Pre-operative clinical status: ASIA Impairment Scale</td><td>___Yes ___No</td></tr>
<tr><td>16</td><td colspan="4">Pre-operative clinical status: ASA Grade</td><td>___Yes ___No</td></tr>
<tr><td>17</td><td colspan="4">Type of intubation</td><td>___Yes ___No</td></tr>
<tr><td>18</td><td colspan="4">Type of anaesthesia</td><td>___Yes ___No</td></tr>
<tr><td>19</td><td colspan="4">Procedures performed</td><td>___Yes ___No</td></tr>
<tr><td>20</td><td colspan="4">Type of surgical approach</td><td>___Yes ___No</td></tr>
<tr><td>21</td><td colspan="4">Procedure location</td><td>___Yes ___No</td></tr>
<tr><td>22</td><td colspan="4">Patient positioning</td><td>___Yes ___No</td></tr>
<tr><td>23</td><td colspan="4">Surgical drains</td><td>___Yes ___No</td></tr>
<tr><td>24</td><td colspan="4">Implant</td><td>___Yes ___No</td></tr>
<tr><td>25</td><td colspan="4">Implant location</td><td>___Yes ___No</td></tr>
<tr><td>26</td><td colspan="4">Bone graft</td><td>___Yes ___No</td></tr>
<tr><td>27</td><td colspan="4">Adjunct drugs/procedures</td><td>___Yes ___No</td></tr>
<tr><td>28</td><td colspan="4">Estimated blood loss</td><td>___Yes ___No</td></tr>
<tr><td>29</td><td colspan="4">Amount of blood transfused</td><td>___Yes ___No</td></tr>
<tr><td>30</td><td colspan="4">Amount of IV fluid transfused</td><td>___Yes ___No</td></tr>
<tr><td>31</td><td colspan="4">Intraoperative Urine Output</td><td>___Yes ___No</td></tr>
<tr><td>32</td><td colspan="4">Other Fluid Output</td><td>___Yes ___No</td></tr>
<tr><td>33</td><td colspan="4">Discharge Disposition</td><td>___Yes ___No</td></tr>
<tr><td>34</td><td>1
Description of surgery/findings were irrelevant or omitted completely</td><td>2</td><td>3
Description of surgery/findings were described but some relevant detail was lacking</td><td>4</td><td>5
Description of surgery/findings were presented in a relevant and detailed fashion, and included adverse events if they had occurred</td></tr>
</table>

Appendix R

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients (Recruitment Questionnaire)

Version 1

Updated July 6, 2011

Capital Health

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients

Recruitment Questionnaire

User number:

Please tick **only one** answer per question. Thank you.

Demographics:

What is your level of medical training? ▫ Clerk ▫ Resident ▫ Neurosurgeon ▫ Other Physician

Is English the language that you first learned at home in childhood? ▫ Yes ▫ No

Computer Experience:

	Never	Once or Twice	Monthly	Weekly	Daily
I have used a word processor (e.g. MS Word) to compose a text document					
I have used a database program (e.g. Access)					
I have used an internet search engine (e.g. Google) to find clinical information					
I have searched the Medline database using the PubMed search engine					

Medical Education:

I have received formal training regarding what content should be included in a synoptic operative report ▫ Yes ▫ No

I have previously used the Capital Health Enterprise Express Voice Dictation and Transcription System to dictate an operative report. ▫ Yes ▫ No

Recruitment Questionnaire for Synoptic Operative report

Page 1 of 1
v.1.0
July 6, 2011

Version 2

Updated July 13, 2012

Capital Health

Utility of Synoptic Reporting to Improve Operative Reports for Spinal Cord Injury Patients

Recruitment Questionnaire

User number:

Please tick only one answer per question. Thank you.

Demographics:

What is your level of medical training? ▫ Clerk ▫ Resident ▫ Neurosurgeon ▫ Other Surgeon/Physician

Is English the language that you first learned at home in childhood? ▫ Yes ▫ No

Computer Experience:

	Never	Once or Twice	Monthly	Weekly	Daily
I have used a word processor (e.g. MS Word) to compose a text document					
I have used an internet search engine (e.g. Google) to find clinical information					
I have searched the Medline database using the PubMed search engine					

Medical Education:

I have entered patient data into an Electronic Medical Record (EMR) ▫ Yes ▫ No

I have used the Horizon Patient Folder (HPF) in CDHA to view patient data ▫ Yes ▫ No

I have used the Sunrise Clinical Manager system in Saint John hospital, NB, to enter data ▫ Yes ▫ No

I have accessed patient information using Meditech hospital information system ▫ Yes ▫ No

I have completed a surgical rotation that required me to enter a synoptic operative report ▫ Yes ▫ No

I have previously used the Capital Health Enterprise Express Voice Dictation and Transcription System to dictate an operative report. ▫ Yes ▫ No

Recruitment Questionnaire for Synoptic Operative report

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v.2.0
July 13, 2012