International Standard

ISO 22287

Health informatics — Workforce roles and capabilities for terminology and terminology services in healthcare (term workforce)

Informatique de santé — Rôles et capacités des effectifs en charge de la terminologie et des services de terminologie dans le domaine de la santé (effectif à durée déterminée)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 215, *Health informatics*.

This first edition of ISO 22287 cancels and replaces ISO/TS 22287:2019, which has been technically revised.

The main changes are as follows:

— inclusion of FAIR principles and the importance of metadata;

— inclusion of implementation specialist as a terminology role.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Countries that began the adoption of health information and communication technology (HICT) products have reported shortfalls in the quantity and skills of the workforce in health information technology (HIT), health information management (HIM), and health informatics (HI).

This document addresses workforce needs when implementing terminology resources (products) in healthcare organizations and related supporting organizations, including regional, national and international HICT programs.

The purpose of this document is to enable healthcare organizations and related supporting organizations that deploy HICT products to safely and effectively support semantic interoperability within systems and between systems locally, nationally, or globally. Semantic interoperability, the ability of computer systems to exchange data with unambiguous and shared meaning, is impacted by the generation, management and sharing of health-related data and information.

Implementation and operation of complex terminologies in healthcare organizations and related supporting organizations without proper knowledge and skills of personnel in those terminological resources is a contributing factor in the resulting failure to deliver expected care outcomes, in delays in electronic health record (EHR) and health information systems (HIS) implementations, and in some cases, in injury caused to patients. Employers need to be able to hire workers with confidence that they have the right skill set for the job.

This document specifies tasks associated with electronic capture, management, sharing and use of health record content in EHR and HIS in the context of clinical care, business processes and information governance activities in healthcare.

This document is targeted to stakeholders involved in HICT products development, deployment and use. Specific values include the following.

— Healthcare organizations and HICT vendors: requirements and guidance for tasks and the skills for human resource staff to guide hiring of terminology standards personnel.

— Professional associations: guidance for terminology skill requirements, training and certification of HIT, HIM and Informatics professionals, as well as accreditation of terminology services programs.

— Academia: guidance for (a) the overall curricula development to support semantic interoperability education under HIT, HIM, and informatics programs, and (b) terminology competencies to support course development.

— eHealth, HIM, HIT, Informatics professionals and others: provide a mechanism to consistently and accurately indicate career pathways and skill expectations.

— Consumers (patients, clinicians, governments, society): safe, quality information is available.

This document supports the deployment of semantic content standards developed by TC 215 in healthcare organizations and governmental entities involved in electronic information sharing using interoperable standards-based HICT products. It provides direction on workforce needs for deployment and operation of terminological resources as well as the roles, competencies and skills to support these needs. Consideration of a business case development and potential numbers needed (i.e. terminology workers) would also be helpful in determining workforce requirements.

It also supports the development of the TC 215 reference standards portfolio (an assembly of individual standards) for interoperable HICT solutions in specific health domains, by identifying specific content area(s) for which a qualified terminology services workforce is needed.

ISO 21298 also describes a number of roles in healthcare. It is possible that some staff with roles described in this document undertake roles described in ISO 21298, or there can be naming collisions.

Health informatics — Workforce roles and capabilities for terminology and terminology services in healthcare (term workforce)

1 Scope

This document specifies the tasks, roles, and key skills, requirements and competencies for personnel involved in terminology services in healthcare organizations.

This document specifies:

— terminology services in healthcare organizations including the selection, authoring, and deployment and use of terminology subsets, data sets and maps; developing and managing terminology management processes and health information management-related policies; performing terminology business analysis; and supporting the adoption, planning and deployment of terminologies;

— workforce needs to perform these services;

— job roles in the healthcare organizations and related organizations responsible for performing terminology related tasks;

> NOTE   Examples of these roles include terminologist, terminology standards developer/manager, mapping specialist, data conversion analyst, interface analyst, coding specialist, data developer/designer, data modeller, and content manager [including Clinical Documentation Improvement (CDI) specialist].

— skill and competency level requirements to safely and effectively undertake each task, taking into account the focus of the task from the perspectives of health information and communication technology (HICT), information management, information governance including information privacy and security, clinical practice and healthcare decision making.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
adoption
act of taking up or following something

3.2
author
entity or set of entities that create and can modify an asset

3.3
classification
terminology which aggregates data at a prescribed level of abstraction for a particular domain

3.4
code system
organized, managed collection of codes, each of which has associated designations, meanings and in some cases relationships, properties or rules

[SOURCE: ISO/TS 17117-2:2022, 3.2]

3.5
code system extension
set of *code system* (3.4) components and derivatives that add to and are dependent on a published code system

3.6
competency
knowledge, *skills* (3.18), abilities and behaviours of an individual to perform a job properly

3.7
conformity
conformance
fulfilment of specified requirements

3.8
data set
identifiable collection of data available for access or download in one or more formats

Note 1 to entry: A data set can be a smaller grouping of data which, though limited by some constraint such as spatial extent or feature type, is located physically within a larger data set. Theoretically, a data set can be as small as a single feature or feature attribute contained within a larger data set.

Note 2 to entry: A data set can be presented in a tabular form and stored and distributed in tables in word processed documents, spread sheets or databases. It can also be presented in a number of alternative formats, including AVRO, JSON, RDF and XML.

Note 3 to entry: A data set can include attributes to facilitate *adoption* (3.1) and maintenance and it can contain maps to a Reference Terminology. Therefore, it should not be confused with a *subset* (3.20) or a *value set* (3.23).

[SOURCE: ISO/IEC 11179-33:2023, 3.5, modified — Note 3 to entry was added.]

3.9
interface terminology
a collection of commonly used terms to support user entry of health information into computer clinical applications

3.10
information management
planning, collection, control, distribution and exploitation of information resources within an organization, including systems development and disposal or long-term preservation

[SOURCE: ISO 5127:2017, 3.2.1.23, modified — Note 1 to entry has been removed.]

3.11
information governance
processes by which an organization obtains assurance that the risks to its information, and thereby the operational capabilities and integrity of the organization, are effectively identified and managed

3.12
information privacy
rights and obligations of individuals and organizations with respect to the collection, use, retention, disclosure and disposal of personal information

[SOURCE: ISO/TS 14441:2013, 3.26]

3.13
information technology
resources (especially computers and telecommunication) used to acquire, process, store and disseminate information

[SOURCE: ISO/IEC 38500:2015, 2.12, modified — "(especially computers and telecommunications)" was added to the definition; the Note 1 to entry was removed.]

3.14
mapping
process of defining a relationship between concepts in one coding system to concepts in another coding system in accordance with a documented rationale, for a given purpose

3.15
safety
freedom from unacceptable risk

3.16
security
combination of confidentiality, integrity and availability

3.17
semantic interoperability
ability of computer systems supporting health care practice and management to correctly and consistently interpret the information being exchanged

3.18
skill
ability to perform a task or activity with a specific intended outcome acquired through education, training, experience or other means

[SOURCE: ISO/IEC/TS 17027:2014, 2.74]

3.19
standards development organization
organization one of whose functions is to create and/or publish standards

[SOURCE: ISO/TS 27790:2009, 3.70]

3.20
subset
code set
a list of coded concepts that meet a specific need

Note 1 to entry: A subset can be used for data entry or health system use extract. The concepts can be drawn or not from a *code system* (3.4).

3.21
terminology service
service that allows healthcare applications to make use of codes and *value sets* (3.23) without having to become experts in the fine details of *code system* (3.4), value set and concept map resources, and the underlying code systems and terminological principles

3.22
terminology standards certification
general accomplishments, *competencies* ([3.6](#)) or *skills* ([3.18](#)) that fulfil the requirements as outlined in a terminology standards' program

3.23
value set
identifiable set of coded values associated with a data element that consists of concept representations drawn from one or more *code system* ([3.4](#))

Note 1 to entry: a value set is not the same as a value domain as defined in ISO/IEC 11179-1:2023.

Note 2 to entry: In HL7 value sets are all uniquely identified.

[SOURCE: Leveraged from HL7]

3.24
workforce
people who provide a service or labour to contribute to business or organizational outcomes

[SOURCE: ISO 30400:2022, 3.8.1]

4 Abbreviations

CDA	Clinical Document Architecture
CDI	Clinical Documentation Improvement
CPT	Current Procedural Terminology
CT	Controlled Terminology
DICOM	Digital Imaging and Communications in Medicine
EHIS	Electronic Health Information Systems
EHR	Electronic Health Record
FAIR	Findable Accessible Interoperable Reusable
FHIR	Fast Healthcare Interoperability Resources
HI	Health Informatics
HIM	Health Information Management
HICT	Health Information and Communication Technology
HIT	Health Information Technology
HL7	Health Level Seven
ICD	International Classification of Diseases
IHE	Integrating the Healthcare Enterprise
LOINC	Logical Observation Identifiers Names and Codes
SDO	Standards Development Organization
SNOMED	SNOMED International

SNOMED CT   Systematized Nomenclature of Medicine Clinical Terms

WHO   World Health Organization

5   Terminology and terminology services in healthcare

The use of clinical terminologies, such as SNOMED CT and LOINC, has been increasing as part of the growing investments in health information technologies. There is a business need in health care organizations to establish services to support the implementation and maintenance of e-health solutions including electronic capture, management, sharing and use of health record content in the context of clinical care, business processes and information governance activities. The following "terminology" roles, activities and products have been identified as in demand or anticipated to be in demand in healthcare organizations.

— Terminology subsets and data sets: creating, maintaining, extending, quality assurance, and distributing and/or publishing subsets or data sets and supporting derivatives.

— Terminology maps: creating, maintaining, extending, quality assurance, and distributing and/or publishing maps and supporting material.

— Terminology management processes/policies: developing, managing and updating health information management-related policies and processes to manage terminologies, including how to create subsets and terminology maps, how to maintain terminologies and requests for change, how to engage clinical experts for validation and overall decision-making processes related to terminology management.

— Terminology business analysis: gathering terminology requirements and defining terminology needs for e-health solutions and/or other tools (e.g. terminology tools, tools to support health analytics), development of recommendations for adopting, adapting or developing terminologies to meet specific business needs, supporting the definition of functional requirements, evaluating requirements as part of a procurement process, documenting workflow, providing terminology guidance to support configuration as required, support deployment of solutions from a terminology perspective (e.g. development of training manuals, development of test scenarios, testing).

— Implementation planning and deployment of terminologies: supporting implementation planning and deployment of terminologies within an organization, region, or jurisdiction as part of an overall strategic plan or solution deployment including communication, education, change management, etc.

— Data retrieval and analysis: utilizing terminologies for effective meaning-based retrieval to support epidemiology, research, evidence gathering and service planning (clinical and administrative), and ensuring the organization is using health information standards appropriately and effectively.

— Decision support protocols, guidelines and other knowledge resources: providing guidance from a health information management perspective on how to integrate terminologies into these resources (e.g. policy requirements, patient care outcome improvements).

— Research of clinical terms and definitions: providing an understanding of clinical terms and how context plays a role in selecting the correct concept or term for the right usage or setting.

Healthcare organizations and supporting organizations need a trained and experienced workforce to support terminology activities.

6   Healthcare terminology professionals

6.1   Workforce shortage and impact

Healthcare terminology professionals are those members of the workforce who are involved in the tasks associated with the terminology services described in Clause 5. Countries that have begun HICT adoption have reported shortfalls in the quantity and skills of the workforce in health information technology, health information management and health informatics. Specific examples of countries' workforce needs are presented in Annex A.

Annex A indicates the impact of human resource competencies and skills on the adoption of HICT technologies and investments in HICT. Workforce impacts have been identified as the following two key demand drivers in various countries:

a) the "employment effect" – increases the number of professionals required;

b) the "skill-broadening effect" – many professionals require additional training or experience to meet terminology services demands.

The occupational group of terminology specialist was specifically identified as needing to grow in number and also requiring broader skills.[27] Organizations such as SNOMED International have begun investing in developing educational materials to promote the effective deployment and use of its product – SNOMED CT.

6.2 Terminology specialists: roles, job and skills requirements, and qualifications

6.2.1 General

Annex B provides the list of specific roles related to terminology and terminology services in healthcare organizations and related supporting organizations. These include, but are not limited to:

— terminology implementation specialist;

— terminology author;

— terminology standards developer/manager;

— mapping specialist;

— data conversion analyst;

— user interface analyst;

— coding specialist;

— data developer/designer;

— data modeller;

— content manager (including clinical documentation improvement specialist).

These various roles can be consolidated under the three levels of specialists performing terminology services:

Level 1 – Terminology technical specialist;

Level 2 – Terminology specialist;

Level 3 – Terminology advanced specialist.

The roles, job requirements, terminology skill requirements, general skills and qualifications for each level are described in 6.2.2, 6.2.3 and 6.2.4. Specific tasks under these roles shall take into account the focus of the task from the perspective of HICT, information management, information governance (including information privacy and security), clinical practice and healthcare decision making.

6.2.2 Terminology technical specialist

6.2.2.1 Role

The terminology technical specialist is responsible for the technical and/or tooling aspects of terminology development, mapping, terminology analytics, maintenance and implementation. The terminology technical specialist will work in a team setting with clinicians, project teams, operational teams, business analysts, mapping specialists and terminology specialists providing knowledge transfer to clients and team members,

implementation support, development of terminology deliverables and overall maintenance of mappings or other products. A key function of this role is the ability to contribute to data quality development and maintenance by enabling the primary and secondary functional aspects of developing, implementing and managing terminology products.

6.2.2.2 Job requirements

— Responsible for technical management of healthcare data, including but not limited to the following:

  — data export from a database to a terminology tool;

  — design and execution of queries on data within a terminology tool or database to support terminology business functions including data analytics;

  — configuration and maintenance of terminology tools including application rules engine(s);

  — installation of version upgrades and managing database functions;

  — provision of backups and ensuring redundancy of data holdings.

— Participates in the selection of tools for mapping, terminology searching, browsing and selecting terminology authoring, and maintenance.

— Provides terminology tool training, installation, and updates.

— Manages subscription services.

— Supports both the clinical, business and technical resources within a project and program:

  — provides the liaison between both types of resources;

  — provides mentorship to junior resources and other team members.

— Provides support in the terminology use and requirements for implementation of data content in HL7 and DICOM standards and/or value sets including messaging, data content, and documents.

— Provides continuous knowledge transfer with clients and other resources on the team, including knowledge transfer for new members to the project or team.

— Governance:

  — Ensures the standards guidelines, procedures, health information management-related policies and processes are aligned with client's existing policies and standards development organizations, and assists with the development of new health information management-related policies.

  — Identifies potential issues and the impact of existing regulations on the project, and for continued use of the program.

  — Responsible for documentation related to terminology work which includes:

    — status updates;

    — assumptions, risks, issues, principles and decisions;

    — roles, responsibilities and processes for sustained use of mappings.

— Develops or utilizes a quality assurance framework for terminology deliverables, including:

  — quality assurance process for procedures and deliverables;

  — developing evaluation methods including development of scripts to verify data integrity;

  — managing the use of terminology testing tools and associated processes;

— versioning as part of maintenance and sustainability.

— Communication:

— Provides updates to the team and client (tailored to the specific audience).

— Develops material to enable a good understanding of options analysis.

— Works to ensure a high level of client satisfaction.

6.2.2.3 Skills requirements for terminology services

— Understanding of the distinction between classifications and clinical terminologies.

— Experience with developing processes for managing unstructured and structured data.

— Experience with and knowledge of terminology tools and tooling requirements.

— Experience with and understanding of natural language processing, data mining and artificial intelligence.

— Understanding of how the coded data are represented in HL7 standards such as Version 2.x, V3, CDA, FHIR.

— Understanding of terminology and mapping principles, terminology business functions, and best practices.

— Understanding of concept representation and links to alternative terms (synonyms) including terms in different languages.

— Expertise and understanding of healthcare clinical information systems.

— Broad understanding and experience with healthcare vocabularies including the World Health Organizations Family of Classifications and national code system extensions and standards.

— Broad understanding and knowledge of clinical terminologies such as SNOMED CT, LOINC.

— Understanding of standards development organizations and their role in and ownership of terminologies.

— Knowledge of healthcare industry and current global healthcare informatics standards.

— Database query knowledge and experience.

— Experience working with transactional databases and data warehouses.

— Experience with extracting, transforming, and loading of data from databases and data warehouses.

— Understanding of effective and practical strategies for search and data capture.

— Experience and understanding from a technical perspective of the possible terminology solutions to support an implementation, including:

— understanding of the types of limitations that can occur in some clinical systems (such as limitations in field length and data element structure) and the ways that these limitations can be addressed.

— Understanding of licensing requirements for terminologies and clinical information systems, electronic medical and electronic health records.

— Understanding of retrieval and analysis approaches to meet different business needs.

— Awareness of meaning-based retrieval and the value of description logics in supporting this is also required at least for the advanced roles.

— Understanding of how transitive closure, concept subsumption and equivalency, and the information model play a role in retrieval and analysis.

— Understanding of how data capture and meaning-based retrieval play a role in decision support.

6.2.2.4 General skills

— Excellent communication skills, both verbal and written, and the ability to work closely with customers and third parties to complete large system integration projects.

— Ability to relay complex topics and information in an audience-appropriate manner.

— Excellent problem-solving, time and project management skills.

— Clinical information systems integration project skills.

— Detail and technically oriented.

— Ability to work independently and set priorities.

— Logical thinker.

— Critical thinking skills.

— Self-motivated.

— Ability to complete assignments with little direction.

— Ability to work in a team environment.

— Attention to detail.

— Knowledge of medical language.

— Experience managing large amounts of data (in database or Microsoft® Excel[1]).

— Ability to collaborate with a variety of different stakeholders.

6.2.2.5 Qualifications and assets

— Understanding of clinical information systems and other health information systems.

— Terminology standards certification.

— Diploma or bachelor's degree in health information management, health informatics, a health profession, or related program.

— Two years minimum experience working in an electronic health record environment and with clinical classifications and terminologies (e.g. SNOMED CT, LOINC, ICD-10).

— Experience in the use medical language is a requirement.

— Database management including data manipulation and analysis (e.g. using Microsoft® Access or SQL[32]).

— Leadership experience is an asset.

— Proven success in a team environment is an asset.

— Project management experience is an asset.

— Experience working with terminology implementations is an asset.

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1) Microsoft office® (including Excel, Word and Access) is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

— HIM and/or HI professional certification is an asset.

6.2.3 Terminology specialist

6.2.3.1 Role

The terminology specialist develops and maintains mappings, data sets and subsets between healthcare related data and clinical terminology systems (including SNOMED CT and LOINC) and classifications. The terminology specialist will work in a multi-disciplinary team in multiple care settings with clinicians, other health care providers, terminology technical specialists, project managers, business analysts, advanced terminology specialists, and vendors as well as in close interaction with the client or implementer. A key component to this role is the ability to understand and use terminologies in different contexts and apply domain knowledge and terminology expertise to tailor and integrate best practices in mapping, to support data set and subset development, and to apply a quality assurance framework in clinical projects or within an operational context to support best practices.

6.2.3.2 Job requirements

— Responsible for developing and validating subsets, data sets, data mapping and transformation of healthcare data into the integration service and/or data warehouse, including the following:

  — performing environmental scan to identify factors that will shape and potentially impact the terminology content development and implementation, such as:

    — the current state of:

      — existing terminology artefacts within the jurisdiction;

      — systems that will be impacted by the new terminology;

      — management/secondary business reporting of the new terminology.

    — other jurisdictions' experience in developing similar terminology artefacts;

    — terminology requirements suitable to meet the needs of any new solution the terminology artefact is intended to be used in.

  — determining mapping, subset and/or data set approach and requirements based upon intended use, purpose and context;

  — performing scans to determine if there is an asset to leverage (adopt, adapt, create);

  — identifying terminology tool requirements;

  — developing version control processes;

  — developing validation and quality assurance processes;

  — developing mapping and subset rule-based processes;

  — developing tooling test plans and verify tooling integrity with technical experts;

  — identifying and resolving mapping and subset tool errors;

  — developing and verifying maps, subsets and data sets;

  — developing or applying mapping and subset heuristics by following established data mapping and terminology principles and best practices.

— Develops and executes a mapping, subset and/or data set development, maintenance and sustainability plan including the development of maintainable processes for changes to client data and changes including versioning with the target terminological system.

— Works with clients and other terminology team members (such as the terminology advanced specialist) to analyse and transform data from disparate healthcare systems into the integration service and data warehouse, including:

  — providing education to multiple stakeholder groups using audience-appropriate communication on the value and benefits of clinical terminology adoption;

  — providing education and guidance to clinical stakeholders to allow them to contribute to the content questions;

  — providing mentorship to junior terminology resources and other team members;

  — providing continuous knowledge transfer with clients and other resources on the team ensuring that knowledge is transitioned as new members join a project or operational team.

— Responsible for communication with clinical stakeholders and team members to:

  — provide high level of client satisfaction and assurance in the quality and reliability of terminology artefacts;

  — recommend the appropriate standardized clinical terminologies and classifications as part of the selection process;

  — assess and recommend the requirement for and/or deprecation of terminology code system extensions and local code sets;

  — progress updates and facilitation of discussion on mapping, data set and subset related issues;

  — propose and implement solutions for mapping, data set and subset issues;

  — provide support to users of the maps, data sets and subsets.

— Governance:

  — Responsible for content development to meet stakeholder needs with standards development organizations such as SNOMED International[35] and Regenstrief Institute[38].

  — Ensures that health information management-related policies, standards, guidelines and procedures exist to ensure the appropriate validation and approvals occur throughout the terminology life cycle, and assists with the development of new health information management-related policies.

  — Ensures the process is aligned with client's existing governance structures.

  — Responsible for documentation during the life of a project and/or operational initiative and for continued use of the program which includes:

    — receiving request for change;

    — gathering requirements;

    — prioritization of requests for change;

    — status updates;

    — assumptions, risks, issues, principles and decisions;

    — roles, responsibilities, and processes for sustained use of mappings and deprecation;

    — benefits evaluation;

    — lessons learned.

— Develops or utilizes a quality assurance framework for terminology deliverables, including:

  — quality assurance process for deliverables and editorial review process;

— developing scripts to verify data integrity;

— testing of maps and associated terminology tools.

6.2.3.3 Skills requirements for terminology services

— Ability to apply clinical terminology principles.[29]

— Understanding of the distinction between statistical classifications and clinical terminologies.

— Broad understanding and experience with healthcare vocabularies including the World Health Organizations Family of Classifications and national code system extensions and standards.

— Experience working with clinical terminologies such as SNOMED CT, LOINC, and others.

— Understanding of concept representation and links to alternative terms (synonyms) including terms in different languages.

— Understanding of the FAIR principles and the importance of metadata within the framework of the FAIR principles.

— Understanding of standards development organizations and their role in terminologies.

— Experience with the subset and mapping process and determination of related requirements including mapping best practices such as available from AHIMA.[30] Understanding of the critical success factors of a good mapping and subset process such as:

  — how the use, purpose and context of the map/subset affects the mapping and subset development process;

  — the way in which the computer system and stakeholders will use the map;

  — the need for client source data cleansing.

— Experience with and understanding of how to use the following types of terminology tools:

  — terminology browsers to access, search, browse and select terminology concepts;

  — data set;

  — subset;

  — mapping tools.

— Ability to apply the basic concepts of the terminology model within the mapping approach.

— Understanding of the processes to develop, implement, maintain, publish and deprecate maps, subsets and content within data sets.

— Experience with clinical information system desirable.

— Knowledge and understanding of clinical documentation practices at the point of care recommended.

— Understanding of the principles and requirements for syntactic and semantic interoperability.

6.2.3.4 General skills

— Excellent written and verbal communication skills.

— Experience with Microsoft office®2), including Excel, Word and Access.

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2)   Microsoft office® (including Excel, Word and Access) is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

— Ability to prioritize workload to meet shifting deadlines and tight timelines.

— Logical thinker.

— Critical thinking skills.

— Self-motivated and self-directed.

— Ability to complete assignments with little direction.

— Ability to work in a team environment.

— Ability to communicate complex concepts using audience-appropriate language.

— Attention to detail.

— Knowledge of medical language, anatomy and physiology.

— Ability to collaborate with a variety of different stakeholders and disciplines.

6.2.3.5 Qualifications and assets

— Terminology standards certification.

— Diploma or bachelor's degree and professional experience working in health information management, health informatics or a health profession.

— Experience working in an electronic health record environment and with terminologies (e.g. SNOMED CT, LOINC) is considered an asset.

— Experience in the use medical language, anatomy and physiology is a requirement.

— Project management experience is an asset.

— HIM and/or HI professional certification is an asset.

6.2.4 Terminology advanced specialist

6.2.4.1 Role

The role of the advanced terminology specialist is to lead terminology activities related to developing, implementing and managing mappings, data sets and subsets, (including strategies and tactics to use coded terminology for clinical decision support and identifying and targeting patient/cohort populations to proactively provide improved care), providing knowledge transfer to clients and team members, implementation support, development of terminology deliverables and overall maintenance (including versioning and deprecating) of mappings or other products. The terminology advanced specialist is responsible for the terminology aspects of the project(s) and will work in a team setting with clinicians, health care providers, architects, project managers, business analysts and other terminology specialists as well as in close interaction with the client or implementer. A key component of this role is the ability to tailor the terminology approach to a specific project or operational context by applying a quality assurance framework.

6.2.4.2 Job requirements

— Works with clients in determining their terminology approach and solution in the context of clinical requirements and enterprise information architecture, including the intended use and purpose of the terminology product.

— Responsible for analysing a client's current and future data state and identifying terminology options:

— understanding the terminology current state;

— investigating terminology options, lessons learned and maintaining ongoing awareness terminology trends;

— identifying the terminology desired state for data capture and secondary use of the data;

— identifying the gaps and impact of those gaps on existing systems and stakeholders;

— determining, leading and developing the implementation of the terminology implementation plan and roadmap in consultation with multiple stakeholder groups.

— In collaboration with multi-disciplinary teams, leads the terminology activities and/ or a team of terminology resources (such as the terminology specialist) in the development of the terminology and/ or data solutions in an electronic health record project including:

— maps;

— data sets;

— subsets;

— adjudication when consensus cannot be achieved between terminology specialists;

— development and encoding of assessment templates;

— solutions for enabling primary and secondary use of coded data;

— analysis and transformation of data from disparate healthcare systems to permit it to be used by the integration service and data warehouse;

— identification of terminology tooling requirements and selection of terminology tools.

— Works with project-based resources in electronic health record projects including clinicians, health care providers, business analysts, architects, and others.

— Provides mentorship to junior terminology resources and other team members.

— Provides continuous knowledge transfer with clients and other resources on the team including knowledge transfer for new members to the project or team.

— Governance:

— Ensures standards, guidelines, health information management-related policies and processes are aligned with the client's existing governance structure as well as those of terminology management services, and assists with development of new health information management-related policies.

— Identifies potential issues and the impact of existing regulations and standards to the project or operational initiative.

— Responsible for documentation during the life of a project, and for continued use of the program which includes:

— development of a standard method for intake of all requests for creation, change and deprecation to ensure a full understanding of the intended use case for the subset, data set and/or mapping;

— managing requests for change;

— status updates;

— development of a standard methodology for prioritizing requests for change according to immediate clinical and business needs with the ability to integrate these needs with existing workload priorities;

— roles, responsibilities, and processes for sustained use of terminology;

— assumptions, risks, issues, principles, and decisions;

— benefits evaluation;

— lessons learned.

— Develops or utilizes a quality assurance framework for terminology deliverables including:

— quality assurance process and editorial review process;

— developing evaluation methods including development of scripts to verify data integrity;

— testing plans, processes, and practices;

— version control as part of creation, maintenance, sustainability and deprecation.

— Communication:

— Identifies the benefits and risks associated with the terminology solution.

— Contributes to briefing notes that can highlight health information management-related policy or process changes.

— Provides updates to the team and client (tailored to the specific audience).

— Develops material to meet the needs of multiple audiences to enable a good understanding of options analysis.

6.2.4.3 Skills requirements for terminology services

— Ability to apply clinical terminology principles.[29]

— An understanding of the distinction between statistical classifications and clinical terminologies.

— Ability to analyse terminology implementation options and select best fit.

— Broad understanding and experience with healthcare vocabularies including the WHO family of classifications and national code system extensions and standards.

— Understanding of concept representation and links to alternative terms (synonyms) including terms in different languages.

— Understanding of the requirements, benefits and value for terminology services.

— Experience with terminology current state analysis and an understanding of the desired future state and the ability to function in an interim state using manual tools and resources until full implementation of a terminology service.

— Understanding and experience with implementing terminology solutions, such as:

— subsets;

— data sets;

— maps;

— encoded templates;

— understanding how to develop a query on a terminology product to identify errors or find desired data.

— Understanding of effective practical and strategies for search, retrieval and data capture.

— Experience with access, search, browse and select clinical concepts within terminologies.

— Understanding of how the representation of meaning in information models, codes and terminologies can interact and overlap.

— Appreciating the general principles that can be applied to information models, user interfaces, and terminologies to minimize ambiguity and ensure effective, meaningful and processable representation of clinical data from multiple perspectives and purposes.

— Experience in the application of terminology best practices.

— Familiarity with licensing and versioning requirements of standards development organizations for specific terminology.

— Understanding of retrieval and analysis approaches to meet different business needs: awareness of meaning-based retrieval and the value of description logics in supporting this is also required at least for the advanced roles.

— Understanding of how transitive closure, concept subsumption and equivalency, and the information model play a role in retrieval and analysis.

— Understanding of how data capture and meaning-based retrieval play a role in decision support.

6.2.4.4 General skills

— Ability to influence stakeholders.

— Excellent written and verbal communication skills.

— Logical thinker.

— Critical thinking skills.

— Self-motivated.

— Ability to complete assignments with little direction.

— Ability to work in a team environment and demonstrate understanding across disciplines.

— Attention to detail.

— Knowledge of medical language, anatomy and physiology.

— Experience managing large amounts of data (in database or Excel).

— Ability to collaborate with a variety of different stakeholders.

6.2.4.5 Qualifications and assets

— Terminology standards certification.

— Diploma or bachelor's degree in health information management, health informatics, a health profession, or related program.

— Five years minimum experience working in an electronic health record environment and with terminologies (e.g. SNOMED CT, LOINC).

— Medical terminology, anatomy and physiology is a requirement.

— Database management including data manipulation and analysis (e.g. using Microsoft® Access[3]) or SQL)

— Leadership experience is a requirement.

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[3] Microsoft office® (including Excel, Word and Access) is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

— Project management experience is a requirement.

— Experience working with terminology implementations is an asset.

— HIM and/or HI professional certification is an asset.

7 Competencies, educational objectives and content

7.1 Competencies

The terminology standards competencies provide the content for terminology standards (TS) educational programs.

The following five core competency domains have been defined.

1) Foundations of controlled terminologies (CT): knowledge and understanding of the types of CT standards in use, including specific core and non-core CTs. As the health informatics and information management (HIIM) field continues to evolve, the specific core and non-core CTs can change including terminologies such as SNOMED CT, LOINC, and classifications such as WHO ICD-10 and the International Classification for Nursing Practice (ICNP).

2) Management of controlled terminologies: knowledge and skills in managing CT standards as an asset in organizations or jurisdictions. This competency covers development, publication/distribution, maintenance and deprecation of CT contents, services and tools.

3) Application of controlled terminologies: knowledge and skills in adopting, implementing and deprecating CT standards in organizations or jurisdictions. This competency covers analysis, evaluation, planning, design, implementation, use and support and deprecation of CTs in health IT applications.

4) Foundations of interoperability standards: basic understanding of the types of interoperability standards in use, with emphasis on the role and relationship of CTs in these interoperability standards.

5) Application of interoperability standards: application of knowledge and skills in adopting, implementing, maintaining and deprecating interoperability standards in organizations or jurisdictions, with emphasis on appropriate use of CTs in the standards and solution development life cycles.

The specific types of education or training modules, the depth and the degree of comprehension upon training completion depend upon the type and availability of education setting (academic or vocational), the method of training delivery (in-class or online), and on the role and responsibilities with regards to the expected role.

7.2 Learning outcomes per competency

The learning outcomes within the terminology standards competencies (outlined in Table 1 to Table 5) are not stated as outcomes or objectives, but rather as learning content. To provide clearer guidance on the expected level of cognitive learning per learning content area, the learning outcomes have been developed to state the specific item of content and the learning level at which it should be taught. Competency considerations are included to support consistency in academic program development. The academic programs themselves, however, will determine how to teach the content at the appropriate level. The competency considerations are examples of topics to be taught to achieve the desired learning outcomes. By design, these are flexible enough to provide guidance yet allow for jurisdiction- and organization-specific needs to be met. The learning levels noted within each item are based on Bloom's taxonomic levels (see Table C.1 in Annex C). Tables 1 to 5 indicate the competencies identified relating to each of the five domains, along with the taxonomy level and competency considerations.

Table 1 describes the knowledge and understanding of the types of CTs and terminology standards in use, including specific core and non-core CTs. As the health informatics and health information management (HI/HIM) field continues to evolve, the specific core and non-core CTs can change; however, some terminologies such as SNOMED CT and LOINC will continue to be core.

Table 1 — 1.0 Foundations of controlled terminologies

		Competency	Bloom's level	Considerations
1.1		Describe why a standardized approach to information management and data governance is important in today's environment.	2 (Understand)	Introduction and contextualization of the program of study including the roles of CT and the stakeholders who use and manage CTs.
1.2		Describe the concepts of information management, data governance and related concepts including, but not limited to, master data management, metadata management, risk management, entities entitled to collect data under legislation.	2 (Understand)	Describe data governance and management of health information – how it supports clinical (primary/direct care use) practice, interoperability, secondary use (e.g. billing, alerts, decision support, analytics), consumer/client populations.
1.3		Apply the meaning of "ontology", "taxonomy", "description logic", "terminology modelling", "metadata" (defined as data about data and within the context of specific terminology) and their relationship to the core terminology standards.	3 (Apply)	Consider the distinctions and meaning between similar terms.
1.4		Identify SDOs that develop, manage or impact the use of controlled terminology including governance and licensing requirements. Minimum terminology standards (and SDO) for inclusion: — Core: SNOMED CT, ICD (WHO), LOINC (Regenstrief), country-specific core requirements; — Non-core: include, but not limited to, HL7 code systems (HL7), CPT, InterRAI Assessments, ISO TC 215, nursing and other domain specific terminologies.	3 (Apply)	Identify each SDO, including history and development of specific core CT standards (SNOMED CT, ICD, LOINC), intellectual property issues, language implications (i.e. availability in required languages) and how each is made available and consumable. Identify licensing requirements for implementing each core CT standard as well as each SDO governance model and development process for creating new content. For non-core terminologies (HL7 Code systems, CPT, nursing and others), identify intellectual property issues, how each standard is available and any licensing requirements as well as the governance model and development process for creating new content. Emphasis for this learning content should be on standards used nationally and internationally to support data analysis, local/national mapping, and/or interoperability where appropriate.
1.5		Explain the design principles of specific core and non-core terminology standards including national adaptations. Minimum terminology standards for inclusion (based on what is being used nationally for data analysis and interoperability): — Core: SNOMED CT, ICD, LOINC, country-specific core requirements; — Non-core: an understanding of other terminologies including but not limited to HL7 code systems, CPT, InterRAI assessments, analyse nursing and other domain specific terminologies.	2 (Understand)	Explain the detailed in-depth structure of specific core CT standards (SNOMED CT, ICD, LOINC) as well as how they are used in electronic systems. Explain how nation-specific adaptations (i.e. SNOMED CT code system extensions, adaptations of ICD-9, ICD and intervention codes) and future ICD-11 have been modified and used in nationally. Explain the current state of trends, issues and example implementation in CT standards landscape. Describe the differences between terminology and classification standards.

Table 1 *(continued)*

		Competency	Bloom's level	Considerations
1.6		Explain Controlled Terminology (CT) usage in data capture, exchange and reuse in specific health care domains including but not limited to laboratory, diagnostic imaging procedures, oncology, primary care, nursing, mental health, drugs. CT usage includes purpose, domain coverage, subsets (e.g. allergies, diagnosis, interventions, adverse reactions), interface terminologies, maps, cross maps, retrieval and documentation.	2 (Understand)	Explain the role of controlled terminologies in the following scenarios: — concept representation and links to alternative terms (synonyms including terms in different languages), interoperability, clinical decision support, and health system use purpose and domain coverage; — representation and/or translation of units of measurement. Describe use cases for clinical terminologies and classification system usage in health care and health IT systems including comparison of gaps, comparability and complementarity. Explain and define the purpose of cross maps between standards and the difference with simple maps. Learners will need to have an understanding of user interface display and structured documentation [e.g. problem lists, pick lists, radio buttons and graphical notations (i.e. the link between clinical documentation and assignment of clinical terminology)].
1.7		Apply knowledge in the technical design for terminology standards.	3 (Apply)	Describe examples of how to apply the Cimino desiderata CT principles in a technical design. Examples of technical design include SNOMED CT features of concept models, description logic, post-coordination, expression constraint language, compositional grammar, and LOINC concept models and attribute builds. Explain the difference between pre- and post coordination and considerations related to data capture, exchange and reuse. Model expressions using SNOMED CT Compositional Grammar. Model a simple query using SNOMED CT Expression Constraint Language.
1.8		Evaluate basic CT tools for development, management and use.	5 (Evaluate)	Understand purpose and use of CT tools Evaluate options and make a recommendation in the selection and use of the following specific tools: — browsing, searching; — mappings; — management (e.g. requests for change, versioning, deprecating); — data sets; — subsets; — authoring; — query tools.

Table 1 *(continued)*

	Competency	Bloom's level	Considerations
1.9	Apply CT tools used for advanced development, management and use.	3 (Apply)	Apply knowledge and skills in the roles and use of the following specific tools including the relationship of use case to tool functionality: — modelling (for code system extensions/post coordination); — classifiers; — conformance tools (e.g. terminology meaning, emerging terminologies); — validation; — visualization tools; — expression builders.
1.10	Understand the FAIR principles to support data management and stewardship.	2 (Understand)	— Understand the FAIR principles: — findability; — accessibility; — interoperability; — re-usability. — Understand the importance of metadata within the framework of the FAIR principles.

Table 2 describes the knowledge and skills in managing controlled terminologies (CT) and terminology standards as an asset in organizations or jurisdictions. This covers development, publishing or distribution, maintenance and deprecation of CT contents, services and tools.

Table 2 — 2.0 Management of controlled terminologies

		Competency	Bloom's level	Considerations
2.1		Determine methodologies for the development and management of controlled terminologies.	5 (Evaluate)	Building on the competencies from section 1.0 Foundations of controlled terminologies: — Evaluate and apply critical thinking to recommend a methodology for CT management including governance structure/process, management of requests for change, prioritization, versioning, roles, responsibilities and processes for sustained use of CT, management of risks, issues and decisions, and lessons learned. — Evaluate and apply critical thinking to recommend a methodology for CTs including needs identification, standards selection, benefits evaluation, development, quality assurance, publication, distribution, and deprecation processes; and selection of terminology development and maintenance tools.
2.2		Demonstrate terminology knowledge by contributing to the development, implementation and support of an operational/human resources including workflow and tools to manage CT in the organization or jurisdiction.	3 (Apply)	Apply terminology understanding in the solution including: — the development of roles and responsibilities in the development process; — managing and adjudication during consensus in the development process; — development of assessment templates.
2.3		Demonstrate terminology knowledge by contributing to the development, implementation and support of CT services, tools and technical infrastructure, to manage CT.	3 (Apply)	Apply terminology services, tools and resources to help articulate clinical, business and technical needs within use cases, requirements, test cases, etc. EXAMPLE There is a need to incorporate terminology considerations to a technical solution (e.g. FHIR, application programming interface or API). Assignment can include a case study.
2.4		Perform quality assurance/improvement of CT in the organization or jurisdiction, including quality audit of the CT content and usage.	4 (Analyse)	Facilitate quality assurance/improvement of CT services and tools in use. (The focus is from the perspective of the organization or jurisdiction that has developed the product and how they are going to continue to maintain it).

Table 2 *(continued)*

	Competency	Bloom's level	Considerations
2.5	Using methodologies as per 2.1, evaluate, develop, publish/ distribute and maintain CT content as part of the CT development life cycle.	6 (Create)	"Recommend" specific CT content for an area of domain coverage that includes consideration for concepts, relationships, subsets, data sets maps, cross maps and concept modelling. "Development" covers the modelling and creation of specific CT contents including but not limited to LOINC and SNOMED CT expressions and code system extensions, modelling, implementation guides, lessons learned material, best practices and technical reference material. "Publish/distribute" covers human readable and computable content and includes the release of specific CT contents such as subsets, maps, terminology metadata, and relevant statistics (e.g. size of subsets, actual usage statistics), rules and documentation (e.g. transitive closure table and implementation guide). "Maintain" covers specific CT content revisions, updates and versioning, and deprecation.
2.6	Develop and implement a CT strategy to ensure compliance with policies and governance on CT implementation and management including: — knowledge of governance and best practice in terminology; — risks and issues with mitigation strategies.	6 (Create)	Consider the requirements/use case scenarios for the use of organizational, jurisdictional, national, and international terminology. Address management of terminology at an organizational, jurisdictional, and/or health system-wide level. Establish organizational/jurisdictional policies to support governance of CT implementation. Incorporate governance and best practice considerations including clinical engagement, collaboration, innovative thinking, sustainability planning and communication. Lead and facilitate steering/advisory committees and working groups for stakeholders on the governance of specific CT in the organization or jurisdiction. Risks and issues include project risks when implementing a terminology; the competency includes understanding methodologies to identify and mitigate risk.
2.7	Develop learning resources and deliver educational/ training sessions for multiple audiences on the development, application and management of the content of specific CT services and tools used in the organization or jurisdiction	6 (Create)	Collaborate with instructional designer/developer to create audience-appropriate educational tools and resources to enable knowledge transfer to the following scenarios. — Educate clinicians, physicians and others on the benefits of clinical terminologies without training them on the inner workings of the CT. — Train those who will be working with and implementing the CT.

Table 3 describes the knowledge and skills in adopting and implementing terminology standards in organizations, including analysis, evaluation, planning, design, implementation, use and support of controlled terminologies in health IT applications.

Table 3 — 3.0 Application of controlled terminologies

		Competency	Bloom's level	Considerations
3.1		Evaluate and recommend CT services and tools used in other jurisdictions to support adoption of CT within a health IT application.	5 (Evaluate)	Focus on the organization or jurisdiction that has implemented CT services and tools and the ongoing support. Evaluate how an organization has implemented CT services and tools and ongoing support mechanisms. Recommend improvements. (Case study).
3.2		Compile requirements and develop a business case for the adoption of a specific terminology standard within an existing/planned health IT application in the organization.	6 (Create)	Develop terminology requirements (e.g. business requirement and use case analysis). Develop an environmental scan. Develop terminology standards options analysis. Develop cost analysis (e.g. licensing, CT development and maintenance costs). Develop value/benefit analysis.
3.3		Determine organizational or jurisdictional readiness and technical feasibility to adopt a specific terminology standard within existing/planned health IT applications in the organization or jurisdiction (e.g. terminology implementation options and selection).	5 (Evaluate)	Engage with administrators, clinical users and support staff on the adoption of a specific terminology standard within health IT applications in the organization or jurisdiction (i.e. be able to understand the different perspectives of those this person will liaise with), including: — document terminology current state; — investigate terminology options; — identify the terminology desired future state for data capture, primary and secondary use; — identify barriers to adoption and tools to manage the barriers (including existing health care practices and health information management-related policies); — identify gaps and impact of those gaps on existing systems and stakeholders; — evaluate strategies and approaches to implement terminology standards into existing systems with an understanding of the impact to the end users (i.e. minimize impact to user) and build the knowledge of why this is important to the leadership, clinicians, and project team.
3.4		Evaluate technical design and implementation of health IT applications to incorporate CT standards including appropriate methods for CT-encoded data entry, storage, retrieval, and analysis	5 (Evaluate)	Determine applicable terminology solution based on: — awareness of meaning-based retrieval and value of description logic; — an examination of how data capture and meaning-based retrieval play a role in decision support; — an examination of how transitive closure, concept subsumption and equivalency and information model play a role in retrieval and analysis

Table 3 *(continued)*

	Competency	Bloom's level	Considerations
3.5	Evaluate types of data capture including but not limited to devices, mobile apps ensuring appropriate binding and/or transformation to CTs in support of patient safety and quality of care.	5 (Evaluate)	Contribute to the evaluation of user interface requirements and solutions for data capture in collaboration with physicians and other clinicians and consumers (e.g. wearable apps).
3.6	Facilitate alignment between terminology development, maintenance, and implementation activities and project activities through collaboration with project management.	5 (Evaluate)	Evaluate use case to support the analysis of CT. Identify and document terminology requirements for request for information/request for proposal. Apply a standard change management framework to enable adoption. Contribute to a communication plan including tools such as briefing notes, status updates, decision making option analysis material.
3.7	Provide and manage ongoing support of specific CTs implemented in health IT applications in the organization and jurisdiction including use, revisions, updates and deprecation of CT contents.	5 (Evaluate)	Leverage maintenance best practices. Understand triggers for change to CT standards and ramifications for application change management. Ensure requirements for master data management shared information applied across organization or jurisdictions (e.g. single source of truth and maintenance of information) are met.
3.8	Evaluate the implementation and post-implementation use and impact of specific CTs in health IT applications in the organization or jurisdiction and provide recommendations for optimization.	5 (Evaluate)	Leverage different evaluation methodologies. Determine and recommend benefits evaluation (e.g. what are the quantitative and qualitative benefits?). NOTE In this context, optimization is defined as application of continual improvement.
3.9	Develop terminology strategic roadmaps and operational/implementation plans ensuring alignment with health system plans and strategies.	6 (Create)	Roadmaps and plans should include design that will accommodate requirements for a phased, staged or full implementation approach to terminology services.
3.10	Develop learning resources and deliver educational/training sessions for multiple audiences on the types of CT standards in use and implementation and adoption of specific CT standards in health IT applications in the organization or jurisdiction.	6 (Create)	Collaborate with instructional designer/developer to create audience-appropriate sessions including the development of interactive workshop resources. Train multiple audiences on the use of specific CT standards implemented in health IT applications in the organization or jurisdiction including internal team members and external stakeholders.

Table 4 describes the understanding of the types of interoperability standards in use, with emphasis on the role and relationship of CTs in these interoperability standards.

Table 4 — 4.0 Foundations of interoperability standards

	Competency	Bloom's level	Considerations
4.1	Demonstrate knowledge in the purpose, history, development and life cycle of interoperability standards.	3 (Apply)	Demonstrate and apply knowledge of the role of standards development organizations in the development of interoperability standards and methodologies. Apply foundational knowledge of interoperability standards such as the meaning and differences in syntactic interoperability and semantic interoperability. Demonstrate and apply knowledge of the Standards Development Documentation Framework (SDDF). Demonstrate and apply knowledge of IHE integration profiles and development life cycle.
4.2	Identify the role of CTs (i.e. why they are being used) in interoperability and metadata standards including but not limited to architecture, Electronic Medical Record (EMR) content standards, EMR-to-EMR data exchange specifications, and ISO 18308 metadata repository standards.	3 (Apply)	Identify three key forms of interoperability (directed, query-based and consumer-mediated exchange). Include the following: — a national focus with international overview; — architecture; — why is description logic important for interoperability?
4.3	Explain messaging and clinical document standards.	2 (Understand)	Describe how controlled terminology is used in all types of messaging standards and terminology binding including: — HL7 meaning of concept representation (concept identifiers, codes, designations); — HL7 messaging standards - HL7 V2.x and V3 and Fast Healthcare Interoperability; — resources (FHIR), HL7 core principles; — document standards include, for example, Clinical Document Architecture (CDA) and Consolidated CDA (C-CDA) including metadata standards, cross-Enterprise document sharing (XDS and XDS-i). Include data types and how they are used with coded terminology. Document ontology (LOINC) for report naming and use with terminology services. The role of value sets in information exchange including the definition methods, versioning and coding strength conformance. Describe the role of Object Identifiers (OIDs) including how they are generated, managed, and applied. Understand the options of sharing "null or negative" values in information exchange.
4.4	Explain why clinical information models and modelling are important or relevant to interoperability, the electronic health record and terminology standards.	2 (Understand)	Explain how representation of meaning in information models and terminology standards support one another and can overlap. Examples include HL7 RIM, HL7 CDA templates, Clinical Information Model Initiative (CIMI). Explain impact of information model and modelling on long-term data utility and patient safety.

Table 4 *(continued)*

		Competency	Bloom's level	Considerations
4.5		Demonstrate knowledge in interoperable EHR standards.	2 (Understand)	Describe the most up-to-date national and local eHealth/EHR blueprint and the role of repositories/registries (e.g. where you need to be aware of local government EHR solutions). To include consideration and different approaches to terminology application with data being sent outside of the point of care system and also received by the point of care system and the implications to terminology use and data management, etc. SDOs to include (but not limited to): — ISO [e.g. ISO 18308, on architecture; ISO 13606 (all parts) on communication]; — HL7 (e.g. EHR/PHR functional model and related profiles); — SNOMED International (including collaboration mechanism); — Regenstrief; — OpenEHR; — IHE (e.g. XDS document sharing infrastructures); — CEN (European Committee for Standardization); — GS1 (Personal identification).
4.6		Explain the implementation of interoperability standards that includes integration process and profiles.	2 (Understand)	Examples include the technical frameworks, structured and synoptic reporting, and data governance. Describe the use of the IHE integration methodology and profiles in different clinical and IT infrastructure domains.
4.7		Explain the use of CT in imaging interoperability.	2 (Understand)	Examples to discuss include: — encapsulated data such as: 1) DICOM and structured reporting; 2) imaging, use of images, jpegs; 3) IHE XDS-I exchange of images/reports; 4) audio files and other formats. — others, including scanned documents. Clinical domains include, but are not limited to, radiology, pathology, cardiology, eye care, gastroenterology, dermatology and wound care images from point of care in all sectors
4.8		Explain the use of CT in interoperability in emerging technologies.	2 (Understand)	Examples to discuss include: — telehealth/telemedicine; — medical devices; — mobile health; — robotics. Patient centred monitoring.

Table 4 *(continued)*

	Competency	Bloom's level	Considerations
4.9	Demonstrate knowledge in specific interoperability tools for development, implementation, use, maintenance and evaluation of interoperability standards.	3 (Apply)	Examples to apply include archetype editor, FHIR tools, Infoway tools and solutions such as HL7 explorer and message builder/validator/ReMixer, Terminology Gateway, V2-V3 mapper, CDA validator and OID repository and HL7 OID registry, IHE connect-a-thon tools.
4.10	Analyse published interoperability documentation and related resources to verify alignment of terminology standards and services.	4 (Analyse)	Includes data governance, information around maintenance of specifications, standards, and value sets will be changeable and fluid. Need to consider changeability and fluidity in course creation. Examples include interoperability blueprints/roadmaps, adoption life cycle, data governance, information around maintenance of specifications/standards and value sets, implementation guides, testing and certification, technical reference manuals and field experience/evaluation reports.
4.11	Demonstrate knowledge of the current trends and issues in the interoperability standards landscape nationally and internationally.	3 (Apply)	Describe the vision for healthcare interoperability nationally, key interoperability patterns, key standards and the role of healthcare providers, software vendors, local/state/province and national agencies in realizing the vision. Contrast with vision(s) of health care interoperability internationally, key interoperability patterns, key standards and the role of healthcare providers, software vendors, other national agencies in realizing the vision. Identify areas of relevance and/or implications for national stakeholders. Survey other international initiatives. Review the ways that national, neighbour state, US, and other international stakeholders are represented within key SDOs (e.g. HL7, SNOMED International), identify advantages and disadvantages of different approaches in terms of national objectives. Discuss initiatives such as the Joint Initiative Council, HL7 Healthcare Standards Integration Working Group, their objectives and their relevance nationally. Examine the impact of innovation (e.g. FHIR standard) on different initiatives and collaborations.
4.12	Demonstrate knowledge of conformity assessment process and standards relating to interoperability.	3 (Apply)	Demonstrate an understanding of ISO/IEC 17025 (on testing) and ISO/IEC 17065 (on conformity assessment). This learning content includes specification (conformance profiles), governance, testing and tools, conformity assessment, and regulation, ISO work on map quality assessment and terminology implementation maturity.

Table 5 describes the application of knowledge and skills in adopting and implementing interoperability standards in organization or jurisdictions, with emphasis on appropriate use of CTs in the standards and solution development life cycles.