



Building the Business Case for SNOMED CT®

***Promoting and Realising SNOMED CT®’s value in enabling
high-performing health systems***

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Acknowledgments

The authors would like to gratefully acknowledge a number of contributors without whose advice and support this paper would not have been possible.

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Many other stakeholders and colleagues supported the project, including the following teams and individuals:

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- Interviewees from the organizations profiled in Appendix A
- Reviewers from NEHTA and the Swedish National Board of Health and Welfare
- Gevity team members including Dr. Margaret Kennedy and Louise Brown

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EXECUTIVE SUMMARY

This paper was commissioned by the International Health Terminology Standards Development Organisation (IHTSDO) to assist members, prospective members, and other stakeholders as they develop business cases to support investment SNOMED CT.

The discussion focuses on the critical role SNOMED CT can play in helping members make effective use of clinical information to **improve patient health outcomes** and to **improve health system performance**. The approach is to unpack the features of SNOMED CT that enable advanced Electronic Health Records Systems, some essential tactics needed to instigate and sustain adoption of SNOMED CT and the benefits to expect from SNOMED CT implementation. This discussion is followed by guidance to help implementers quantify their business cases.

The key message is that use of SNOMED CT within Electronic Health Records (EHR) and clinical knowledge management systems can deliver a broad spectrum of tangible benefits. At one end of the spectrum, SNOMED CT provides basic operational cost savings to implementers by providing off-the-shelf terminology that is usable by clinicians, mapped to key classification systems used for regulatory reporting, and supported by a large and growing number of software vendors ... without the costs of developing and maintaining a full terminology locally. At the other end of the spectrum, SNOMED CT opens the door to broad, systemic benefits by making the clinical information captured in EHR systems easier to exchange, aggregate, analyse and reuse. This turns EHR data into a tool to enhance the clinical and operational processes healthcare systems employ to reduce waste, reduce errors and improve population based care.

We have estimated potential benefits by focusing on six implementation stages or functional packages (as outlined in Appendix D) that illustrate the potential order-of-magnitude benefits which SNOMED CT®, when appropriately deployed, can help provide. Due to the availability of data, the quantification examples in this paper focuses primarily on developed economies but are based upon models that apply everywhere health information technology is used to help manage and improve care.

Table 1: Implementation Stages and OOM Benefit Quantification

Implementation Stage	Order-of-Magnitude (OOM) Benefit Quantification
Enabling Basic Access Tactics to ensure country wide access to SNOMED CT Intellectual Property (IP).	IHTSDO membership fees are devised on an “ability to pay” model. G20 countries are levied, on average, just under US\$ 1M in annual IHTSDO membership fees against health system budgets in the billions. Only four of the world’s largest economies are levied fees over US\$ 1M. Conversely, 154 out of 157 non-G20 countries for which fees have been set, are levied annual membership costs <u>under US\$ 100K per year</u> – with 99 counties levied fees <u>under US\$ 10K per year</u> . In both cases membership fees reflect a small fraction of health IT expenditures and are certainly dwarfed by national health care budgets. Both large and small economies benefit immediately from membership given the full access to SNOMED CT® IP within their borders. Those who already have local users (either directly or through deployment of products which use SNOMED CT) eliminate any local licensing costs and may have an immediate return on investment, depending on the number of systems deployed. This amount is typically several times the cost of membership.
Establishing Localization & Initial Adoption Tactics to ensure that SNOMED CT has utility within domestic health systems.	Localization enables SNOMED CT adoption and use within EHR/EMR systems, making documentation more precise and information more comparable information. SNOMED CT adoption enables more efficient care delivery and savings from reduced duplication of diagnostic investigations. While hard cost savings will depend on test volumes, per test costs, and the extent to which EHR/EMR solutions include searchable laboratory and imaging data, large savings are possible. A 2% reduction in clinical lab test costs and a 5% reduction in Diagnostic Imaging (DI) costs on only 10% of overall OECD reported Clinical Laboratory and DI costs would yield a saving of US\$ 2.4M in the Netherlands or US\$ 43M in Germany.
Enabling Clinical Decision Support (CDS) Tactics that leverage SNOMED CT to direct Care and Outcome Improvements.	EHR solutions that use SNOMED CT to establish Clinical Decision Support capabilities provide a dramatic opportunity to realize benefits. Rather than simply providing access to searchable records these systems provide alerts and triggers which, if appropriately implemented, can provide further savings. For example, the savings identified for duplicate lab and DI test could ostensibly double with the introduction of triggers to identify existing tests during the order process and continue to grow as more advanced systems help providers use tests more appropriately. The opportunity to reduce costs associated with errors, particularly preventable Adverse Drug Events (pADEs), is even more substantial, with evidence that clinical decision support systems can reduce the burden by 55% - 83% according to Partners HealthCare in the US. Assuming a modest uptake for SNOMED CT based solutions of 10% and a savings of avoidable costs of only 10% the potential savings

Implementation Stage	Order-of-Magnitude (OOM) Benefit Quantification
	<p>benefit in the US alone is US\$ 200M per year against an estimated error cost of US\$ 21B.</p>
<p>Enabling Exchange of Clinical Information and/or Knowledge Resources</p> <p>Tactics that leverage SNOMED CT to enable sharing and reuse of patient health information and clinical knowledge.</p>	<p>The benefit for other members or potential members can be estimated using this same 1% factor against the applicable pADE cost estimate.</p> <p>It should be noted that these estimates do not consider additional potential savings pertaining to either, optimal use of medications and investigative procedures, or improved adherence to clinical best practice.</p>
<p>Enabling Clinical & Business Intelligence Systems</p> <p>Tactics that leverage SNOMED CT to precisely define patient populations and to measure and manage performance.</p>	<p>A key challenge in capturing the benefits of CDS is the cost to develop, deploy and maintain these systems. SNOMED CT can help enable adoption of best-practice and evidence based clinical decision support tools by providing a standard way to encode and exchange the clinical criteria used to drive alerts and thereby to reduce per-implementer maintenance and development costs.</p> <p>This triggers a modest administrative benefit across each system but also lowers adoption barriers to allow the benefits of CDS to be more readily realized across more facilities and thereby to address more sources of waste and more clinical errors.</p> <p>From a quantification perspective this means scaling any benefits up across a broader number of sites.</p> <p>Using the US example, every 10% increase in adoption could offer an order of magnitude increase in the potential benefit.</p>

Implementation Stage	Order-of-Magnitude (OOM) Benefit Quantification
<p>Expanding to Derive Deeper Network Benefits</p> <p>Tactics to deepen and expand SNOMED CT adoption throughout the health care system to accelerate clinical knowledge translation and adoption.</p>	<p>As SNOMED CT enabled solutions, particularly clinical decision support and knowledge management based solutions, become ever more pervasive, we project a potential network effect as more facilities (1) are able to develop, or implement decision support systems and (2) are able to contribute data to clinical research.</p> <p>There is evidence to suggest that widespread adoption of EHR systems, which enable efficient knowledge translation and disease management, can significantly improve outcomes for entire populations of patients. Considering the significant health system and lost productivity costs associated with premature morbidity due to chronic disease, the potential benefits of ubiquitous decision support and population management systems are substantial.</p>

In addition to outlining key benefits and offering quantification guidance to help members and prospective members in the development of their own business cases, the paper proposes an overarching SNOMED CT adoption framework (in Appendix C) to help stakeholders establish potential implementation strategies from which cost and benefit projections can be devised using the models presented in Appendix D.

The benefits of SNOMED CT adoption begin to be realized very early in the adoption cycle and could increase by orders of magnitude as widespread adoption begins to enable effective and efficient exchange and reuse of the clinical information throughout the health care system. For this reason, there is a strong and compelling business case for implementing SNOMED CT within Electronic Health Records particularly if these are established to support the journey towards implementation of Clinical Knowledge Management systems.

1.0 INTRODUCTION

1.1 PURPOSE

This paper was commissioned by the International Health Terminology Standards Development Organisation (IHTSDO) to help its members and other organizations develop and articulate the business case for investment in SNOMED CT.

The objective is to help stakeholders respond to four key questions in their business cases:

- ***Why SNOMED CT?***

In section 2, the key features and enabling-capabilities of SNOMED CT are outlined to help establish a common understanding and language for users of the document.

- ***What is required to instigate and sustain adoption as well as meaningful use¹ of SNOMED CT?***

Section 3 continues to establish the business case foundation by outlining key aspects of program development so as to establish a common context for the wide set of potential users of this document.

- ***What benefits can be expected from SNOMED CT implementation?***

Section 4 outlines a series of qualitative benefits to directly support business case writers as well as to position for the quantification techniques that follow.

- ***How can I quantify both costs and benefits?***

Section 5 provides key quantification techniques to highlight both the costs and basic benefits of adopting a common, internationally managed clinical terminology as well as the deeper, health system improvement benefits which effective use of SNOMED CT can help enable.

1.2 BACKGROUND

According to Accenture, by 2015 the global market for Electronic Health Records (EHR) systems is expected to exceed \$25 billion (US)² annually, largely as a result of government

¹ While use of the phrase “meaningful use”, in this paper, is not intended to refer to the US program of the same name, it is intended to convey the same intent, namely the purposeful and effective use of EHR technology to improve various aspects of the health system.

² Source: <http://newsroom.accenture.com/news/global-market-for-electronic-health-records-expected-to-reach-22-3-billion-by-the-end-of-2015-according-to-accenture.htm>, accessed July 5, 2014.

incentives and mandates. This expenditure of public funds is an investment toward systems, which, in many countries, are expected not only to improve quality, safety and efficiency within the healthcare system but also to help stem a tide of rising costs instigated by the demands of aging populations, increased prevalence of chronic diseases, rising consumer expectations and advances in the life sciences.

Beyond initial reductions in record keeping and storage costs, benefit from EHR implementation is realized in proportion to an EHR's ability to share and use clinical information in a manner that enables or enhances patient, population or health system outcomes. For example:

- Patient mobility and access to care is enhanced when patient information flows freely between healthcare settings and providers;
- Patient safety and quality is enhanced when healthcare providers have access to a patient's complete history when diagnosing illness or prescribing medications;
- Quality is enhanced when clinical knowledge is translated into actionable alerts and delivered to providers when and where it can best influence their treatment decisions;
- Clinical knowledge is enhanced when data gathered at the point of care is used to compare and evaluate the clinical effectiveness of existing and new technology or therapies in real world care settings;
- Patient outcomes and health system performance are enhanced when new discoveries and emerging technologies are effectively and efficiently translated into practice.

To help support adoption and meaningful use of clinical information systems, HIMSS Analytics³ and Gartner⁴ have produced well-established assessment tools, which identify key features and capabilities of clinical systems at different levels of maturity and adoption. Both identify **structured data** and **controlled medical vocabularies**, such as SNOMED CT, as key, foundational, EHR features that are required to enable meaningful sharing and use of clinical information.

Simply put, computers, like people, are better able to process and act on information that is presented in a familiar format using familiar language. Formally structured information and

³ Source: <http://www.himssanalytics.org/emram/>, accessed July 2014.

⁴ Source: <http://www.gartner.com/doc/414876?ref=SiteSearch&sthkw=Ehr%20generation&fnl=search>, accessed July, 2014.

controlled vocabularies enable EHR systems to recognize important information within patient health records and use it to support care delivery, monitoring, reporting and analysis.

As the most comprehensive, multilingual clinical healthcare terminology in the world, SNOMED CT is ideally positioned to be the Rosetta Stone of healthcare information exchange and, thus, to help unlock significant benefits from EHR investment. The important features of SNOMED CT and their benefits, including quantification approaches, are explored in the sections that follow.

2.0 WHY SNOMED CT?

2.1 A COMPREHENSIVE AND MULTILINGUAL FOUNDATION

The “Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT) is the most comprehensive, multilingual clinical healthcare terminology in the world”⁵. It was designed to provide the core general terminology for the electronic health record (EHR). It currently contains more than 311,000 active concepts with unique meanings that are expressed using formal logic-based definitions and organized into hierarchies to provide a comprehensive representation or graph of clinical knowledge.

When implemented in software applications, SNOMED CT can be used to represent clinically relevant information consistently, reliably and comprehensively as an integral part of the electronic health record.⁶

2.2 A CONTROLLED VOCABULARY WITH EXTENSIVE CONTENT COVERAGE

SNOMED Clinical Terms are clinician oriented, clinically validated and semantically rich. Clinical terms cover a broad range of clinical specialties, disciplines and requirements. This extensive content coverage includes clinical findings, procedures, observable entities, body structures, organisms and pharmaceuticals (among others).

The Power of Relationships

Coined by Tim Berners-Lee, inventor of the World Wide Web, the term Linked Data refers to a method of making information on the Internet easier to find and more useful by publishing documents and data with machine-readable descriptive metadata including links to related information. Linked Data is expected to make it easier to navigate and use the Internet by helping disambiguate search results and by providing better ways to bring context relevant information to the user. Linked Data can be seen at work within social networking sites that filter search results based on your existing network or use the relationships or preferences of others within your network to identify people you know or articles in which you may be interested.

SNOMED CT's description logic defines clinical concepts in terms of their relationships with one another forming a clinically validated graph of clinical knowledge. Encoding clinical information and knowledge resources with SNOMED CT connects your information with the rich network of relationships in SNOMED CT. Organizations including the Hong Kong Hospital Authority and Kaiser Permanente use these relationships to make it easier for clinicians to identify and act upon significant information stored within patient medical records.

⁵ Source: One-VA Technical Reference Model v14.8, <http://www.va.gov/trm/StandardPage.asp?tid=5210>, accessed September, 2014.

⁶ Source: <http://www.ihtsdo.org/snomed-ct>, accessed July, 2014.

SNOMED CT allows its users to be expressive. A single clinical concept in SNOMED CT, such as **myocardial infarction (disorder)**, may be represented by multiple, synonymous descriptions, such as **cardiac infarction** or **heart attack**, to correspond with the different ways that users of different specialties and backgrounds may express their clinical observations, interpretations and interventions. A SNOMED CT term or concept can be encoded within the health record using an identifier unique to the specific term selected by a user or the underlying concept.

2.3 A SYSTEM OF FORMAL STRUCTURED MEANING

SNOMED CT concepts have precise, clinically validated definitions that are expressed using computer processable description logic.⁷

SNOMED description logic is a structured method of defining **concepts** in terms of their *relationships* with other **concepts**. For example, using this syntax, **bacterial pneumonia is a(n)⁸ infective pneumonia** which has a **causative agent bacteria** and **finding site lung structure**. (See Figure 1 for an illustration of the fully modeled concept as it is represented in SNOMED CT.)

Underpinning controlled medical vocabulary with description logic based ontology provides two key benefits to implementers of health informatics solutions:

- **Quality Terminology:** modeling terms using description logic helps terminology authors, mappers and supporting systems recognize and appropriately represent synonymous terms.

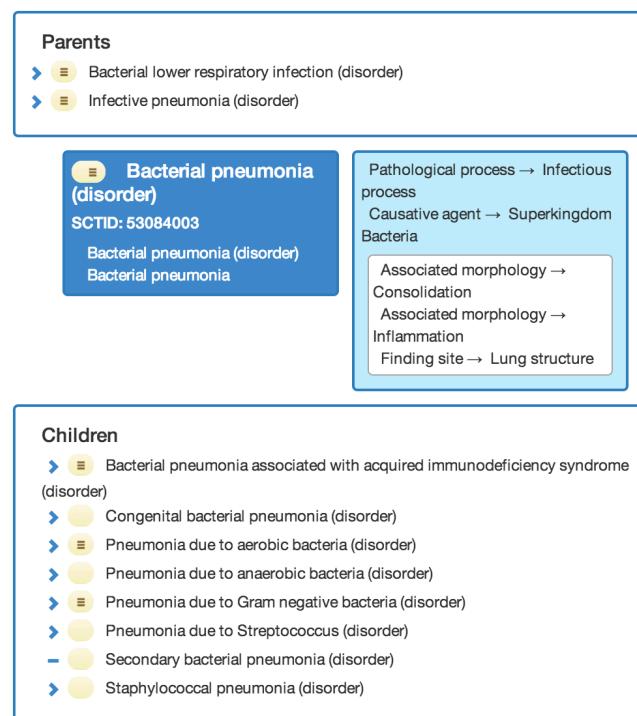


Figure 1: SNOMED CT Concept - Bacterial pneumonia (<http://browser.ihtsdotools.org/>)

⁷ K. A. Spackman, K. E. Campbell, R. A. Côte <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2233423/?page=3>, accessed June, 2014.

⁸ Note that “is a” reflects a formal relationship descriptor which does not concern itself with grammatical alignment.

- **Information Enrichment:** a description logic based ontology is a clinically validated map or graph of clinical knowledge that, once linked to clinical content in an EHR, can be used to connect, aggregate and analyse SNOMED CT encoded information within and across patient charts.

Description logic distinguishes SNOMED CT from other vocabulary and classification systems used in healthcare by making it a powerful tool for information processing.

2.4 A SCOPE THAT IS CLEARLY INTERNATIONAL

SNOMED CT is an international standard in use in over 50 countries⁹. It is owned and maintained by the IHTSDO, a Denmark based not-for-profit organization governed by members representing over 25 nations.

SNOMED CT descriptions are currently available in several languages including English, Spanish, Canadian French, Danish and Swedish¹⁰ (among others) and tools and expertise exist to support further translation and expansion. Multilingual descriptions associated with the same SNOMED CT concept enable clinical information exchange activities to transcend linguistic boundaries. (See inset.)

2.5 A WELL CONNECTED STANDARD SUPPORTING WELL CONNECTED SOLUTIONS

As custodians of SNOMED CT, the IHTSDO and its members collaborate with public and private stakeholders and other standards development organizations to foster SNOMED CT enabled and interconnected solutions. These solutions include commercially available clinical

Smart Open Services for European Patients

The European Union's *Smart Open Services for European Patients* or epSOS pilot project is a classic example of the use case for an international, multilingual terminology standard. Concluded in June 2014, the epSOS project demonstrated how an international and multilingual electronic health data interchange could offer seamless healthcare to European citizens. SNOMED CT supported multiple content areas in epSOS and demonstrated that a multilingual controlled vocabulary can effectively support an international health data interchange.

(See the respective implementer profile in Appendix A for more information about the epSOS initiative.)

⁹ Source: <http://www.ihtsdo.org/snomed-ct/whysnomedct/snomedfeatures/>, Accessed July 2014.

¹⁰ SNOMED CT is currently primarily modelled in English so that other translations represent lagging subsets updated as per the requirements of the respective language custodians. For example, Canada maintains a French Canadian translation for a subset of the full SNOMED CT release.

information systems that use integrated terminology products¹¹ to help automate administrative coding and charge capture processes and employ standards based data interchange standards to link to government hosted knowledge resources¹².

Interconnected solutions are important because stakeholders throughout the healthcare community have interdependent and shared information needs. For example:

- Healthcare providers, regulators, public and private sector payers and researchers all use information gathered at the point of care to provide services that help make healthcare accessible, safe and effective for patients, and
- Healthcare providers who are aware of innovations, regulatory requirements and patient health care coverage are better able to develop care plans aligned with best practice and tuned to patient needs. This can improve patient compliance and patient outcomes.

Relationships within SNOMED CT and standardized maps to other healthcare related coding systems provide a clinically validated way for computer systems to collect, connect, aggregate, translate and exchange health information for various uses.

Affiliates

Over 5000 individuals and organizations have registered as IHTSDO affiliates. Registered affiliates are organizations that use SNOMED CT within their products and services or develop software or services that allow others to use SNOMED CT.

Key Collaborations

IHTSDO collaborates with many other standards organizations to ensure compatibility and interoperability between SNOMED CT and other associated informatics standards. Key among these are the following:

- **The World Health Organization (WHO)** to ensure that appropriate maps exist between SNOMED CT and the WHO classifications. Work is underway to develop a common ontology for ICD-11 based on SNOMED CT.
- **The Regenstrief Institute Inc.** to link SNOMED CT with the institute's LOINC (Logical Observation Identifiers Names and Codes) system.
- **Health Level Seven International (HL7)** to facilitate standards development and benefits for those who use SNOMED CT in standard models and message specifications including HL7 messages and CDA documents.
- **The Global Medical Devices Nomenclature Agency (GMDNA)** to enable inclusion of the Global Medical Devices Nomenclature (GMDN) in SNOMED CT and for SNOMED CT medical device content to inform GMDN development.
- **The International Council of Nurses (ICN)** to develop cross-maps between SNOMED CT and the International Classification for Nursing Practice (ICNP).

¹¹ The IHTSDO Affiliate forum includes leading clinical information system vendors and vendors SNOMED CT based terminology projects that collaborate to provide integrated solutions.

¹² For an example, please see MedlinePlus website: <http://www.nlm.nih.gov/medlineplus/connect/service.html>, accessed August 2014.

2.6 AN EXTENDABLE MODEL

SNOMED CT is designed to support cases where extension is needed to meet specific national, local or organizational requirements:

- A well-established Namespace mechanism provides a formal method to add local descriptions to existing SNOMED CT concepts or to create new concepts and hierarchies while maintaining interoperability with the core International Edition.
- Reference Sets provide a flexible, standard way to identify the subsets of SNOMED CT content needed to manage language preferences (human or specialty), constrain search results or operationalize meaning based decision support rules.^{13,14}
- Reference sets can be defined using description logic based conditions or explicit lists of terms. In both cases, a reference set can be composed of concepts or terms spanning multiple different namespaces.

In situations where local extension content is appropriate for more general use, IHTSDO's maintenance, Request for Change (RFC) and governance processes support the adoption of local content into the core International Edition.

2.7 A UNIQUE TERMINOLOGY OFFERING

As the world's most comprehensive clinical terminology, SNOMED CT has no meaningful competitors. As stated by the Slovak eHealth Governance Initiative in their 2013 information paper¹⁵:

Although currently imperfect, there is no real alternative to SNOMED CT at this time if one wants to provide a fine grained and multidisciplinary care terminology which, despite primarily being meant for clinical records and communications, is enabled to cover the needs of all related sectors (administration, social care, research, secondary data use). SNOMED CT provides a very comprehensive set of clinical concepts together with an ontology which organizes these concepts.

¹³ See Kaiser Permanente profile, Appendix A.6.

¹⁴ See the SNOMED CT Starter Guide for more information: <http://snomed.org/starterguide>, accessed June 2014.

¹⁵ The Ministry of Health of the Slovak Republic National Health Information Center (NHIC), eHealth Governance Initiative (eHGI), Information Paper: Making use of SNOMED CT: Key Questions and Status as of September 2013.

Researchers from the Medical University of Warsaw estimate that to recreate SNOMED CT would require an investment of between \$25M and \$50M¹⁶.

Although collaboration between the World Health Organization and the IHTSDO is expected to produce an ICD 11 based on a SNOMED CT compatible ontological model, it is not slated for release until 2017 and, more importantly, its primary purpose will continue to be to support retrospective codification of clinical information for statistical purposes rather than documentation of clinical observations, interpretations and interventions by clinicians during the course of patient care.

¹⁶ Rudowski, R. et al, "SNOMED CT standard in E-health. Is it really needed?", http://www.medetel.lu/download/2007/.../SNOMED_CT_STANDARD.doc, accessed August 2014.

3.0 HOW TO INSTIGATE ADOPTION & SUSTAIN MEANINGFUL USE

As described in the previous section, SNOMED CT offers many unique features that can help EHR solutions become more useful and useable by clinicians. Realizing this potential requires successful implementation and meaningful use of SNOMED CT. How this is actually achieved and organized, at either a country or healthcare delivery organization level, will vary from country to country and from organization to organization. However, there are certain techniques and emerging best practices which can help frame the development of potential adoption strategies and associated business cases.

For the context of this section we will distinguish between two key roles:

SNOMED CT IMPLEMENTATION “PROGRAM”

A SNOMED CT implementation “program” refers to a set of coordinated activities provided to support and encourage adoption of SNOMED CT at a country or member level or within an organization. At a country or member level the program may be administered by the NRC or by another agency, department or organization working with the NRC. In an integrated health system, the program function may rest in a particular department or group. Note that stakeholders establishing member-level “Programs” represent the primary audience for this paper.

SNOMED CT IMPLEMENTATION “PROJECT”

A health informatics implementation “project” would be any initiative charged with delivering specific business and clinical objectives through the implementation a clinical system solution which utilizes SNOMED CT, either directly or indirectly, in order to achieve some or all of these objectives.

The degree of coordination and control a program will have over individual projects will vary widely based on context. At one extreme an integrated health system may have a well-defined enterprise architecture supported by an enterprise project portfolio management and terminology strategy; in this scenario the program and the associated projects are likely to be well integrated and responsive to the needs of the program. The other extreme is more characteristic of a country- or member-level program, where an NRC may have little or no direct

influence or control over the entities accountable for planning and delivering projects. In these cases, some combination of legal / policy drivers, incentives or goodwill will be relied upon to encourage adoption and meaningful use of SNOMED CT.

Regardless of the scenario, it is essential to remember that successful technology programs, particularly in their early phases, focus on the needs of people and not on the technology *per se*. Success will be measured in terms of the value the program returns to the people and organizations that use the solutions, products and services the program delivers not the elegance of the solutions SNOMED CT enables. Therefore, the road to success lies not in demonstrating the power and value of SNOMED CT itself but in delivering a program that is empathetic to stakeholder needs; delivers value to them early and often; adapts to challenges; and builds upon its successes. The sections below recommend priorities for different stages of a growing program. These priorities are drawn both from literature as well as from the experience of the authors and members of a working group struck to support the development of this paper. Appendix C provides a supporting Adoption Maturity Model to help enable tactical planning.

3.1 ENABLE ACCESS

Convenient legal access to SNOMED CT is the first step to developing an environment that encourages awareness, learning and adoption. The establishment of the IHTSDO has created a convenient mechanism to enable cost-effective access to SNOMED CT at a country level. Membership ensures that all domestic users have legal access to SNOMED CT in both locally developed systems as well as in the deployment of international products which contain SNOMED CT.

Membership is typically managed through a lead agency charged with administration of the relationship with the IHTSDO and sponsoring the operation of a National Release Centre (NRC) to provide local access to SNOMED CT through a domestic licensing and distribution scheme. The extent to which the lead agency and the NRC are combined is not explicitly addressed in this paper nor is the extent to which these two groups have the mandate to drive further adoption.

Rather, the focus is on the types of specific techniques and tactics which can be established at a member or implementer level to help drive adoption in order to unlock key health system

benefits. Regardless of how these responsibilities are distributed within a member country, a business case for SNOMED CT will ultimately rest (1) on the costs of membership, any common adoption tactics, and direct implementation costs, and (2) on the benefits which are enabled either by the access which simple membership offers as well as those which are enabled through effective deployment of SNOMED CT throughout the health system.

3.2 DEVELOP LOCAL EXPERTISE

System implementers and their users generally accept technology solutions that make their work easier or more productive or that deliver better results. This is also true for SNOMED CT. The first priority in any SNOMED CT implementation program should be to learn to use SNOMED CT to address the real world challenges faced by system implementers and their users.

Starting small with pilot projects that offer manageable scope, willing participants and high value use cases provides an unparalleled opportunity for an organization as well as project participants to learn how to use SNOMED CT to address real world clinical, business and technical needs. From a program standpoint, pilot projects should be approached not only as an opportunity to develop technical proficiency but to learn how SNOMED CT provides value to stakeholders and to identify and foster future advocates of the program.

Many organizations will engage external experts to help launch and staff new programs. Using experienced resources can be a significant enabler to a new program by helping the organization recognize opportunities and avoid known pitfalls. Even so, outside experts should support local resources that retain accountability to stakeholders for decision-making and

First Steps

In the early stages of a program, pilot projects offer a unique opportunity to use SNOMED CT to solve real world problems. Ideal projects will require structured, codified information to address concrete, near term needs while offering adopters some incentive for change. Opportunities can often be found in Health System Driven Initiatives that provide built in incentives and timelines that offer momentum to a project.

For Healthcare Software (HCS), an Australian eHealth solution vendor, the opportunity came in the form of a state mandated requirement for hospitals to produce Electronic Discharge Summaries (EDS). One of their customers, the Royal Hobart Hospital in Tasmania, had implemented HCS' EDS solution but lacked an efficient way to measure and manage their performance against state mandated KPIs. Working closely with end users, the hospital's management and experts at the Australian eHealth Research Centre (csiro.au), HCS enhanced their product to use SNOMED CT enabled structure forms.

For more information,
See the HealthCare Software and Royal Hobart's Hospital profile in Appendix A.1.

outcomes to ensure that the program develops and retains the SNOMED CT knowledge and expertise essential to its ongoing success.

Similarly, third party terminology products and tools can be a significant accelerator to projects, providing ready-made solutions to address common requirements. As with contractors and consultants, third party products and tools should be chosen to support, rather than direct, local requirements and therefore decisions should be made within the program, not be delegated to vendors. It is acceptable, even preferable, for tool selection in the early phases of a program to put tangible, short-term project needs ahead of ‘best practice’. Local experience acquired through early projects is needed to translate best practice into successful local solutions over the long term.

3.3 FOCUS ON HIGH-VALUE USE CASES

Selection of projects, particularly in the early stages of the program, can have a direct impact on the success of SNOMED CT deployment. Projects which are based on a strong business case that targets concrete clinical benefits through the establishment of health IT solutions which translate structured data and vocabulary into better care decisions, reduced errors and reduced duplication, are likely to provide a particularly fertile foundation for SNOMED CT.

Consider, for example, the implementation of a program to improve the management of a particular chronic condition. Such a program might include the following:

- the rollout of specific practice guidelines and associated change management activities;
- the establishment of clinician incentives (e.g. financial incentives in fee for service settings);
- the implementation of an Electronic Health Record (EHR) or other SNOMED CT enabled systems; and,
- the establishment of benefit evaluation or other post-implementation review activities.

The structures and codification in the EHR enable not only the implementation of key business triggers to support evidence-based care, but they also create the foundation for deeper analytics and reporting in support of program goals – both operationally as well as to enable benefit evaluation. Ideal conditions to deploy SNOMED CT to not only demonstrate viability but to position for the deeper potential benefits it can support.

3.4 BE EMPATHETIC TO STAKEHOLDER NEEDS

Advocates who are willing to lend their influence to support the needs of the program are essential to its ongoing success. Whether these individuals recognize and believe in the value of SNOMED CT, the business objectives of the program, or the people doing the work, their good will and influence lends momentum to the program by helping bring along other adopters and supporters. Advocates typically arise among the participants, stakeholders and beneficiaries of projects and therefore may be won or lost based on the quality of project execution, project outcomes or even events which occur after a solution goes live. A program that is empathetic and responsive to the needs of its stakeholders and participants has a much better probability of success.

Projects will necessarily be focused on delivery but it is important to regularly step back to assess and evaluate progress. Bringing together participants to discuss challenges and to develop solutions can help ensure successful delivery of the project and provide information needed to support planning and delivery of future projects. It is also important to take stock of which activities, resources and deliverables are necessarily specific to the project versus potentially reusable across projects. Reusable, ancillary activities, resources and deliverables may be better managed and delivered through a centralized, shared service or even acquired externally to enable a more efficient and effective program.

Change management processes, maintenance processes and stakeholder facing tools are essential components of a successful program. Clinical knowledge continuously evolves, as does SNOMED CT. Processes must be defined to manage user requests for new terminology as well as to cascade changes and updates to SNOMED CT into deployed solutions. Downstream impacts need to be managed. Poorly managed change can disrupt an otherwise successful program. The needs of end users and implementing organizations must be understood and incorporated into the design of maintenance processes and tools.

3.5 BUILD UPON A FOUNDATION OF SUCCESS

Successful solutions supported by advocates who recognize and understand the value provided by SNOMED CT provide a strong foundation for a growing program. Early expansion will typically focus on pursuing low hanging and high value projects that build upon existing solutions. Over time the emphasis will shift more and more toward the use of SNOMED CT to

connect, exchange and reuse clinical information. At key milestones, the program should engage key stakeholders, participants and advocates to assess the status of the program, identify approaches and opportunities to build upon the value provided by existing solutions, tools and services and to discuss how clinical information within existing and new solutions could be further used and enriched through further integration and exchange.

In the early phases of growth, the priority will be to reinforce, strengthen and build upon the foundation that was established during the pilot phase by enhancing solutions to address issues and to support additional use cases, rolling out solutions to new organizations and users, and integrating solutions with interdependent tools, clinical and business processes. The objective is to use SNOMED CT to support clinical and business integration, provide more functional tools, to make better and fuller use of information and to demonstrate improved outcomes as a result. Project emphasis continues to be on learning, demonstrating value and fostering advocates of the program by providing solutions to recognized problems. Outcomes should be measured and successes should be publicised to generate awareness. Ancillary services will be developed and refined to enable efficient delivery of projects and to help maintain the stability of existing solutions as the overall, integrated solution grows more complex and more interconnected.

A program that consistently delivers solutions that provide value back to stakeholders, high levels of user acceptance and support from influential advocates is positioned to strengthen its leadership posture and its ability to promote aggressive expansion. This is the time to bring together key stakeholders and advocates to recognize what has been accomplished, to discuss what is working (why and for whom) as well as untapped value within existing solutions, tools and services and to engage in blue sky discussions about opportunities and benefits of using SNOMED CT to more efficiently connect, share and use health information. These discussions are needed to develop the shared vision and strategy needed to establish and fund a broad based program. The value chain is discussed in the section that follows.

4.0 UNDERSTANDING THE BENEFITS

Healthcare is a knowledge industry and information is a core commodity within, and enabler of the system. The purpose of an electronic health record (EHR) system is to place accurate, complete information at the hands of clinicians when and where it can best support quality patient care, and to enable meaningful sharing and use of health information throughout the healthcare system. The benefit of systems that meet these objectives is better outcomes for patients, populations and the healthcare system as a whole.

Using SNOMED CT to encode clinical information will help organizations realize the full potential of their EHR investments by helping them make better and fuller use of the health information contained therein. Key elements of the value chain are captured in the sections below.

4.1 CLINICALLY VALIDATED VOCABULARY

Structured data and controlled medical vocabularies enable meaningful sharing and use of health information. Development and maintenance of controlled medical vocabulary systems requires an organization to acquire or develop a pool of skilled resources with specialized clinical knowledge and an interest in system usability and linguistics.

Adoption of SNOMED CT allows an organization to share development and maintenance costs and to realize quality and productivity advantages that arise from:

- extensive clinically validated and professionally maintained terminology content,
- a network of users to provide requirements and input to the standard,
- well-established governance processes, and
- access to experts with core competency in clinical terminology in general and SNOMED CT in particular¹⁷.

When localization or customization is needed to support an implementation, SNOMED CT provides formal mechanisms to extend SNOMED CT to meet local needs while retaining the full functionality of the core international standard. The tools and services needed to support

¹⁷ Experts at IHTSDO are available to support members. A community of third party experts, including vendors and other implementers, are also available to provide help.

localization, implementation and adoption of SNOMED CT are available from a large and growing community of IHTSDO affiliates.

4.2 IMPROVED DECISION SUPPORT

Information systems that can recognize patterns in health information and deliver current and actionable information to health care providers as it is relevant to their work can help users stay abreast of innovations, recognize patient needs and, in turn, deliver better outcomes for their patients.¹⁸

Implementation and maintenance of decision support systems is challenging, typically requiring an organization to develop and maintain complex logic-based rules that rely on lists of terms or codes that correspond to problem list entries, observations, prescriptions (etc.) to trigger reminders, alerts or order sets.

The features of SNOMED CT work together to benefit both the developers and users of decision support systems:

- SNOMED Clinical Terms allow users to capture and encode clinical information using clinician friendly language and at an appropriate level of detail. Usable clinical terminology is required to support user adoption of the structured documentation tools needed to host decision support tools.
- SNOMED description logic allows decision support authors to specify rules semantically using clinically meaningful criteria. Using a semantic query is a powerful alternative¹⁹ to other lexical or classification system based methods of specifying clinical criteria (see inset)

Effective Decision Support

In 2005, Kawamoto et. al. conducted a systematic review and study of randomized trials to identify features of clinical support systems. Seventy studies were included. Decision support systems significantly improved clinical practice in 68% of trials. Five system features were identified as being significantly more likely to improve clinical practice than interventions lacking the feature: automatic provision of decision support as part of clinician workflow, provision of recommendations rather than just assessments, provision of decision support at the time and location of decision making, and computer based decision support. Of 32 systems possessing all four features, 30 (94%) significantly improved clinical practice.

For more information:
 Kawamoto et al. BMJ 2005; 330 doi:
<http://dx.doi.org/10.1136/bmj.38398.500764.8F>, Accessed Aug 2014

¹⁸ Kawamoto et al. BMJ 2005; 330 doi: <http://dx.doi.org/10.1136/bmj.38398.500764.8F>, Accessed Aug 2014.

¹⁹ Kaiser Permanente's decision support authoring process typically uses a combination of (redundant) SNOMED CT, lexical and taxonomy based criteria to help authors refine their selection criteria. These are refined through the authoring process using a combination of inclusion and exclusion criteria. See profile in Appendix A.6.

within decision support rules. As new terms or concepts are added to SNOMED CT (or an extension) they automatically become visible to query tools, which reduces the effort required to maintain rules.²⁰

Moreover, SNOMED CT expressions provide implementers with a standard way to encode the clinical criteria used in decision support systems. This makes clinical criteria sharable between SNOMED CT enabled healthcare systems and reusable for related purposes including performance measurement and reporting.

In the United States, the Centers for Medicare and Medicaid Services (CMS) is actively sponsoring the development of Quality Measures, including SNOMED CT encoded clinical criteria, to support their quality initiatives and the National Library of Medicine Value Set Authority Center (VSAC)²¹ is working to make the CMS value sets available to EHR systems in machine-readable format.

4.3 INTEROPERABLE INFORMATION AND KNOWLEDGE RESOURCES

The classic benefits sought through EHR implementation are improved patient access to care, improved safety and improved outcomes as a result of more efficient exchange and reuse of patient-focused clinical information between health care providers. SNOMED CT enables these outcomes by providing healthcare organizations with a standard way to encode clinical information for exchange. SNOMED CT encoded information exchanged between SNOMED CT enabled systems is not only visible within a receiving system but is typically also interoperable with system workflows and decision support tools.

²⁰ Due to system constraints and/or local QA requirements, some implementers, including Kaiser Permanente, use semantic queries within maintenance tools and processes but extend results into an explicit list of concepts prior to implementation. Multiple COTS solutions are available to support this approach.

²¹ <http://www.nlm.nih.gov/healthit/vsac.html> Accessed Aug 2014.

Looking more broadly, a key challenge to the provision of safe and effective care is timely and effective translation of evolving healthcare-related science and technology into every day practice. Studies suggest that it takes an average of 17 years for new research findings to reach clinical practice.²² This has led to considerable interest and investment in research directed toward reducing the lag time between knowledge discovery and practice, including the development of models to help organizations understand the cycles of interdependent activities required to: translate emerging knowledge into tools and products; translate knowledge products into appropriate interventions at the point of care; and to translate interventions into outcomes.^{23,24}

Efficient development and maintenance of knowledge products and interventions (in the form of decision support tools) requires an efficient way for organizations to monitor changes to corresponding evidence and knowledge resources. In turn, effective translation of interventions into outcomes requires an efficient way to monitor and evaluate the impact of interventions and to tune systems to deliver the expected results.

As a comprehensive terminology product, SNOMED CT can help organizations develop a more systematized way to manage these interdependent processes by providing:

- a standard way to encode and connect clinical information contained within patient charts, decision support tools and knowledge resources,

Just-in-Time Knowledge Delivery

Partners HealthCare, an American integrated health system founded by Brigham and Women's Hospital and Massachusetts General Hospital, is an innovator in the use of knowledge management and clinical decision support systems to improve both patient and healthcare system outcomes. Their approach is to make “knowledge so readily available that it cannot be avoided ... by embed[ding] it into the technology that [clinicians] use to do their jobs” and by integrating their care delivery and clinical knowledge management processes and tools. The objective is to ensure that the evidence Partners provides to clinicians is not only delivered in the context of their work but is also current and consistent with best practice. In the background, collaboration tools and a team of 50 people support clinical knowledge management processes at Partners. It is a big investment but it delivers results in the form of rapid translation of evidence into practice, improved patient outcomes and improved organizational financial performance.

For more information:
<http://hbswk.hbs.edu/archive/3049.html>, Accessed Sept 2014 and
<http://www.cwhonors.org/viewCaseStudy2008.aspx?NominationID=365>, Accessed Sept 2014

²² <http://www.ihi.org/resources/Pages/Publications/Managingclinicalknowledgeforhealthcareimprovement.aspx> Accessed Aug 2014.

²³ <http://www.socialresearchmethods.net/research/Evaluating%20Translational%20Research%20-%20A%20Process%20Marker%20Model.pdf> Accessed July 2014.

²⁴ <http://ktclearinghouse.ca/knowledgebase/knowledgetoaction> Accessed Aug 2014.

- an ontology to organize, aggregate and analyse knowledge resources, and
- a standard way to encode clinical criteria for reuse across a range of clinical, knowledge management and monitoring tools.

The benefit of more efficient and effective knowledge translation is improved outcomes for patients and populations and, in turn, improved health system performance. (See Appendix B for a deeper discussion of how SNOMED CT can enable knowledge management and translation.)

4.4 IMPROVED CLINICAL AND BUSINESS INTELLIGENCE

The ability for an organization to effectively monitor the impact of an intervention and to fine tune criteria is essential for it to realize and sustain improved patient outcomes through the use of decision support tools. Borrowing from the parlance of the Big Data Hype, information systems that are capable of providing organizations with insight into trends or patterns that impact the health of populations can enable more precise identification of patient populations and, in turn, finer and more precise tuning of decision support and monitoring systems and better outcomes. The opportunity is recognized within the industry and is reflected in a growing market for health analytics solutions.

Comparable, machine processable information is an enabler, if not a prerequisite, to effective analytic tools. Outside of healthcare, ontologies similar to SNOMED CT are increasingly employed as a mechanism to encode narrative documents and images on the internet so they

Superior Outcomes

Kaiser Permanente (KP) is a large US based integrated health delivery system that is recognized for its successful disease management programs. Examples include KP's Cardiac Disease Programs, which are attributed with increasing rates of hypertension control among its members to over 80% (vs 50% nationally), reducing incidences of serious heart attacks by 62% and significantly improving overall survival rates of survivorship in comparison to patients receiving standard cardiac care.

The organization employs a systemized approach to disease prevention, treatment and research supported by KP's Electronic Health Records system. Within this system, KP's SNOMED CT based enterprise Convergent Medical Terminology (CMT) enables the clinician facing documentation tools and logic-based rules employed to drive and monitor KP's decision support systems.

For more information, Kaiser Permanente profile in Appendix A.6, <http://cardiacare.kaiserpermanente.org>, Accessed Sept 2014, and <http://share.kaiserpermanente.org/tag/convergent-medical-terminology/>, Accessed Sept 2014

become more discoverable, more accessible and more usable sources of information.^{25,26} The structure and technical underpinnings of different EHR systems and the internet vary, but the challenges of processing narrative information and benefits of using ontologies to encode, connect and aggregate information are not specific to any single application or system.

²⁵ http://en.wikipedia.org/wiki/Web_Ontology_Language Accessed June 2014.

²⁶ http://en.wikipedia.org/wiki/Linked_data Accessed June 2014.

4.5 NETWORK BENEFITS

Network benefits accrue when connections between people and organizations create new efficiencies or business opportunities that provide economic value. The classic example of a technology that provides network benefits is the telephone, which provided a new way for people to stay in touch with one another or to conduct business without being in the same place. As an early adopter, the value of the telephone was limited but the value increased exponentially as more and more people brought telephones into their homes and businesses.

Health information is a core enabler of the healthcare system. From an economic perspective, health information has tremendous potential to deliver economic return to organizations as cost savings accrue from uses that improve patient outcomes or provide more effective and efficient use of technology and pharmaceuticals.²⁷

Health information in unstructured narrative form is difficult to exchange and reuse as evidenced by the significant lag time between knowledge discovery and its translation into everyday practice. Consistently encoding information within EHR systems, clinical criteria within decision support tools and abstracts of knowledge resources using SNOMED CT will help make health information more discoverable, more exchangeable, and more interoperable (reusable) across organizations. Consider the following example:

An efficient mechanism to exchange health information can help make the value of health information more readily accessible to both knowledge producers and consumers.

1. Innovators translate emerging medical evidence into knowledge products (decision support tools) with the goal of improving local clinical or business outcomes.
2. The innovation improves performance for and/or delivers cost savings to the innovator.
3. Standardized vocabulary and structures²⁸ make the knowledge products more readily implementable elsewhere, allowing the innovator to share its knowledge products with other organizations.
4. Exchange provides a mechanism for consumers to realize benefit from the innovation and, potentially, for the producer to realize revenue and further economic return on their initial investment.

²⁷ See Kaiser Permanente Profile in Appendix A.6

²⁸ <http://healthit.ahrq.gov/ahrq-funded-projects/structuring-care-recommendations-clinical-decision-support> Accessed Sept 2014.

Making the value of health information more accessible can, in turn, also help accelerate the rate at which new innovations are translated into consumable knowledge products and into practice.

Encoding information using an international, multilingual standard like SNOMED CT can also help reduce linguistic and economic barriers to knowledge translation and adoption.

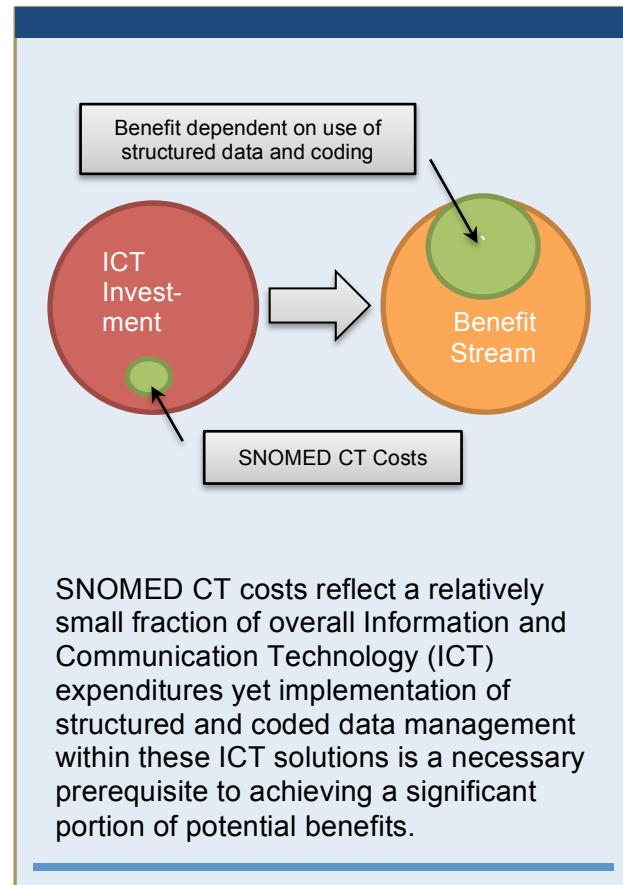
5. Where revenue is realized, it provides potential source of funding for further investment in knowledge products.
6. Where revenue is realized, it also provides an incentive for other innovators and knowledge producers to translate their innovations into exchangeable knowledge products.
7. Knowledge producers and consumers can express the clinical criteria used to identify, discover, deploy knowledge products and underlying evidence in a language neutral way.
8. Knowledge translation costs are distributed among consumers, potentially lowering costs of knowledge acquisition and adoption for individual consumers.
9. Competition among knowledge producers may also lower costs of knowledge acquisition and adoption for consumers.

As the most comprehensive, multilingual clinical healthcare terminology in the world, SNOMED CT is well positioned to be the Rosetta Stone of health information exchange. Through the mechanisms described above, SNOMED CT enabled systems can help unleash the value of health information within implementing organizations and help contribute to more efficient knowledge exchange and translation throughout national healthcare systems as well as internationally. The expected benefit is more efficient and effective healthcare services, improved patient and population health, better and more appropriate use of technology, improved health system financial outcomes as well as societal benefits that accrue from a healthy and productive population and more efficient and effective use of tax money.

A potential ancillary benefit of more efficient knowledge exchange and translation processes may be to help lower the economic barriers that contribute to health disparities within and between communities and nations of different means.

5.0 QUANTIFYING THE BUSINESS CASE

As described in section 4.0, SNOMED CT was designed to provide a wide spectrum of benefits to the health system, especially when used as a building block to implement clinical knowledge management strategies that drive evidence-based health system improvements. Quantification of these benefits is challenging for several reasons. First, benefit quantification relies on clear factors which may vary from health system to health system. Next, few benefits except basic operational cost avoidance can be ascribed to SNOMED CT alone; rather, benefits arise as clinical practices leverage effective electronic health information management solutions, SNOMED CT and clinical information to improve care delivery. Fortunately, the cost of SNOMED CT typically reflects a small portion of overall Information and Communication Technology investment costs while the benefits that reasonably can be attributed to the use of structured and coded information reflect a correspondingly larger portion of the benefit stream particularly in the later stages of implementations. (See inset as well as Appendix D)



The quantification approach that follows is illustrative rather than absolute, offering quantification techniques for consideration by members or prospective members of the IHTSDO (e.g., stakeholders who are taking a country level perspective²⁹) when called upon to develop business cases to support IHTSDO membership, establishment of a National Release Centre (NRC), and/or other SNOMED CT implementation initiatives.

²⁹ Where applicable, suggestions for interpretation of these techniques by major health systems or initiatives operating within a member country have also been included.

5.1 APPROACH

5.1.1 General

This section offers broad quantification examples that are expanded upon in Appendix D. Both the examples and the detailed profiles are based on the following principles.

Focus on Incremental Costs to Enable Key Benefits

The quantification approaches in this section build upon the qualitative discussion in Section 4.0 to illustrate potential costs and benefits that may be realized through various tactics. The costs identified represent an incremental investment in SNOMED CT above and beyond the costs of the tools and associated IT programs. In turn, few benefits can be attributed to SNOMED CT alone, but accrue either from investment in SNOMED CT or from equivalent or larger investments in the development or acquisition of technology that provides similar capabilities. (See inset on previous page for an illustration.)

Planning Horizon Neutrality

Business cases typically cover a particular planning horizon over which investment costs are accrued and benefit realization is targeted. This report does not propose or rely on any particular planning horizon but, rather, is focused on providing general quantification techniques for application in actual business cases. Readers who are developing their own specific business cases will need to consider carefully which costs are recurring and which are one-time investments when considered in the context of a particular planning window and implementation strategy.

Ensuring Global Relevance

In order to ensure that the business case guidance provided has local relevance and applicability, it is important to segregate costs and benefits which are subject to global market forces from those where an implementer's local economic conditions prevail.

For example, NRC staffing and other activities in a country will be based on local labour rates and cost structures which can result in large cost variations when expressed in hard currency terms. As a result, where possible, the report identifies typical effort ranges rather than specific cost estimates even if these effort ranges have been deduced from actual experience and expenditure data in other countries.

Those benefits which are derived from the avoidance of specific activities (e.g. avoiding the development of local terminology systems or reduced laboratory test duplication due to improved access and search-ability of data), should also be quantified based on local cost structures. Quantification of more complex benefits streams (e.g. improved management of chronic conditions or reductions in the incidence of errors) are even more dependent on local conditions since these will depend not only on local cost structures but on the incidence of certain conditions, population size and other factors. For these, broad measures and general quantification techniques are proposed.

5.1.2 Investment Categories

In order to provide a generic cost estimating framework that can be applied across a wide range of implementation strategies and countries, a series of investment categories are outlined in the following table.

Table 2: Investment Categories and Cost Components

Investment Category	Major Cost Components	
	Member Country ("Program" Perspective)	Implementing Organization ("Project" Perspective)
Licensing / Membership	The right to access the SNOMED CT international release and associated intellectual property at a country level is part of the IHTSDO membership fees.	<i>For the purpose of this paper, SNOMED CT licensing and any applicable localization translation efforts are assumed to be undertaken at a member level.</i>
Localization	Localization ranges from the establishment of local language or dialect (human, clinical specialty) subsets and translations to the development of country specific content (e.g. local medication extension to map generic SNOMED CT concepts to drug product concepts relevant in the local market and typically managed by the domestic drug regulatory agency).	<i>Similarly, although members may charge fees on a cost-recovery basis, such transfers are not germane to the system level cost / benefit determination targeted by this paper.</i>
Ongoing Core Operations	At a member level, ongoing operations typically involves the establishment of a National Release Centre (NRC) which provides the liaison point between the IHTSDO and implementers; typical activities will include at a minimum:	Organizations that develop or operate significant electronic health record (EHR) and associated clinical knowledge management infrastructures using SNOMED CT have to consider the extent to which they will actively develop and manage their own terminology

Investment Category	Major Cost Components	
	Member Country (“Program” Perspective)	Implementing Organization (“Project” Perspective)
	<ul style="list-style-type: none"> • In-country publication and distribution of SNOMED CT which may include the international release, country specific localizations as well as associated support materials; • Release management, including updating country specific extensions as/when the core International Edition is updated; • Acting as a conduit for SNOMED CT enhancement requests which may include triaging and supporting these requests; • Management of domestic affiliate licenses and other obligations related to the IHTSDO license agreement; and • Acquisition, support and maintenance of tools required supporting the activities above. <p>In addition, these activities may also apply:</p> <ul style="list-style-type: none"> • Inter-professional clinician engagement to support identification, validation, development and ongoing maintenance of national extensions; and • Provision of communication campaigns, adoption support, and education for clinicians and implementers within the member country. 	<p>resources. Although some of this may be outsourced to the prevailing EHR solution providers or other service providers, typical activities could include:</p> <ul style="list-style-type: none"> • Localization of terminology content (typically development and maintenance of terminology value sets); • Integration and/or implementation of terminology within local systems; and • Release management, including change request management and distribution processes needed to maintain localizations.
Initiative Enablement	<p>In the context of this paper, Initiative Enablement refers to a wide range of activities which are often needed to enable, encourage and support SNOMED CT adoption throughout the health system – whether at a national level or within major health delivery organizations.</p> <p>The extent to which these activities are provided, coordinated or funded centrally by the member (e.g. the applicable Ministry or Department of Health or other IHTSDO membership coordinating agency) will be a reflection of how the healthcare system is organized and funded as well as other social and political constraints unique to different nations. For example, in some countries government may have a</p>	

Investment Category	Major Cost Components	
	Member Country ("Program" Perspective)	Implementing Organization ("Project" Perspective)
	<p>regulatory role but not a strong operational role, while in others these two responsibilities may be linked or distributed between different levels of government. Regardless of who provides, organizes or funds services, any broad scale SNOMED CT implementation program will require supporting services which may include:</p> <ul style="list-style-type: none"> • Establishment of training and support services in order to create and/or expand local expertise; • Facilitating the development, publication, distribution and maintenance of shared assets such as SNOMED CT reference sets (or refsets); and • Establishment of incentives for SNOMED CT adoption, whether directly or as part of eHealth initiatives. <p>Some existing members centralize many of these ancillary functions in their National Release Centers³⁰, others distribute ancillary functions among stakeholders and/or depend heavily on commercial product and service offerings.</p>	
Implementation	<p>Costs to replace and upgrade incompatible legacy systems have not been provided in the tables that follow. Estimates assume that SNOMED CT implementations would typically:</p> <ul style="list-style-type: none"> • take place within greenfield system implementations or system replacements; or • that legacy systems participating within integrated solutions would be supported by providing SNOMED CT derived terminology assets or services that are compatible with the target solutions. <p>In each of these cases, costs to build and maintain selection lists and other tools using SNOMED CT would be comparable and often less than other options. The rationale is that a SNOMED CT business cases should not bear the full cost of moving implementers to solutions with structured and coded data unless the SNOMED CT adoption is the sole impetus for doing so. (This would rarely, if ever, be the case.)</p> <p>Data translation or conversion costs are an incremental cost of SNOMED CT implementation. Mapping costs to support these activities are identified where they apply.</p>	

³⁰ See Canada Health Infoway's Standards Collaborative (<https://www.infoway-inforoute.ca/index.php/programs-services/standards-collaborative>).

5.1.3 Quantifiable Benefit Categories

Similar to costs, benefits can be grouped into several basic categories with different potential components. Key benefit categories are identified in the table below together with sample benefit streams which have a potential for quantification in certain settings:

Table 3: Quantifiable Benefit Categories

Benefit Categories		Sample Benefit Streams with Potential for Quantification
Administrative & Management Cost Savings	Administrative Cost Avoidance or Reductions	<ul style="list-style-type: none"> • Elimination of SNOMED CT licensing costs at a facility or user level and associated administrative overheads. • Reduction in medical records administration / health information management (HIM) costs as standardized SNOMED CT to ICD maps and software help automate coding processes.
	“EHR” Management Cost Avoidance and/or Reductions	<ul style="list-style-type: none"> • Reduction in costs to acquire or to develop and maintain local terminology products. (e.g. value sets used in messaging, selection lists, etc.). • Reduction in costs to acquire or to develop and maintain clinical criteria used to identify patient cohorts within clinical decision support and performance monitoring (clinical and business intelligence) systems. • Reduction in costs to acquire or to develop and maintain clinical decision support tools and other knowledge products.
Care and Outcome Improvements	Efficient Care Delivery	<ul style="list-style-type: none"> • Reduction in costs associated with duplicate or unnecessary investigations (e.g. laboratory tests and imaging studies). • Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay). • Reduction in costs due to more optimized use of medications (e.g. appropriate, cost effective use of drug therapies) and other technologies (e.g. appropriate, cost effective use of laboratory tests and imaging studies).
	Improved Patient Outcomes	<ul style="list-style-type: none"> • Reduction in costs due to better disease management, better patient outcomes and lower health system utilization.
	Improved Societal Outcomes	<ul style="list-style-type: none"> • Improved economic productivity from better population-wide health (“Healthy Happy Productive Communities”).

5.2 A STAGED VIEW OF COSTS AND BENEFITS

While the journey of implementing SNOMED CT enabled solutions will vary among countries and health systems, the types of tactics and benefits which can be realized are fundamentally

similar since these are based on providing better information and better decision making tools to clinicians, researchers and health system administrators. In order to enable members to build their own business cases we have bundled example costs and benefits into a series of staged packages which are intended to illustrate specific tactics; approaches to estimate the associated costs; as well as approaches to quantify the benefits targeted by these tactics. These packages build on each other to yield progressively more benefits, through broader and deeper adoption of SNOMED CT enabled solutions as shown in the figure below:

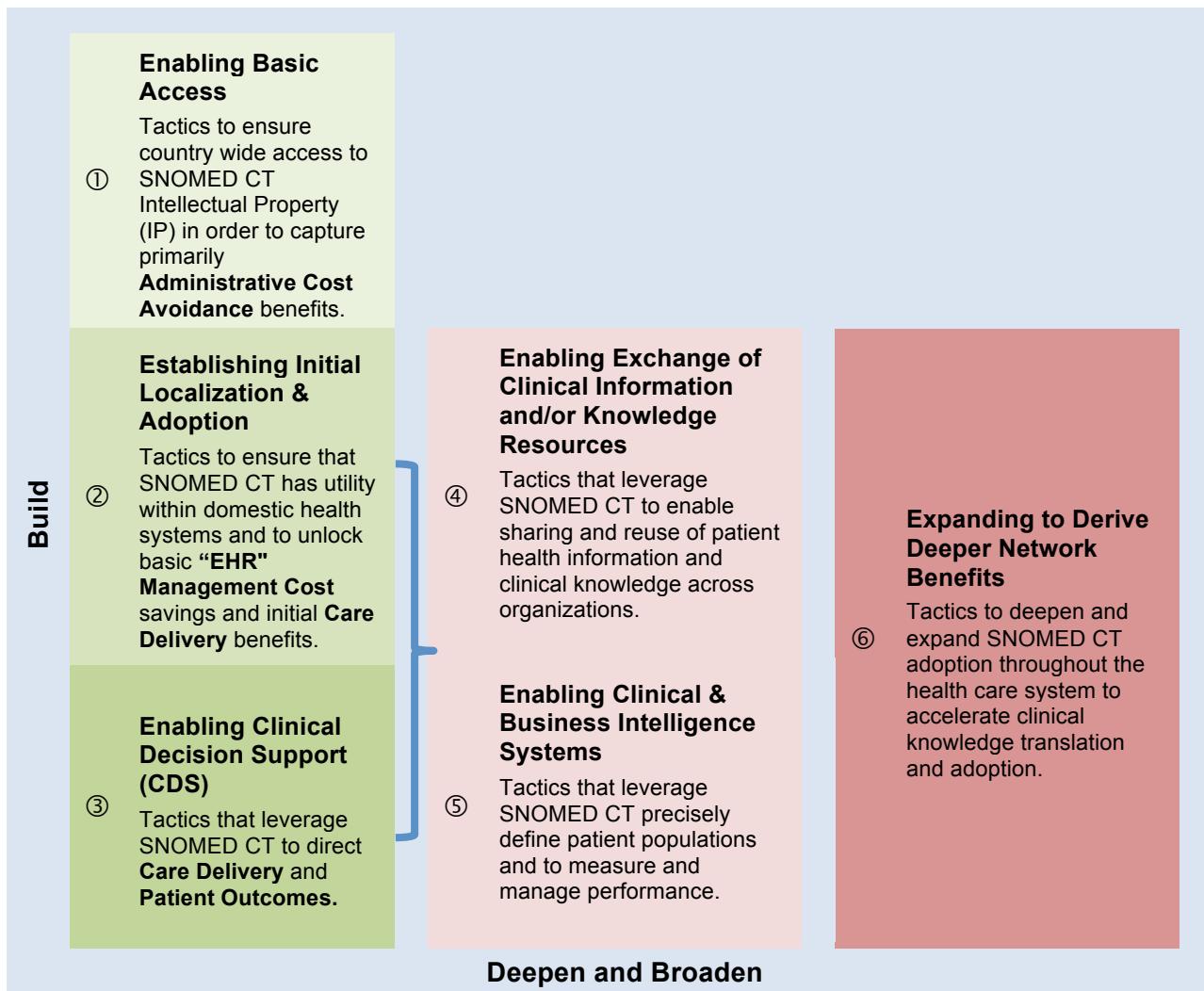


Figure 2: Staged Benefit and Cost Packages

The tactics in these “stage packages” target specific benefits from among those potentially quantifiable, as shown in the table below:

Table 4: Quantifiable Benefits Targeted by Stage

Benefit Categories	Sample Benefit Streams with Potential for Quantification	Enabling Basic Access	Establishing Localization & Initial Adoption	Enabling Clinical Decision Support (CDS)	Enabling Exchange of Clinical Information and/or Knowledge Resources	Enabling Clinical & Business Intelligence Systems	Expanding to Derive Deeper Network Benefits
<i>Administrative & Management Cost Savings</i>							
Admin. Cost Avoidance and/or Reduction	<ul style="list-style-type: none"> Elimination of SNOMED CT licensing costs at a facility or user level and associated administrative overheads. Reduction in medical records administration / health information management (HIM) costs as standardized SNOMED CT to ICD maps and software help automate coding processes. 	✓					
“EHR” Mgmt. Cost Avoidance and/or Reduction	<ul style="list-style-type: none"> Reduction in costs to acquire or to develop and maintain local terminology products (e.g. value sets used in messaging, selection lists, etc.) Reduction in costs to acquire or to develop and maintain clinical criteria used to identify patient cohorts within clinical decision support and performance monitoring (clinical and business intelligence) systems. Reduction in costs to acquire or to develop and maintain clinical decision support tools and other knowledge products. 		✓				✓
<i>Care and Outcome Improvements</i>							
Efficient Care Delivery	<ul style="list-style-type: none"> Reduction in costs associated with duplicate or unnecessary investigations (e.g. laboratory tests and imaging studies) Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay) 		✓ ^a	✓ ^b	✓ ^c	✓ ^d	✓ ^e

Benefit Categories	Sample Benefit Streams with Potential for Quantification	Enabling Basic Access	Establishing Localization & Initial Adoption	Enabling Clinical Decision Support (CDS)	Enabling Exchange of Clinical Information and/or Knowledge Resources	Enabling Clinical & Business Intelligence Systems	Expanding to Derive Deeper Network Benefits
	<ul style="list-style-type: none"> Reduction in costs due to more optimized use of medications (e.g. appropriate, cost effective use of drug therapies) and other technologies (e.g. appropriate, cost effective use of laboratory tests and imaging studies). 		✓	✓ ^c	✓ ^d	✓ ^e	
Improved Patient Outcomes	<ul style="list-style-type: none"> Reduction in costs due to better disease management, better patient outcomes and lower health system utilization. 		✓	✓ ^c	✓ ^d	✓ ^e	
Improved Societal Outcomes	<ul style="list-style-type: none"> Improved economic productivity from better population-wide health ("Healthy Happy Productive Communities"). 						✓

Notes:

- (a) Initial improvements in care delivery and patient outcomes accrue as more consistent use of language and presentation of information within clinical systems make it easier for clinicians to find and recognize information within patient charts. Without clinical information exchange or decision support tools, benefits are limited by the completeness of information available to clinicians and their ability to discover and recognize issues.
- (b) Introduction of clinical decision support tools (reminders, alerts, order sets) can be a significant aid to clinicians by directing attention to potential issues. The costs of acquiring or developing and maintaining decision support systems and related content can be significant, limiting benefits to facilities and clinical practices with the financial capacity to invest in these systems.
- (c) Enabling Exchange of Clinical Information improves the completeness of patient information required to drive alerts. Exchange of knowledge resources among provider groups should help reduce the cost to acquire and implement decision support tools and clinical content. Lowering the costs of entry can help increase the number of facilities and clinical practices employing decision support systems and/or increase the scope of clinical decision making supported by decision support systems.
- (d) Enabling Clinical & Business Intelligence Systems allows adopters of clinical decision support tools to monitor the impact of decision support rules on organizational performance and to gain better insight into defects and opportunities for improvement of local practice. These insights provide the input needed to maximize the benefit provided by decision support tools. Similar to decision support systems, costs to acquire analytic capacity can be significant, limiting benefits to organizations with sufficient means.
- (e) Network Benefits accrue as widespread adoption of SNOMED CT and related technologies provides a platform for increasingly more efficient exchange mechanisms that serve to make the technologies that provide the benefits above ubiquitous.

It is important to note that both the depth and breadth of activities in each stage will vary by country or organization. Readers are therefore cautioned to consider these illustrative “bundles” as a foundation from which to develop their own, more nuanced and tailored, program or programs. (For further information please see also the adoption model outlined Appendix C).

5.2.1 Enabling Basic Access

This package is based on the costs of **Licensing / Membership** as well as operation of a minimal **National Release Centre (NRC)** to achieve **Admin. Cost Avoidance and/or Reduction**, primarily in the form of any applicable SNOMED CT licensing costs which health care facilities in the member country would need to pay.

IHTSDO Membership fees are based on an ability-to-pay model which establishes fair share percentages. Current 2014 member fees are based on the 2011 Gross National Index as published by the World Bank and are available at the IHTSDO website³¹. As a result, annual fees range between a low of US\$ 18 / year for the Pacific Island nation of Tuvalu to high of US\$ 5.4M for the United States with the majority of fees well under US\$ 200,000 per year for countries other than G20 economies whose fees fall somewhere in between. In fact, the average cost for non-G20 economies is approximately US\$ 30,000 per year.

Management of the IHTSDO relationship as well as the twice-yearly releases is expected to require a minimum of 1 to 2 Full-time Equivalents (FTEs) at local salary rates, appropriately loaded with applicable administrative overheads. In almost all countries the combined membership and baseline NRC investment will be a small fraction of national health IT expenditures and a very small amount when compared to overall health expenditures.

Contrasting these costs against site-by-site licensing of SNOMED CT suggests an immediate return on investment since each site in a non-member country faces a cost of US\$ 1,688 per annum per data entry or analysis system. Even in a relatively small country where only 100 physician offices are using SNOMED CT enabled EMRs and 50 hospitals / clinics are using SNOMED CT, operating, for example, 2 systems per site, this means an annual licensing cost avoidance of approximately US\$ 363,000 not counting administrative overheads to manage these licenses.

³¹ See http://www.ihtsdo.org/fileadmin/user_upload/Docs_01/Members/Fees/IHTSDO_2014_Membership_Fees_v1.0.pdf, accessed August, 2014.

5.2.2 Establishing Initial Localization & Adoption

Localization enables SNOMED CT adoption and use within EHR/EMR systems, making documentation more precise and information more comparable. SNOMED CT adoption enables more efficient care delivery and savings from, among other things, reduced duplication of diagnostic investigations. While hard cost savings will depend on test volumes, per test costs, and the extent to which EHR/EMR solutions include searchable laboratory and imaging data, potentially large savings are possible.

A 2% reduction in clinical lab test costs and a 5% reduction in Diagnostic Imaging (DI) costs on only 10% of overall OECD reported Clinical Laboratory and DI costs would yield a saving of US\$ 2.4M in the Netherlands or US\$ 43M in Germany.

5.2.3 Enabling Decision Support

EHR solutions that use SNOMED CT to establish Clinical Decision Support capabilities provide a dramatic opportunity to provide benefits. Rather than simply providing access to searchable records these systems provide alerts and triggers which, if appropriately implemented, can provide further savings.

For example, the savings identified for duplicate lab and DI test could ostensibly double with the introduction of triggers to identify existing tests during the order process.

The opportunity to reduce costs associated with errors, particularly preventable Adverse Drug Events (pADEs), is even more substantial, with evidence that clinical decision support systems can reduce the burden by 55% - 83% according to Partners HealthCare in the US. Assuming a modest uptake for SNOMED CT based solutions of 10% and a savings of avoidable costs of only 10% the potential savings benefit in the US alone is US\$ 200M per year against an estimated error cost of US\$ 21B.

The benefit for other members or potential members can be estimated using this same 1% factor against the applicable pADE cost estimate.

It should be noted that these estimates do not consider additional potential savings pertaining to either, optimal use of medications and investigative procedures, or improved adherence to clinical best practice.

5.2.4 Enabling Exchange of Clinical Information and/or Knowledge Resources

A key challenge in capturing the benefits of CDS is the cost to develop, deploy and maintain these systems. SNOMED CT can help enable adoption of best practice and evidence based clinical decision support tools by providing a standard way to encode and exchange the clinical criteria used to drive alerts and thereby to reduce per-implementer maintenance and development costs.

This triggers a modest administrative benefit across each system but also lowers adoption barriers to allow the benefits of CDS to be more readily realized across more facilities and thereby to address more sources of waste and more clinical errors.

From a quantification perspective this means scaling any benefits up across a broader number of sites.

Using the US example and given an environment where clinical information and knowledge is exchanged to expand the use of and improve the effectiveness of Clinical Decision Support systems, every 10% increase in adoption could offer an order of magnitude increase in the potential benefit..

5.2.5 Enabling Clinical and Business Intelligence Systems

The mechanisms that enable clinical information processing within CDS systems can also be leveraged to establish SNOMED CT enabled clinical and business intelligence solutions. This offers the foundation to measure the performance of CDS systems and a source of clinical knowledge generation as cost effective, retrospective studies using EHR data and large patient cohorts are used to enable clinical evaluation and comparative effectiveness studies.

Retrospective studies can be done quickly and very cost effectively in comparison to Randomized Controlled Trials (RCTs), as illustrated by the difference between the US\$ 120M ALLHAT study and the US\$ 200K Magid study – both focused on hypertension control.

Effectively used, these clinical and business intelligence tools can improve the effectiveness of Clinical Decision Support tools by providing the evidence for addition of new rules and tuning of existing rules.

Drawing on the pADE example and our proposed estimating formula, every 10% increase in effectiveness would further double the benefit.

5.2.6 Expanding to Derive Deeper Network Benefits

As SNOMED CT enabled solutions, particularly clinical decision support and knowledge management based solutions, become ever more pervasive, we predict a network effect as more facilities (1) are able to develop, or implement decision support systems and (2) are able to contribute data to clinical research.

There is evidence to suggest that widespread adoption of EHR systems, which enable efficient knowledge translation and disease management, can significantly improve outcomes for entire populations of patients. Considering the significant health system and lost productivity costs associated with premature morbidity due to chronic disease, the potential benefits of ubiquitous decision support and population management systems are substantial.

6.0 CONCLUSION

As the most comprehensive, multilingual clinical healthcare terminology in the world, SNOMED CT provides a broad range of features that, when implemented within Electronic Health Records and Knowledge Management systems, help enrich clinical information making it readily susceptible to exchange, aggregation, analysis and reuse to **improve patient health outcomes** and to **improve health system performance**. Quantitatively, the benefits of SNOMED CT adoption begin to be realized by implementers early in the adoption cycle and can increase dramatically – potentially by orders of magnitude – as adoption of SNOMED CT enables effective and efficient exchange and reuse of the clinical information throughout the health care system. For this reason, there is a strong and compelling business case for implementing SNOMED CT within Electronic Health Records and Clinical Knowledge Management systems. Moreover, SNOMED CT has no meaningful competitors. For EHR systems to deliver return in proportion to a worldwide investment of \$25 billion (US) annually they must deliver real and sustained improvements in individual and population outcomes. Using SNOMED CT to encode clinical information within EHR systems provides organizations with the means to realize the full potential of their EHR investments by helping them make better and fuller use of the health information contained therein.

Appendix A Implementation Project Profiles

A.1. Overview

In order to seek real-world implementation examples to illustrate key benefits and business case drivers, the authors of this paper engaged various organizations in brief interviews to understand the SNOMED CT journey through their experience. The result of this work is a set of Implementation Profiles which are referenced in the body of the report. These profiles are also included below in their entirety.

A.2. Pragmatic First Steps: Healthcare Software & Royal Hobart Hospital

The Organization

Healthcare Software (HCS) is an Australian eHealth company that specializes in creating clinical software solutions. HCS provides customers throughout Tasmania and Southern Australia with multi-disciplinary clinical information systems, including closed-loop medication management and clinical communication tools.

Royal Hobart Hospital, Tasmania's largest hospital and a major referral centre, has engaged HCS on a number of projects and implemented several HCS tools, including its Electronic Discharge Summary (EDS) solution which was implemented as part of the Tasmanian Department of Health and Human Services patient discharge medication record project. Post implementation, HCS was engaged to help increase uptake of the EDS solution within the neurosurgery team and to help the hospital improve performance against mandated EDS related KPIs.

The Role of SNOMED CT

A key factor impacting uptake of the discharge summary within the hospital's neurosurgery department was the lack of a systematized way to track provider workflow or to measure completion of the discharge summaries within the department. (The patient administration system in use in the hospital does not track the full surgical team.) HCS responded by working with the physicians in the neurosurgery department to develop an efficient, structured way to capture surgical notes that was aligned with their existing workflow, Tasmania's discharge reporting requirements and the hospital's information needs.

SNOMED CT was selected for use within the solution for several reasons that included 1) the need for a standardized vocabulary to support the reporting requirements, 2) the extensive, usable content available within SNOMED CT, and 3) the fact that the standard was endorsed by NEHTA. HCS and the client also had interest in gaining experience working with SNOMED.

Implementation Approach

The primary objective of the project was to increase uptake of the Discharge Summary Solution, with a secondary requirement to create structured documentation and reporting tools to support departmental management. Consequently, the solution was designed to position workflow

requirements first by helping physicians find and enter standardized information into the structured forms without restricting their data entry to a list of controlled vocabulary.

Similar to completion matching in a web browser, users of the HCS solution can type anything they wish into the structured forms. As the clinician enters text, a list of appropriate SNOMED CT concepts is dynamically generated and displayed. If a SNOMED CT concept is chosen by the user, the description the user selected and the concept id are stored in the form. If the user enters free text into the field, only the free text is stored.

In the background, Ontoserver, developed by the Australian eHealth Research Centre (csiro.au), provides the SNOMED CT search functions HCS incorporated into the tool.

Ontoserver accepts the SNOMED CT release in the format distributed by NEHTA and uses intensionally defined subsets with both inclusion and exclusion criteria to constrain the search results to appropriate concepts. All available descriptions (synonyms) are used when searching to maximize the probability of returning a match. Staff at the research centre helped HCS develop the subsets and implement the tools.

Business Drivers and Outcomes

The project succeeded in improving the hospital's performance against the discharge reporting performance indicators (KPIs) imposed by the state of Tasmania and was therefore perceived as highly successful by HCS and their client.

Behind the scenes, overall completion rates (instances where a user selects a SNOMED CT concept over free text entry) within the structured form are 60% but fluctuate significantly, 39-90%, among users. The variation among users is perceived as a change management issue related to different physician's willingness to accept change as opposed to a limitation related to SNOMED CT or the tool. The variation is therefore expected to decrease over time, resulting in overall completion rates closer the higher end of the range.

Increasing completion rates beyond 90% would require HCS to add the capacity to post-coordinate SNOMED CT expressions in the tool (to document compound resources) and potentially work with NEHTA to close gaps in SNOMED CT related to less frequently used concepts. Both are currently seen by the hospital as large investments toward an incremental improvement in reporting capability and therefore are not considered a priority.

HCS attributes the success of the project to an appropriate engagement and change management strategy that brought physicians on board early and involved them in developing the solution. Open communication and collaboration within the project team led to a pragmatic

decision to put clinical and workflow needs ahead of the requirement for consistently codified information to support management reporting. Completion rates are impacted by the pragmatic approach but are perceived as satisfactory for an initial implementation. Moreover they are seen as likely to improve over time.

Benefit Quantification

Benefits were identified qualitatively but not quantified.

A.3. Harmonizing Clinical Data for Patient Activation: NexJ Systems Inc.

The Organization

NexJ Systems is a Canadian software company whose portfolio of products includes a platform for patient engagement or Patient Activation (PA). Moving beyond the idea of a Patient Centric Health Record (PcHR or PHR), PA platforms aim to create communities of clinicians and patients that enable ongoing engagement to support a full spectrum of activities ranging from wellness management to chronic disease management.

The Role of SNOMED CT

A key requirement for PHR and Patient Activation platforms is to be able to integrate with existing infrastructures ranging from primary care Electronic Medical Record (EMR) systems, through to full scale Hospital Information Systems (HIS) in larger facility settings, to a wide variety of unstructured data sources including devices such as consumer/patient monitoring tools (e.g. FitBits), digital scales or blood pressure readers.

Where this integration is intended to provide concrete clinical data from EMR/HIS sources into the PHR/PA platform, a key challenge is the lack of structured data in many EMR products, particularly in the Canadian context, as well as the lack of consistent structure in feeds from some devices. Conversely, the wide variety of coding systems currently in use in the HIS world requires PHR/PA platforms to be able to effectively work with multiple coding systems.

Given this landscape, NexJ found that a key success factor of their interoperability strategy is to incorporate SNOMED CT into their product. SNOMED CT is used as a common reference terminology and point for mapping.

Implementation Approach

NexJ's PA platform incorporates SNOMED CT (as well as LOINC and other key terminology systems) within the context of a terminology engine to ensure that they can interpret incoming data from the EMR/HIS sources. This also allows them to codify specific incoming unstructured data.

Business Drivers and Outcomes

As noted above, the business drivers for stakeholders such as NexJ emerge from the need to integrate both structured and unstructured data from multiple sources. At this time, the firm believes their terminology architecture allows them to readily build interfaces with a wide variety of data sources. Although they recognize the opportunities offered by SNOMED CT's deeper ontological features, this is seen as an advanced use to be explored in future.

Benefit Quantification

Benefits were identified qualitatively but not quantified.

A.4. Data Analysis and Reporting: Hong Kong Hospital Authority

The Organization

Established in 1990, the Hong Kong Hospital Authority (HA) is a statutory body created to manage Hong Kong's public hospitals and their services. Currently, the HA workforce consists of approximately 67,000 employees, working within 42 hospitals, 48 specialist outpatient clinics and 73 general outpatient clinics. The HA account for 90% of hospital inpatient visits, and around 24% of general outpatient visits within the territory, totalling approximately 9 million patient records.

In line with the Hong Kong Government's policy that "no one should be prevented, through lack of means, from obtaining adequate medical treatment", the focus of the HA is to help people stay healthy by focusing on people-centered care, professional services, committed staff and teamwork.³²

The Role of SNOMED CT

The HA has adopted a centralized approach to developing IT systems for use within the authority's facilities, both to help manage IT costs and to help enable patient and provider mobility across the healthcare system. One aspect of this centralized approach was the development of multiple generations of HA clinical vocabulary tables (HACVT), which grew with the scope of its clinical systems.

In 2003, SNOMED CT was first introduced to the HA but did not start to make its way into the HACVT until 2009. Interest in increasing decision support and data retrieval capabilities within HA clinical systems led to a decision to map the existing HACVT procedure and diagnosis files to SNOMED CT and to expand the HACVT to include organisms and medication.

SNOMED CT's comprehensive domain coverage and description logic informed the decision to map the HACVT to SNOMED CT concepts. Underlying description logic allows the HA to develop rich, criteria-based queries that are used to identify patient cohorts for decision support and reporting purposes.

³² "Vision, Mission and Values." *Hospital Authority*. HACW, Web. 8 Jul 2014.

Implementation Approach

Past experience migrating diagnosis terms within HACVT from ICD-9 to ICD-10 informed the decision to retain existing descriptions and identifiers within the HACVT and to map the terms to SNOMED CT. The rationale behind this approach was two-fold: 1) to minimize the impact on end users and possible loss of historical data and 2) adding the ability to use SNOMED CT hierarchies and description logic to aggregate and analyse new and existing information captured within the systems.

Mapping the existing HACVT diagnosis and procedure records to SNOMED CT was a three-year project which resulted in approximately over one half of the approximately 39,000 clinical terms in HACVT being mapped directly to existing SNOMED CT concepts. Remaining terms were either submitted to IHTSDO for inclusion within the core International Edition or modeled as post-coordinated expressions that are mapped to the HACVT id and description.

HA is currently piloting use of the SNOMED CT hierarchy and description logic to support analysis of organism data within its Clinical Data Analysis and Reporting System (CDARS). HA has incorporated a third party terminology server into its home-grown terminology management engine, Information Architecture Management System (IAMS) to allow post-coordinated terms to be displayed and retrieved as SNOMED CT concepts within queries. This enables all HACVT terms to be included in search results without having a one to one match between HACVT terms and SNOMED CT concepts.

Mapping the HACVT to SNOMED CT also required HA to establish editorial policy and governance functions. These governance supports are widely perceived as having significantly improved the quality of the existing HACVT content.

The territory-based electronic health record (eHR) will build upon the HACVT content and experience using SNOMED CT to support retrieval and aggregation of clinical information.

Benefit Quantification

Benefits were identified qualitatively but not quantified.

A.5. Driving Clinical Improvement: Cystic Fibrosis ECR Study

The Organization

This profile pertains to an academic study of an ECR (Electronic Care Record) implementation at three hospital sites in the UK (See <http://www.ncbi.nlm.nih.gov/pubmed/24670246>). A commercial ECR product, designed to support structured and coded health records, was modified for hospital use and clinical codes were identified to document all aspects of Cystic Fibrosis (CF) care using SNOMED CT. In addition to an assessment of performance and usability, the study quantified various benefits to patients and the healthcare system.

The Role of SNOMED CT

The program reviewed by this study is a direct example of how establishment of a coded health record can be used to achieve improved health system results. In this case, the implementation of a new ECR based on commercial product that leverages SNOMED CT, among other coding systems, provided the foundation for a range of positive outcomes in Cystic Fibrosis care.

SNOMED CT was used to codify a number of information elements and according to study authors, “registration of codes using SNOMED CT ensures wider applicability and the potential for the programme to align with other portal information required for database management.” The authors go on to highlight SNOMED’s capacity to describe a patient’s characteristic in order to correlate this with causal factors:

“Our migration to the SNOMED coding system has been a key implementation because of its utility in clearly defining existing items of information. The key advantage of the approach we have adopted is that it can easily be integrated into information strategies, for example that more precisely define the phenotype for elucidating the relationship with genetics and the biochemistry of diseases that relate to their genetic causes.”

Implementation Approach

At a project/program level, the study highlights the steps towards a successful implementation of a coded care record that heavily leverages SNOMED CT.

- **Creation of Codes and Templates:** The lack of pre-existing templates and the scarcity of predefined codes relating to CF resulted in the development of 523 new codes which were embedded within 60 templates. “Local codes were migrated to EMIS national codes stored

on the EMIS systematised nomenclature of medicine clinical terms (SNOMED CT) namespace.”

- **Coding Across a Broad Set of Data Elements:** Coding included presenting diagnoses, health histories, examinations, microbiology, genetics, physiology, interventions, medications, allergies, and pathology. Clinical data was “captured for use in clinical monitoring and as part of longitudinal research.” Where appropriate, data feeds were automated and data gaps addressed. For example, a special tick box template was designed to enable the coding of each isolate during electronic filing of microbiology feeds to resolve instances where pathology results lacked coded pathogen data.
- **Establishment of a Change Management Program:** Training and evaluation were embedded from the outset. This evaluation included not only staff questionnaires but also clinical process evaluation. For example, it assessed the completion of specific protocol investigations in order to test “the system's sensitivity in meeting standards of monitoring of care through regular audit. This included annual completion of fasting vitamins, oral glucose tolerance tests for detection of diabetes and the time taken to complete discharge summaries before and after implementation.”
- **Leveraging Data for Direct Care and Process Improvement:** The system's ability to use structured data to improve the consistency of data entry positively impacted the perceived reliability of the data. Use of this data to establish alerts and other mechanisms supported various care process improvements (see below).

Business Drivers and Outcomes

According to the study, “staff reported a positive impact of ECR on the quality of care resulting from the early identification of problems through the graphical display, the filing of electronic pathology results linked to patient records, the accessibility of records and the presence of alerts which allowed more accurate communication.” They went on to state, “our experience accords with other recent work reporting that electronic health records have the potential to enhance quality and efficiency of care through more streamlined processes and patient flow, fewer duplicative tests, faster responses to patient inquiries, redeployment of staff and more complete capture of detailed coded data. This is similarly true of opportunities for the conduct of research. The longitudinal data retrieved from the system enable the systematic analysis of clinical trends and provides a unique resource with the potential to elucidate the natural history

and risk factors for progression. This concurs with studies using data from primary care database management which illustrate its usefulness in reporting epidemiological disease trends for diseases other than cystic fibrosis.”

Benefit Quantification

Although the study quantified various benefits arising from the profiled ECR implementation (such as improved cost recovery for medications and better adherence to standards of care), these related largely to the implementation of an integrated, automated system rather than the establishment of a structured and coded care record. Clinical and administrative benefits arising from the introduction of an ECT with codified data structures and SNOMED CT were primarily qualitative. However, the following observations about system outcomes should be considered relevant to potential quantification strategies:

- **Availability Medication Safety Data:** Measurable occurrence of alert triggers and recorded drug allergies/adverse reactions provide the foundation for not only improving patient medication safety but for potentially measuring the incidence of potential medication errors avoided;
- **Improved Adherence to the Standards of Care:** An increase in completed annual blood tests (AAB) based on improved adherence to the standards of care, driven in part by automated assessment triggers. ABB adherence increased from 43% before system implementation to 72% after system implementation in 2008.

A.6. Managing Populations and Health Outcomes: Kaiser Permanente

The Organization

Kaiser Permanente is the largest not-for-profit integrated health delivery system in the United States, serving 8.7 million members in 8 regions that span 9 states and the District of Columbia. As an integrated system, Kaiser Permanente (KP) provides and coordinates the entire scope of its members' care and is recognized for its successful disease management programs, which are supported by the enterprise electronic health records (EHR) system KP HealthConnect.

Examples include KP's Cardiac Disease Programs, which are attributed with significantly improving rates of hypertension control³³, reducing serious heart attacks³⁴ and improving survival rates for patients with coronary artery disease.³⁵ These outcomes are, in part, the outcome of a systemized approach to disease prevention, treatment and research supported by KP HealthConnect.

The Role of SNOMED CT

Within KP's disease management programs, KP HealthConnect plays a key, supporting role by:

- Helping doctors:
 - remember preventative services (reminders),
 - identify patients with care gaps and risk factors (panel management),
 - identify appropriate treatment options (order sets), and
 - monitor patient compliance with prescribed treatments (panel management);
- Helping the organization monitor the performance of its protocols, disease management programs and physician support tools; and
- Providing a mechanism to gather evidence needed to evaluate the impact of medical innovations as they are piloted and translated into practice within the organization.

These functions require KP HealthConnect to use information captured within patient health records to identify cohorts of patients, identify gaps in care, and to recognize when to exclude inappropriate or contra-indicated therapies from treatment plans and monitoring tools. This

³³ <http://jama.jamanetwork.com/article.aspx?articleid=1730511>

³⁴ <http://share.kaiserpermanente.org/article/kaiser-permanentes-allphase-initiative-wins-2010-care-continuum-alliance-quality-impact-award-for-greatest-impact-on-health/>

³⁵ <http://share.kaiserpermanente.org/article/heart-disease-prevention-program-saves-lives-and-reduces-costs-kaiser-permanente-study-finds/>

functionality is enabled through the creation of logic-based rules which are built upon KP's SNOMED CT based Convergent Medical Terminology (CMT).

Implementation Approach

KP HealthConnect is composed primarily of commercial off-the-shelf (COTS) software applications provided by Epic Systems Corporation. These applications provide rich, user-friendly tools to support clinician workflow and to enable collection and sharing of clinical information in a structured format.

Within KP HealthConnect, CMT supports clinician documentation requirements and provides the building blocks of the logic-based rules that support KP's disease management programs. Specifically:

- master files (diagnosis, procedure, immunization, allergen, etc.) provide appropriate terminology for use within the different application contexts (problem list, encounter diagnosis, medical history, order entry, etc.) and patient health records; and
- a collection of 'groupers', or subsets derived from the master files, are used to operationalize clinical definitions within population management, decision support and performance management rules (e.g. the definition of acute myocardial infarction used in the US CMS Quality Measure AMI-8a includes almost 130 different MI related terms in KP's diagnosis master file).

Behind the scenes, CMT is comprised of multiple interdependent terminology components:

- The master files in KP HealthConnect are collections of (typically SNOMED CT based) clinical terms that are added to master files as needed to support operational requirements. Maintenance and naming conventions reflect physician needs and the requirements of the COTS tools.
- Individual terms within the master files are mapped to reference terminology (e.g. SNOMED CT, LOINC) and administrative codes (e.g. ICD, CPT) to support 'other things' such as interoperability between systems, population management, clinical decision support, reporting and billing.
- Mapping local terms to standard terminologies informs the content of CMT master files by providing a reference point to minimize redundancy (exposing existing lexical variants of a

requested term), and exposing business requirements imposed by external billing or reporting requirements.

- Once terms are mapped, SNOMED CT's hierarchies and defining relationships (description logic) become available to maintenance tools used to support development and maintenance of groupers.
- Groupers are intensionally defined using SNOMED hierarchies, SNOMED defining relationships and/or other descriptions and codes associated with master file records. Groupers are extended into result sets for deployment to KP HealthConnect.

Intensionally defining groupers allows KP to regenerate (extend) the groupers to prevent gaps in decision support rules as new terms are added to master files. Use of SNOMED CT allows groupers to be defined using clinically meaningful criteria. Groupers used to identify patient cohorts for KP's disease management programs are commonly defined using SNOMED CT as well as the ICD based criteria specified by the Joint Commission or HEDIS. This typically results in a more inclusive set of results which is then reviewed and refined to meet the objectives of the program.

Business Drivers and Outcomes

In addition to the individual and societal benefits of improving patient outcomes, the cited Cardiac Disease programs provide significant per member cost savings to the organization as a result of lower levels of health system utilization, more efficient care practices and effective use of pharmaceuticals. Benefits related to SNOMED CT implementation within these programs include efficient translation of business rules into decision support tools and performance measures used to support the program (due to the use of criteria based definitions), and improved usability of the KP HealthConnect application (due to more expressive clinical terminology and precisely tuned decision support rules). Together, these contribute significantly to the success of the program.

Benefit Quantification

Kaiser Permanente has not quantified benefits associated with its SNOMED CT implementation.

A.7. Medication Information System Business Case: Denmark Health Regions

The Organization

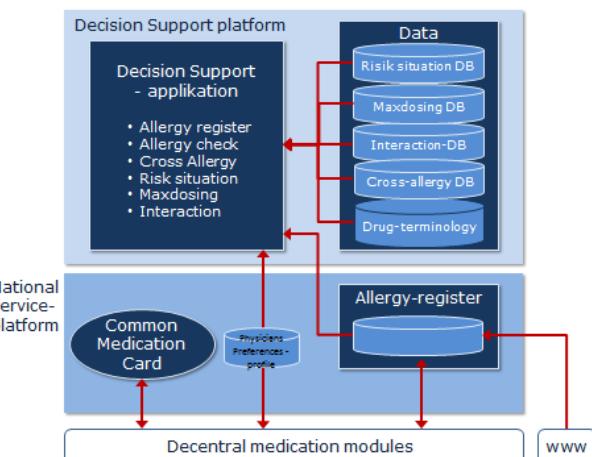
Denmark's Health Regions are responsible for the delivery of healthcare throughout the nation. Their eHealth strategies are supported by the Danish National eHealth Authority, which establishes the framework for digitization across Denmark's health care system. The authority is the government agency responsible for setting national standards for eHealth with powers stipulated in legislation. Having established an online catalogue of standards their work includes the development of reference architectures that provide a coherent data and ICT architecture for the Danish healthcare sector.

The Role of SNOMED CT

In collaboration with the National eHealth Authority, Danish regions conducted an analysis project to develop a comprehensive business case for the establishment of Decision Support Modules, CAVE - registration (e.g. drug allergy alerts) and the associated central databases. This work included both the costs as well as an analysis of the expected gains from implementation of these systems on the National Service IT Platform.

A mapping between the Danish drug terminology and SNOMED CT underpins this system by providing the critical linkages to document various contraindications such as, for example, drug-to-allergy.

A key driver for the development of the business case was the observation that a number of studies which illuminate the medication safety space were outdated, and, from a Danish perspective, mostly foreign.



Source: Greibe, Kell. "Development of a SNOMED CT based national medication decision support system", MedInfo 2013 submission.

Implementation Approach

According to Kell Greibe, the Danish SNOMED CT extension is being developed in three steps:

1. **Extract:** An extract from the official Danish Medicine Agency database is made containing all Danish drugs on the market.
2. **Map:** A computer generated mapping is made between the extract and SNOMED CT drug product codes.
3. **Create:** A script generates the Danish concepts automatically, adding strength and measurement unit attributes to product concepts to make them fully defined.

Once established this Danish terminology will support the operation of the overall Electronic Medication System (EMS). During the prescribing process, “the drug code will be matched in the central services using the SCT codes of substances, products, dose forms, strength and allergies. The EMS will receive an alert and a text message detailing any precautions. The alert will be treated in the local system as specified by the physician’s setup (e.g. a simple message box or a total system halt). All 5 databases included on the central platform - an allergy register, an allergy alert service, an upgraded interaction service, a risk situation database and a max dose database – work through SNOMED CT.”

Business Drivers and Outcomes

The consequences of medication errors were reviewed in detail to identify a very specific potential benefit stream, including quantitative benefit estimates, arising from reduced incidence of these errors. The following table summarizes the streams as well as key quantification measures:

Benefit Stream	Key Measures
Reduced admission, re-admission or other interaction;	An average cost based on various costs (e.g. general hospital admission; intensive care admission; outpatient visit) and likely distribution.
Reduced malpractice insurance claims;	Average cost of claim.
Reduced administrative costs arising from complaints;	Average cost of complaint.
Cost of drugs (e.g., wrong drug or excess dosage may have been administered leading to a second prescription);	This is not part of the Business Case due to quantification challenges.
Reduced surgical intervention (in the event the reaction resulted in serious harm);	Incidence of serious harm and average cost to treat.

In addition to the measures above, the average incidence of errors before system introduction and average incidence after such introduction are critical.

Key challenges include (1) the need to apply a conservative approach to the calculation of costs and benefits; and (2) the establishment of regional monitors to help demonstrate that improvements/gains are from the introduction of the SNOMED CT based Decision Support infrastructure, and not from one of several other IT initiatives being worked on in parallel in the Danish regions.

Benefit Quantification

As noted, this profiled project revolves entirely around the notion of building a business case framework and so quantification is at its core.

Details of the quantification were not reviewed as these are available only in Danish.

"When the functionality is implemented in the local systems, most health stakeholders benefit from national decision support services:

- Fewer patients will be injured and hospitalized due to medication errors and the quality of care will increase with shorter treatment and hospitalizations;
- The medical societies, but also narrow fields of experts with few resources, get an easy way to get their expert knowledge spread to the doctors who need it.
- The GPs can use decision support services without the cost of integrating a number of knowledge bases in their own system. Central decision support services can also make it more attractive for GPs to use the Common Medication Record.
- A key allergy register will give GPs automatic access to allergy information discovered in hospitals - and vice versa.
- Suppliers of medication modules could improve their systems and provide better services to doctors with structured data. Competition for best exploiting access to the key information will be increased and the quality of care will increase.
- The Regions save money on admissions caused by medication errors.
- Patients may eventually have access to their own data in an allergy register.
- The creation of a SNOMED CT based medical terminology and key decision support services will promote SNOMED CT implementation in Denmark, which would eventually lead to overall better structured health data."

(Source: Auto-translated backgrounder)

A.8. Cross Border Interoperability: epSOS

The Organization

epSOS means "Smart Open Services for European Patients."³⁶ The pilot project, which concluded in June 2014, was intended to design, build and evaluate a service infrastructure that demonstrates cross-border interoperability between electronic health record systems in Europe.

epSOS was intended to demonstrate practical cross-border eHealth services and attempted "...to offer seamless healthcare to European citizens. Key goals (were) to improve the quality and safety of healthcare for citizens when travelling to another European country. Moreover, it (concentrated) on developing a practical eHealth framework and ICT infrastructure that enables secure access to patient health information among different European healthcare systems.

epSOS can make a significant contribution to patient safety by reducing the frequency of medical errors and by providing quick access to documentation as well as by increasing accessibility of ones prescribed medicine also abroad. In emergency situations, this documentation provides the medical personnel with life-saving information and reduces the (sometimes needless) repetition of diagnostic procedures".³⁷

The Role of SNOMED CT

In order to enable the exchange of clinical data the epSOS infrastructure needed to establish technical integration standards that included designating specific terminology or code systems for various data elements. According to a report outlining the code system selection process³⁸, SNOMED CT is used for the following information categories:

- Key components of the allergy model including Reaction Allergy, AdverseEventType and non-drug Allergens;
- Vaccine information;
- Surgical procedures;
- Blood group information;
- Medical device information; and

³⁶ <http://esante.gouv.fr/en/the-mag-issue-3/the-european-epsos-project>

³⁷ <http://www.epsos.eu/home/about-epsos.html>

³⁸ "THE EXPERIENCE OF SELECTING THE CODE SYSTEMS FOR THE DEVELOPMENT OF THE EPSOS MASTER VALUE CATALOGUE (MVC)", epSOS, September 23, 2014.

- Various supplemental information categories including CodeNoMedication, CodeProb, ResolutionOutcome, Severity, SocialHistory, SstatusCode, UnknownInformation, and MedicalEquipment.

Implementation Approach

This project assessed a wide range of information categories and carefully reviewed potential code system options. This evaluation was based on multi-step process. First, potential code systems were assessed based on the following factors³⁹:

- ***Internationally Used:*** An international code system such as those released by ISO or WHO, for example, which has the advantage of being elaborated by experts with vast experience in terminology implementation and application. The internationally used code systems have implementation guidelines that are used at a national level, as well as maintenance guidelines. The code system used in the Value Sets Catalogue must be internationally recognized. The suitability should be evaluated in the field by both clinicians and non-clinician experts.
- ***In Use:*** The second most important criterion in selecting the code system is its use in the Participating Nations (PNs). A survey was conducted among the experts working on the epSOS Value Sets Master Catalogue in order to have an accurate representation of the code systems used in each country.
- ***Availability of translation in Different Languages:*** The existence of translations into different languages is another key element to be evaluated, since it will dramatically reduce the activity of translating the Value Sets Catalogue terms into the local (national) language. If a code system exists in the local (national) version, it is likely that existing translations have been already validated and kept aligned when newer versions are released.
- ***Transparent Maintenance Process:*** A code system that has an official maintenance process is highly desirable. The release of new versions should be taken into account during deciding process. The maintenance process should include specifications for distribution and support.
- ***Existence of Transcoding Systems / Services:*** The existence of officially defined or, at least, of consolidated systems/services to perform transcoding from one code system to

³⁹ Ibid.

another one is a desirable element in order to reduce costs and risks. However it is known that this is an important issue with which many Standards Development Organization (SDOs) and national standards bodies are struggling. Nevertheless, whenever official attempts exist to map one code system to another, it is considered very useful as this provides guidance for mapping.

- ***Cost of licenses, implementation and maintenance:*** Although for research purposes most of the code system licenses are provided for free, the cost might prove to be prohibitive. In addition to the cost of the licenses, the cost of the implementation and maintenance need to be considered.
- ***The code system must be easily implementable:*** The code system must be easily implementable based on a sound methodology which takes into account both the syntactic and vocabulary aspects.

Once a code system was accepted, based on an assessment of these factors and the needs of the various clinical documents underpinning the epSOS integration framework, specific value sets were devised.

Business Drivers and Outcomes

This project faced a number of barriers in adopting SNOMED CT for some of its information categories. Foremost among these was a political and organizational milieu that actually stood squarely in the way of SNOMED CT integration. In the words of the MVC selection report, the evaluation process:

“turned out very fast to be a political, organizational, procedural and economical discussion instead of a semantic and clinical discussion. SNOMED CT is owned by the SDO named IHTSDO. IHTSDO is a member-owned organization and in order use SNOMED CT, one must have a license with IHTSDO. Several of the participating countries were not in that position. Why? They legally did not have the right to continue with using the content selected based on SNOMED CT.”

The fact that, notwithstanding these issues, SNOMED CT proved to be the most effective solutions for a large number of information categories speaks not only to the positive alignment between SNOMED CT as a terminology system and the evaluation parameters, but also to SNOMED CT's ability to fulfill clinical and technical requirements.

It is also important to note that SNOMED CT was not selected as the preferred code system for problems and medications. The primary reason for not applying SNOMED CT to the illness and/or problem identification requirement was the lack of political traction and the entrenched use of ICD. The situation for medications was more nuanced. Although the European Medication Agency (EMA) and several national regulators currently use other, potentially less effective, terminology systems, SNOMED CT has known limitations in its coverage of the medication coding requirements.

Although the epSOS pilot has now been completed, it successfully demonstrated the establishment of an electronic health data interchange on an international, multi-lingual basis. More importantly, SNOMED CT was a key, enabling building block. (The outcomes of the project are more fully outlined in a letter posted on the epSOS website⁴⁰).

Benefit Quantification

Benefits were identified qualitatively but not quantified.

⁴⁰ http://epsos.eu/fileadmin/content/pdf/deliverables/epSOS_letter_to_contributors_1July2014.pdf.

Appendix B C-KM - Putting Clinical Information to Work

B.1. Introduction

The enclosing report highlights a range of potential uses for SNOMED CT within health informatics infrastructures and the associated benefits. The objective is to provide support to IHTSDO members and other SNOMED CT implementers as they develop business cases for IHTSDO membership or other SNOMED CT related projects and investments.

A significant focus of the report is on the benefits of using SNOMED CT to help connect and better systematize clinical knowledge management and knowledge translation processes. This section explores the ideas, underlying concepts and processes in more depth to help readers better synthesize the potential benefits as they consider how SNOMED CT may be applied to the reader's own context.

The key point is that chronic conditions and the use of emerging technology and pharmaceuticals are significant and manageable cost drivers. Information and communication technologies, including SNOMED CT, can play a significant role in helping enable the organizational learning process needed to better manage these costs. Promoting SNOMED CT adoption as a way to support the necessary evolution toward a learning health system is a critical step toward establishing the long term business case for SNOMED CT as well as other healthcare related information and communication technology investments.

A **learning health system** seeks to create value (e.g. improved performance on quality, equity, access, and healthy lives, in addition to savings⁴¹) through a process of continuous quality improvement. SNOMED CT enabled Clinical Knowledge Management, or C-KM, refers to a series of interdependent knowledge management processes that could be improved by data standards and system integrations to provide more efficient translation of emerging knowledge into routine medical practice. A considerable body of research and supporting models exist to help stakeholders understand the various interdependent activities required to effectively

⁴¹ Source: <http://www.commonwealthfund.org/publications/fund-reports/2007/dec/bending-the-curve--options-for-achieving-savings-and-improving-value-in-u-s--health-spending>, accessed July 29, 2014.

translate research into practice.^{42,43} The intent of this section is not to duplicate that work but, rather to complement it by illustrating how SNOMED CT enabled systems can help support knowledge translation process.

B.2. Data Driven Health System Performance and Improved Health Outcomes

Continuous learning is a key component of health system performance improvement.⁴⁴ High performing health systems such as Kaiser Permanente and the US Veterans Administration (among others) distinguish themselves in their ability to use information technology to systematically identify opportunities to improve healthcare services and to support changes that result in better patient and organization level outcomes.

The following points provide a simplified view of the underlying process:

- Data collected at the point of care is a key input to business intelligence, comparative effectiveness research and related data analysis and synthesis activities which are directed toward understanding how resources within an organization are used as well as the effects different care models, interventions or technologies employed at the point of care have on patient health and system performance. Together these processes provide an organization with the means to identify areas for improvement as well as to monitor and measure the impact of change as new practices or technologies are absorbed into the system.^{45,46,47,48}
- At the point of care Electronic Health Records (EHR) systems provide a mechanism to gather data needed to monitor performance as well as the means to drive organizational change by providing actionable information back to clinicians when and where it can best influence their decisions and actions.

⁴² <http://www.socialresearchmethods.net/research/Evaluating%20Translational%20Research%20-%20A%20Process%20Marker%20Model.pdf> Accessed July 2014

⁴³ <http://ktclearinghouse.ca/knowledgebase/knowledgetoaction> Accessed Aug 2014

⁴⁴ Best Care at Lower Cost, The Path to Continuously Learning Health Care in America, Institute of Medicine, 2013. (http://www.nap.edu/catalog.php?record_id=13444)

⁴⁵ http://www.hsrdr.research.va.gov/for_researchers/cyber_seminars/archives/hmcs-091912.pdf Accessed Aug 2014

⁴⁶ <http://searchbusinessanalytics.techtarget.com/feature/Kaiser-Permanente-VP-prescribes-bigger-role-for-healthcare-data-analytics> Accessed Aug 2014

⁴⁷ <http://content.healthaffairs.org/content/29/10/1906.long> Accessed Sept 2014

⁴⁸ http://www.dor.kaiser.org/external/research/topics/Comparative_effectiveness_research/ Access Sept 2014

Together health information and EHR systems support continuous learning and performance improvement within an organization by providing the organization with the tools needed to understand how their organization works, to identify issues, to provide context appropriate information to clinicians to support their practice and to monitor how changing clinical practices and technology impact patient outcomes and overall organizational performance.

These organizations provide a model of how EHR systems can support the translation of clinical innovations into routine clinical practice (e.g. “Bedside to Bench and Back” or BB&B as the US National Institutes of Health have coined [<http://cc.nih.gov/ccc/btb/>]). Extending this model across organizations to enable more efficient exchange and adoption of clinical best practice throughout the health system could be a significant step toward improving the overall performance of national health systems and, potentially, reducing health disparities within and across communities.

Extending the model requires an effective way to compare and share information across organizations. The scope and features of SNOMED CT make it ideally suited to this purpose.

B.3. Fundamental Components of a Learning Health System

To illustrate the role SNOMED CT could play in enabling a learning health system more fully, it is useful to decompose the key technical building blocks, or components, of a C-KM enabled healthcare delivery system.

Knowledge Translation

The “Bench to Bedside” and “Translational Medicine” movements highlight the growing application of bioinformatics and data interchange standards in speeding the translation of research findings into improved clinical care.

A recent collaboration between HL7 International and the United States National Cancer Institute showed how interoperability standards, including SNOMED CT, could move breast cancer clinical trials data more quickly to the point of care.

Component 1: Electronic Health Records

Gartner Group has devised a generational model of Electronic Health Records systems (EHR, also referred to as Computerized Patient Record, CPR)⁴⁹, illustrated in Figure 4, that provides a widely referenced and useful model for conceptualizing the required capabilities of clinical information systems as they evolve from serving primarily as tools for data collection and storage to sophisticated information systems that serve to mentor healthcare providers by delivering clinical knowledge to them as it is pertinent to their work.⁵⁰ While Gartner's model is generally focused on the evolution of EHR products in the marketplace, it also provides a useful illustration of the components of advanced EHR systems and the role that Controlled Medical Vocabularies (CMV), such as SNOMED CT, play in supporting them. This is illustrated in Figure 3.

When viewed in terms of the capabilities of a EHR, the role of CMV is to support clinical workflow and decision making by providing the EHR with the means to capture and encode information within a patient's chart in a manner that allows the

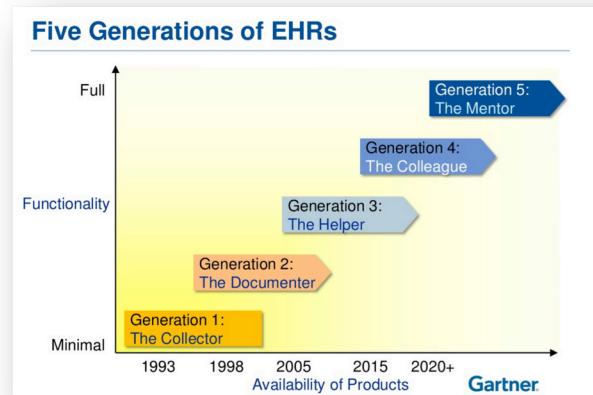


Figure 4: Gartner 5-Generation Model

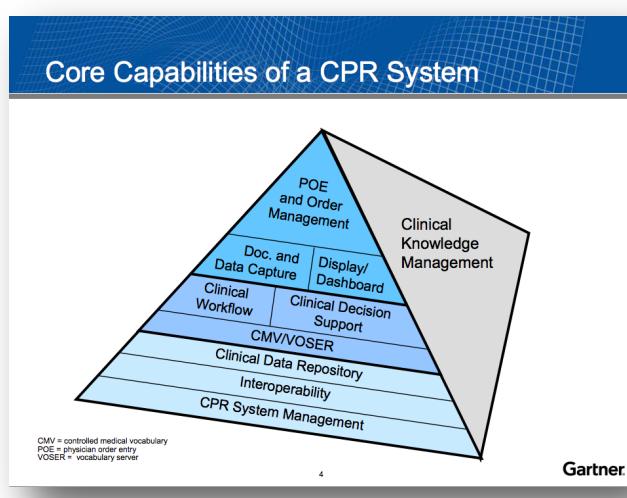


Figure 3: Core Capabilities of a Computerized Patient Record (CPR) System

⁴⁹ Source: <http://www.gartner.com/doc/414876?ref=SiteSearch&sthkw=Ehr%20generation&fnl=search>, accessed July, 2014.
⁵⁰ Ibid.

information to be used to delivery clinical knowledge to clinicians as it is most relevant to their work. The broad scope of content and underlying reference features of SNOMED CT make it very well suited to this purpose.

The C-KM perspective gives the body clinical knowledge equal footing to workflow and decision-making at the point of care. In this manner, a key role of the EHR is to capture clinical knowledge, in the raw form of patient centric information, to enable other C-KM processes as well as to deliver clinical knowledge back to providers to support their decision-making.

Component 2: Comparable and Computable Clinical Information and Knowledge

The C-KM perspective also refines the role of CMV, which, given the broader perspective, must not only provide the means to capture and encode information in a manner useful to the functionality of the EHR, but also link clinical information and knowledge resources throughout the full spectrum of C-KM activities. The features that make SNOMED CT useful capturing, encoding and processing information within the EHR are also well suited to other knowledge management activities.

SNOMED CT is a comprehensive terminology product that provides value at the point of care by providing clinician friendly, clinically validated terminology to support documentation in the EHR. In the background, reference features, including computable definitions (see inset) support aggregation and analysis of the clinical information captured within patient health records.

The computable definitions within SNOMED CT are constructed as a series of relationships between different clinical concepts. When clinical information within an EHR or knowledge repository is encoded using SNOMED CT, these relationships provide computer systems with a map of clinical knowledge that can be used to query and process the encoded information.

SNOMED CT concepts have both **hierarchical** and **definitional** relationships to support

It's in the Relationships

The concept "*viral pneumonia*" has both hierarchical and definitional relationships:

Hierarchical Relationship "*viral pneumonia*" has an "is a" relationship to the more general concept "*infective pneumonia*".

Definitional Relationship "*viral pneumonia*" has a "causative agent" relationship to the concept "*virus*" and a "finding site" relationship to the concept "*lung*".

Note that the relationships in SNOMED CT are expressive and meaningful in natural language.

sophisticated queries on multiple axis (e.g. “find all patients having any type of cardiomyopathy”, “find all patients having any type of procedure on the left cardiac ventricle or pericardium”).

As a result, SNOMED CT provides a powerful mechanism to enable systems to identify target patient cohorts to extract information from within an EHR; to operationalize clusters of terminology that are needed to drive decision support (e.g. a list of diagnosis descriptions which correspond to the HEDIS⁵¹ definition of Asthma); or to operationalize the rules which are used to monitor clinical knowledge resources for groups of existing or new publications which may impact evidentiary basis of clinical content in the EHR.

Component 3: System-Wide Sharing

Using a single CMV to establish semantic links between patient centric information within EHR systems and other clinical knowledge sources (including research, publications, clinical guidelines and decision support tools) reduces the need for redundant and potentially error prone codification of the clinical criteria used to identify, collect, synthesize, interpret, distribute or implement clinical information and knowledge across a broad spectrum of interdependent use cases. Using a single CMV across organizations allows clinical information and knowledge resources to be more efficiently shared and reused. As the world’s most comprehensive and multilingual terminology standard, SNOMED CT is well suited not only to enable C-KM activities that span organizations within a single nation but also across national and linguistic boundaries.

B.4. Translating data to information to knowledge to action

Taking a simplified⁵², system-wide view, Figure 5 illustrates the high level C-KM activities, key health system participants (actors), relationships between actors and the SNOMED CT features that lay a foundation for effective C-KM collaborations.

⁵¹ See <http://www.ncqa.org/HEDISQualityMeasurement/WhatisHEDIS.aspx>.

⁵² For a deeper discussion of the complexities and approaches to knowledge management and translation activities please see sources such as <http://www.clintransmed.com/content/2/1/14> and <http://ktclearinghouse.ca/knowledgebase/knowledgetoaction>.

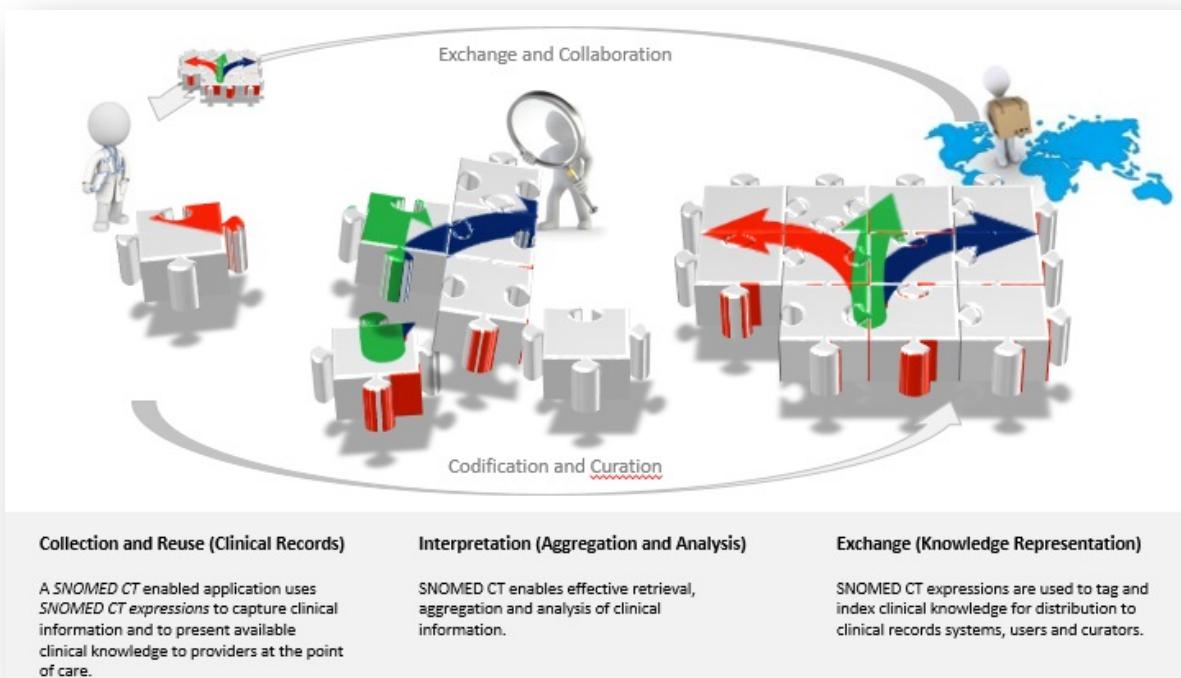


Figure 5: SNOMED CT enabled C-KM cycle

The figure focuses on three categories of activities within the C-KM cycle:

**Collection and Codification
(Clinical Records)**

Healthcare providers working at the point of care are the most visible participants in the C-KM cycle. They record assessments, patient conditions and symptoms, and interventions which are then contextualized within clinical knowledge to direct care provision. Information collected at the point of care is the basic, raw input to the C-KM cycle. Healthcare providers are also primary users of C-KM outputs.

**Interpretation
(Aggregation and Analysis)**

At the point of care and behind the scenes, clinicians, researchers, health system administrators, and policy makers aggregate and analyse available data to piece together an understanding of the relationships between patient needs, interventions and outcomes. Through interpretation, aggregation, and analysis, data is converted into information and knowledge. New treatment patterns and best practice treatment plans are devised as a direct result of interpretations derived from information aggregation and analysis.

**Exchange
(Knowledge Representation)**

To provide value, available knowledge must be distributed to healthcare providers. Healthcare journals, vendors of clinical content and decision support systems and even inter-professional collaboration among healthcare providers (within and across countries) are examples of activities which support knowledge exchange.

The C-KM cycle encompasses a series of activities whereby clinical information is progressively collected, encoded, interpreted and exchanged among health system actors who progressively translate raw clinical information into knowledge, knowledge into tools, tools into actionable interventions, and interventions into outcomes. At each stage, data collection, curation, interpretation, and synthesis activities are required to produce and maintain knowledge assets that are made subsequently available for exchange and use by others.

The various health system actors perform four characteristic roles as Producers (P), Curators (C), Distributors (D) and Users (U) of clinical knowledge. Activities performed by these actors are directly related to and supported by distinct features of SNOMED CT that are described and illustrated in Figure 6.

Clinical Knowledge Management	Key SNOMED CT® Components
Collection and Reuse  KM Role : User (U) <ul style="list-style-type: none"> - Decisions support systems use relationships within clinical information systems to provide Users with available information as it is relevant to their work. KM Role : Producer (P) <ul style="list-style-type: none"> - Healthcare Providers capture information about patient conditions, medical interventions and outcomes in Clinical Records Systems as they care for their patients. 	SNOMED CT® Concepts <ul style="list-style-type: none"> - <i>codes (& expressions)</i> capture information within patient records. Underlying definitional relationships may be used to develop triggers to provide reminders or information.
Interpretation  KM Role: Curator (C) <ul style="list-style-type: none"> - Healthcare Providers, Researchers and other Clinical Knowledge Curators collect information from within Clinical Records and other Knowledge Resources to understand health issues and possible interventions. 	SNOMED CT® Interface Features <ul style="list-style-type: none"> - <i>preferred terms</i> and <i>synonyms</i> allow health care providers to use familiar language to capture coded, structured statements in a patient health record. - <i>reference sets</i> may: constrain data entry to terms and/or concepts appropriate within context of use; and/or operationalize decision support rules.
Share  KM Role: Distributor (D) <ul style="list-style-type: none"> - Medical Journals, Clinical Content vendors and other Knowledge Distributors collect medical knowledge resources for distribution to users. 	SNOMED CT® Reference Features <ul style="list-style-type: none"> - Definitional <i>relationships</i> within SNOMED CT enable logic based computer assisted retrieval, aggregation and analysis of clinical information within patient charts, or tagged knowledge resources. - Relationships can be inferred as concepts are added or changed. SNOMED CT® Concepts <ul style="list-style-type: none"> - <i>codes (& expressions)</i> may be used to tag knowledge resources for distribution to Users or Curators. - Definitional relationships enable computer assisted maintenance of existing knowledge archives or decision support systems.

Figure 6: C-KM Processes, Roles and SNOMED CT Facets

Use of a single, standard controlled medical vocabulary, like SNOMED CT, provides a consistent way to encode and link information assets across different research, knowledge

management and care delivery related activities as described in the following potential C-KM flows: (Also illustrated in Figure 7.)

- Healthcare providers in the **Producer (P) Role** capture encoded clinical knowledge in their EHRs as part of care provision. In this process they may also act in a **User (U) Role** when they leverage interface terminologies (e.g. preferred terms and synonyms) in order to be able to use familiar language to capture coded, structured statements.
- Researchers in the **Curator (C) Role** use the reference terminology features of SNOMED CT to identify and collect information from within clinical records and existing research.
- Researchers in the **Producer (P) Role** tag and publish research for consumption by others.
- Content providers in the **Curator (C) Role** use SNOMED CT to identify and collect knowledge references.
- Content providers in the **Producer (P) Role** distribute encoded clinical and healthcare knowledge resources for use by providers and/or implementation in clinical systems.
- Healthcare providers in the **User (U) Role** leverage decision support systems or decision support capabilities within their EHR. These decision support capabilities are enabled by exploiting relationships within clinical information systems to provide relevant available information.

Example:

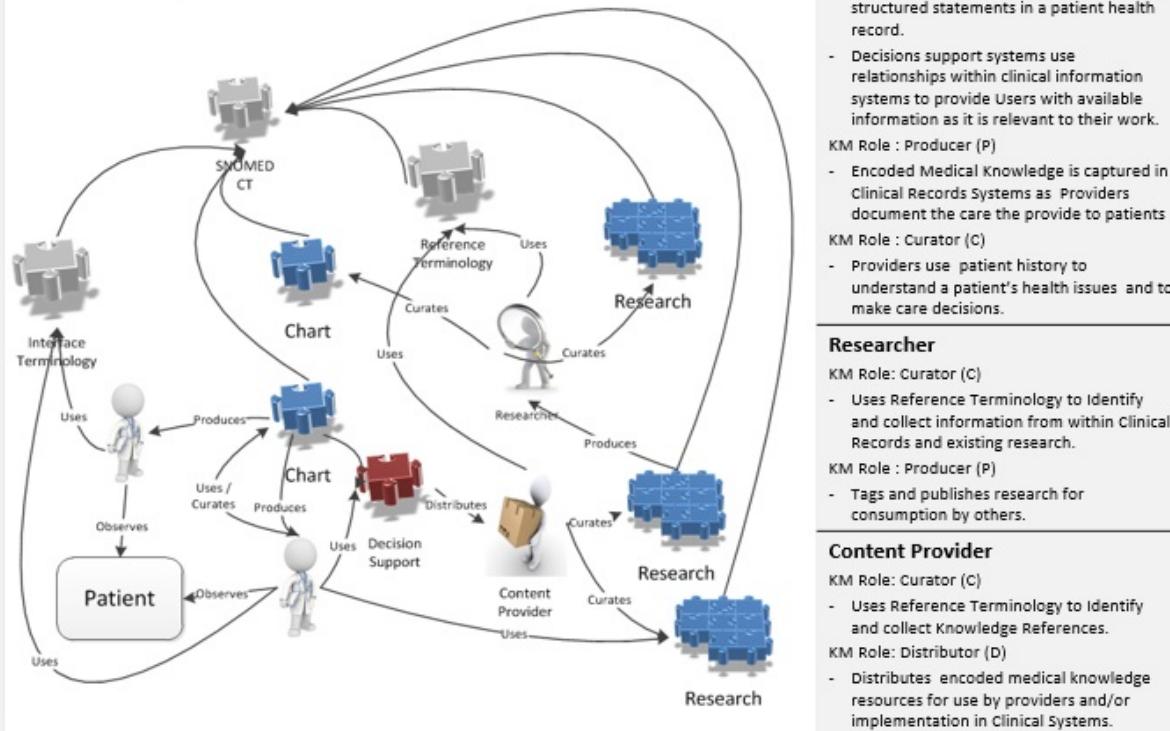


Figure 7: C-KM Flow Example

B.5. Understanding C-KM Benefits

C-KM benefits can be understood from two distinct perspectives:

System-Wide Benefits

As demonstrated by high performing health systems like Kaiser Permanente and the Veteran's Health Administration, effective C-KM processes translate into more efficient and effective use of clinical knowledge and technology, better patient outcomes and cost savings. When viewed from the macro, economic level these translate into a healthier, more productive population and more efficient and effective use of tax funds allocated to the healthcare system.

Figure 8 illustrates this from the perspective of a national health system.

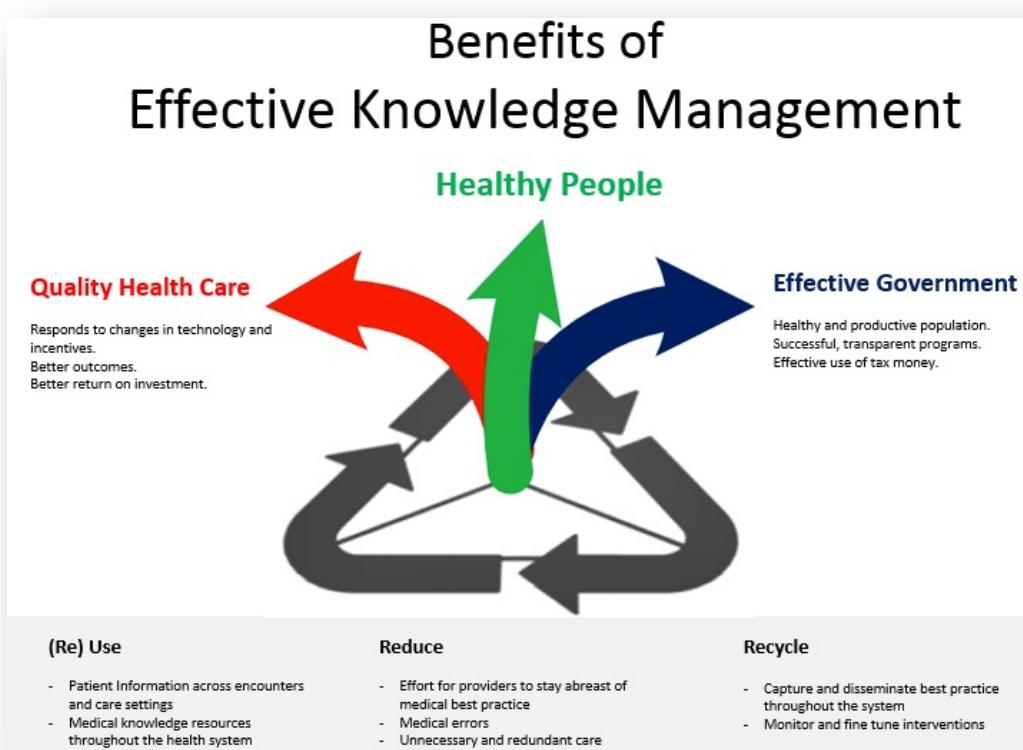


Figure 8: Benefits of Effective Knowledge Management

These benefits accrue as available information and knowledge is effectively shared and used across the spectrum of caregivers, health researchers and health system managers.

Stakeholder-targeted benefits

Benefits also accrue to the individual stakeholders and organizations that use health information (in various forms) to perform their work or who benefit from the outputs of this work.

Table 5: Audience Specific Messaging

	<p>A learning health system can drive continued improvements in the quality and efficiency of the healthcare system.</p>						
Overarching Value Proposition	<p>SNOMED CT enables learning and innovation within the healthcare system by connecting Clinical Knowledge Management activities with Care Delivery. This will help accelerate adoption of new medical innovations within the healthcare system.</p>						
Citizens	<p>Healthcare providers must stay abreast of healthcare innovations to effectively care for their patients. Advanced Electronic Health Records systems provide doctors with new, efficient ways to stay abreast of innovations. The benefit is better outcomes for patients and more efficient use of healthcare funds.</p>						
Political Actors & Health System Decision Makers	<p>Healthcare is a knowledge industry.</p> <p>Information and Communication Technologies that enable patient health information and medical knowledge to flow efficiently between clinicians, researchers and other stakeholders can have a profound impact on patient outcomes and system level performance.</p>						
C-KM Cycle Participants	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Overarching C-KM Cycle Participant Message</td> <td>SNOMED CT enabled Clinical Knowledge Management will accelerate the clinical knowledge adoption cycle by linking care delivery with underlying clinical research, knowledge management and distribution activities.</td> </tr> <tr> <td>Users of SNOMED CT and Clinical Knowledge</td> <td>SNOMED CT enabled systems can connect information captured within a patient's chart with available reference information and decision support tools to make it easier to integrate best practice into your practice.</td> </tr> <tr> <td>Curators of Clinical Knowledge (Researchers and Publishers of Research)</td> <td>Information within patient charts, research abstracts and decision support tools is enriched when encoded using SNOMED CT. SNOMED CT adds semantically rich, computable definitions and a rich network of relationships to clinical information, making it more readily discoverable, sharable and usable.</td> </tr> </table>	Overarching C-KM Cycle Participant Message	SNOMED CT enabled Clinical Knowledge Management will accelerate the clinical knowledge adoption cycle by linking care delivery with underlying clinical research, knowledge management and distribution activities.	Users of SNOMED CT and Clinical Knowledge	SNOMED CT enabled systems can connect information captured within a patient's chart with available reference information and decision support tools to make it easier to integrate best practice into your practice.	Curators of Clinical Knowledge (Researchers and Publishers of Research)	Information within patient charts, research abstracts and decision support tools is enriched when encoded using SNOMED CT. SNOMED CT adds semantically rich, computable definitions and a rich network of relationships to clinical information, making it more readily discoverable, sharable and usable.
Overarching C-KM Cycle Participant Message	SNOMED CT enabled Clinical Knowledge Management will accelerate the clinical knowledge adoption cycle by linking care delivery with underlying clinical research, knowledge management and distribution activities.						
Users of SNOMED CT and Clinical Knowledge	SNOMED CT enabled systems can connect information captured within a patient's chart with available reference information and decision support tools to make it easier to integrate best practice into your practice.						
Curators of Clinical Knowledge (Researchers and Publishers of Research)	Information within patient charts, research abstracts and decision support tools is enriched when encoded using SNOMED CT. SNOMED CT adds semantically rich, computable definitions and a rich network of relationships to clinical information, making it more readily discoverable, sharable and usable.						

**Distributors of
Clinical
Knowledge**

Knowledge products are more discoverable, sharable and interoperable when encoded with SNOMED CT. SNOMED CT offers a standard, consistent way to codify the clinical criteria used to associate tools with patient populations or to monitor evidence within archives.

Appendix C SNOMED CT Adoption Maturity Model

C.1. Introduction

The enclosing report highlights some high level tactical considerations for organizations working to foster adoption and meaning use of SNOMED CT. The objective is to provide support to IHTSDO members and other SNOMED CT implementers developing business cases for IHTSDO membership, SNOMED CT related projects and/or other related investments by helping surface requirements that could impact how the program is organized, resourced and timed.

"all models are wrong, but some are useful"

George E. P. Box

The following SNOMED CT Adoption Maturity Model provides a conceptual framework to help stakeholders identify, frame and discuss the status of a SNOMED CT program as well as the challenges and opportunities ahead when developing strategy or operational plans or considering projects within a large scale SNOMED CT implementation program. Using this model together with the cost and benefit quantification techniques proposed in Appendix D provides a potential structure for the development of strategies and associated business cases.

Discussion within the sections that follow describes the model and its application.

C.2. Description

The Adoption Maturity Model (the model) is depicted as a graph (Figure 9) that considers the growth of a SNOMED CT program in two fundamental directions, Scope of Implementation and Operational Maturity. The graph is separated into four quadrants by Adoption and Sustainability hurdles that the program will face and must overcome as the scope and maturity of the SNOMED CT implementation increases. The four quadrants of the graph correspond to four different states that a typical program will move between (often iterate between) on the way to realizing a broad based and mature SNOMED CT implementation. Each of the components of the model are described in more detail below.

Scope of Implementation refers to the scale, breadth and depth of an implementation where: scale relates to the number of users, number of different places or number of different systems using SNOMED CT; breadth corresponds to the number of SNOMED CT concepts in use (e.g. number of clinical domains); and depth corresponds to the number of different features of SNOMED CT in use (e.g. clinical terminology, expressions, description logic and reference sets). Increasing scope is typically associated with increasing complexity.

Operational Maturity refers to the availability, adequacy and stability of any shared services and tools needed to support SNOMED CT implementers and users. (For example, the US National Library of Medicine Value Set Authority Center (VSAC) is an ancillary service that supports implementers of the CMS Quality Measures by providing them with access to shared value sets in a machine-readable format. The stability of VSAC funding, resources and tools could be considerations when assessing the Operational Maturity of the CMS Quality program.)



Figure 9: SNOMED CT Adoption Model

Individual projects within a broader SNOMED CT program will contribute to the scope of SNOMED CT implementation and/or provide and improve services and tools that contribute to the operational maturity of the program. In either case, there are predictable hurdles (tasks or challenges specifically related to the use of standardized controlled medical vocabularies or SNOMED CT) that projects will encounter and that the program must overcome to be successful. These are grouped Adoption and Sustainability hurdles that correspond to the different dimensions of the model:

C.2.1. Adoption Hurdles

Adoption hurdles correspond to implementation challenges. Overcoming these hurdles is a key focus of projects directed toward: increasing breadth of use by encoding additional content; increasing depth of use by using additional features of SNOMED CT and/or increasing scale by adding new organizations or new users to an existing solution or reusing terminology assets produced by one project within another. Common adoption hurdles and potential tactics are identified in Table 6 through Table 8.

Table 6: Adoption Hurdles – Increasing Breadth

Goal & Description	
Increasing Breadth of Use by increasing the number of SNOMED CT concepts in use.	
Projects increase breadth of use by using SNOMED CT concepts and structured documentation tools to encode new EHR content areas and/or knowledge resources within an existing or new solution. These projects develop new terminology assets to support the project and program as they identify the SNOMED CT content needed to support new use cases, validate suitability for local use, address gaps, package artefacts into a deployable format and train new implementers and users.	
Common Hurdles	Tactical Options
Skilled Resources	Acquire knowledgeable resources. (Contract or permanent) Acquire education and training services. Develop and maintain a local resource pool. Develop and maintain education and training services. Develop and maintain local resource pool.
Specialized SNOMED CT technical knowledge, proficiency with tools and/or specific clinical domain specific knowledge will be required to constrain content, address gaps in terminology and/or enhance systems.	

Goal & Description

Constraining SNOMED CT to Scope

SNOMED CT contains hundreds of thousands of concepts and descriptions. For most applications, these must be constrained into lists of concepts appropriate for the context.

Language Localization

A single concept in SNOMED CT may have multiple descriptions using conventions appropriate to different types of users and different word order. Some applications will lists of concepts to be further constrained to a list of terms appropriate to a specific user community, clinical specialty or even word order to function correctly in the desired context.

Different human languages (e.g., French vs English) are managed through similar mechanisms as above.

Addressing Content Gaps

When constraining (or localizing) content required concepts and/or appropriate descriptions may not be available and must be added to SNOMED CT's core International Edition, built and maintained as a local extensions, managed as SNOMED CT expressions and/or supported through alternate methods that may limit or exclude use of other SNOMED CT features.

Legacy Systems

Existing legacy systems that provide structured documentation tools will not necessarily provide any native support for SNOMED CT release formats.

Legacy Terminology

Existing legacy systems that provide structured documentation tools will also include legacy terminology.

In many cases, legacy "terminology" will be a master list of terms developed to support workflow; integration with devices or ancillary systems; or for administrative coding / billing purposes and therefore have dependencies and/or maintenance heuristics that will be a consideration.

Acquire an existing constrained value set. Depend on external process to address (or live with) content gaps.

Acquire, localize and maintain an existing constrained value set. (Borrow or Buy) Develop and maintain local content and processes to address content gaps in acquired content and SNOMED CT.

Develop and maintain a constrained value set. Develop and maintain local content and processes to address content gaps in SNOMED CT.

Ancillary product and service opportunities:

Provide shared resource pool and/or tools to localize terminology on behalf of implementers.

Maintain localized content as a shared asset and distribute to implementers.

Fund localization efforts.

Replace legacy systems with SNOMED CT enabled systems. Develop or acquire any terminology maps required for legacy data conversion.

Enhance legacy systems to use SNOMED CT and replace legacy terminology. Develop or acquire any terminology maps required for legacy data conversion.

Enhance legacy systems to enrich legacy terminology with SNOMED CT codes. Develop and maintain terminology maps.

Develop and maintain terminology maps. Acquire (or Develop and Maintain) systems to implement maps outside of legacy systems.

Ancillary product and service opportunities:

Develop and maintain shared processes to distribute SNOMED CT content in a legacy system compatible format.

Provide shared resources and/or tools to develop and maintain maps.

Fund legacy system upgrades and enhancements.

Goal & Description	
Decision Making and Funding Most decisions entail some sort of compromise impacting quality, cost, resource utilization or timelines that might impact different stakeholders in different ways.	Centralize decision-making within an organization capable of mandating change. Centralize decision-making and accountability in an organization capable of funding and/or resource development and implementation efforts. Share decision-making, accountability and/or costs among implementers and beneficiaries.

Table 7: Adoption Hurdles – Increasing Depth

Goal & Description	
Increasing Depth of Use by increasing the number of SNOMED CT features in use and level of integration.	
Common Hurdles	Tactical Options
Shared Terminology Integrating different departments, clinical settings and/or organizations requires that important information entered in one setting will be recognized and usable in another.	Acquire or Develop and Maintain terminology assets within organizations. Manage integration issues separately. Develop and Maintain formal, shared mechanisms to communicate change.
Quality Inconsistent system functionality or use of terminology across integrated settings can cause unexpected quality and, potentially, safety issues. Software will typically assume externally sourced information conforms to local business rules.	Acquire or Develop and Maintain terminology assets as a shared resource. Develop and maintain shared terminology change processes. Manage implementation at the organization level. Develop and maintain formal, shared mechanism to communicate change.
Change Changing business and clinical requirements, technology changes, external requirements (e.g. updates to SNOMED CT) and quality issues can introduce the need to add or remove content from constrained value sets.	Acquire or Develop and Maintain terminology assets as a shared resource. Develop and Maintain formal shared change and governance processes for terminology and technology.

Goal & Description	
Decision Making and Funding	Centralize decision-making within an organization capable of mandating change.
Most decisions entail some sort of compromise impacting quality, cost, resource utilization or timelines that might impact different stakeholders in different ways.	Centralize decision-making and accountability in an organization capable of funding and/or resource development and implementation efforts.
	Share decision-making, accountability and/or costs among implementers and beneficiaries.

Table 8: Adoption Hurdles – Increasing Scale

Goal & Description	
Increasing Scale by increasing the number of Users, Organizations and/or Systems using SNOMED CT.	
Common Hurdles	Tactical Options
Coordination and Complexity	Develop capabilities in to adapt and implement terminology assets and/or solutions within implementing organizations. Identify human resources, products and services within existing teams susceptible to sharing and develop any necessary organizational supports.
Decision Making and Funding	Centralize decision-making within an organization capable of mandating change. Centralize decision-making and accountability in an organization capable of funding and/or resource development and implementation efforts. Share decision-making, accountability and/or costs among implementers and beneficiaries.

C.2.2. Sustainability Hurdles

Sustainability hurdles correspond to the operational challenges associated with maintaining a stable, well-functioning set of products and services to support implementers and users of SNOMED CT. Operational complexity will increase with the scope of implementation, which may destabilize operational processes. Common sustainability hurdles and potential tactics are identified in Table 9.

Table 9: Sustainability Hurdles

Goal & Description	
Increasing Sustainability	
Common Hurdles	Tactical Recommendations
<p>Maintenance</p> <p>Terminology assets whether explicitly shared or managed locally and participating in integrated solutions will need to be maintained or local solutions will diverge causing integration issues. The extent of changes in SNOMED CT itself is also a consideration as releases to the core International Edition impact local assets deployed within solutions.</p> <p>Similarly, all shared services and products within the program need to be maintained to remain relevant.</p>	<p>Programs grow and evolve. Over time, the feasibility of driving a program through mandated change and/or centralized funding sources will grow more and more limited. The program must deliver value to stakeholders early and often to build momentum and generate sufficient goodwill and funding to sustain the program in the short- to medium-term and, ultimately, to generate demand for its services.</p> <p>Centralizing shareable terminology assets, tools and services within ancillary shared service organizations provides cost and coordination efficiencies as well as meaningful career paths to maintain experts if it is politically and financially feasible.</p>
<p>Tools and Processes</p> <p>There is only so much you can do with an infrastructure based on spreadsheets and email. Robust tools and processes are needed to address reference set creation and maintenance, cross-mapping, extension management, IHTSDO submissions, workflow, concept editing, repository access, and more.</p> <p>Processes used to update terminology artefacts upon a new release of SNOMED CT or in response to implementer requests need to also be carefully considered and formalized.</p>	<p>Services provided by IHTSDO members and affiliates provide a range of examples of ancillary services delivered within public government departments, arm's length publicly funded organizations and commercial enterprises. There is no single correct solution, recognizing that the level of integration and coordination provided through the model needs to be aligned with the integrated solution in use.</p>

Goal & Description

People

Falloff of knowledgeable resources may be an issue as the projects complete and the program and participating organizations evolve. Successful programs must be designed to attract and retain advocates and a skilled resource pool.

Decision Making and Funding

Most decisions entail some sort of compromise impacting quality, cost, resource utilization or timelines that might impact different stakeholders in different ways.

These Adoption and Sustainability Hurdles divide the model into four conceptual quadrants that correspond to different states of adoption and maturity that a typical program will move between on the way to realizing a broad based and mature SNOMED CT implementation. The four states, numbered in the illustration of the model in Figure 9, are described in Table 10 below. An arrow spans States 1 - New, 2 - Stable and 4 - Mature of the graph reflecting the desired path of progression through the states of the model. The reality is that most programs will experience periods of over commitment (3) and instability as the scope of SNOMED CT adoption increases and new solutions and users strain the services created to support them.

Table 10: SNOMED CT Adoption Maturity Model Quadrants

State	Description and Focus
1	Description: New Program with pilot projects in planning or underway. Focus: Learning to use SNOMED CT. Successful delivery of pilot projects. Building support for the program.
2	Description: Solutions are live with users. Shared services and the solutions they support are operationally stable. The program is realizing value in proportion to scope. Focus: Maintenance. Fostering advocates among users. Increasing scope.
3	Description: Solutions are live with users. Shared services are non-existent, insufficient or over committed and, as a result, the solutions they support are unstable. Value is at risk. Focus: Maintenance. Developing the services needed to provide

State	Description and Focus
4	<p>stability to users.</p> <p>Description: Mature, broad based implementation. Steady state. The program is maximizing value from SNOMED CT.</p> <p>Focus: Maintenance, fine-tuning.</p>

C.3. Application

As a straightforward conceptual framework, the model is a reference to help stakeholders discuss and evaluate the state of a SNOMED CT implementation program; the goals, objectives and challenges of upcoming projects; and the potential impact an upcoming project may have on existing shared services as well as the solutions and users that depend on them. The descriptions of hurdles and tactics, should be not be interpreted as comprehensive lists, but, rather, as examples to help direct and facilitate the discussions that are necessary to identify and explore actual challenges faced by stakeholders, potential gaps in project plans, impacts of scope and service changes, etc., as well as root causes of issues and tactic to address challenges or exploit opportunities. The sections that follow provide some ideas to help stakeholders plan discussions that leverage the model.

C.3.1. Assessment and Goal Setting

At key milestones in the program (e.g. when considering new projects, transferring projects to production and during annual budgeting processes) it is useful to bring together key stakeholders, project participants and advocates to discuss and assess the status of the program as well as current challenges and opportunities that lie ahead.

During these discussions, the graph and descriptions of hurdles can be used to provide a common reference to explore the state of the program, the state of specific products and services and/or the impact that a new project may have on the services currently in place:

Level Set

Establish a level understanding of the purpose of the session as well as a shared understanding of what a mature SNOMED CT implementation (quadrant 4) is. Depending on the objective of the session, this may be a presentation or discussion that draws upon project of objectives, an existing future state vision and/or discussion benefits to establish a level vision among the

participants. (The discussion of features and benefits in the core report and C-KM model provide useful references for a vision session.)

Assess Program

With a level understanding of the goal, the program assessment focuses on understanding the current state. Activities for the current state assessment may include:

- Present the past accomplishments of the program as well as objectives and status of current projects.
- Present and discuss current end uses and users of SNOMED CT and the business value currently being realized as well as known challenges and potential untapped opportunities. Use model adoption goals (breadth, depth, scale) descriptions and hurdles as examples to help identify and categorize challenges and opportunities.
- Present and discuss any shared services and products generated by the program, who is using them, known challenges and potential untapped opportunities to add new products and services. Use model sustainability goal description and hurdles as examples to help identify and categorize challenges and opportunities.
- Present the model, quadrant descriptions and focuses. Ask participants to identify current state (quadrant) of the program (and/or the specific shared service areas identified above). Ask participants to identify the accomplishments, challenges or opportunities (from above) that led to their assessment.

Goal setting

Upcoming, known business opportunities will be an input to goal setting as well as challenges and opportunities identified in the Program assessment. The model goal descriptions, hurdles ad tactics provide useful inputs to identify and discuss strategic and tactical options for the project such as the impact that business opportunities may have on shared products and services.

C.3.2. Planning

Whether the focus is specific project level planning or higher level strategic and operational planning, use of the model is consistent. Plans focus on activities that will contribute to the scope (breadth, depth, or scale) of SNOMED CT implementation and/or provide and improve services and tools that contribute to the operational maturity of the program. (Usually more than

one.) The model and goal descriptions provide a mechanism to help identify the direction of movement within the model and to identify potential hurdles and tactics related to the plan in scope. As with the program assessment, the model is most useful when used to establish a shared frame of reference and examples to support discussion among a group of stakeholders who will surface real world challenges and opportunities and help select among tactical options.

Appendix D Cost and Benefit Quantification Methods

D.1. Overview

This appendix offers specific quantification approaches for both potential costs and benefits related to each of the 6 implementation stages outlined in sections 5.

Since the proposed activities and associated cost are intended to be illustrative rather than exhaustive, readers should also consult Appendix C when developing their own strategies and associated business cases.

It should also be noted that many of the benefits quantified in this appendix rely on the implementation of health informatics solutions which use structured data and codification. While those benefits identified for the early stages (particularly 1 and 2) do not necessarily demand use of SNOMED CT (i.e. other terminologies, including proprietary solutions can unlock these benefits), the benefits asserted in stages 3 through 6 demand the establishment of a comprehensive clinical terminology strategy enabled via a rich ontology, such as that offered by SNOMED CT and certain proprietary solutions. The purpose of this appendix is not to reiterate SNOMED CT's broad advantages from earlier sections, but rather to provide quantification techniques for implementation of comprehensive terminologies generally and SNOMED CT in particular.

D.2. Enabling Basic Access

This section represents the core costs for a country to (1) become an IHTSDO member (and to maintain membership on an annual basis) and (2) to staff a National Release Centre. These costs are entirely independent of deeper investments to support the development of country specific localizations, sponsoring implementations, or other investments.

For some countries this may only be a basic foundational step while others, particularly those with limited eHealth infrastructures, may simply stop here in order to subsequently focus and justify further investments on the basis of very specific eHealth initiatives.

Costs By Component

①	Membership costs
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Key Decision and/or Scoping Factors

IHTSDO membership fees are based on an ability-to-pay model which establishes fair share percentages. Current 2014 member fees are based on the 2011 Gross National Index as published by the World Bank and are available at the IHTSDO website⁵³.

Quantification Techniques

Apply IHTSDO pricing model over the anticipated planning horizon.

Example(s)

- Australia – US\$ 368K per year
- Canada – US\$ 561K per year
- Malaysia – US\$ 86.8K per year
- Marshall Islands – US\$ 76 per year
- United States – US\$ 5.4M per year

②	Core Operations
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Key Decision and/or Scoping Factors

Various sources provide background on the operation of a National Release Centre including a guide published by the IHTSDO⁵⁴. For members seeking to only establish a basic NRC function, in order to enable access to SNOMED CT in their jurisdiction, the activities can be distilled down to three basic categories:

- Management of the IHTSDO relationship (e.g. engaging in various governance and membership activities);
- Management of the twice-annual releases of the SNOMED CT core International Edition; and
- Administering a domestic sublicensing scheme.

⁵³ See http://www.ihtsdo.org/fileadmin/user_upload/Docs_01/Members/Fees/IHTSDO_2014_Membership_Fees_v1.0.pdf, accessed August, 2014.

⁵⁴ See <http://www.ihtsdo.org/develop/documents/running-a-national-release-centre>, accessed August 2014.

Quantification Techniques

Cost quantification should be based on an allocation of FTEs with any applicable corporate overhead load costs for space and technology, as well as a travel expense allowance to enable attendance at IHTSDO related meetings.

Based on information from other members and experience of the authors, a minimal NRC can be operated via an allocation of 1 to 2 FTEs.

This would be expanded based on the extent of localized and extended content which is to be maintained / reviewed for each IHTSDO SNOMED CT release as well as any ancillary services (e.g. modelling support, training, etc.) provided by the NRC. In the model presented in this appendix, these would be part of the “Establishing Localization & Initial Adoption” package.

Formula(s):

Cost = (No-of-FTEs x FTE-Salary-Cost x Salary-Overhead-Load-Factor) + Allocation-for-Travel

Example(s):

- South East Asia – 2 x (US\$ 39.9K x 1.5) + US\$ 5K = US\$ 124.7K
- Central Europe – 2 x (US\$ 100.2K x 1.5) + US\$ 5K = US\$ 305.6K

Note(s):

Sample rates are based on the mid-point salaries for staff based Business Consultant or Business Analysis Manager from the Robert Walters 2014 salary survey using Malaysia and the Netherlands as data points.⁵⁵

⁵⁵ See <http://www.robertwalters.co.uk/career-advice/salary-survey.html>, accessed September 2014.

Quantified Benefits

The benefits that accrue solely from enabling access through membership are fairly basic but include the following:

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Administrative & Management Cost Savings</i>		
Admin. Cost Avoidance or Reductions	<p>Elimination of SNOMED CT licensing costs at a facility or user level and associated administrative overheads⁵⁶.</p>	<p>Per site costs for use of SNOMED CT in non-member countries are available at on the IHTSDO website⁵⁷ and are based on an annual fee for each data creation system as well as for each data analysis system. These costs are graduated based on the wealth of a country.</p> <p>Formula(s): $\text{Benefit} = \text{Per-application-license-cost} \times (\text{Site-count} \times \text{Average-applications-per-site})$</p> <p>Example(s): Using the OECD 2014 health statistics, Germany (currently a non-member country) had 3229 sites identified as hospitals in 2012. Note that this figure does not include the vast number of clinics or physician offices, all of which could run systems using SNOMED CT. Even if only 10% of hospitals (i.e. 323) were to use SNOMED CT with an average of 3 systems each (2 data entry and one analytical), this equates to an avoidable cost stream as follows: $(3 \times \text{US\\$ } 1,688) \times 32 = \text{US\\$ } 1.64\text{M}$</p> <p>Note(s): It should be noted that the amount calculated above does NOT include the cost of administration for individual licenses and is based on a very small fraction of overall potential sites and systems. However, it is still less than the US\$ 1.13M annual fee which would currently be allocated to Germany if that country were to join.</p>
	Reduction in medical records administration	Administrative costs to code health information for statistical reporting or billing purposes are a significant overhead to

⁵⁶ Some non-member countries may have stakeholders which use SNOMED CT, directly or embedded in a product, but who do not currently pay a license fee, whether directly or via their software provider(s). Although these stakeholders and countries would not be offsetting actual expenditures it should be noted that the IHTSDO intends to assert its Intellectual Property (IP) rights in order to ensure its continued financial sustainability and, in so doing, to protect the organization's ability to support and evolve SNOMED CT.

⁵⁷ See <https://docs.google.com/viewer?url=http%3A%2F%2Fwww.ihtsdo.org%2Flicensefees.pdf>, accessed September 2014.

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
	<p>/ health information management (HIM) costs as standardized SNOMED CT to ICD maps and software help automate coding processes (e.g. processes to create coding for financial purposes).</p>	<p>healthcare organizations. EHR systems that use structured documentation tools can help automate the collection and aggregation of information for billing and reporting purposes. Cross maps between SNOMED CT and ICD-10 maps can be used to improve mapping productivity for charts which contain SNOMED CT based clinical data, given the additional clinical detail which SNOMED CT provides.⁵⁸.</p> <p>Formula(s): $\text{Benefit} = [(\text{Number-of-Encounters-or-Visits}) \times (\text{Time-to-Code-Record}) \times (\text{Local-resource-hourly-labour-cost}) \times (\text{productivity-Improvement-Ratio})]$</p> <p>Example(s):</p> <ul style="list-style-type: none"> • Canadian inpatient-stay coding productivity 3.75 per hour.⁵⁹ • 2.8 million inpatient-stays in Canada in 2011.⁶⁰ • Average Medical Coding Specialist wage is approximately CA\$ 19/hr • Potential fractional cost savings (i.e. Productivity-Improvement-Ratio) will vary significantly depending on the level of existing automation. <p>Looking at only inpatient hospital stays and low productivity gains of 10%.</p> <p>Benefit (Canada): $[(2.8 \text{ M}) \times (.26) \times (\text{CA\\$19}) \times (.1)] = \text{CA\\$1.38M}$</p> <p>Note(s): N/A</p> <p>Cited References(s): http://library.ahima.org/xpedio/groups/public/documents/ahima/bok3_005558.hcsp?dDocName=bok3_005558</p>

⁵⁸ Bowman, Sue. "Coordination of SNOMED-CT and ICD-10: Getting the Most out of Electronic Health Record Systems." *Perspectives in Health Information Management*, Spring 2005 (May 25, 2005).

⁵⁹ http://library.ahima.org/xpedio/groups/public/documents/ahima/bok3_005558.hcsp?dDocName=bok3_005558 , Accessed Sep 2014

⁶⁰ https://secure.cihi.ca/free_products/DAD-NACRS_Highlights_2010-2011_EN.pdf, Accessed Sep 2014

D.3. Establishing Initial Localization & Adoption

This section represents the basic costs and benefits associated with using SNOMED CT to provide controlled medical vocabulary within clinical and knowledge management solutions. Basic costs relate primarily to: the effort needed to constrain and localize SNOMED CT to the requirements of the projects and/or solutions it is intended to support; and, in situations other than green field implementations where no existing structured clinical documentation tools exist, the effort needed to map legacy terminology to SNOMED CT, either to support migration of legacy data to new systems or to allow legacy applications to participate in SNOMED CT enabled applications through runtime translation.

Effort and investment in this area is depended on various factors, including the following:

- **Clinical Speciality and Setting Scope:** The number of clinical areas or settings for which localized assets are devised or mappings developed, will impact overall effort.
- **Degree of Cost Centralization:** The extent to which the development of common, localized artifacts (e.g. translations of SNOMED CT content, refsets, etc.) is **budgeted** centrally by a member's lead agency or by other health system actors such as sub-national governmental units (e.g. 'states') or within the delivery sector (e.g. hospitals, health management organizations, etc.). Whether budgeted at a national level or not, the more likely that these assets have utility across the entire system the more it behoves planners to allocate resourcing either for development or, at a minimum, for curation of such assets.
- **Services Scope:** The extent to which the member's lead agency maintains resources to support SNOMED CT adoption and use through consulting and training services.
- **Cost Recovery Model:** The extent to which the member's lead agency establishes cost recovery models for support of SNOMED CT will impact the business case. While such internal cost transfers are not relevant from an overall economic cost benefit assessment, it may be highly relevant from an administrative budgeting and approval perspective.
- **Requirement for Language Translation:** Members will need to assess whether they require translation of some or all of SNOMED CT into a national language or dialect. It should be noted that many uses of SNOMED CT, particularly its ability to act as a reasoning and analytical tool, may not require translation, particularly if mappings to user interface terminologies are established.

Given these facts, the costs proposed for inclusion in member business cases below are based on potential activities and will require assessment on a member-by-member, case-by-case basis.

Basic benefits accrue from two main dimensions:

- reduction in cost and/or effort to acquire, build, maintain or implement terminology and terminology supported functions within the broad portfolio of health information management solutions deployed across a member's health system; and, potentially,
- efficiency improvements when more comparable and better structured information makes it easier for users to recognize, trend and appropriately act upon information within SNOMED CT enabled solutions.

Costs By Component

With the exception of any local "translation" requirements it is impossible to develop a one-size-fits-all strategy for development of local content and local maps. Rather this paper offers some basic quantification techniques by cost component and sub-component:

②	Initial Localization
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Key Decision and/or Scoping Factors

The following localization activities and quantification technique(s) represent the main cost drivers:

Localization Activity	Quantification Technique(s)
Investment in tools	<p>At each stage of implementation, tools are required to support localization, maintenance and distribution of SNOMED CT based terminology assets.</p> <p>In the early stages of a program, freely available terminology browsers, spreadsheets and email may be sufficient to support project requirements.</p> <p>More complex programs will require robust tools to support reference set creation and maintenance, cross-mapping, extension management, IHTSDO submissions, workflow, concept editing, repository access, distribution, and more. Large, mature programs within large health systems may invest millions of dollars in tools as part of their, often substantial, investments in health informatics solutions.</p>

Localization Activity	Quantification Technique(s)
	<p>The U.S. SNOMED CT® Content Request System⁶¹, UMLS Terminology Services⁶² and NLM Value Set Authority Centre⁶³ are examples of enabling services provided by the US National Library of Medicine. Other members, including Canada (Canada Health Infoway⁶⁴) and the UK (UK Terminology Centre⁶⁵), offer similar services to support implementers.</p>
<p>Refset Development ("Identify the content required")</p>	<p>Using SNOMED CT description logic to define clinical criteria used to identify a list of terms for implementation in a problem list or structured form will often be more efficient than other methods of gathering clinical requirements from stakeholders and then manually extending the requirements to a list of terms. <u>As a result, the potential exists for SNOMED CT to help lower cost in this area.</u></p> <p>Conservative estimators may prefer to allocate a small incremental effort (~5 days) in comparison to other methods, in order to address time required to decide how SNOMED CT will be constrained, to orient project participants to SNOMED CT, to address SNOMED CT content gaps (if / when applicable), and to acquire the necessary tools.</p> <p>Formula(s):</p> $\text{Ref-Set-Development-Cost} = \text{No-of-RefSets} \times 5 \text{ days} \times \text{Local-SNOMED-Expert-Daily-Cost}$ <p>Note(s):</p> <ul style="list-style-type: none"> • Some implementers will map existing interface terminology to SNOMED CT. In this case, use the mapping estimate below. • Existing SNOMED CT reference sets used by other implementers can often be acquired and localized to accelerate the process. • Effort to engage stakeholders, gather requirements and to facilitate review and QA processes will be substantially more than effort to identify SNOMED CT content – these costs have not been included in this estimating model. • Similar methods can be used to develop selections lists for use when encoding key words within knowledge archives.
<p>Extending SNOMED CT ("Identify and close any gaps")</p>	<p>It is not unusual to have to add new concepts or descriptions to SNOMED CT to support local requirements.</p> <p>To account for this effort, estimate the size of the reference sets to be developed above (#of concepts) and establish a ratio that corresponds to the number of new SNOMED CT concepts and/or descriptions that may need to be requested from IHTSDO, created as local extensions and/or supported through use of compositional expressions to complete the refset. (See note</p>

⁶¹ <https://uscrs.nlm.nih.gov/>, accessed Sept 2014.

⁶² http://www.nlm.nih.gov/hit_interoperability.html#UMLS_Terminology_Services_UTS, accessed Sept 2014.

⁶³ <https://vsac.nlm.nih.gov/>, accessed Sept 2014.

⁶⁴ https://infocentral.infoway-inforoute.ca/2_Standards/1_pan-Canadian_Standards/Terminology/1_SNOMED_CT, accessed Sept 2014.

⁶⁵ <http://systems.hscic.gov.uk/data/uktc/snomed>, accessed Sept 2014.

Localization Activity	Quantification Technique(s)
	<p>below.)</p> <p>Assume a productivity factor of 1-4 concepts per hour with local resource costs to perform the activities above.⁶⁶</p> <p>Assign a quality assurance / review factor depending on the method by which maps are reviewed by a QA resource. A factor of 2 would provide a very conservative measure.</p> <p>Refine costs via local pilot to determine costs pertaining to modelling of new SNOMED CT content requirements (e.g. modelling of new concepts because SNOMED CT content has gaps in the areas of interest); and QA effort.</p> <p>Formula(s):</p> $\text{Extension-Cost} = [(\text{No-of-missing-concepts} \times \text{Average-Modelling-Productivity} \times \text{Local-SNOMED-Modeller-Hourly}) \times \text{Modelling-QA-Factor}]$ <p>Example(s):</p> <ul style="list-style-type: none"> • Consider the 16,874 local terms in the Core SNOMED CT Problem List subset. In the 201108 release, 92% of the terms had corresponding SNOMED CT concepts.⁶⁷ • Creating new SNOMED CT concepts to address the gap (e.g. 8% or approx. 1350 concepts) and a modelling productivity of 2 concepts per hour, this would yield an effort of roughly 1350 hours. <ul style="list-style-type: none"> • Assuming an hourly rate of US\$ 40.00 this equates to US\$ 54,000. • Assuming an hourly rate of US\$ 100.00 this equates to US\$ 135,000. <p>Note(s):</p> <ul style="list-style-type: none"> • The extent of the requirement to extend SNOMED CT will correspond to the uniqueness of the use case and an implementer's ability to adapt to the existing naming conventions in SNOMED CT. (e.g. Accepting problem list content implemented elsewhere will be less work than blazing the trail in new content areas.) • Examples above do not include the cost to establish and manage a project, including the development of stakeholder engagement and governance processes. • Effort to create and manage a request to IHTSDO vs the effort to model the concept locally are similar. Requirements and costs of authoring tools will vary depending on the extent and approach to modeling concepts locally.
Language / Dialect Translation	<p>Identify target set of concepts (after utilizing IHTSDO translation service) and estimate upper bound on the basis of 30 minutes per concept with local resource costs.</p> <p>Refine costs via local pilot to confirm applicable per concept productivity factor.</p> <p>Formula(s):</p>

⁶⁶ These figures are based on the authors' estimating guidelines. Information gathered informally from stakeholders suggests significant differences in productivity among experienced modelers in different organizations, ranging from 0.25 to 6.25 concepts per hour.. The variance warrants further study.

⁶⁷ http://www.nlm.nih.gov/research/umls/Snomed/core_subset.html, accessed Sept 2014.

Localization Activity	Quantification Technique(s)
	<p>Translation-Cost = [(No-of-Concepts-Targeted) x (Local-Translator-hourly-labour-cost x 0.5)] (less US\$150,000 where translation policy applies)</p> <p>Example(s):</p> <ul style="list-style-type: none"> • Translation of the Core SNOMED CT Problem List at a rate of 30 minutes per term would take 8437 hours. • Sweden invested roughly SEK 38.6M (roughly equivalent to US\$ 5.43M at today's exchange rate) to translate 280,000 concepts for a cost of US\$ 20 per concept. (US\$ 168,740 for the Core SNOMED CT Problem List.) • The IHTSDO translation policy offers up to US\$ 150,000 for translation of up to 5,000 concepts, suggesting a global cost basis of US\$ 30 per concept. (US\$ 253,110 for the Core SNOMED CT Problem List.) <p>Note(s):</p> <ul style="list-style-type: none"> • Mapping existing controlled vocabularies to SNOMED CT may be an alternative to translation where bilingual resources familiar with the clinical domain and SNOMED CT exist. (See next cell.)
Mapping Legacy Terminologies to SNOMED CT	<p>Members choosing to adopt SNOMED CT to replace legacy controlled vocabulary systems (examples include the UK Read system or the Hong Kong Hospital Clinical Vocabulary Tables) may choose to map their legacy systems to SNOMED CT to enable transition to SNOMED CT. Maps developed may be used to migrate legacy solutions, to incorporate legacy descriptions (and codes) into SNOMED CT or to support translation of information between legacy and new systems.</p> <p>Apply a productivity factor of 20 to 40 concept mappings per hour mapping with local resource costs.⁶⁸</p> <p>Assign a quality assurance / review factor depending on the method by which maps are reviewed by a QA resource. A factor of 2 would provide a conservative measure.</p> <p>Refine costs via local pilot to determine per concept mapping productivity and QA effort.</p> <p>Formula(s):</p> <p>Mapping-Cost = [(No-of-local Concepts-to-be-mapped / Mapping-Productivity-Factor) x (Local-Mapper-hourly-labour-cost)] x Mapping-QA-Factor</p> <p>Example(s):</p> <ul style="list-style-type: none"> • Consider the 16,874 local terms in the Core SNOMED CT Problem List subset. Assuming a mapping productivity of 20 concepts per hour, a QA factor of 2, this would yield an effort of roughly 1,690 hours. <ul style="list-style-type: none"> • Assuming an hourly rate of US\$ 40.00 this equates to US\$ 67,600. • Assuming an hourly rate of US\$ 100.00 this equates to US\$ 169,000. <p>Note(s):</p> <ul style="list-style-type: none"> • Examples above do not include the cost to establish and manage a project,

⁶⁸ Based on authors' estimating guidelines. Information gathered informally from stakeholders consistently fell within this range.

Localization Activity	Quantification Technique(s)
	<p>including the development of stakeholder engagement and governance processes.</p> <ul style="list-style-type: none"> • The productivity factor provided represents an average for content areas where SNOMED CT is widely implemented. In these cases, a large percentage of terms will typically be mapped easily. Resolution of issues will be time consuming. • Mapping projects will typically also involve extending SNOMED CT. • Where existing controlled medical vocabularies exist and are in use, mapping the existing terminology to SNOMED CT can be used as a method of localizing the content. This was the approach used by Hong Kong for the Hospital Authority Clinical Vocabulary Tables (HACVT). (see profile in Appendix A.4).

③ Core Operations

Key Decision and/or Scoping Factors

With the development of substantive local content, core operations resourcing will need to be scaled up to ensure that refsets, extensions and translations are updated with new releases of the SNOMED CT core International Edition.

Quantification Techniques

Quantification should be on the basis of the number of localized assets and, ideally, undertaking at least one release iteration to determine local productivity.

④ Initiative Enablement

Key Decision and/or Scoping Factors

Initiative enablement typically ranges from the basic provision of support services to the establishing of a broader investment program which provides actual funding incentives (e.g. eHealth accelerator funding):

Initiative Enablement Activity	Quantification Technique(s)
Deeper change management support (e.g. Support for the IHTSDO Request for	General support for expanding the SNOMED CT core international release content can be limited to basic pass-through of RFCs from implementers to the IHTSDO. However, in order to remove adoption barriers and to streamline processes, it will often make sense to assist implementers by

Initiative Enablement Activity	Quantification Technique(s)
Change (RFC) process).	<p>coordinating efforts to develop and maintain reference sets, translations and local SNOMED CT extensions centrally.</p> <p>The ongoing effort to maintain shared assets is only incrementally more than the cost of maintaining the same asset at a single site. Additional effort will be required to develop governance processes as well as (typically) investment in tools to manage request for change (RFC) processes and to distribute content to implementers. Costs directly correspond to cost of tools, services provided and resource costs.</p>
Establishment of training and support services and the extent to which these operate on a cost-recovery basis	Identify the number of FTEs allocated based on local requirements, cost structures and cost recovery provisions.
Establishment of incentives for SNOMED CT adoption, whether directly or as part of eHealth initiatives	Identify these based on local eHealth acceleration strategies. If these are already established, then the extent to which costs for standards adherence / adoption, including incorporation of SNOMED CT, is explicitly identified in support of a business case will depend on local conditions.

⑤ Implementation

Costs to implement SNOMED CT into information systems used at the point of service will often be borne by the individual organizations responsible for the implementation of health information management solutions within clinical settings and, therefore, may be considered outside of the scope of the IHTSDO member's "SNOMED CT" business case. The following points have been provided for consideration when considering business cases for supporting implementation activities:

Incorporating SNOMED CT into a project that is already implementing information systems that use structured forms to capture and encode clinical information is likely to result in a modest increase in cost due to the need to provide SNOMED CT expertise to the project team to help address content or technical questions. Effort will typically correspond to the quality and completeness of SNOMED CT content within the specific clinical domain being implemented and/or the technical constraints of the systems where SNOMED CT is implemented. The challenge of sourcing the required expertise to support projects may be a bigger consideration

than the actual cost. There is potential value in providing a pool of subject matter experts centrally, at a program level, to support implementers.

Initiatives that include the integration of legacy systems into SNOMED CT-enabled solutions, will often require maps between existing terminology used within legacy systems and SNOMED CT to enable migration of systems or real time translation of information as it exchanged between systems. Legacy terminology systems may be organization specific and, in these cases, per site costs to develop maps can be substantial (see table above for information to estimate translation costs per site) and sites may therefore require funding support. Terminology mapping also requires skilled resources that may be more efficiently provided through a centralized shared service.

Finally, pushing SNOMED CT (or any controlled medical vocabulary system) into a project or organization that didn't contemplate the introduction of tools to capture and encode clinical information in structured form can be both disruptive and expensive. It is the contention of the authors that implementation of SNOMED CT should be coordinated with projects that provide a business or clinical rationale for introducing structured documentation tools and, in turn, that these projects should provide the business case for upgrading systems. For this reason, costs to upgrade information systems need not necessarily be an element of SNOMED CT focused business cases.

Quantified Benefits

As localized SNOMED CT content is implemented within clinical systems, implementers should expect to begin to realize the following benefits:

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Administrative & Management Cost Savings</i>		
“EHR” Management Cost Avoidance and/or Reductions	Reduction in costs to acquire or to develop and maintain local terminology products. (e.g, value sets used in messaging, selection lists, etc)	<p>Development: Using SNOMED CT’s clinically expressive description logic to search a comprehensive and mature collection of terminology is a very efficient way to translate physician requirements into a usable list of clinical terms.</p> <p>Maintenance: Once criteria have been developed, new concepts added to SNOMED CT will typically be recognized</p>

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
		<p>by refset definitions, reducing effort to maintain content.</p> <p>Recommendation: Savings that accrue to a single developer will be small depending on the frequency that related content (e.g. problem list) changes and are likely not worth quantifying unless many terminology assets are under maintenance. See section D.5 for benefits associated with sharing assets.</p> <p>Centrally developed or administered value sets, such as the Core SNOMED CT Problem List subset, provide ready-made content for implementers, potentially allowing these implementers to avoid the costs of developing and maintaining the associated terminology assets locally.</p> <p>Formula(s): $\text{Benefit} = (\text{Site-count} \times \text{Average-development-cost-per-site})$</p> <p>A straightforward way to estimate average-development-cost-per-site would be to consider the investment in assets being shared, deduct the overheads associated with the consensus process and deduct costs of any further site specific localization.</p>

Care and Outcome Improvements		
Efficient Care Delivery	<p>Reduction in costs associated with duplicate or unnecessary investigations (e.g. laboratory tests and imaging studies)</p>	<p>"Laboratory testing is an integral part of modern medicine. Testing figures prominently across specialties and in multiple medical contexts, including outpatient screening (e.g. cholesterol for heart disease, hemoglobin A1c for diabetes mellitus), inpatient diagnosis and management, and disease monitoring (e.g. tumor markers for cancer). As a result, testing is the single highest-volume medical activity, with an estimated 4–5 billion tests performed in the United States each year."⁶⁹</p> <p>Various sources provide evidence about the reduction in inappropriate duplicate investigations ordered as a result of automation^{70 71}, particularly in environments where patients are moved between settings which do not share an electronic health record. The potential for up to 20% reduction in testing appears to exist.</p> <p>Complicating this assessment is the question of whether simple, readily searchable access to prior investigations is sufficient or whether automated order entry, supplement with business rules which would warn about a potential duplication, are required. While certain sources suggest that simply having access to prior results in a searchable manner may not be enough⁷², the much cited work by Tierney⁷³ suggests a potential reduction of 13% from presentation and search alone.</p> <p>Since effective searching relies on well coded results, the introduction of coded records may directly yield this benefit. With Laboratory related expenditures (not counting DI) already at 10% of the US health care system in 1994⁷⁴ and given significant annual growth, this is an area for significant potential benefit.</p> <p>Recognizing that competing terminologies in the laboratory space, namely LOINC®, can achieve many of these benefits we have arbitrarily discounted the benefit to just 2% of lab costs (e.g, only 1/5 of the potentially reduced duplication is attributed to use of SNOMED) and 5% of DI costs, which is conservative given SNOMED CT's strength in indexing key aspects of microbiology results and imaging studies. Applying these savings to only 10% of the costs to highlight slow uptake, the potential benefit remains substantial.</p> <p>Formula(s):</p>

⁶⁹ Zhi, M. "The landscape of inappropriate laboratory testing: a 15-year meta-analysis", PLoS One. 2013 Nov 15;8(11).

⁷⁰ Stewart, B. et al. "A preliminary look at duplicate testing associated with lack of electronic health record interoperability for transferred patients", J Am Med Inform Assoc. 2010 May-Jun; 17(3): 341–344.

⁷¹ May, T. et al. "Reducing Unnecessary Inpatient Laboratory Testing in a Teaching Hospital", Am J Clin Pathol 2006;126:200-206.

⁷² McCormick, D. "Giving Office-Based Physicians Electronic Access To Patients' Prior Imaging And Lab Results Did Not Deter Ordering Of Tests". Health Affairs. 2012 Mar;31(3):488-9.

⁷³ Tierney WM. Computerized Display of Past Test Results. Annals of Int Medicine 1987;107:569-574.

⁷⁴ Robinson, A. "Rationale for Cost-Effective Laboratory Medicine", CLINICAL MICROBIOLOGY REVIEWS, Apr. 1994, p. 185-199.

	<p>Benefit = [2% x 10% x Cost-of-Lab-Investigations] + [5% x 10% x Cost-of-DI]</p> <p>Example(s):</p> <p>Based on OECD data for 2012, the following reflect cost savings in accordance with the proposed quantification method:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; background-color: #d3d3d3;">Country</th><th style="text-align: center; background-color: #d3d3d3;">Lab & DI Expenditures</th><th style="text-align: center; background-color: #d3d3d3;">2% & 5% Saving Respectively on 10% of Lab & DI</th></tr> </thead> <tbody> <tr> <td>Austria</td><td style="text-align: center;">US\$ 518.8M</td><td style="text-align: center;">US\$ 1.9M</td></tr> <tr> <td>Netherlands</td><td style="text-align: center;">US\$ 1,002.5M</td><td style="text-align: center;">US\$ 2.4M</td></tr> <tr> <td>Germany</td><td style="text-align: center;">US\$ 11,914.9M</td><td style="text-align: center;">US\$ 43M</td></tr> </tbody> </table>	Country	Lab & DI Expenditures	2% & 5% Saving Respectively on 10% of Lab & DI	Austria	US\$ 518.8M	US\$ 1.9M	Netherlands	US\$ 1,002.5M	US\$ 2.4M	Germany	US\$ 11,914.9M	US\$ 43M
Country	Lab & DI Expenditures	2% & 5% Saving Respectively on 10% of Lab & DI											
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Netherlands	US\$ 1,002.5M	US\$ 2.4M											
Germany	US\$ 11,914.9M	US\$ 43M											
	<p>Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay)</p> <p>There are several challenges in projecting SNOMED CT related savings from reduced incidence of errors; key among these are the following:</p> <ul style="list-style-type: none"> • The potential cost savings will vary across countries and settings. In some countries the costs or errors may be isolated to the cost of additional care (e.g. greater length of stay) while in others the cost may also include significant litigation expenditures and consequential increases in liability insurance rates. • There are variations in the cost benefit of different solutions to the reduction of errors. For example, the incidence of preventable adverse drug events (pADEs) can be reduced by a variety of interventions including computerized physician order entry (CPOE), participation of pharmacists on ward rounds, and bar coding systems at administration. In practice all of these are often implemented, making it difficult to assess the unique role of any one intervention. • It is similarly difficult to accurately apportion the benefit to the role that terminologies play in enabling applicable IT based interventions (e.g. CPOE) – particularly at this implementation stage where SNOMED CT is simply used for codification without deeper investment in the development of decision support rules. <p>Notwithstanding these challenges, it is self-evident that errors generate costs and that these costs are substantial. One literature survey⁷⁵ cites several international studies to suggest that approximately one dollar in every seven dollars spent on hospital care can be attributed to health care associated injury. This ratio of hospital costs reflects only a fraction of the potential opportunity for savings since it reflects only internal</p>												

75 <http://www.patientsafetyinstitute.ca/English/research/commissionedResearch/EconomicsofPatientSafety/Documents/Economics%20of%20Patient%20Safety%20Literature%20Review.pdf>, accessed September 2014.

	<p>costs and does not incorporate broader economic impacts; moreover, this estimate is solely focused on inpatient settings and so avoidable costs related to errors in outpatient settings are also excluded.</p> <p>Recommendation:</p> <p>Taking medication errors as one example, CPOE without an associated Clinical Decision Support System (CDSS) is only likely to impact those errors which relate to the clear interpretation of prescriptions (e.g. techniques to avoid the “ongoing use of potentially dangerous abbreviations and dose expressions”⁷⁶ as well as to ensure legibility). While this clearly represents only a portion of the potential benefit stream, empirical evidence suggests that some benefit can be realized.⁷⁷</p> <p>One approach to quantification is to proceed as follows:</p> <ul style="list-style-type: none"> • Consider the <u>potential</u> for savings through the reduction of hospital related medical errors as 1/7 of hospital expenditures; • Consider that prescribing or medication related errors represent a large percentage of errors and, when gauged against potential harm vs. other types of errors, may reflect a substantial portion of these costs⁷⁸. Taking a more conservative approach of simply scaling based on the statistical incidence of medication related errors vs. other errors suggests a number in the 20%⁷⁹ to 30% range⁸⁰, or, say, 25%. • Assume that only 50% are preventable (Note that estimates on this will vary across settings; we drew a 50% figure from the work of Graham Neale et al.⁸¹). • Assume that only 10% of these preventable errors are related to poor legibility or other prescription quality issues. • Since it is unclear whether harm and costs are distributed uniformly across all types of ADEs and since the role of SNOMED CT reflects only part of the solution, we suggest a further discount of 50% of this value.
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⁷⁶ The Joint Commission. “Medication errors related to potentially dangerous abbreviations”, September 1, 2001. http://www.jointcommission.org/assets/1/18/SEA_23.pdf, accessed September 2014.

⁷⁷ Shulman, Rob et al. “Medication errors: a prospective cohort study of hand-written and computerised physician order entry in the intensive care unit”. Crit Care, 2005; 9(5): R516-R521. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1297620/?tool=pubmed>. Accessed September 2014.

⁷⁸ West, David et al. Relationship Between Patient Harm and Reported Medical Errors in Primary Care: A Report from the ASIPS Collaborative, http://www.ahrq.gov/downloads/pub/advances2/vol1/Advances-West_102.pdf, accessed September, 2014.

⁷⁹ Neale, G. et al. Exploring the causes of adverse events in NHS hospital practice. . J R Soc Med., Jul 2001; 94(7): 322-330. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1281594/>, accessed September 2014.

⁸⁰ US Department of Health and Human Services. ADVERSE EVENTS IN HOSPITALS: NATIONAL INCIDENCE AMONG MEDICARE BENEFICIARIES. <http://oig.hhs.gov/oei/reports/oei-06-09-00090.pdf>, accessed September, 2014.

⁸¹ Neale, G. ibid.

Formula(s):

Benefit (per capita) = (Per-Capita-Hospital-Funding / 7) x 25%
 $x 50\% \times 10\% \times 50\%$

(Although this number could be divided by the number of sites to arrive at a notional benefit per site/implementation figure it is important to note that potential benefits are unlikely to be distributed evenly across all facility types).

Example(s):

Country	Hospital Funding (Per Capita)	Poten'l Benefit (Per Capita)	Pop'ltn	Poten'l Benefit (Total)
United States	1,526.00	1.36	287.6M	390M
France	1,196.00	1.07	60.3M	64M
Netherlands	1,178.00	1.05	16.2M	17M
Germany	1,073.00	0.96	82.5M	79M
Australia	1,024.00	0.91	19.7M	18M
OECD Median	904.00	0.81	N/A	N/A
Japan	855.00	0.76	127.7M	97M
Canada	842.00	0.75	31.6M	23M

Source: Per capita funding data and population figures for 2003 data are sourced from OECD Health Data 2005, with costs adjusted for differences in Cost of Living. All cost figures are in US\$.

Note(s):

- These figures are solely intended to illustrate a potential, order-of-magnitude benefit stream from investments in country-wide implementation of CPOE solutions enabled through coding. Business cases may need to scale the overall benefit back to the number of hospitals/facilities targeted for implementation over the planning horizon.
- The ability to better track the incidence of errors for analysis, through introduction of SNOMED CT enabled CPOE solutions, will also yield benefits for which quantification work could be pursued.

D.4. Enabling Decision Support

Information within clinical or knowledge management systems which has been encoded using SNOMED CT is enriched by SNOMED CT's hierarchies, defining relationships and description logic. This section identifies the initial costs and benefits associated with extending SNOMED CT enabled solutions to provide decision support. (See the discussion in section 4.2 of the enclosing report for further context.)

Costs By Component

②	Initial Localization
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Key Decision and/or Scoping Factors

The following localization activities and quantification technique(s) represent the main cost drivers:

Localization Activity	Quantification Technique(s)
Refset Development ("Encode clinical definitions")	<p>The building blocks of many decision support systems are terminology value sets that correspond to criteria within a clinical guideline. (e.g. The US Joint Commission definition of Acute Myocardial Infarction (AMI) is more general than the concepts typically used to record patient diagnosis, a rule for AMI would encapsulate these concepts into a list to trigger an alert.)</p> <p>Use of SNOMED CT to specify clinical criteria to trigger decision support allows clinicians to specify criteria using clinically familiar language rather than searching for terms lexically or translating clinical criteria into lists codes within a classification when creating value sets. Moreover, logic based expressions will 'see' new terms added to refsets used in documentation tools, easing maintenance.</p> <p>While SNOMED CT may well offer an opportunity to lower costs in this area, conservative estimators may assume that a small, one time, effort (approximately 5 days) per measure is needed to address time required to orient project participants to SNOMED CT and to acquire the necessary tools.</p> <p>Formula(s): $\text{Ref-Set-Development-Cost} = \text{No-of-Alerts} \times 5 \text{ days} \times \text{Local-SNOMED-Expert-Daily-Cost}$</p> <p>Note(s):</p> <ul style="list-style-type: none"> Effort to engage stakeholders, gather requirements and to facilitate review and QA processes will be substantially more than effort to identify content.

(4) Initiative Enablement

Key Decision and/or Scoping Factors

Initiative enablement typically ranges from the provision of support services to the provision of actual funding incentives:

Initiative Enablement Activity	Quantification Technique(s)
Establishment of training and support services and the extent to which these operate on a cost-recovery basis	Identify the number of FTEs allocated based on local requirements, cost structures and cost recovery provisions.
Establishment of incentives for SNOMED CT adoption, whether directly or as part of eHealth initiatives	Identify these based on local eHealth acceleration strategies.
Facilitating the development, publication and maintenance of shared assets such as SNOMED CT reference sets (or refsets)	This will require careful analysis of the potential scope for shared assets and the expected degree of change.

(5) Implementation

Costs to implement SNOMED CT into information systems used at the point of service will often be borne by the individual organizations responsible for the implementation within clinical settings and, therefore, may be considered outside of the scope of the IHTSDO member's business case. The following points have been provided for consideration when considering business cases for supporting implementation activities:

Implementation effort will typically correspond to the quality and completeness of SNOMED CT content within the specific clinical domain being implemented and/or the technical constraints imposed by the systems where SNOMED CT is implemented. The challenge of sourcing the required expertise to support projects may be a bigger consideration than the actual cost.

There is potential value in providing a pool of subject matter experts centrally, at a program level, to support implementers.

Quantified Benefits

As decision support solutions are devised and deployed, a deeper set of Care and Outcome benefit streams become possible:

Benefit Component	Potentially Quantifiable Benefit	Proposed Quantification Approach
<i>Administrative & Management Cost Savings</i>		
“EHR” Management Cost Avoidance and/or Reductions	Reduction in costs to acquire or to develop and maintain clinical criteria used to identify patient cohorts within clinical decision support and performance monitoring (clinical and business intelligence) systems.	<p>Development: Use of SNOMED CT to specify clinical criteria to trigger decision support allows clinicians to specify criteria using clinically familiar language rather than searching for terms lexically or translating clinical criteria into lists codes within a classification.</p> <p>Maintenance: Once criteria have been developed, maintenance costs are lower as criteria used to create the set will usually be able to recognize new content added to SNOMED CT.</p> <p>Recommendation: Savings per “rule” that accrue to a single developer will be small depending on the frequency that related content (e.g. problem list) changes and are likely not worth quantifying. See next section for benefits associated with sharing.</p>

Care and Outcome Improvements															
Efficient Care Delivery	<p>Reduction in costs associated with duplicate or unnecessary investigations (e.g. laboratory tests and imaging studies)</p>	<p>Benefits quantified for reduction in duplicate laboratory tests in the previous section are relatively modest due to the need for clinicians to search for and recognize information within the chart to realize savings. The introduction of rules to alert providers of duplicate tests could substantially improve results.</p> <p>The formula below conservatively assumes that initial introduction of decision support systems will deliver a further 2% reduction in lab costs and a further 5% reduction in DI costs. These savings continue to be applied to only 10% of costs to reflect slow uptake of decision support systems.</p> <p>Formula(s): $\text{Benefit} = [2\% \times 10\% \times \text{Cost-of-Lab-Investigations}] + [5\% \times 10\% \times \text{Cost-of-DI}]$</p> <p>Example(s): Based on OECD data for 2012, the following reflect cost savings in accordance with the proposed quantification method:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; background-color: #f2f2f2;">Country</th><th style="text-align: center; background-color: #f2f2f2;">Lab & DI Expenditures</th><th style="text-align: center; background-color: #f2f2f2;">2% & 5% Saving Respectively on 10% of Lab & DI</th></tr> </thead> <tbody> <tr> <td>Austria</td><td style="text-align: right;">US\$ 518.8M</td><td style="text-align: right;">US\$ 1.9M</td></tr> <tr> <td>Netherlands</td><td style="text-align: right;">US\$ 1,002.5M</td><td style="text-align: right;">US\$ 2.4M</td></tr> <tr> <td>Germany</td><td style="text-align: right;">US\$ 11,914.9M</td><td style="text-align: right;">US\$ 43M</td></tr> </tbody> </table>		Country	Lab & DI Expenditures	2% & 5% Saving Respectively on 10% of Lab & DI	Austria	US\$ 518.8M	US\$ 1.9M	Netherlands	US\$ 1,002.5M	US\$ 2.4M	Germany	US\$ 11,914.9M	US\$ 43M
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Austria	US\$ 518.8M	US\$ 1.9M													
Netherlands	US\$ 1,002.5M	US\$ 2.4M													
Germany	US\$ 11,914.9M	US\$ 43M													
<p>Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay)</p>	<p>As noted in section D.3 (above), the potential to reduce errors, particularly preventable Adverse Drug Events (pADEs) through introduction of SNOMED CT enabled CPOE systems provides a clear potential benefit stream. The addition of clinical decision support to deepen the benefit through, for example, detection of drug-to-drug, drug-to-patient, or drug-to-allergy contraindications further depend this potential pool of avoidable costs.</p> <p>One way to estimate this is simply to scale up the corresponding benefit in stage by a factor of 10 to account for the 9 of 10 errors presumed NOT to be caused by prescription/order legibility or quality but rather by various contraindications or administration errors.</p> <p>Alternatively, a top down approach may also be viable since that could address medication errors across the full system or a broader range of avoidable errors:</p> <p>For example, in the United States, adverse events attributed to preventable medication errors are associated with US\$21B⁸²</p>														

⁸² New England Healthcare Institute. (2010). Preventing medication errors: A \$21 billion opportunity. www.nehi.net/bendthecline/sup/documents/Medication_Errors_%20Presentation.ppt, accessed September, 2014.

	<p>in avoidable healthcare costs. Partners Healthcare attributes their decision support systems with a 55-83%⁸³ decrease in non-intercepted serious Adverse Drug Events. If this was to be extrapolated across the entire system it would clearly amount to a significant potential benefit stream of between US\$10B and US\$16B.</p> <p>Recommendation: As above, use conservative estimates for both the impact of SNOMED CT (10%) and rate of uptake (10%).</p> <p>Formula(s): $\text{Benefit} = [10\% \times 10\% \times \text{Avoidable costs}]$</p> <p>Example(s): For the US, this equates to US\$200M of potential savings.</p>
	<p>Reduction in costs due to more optimized use of medications (e.g. appropriate, cost effective use of drug therapies) and other technologies (e.g. appropriate, cost effective use of laboratory tests and imaging studies).</p> <p>Beyond duplicate testing and medical errors, inefficient use of pharmaceuticals, laboratory testing and imaging are a significant source of avoidable healthcare costs. Consider the following:</p> <ul style="list-style-type: none"> • Misuse of antibiotics, suboptimal use of generics and delays in the implementation of evidence-based treatment are estimated to cost US\$86.5B⁸⁴ annually, over 2% US healthcare spending. • Inappropriate lab testing is not limited to duplicate tests, studies suggest significant rates of both under and overutilization of tests used to evaluate the need for and to monitor the impact of prescriptions and other medical procedures⁸⁵. • Inappropriate imaging studies occur at roughly the same rate as inappropriate lab tests. <p>Recommendation: As above, use conservative (and somewhat arbitrary) estimates for both the impact of SNOMED CT (10%) and rate of uptake (10%).</p> <p>Formula(s):</p>

⁸³ Managing Evidence at the Speed of Change (Presented at the Massachusetts Health Data Consortium Conference, Managing Evidence-based Medicine, From Research to Practice, 02/2006).

⁸⁴ IMS Institute for Healthcare Informatics. "Avoidable Costs in U.S. Healthcare: The \$200 Billion Opportunity from Using Medicines More Responsibly". http://www.imshealth.com/deployedfiles/imshealth/Global/Content/Corporate/IMS%20Institute/RUOM-2013/IHII_Responsible_Use_Medicines_2013.pdf, accessed September, 2014.

⁸⁵ Zhi M, Ding EL, Theisen-Toupal J, Whelan J, Arnaout R (2013) The Landscape of Inappropriate Laboratory Testing: A 15-Year Meta-Analysis. PLoS ONE 8(11): e78962. doi:10.1371/journal.pone.0078962. <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0078962>, accessed September, 2014.

		<p>Benefit = [10% x 10% x Avoidable costs]</p> <p>Example(s): Focusing only on drug related costs, this equates to \$865M of potential savings.</p>
Improved Patient Outcomes	<p>Reduction in costs due to better disease management, better patient outcomes and lower health system utilization.</p>	<p>The cost of unmanaged disease is staggering. Health care spending to treat patients with chronic, non-communicable diseases represents a significant and growing portion of total health care spending worldwide.^{86 87}</p> <p>According to the World Health Organization, Cardiovascular Diseases (CVD) alone represent between 8-22% of total health system expenditures in countries where data is available for analysis. For example:</p> <ul style="list-style-type: none"> • In the US, direct healthcare costs of Cardiovascular diseases were US\$272.5 billion in 2010.⁸⁸ • Costs (using a slightly different definitional scope) for the UK health system in 2009 were 12.7 billion pound.⁸⁹ <p>Implementing simple interventions (e.g. exercise, weight control, blood pressure control, etc.) could reduce deaths and the associated indirect costs by two thirds. To the extent that SNOMED CT enabled systems can help identify at-risk patients and promote appropriate treatment, some portion of these benefits could be realized.</p> <p>A good example of this is Kaiser Permanent which reduced overall mortality among cardiac patients in Colorado by 73% through the use of team based medical best practices and computer supported care registries⁹⁰.</p> <p>(Note there are other potential examples, such as sepsis reduction, which may be more relevant for specific situation).</p> <p>Recommendation: Implementation of CDS systems at individual care settings will benefit individual patients but it would be hard to assert systemic benefits at this level. Therefore it is suggested to defer this benefit group to the next stage where decision rules can be more readily exchanged and, therefore, broadly applied.</p>

⁸⁶ Garg, C. and David Evans, "What is the impact of non-communicable diseases on national health expenditures: A synthesis of available data", World Health Organization, Discussion paper No. 3, Geneva 2011.

<http://www.who.int/healthsystems/NCDdiscussionpaper3.pdf>, accessed September 2014.

⁸⁷ Bloom, D.E., et al. The Global Economic Burden of Noncommunicable Diseases. Geneva: World Economic Forum.
http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf, accessed September 2014.

⁸⁸ American Heart Association Policy Statement, <http://circ.ahajournals.org/content/123/8/933.long>, accessed September 2014.

⁸⁹ British Heart Foundation, Coronary Heart Disease Statistics 2012. <http://www.bhf.org.uk/publications/view-publication.aspx?ps=1002097>, accessed September 2014.

⁹⁰ Kaiser Permanente, "Case Study: Collaborative Cardiac Care Service – Collaborative Teams Improve Cardiac Care with Health Information Technology", <https://xnet.kp.org/future/ahrstudy/032709cardiac.htm>, accessed September 2014.

Improved Societal Outcomes	<p>Improved economic productivity from better population-wide health (“Healthy Happy Productive Communities”).</p>	<p>The benefits of effective disease management go far beyond direct health care savings. 63% of all deaths worldwide are associated with non-communicable diseases and half of people who die of chronic non-communicable disease are in the prime of their productive years.⁹¹</p> <p>Lost productivity due to premature illness and death exact a significant economic cost to countries across the economic spectrum, in the studies identified above:</p> <ul style="list-style-type: none"> • In the US, indirect costs of CVD add another US\$ 172 billion, or roughly 63% over direct costs⁹². • In the UK, indirect costs were 16.5 billion pounds in 2009. <p>Recommendation:</p> <p>Implementation of CDS systems at individual care settings will benefit individual patients but it would be hard to assert systemic benefits at this level. Therefore it is suggested to defer this benefit group to the next stage where decision rules can be more readily exchanged and, therefore, broadly applied.</p>
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⁹¹ Bloom, D.E., et al. The Global Economic Burden of Noncommunicable Diseases. Geneva: World Economic Forum. http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf, accessed September 2014.

⁹² Mensah , George and David W. Brown, “An Overview Of Cardiovascular Disease Burden In The United States”, Health Aff January 2007 vol. 26 no. 1 38-48. <http://content.healthaffairs.org/content/26/1/38.full>, accessed September, 2014.

D.5. Enabling Exchange of Clinical Information and/or Knowledge Resources

A standard method of encoding concepts within patient health information will help make patient information more exchangeable and more complete within the settings where patients receive care. This is the minimum capability expected from emerging electronic health record solutions and the associated terminology components. Applying the same type of standardized encoding of clinical concepts within knowledge resources (disease filters, order sets, problem indexed articles, etc.) and CDS systems will help make these knowledge resources and tools also more discoverable and reusable. This has the potential of dramatically enhancing the utility of electronic health record systems.

This section identifies the costs and benefits associated with exchanging clinical information as well as clinical knowledge resources.

Costs By Component

④	Initiative Enablement
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Key Decision and/or Scoping Factors

At this level, initiative enablement pertains to the organizations and processes needed to provide a stable platform for SNOMED CT enabled clinical information and knowledge exchange:

Initiative Enablement Activity	Quantification Technique(s)
Facilitating effective and coordinated management of shared terminology assets.	<p>Providing a shared platform of terminology assets requires well coordinated and well governed terminology asset management and maintenance processes. Centralizing shareable terminology assets, tools and services within stable and centrally funded shared service organization will likely become a necessity over time.</p> <p>Services provided by IHTSDO members and affiliates provide a range of examples of ancillary services delivered within public government departments, arm's length publicly funded organizations and commercial enterprises. There is no single correct solution, recognizing that the level of integration and coordination provided through the model needs to be aligned with the integrated solution in use.</p> <p>Recommendation: Although substantial funding may be required to establish and maintain the</p>

Initiative Enablement Activity	Quantification Technique(s)
	shared service and appropriate tools, these costs should be off-set by savings to implementers. Therefore, assume no incremental cost at this level.

⑤	Implementation
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At this level implementation costs should begin to fall as terminology assets and derivative content including clinical criteria used in CDS systems becomes more readily available and exchangeable.

Quantified Benefits

As decision support and other clinical knowledge resources are encoded or indexed using SNOMED CT, the benefits of the latest translational medicine innovations and clinical research can be deployed more efficiently across the health system:

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Administrative & Management Cost Savings</i>		
“EHR” Management Cost Avoidance and/or Reductions	Reduction in costs to acquire or to develop and maintain local terminology products. (e.g, value sets used in messaging, selection lists, etc)	<p>Where SNOMED CT reference sets are centrally developed or administered, such as the Core SNOMED CT Problem List subset, they provide ready-made content for implementers, potentially eliminating the costs of developing and maintaining local terminology systems.</p> <p>Formula(s): $\text{Benefit} = \text{Site-count} \times ([\text{Average-development-cost-per-site}] + [\text{Average-maintenance-cost-per-site}])$</p> <p>A straightforward way to estimate average-development-cost-per-site would be to consider the investment in asset being shared, deduct the overheads associated with the consensus process and deduct costs of any further site specific localization.</p>

	<p>Reduction in costs to acquire or to develop and maintain clinical criteria used to identify patient cohorts within clinical decision support and performance monitoring (clinical and business intelligence) systems.</p>	<p>Similar to above, SNOMED CT encoded clinical criteria (e.g. list of terms corresponding to Acute Myocardial Infarction) that are centrally developed or administered provide ready-made content for implementers, potentially eliminating the costs of developing and maintaining local terminology systems.</p> <p>Formula(s): $\text{Benefit} = \text{Site-count} \times ([\text{Average-development-cost-per-site}] + [\text{Average-maintenance-cost-per-site}])$</p>
	<p>Reduction in costs to acquire or to develop and maintain clinical decision support tools and other knowledge products.</p>	<p>Maintenance of CDS systems requires continuous monitoring of evidence and updating of rules and criteria.</p> <p>The Clinical Informatics Research & Development group of Partners HealthCare has a team of over 70 staff dedicated to the mission of improving “the quality and efficiency of care for patients at Partners HealthCare System by assuring that the most advanced current knowledge about medical informatics (clinical computing) is incorporated into clinical information systems at Partners HealthCare.”⁹³</p> <p>Even smaller, stand-alone hospitals can and do engage in this activity but on a smaller scale. For example, King's Daughters Medical Center, a 465-bed hospital in Ashland, Kentucky, US, “set a goal of reducing its annual operating budget by 1 percent, or \$6 million. The biggest share of that savings is coming from clinical effectiveness bundles, or evidence-based EHR order sets and care plans for cardiac surgery, total joint replacements, heart failure, and other common procedures and diagnoses.”⁹⁴ To do so, a team of clinicians were gathered to review evidence and build best practice decision support rules.</p> <p>Using SNOMED CT to encode keywords and abstracts within knowledge repositories would make clinical criteria used to within decision support systems reusable to discover new evidence corresponding to measures. This would be a step toward lowering costs for CDS developers.</p> <p>Recommendation: Assume that few sites are developing CDS systems and that this item reflects a modest incremental benefit. However, as the number of sites increases and the portability of rules improves this benefit could grow.</p> <p>Initially any FTE reductions in large facilities with significant CDS support groups could be included in benefit calculations.</p>

⁹³ <http://www.partners.org/cird/AboutUs.asp?cBox=Miss>. Accessed, September 2014.

⁹⁴ Butcher, Lola. Building Effective Clinical Decision Support, HFMA, Oct 31, 2012. <http://www.hfma.org/Content.aspx?id=14019>. Accessed September, 2014.

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Care and Outcome Improvements</i>		
Efficient Care Delivery	Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay)	<p>Potential benefit streams in this area may be scaled up over the estimates in the previous stage as more facilities begin to implement solutions which leverage SNOMED CT based clinical decision support capabilities.</p> <p>Although this expansion may simply be organic, as new facilities explore and implement CDS tools, it is not difficult to imagine that if decision rules and knowledge assets are shared more easily that this would reduce adoption costs and, therefore, lower one adoption barrier.</p> <p>Formula(s): $\text{Benefit} = (\text{Additional-Site-Count} / \text{Previous-Site-Count}) \times \text{Benefit-from-previous-stage}$</p>
	Reduction in costs due to more optimized use of medications (e.g. appropriate, cost effective use of drug therapies) and other technologies (e.g. appropriate, cost effective use of laboratory tests and imaging studies).	
Improved Patient Outcomes	Reduction in costs due to better disease management, better patient outcomes and lower health system utilization.	<p>With the widespread adoption and exchange of CDS systems and other knowledge resources, members may begin to realize reductions in both direct health system costs and lost productivity due to unmanaged chronic conditions at this stage.</p> <p>Section D.5 provides a couple references for costs that can be used as a basis for quantification. Given the scale of these costs, small improvements would represent a significant benefit:</p>
Improved Societal Outcomes	Improved economic productivity from better population-wide health (“Healthy Happy Productive Communities”).	<p>Formula(s): $\text{Benefit} = [\text{Deployment-Ratio (\%)} \times \text{Improvement-Ratio} \times \text{Cost-of-Unmanaged-Chronic-Disease}]$</p>

D.6. Enabling Clinical and Business Intelligence Systems

Performance monitoring and measurement are essential to understand outcomes of different interventions taken by clinicians when caring for patients as well as interventions that organizations provide to modify clinician behaviour. This section identifies the costs and benefits associated with using SNOMED CT to help enable clinical and business intelligence systems.

Costs By Component

The following costs components are relevant at this stage:

⑤	Implementation
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The implementation of a Business Intelligence (BI) infrastructure and associated analytical function (e.g. processes, people, policies, etc.) will demand substantial investment across the health system. It is the contention of this paper that use of SNOMED CT within the BI function, particularly in member countries that have and continue to make investments in support of stage 1 through 5 activities need not necessarily attract additional, SNOMED CT specific, costs.

Quantified Benefits

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Administrative & Management Cost Savings</i>		
“EHR” Management Cost Avoidance and/or Reductions	Reduction in costs to acquire or to develop and maintain clinical decision support tools and other knowledge products.	The cost of clinical learning can be substantial when using traditional methods such as Randomized Controlled Trials (RCTs). Citing two study examples, Terhilda Garrido, VP HIT Transformation and Analytics at KaiserPermanente noted that while “RCTs are the traditional gold standard for healthcare research. EHRs and their vast store of data (in depth and breadth) offer an alternative with pros and cons.” ⁹⁵ The two studies were as follows: <ul style="list-style-type: none"> • ALLHAT study on hypertension <ul style="list-style-type: none"> • Conducted on 42,418 patients over an 8 year span and costing US\$120M. • Conclusion: Thiazide-type diuretics are most effective at

⁹⁵ Garrido, T. KP HealthConnect Information driving reform, presentation to the Institute of Health Economics, Innovation Forum- Edmonton Canada, November 29, 2011. <http://www.ihe.ca/documents/Terhilda%20Garrido%20Presentation.pdf>. Accessed September 2014.

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
		<p>controlling hypertension</p> <ul style="list-style-type: none"> • Magid study <ul style="list-style-type: none"> • Conducted on 4,000,000 patients over a 1.5 year span and costing US\$ 200k. • Conclusion: For the 60% of patients that were not under control complete hypertension control, ACE Inhibitors and beta blockers are effective as 2nd line medications. <p>Notwithstanding the typical statistical challenges (e.g. patient basis) which must be overcome to approach the rigor of RCTs, this comparison highlighted the extent to which large volumes of appropriately coded EMR data can offer a treasure trove of clinical insights at a fraction of the cost. See also David C Kaelber et al for a similar example of an EMR based study using data from multiple health systems⁹⁶</p> <p>If even a small fraction of RCTs could be replaced by EMR-based retrospective studies, the potential cost saving could be dramatic. Estimating the saving at a very conservative 90% per <u>applicable</u> study would appear to be reasonable.</p> <p>Formula(s): $\text{Benefit} = \text{Applicable-Study-Cost} \times 90\%$</p>

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
<i>Care and Outcome Improvements</i>		
Efficient Care Delivery	Reduction in costs associated with duplicate or unnecessary investigations (e.g. laboratory tests and imaging studies)	There is little question that clinical research will provide evidence to continuously attenuate or improve care processes. The fact that EMR based, retrospective analysis can be a key part of that process brings the potential benefits from these improvements to the SNOMED CT business case equation.
	Reduction in costs associated with errors (e.g. reduced liability and reduced lengths of stay)	While stage 5 provided a breadth multiplier (e.g. number of sites), this stage reflects a depth or effectiveness multiplier (e.g. increased effectiveness of Clinical Decision Support systems by X%, say 25%).

⁹⁶ Kaelber, David et al Patient characteristics associated with venous thromboembolic events: a cohort study using pooled electronic health record data. J Am Med Inform Assoc. 2012 Nov-Dec; 19(6): 965–972.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3534456/>. Accessed September, 2014.

Benefit Component	Potentially Quantifiable Benefit	Quantification Technique(s)
	Reduction in costs due to more optimized use of medications (e.g. appropriate, cost effective use of drug therapies) and other technologies (e.g. appropriate, cost effective use of laboratory tests and imaging studies).	Formula(s): $\text{Benefit} = \text{Benefit-from-previous-stage} \times 1.25$
Improved Patient Outcomes	Reduction in costs due to better disease management, better patient outcomes and lower health system utilization.	
Improved Societal Outcomes	Improved economic productivity from better population-wide health ("Healthy Happy Productive Communities").	

D.7. Expanding to Derive Deeper Network Benefits

The market for clinical knowledge exchange is currently somewhat fragmented with various niche players on the one hand and the sophisticated EMR platforms of major vendors enabling custom solutions on the other. Clinical knowledge is largely interchangeable the old fashioned way (e.g. PubMed), through use of various proprietary solutions (e.g. “PatientOrderSets.com”, IMS, etc.), or within and across various EMR solutions (e.g. Cerner, EPIC, etc.). This places limits on the flexible exchange of such information.

A SNOMED CT enabled, standards-based platform for CDS systems and clinical knowledge exchange, as contemplated in the previous stages, should bring down per-facility costs and can reasonably be expected, over time, to increase adoption given continued demand for CDS and continued growth of EMR penetration. We suggest that this can give rise to network multiplier effects as more clinicians and facilities become engaged in decision rule development, as more clinical evidence is captured using coded mechanisms, and as this information is shared, validated, and applied across a broader community.

This type of collaboration may not be imminent given challenges in EMR uptake, competitive barriers (e.g. reasons not to share) and, of course, the lack of a mature, open, interoperable clinical decision support (CDS) exchange ecosystem. Therefore this project has not established a detailed quantification model for this stage.

However, readers who accept the premise of the potential benefit streams proposed in the earlier stages will recognize that deeper and broader adoption coupled with more comparable data are likely to drive dramatic improvements through the health system. As a result, it may be possible to scale up these benefits, particularly once a critical mass of facilities become engaged.

It is the contention of the authors of this paper that the realization of this stage reflects the full vision of an integrated collaborative Clinical Knowledge Management environment that can position health systems everywhere on a path to continuous, evidence-based improvement.

Appendix E Glossary

Term	Definition
Clinical Knowledge Management (C-KM)	The mechanisms by which computer technology and data standards are used to structure and formalize healthcare data to support data analysis and reuse. C-KM is a core component of a learning health system.
Clinical Decision Support (CDS)	Clinical Decision Support is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery. Information recipients can include patients, clinicians and others involved in patient care delivery; information delivered can include general clinical knowledge and guidance, intelligently processed patient data, or a mixture of both; and information delivery formats can be drawn from a rich palette of options that includes data and order entry facilitators, filtered data displays, reference information, alerts, and others. (Improving outcomes with clinical decision support: an implementer's guide. Second Edition. HIMSS. 2011 (in press))
Controlled Medical Vocabulary (CMV)	Terminology systems (such as SNOMED CT) that adhere to a set of structural and functional requirements, as described in JJ Cimino's "Desiderata for controlled medical vocabularies in the twenty-first century" (http://www.ncbi.nlm.nih.gov/pubmed/9865037).
Computerized Patient Record (CPR)	See Electronic Health Record (EHR).
Current Procedural Terminology (CPT)	Current Procedural Terminology (CPT®) is a code set that is used to report medical procedures and services to entities such as physicians, health insurance companies and accreditation organizations.
Electronic Health Record (EHR)	A systematic collection of electronic health information about an individual patient or population. Also referred to as a Computerized Patient Record (CPR). (http://en.wikipedia.org/wiki/Electronic_health_record).
Full-time equivalent (FTE)	Is a unit that indicates the workload of an employed person (or student) in a way that makes workloads comparable across various contexts. (Wikipedia)
Intensional Definition	In logic and mathematics, an intensional definition gives the meaning of a term by specifying all the properties required to come to that definition, that is, the necessary and sufficient conditions for belonging to the set being defined. (Wikipedia) In the context of SNOMED CT refsets this refers to the process of defining sets by describing their characteristics rather than enumerating the specific members. For example, Set X includes all of the concepts which are have the child relationship to concept Y.
International	The International Classification of Diseases (ICD) is a standard diagnostic

Term	Definition
Classification of Diseases (ICD)	tool for epidemiology, health management and clinical purposes. This includes the analysis of the general health situation of population groups. It is used to monitor the incidence and prevalence of diseases and other health problems, proving a picture of the general health situation of countries and populations. (http://www.who.int/classifications/icd/en/)
Learning Health System	An ecosystem designed to iteratively “generate and apply the best evidence for the collaborative healthcare choices of each patient and provider; to drive the process of discovery as a natural outgrowth of patient care; and to ensure innovation, quality, safety, and value in healthcare” (http://www.iom.edu/activities/Quality/LearningHealthCare.aspx).
Logical Observation Identifiers Names and Codes (LOINC)	LOINC was initiated in 1994 by the Regenstrief Institute and developed by Regenstrief and the LOINC committee as a response to the demand for electronic movement of clinical data from laboratories that produce the data to hospitals, physician's offices, and payers who use the data for clinical care and management purposes. (http://loinc.org/background)
National Release Center (NRC)	The focal point within the IHTSDO member's jurisdiction for interfacing with IHTSDO and with entities in the member's territory who have an interest in SNOMED CT. (http://www.ihtsdo.org/members/joining-as-a-national-member/national-release-centers/).
Reference Set	The SNOMED CT design includes the Reference Set mechanism which provides a standard way to refer to a set of SNOMED CT components (including concepts, descriptions, language subsets, etc). Reference Sets can be used to configure different views of SNOMED CT by constraining searches or representing short lists of terms for a data entry field. They can also be used to meet other requirements including checking that a concept id falls within a permitted set of values for a field in a data structure or message (e.g. to represent an HL7 value set). (cf: Subset, Value Set).
Subset	A general term often used to refer to a SNOMED CT Reference Set, a value set, or any grouping of SNOMED CT concept identifiers. (cf: Reference Set, Value Set).
Value Set	A list of concept identifiers, with descriptions. (cf: Reference Set, Subset).

Appendix F References & Reading List

The following list reflects not only publications that have been referenced in this report but also potential readings that have influenced the authors and that may be relevant to implementers:

1. Cain, Mary and Robert Mittman. "Diffusion of Innovation in Health Care." Institute for the Future, California HealthCare Foundation. May 2002.
2. "Implementation of SNOMED-CT Needed to Facilitate Interoperable Exchange of Health Information." American Health Information Management Association, Dec 2007.
3. Zanstra, Pieter E. "Health terminologies: Criteria for decision making." *Health terminologies workshop*. eHealth Working Group Workshop Brussels. Mar 08, 2008.
4. Booz Allen Hamilton, *Canada Health Infoway 10-Year Investment Strategy*. April 18, 2012, https://www.infoway-inforoute.ca/index.php/resources/video-gallery/doc_download/83-canada-health-infoway-s-10-year-investment-strategy-executive-summary. Accessed 2014.
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