FULL REPORT

The Case for Investment in **SNOMED CT**

SNOMED International

SNOMED CT
The global language of healthcare

CASE FOR INVESTMENT

Our Approach

The Case for Investment in SNOMED CT has been developed using:

- The SNOMED CT value framework and its focus on how SNOMED CT-embedded clinical information systems, health data & analytics platforms and interoperability solutions can contribute to improving **patient service outcomes** (i.e. access and productivity) and **patient health outcomes** (i.e. patient safety, morbidity and mortality).
- The domains where SNOMED CT is used (e.g. data entry/integration, information sharing, analytics and research).
- A combination of ten case studies, a benefits model, an economic analysis, and the case for investment in SNOMED CT.
- Both quantitative and qualitative analysis.

Assumptions

Case for Investment

The Symbiotic Relationship

- SNOMED CT must be embedded in a clinical information system, health data & analytics platform or an interoperability solution for it to function.
- Conversely, clinical information systems, health data & analytics platforms and interoperability solutions must use clinical terminologies like SNOMED CT to operate effectively.

Patient Outcome Benefits

- SNOMED CT is only one of many contributing factors to improving patient outcomes.
- There are no studies that demonstrate improved patient outcomes benefits directly attributable to SNOMED CT.
- However, studies do show that the use of SNOMED CT-embedded systems do provide significant qualitative and quantitative patient outcome benefits.

Benefits Measurement

- Patient outcome benefits are described as patient service outcomes (e.g. improvements in access and productivity) and patient health outcomes (e.g. improvements in patient safety, morbidity and mortality).
- Benefits are measured in both financial terms (e.g. dollars saved) and non-financial terms (e.g. bed days reduced, deaths avoided).
- The case studies and quantitative models provide directional estimates of select benefits enabled (in part) by SNOMED CT.

SNOMED CT
Case for Investment

The Case for Investment Identifies why a country would invest resources to implement SNOMED CT

1. What **value** does a country or healthcare entity **desire** from a clinical terminology?
2. What **potential value** does SNOMED CT provide to a specific country or a healthcare entity?
3. What demonstrated value has SNOMED CT provided to a country or a healthcare entity in the past?
4. What are the future opportunities for SNOMED CT?
5. Why would a country or a healthcare entity invest resources to implement SNOMED CT?

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Q1. What Value Does a Country Desire From a Clinical Terminology?

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SNOMED CT

Case for Investment

Cimino

AHIMA

ASSESS CT

- ✓ SNOMED CT is “fit for purpose” as a clinical terminology using the Cimino criteria
- ✓ SNOMED CT meets all the AHIMA data quality requirements
- ✓ SNOMED CT meets the clinical terminology suitability requirements of the E.U. community
- ✓ SNOMED CT is professionally managed and maintained

“SNOMED CT is the best available core reference terminology for cross-border, national and regional eHealth deployments in Europe”

ASSESS CT 2016

Q1. What Value Does a Country Desire From a Clinical Terminology?

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Q1. What Value Does a Country Desire From a Clinical Terminology?

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When a country or healthcare entity evaluates a clinical terminology they do it from two perspectives:

- **the value of the terminology itself, and**
- **the on-going management of the terminology.**

To assess the value of the SNOMED CT to a country we considered frameworks from three separate studies:

1. The desired features of a controlled terminology (vocabulary) as outlined by **Cimino**[1]. The presence of these features in a controlled vocabulary (terminology) demonstrate whether the terminology is fit-for-purpose, or not.
2. The data quality management criteria used by the **American Health Information Management Association** to critique the similarities and differences between SNOMED CT and ICD-10[2].
3. The criteria developed by **ASSESS CT** through research, interviews and focus groups to evaluate the suitability of SNOMED CT for large scale e-health deployments within the E.U[3].

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Q1. What Value Does a Country Desire From a Clinical Terminology?

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1. SNOMED CT meets all the Cimino criteria that determine whether a terminology is fit-for-purpose.

Terminology Criteria	Description	SNOMED CT
1. **Content**	Does the terminology have comprehensive content?	SNOMED CT meets this requirement
2. **Concept Orientation** SNOMED CT meets all the Cimino criteria that determine whether a terminology is fit-for-purpose.	Do the terms correspond to at least one meaning (nonvagueness) and no more than one meaning (non-ambiguity), and that meanings correspond to no more than one term (non-redundancy)?	SNOMED CT meets this requirement
3. **Concept Permanence**	Is the meaning of a concept, once created, inviolate (does not change)?	SNOMED CT meets this requirement
4. **Non-Semantic Concept Identifier**	Do the concepts have a unique identifier, without any meaning built into the identifier?	SNOMED CT meets this requirement
5. **Poly-Hierarchy**	Is the terminology organized into multiple hierarchies?	SNOMED CT meets this requirement
6. **Formal Definitions**	Does the terminology have formal definitions, including the expression of relationships among concepts that can be manipulated with a computer?	SNOMED CT meets this requirement
7. **Reject "Not Classified Elsewhere"**	Does the terminology NOT include catch-all terms (e.g. not classified elsewhere) which can be used to encode information that is not represented by other existing terms.	SNOMED CT meets this requirement
8. **Multiple Granularities**	Does the terminology allow multiple granularities (i.e. coarse-grains and fine-grained) to serve different uses of the terminology?	SNOMED CT meets this requirement
9. **Multiple Consistent Views**	Does the terminology provide multiple views so that it is suitable to be used for different purposes?	SNOMED CT meets this requirement
10. **Context Representation**	Does the terminology contain context representation through formal, explicit information about how concepts are used?	SNOMED CT meets this requirement
11. **Evolve Gracefully**	As the content and structure of the terminology changes are clear, detailed descriptions provided of what changes occur and why?	SNOMED CT meets this requirement
12. **Recognize Redundancy**	Does the terminology permit the same information to be stated in two different ways (synonyms)?	SNOMED CT meets this requirement

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2. The American Health Information Management Association data quality management criteria was used to compare SNOMED CT and ICD-10. SNOMED CT met the requirements of all the criteria and out-performed ICD-10 on all counts.

Terminology Criteria	Description	SNOMED CT
1. **Accessibility**	Does the terminology easily support data accessibility?	SNOMED CT provides standardized data for use at the point-of-care, for data sharing and interoperability, as well as for analytics and research.
2. **Accuracy**	Is the terminology coded accurately?	SNOMED CT is an automated clinical terminology where clinical representations are automatically encoded using a variety of coding applications. This reduces the opportunity for human error
3. **Comprehensiveness**	Is the terminology comprehensive in its breadth (i.e. the number of concepts and hierarchies)?	With 350,000 concepts in 19 hierarchies SNOMED CT is the most comprehensive clinical terminology available.
4. **Consistency**	Are the terminology concepts consistent among different users and across all clinical applications?	Concepts in SNOMED CT are the same among different users and across all clinical applications.
5. **Currency**	Is the content of the terminology kept current?	SNOMED CT in its current form was developed in 2007 and is updated twice per year.
6. **Definition**	Is the content of the terminology logical and well defined?	Developed by clinicians SNOMED CT's logical structure is easy for clinicians to understand.
7. **Granularity**	Does the terminology have the depth necessary to support its intended use?	SNOMED CT is the most fine-grained clinical terminology available.
8. **Precision**	Does the terminology describe clinical expressions precisely?	Concepts have the same values in SNOMED CT; studies have shown up to 93 percent precision of SNOMED CT for identifying clinical expressions
9. **Relevancy**	Is the terminology relevant for multiple uses?	SNOMED CT directly supports clinical care, information sharing and interoperability, point-of-care, population and management analytics, as well as research.
10. **Timeliness**	Is the input of the terminology content in real-time?	SNOMED CT data is automatically coded in real-time. It is not coded by humans after-the-fact.

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3. The ASSESS CT suitability evaluation of SNOMED CT for large scale e-health deployments within the E.U.

Internal Terminology Criteria	SNOMED CT
1. The terminology provides representational units (“concepts”) in sufficient granularity across all areas of health care and of biomedical research	SNOMED CT meets this requirement
2. The terminology is explicit regarding its scope.	SNOMED CT meets this requirement
3. The terminology is independent regarding language, but supports the connection to language and context specific vocabularies	SNOMED CT meets this requirement
4. The terminology provides precise definitions of all representational units (“concepts”)	SNOMED CT meets this requirement
5. The terminology has a compositional architecture that allows fine-grained representations	SNOMED CT meets this requirement
6. The terminology can be harmonized with other terminological and semantic interoperability assets in use	SNOMED CT meets this requirement
7. The terminology governed by a non-for-profit body that is controlled by end users and stakeholders and can provide a forum for terminology knowledge sharing and collaboration	SNOMED CT meets this requirement
8. The terminology catches up with the progress of the domain by periodic updates	SNOMED CT meets this requirement
9. The terminology meets quality criteria for standards	SNOMED CT meets this requirement
10. The terminology supports sophisticated navigation and post-coordination	SNOMED CT meets this requirement
11. The terminology supports cross-border information and knowledge exchange	SNOMED CT meets this requirement
12. The terminology follows current specifications for semantic interoperability assets	SNOMED CT meets this requirement
13. The terminology is supported by user-friendly tools and is easily implementable	SNOMED CT meets this requirement
14. The terminology supports computer processing and is rooted in a rigid, understandable upper-level model	SNOMED CT meets this requirement
15. The terminology has a maintenance process.	SNOMED CT meets this requirement

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3. The ASSESS CT suitability evaluation of SNOMED CT for large scale e-health deployments within the E.U.

External Terminology Criteria	SNOMED CT
1. The terminology is used internationally on other continents	SNOMED CT meets this requirement
2. The terminology supports cross-border use cases (epSOS Patient summary).	SNOMED CT meets this requirement
3. The terminology is in use in EU Member States	SNOMED CT meets this requirement
4. The cost of licenses, implementation and maintenance	SNOMED CT meets this requirement with reservations (see below)
5. The terminology has a compositional architecture that allows fine-grained representations	SNOMED CT meets this requirement
6. The terminology complies with the EU Regulation No 1025/2012 of the European Parliament and of the Council of 25 October 2012, on European standardization, Annex II: Requirements for the Identification of ICT Technical Specifications11.	SNOMED CT meets this requirement

ASSESS CT Identified Challenges

- In 2016, SNOMED CT was not in widespread use within, or across, EU countries.
- The SNOMED CT license policy and cost is perceived as a critical barrier in the decision/start-up phase.
- The direct costs of adopting SNOMED CT (e.g. licensing costs) only constitute a small part of the overall costs to deploy the terminology within a country (note: this applies to all terminologies).
- The actual, or perceived, complexity of SNOMED CT is an initial barrier to adoption and use.

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SNOMED CT is enhanced and maintained in a professional manner.

Terminology Management	Description	SNOMED CT
1. **Validated Content**	Are any updates or changes in the terminology scientifically validated?	All SNOMED CT updates and changes are scientifically validated.
2. **Extent of Use**	Does the terminology have a wide base of use and support, either within the country, or globally?	SNOMED CT is used in over 80 countries and is strongly supported by a 40 national member base.
3. **Language**	Is there support to translate the terminology into the home language?	This is supported by SNOMED International. SNOMED CT has currently been translated into two languages (i.e. English and Spanish), with refsets in four additional languages..
4. **Extensions**	Can the terminology be extended with additional concepts, definitions and relationships?	SNOMED CT supports national, regional, or health entity extensions (e.g. Nebraska Lexicon).
5. **Tools**	Are there tools available to ease the burden of implementing and managing the terminology within a country or healthcare entity?.	SNOMED International has developed open-source tools to support SNOMED CT deployment and management (e.g. authoring tool, SNOMED CT browser, mapping tool, Refset management and translation tool and the SNOMED CT managed service),
6. **Education**	Are there a variety of education programs to be available for implementers and users of SNOMED CT.	SNOMED International provides forums, EXPOS, focused education programs, and an extensive knowledge-base of documents and artefacts.
7. **Participation**	Are there opportunities countries to be involved in the governance of the terminology organization, and do they get the opportunity to interact with their peers?	SNOMED International is governed by the 41 Member General Assembly which sets the future direction for the organization. Through regular meetings and annual EXPOs SNOMED International provides opportunities for all countries to interact with their peers.
8. **Cost**[4]	Is the terminology free to use?	SNOMED CT is free to use only for countries, healthcare entities and other organizations who have paid for a national or affiliate license.

4. Terminologies such as LOINC, RxNorm and ICD do not require a license fee and are free-to-use globally. However, like SNOMED CT these terminologies require funding to be maintained and enhanced. LOINC and RxNorm are primarily funded through U.S. Government agencies (e.g. Dept. of Health and Human Services), often in the form of project grants. ICD is funded through the World Health Organization's 194 member country contributions plus private donors.

Q1. What Value Does a Country Desire From a Clinical Terminology?

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The Terminology

- SNOMED International has designed the SNOMED CT clinical terminology so that it is fit-for-purpose. It meets all the 12 desired features of a controlled terminology as defined by **Cimino**.
- SNOMED International has designed the SNOMED CT clinical terminology so that it meets all the 10 quality data management criteria, as defined by the **American Health Information Management Association**.
- SNOMED International has designed SNOMED CT so that meets the suitability requirements of the E.U. community as determined by **ASSESS CT** through literature reviews, interviews and focus groups.

Management of the Terminology

- SNOMED International manages the SNOMED CT clinical terminology product and services in a professional manner.

The Desired Value of SNOMED CT is further Reinforced by:

- **E.U. Assessment** - after extensive stakeholder input and analysis, Assess CT (2016) evaluated SNOMED CT for use in large scale eHealth deployments in the European Union and recommended that:

"SNOMED CT is the best available core reference terminology for cross-border, national and regional eHealth deployments in Europe". - Assess CT

Q2. What Potential Value Does SNOMED CT Provide to a Country?

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SNOMED CT

Case for Investment

RAND CORPORATION

validated by

McKinsey & Company

Canada Health Infoway | Inforoute Santé du Canada

Productivity (Model 1)

Cost savings from improvements in inpatient nursing time, lab tests, drug utilization, length of stay and medical records; plus outpatient transcription use, chart pulls, lab/radiology tests, & drug utilization.

Disease Prevention (Model 2)

Reduced bed days, workdays missed, as well as increased deaths avoided and life years gained from immunizations and cancer screening.

Patient Safety (Model 3)

Reduction in adverse drug events, inpatient bed days, and deaths avoided from CPOE use.

Data from Five Studies

BCM & IRR (Model 4)

The Benefits Cost Multiple and the Internal Rate of Return from investing in clinical information systems and interoperability solutions.

Data from Model 1

Impact on GNI (Model 5)

The average annual increase to a nation's GNI as a result of the investments in clinical information systems and interoperability solutions

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SNOMED CT Break-Even Analysis

Q2. What Potential Value Does SNOMED CT Provide to a Country?

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- Potential value is derived from modelling the quantitative impact of SNOMED CT-embedded clinical information systems and interoperability solutions (note: robust studies for health data & analytics platforms are not yet available). The U.S. RAND study used 2005 as a baseline and projected potential benefits to 2020 (i.e. for 15 years). The findings showed:

Productivity Gains

Inputs:

- The 2005 annual expenditure for healthcare in the United States was USD$2,024 billion.
- The adoption rate for integrated, clinical information systems was 15% in 2005 and this increased to 99.9% by 2020 (i.e. a significant investment in clinical information systems over the past 15 years).

Outputs:

- The estimated, potential annual mean savings as a result of the integrated, clinical information systems investment was USD$58.25 billion (i.e. approximately 3% of the 2005 annual U.S.A. healthcare expenditure).
- The estimated, potential cumulative savings over the 15 years was USD$875.8 billion.
- This was a result of patient service outcome benefits from inpatient care (i.e. nursing time, lab tests, drug utilization, length of stay and medical records) and outpatient care (i.e. transcription, chart pulls, lab tests, drug utilization and radiology).

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Disease Prevention Benefits

Inputs:

- Total annual deaths (2005) from influenza, pneumococcal diseases, breast cancer, cervical cancer and colorectal cancer was 20,000, 40,000, 41,394, 4,100, and 57,000 respectively.
- The population over 65 with an annual (2005) diagnosis of influenza was 1,220,641 and pneumococcal diseases was 1,389,907.
- The proportion of people vaccinated (2005) for influenza and pneumococcal diseases was 65% and 53%.
- The percent of the population screened (2005) for breast cancer 70%, for cervical cancer 85% and for colorectal cancer 34%.

Outputs:

- Influenza vaccination resulted on average in 292,424 reduced bed days, 51,508 reduced workdays missed, and 1,298 deaths avoided.
- Pneumococcal vaccination resulted on average in 458,515 reduced bed days, 33,358 reduced workdays missed and 956 deaths avoided.
- Breast Cancer screening resulted in a mean of 1,976 deaths avoided.
- Cervical Cancer screening resulted in 338 deaths avoided and 8,437 life-days gained.
- Colorectal Cancer screening resulted in a mean of 1,392 deaths avoided and 39,654 life-days gained.

Q2. What Potential Value Does SNOMED CT Provide to a Country?

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Patient Safety Benefits

The patient safety benefits are derived from the introduction of CPOE functionality in clinical information systems in the U.S. The HITECH Act of 2009 enabled significant investment to be directed toward CPOE as part of the Meaningful Use requirements. We have elected to use a recent CPOE adoption rate of 74% based on HIMSS EMRAM ratings. However, there are studies that indicate that e-prescribing in the U.S. may be higher than this number (i.e. 90+%).

Inputs:

- The total annual inpatient days in the U.S. in 2005 was 167,199,099.
- The total annual outpatient visits in the U.S. in 2005 was 823,541,999.
- The CPOE adoption in the U.S. in 2005 was 4% and had risen to 74% by 2016.

Outputs:

- Inpatient benefits from increased use of CPOE functionality in clinical information systems resulted in:
  - A median of 100,974 reduced adverse drug events, 314,176 reduced bed days and 2,037 deaths avoided.
- Outpatient benefits from using CPOE functionality in clinical information systems resulted in:
  - A median of 1,078,953 reduced adverse drug events, 6,135,644 reduced bed days and 6,387 deaths avoided.

Q2. What Potential Value Does SNOMED CT Provide to a Country?

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Benefits to Cost Model and Internal Rate of Return

Based on a range of studies the U.S.A. could anticipate a Benefits to Cost Multiple of 1.8 - 4.1 from an investment in SNOMED CT embedded clinical information systems and interoperability solutions. Alternatively, the Internal Rate of Return for the same investment would be in the range of 10-42% (i.e. the higher the IRR the more attractive the investment).

Economic Benefits

An increase in GNI has been empirically correlated with higher living standards, higher real incomes and the ability to devote more resources to areas like health care, education, research and development and capital investment. These measures in turn are correlated to higher literacy, life expectancy and higher technological innovation.

Inputs:

- The 2005 annual expenditure for healthcare in the United States was USD$2,024 billion.
- The 2005 GDP for the United States was USD$13,040 billion.
- The 2005 GNI for the United States was USD$13,170 billion.

Outputs:

- The average annual increase to U.S. GNI as a result of investments in integrated, clinical information systems was 0.23%.
- Further, the average annual increase to U.S. GNI was USD$30.71 billion.

Q2. What Potential Value Does SNOMED CT Provide to a Country?

In Summary

For the United States the potential cost savings, patient service outcome and patient health outcome benefits that can result from a targeted investment in integrated clinical information systems and interoperability solutions over 15 years are:

- Potential mean savings of USD$58.25 billion per year from improvements in inpatient nursing time, lab tests, drug utilization, length of stay and medical records and outpatient transcription use, chart pulls, lab tests, drug utilization and radiology services.
- Over 750,000 reduced bed days, approximately 85,000 reduced workdays missed and over 2,200 deaths avoided from influenza and pneumococcal disease immunizations.
- Over 3700 deaths avoided and 50,000 life-years gained from breast, cervical and colorectal cancer screening.
- A reduction of over 1.1 million adverse drug events and 6.4 million bed days, as well as 8,300 deaths avoided from CPOE use.
- A Benefits to Cost Multiple of 1.8 - 4.1 and an Internal Rate of Return for the same investment of 10-42%.
- The average annual increase to U.S. GNI as a result of the investments in clinical information systems and interoperability solutions was 0.23% or USD$30.71 billion.
- The estimated cost of implementing a SNOMED CT license in the USA for the study period was USD$87M. Using only the Model 1 cumulative benefits of USD$875.8B the breakeven percentage is 0.01%.

In conclusion, the potential value[5] that SNOMED CT can provide a country is significant when it is embedded in clinical information systems and interoperability solutions.

5. Note: Potential Value should be viewed as directional, rather than absolute benefits. Ideally, potential value needs to be considered together with demonstrated value as a way to understand and project future patient outcome benefits. As such potential value should not be considered in isolation from other ways to determine benefits.

Q2. What Potential Value Does SNOMED CT Provide to a Country?

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SNOMED CT

Potential Case for Investment

validated by RAND CORPORATION, McKinsey & Company, Canada Health Infoway, Inforoute Santé du Canada

Productivity (Model 1)

Potential mean savings of USD$58.25 billion per year in improved inpatient and outpatient services.

Disease Prevention (Model 2)

Over 750,000 reduced bed days, approximately 85,000 reduced workdays missed and over 2,200 deaths avoided from immunizations, and over 3700 deaths avoided and 50,000 life-years gained from cancer screening.

Patient Safety (Model 3)

A reduction of over 1.1 million adverse drug events and 6.4 million bed days, as well as 8,300 deaths avoided from CPOE use.

Data from Five Studies

BCM & IRR (Model 4)

A Benefits to Cost Multiple of 1.8 - 4.1 and an Internal Rate of Return for the same investment of 10-41%. from investing in clinical information systems and interoperability solutions.

Data from Model 1

Impact on GNI (Model 5)

The average annual increase to U.S. GNI as a result of the investments in clinical information systems and interoperability solutions was 0.23% or USD$30.71 billion.

SNOMED International

The estimated cost of implementing a SNOMED CT license in the USA for the 15-year study period was USD87M.

Using only the Model 1 cumulative benefits of USD$875B the breakeven percentage is 0.01%.

Case for Investment

Q3. What Demonstrated Value Has SNOMED CT Provided a Country?

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SNOMED CT

A Demonstrated Case for Investment: Real World Use

Patient Outcome Benefits across the varied applications of SNOMED CT

Patient Service Outcome Improvements

- ✓ Patient (Panel) Management
- ✓ Health Record Management
- ✓ Diagnostic Tests
- ✓ Patient Safety
- ✓ Infection Control
- ✓ Referral Management
- ✓ Population Health
- ✓ Data Sharing
- ✓ Efficiencies and Cost Savings

Patient Health Outcomes Improvements

- ✓ Patient Safety
- ✓ Infection Control
- ✓ Population Health
- ✓ Analytics and Research

Q3. What Demonstrated Value Has SNOMED CT Provided a Country?

Patient Service Outcome Benefits		
Health Record Management	**Diagnostic Tests**	**Patient (Panel) Management**
1. Elimination of paper health records	10. Reduction in duplicate tests (e.g. lab, imaging)	16. Decrease in office visits; Increase in virtual visits
2. Comprehensive, legible health record	**Infection Control**	17. Improved patient communications (e.g. letters)
3. 24x7 access to the health record	11. Improvement in ED and inpatient infection control	18. Improved appointment booking
4. Reduction in chart pulls	**Referral Management**	19. Increase in patient throughput
5. Improved record coding and document updates	12. Reduction in referrals and wait-lists	20. Increase in physician satisfaction
Patient Safety	**Population Health**	21. Improvement in the physician-patient relationship
6. Increase in electronic ordering	13. Improvement in disease screening (e.g. cancer)	22. Improvement in patient engagement
7. Increase in evidence-based ordering	**Efficiencies and Cost Savings**	**Data Sharing/Interoperability**
8. Increase in drug interaction alerting	14. Reduction in (re) hospitalizations and LOS	23. Improved documentation and care coordination
9. Improved medication turn-around time	15. Reduction in inpatient/outpatient costs (e.g. MedRec, ADEs, infections, LOS, film, medical record ops)	27. Improved quality of care

The **demonstrated value** of SNOMED CT is derived from the ten case studies where exemplar, SNOMED CT-embedded clinical information system, health data & analytics platform and interoperability solution deployments were reviewed. Throughout this report the demonstrated value has been presented as patient service outcome and patient health outcome benefits.

Q3. What Demonstrated Value Has SNOMED CT Provided a Country?

Patient Health Outcome Benefits		
Patient Safety	**Population Health**	**Analytics and Research (some examples)**
1. Reduction in adverse drug events	9. Improved control of cholesterol	18. Improved COVID-19 hydroxychloroquine safety
2. Reduction in patient harm	10. Improved control of diabetes	19. Improved chlorthalidone vs hydrochlorothiazide hypertension safety
3. Reduction in VTE (evidence-based order sets)	11. Improved control of high blood pressure	20. Improved cervical cancer risk identification
4. Reduction in inpatient preventable mortality from pneumonia and COPD exacerbation	12. Improved control of cardiovascular disease	21. Improved uni-compartmental vs total knee replacement risk differentiation
5. Reduction in mortality due to best practice review of ventilator tidal volumes	13. Improved control of breast cancer	22. Increased precision in identifying cancers (AI)
Infection Control	14. Improved control of cervical cancer	23. Improved identification of missed fractures (AI)
6. Reduced risk of exposure to infection	15. Improved control of colon cancer	24. Improved identification of antibiotic resistance (AI)
7. Reduced infection transmission rates	16. Improved control of COVID-19	25. East London Gene and Health studies (multiple)
8. Reduction in sepsis mortality rates	17. Reduction in morbidity and mortality	

Note: The analytics and research examples shown here are an extremely small subset of what has been completed by healthcare organizations around the world. Further, with the more recent deployment of advanced analytics capabilities (i.e. point-of-care analytics, population analytics and management analytics), the impact on patient safety, infection control, population health and other areas of healthcare is expanding rapidly and may not be reflected in this table.

Q3. What Demonstrated Value Has SNOMED CT Provided a Country?

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Patient Outcome Benefits

- The use of SNOMED CT-embedded clinical information systems have demonstrated a wide range of patient service outcome benefits: health records management, patient/panel management, patient safety, diagnostic tests, infection control, referral management, data sharing/interoperability, population health, efficiencies and direct cost savings.
- The use of SNOMED CT-embedded clinical information systems have resulted in patient health outcome benefits: patient safety, infection control, referral management, population health, and the impacts of analytics and research studies.
- Therefore, SNOMED CT when embedded in clinical information systems, health data & analytics platforms and interoperability solutions has demonstrated value that enable improved patient outcomes, and in part mirror the potential value shown in the modified RAND study of the U.S.

The Proof of Demonstrated Value of SNOMED CT is further Reinforced by:

1. **Size of the Existing User Base** - 41 member countries and over 80 countries where the terminology is used.
2. **Clinical Information System Products** – By one count (i.e. KLAS), SNOMED CT is available in approximately 72% of the clinical information system products globally (note: this does not include the China or Russia markets).
3. **Exemplar Implementations - I**n healthcare organizations like: Veterans Health Administration (U.S.), Kaiser Permanente (U.S.), BARTS NHS Trust, ELHCP and OneLondon (U.K.), and Cambridge University Hospitals NHS Foundation Trust (U.K.).

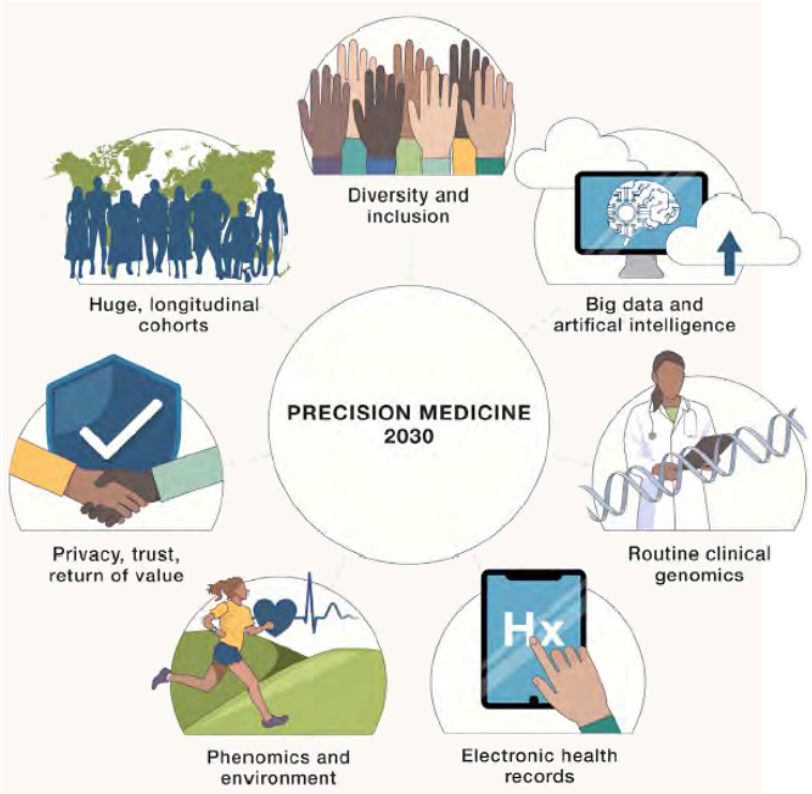
Q4. What are the Future Opportunities for SNOMED CT Use?

4

SNOMED CT

Future Value

Personalized, Precision Medicine 2030



1. **Huge Interoperable Longitudinal Cohorts** - Over the last 20 years, national cohorts (e.g. UK Biobank), have amassed huge populations with genomic, laboratory, and lifestyle assessments as well as longitudinal follow-up on health outcomes. The breadth and depth of data is staggering, as is the opportunities for discovery.
2. **Diversity and Inclusion** - With a growing depth of data, we have an opportunity to replace adjustments for race and ethnicity with more specific measures.
3. **Big Data and AI** - AI approaches in medicine have been limited by the (un)availability of large, commonly structured datasets. Looking forward, biomedical datasets will become increasingly ready for analyses.
4. **Routine Clinical Genomics** – Moving forward, whole genome approaches will become a routine, early step in the understanding, prevention, detection, and treatment of common and rare diseases.
5. **Electronic Health Records** – Many site-based and national research cohorts now use EHRs and other health data to provide up to decades of disease and treatment information that can be repurposed for research. This use will continue to expand.
6. **Phenomics and Environment –** Continued growth of research and clinical uses for different ways to measure clinical phenotypes, exposures, and lifestyles.
7. **Privacy, Trust and Return of Value -** The utility of precision medicine is dependent on broad participation, and broad participation of large populations requires trust, protection of privacy, and a return of value to the participants.[8]

The healthcare industry is ever evolving. The future opportunities for SNOMED CT will be driven by new healthcare data sources and new healthcare technologies.
From a health care industry-wide perspective the following new data sources and technologies are seen as significant.

4

FULL REPORT

The healthcare industry is ever evolving. The future opportunities for SNOMED CT will be driven by new healthcare data sources and new healthcare technologies.

From a health care industry-wide perspective the following new data sources and technologies are seen as significant.

New Data Sources – unstructured-to-structured data, "omics" data.

New Technologies – machine learning, artificial intelligence, deep learning, blockchain, bio-sensors, advanced semantic interoperability, differential privacy, quantum computing[6].

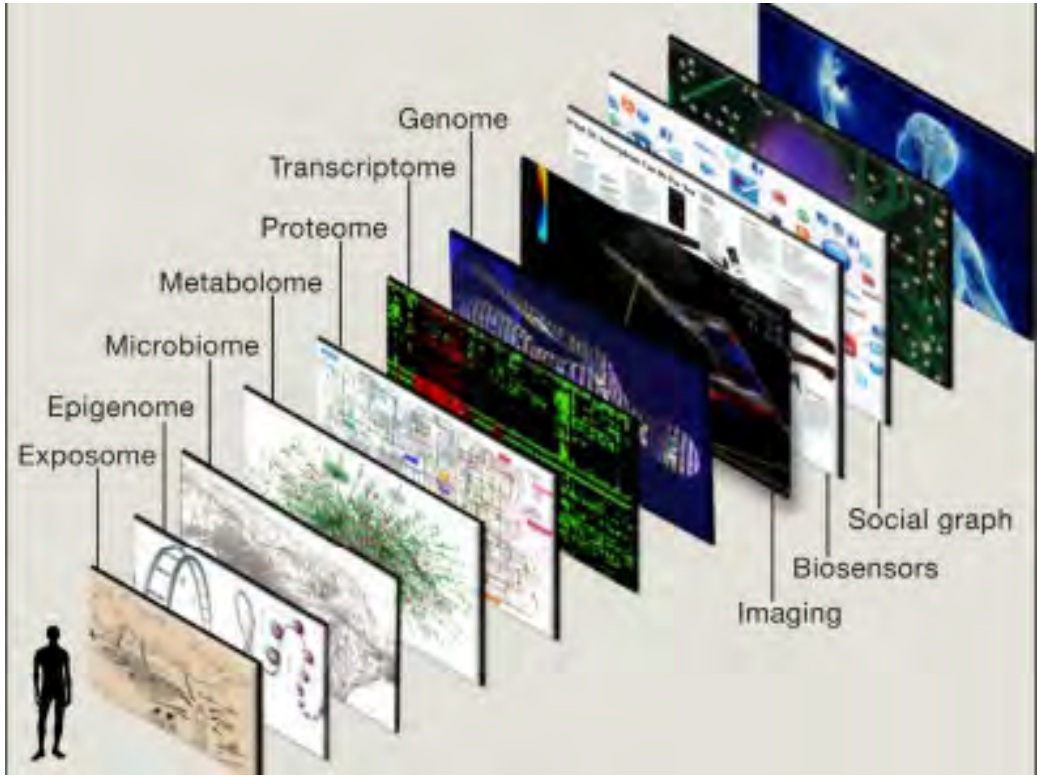
However, 'omics' data coupled with artificial intelligence, machine learning, deep learning and other technologies are drawing the most attention globally given their contribution to the field of **personalized, precision medicine.**

Q4. What are the Future Opportunities for SNOMED CT Use?

4

Personalized, Precision Medicine

The ability to digitize the medical essence of a human being is predicated on the integration of multiscale data, akin to a Google map, which consists of superimposed layers of data such as street, traffic, and satellite views. For a human being, these layers include demographics and the social graph, biosensors to capture the individual's physiome, imaging to depict the anatomy (often along with physiologic data), and the biology from the various omics (genome-DNA sequence, transcriptome, proteome, metabolome, microbiome, and epigenome). In addition to all of these layers, there is one's important environmental exposure data, known as the ''exposome.''[7]



7. Topol, E, "Personalized Medicine from Prewomb to Tomb", Cell 157, March 27, 2014. See https://www.sciencedirect.com/journal/cell/vol/157/issue/1

Q4. What are the Future Opportunities for SNOMED CT Use?

4

Personalized, Precision Medicine 2030

1. **Huge Interoperable Longitudinal Cohorts** - Over the last 20 years, national cohorts (e.g. UK Biobank), have amassed huge populations with genomic, laboratory, and lifestyle assessments as well as longitudinal follow-up on health outcomes. The breadth and depth of data is staggering, as is the opportunities for discovery.
2. **Diversity and Inclusion** - With a growing depth of data, we have an opportunity to replace adjustments for race and ethnicity with more specific measures.
3. **Big Data and AI** - AI approaches in medicine have been limited by the (un)availability of large, commonly structured datasets. Looking forward, biomedical datasets will become increasingly ready for analyses.
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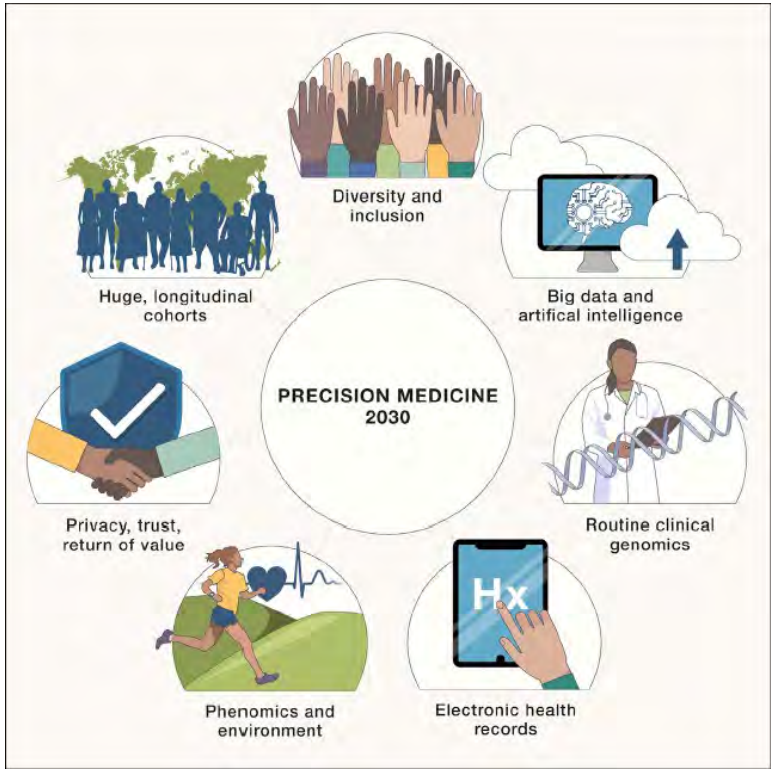


8. Denny J. and Collins F., "Precision Medicine in 2030 – Seven Ways to Transform Healthcare", Cell 184, March 18, 2021. See https://www.cell.com/cell/fulltext/S0092-8674(21)00058-1?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0092867421000581%3Fshowall%3Dtrue

Q4. What are the Future Opportunities for SNOMED CT Use?

4

FULL REPORT

Personalized, Precision Medicine 2030

Personalized, precision medicine promises improved health by accounting for individual variability in genes, environment, and lifestyle. It will continue to transform healthcare in the coming decade, and beyond, as it expands in key areas: huge cohorts, artificial intelligence (AI), routine clinical genomics, phenomics and environment, and returning value across diverse populations.

SNOMED CT as a core reference clinical terminology is well-positioned the enable the semantic 'interoperation' and knowledge representation of massive, diverse health data sets, using advanced technologies (e.g. AI/ML), that need to be positioned for personalized, precision medicine, analytics and research.

Envisioning how precision medicine will affect clinical medicine and research in the next decade

	Where we are today	Where we will be in 2030
Clinical applications		
Genomics for disease	Primarily limited to rare disease and select cancers.	Genomics is routine. Genetic causes and targeted therapies are discovered for many "common" diseases. Microbiome measures are routinely included.
Pharmacogenomics (PGx)	Common in cancer and within select applications of older medications at select sites.	Genome-aware EHRs make PGx easy and automatically update rules from central guidelines. New PGx associations discovered from clinical data.
Genomics for healthy individuals	In research, whole-genome sequencing and search for mutations in one of the ACMG59 genes, present in about 3% of people. Variant interpretation is hard.	ACMG59 grows to > 200, variant interpretation improved by huge, diverse sequenced populations. Cell-free DNA becomes a mainstay of cancer screening
EHRs	Episodic capture from healthcare without robust genomics support. EHR data is essentially not portable.	Genome- and device- enabled. Data can be easily moved between EHRs and to participant apps.
Environmental influences on health	Patient-reported habits and exposures	Geocode-based exposure linkage Real time monitoring of multiple environmental exposures Precision nutrition
Wearable sensors	Ad hoc use of activity monitors	Continuous monitoring of physical activity, sleep, metabolic parameters
Research applications		
Population demographics	>80% European ancestry	>50% non-European ancestry
Routinely available data	Surveys of health conditions, lifestyle, behavior, and diet. GWAS data, lab assays, structured EHR data, and geocoded exposure linkages.	Whole genomes, lab assays, surveys, full EHRs, environmental, genomic and sensor data. Includes imaging, narrative, geocoded, and continuous monitoring approaches to clinical care, activity, precision nutrition, and environment.
Size of cohorts used in analysis	Up to 500K, data downloaded and manually harmonized to sets of several million	>100M using cloud-based federated analyses facilitated by common standards
Largest genomic studies performed on a trait	>1M (GWAS)	>50M (GWAS) >2M (WGS)
Cost of a whole genome	$500	$20*

*Sequencing costs have often fallen faster than Moore's law. Using Moore's law, sequencing costs would be 1/32 of US $500, or $15.63.

SNOMED CT

Why would a Country Invest in SNOMED CT?

Desired Value

SNOMED CT is a best-in-class, core clinical reference terminology that is well-designed, comprehensive, serves multiple uses, is widely adopted, and enables improved patient outcomes – it clearly passes the bar for the value that a country desires from a clinical terminology and as such makes for a Strong Case for Investment.

Potential Value

Through the modelled deployment in clinical information systems and interoperability solutions SNOMED CT has clearly shown strong potential value and as such makes for a Strong Case for Investment.

Demonstrated Value

The ten Case Studies clearly demonstrate the value that SNOMED CT can bring when used in clinical information systems, health data & analytics platforms and interoperability solutions, and again make for a Strong Case for Investment.

Future Value

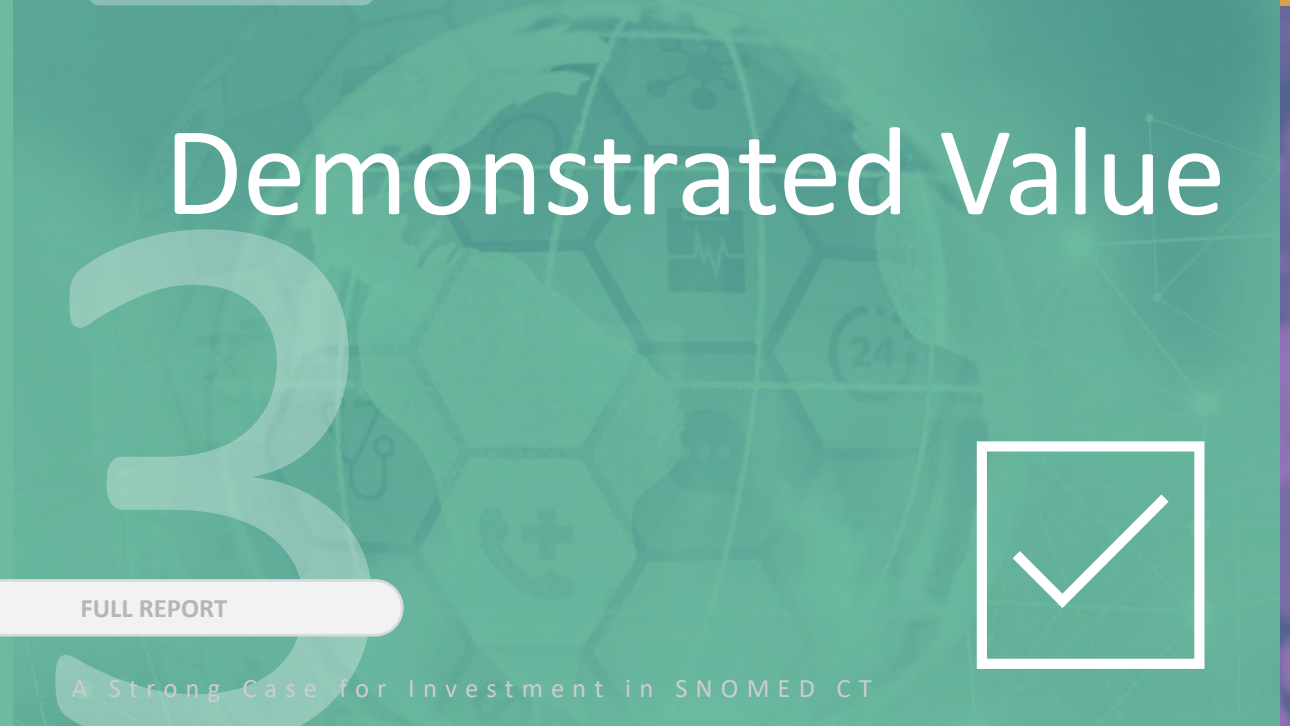
Future opportunities, especially in personalized, precision medicine and research, using advanced technologies, are a perfect fit for SNOMED CT, which in turn bolsters its Strong Case for Investment.

The SNOMED CT Case for Investment

Desired Value + Potential Value + Demonstrated Value + Future Value = Strong Case for Investment


1
Desired Value


2
Potential Value


3
Demonstrated Value
FULL REPORT


4
Future Value

SNOMED International

A Strong Case for Investment in SNOMED CT

Experience the value of SNOMED CT

Read the full report and visit the value platform at:

snomed.org/value

SNOMED CT
The global language of healthcare