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Health informatics — Terminological resources —

Part 3: Terminology implementation maturity model (TIMM)

Informatique de santé — Ressources terminologiques —

Partie 3: Modèle de maturité pour la mise en œuvre de la terminologie

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Foreword

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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 documents 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*.

A list of all parts in the ISO 17117 series can be found on the ISO website.

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

This document identifies a model for evaluation of the maturity of terminology implementation in healthcare systems and identifies a maturity module for terminology implementation for use in electronic health records (EHRs) and healthcare systems in general.

This document supports common activities of healthcare including:

— identification of the relationship between each terminology resource capability to the safety and effectiveness of system use in healthcare;

— support healthcare software vendors and organizations to;

  — compare software terminological resource capabilities and organizational requirements for those resources;

  — plan improvements, i.e. align requirements and capabilities, as needed;

— improve the safety and utility of healthcare information systems and the data in them, and the use of terminological resources in applications such as clinical decision support systems;

— improve information sharing (semantic interoperability) between organizations and systems;

— support short and long-term analytics within the organization and more broadly to enable knowledge acquisition.

The impact of tooling (including computer-assisted coding, speech recognition, template development) on the capability of the terminological resources is not covered in detail in this document.

This document provides a model against which conformity can be measured and improvements made to products and implementations with a positive impact both on efficiency and patient safety. This assists implementation, reduces inappropriate spending, manages expectations more effectively and encourages software vendors and decision makers at all levels to progress their products into higher functional capacity. This document is also produced to encourage the development of the skills required to safely and efficiently implement and use terminologies in healthcare systems.

The users of this document include:

— health care organisation, to assess product capabilities and plan future directions and purchases;

— vendors (including cloud services and conventional software products), to:

  — support implementation of terminological resources in their products;

  — enable semantic interoperability across different systems;

  — assess product conformance requirements influencing future directions for software development;

— government and other decision makers;

— educators and educational organizations;

— terminological resource developers.

Health informatics — Terminological resources —

Part 3: Terminology implementation maturity model (TIMM)

1 Scope

The document defines the progression of implementation of terminology capability in information systems.

This document does not specify requirements for any specific terminological resource. It is intended to provide a basis for conformance criteria for terminological resources capabilities in specific use cases. This document does not cover in detail the software being used, though the capabilities of that software are included and impact the level of maturity reached. This document is applicable to terminological resources of all types, terminologies, classifications, value sets, code systems, and value domains.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11179-1, *Information technology — Metadata registries (MDR) — Part 1: Framework*

ISO/IEC 11179-3, *Information technology — Metadata registries (MDR) — Part 3: Metamodel for registry common facilities*

ISO/IEC 11179-4, *Information technology — Metadata registries (MDR) — Part 4: Formulation of data definitions*

ISO/TS 21526, *Health informatics — Metadata repository requirements (MetaRep)*

ISO/TS 21564, *Health informatics — Terminology resource map quality measures (MapQual)*

ISO 22287, *Health informatics — Workforce roles and capabilities for terminology and terminology services in healthcare (term workforce)*

HL7, *Value Set Specification*[1)]

3 Terms and definitions

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

ISO and IEC maintain terminology 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/

1) Available at https://www.hl7.org/fhir/valueset.html.

3.1
concept
unit of knowledge created by a unique combination of characteristics

Note 1 to entry: Informally, the term 'concept' is often used when what is meant is 'concept representation'. However, this leads to confusion when precise meanings are required. Concepts arise out of human individual and social conceptualizations of the world around them. Concept representations are artefacts constructed of symbols.

Note 2 to entry: Concept representations are not necessarily bound to particular languages. However, they are influenced by the social or cultural context of use often leading to different categorizations.

[SOURCE: ISO 17117-1:2018, 3.1.1]

3.2
implementation
<information technology> life cycle phase at the end of which the hardware, software and procedures of the system considered become operational

[SOURCE: ISO 81001-1:2021, 3.2.6]

3.3
term
linguistic representation of a *concept* (3.1) in a specific subject field

[SOURCE: ISO 17117-1:2018, 3.1.2]

3.4
terminology implementation
process of taking a terminological system and applying it for *concept* (3.1) representation to achieve efficient and accurate concept representation

Note 1 to entry: Terminology implementation relates to implementing a terminological resource in a system rather than the system itself. So, during a design and development of a system that uses a terminology, its implementation occurs at that stage of the SDLC and not after Software Development Life Cycle.

[SOURCE: ISO/TS 17117-2:2022, 3.4, modified — Note 1 to entry was added.]

3.5
terminological resource
controlled set of *terms* (3.3) in healthcare

Note 1 to entry: Usually designed and controlled for use with computers for specific healthcare purposes, such as data entry, aggregation, retrieval and analysis.

Note 2 to entry: Value domains, ontologies, computable terminologies, code sets and classifications.

[SOURCE: ISO/TR 12300:2014, 2.2.11, modified — The example was added.]

3.6
terminological resource capability
services and functionality that a terminology is able to deliver when implemented

Note 1 to entry: These services and functionality are dependent upon the design structure, maintenance and scope of the terminological.

Note 2 to entry: For example, terminologies which do not have multilingual features are not able to support multiple languages or translations.

Note 3 to entry: For example, a single hierarchy terminological resource is not able to support multi-hierarchical reporting or retrieval.

3.7
software terminology capability
specification of a software's ability to deliver the *terminological resource capabilities* (3.6) in an *implementation* (3.2)

Note 1 to entry: This includes functionality such as the ability to calculate subsumption, equivalence, post-coordination requirements.

Note 2 to entry: Software includes terminology servers but also the health software product within which the terminology is used. The software terminology capability is dependent upon the suite of software, available to support the implementation.

Note 3 to entry: Software tool includes the use of servers but also the software system within which the terminology is used, including:

— functions used to access and manage maintenance of the terminology within the organisation (server capabilities) processing operations using the knowledge in the terminology resource;

— maintenance functions used to maintain a terminological resources implementation within the organisation;

— user software - user interface and retrieval and display name requirements.

4 Terminology implementation maturity

4.1 General

This document provides a method to assess the capability of an implemented terminological resource based on the information lifecycle (5 maturity pillars) and levels of maturity within these pillars. Capability is defined across each of these 5 pillars and a method of calculation is included.

The 5 pillars are described in detail in ISO/TS 17117-2. These pillars are:

a) Pillar 1: Data design (data specifications);

b) Pillar 2: Data capture (user interface), including data validation, binding;

c) Pillar 3: Data storage (meaning management over time, binding);

d) Pillar 4: Data retrieval in health systems (includes use of retrieval and comparison tools such as queries, subsumption, equivalence checking);

e) Pillar 5: Data exchange and data re-use (includes use of maps).

The pillars cover representation of instances of patient information captured in health systems including conformity to standards, terminology governance capability, terminology implementation workforce capability, software terminology capability and terminology resource (the code system) capability.

ISO/TS 17117-2 defines the determinants of maturity for each pillar and sub pillar activities, maturity levels.

4.2 Purpose and audience

The maturity model helps vendors, implementers, project leaders and decision makers to:

— identify implementation best practice for clinical safety;

— ensure that the environment for using terminologies is efficient, safe and fit for use (both existing and newly introduced terminological resources);

— benchmark where an organization, data collection or product stands in relation to others with respect to terminology implementation;

— assess the areas of strength and performance gaps in implementations;

— identify the steps that can be taken to close gaps and move to the next stage of maturity;

— communicate progress to the broader community and within the organization;

— identify resource requirements for quality terminology use (technical and workforce).

4.3 Implementation maturity levels

The following levels are used throughout this document and are based upon ISO 30401, modified to reflect clearer common usage.

a) Level 1: Initial (Ad Hoc) – implementation where terminologies, code systems and classifications may be used but are not governed across the implementation. This includes code sets created for initial use to meet a single need, often without consideration of other potential uses or the need to communicate or share data. The terminology may represent some of the concepts but is not governed to ensure completeness of representation.

b) Level 2: Repeatable (Rudimentary) – includes implementations where terminologies are maintained and deployed within software implementation but are largely reactive. The terminological resource is maintained locally, i.e. not governed outside the organisation.

c) Level 3: Defined (Organized and Repeatable) – terminologies that are clearly defined. The definition may be textual or computable and that definition informs the collection and use of the data. The terminological resource is well maintained and governed at least at national level with clear context associated with the information mode.

d) Level 4: Capable (Managed and Standardised)– where the implementation supports safe care and the data supply chain, and where terminology implementation is capable of clear and safe information exchange through semantic interoperability. A capable terminology represents all concepts, with longevity of meaning, is nationally governed and implemented with a standard information model supporting semantic interoperability.

e) Level 5: Efficient (harmonised terminology and information model). Safe use of data requires that the data is defined and capable and governed at all levels and where terminology and the information model are optimised. The terminological resource can represent all concepts, with longevity of meaning, is internationally governed and implemented with a standard information model supporting international semantic interoperability.

Clauses 5 to 10 of this document identify the capabilities of terminology implementation and where each of these fit in the maturity evaluation of an implementation. A checklist is also provided to assist in such evaluations.

Determination of the importance of each capability was influenced by the Desiderata for controlled medical vocabularies in the twenty-first century[12] and SNOMED International Implementation Maturity[13].

5 Pillar 1: Design of the data (data specifications)

5.1 Terminological capabilities

5.1.1 General

When collecting data, the ability of the code system or terminological resource selected to represent the data impacts the capacity to represent the concepts required. This pillar assesses the ability of the selected concept representations to accurately meet the needs of clinical care in a health record.

5.1.2 Terminology resource selection

5.1.2.1 General

The choice of a terminological resource (code system) for a specific use case shall take into account that use case and the characteristics of the terminology itself and shall be able to support safe and efficient information capture and exchange for that use case. The specific levels of maturity are indicated in 5.1.2.3 for each capability of a terminological resource for the two most common use cases, clinical use and statistical use. These levels do not reflect the implementation of the code system, this is measured later.

The measures provided indicate the level of conformance that shall be present to claim the specified level of maturity for the terminology implementation in a health record system.

5.1.2.2 Determinant 1:1 Ability to represent concepts at different levels

The terminological resource selected to represent each data element shall be assessed and confirmed to represent the data at the level of specificity or specificities required by the users of the data for a specific use case. Where the data element is re-used the representation should be reassessed for that purpose of use.

This assessment shall be clearly documented including the rationale for the decision made.

a) Level 1: all concepts are represented at one level of specificity only.

b) Level 2: all concepts are able to be represented at different levels of granularity suited to clinical need.

c) Level 3: in addition to level 3 requirements, all decisions made about the data element rules and instructions are clearly documented.

d) Level 5: in addition to level 3, any changes are documented, and that documentation is maintained historically to ensure the ability to support data permanence.

As there are only 3 criteria to be met here, level 4 is not used.

5.1.2.3 Determinant 1:2 Ability to represent precise meaning of the concept

Where the use case requires clear and accurate meaning, the terminology chosen shall provide the ability to consistently represent that meaning, including clear representation of what is known and what is not known. This supports clinical care. Use cases which are rule-based, such as fiscal reporting or morbidity data, represent meanings which are dependent not just on the terminology or code but also on acknowledging where the rules are not suitable for clinical use or clinical interoperability.

Table 1 is an example of the maturity of an implementation which is suitable for clinical use showing the pillar level needed.

Table 1 — Terminological resource selection — Maturity for clinical use

Level of maturity needed	1	2	3	4	5	Comment
Ability to represent:						
— concept at different levels of granularity;				X		It is essential that clinicians are able to indicate the level of information relevant to their use case and are not forced into grouping of concepts which do not meet clinical needs.
— the meaning of that concept.				X		The meaning of the concept shall be consistently applied and retained across all clinical use cases with a minimum of mapping to ensure that meaning is not changed.
Ability to persist meaning over time					X	Ask health records persist longer through the advent of electronic health records, the meaning of information collected in those systems using terminological resources shall persist over time. This is especially vital when considering clinical decision support systems which use data recorded in the past to trigger actions today.
Design supports retrieval of concepts by multiple attributes (multi-hierarchical) or using ontological relationships					X	Terminological resources used in health records shall be able to be easily queried. Terminology servers are designed to undertake this analysis, but not all healthcare environments can afford or implement such sophisticated tools. The use of a standardised information model with standardised terminology supports simpler retrieval of data from the record.
Scope of the terminological resource able to represent all concepts for the use case				X		In clinical practice a concept, no matter how unusual or rare still needs to be able to be represented. The rarer the condition, the more important it can be to represent the concept correctly in clinical practice.
Scope of the terminology reducible to concepts required for the use case				X		The ability of a terminology resource to be presented in a subset to represent the specific concepts is needed to assist data capture and the user interface.
Clear definition and differentiation between concepts to ensure clarity of meaning			X			Note: many code systems do not meet this requirement as the code/s selected are often dependent upon standards, rule or guidelines, and the quality of these rules or guidelines impacts the code system's ability to meet this requirement.
Existing, international, robustly governed and maintained				X		Maintenance of terminological recourses and information models is an expensive task; the more shared these resources are, the less expense across all of healthcare and the simpler and safer information sharing becomes.
Mean level in this example			1	5	2	
'X' indicates the level of maturity needed to achieve the desirable functionality.						

The clinical and statistical use cases require different levels of maturity to reflect the different safety and efficiency requirements for implementation in each use case as well as reflecting the need to aggregate data in a statistical environment. For example, Table 2 shows maturity requirements for statistical systems. In a statistical terminological resource, all concepts must be represented somewhere in the code system to account for all cases being analysed. Often a specific level of granularity is used to aid comparability. This means that the use of concepts such as 'not otherwise specified, and other' is relevant to this type of terminological resource. These concepts are not suited to direct patient care as they introduce a lack of specificity which is unclear for clinical use, though highly useful for statistical aggregation and comparison of data.

Table 2 — Terminological resource selection — Maturity for statistical use

Level of maturity needed	1	2	3	4	5	Comment
Ability to represent not otherwise specified or unspecified concepts			X			Statistical analysis requires grouping of data. To achieve this there shall be a place to put codes that are very rare, new or not yet understood. The use of 'not otherwise specified' provides that functionality.
Support for data aggregation at a specified level of granularity so that concepts can be counted			X			Statistical analysis requires the ability to analyse groups of data at a common level of granularity.
Ability to represent a concept at different levels of granularity			X			Often not desirable for statistical analysis where a specific level of granularity is defined for the use case.
The ability to represent the precise meaning of that concept			X			This characteristic may be achieved through the use of data collection or representation standards for the specific use case which may be different from those applied for clinical use.
The ability to persist meaning over time			X			The level of importance of this characteristic will be dependent upon the use case – yearly collections require consistency over the year, but not necessarily persistence, while those intended to compare data over time require persistence.
Support retrieval of concepts by multiple attributes (multi-hierarchical) or where ontological relationships are available			X			The relevance of this capability will be dependent upon the statistical use case, but data is generally more valuable when able to be queries by alternative pathways
Scope of the terminological resource able to represent all concepts for the use case			X			This is essential for this use case.
Mutual exclusivity			X			The terminological resource shall have clear mutual exclusivity if it is to support statistical analysis.
Clear definition and differentiation between concepts to ensure clarity of meaning.			X			Note: many code systems do not meet these requirements as they are dependent upon standards, rule or guidelines, and the quality of these rules or guidelines impacts the quality of this characteristic in the code system.
Existing, international robustly governed and maintained				X		

5.1.3 Data governance

Data governance involves the following activities:

— engagement with data standards development (including participation);

— decision making processes and rationales;

— editorial guidelines.

The level of maturity reflects the degree of formalization and documentation of workflows and decision making (see Table 3).

Table 3 — Maturity levels of data governance

	Level 1	Level 2	Level 3	Level 4	Level 5
Decision making	No formalized or documented workflows and decision-making processes.	Few decisions are documented, but no established and standardized workflows and decision-making processes.	Some workflows and decision-making processes are formalized and documented.	Most workflows and decision-making processes are formalized and documented.	All workflows and decision-making processes are formalized and documented using standardized language (such as UML or archetype definition language).
Editorial guidelines	No editorial guidelines are available or applied.	Local editorial guidelines are available and applied.	National editorial guidelines are available and applied.	International editorial guidelines are available and applied, including translation guidelines if applicable.	International editorial guidelines are available and applied, including translation guidelines if applicable, and the organisation participates in the management of these guidelines.
Engagement with data standards development	Participation in standards ballots.	Provision of comments to draft standards.	Participation in national standards committees.	Participation in international standards committees.	Provision of experts to international standard working groups.

5.1.4 Data dictionary

A reference to metadata used to describe and define the terminology resource and the relationship to the data element shall be used. The dictional shall demonstrate conformity with ISO/IEC 11179-1 and ISO/TS 21526.

The following levels of maturity shall be considered for data dictionary implementation.

a) Level 1: there is a data dictionary, but it is not available to all users.

b) Level 2: the data dictionary is available to all but does not include clear links to standard value domains and code systems.

c) Level 3: the data dictionary is conforming to ISO/IEC 11179-3 but is not clearly versioned or maintained.

d) Level 4: the data dictionary is fully conformant to ISO/IEC 11179-3 with versioning and regular maintenance and ensures one definition for any given concept (no duplication of concepts) This reduces data silos.

e) Level 5: data silos reduced through reduced duplication and consistent value domains, and use of standardised information model definitions and relationships.

5.2 Maturity of terminology implementation within software product

5.2.1 Relationship to the information model

Terminological resources represent concepts that are used in a healthcare environment, a person's health journey and specific care instances. For the information to be consistent, semantically interoperable and able to be analysed, the code systems need to be used consistently within a computer system and data supply chain. This means that it is the terminology resource use within a preferably standardised information

model of the concepts of healthcare that gives the most resilient and semantically stable information. A terminological resource which pre-coordinates the diagnosis, its stage, and location requires more codes than an implementation model which uses the information model to atomise data.

Example ICD-10-CM 2022 has 249 different individual codes representing glaucoma. This includes only 18 different types of glaucoma, some of which represent causative agents or associated conditions. Each type, cause and associated condition can then be represented to indicate laterality (left eye, right eye, bilateral, unspecified eye) and many also include 5 further subdivisions for the stage of the disease. A structure which represents the condition, the cause, associated conditions, laterality and the disease stage is simpler to collect and query which leads to more accurate data in the health record. This approach also reduces code system maintenance issues and has the potential to improve concept representation permanence.

Information model standardised for the EHR maturity levels is:

a) Level 1: no information model available, or vendor dependent information model used.

b) Level 2: shared model for data exchange (not necessarily the same as the model used in the EHR).

c) Level 3: Shared model used for information exchange and terminological resource used to define concepts in the model (e.g. SNOMED CT concept IDs used to identify concepts in the model).

d) Level 4: EHR information model used is standardized (locally) and terminological resource used to define concepts in the model.

e) Level 5: EHR information model used is standardized internationally and vendor neutral, including standardized concept representation in the model.

5.2.2 Software functionality

Software implemented in healthcare shall maintain a current metadata repository for open and easy access to the data specifications, rules, guidelines, and information model.

Software implemented in healthcare shall implement terminological resources in a manner conformant to standards including:

— HL7, Value Set Specification HL7;

— ISO/IEC 11179-1, ISO/IEC 11179-3, and ISO/IEC 11179-4;

— ISO/TS 21526;

— ISO 13606;

— ISO/TS 21564;

— ISO 22287.

Each software implementation can be assessed for its implementation maturity based upon the following management. The levels of maturity for terminology software implementation are:

a) Level 1: no terminology service or software management.

b) Level 2: terminology content bound to the information model for extraction. Terminology resource currency (within required time frames of current version).

c) Level 3: content governance committee across all organisational activities (repeatable data use). Review of data requirements occurring at least yearly, and a terminology service is available which can create value domain content (lists of valid codes) based upon rules.

d) Level 4: terminology service software to manage term delivery and queries across different versions of the code system in the record. The terminology service can process equivalence, pre/post coordination with the ability to identify pathways through parents and children of concepts.

e) Level 5: all capabilities of previous levels plus quality assurance of maps used, skills in place, data specification and other standards for content.

Terminology content bound to the information model for extraction. Except for governmental reporting requirements, which are beyond the scope and control of the organisation, all data extracted and shared with other systems indicate the:

— code system version of the code system used;

— data element specification (and version ID) for the data element in which the data was collected.

These capabilities are measured under other data dictionary requirements.

Terminology resources in software shall be current, unless there is a clinical reason otherwise. As code systems change the meaning of individual codes also change and therefore meaning is only consistently maintained if the code system is known and it is current (the same as that used by others with whom the data is shared). Where new versions or editions of code systems are released there can be international, national or local implementation date requirements. These requirements can be legal associated with the licence for use of the code system or legislated for reporting requirements.

Governance of terminological resources in software products at level 5 includes:

— a governance team with the skills required for terminology design, governance and implementation as defined in ISO 22287;

— a governance team with representation of all stakeholders, led by an individual independent of the software vendor and ensuring input from all clinical domains and administration;

— a governance plan which identifies the frequency and requirements of standards conformance with progressive improvement requirements identified where appropriate;

— screen design committee or similar infrastructure to support data specification and terminology requirement specification for users of the system;

— regular review of data quality - data capture in the organisation's systems.

To determine the level of an implementation, the following governance requirements shall be met:

— Level 1: 1 or none of the governance requirements are met by the implementation.

— Level 2: 2 of the governance requirements are met by the implementation.

— Level 3: 3 of the governance requirements are met by the implementation.

— Level 4: 4 of the governance requirements are met by the implementation.

— Level 5: 5 of the governance requirements are met by the implementation.

6 Pillar 2: Data capture (user interface) in healthcare implementations

6.1 Capability to display code system content

The information system shall be able to display the following information to support safe clinical use and code selection. The following list indicates the required and recommended characteristics required.

a) Drop down lists (if used) should include no more than 10 options from which to choose.

b) Embedded or tree lists (opening up from initial or search-based list) should have no more than 3 sub-lists provided.

c) Terminology browser software shall not be used as a user interface tool in clinical systems.

d) The code should not be used as a retrieval mechanism, nor a sorting mechanism, though such use in non-clinical environments is acceptable.

e) The implementation system shall display the preferred term of the concept rather than synonyms or abbreviations.

f) The implementation shall represent code system content based upon workflow roles and activities, for example use of nursing preferred terms in a nursing setting and surgeon terms in their workflow.

g) The implementation shall not display the concept ID in the clinical user interface if that concept ID is meaningless (e.g. SNOMED 7771000 – left).

h) The implementation shall use text-based filtering to reduce list sizes where it is not possible to restrict the list to 10 options or a tree to 3 levels. Where text-based filtering is used, a filter should be applied to the data element to restrict the search to relevant concepts only.

i) The implementation shall use atomic representation to deliver safe and efficient user interfaces and data that is able to be used to support decision making and analytics.

The implementation shall demonstrate effective use of the relationship to the information model and terminology to suit the clinical data workflow.

EXAMPLE Entry of Diagnosis Field (restricted to clinical findings): Fractured Femur as textual filtering to return Fracture of Femur (Diagnosis) this term and its children (not just immediate children).

To determine the level of an implementation, the requirements for display of code system content shall be met:

— Level 1: system display capability meets 2 or less of the characteristics listed.

— Level 2: system display capability meets more than 2 but less than 4 of the characteristics listed.

— Level 3: system display capability meets at least 4 but less than 6 of the characteristics listed.

— Level 4: system display capability meets at least 6 but less than 8 of the characteristics listed.

— Level 5: system display capability meets all characteristics listed.

6.2 Capability of terminology tooling

The terminology implementation shall demonstrate the capability to represent semantically consistent meaning in a record over time and recognise this requirement throughout the data life cycle. The following shall be in place within the software or procedural management in the organisation:

a) governance that manages versions;

b) EHR system to dynamically identify archived concepts, display and analyse these concepts, e.g. ability to always return the concept and meaning as originally intended when recorded;

c) tooling to manage requests for change in terminology and to find where changed items have been implemented and require update;

d) display of archived status of a code to support clinical analysis of the record and its meaning over time for clinical communication.

The levels of maturity are based upon the implementation's demonstration of these characteristics:

— Level 1: a system meets none of the terminology tool requirements.

— Level 2: a system meets 1 of the terminology tool requirements.

— Level 3: a system meets 2 of the terminology tool requirements.

— Level 4: a system meets 3 of the terminology tool requirements.

— Level 5: a system meets all the terminology tool requirements.

6.3 Standards conformance

Implementation maturity is impacted by the conformance of that implementation to international standards including:

— ISO 13606 series;

— ISO 11615;

— ISO/TS 22220;

— ISO 22287.

The capability of the workforce to define concepts for data collection and to record appropriate documentation for maintenance of clinical meaning. All people working with terminology in user interface design shall meet the requirements in ISO 22287.

To determine the level of an implementation, the following standards conformance requirements shall be met:

— Level 1: a system is not conformant with any of these international standards.

— Level 2: a system and workplace are conformant with 1 of these standards.

— Level 3: a system and workplace are conformant with 3 of these standards.

— Level 5: a system and workplace are conformant with all these standards.

As there are only 3 criteria to be met here, level 4 is not used.

7 Pillar 3: Data storage

Once data is collected it shall be stored and made available for future use. The following list indicates the different criteria used to determine the maturity of data storage quality in the electronic health record system.

a) Data is stored with the version of the data definition and value domain content.

b) Capability to permanently maintain longevity of the record and semantic concept permanence.

c) Binding requirement principles – the requirement for terminology content to be clearly linked to the data element/use case in which it is applied.

d) Capability of governance processes and data management. Analysis of how the key information governance principles in healthcare (availability, integrity, protection, accountability, transparency, retention and disposition) apply to data capture.

To be considered at a level of maturity the following criteria shall be met:

— Level 1: the organisation's EHR storage does not meet any of the requirements listed.

— Level 2: the organisation's EHR storage has 1 of the required capacities.

— Level 3: the organisation's EHR storage has 2 of the required capacities.

— Level 4: the organisations EHR storage has 3 of the required capacities.

— Level 5: the organisation's EHR storage meets all requirements.

8 Data retrieval

Once data has been collected it may be retrieved for many purposes. This includes display of patient details to support their ongoing care, identification of patients or care event which meet specific criteria relevant to clinical decision making. When data is retrieved it shall retain the original meaning and context in which the data was captured. The following measures of maturity can be used to evaluate the impact of data retrieval on the quality of the data, and its safety for use.

a) Presentation of captured content – being able to collect or display data stored at different times and places with clear knowledge of any meaning change or transformation (e.g. clear method of indicating changes and informing the change details).

b) Capability to retrieve record content based upon the functionality of the terminology resource (consider tooling available as well as skills to support retrieval). Terminology servers, for example, are softwares which can retrieve all children of a terminology concept [not just direct children (one generation) but all children of children].

c) Handling changes over time. To retrieve data from a health record that has existed over a period of time the terminology shall be able to identify and retrieve concepts that might have been defined in different ways in the past, such as concepts which are now archived, but were a type of the item to be retrieved at the time they were collected and added to the record.

To achieve a level of maturity, the implementation shall demonstrate the following characteristics:

— Level 1: the organisation's data retrieval does not meet any of the required capabilities.

— Level 2: the organisation meets one of the required capabilities.

— Level 3: the organisation meets 2 of the required capabilities.

— Level 5: the organisation meets all of the required capabilities.

As there are only 3 criteria to be met here, level 4 is not used.

9 Data exchange and re-use

9.1 Data exchange

Data exchange relates to data being extracted from one computer system and received by another. These systems can be within the one organisation or in other organisations, within a local area or national or international.

The terminology in the EHR is often collected and exchanged and maturity is assessed based upon the following capabilities:

a) Capability to support share information content between systems (what additional data is needed when attempting semantic interoperability) and identify the levels of functionality associated with different data in a message/ document (level of maturity of information exchange).

b) Capability of governance processes and data management. Analysis of how the key information governance principles in healthcare (availability, integrity, protection, accountability, transparency, retention and disposition) apply to data capture.

c) Capability to accurately translate data into / from local languages from source data.

d) Ability to retain consistent meaning at the level of detail appropriate to the use of the data in other systems or organizations (secondary data use).

e) Capability of workforce to design, implement and maintain data exchange requirements.