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SNOMED CT-AU
Mapping Guidelines

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1.0	30 Sep 2011	Initial release
2.0	29 Aug 2014	Was previously entitled *Mapping to SNOMED CT-AU: Guidelines and requirements*. The document no longer includes requirements details, and has been renamed to reflect this narrower scope.
3.0	30 Jun 2022	Updated to Agency template and combined with *AMT Mapping Guidelines*.

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1 Introduction

1.1 Purpose

This document describes a mapping methodology that should be followed when mapping local and proprietary coding systems to SNOMED CT content, which is distributed as the Australian edition (SNOMED CT-AU) and includes the Australian Medicines Terminology (AMT).

The key purpose of this document is to provide guidelines for mapping existing coding systems to SNOMED CT that assist vendors and healthcare providers in their implementations.

1.2 Intended audience

The audience of this document should understand SNOMED CT and AMT design and content, and the theories and practices of mapping.

The intended audience includes:

- Health software vendors and vendors of proprietary health terminology products.
- Health jurisdictions and healthcare providers who develop their own maps or outsource the mapping to vendors.
- Terminology and classification communities.

1.3 Scope

The scope of this document is limited in the following respects:

- This document provides guidance for those mapping projects to be undertaken as part of My Health Record adoption and other digital health initiatives. It assumes that a local or proprietary code system is mapped to SNOMED CT for interoperability.
- Any users who wish to implement SNOMED CT via mapping may also use this document to assist in their implementations.
- This document but may also be useful to those developing maps for other purposes, but further guidance should be obtained from the National Clinical Terminology Service (NCTS) about:
    - ‘one to many’ and ‘many to many’ mapping.
    - Backwards and bidirectional mapping.
- This document does not provide guidance or information on how to implement mapping files into software applications or messaging feeds.

1.4 Supporting documentation

This document should be read with the following documents:

- NCTS Guidance for People and Processes [1]:
    - Provides guidance for those involved in adopting SNOMED CT.

- This guidance may be used to minimise clinical safety risks and maximise the benefits associated with using SNOMED CT.

- NCTS Guidance for Use in Healthcare Software [2]:
  - Provides guidance for managing risks when implementing SNOMED CT in healthcare software.
  - This guidance complements the software requirements provided by other eHealth specifications.

If the implementation includes the sharing of clinical information between systems, the following document should also be read:

- NCTS Use of Medical Nomenclatures in Information Exchange [3]:
  - Provides guidance for healthcare software systems that produce and consume clinical messages containing medical nomenclatures.
  - This guidance helps software developers to manage risks when developing healthcare software systems using medical nomenclatures for the purpose of supporting healthcare delivery through the exchange of clinical information.
  - This guidance also complements the requirements provided by other eHealth specifications.

The clinical terminology guidance is provided to all software developers interested in incorporating SNOMED CT into their software systems. They are not part of the set of software conformance requirements for healthcare software accessing the My Health Record system; however, adoption of this clinical terminology guidance is strongly encouraged.

1.5 Questions and feedback

Continuous improvement of NCTS products such as SNOMED CT-AU relies on the input and co-operation of the healthcare community. We value your feedback and encourage questions, comments, or suggestions about our products.

To provide feedback, or for further information regarding licensing, please contact us via email at help@digitalhealth.gov.au.

2 Mapping to SNOMED CT

2.1 Overview of SNOMED CT in Australia

SNOMED CT is a clinical terminology designed to record clinical information at the point of care. It enables clinicians to record patient data at an appropriate level of detail and covers areas such as diagnoses, procedures, and body structures. As a common global language, SNOMED CT supports:

- consistent data entry.
- analysis of clinical data.
- sharing of information between healthcare systems.

The National Clinical Terminology Service (NCTS) within the Australian Digital Health Agency is responsible for managing, developing, and distributing the SNOMED CT Australian Release (SNOMED CT-AU) in Australia. SNOMED CT-AU contains content from the International release of SNOMED CT plus Australian-developed terminology. It provides local variations and customisations of terms relevant to the Australian healthcare community. Documentation to assist with implementation in Australian clinical IT systems is available.

The SNOMED CT-AU package also includes the Australian Medicines Terminology (AMT), which is the subset of content that uniquely identifies commonly used medicines in Australia. Through standardised identifiers and naming conventions, it supports several electronic medication management workflows including prescribe, record, review, dispense, administer and transfer of information.

Throughout this document, SNOMED CT-AU generally refers to the release package, while references to SNOMED CT are generally applicable to the AMT because they follow the same technical specification.

SNOMED CT is one of the key foundations for My Health Record and is included many national specifications for health messaging standards, including:

- Electronic prescriptions.
- Prescription Record.
- Dispense Record.
- Discharge Summary.
- Shared Health Summary.

2.2 Licence agreements

All parties who download and use SNOMED CT-AU are required to agree to the SNOMED CT Affiliate Licence Agreement [4] and the Australian National Terminology Release Licence Agreement [5]. When developers integrate SNOMED CT-AU into their products, whether it is a proprietary terminology product or a proprietary software product, the developer needs to comply with all licensee obligations. All developers of maps, therefore, are also required to review and understand these licence terms.

2.3 What is a map?

Mapping is a process of defining a relationship between concepts in one coding system ('source') to concepts in another coding system ('target') in accordance with a documented rationale for a given purpose [6].

The 'source' and 'target' coding systems often have different structures, so rules are applied to translate from one representation to another while indicating degree of equivalence. The process of mapping produces individual map entries where each row in a map table shows the source code value and the equivalent value in SNOMED CT. It also contains details of the status of each individual map, the issues related to each entry, and the resolution of the issue. This is often called a 'build' map because it is used to manage the mapping process by progressively building individual maps.

The final map is an extract of the build map. It holds a subset of the information held in the build map. It is often computable and used to automate conversion from the 'source' to the 'target' and can be used in the other direction if the map was designed this way. If the final map is to be used by humans, then descriptions are included for readability. Figure 1 shows the relationship between map rows, the build map and the final map.

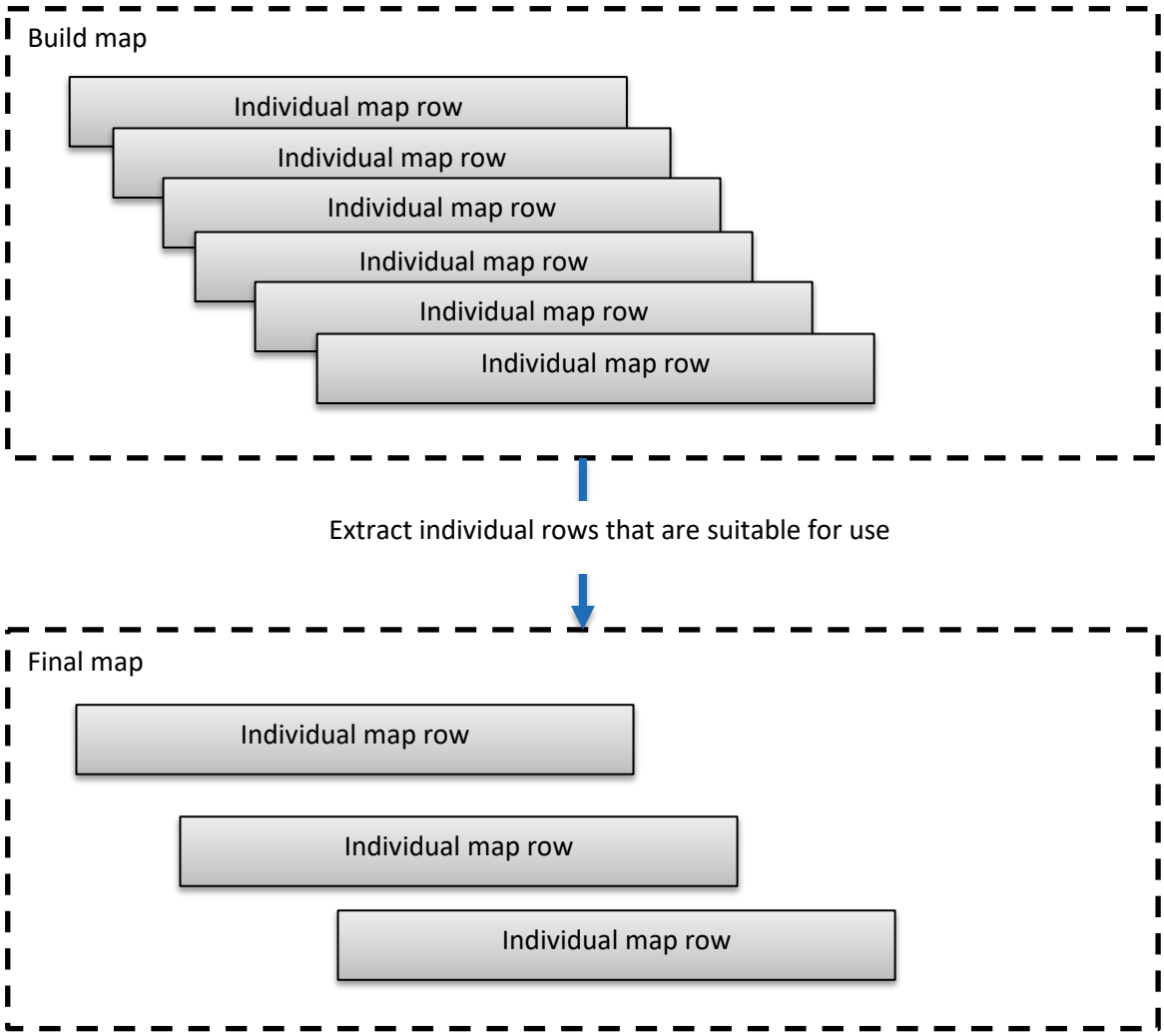

Figure 1: Map tables and components

Any map produced should have a clearly defined direction. In the context of this guideline, this would be from your local or proprietary code system to SNOMED CT. The reason for mapping in this direction is to support the transformation of various local and proprietary code sets into a common national terminology for eHealth messaging and system interoperability.

If there is a requirement to understand the meaning of the SNOMED CT term in the local or proprietary system and the map between the terms is not equivalent, then an additional mapping in the reverse direction would be required. Contact the NCTS for further guidance.

The mapping process must also produce a mapping methodology document which identifies the purpose and processes used to develop the map. Section 3 provides the steps for the mapping process.

2.4 'Why map?' and the implications of mapping

Maps always need a defined purpose that should be stated in the mapping methodology documentation. Vendors and implementers might consider mapping for information exchange as a temporary solution when a native implementation of SNOMED CT into clinical information systems is not yet possible. Such a mapping will not alter data entry by end user clinicians. This can be implemented alongside the data entry process (so users can see the item their entry term was mapped to) or in the backend when the messages are being compiled and sent.

Some other reasons for mapping include funding, historical use, and secondary use or reuse of data. In the case of messaging communications, this type of mapping is seen as a mechanism to give vendors time and opportunity to transition to the use of SNOMED CT within their local systems.

Developers and users of maps need to be aware of the implications of using a map and the importance of ensuring sound mapping practices. Maps require a commitment of resources and tools and, if intended for ongoing use, will be costly to maintain. Maintenance is required each time there are changes to either the source or target terms, e.g. a new release of SNOMED CT-AU.

Consideration also needs to be given to the potential change or loss of meaning due to the possible differences in meaning between terms within the source and target systems as well as the potential need to map to a term that is broader in meaning where no suitable match is available. These maps would require clinical review prior to implementation to support safe clinical practice. The inclusion of local terms in the message would also be required.

Where the required terms are not available, requests for new content can be made to the NCTS. Further information is provided in Section 3.14 about this process.

3 Mapping methodology

The SNOMED CT map is a table or computable representation of a concept in a local system (source) and the equivalent representation (or where suitable a supertype) of that same concept in SNOMED CT (target) for a specific purpose.

The development and maintenance of a SNOMED CT map requires commitment of resources, use of tools, documentation, and consistent and repeatable steps. Each of these requirements is clarified in this section and guidance is provided on how to progress each process to a suitable quality.

3.1 Development of the methodology within these guidelines

The mapping methodology presented in these guidelines has been based on:

- Draft or published standards, guidelines, and reports on mapping of health terminologies by standards organisation such as SNOMED International, International Organization for Standardization (ISO) and Standards Australia.
- Lessons learnt from projects to map to SNOMED CT in Australia and international terminology mapping projects.
- Clinical safety risk assessment and requirements for SNOMED CT.
- The SNOMED CT and SNOMED CT-AU technical specifications, editorial rules, and release notes.
- Clinical document specifications.

3.2 Benefits of this methodology

Sound mapping practices benefit all users of the map and ensure that the data produced is consistent and reliable. Specific reasons for investing in sound mapping processes include:

- Maintenance of meaning (and thereby utility and clinical safety) of the information in the source and target systems.
- The ability to re-use and apply ongoing improvement to the map – thereby reducing the cost of map maintenance.

The methodology outlined in this document describes a repeatable quality process to guide production and reproduction of maps. If followed, it will produce a map that is safe and fit for use to support information exchange between healthcare systems.

A map that supports the ongoing translation of local code systems to the SNOMED CT for use in information exchange, is not used once, but is used repeatedly each time data is shared or reported. The map must be maintained and updated each time either the source or the target code system has changed.

It is essential that once a decision has been made, e.g. mapping a specific type of concept a specific way, that this decision is maintained consistently throughout the map.

Example:

Local code system: Lamivudine 10 mg/ml oral solution

AMT preferred term: lamivudine 10 mg/mL oral liquid

Each of the medications is described with a different word to indicate dose form (oral solution vs. oral liquid).

Following analysis of the two data sets to create a map from the local system to the AMT, a decision might be documented to accept the term 'oral solution' in the local system as equivalent to the term 'oral liquid' in the AMT.

Note: If the map is in the opposite direction, that is, from the AMT to the local system, these terms may not be equivalent as an oral liquid may have more than one subform, for example, oral suspension.

It is possible that in a future version of any map, decisions made may be changed. Such changes must be clearly defined and applied consistently throughout the version of the map. Decisions made must be documented so that those using the information that results from the map can do so knowing what is intended to be included and the meaning implied. Users of the resultant data must be able to identify when the meaning of the results of the map have changed.

A map with appropriate documentation can reduce the ongoing maintenance costs. The documentation can also be used to induct new staff and assist those who use the resultant information in understanding where information may have been modified or lost in the process of mapping.

Clinical systems may use the map to automatically translate from the local or proprietary code system to SNOMED CT, for information exchange or storage in shared repositories such as My Health Record. It is therefore essential that the map has a consistent structure and content, as well as a quality approach to its development and maintenance, to ensure that clinical software can safely use the map and not misrepresent the shared information in clinical situations.

It is expected that those who prepare maps from local systems to SNOMED CT will take all care to ensure clinical safety and alignment to the NCTS guidance described in Section 1.4.

3.3 The mapping process

The production of the map should include documentation of:

- The purpose of the map.
- Examples of scenarios which describe how the map is to be used.
- The map development process.
- Map team members and skills.
- Issues identified and decisions made.
- Format of the build map (the version that includes all results of the mapping process, issues, and status).
- Format of the published final map.
- Map maintenance timeframe.

There are alternative processes which may be used to produce a map. Figure 2 indicates the process considered to be the minimum level of acceptable quality control. The following sections of this document describe this process in detail.

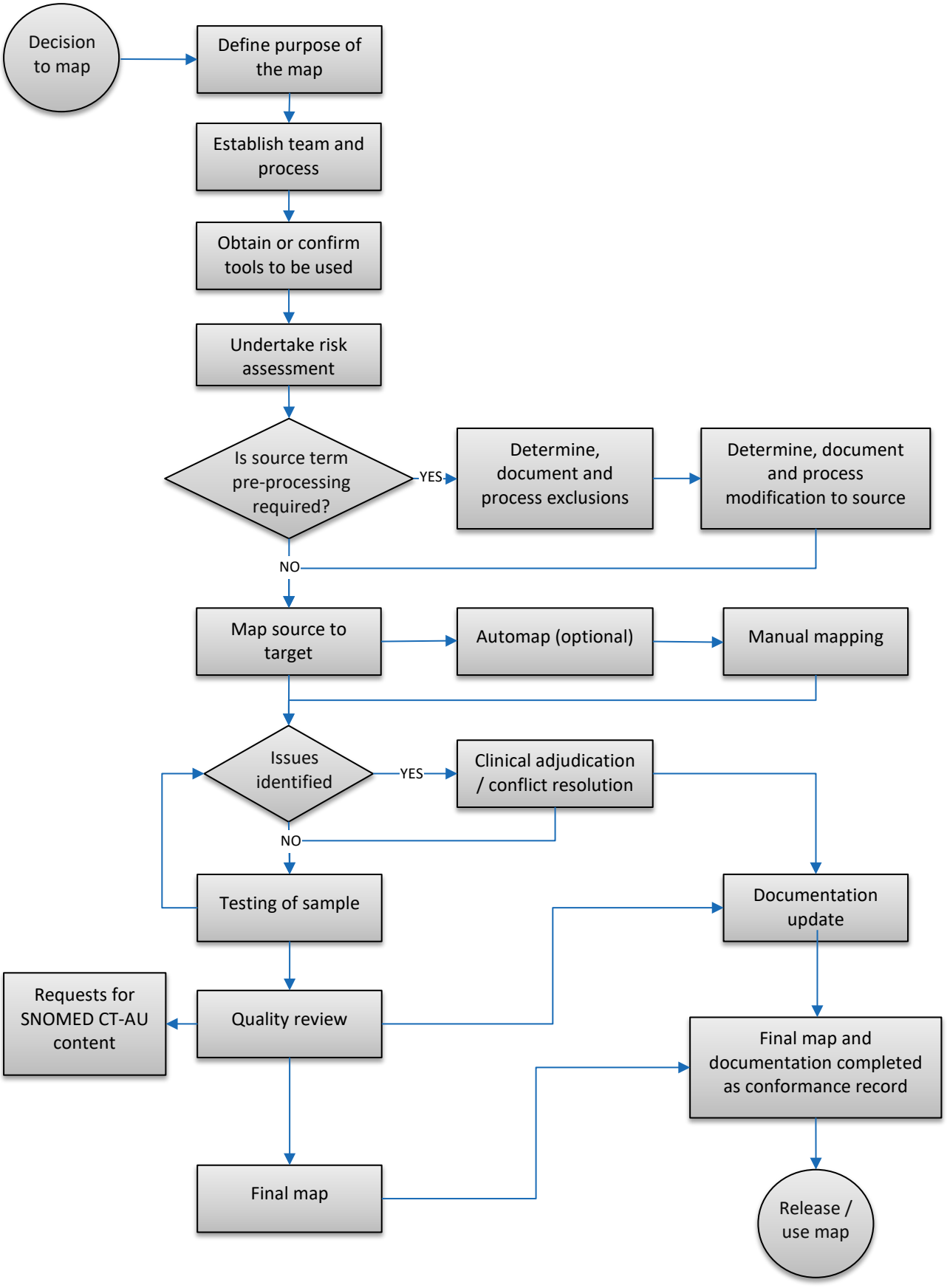

Figure 2: Outline of the mapping process

3.4 Decision to map

Before a map is built or updated, a review of whether to use a map or to convert existing local or proprietary data to SNOMED CT is required. The ongoing costs associated with mapping are significant, and for this reason it is envisaged that mapping will be seen as a mechanism to give vendors time and opportunity to transition to the use of SNOMED CT within their local systems and thereby removing the need to map.

There are effectively two choices to consider:

1 Use SNOMED CT natively in your system.

You may choose to use SNOMED CT within your software product or local implementation. This will require conversion which changes the standard code system used in a software product from a local or proprietary code system to SNOMED CT.

This option may be the least expensive over time, however it will involve significant work for the software vendor as changes may be required to database structures.

Migration to SNOMED CT can be achieved in several ways:

a Single step

The developer may leave the data from the old code system in historical records and use SNOMED CT from a given start date. If the developer decides to convert historical data, this process is a once-only mapping process. The data is converted, stored, retrieved, and represented using SNOMED CT (plus any local concepts where required). This option may be the least expensive over time; however, it will involve significant work for the software vendor as major changes may be required to database structures.

b Phased approach

Use a SNOMED CT map as an interim solution with the plan to evaluate and natively implement SNOMED CT within the software system later. The mapping process can assist in defining the differences and gaps between the local or proprietary code system and the SNOMED CT. This can assist in bridging those gaps between each system through content requests to SNOMED CT. Eventual adoption of SNOMED CT removes the need and expense of map maintenance.

2 Develop a map from your system to SNOMED CT.

You may choose to keep your current code system and therefore build and use a SNOMED CT map. You would be required to update the map whenever changes occurred to the local or proprietary code system and with each monthly release of SNOMED CT-AU.

It is highly recommended that mapping of local or proprietary code systems to SNOMED CT should be considered as a short-term strategy leading to native implementations of the SNOMED CT in the mid- to long-term. This will increase semantic interoperability and reduce maintenance burden for implementers.

3.5 Define the purpose of the map

3.5.1 Statement of purpose of the map

A map must have a defined purpose. This purpose influences decisions made about how to handle those concepts which do not have exact comparisons between the local or proprietary code system and SNOMED CT. Providing specific scenarios which describe the use also forms the basis for further decision-making around the mapping process.

For example, a map for clinical purposes would consider the clinical needs of those who use the result of the map. A map that supports fiscal reporting (e.g., PBS) would include some rules that relate to charging conditions or requirements.

3.5.1.1 Purpose of local system map to SNOMED CT

In the context of these guidelines, the map is being provided to support interoperability and sharing of information in healthcare for continuity of care in a manner that is safe and provides consistent representation of clinical information such as problems/diagnoses and medications.

A map used for this purpose must not change the meaning originally intended by the author of the information due to clinical and safety implications.

Table 1 provides an example of currently known use cases of maps from local code systems to the AMT. These purposes recognise that the AMT is primarily for prescribing, dispensing, recording, reviewing, and administering medications.

Table 1: AMT map use definition

General use	Description	Comment (indicate the impact of this usage upon the map or the mapping process)
Direct patient care (clinical use)	The AMT is primarily used to support prescribing, dispensing and administration of medications and unambiguously identifies medicines to clinicians at various levels of abstraction. A map used for this purpose must not change the meaning originally intended by the author of the information. This usage requires an exact semantic match between concepts.	This is a clinical use. It is therefore important that the map not change the meaning intended by the original author.
Sharing of information (transfer)	The map is to be used when information is shared outside the originating system. Specific examples include the clinical documents uploaded to the My Health Record system. This has implications for direct patient care implications (that is, clinical use, which requires an exact semantic match when mapping).	The ability to transfer information consistently will support sharing between systems inside and outside of the organisation. Indicate the specific information sharing intended to be used in this map, through the scenarios of use.
Other – indicate	Indicate other intended purposes of the map.	

3.5.2 Scenarios of intended use

Scenarios should be used to explain the intended use of the map. Each specific business example of where the map could be used or how the map could be used must be described in the scenario.

The scenario applicable to this document is for communication of information through messages that align with Agency specifications. This means that there are requirements for the SNOMED CT concepts that are mapped to (i.e., the targets) to be members of reference sets that are specified in the published specifications.

Example:

A GP may be sending a referral to a specialist which includes information about the patient's condition. The Agency specification being used would be the *Referral letter structured content specification*, which contains a data element named *Problem/Diagnosis*.

The specifications list the *Problem/Diagnosis reference set* as the applicable value domain, and this means that any mapping undertaken for the purposes of communicating patient conditions must comply to this requirement. Any mapping of GP local codes must be mapped to SNOMED CT concepts that are a member of the *Problem/Diagnosis reference set*.

3.5.3 Audience

Indicate the intended users of the data that will result from the map. The audience should be clear from the scenarios.

For the purpose described in this document, the intended users are the clinicians involved in providing continuity of care for the patient. Other examples applicable to other scenarios might be:

- Consumers of healthcare to support their care and decision making.
- Government to support accountability and planning.
- Epidemiologists to support public health monitoring and review.
- Software developers and system implementers.

3.6 Establish the processes and team

3.6.1 Define the scope of the map

Once the purpose and the scenarios have been identified, the next step is to define the scope of the map. Maps do not necessarily map every concept in the source to the target. A subset may be chosen for inclusion to meet the declared purpose.

The scope of the map has two elements:

1 The level at which to map.

2 Which content of the existing local or proprietary code system is to be included in the map.

3.6.1.1 The level at which to map

Consider the level at which the data in the local or proprietary code system is set and the purpose of the map. To be clinically relevant and safe for use the map should, wherever possible, be at the same level of granularity as the majority of information stored in the local or proprietary code system.

Document the level of detail in the local code system and the level of SNOMED CT to which the map will be built. It is recommended that you consider first the representation from the lowest (or exact equivalence) levels and move to higher (less equivalent) levels only if it is not possible to map appropriately at the lower levels. Any decisions to map to higher levels should be clearly documented.

Example:

A disorder such as 'acute myocardial infarction' from the local system may not have an equivalent concept in SNOMED CT but a parent concept on a higher level, e.g. *Myocardial infarction* may be sufficient for the purpose of mapping.

The above scenario may well be considered to be appropriate for the purpose of communicating patient conditions using Agency specifications.

The AMT has concepts at different levels of specificity, which are known as the '7 notable product classes'. These levels and the relationships between them are shown in Figure 3. By leveraging the relationships in the AMT model, any of the product levels can be programmatically retrieved for other purposes. This reduces maintenance efforts needed when mapping at multiple levels.

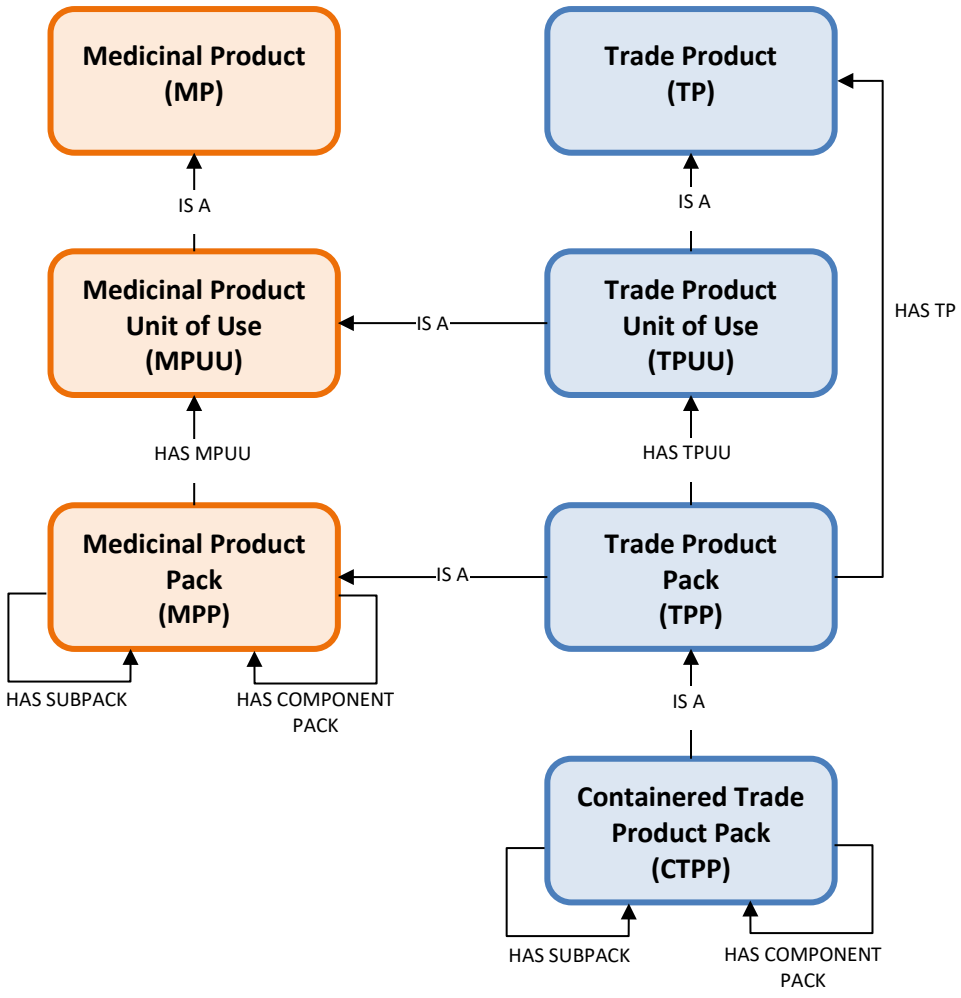

Figure 3: The AMT v3 model

The AMT Concept Model and Business Use Cases document [7] describes these product concepts and their defining attributes in more detail. Table 2 provides some recommendations when mapping to the AMT.

Table 2: Some recommendations when mapping to the AMT

Map purpose	Suitable AMT product class	Notes
Local code system contains trade names with marketed pack sizes, devoid of container type	• TPP	
Local code system identifies medicines by generic information, as often occurs in hospital settings	• MPUU • MPP	Choice depends on the local system current requirement for pack size.
Compose and send clinical documents as indicated in Agency specification	• MP • MPUU • MPP • TP • TPUU • TPP • CTPP	Choice depends on conformance to AMT coding requirements of these clinical document specifications. For example, the Prescription Record – CDA Implementation Guide [8] includes the following requirements for the AMT concepts used to describe prescription items: "Prescription Item (MEDICATION INSTRUCTION) > Therapeutic Good Identification Where therapeutic Good Identification can be identified by an Australian Medicines Terminology (AMT) concept, this SHOULD be represented by the AMT ConceptID and Preferred Term.

3.6.1.2 The relevant reference set

You will need to consider which existing reference sets meet the requirements for the terms you are planning to map. Information on which reference sets are relevant for use in different parts of eHealth messages can be found within the Structured Content Specifications that are produced by the Agency[1].

Example:

Terms which are disorders such as 'acute myocardial infarction' would map to concepts within the *Problem/Diagnosis reference set*.

Terms which support pack-based dispensing in a community pharmacy would map to concepts within the *Containered trade product pack reference set*.

3.6.1.3 How much of the code system should be mapped?

In general, maps do not necessarily map every concept in the source (local termset) to the target. A subset may be chosen for inclusion to meet the declared purpose. It is necessary to determine what will not be mapped and to document this clearly.

[1] Available at https://developer.digitalhealth.gov.au/.

Example:

If the purpose of the map is for representation of diagnosis, the content of the map may be limited to the range of clinical findings used in that specific environment.

If the purpose of the map is for exchange of medicine information, only those individual maps with clinically safe semantic matches should be included in the final AMT map.

Pre-processing should remove concepts that are not appropriate to be mapped, such as duplicates and historical concepts. During the mapping process, some concepts may not be appropriate to map. For ongoing maintenance purposes, it is easier to keep them in the build table and mark them as 'Not to be mapped'.

Some of the local terms which should not be mapped might include:

- duplicate entries.
- inactive terms.
- ambiguous terms.
- terms that do not meet requirements such as reference set membership.

Some medicinal concepts which should not be mapped to the AMT because they are out of the scope of the AMT include:

- locally manufactured products.
- veterinary products.
- pre-packs – such as those used in hospitals and emergency departments.
- clinical trial drugs.
- non-therapeutic products including food and devices (unless listed on the PBS).

A list of the total number of concepts, and the number of concepts of each exclusion type must be maintained for each version of the map. Table 3 illustrates this point.

Table 3: Example concept exclusion table

Exclusion	Number of concepts
Total in original table at start	150
Inactive concepts	3
Duplicate entries	2
Number to be removed	5
Remaining total	145

3.6.2 Mapping patterns

Mapping can be considered to happen in the following patterns:

- **One to one mapping:** This is where one local term maps to one SNOMED CT concept.
- **Many to one mapping:** This is where more than one local term maps to the same SNOMED CT term. Within the mapping file only one instance of the local termset exists,

but multiple listings of one SNOMED CT concept appear against different local source terms.

- **One to many mapping:** There may be instances where one local termset item contains two distinct representations that cannot be mapped to a single SNOMED CT concept, e.g. the local code system contains 'Depression/Anxiety'. Depending on the purpose of the map, it may be mapped to more than one SNOMED CT concept or remain unmapped.

This document provides guidance around mapping structures for mapping one local termset item to one SNOMED CT concept which covers the 'one to one' and 'many to one' scenarios listed above. Where you have requirements for 'one to many' maps we recommend that you approach industry specialists for advice.

3.6.3 Structure of the map

The map is a table which displays the uniquely identified concepts in one code system to be converted to unique SNOMED CT concepts. The general intent is that a map indicates some correlation between members of a source code system (local termset) and the terminology (SNOMED CT). Some match types that describe the correlation between code systems include:

- **Equivalent:** Indicating the source code and SNOMED CT are semantically equivalent (i.e., mean the same thing).
- **Broader:** Indicating the target concept is broader in meaning than the source concept. This is a consequence of suitably specific concept being currently unavailable in the target code system. The 'acute myocardial infarction' term being mapped to 'myocardial infarction' is an example that uses the match type of 'broader'. Another local code set might contain the concept "amlodipine besylate", which is more specific than the nearest equivalent the AMT concept, "amlodipine". However, considerable care must be taken with these maps, as any inferences that usually can be drawn from equivalent mapped entries may not be applicable (for example, for decision support). Contact the NCTS for further guidance and some maintenance considerations are covered in Section 3.17.
- **Narrower:** Indicating the target concept is narrower in meaning than the source concept. Caution is required when using this map type, since adding information that was not specified by the clinician is of a higher clinical safety risk than loss of information. If a term such as 'acute' was added to a patient with 'asthma' without the clinician making this distinction, this could result in a patient receiving treatment that they do not need and may in fact cause harm.
- **Not to be mapped:** Indicating that the source term is not suitable or does not meet requirements for mapping.

Table 4 shows different types of matches with examples from the AMT. Lexical matches are those where the actual words in the description of each concept are exactly the same. Semantic matches are those where the meaning of the concept is the same even if the words are slightly different. The level of matching indicates how accurate the match is and whether it is suited to clinical use. For clinical purposes, only match types 1, 2 or 3 are considered suitable for use. Match type 4 may be appropriate if mapping specialists agree on the semantic match.

Table 4: Match type explanations and examples

Match types	Description of Level	Clinically Suitable	Example showing AMT Preferred Terms
1	Lexical and semantic match (same meaning and same words used)	Yes	**Local code system:** Alprazolam-DP 1mg Tablets, 50 **AMT TPP:** Alprazolam (DP) 1 mg tablet, 50
2	Semantic match, no lexical match, but words that are not misleading or confusing	Yes	**Local code system:** Aventis (Protamine 1%, 5 ml) Injection, 10 **AMT TPP:** Protamine Sulphate (Sanofi-Aventis) 50 mg/5 mL injection, 10 x 5 mL ampoules
3	Rules-based Semantic Match, when rules are applied, there is no change of meaning	Yes	**Local code system:** Fluvax injection, 1 x 0.5 mL syringe **AMT TPP:** Fluvax 2011 injection, 1 x 0.5 mL syringe
4	Semantic match, but no lexical match and words are confusing.	Poor	**Local code system:** acetaminophen **AMT MP:** paracetamol
5	Concept not present in the target	Not included in the map	**Local code system:** Sunscreen Cream 75 g, 1
6	Concept is a subset of a single match in the target	Not included in the map	**Local code system:** diclofenac potassium **AMT MP:** diclofenac If there are matches of this type, consideration of changing the level of the map should be given, or identification of computable rules should be introduced.
7	Concept partly matches a single or more than one concept in the target	Not included in the map	**Local code system:** Phlexy-10 **AMT TPP:** • Phlexy-10 Citrus Burst powder for oral liquid, 30 x 20 g sachets • Phlexy-10 Tropical Surprise powder for oral liquid, 30 x 20 g sachets • Phlexy-10 Apple and Blackcurrant powder for oral liquid, 30 x 20 g sachets
8	Other	Not included in the map	

The map format will be dependent on the structure of the source and target code systems. It is also dependent on its intended purpose. For example, a working draft or 'build map' may need to indicate authors associated with a map. It is useful to retain the match level in the build table for consideration of submission requests to the NCTS, or to assist in development of local system descriptions or code concepts. The build table is also useful when maintaining the map, requiring

modifications and additions to be made only in the build table, from which the final map can be reproduced. Whereas a distribution format or 'final map' is the published product and intended for direct computer consumption and does not require this information. The final map though, requires history tracking to ensure backward compatibility where different versions are used across different sites that have the same local termset. Human-readable terms may also be provided within final maps to simplify implementation.

The map structure and technical format of the build and the final map should be clearly explained. For example, the map might be built in Microsoft Excel, and held in a SQL server database for secure use. Table 5 provides examples of suitable documentation.

Table 5: Example explanation of a build map structure

Map field	Description
Map ID	Unique identifier of each row entry in the map.
Source ID	The unique identifier (code) of the concept in the local or proprietary system.
Source description	A description from the source code system. Typically, this is the display term representing the concept, as a clinician would view it.
SNOMED CT concept ID	The unique code used to represent an individual concept in SNOMED CT.
SNOMED CT description	A suitable description from the terminology. Preferred terms are recommended where the term will be displayed in application interfaces. The unambiguous Fully Specified Name (FSN) is useful during the review and consideration should be given to the collection of both relevant descriptions because preferred terms may not be unique across the different hierarchies.
Additional fields	It may be appropriate to include additional fields of information from either the source or target code systems to assist with assessment of equivalence and verification of mapped item.
Match type	An indicator of the correlation between the source code and SNOMED CT.
Mapper	Identification of the person who did the match. This field can be used to go to the mapper for further explanation of any documented issues, or where errors are identified later in verification processes
Status	Indicates whether the term is mapped (completed and agreed), referred for clinical adjudication, not to be mapped, or other status values that are helpful to the mapping process being used by the organisation.
Issue	This should outline any issues arising in completing the map including whether they are still open or resolved. For example, items where clinical guidance is needed, or where it was not possible to find a match in the target or a rule has been applied.

If an implementation requires the creation of maps that are nationally applicable, then they may be of value to others in the clinical terminology community of practice. Contact us at help@digitalhealth.gov.au if you would like the map considered for inclusion in the national release.

3.6.3.1 Build map example

As noted in the previous section a build map must clearly indicate both the codes and terms used in the source and target systems, as well as map status and details about the individual who performed the map as well as any editorial comments.

Table 6 illustrates an example of the content of a build map.

Table 6: Sample Build map structure for clinical terms

Map ID	Source ID	Source description	Target ID (concept ID)	Target description	Match type	Mapper	Status	Comments
1	C0287	Acute MI	57054005	Acute myocardial infarction	Equivalent	AG	Mapped	
2	D0025	Left fractured NOF	5913000	Fracture of neck of femur	Broader	FR	Mapped	
3	D0021	Right fractured NOF	5913000	Fracture of neck of femur	Broader	MS	Mapped	
3	Z0104	Ref – AIHW Chronic Dx				TC	Do not map	Internal flagging Code

Table 7 shows an AMT build map and identifies an issue with individual map ID 3. The source concept could partially match a number of concepts in the AMT, but here, an additional data field “Year of Issue” has been included to enable the map to be completed. When the issue was first discovered, the status would have been “seek clinical advice”. On resolution the status is updated to reflect the outcome, in this case “mapped”.

Table 7: Sample build map at TPP level showing complex map structure

Map ID	Source ID	Source description	Year of issue (additional field from source data)	Target ID (concept ID)	Target description (preferred term)	Additional descriptions from target data (fully specified name)	Match type	Mapper	Status	Comments
1	2234-55jjc-a	Alprazolam-DP 1mg Tablets, 50		13885011000036103	Alprazolam (DP) 1 mg tablet, 50	Alprazolam (DP) (alprazolam 1 mg) tablet, 50 tablets (trade product pack)	1	MS	Mapped	
2	9982-8891ra	Aventis (Protamine 1%, 5 ml) Injection, 10		738411000168105	Protamine Sulphate (Sanofi-Aventis) 50 mg/5 mL injection, 10 x 5 mL ampoules	Protamine Sulphate (Sanofi-Aventis) (protamine sulfate 50 mg / 5 mL) injection, 10 x 5 mL ampoules (trade product pack)	2	AG	Mapped	Aventis and Sanofi-Aventis are different representations of the same supplier. Confirmed product equivalent.

Map ID	Source ID	Source description	Year of issue (additional field from source data)	Target ID (concept ID)	Target description (preferred term)	Additional descriptions from target data (fully specified name)	Match type	Mapper	Status	Comments
3	88332134-audk54	Fluvax injection, 1 x 0.5 mL syringe	2011	929552011000036100	Fluvax 2011 injection, 1 x 0.5 mL syringe	Fluvax 2011 (A/California/7/2009 (H1N1)-like strain (A/California/7/2009 (NYMC X-181)) 15 microgram + A/Perth/16/2009 (H3N2)-like strain (A/Victoria/210/2009 (NYMC X-187)) 15 microgram + B/Brisbane/60/2008-like strain (B/Brisbane/60/2008) 15 microgram) injection, 1 x 0.5 mL syringe (trade product pack)	3	TC	Mapped	There are many potential matches to this code, depending on the year of issue. Use additional information from source data (year of issue) to confirm equivalence with the AMT Mapping rule applied.

3.6.3.2 Final map example

The requirements of the file format for implementation are dependent on the intended use, potential consequences, and capabilities of the system into which it is to be implemented. If the scope of the implementation is only to provide SNOMED CT codes in parallel to an existing code system, the system only needs access to active mappings and the appropriate preferred terms. If the system does not use either an internal or external terminology service, the required information should be distributed in a single file.

Table 8: Sample final map structure derived from the Build map example above

Map ID	Date	Status	Source ID	Source Description	Target ID (Concept ID)	Target Description	Match type
1	01022009	Active	C0287	Acute MI	57054005	Acute myocardial infarction	Equivalent
2	0102209	Active	D0025	Left fractured NOF	5913000	Fracture of neck of femur	Broader
3	30092010	Active	D0021	Right fractured NOF	5913000	Fracture of neck of femur	Broader

Table 9: Sample final AMT map at TPP level

Map ID	Source ID	Source Description	Target ID	Target description
1	223455jjc-a	Alprazolam-DP 1mg Tablets, 50	13885011000036103	Alprazolam (DP) 1 mg tablet, 50
2	99828891ra	Aventis (Protamine 1%, 5 ml) Injection, 10	738411000168105	Protamine Sulphate (Sanofi-Aventis) 50 mg/5 mL injection, 10 x 5 mL ampoules
3	88332134-audk54	Fluvax injection, 1 x 0.5 mL syringe	929552011000036100	Fluvax 2011 injection, 1 x 0.5 mL syringe

The structure shown in the Table 8 and Table 9 includes appropriate preferred terms from each system. Such detail may be excluded only if it is readily available during implementation.

Thorough configuration management is required in producing a final map. As well as the final map itself being versioned, the full details of the source and target systems (OID, version, name) must be clearly documented. To satisfy the requirements of traceability, processes must be in place to facilitate a full audit of the map including when every change was made and against which versions of the source and target code systems the map was performed.

3.6.4 Personnel

Mapping requires a multidisciplinary group of people to administer the development of the map, undertake the actual mapping, verify content, determine the action where there is discrepancy, test, and document and release the map.

It is the responsibility of the owner of the map to ensure that an appropriately skilled team is used to develop and maintain their map. This responsibility is true for internally or externally developed maps. The qualifications of team members and the skills they represent should be recorded in the documentation of the mapping process.

Skills required include:

Clinical	Expertise and understanding of the discipline and the way in which the concepts in the result of the map will be used in clinical practice. In order to provide appropriate advice these individuals should have actual clinical practice experience. Their role is to provide decisions on the clinical safety and appropriateness of the results of each individual map.
Source	Expertise and understanding of the source content and structure in order to ensure that the meaning of the source is clearly understood.
Target	Expertise and understanding of the target content and structure in order to ensure that the meaning of the target is clearly understood.
Technical	Expertise and understanding of the computer systems from which the source data originates, the system in which the target data will be used and the automated process to transform the data from the source to the target.
Administrative	Management of the process and project, ensuring repeatability, quality, risk management (minimisation of patient risk) and consistency. (See Section 3.8 for risk management details.)

Table 10 is based upon work from the Mapping Special Interest Group[2] and provides a short description of these requirements to assist in building or selecting appropriate staff or organisations to undertake map building and maintenance.

It is suggested that mapping personnel should have the following competencies:

- Understand and be able to apply the structure, content, and relationships for the local or proprietary code system and SNOMED CT.
- Understand and explain the purpose of the map.
- Be able to apply the basic concepts of the SNOMED CT concept model and description logic (the logic and relationships used to define concepts within SNOMED CT). This is necessary to be able to determine if two concepts are equivalent or not.
- Understand the way in which the computer system will use the map.
- Understand the processes associated with new releases of SNOMED CT-AU.
- Principles of pharmacology and pharmaceutical formulations – the relevant personnel must understand what is meant by the concepts included in the AMT and understand their use and meaning in a clinical setting to assess clinical risk.

[2] Archive available at https://confluence.ihtsdotools.org/display/CP/Mapping+SIG+Home.

Though teams may be small, each of the roles indicated below need to be accounted for. In a small team the mapping manager and specialist may be the same individual.

Table 10: Mapping personnel roles and competencies

Role	Responsibilities	Competencies
Mapping Manager	Responsible for the conduct and documentation of the process, ensuring that decisions are logical, appropriate staff allocated to all tasks and appropriate processes employed.	In addition to general skills required in project management and being an experienced mapper, this person must be able to: • Design and apply change management principles and version control. • Design and apply mapping quality assurance processes. • Design and apply verification and testing processes suited to the purpose and content of the map. • Assess the risks and strengths of mapping versus conversion to SNOMED CT.
Mapping Specialist	Responsible for mapping content from one system to another.	In addition to general terminology skills: • Use understanding of the SNOMED CT concept model and description logic applicable to the terminology to identify the level of match between the source and the target code. • Use tools designed to assist and support the mapping process. • Apply the mapping process. • Develop and apply quality assurance measures to map content and production. • Consistently apply the rules established for the map.
Clinical Map Advisor	Responsible for clinical guidance where the meaning of either source or target is unclear.	In addition to clinical skills: Apply the SNOMED CT concept model description logic used in the terminology to determine meaning consistently. Consistently apply the rules established for the map.
Technical Advisor	Responsible for the technical utility and release of the map for technical use.	In addition to IT/IS skills: • Design and apply mapping structure and rule automation. • Design and build file structures to support the building and release of the map. • Document release processes for use of the map in software.

3.7 Tools

There are software applications that support building the map, browse SNOMED CT to assess appropriate map targets, and investigate alternative map results where there are issues or alternatives.

Mapping tools used should be evaluated against the following requirements and assessed to establish if they are appropriate to use in mapping to SNOMED CT.

- The tool should include SNOMED CT-AU.
- Appropriate filters to limit the map to a specific hierarchy should be available. For example, a map of diagnostic concepts might be restricted to the concepts of the clinical finding part of the hierarchy.
- The tools should map against the FSN but be able to search against preferred terms and synonyms in order to identify the relevant FSN. The ability to remove or ignore the hierarchy label (semantic tag) may assist the matching process.
- The tool should have the ability to limit mapping to concepts with a status of 'Active'.
- The tools used should be able to provide details of the concept and relationships to other concepts in SNOMED CT. This includes navigating up and down the hierarchies to see other options, and the attributes of the SNOMED CT concept to allow the mapping specialist to confirm the meaning of the SNOMED CT concept where there is doubt about the term from which it is being mapped.
- Automapped items need to be identified as such for further validation.
- It should be able to record comments and resolutions.
- It should have the ability to produce a computable version of a SNOMED CT map.
- It should be able to be limited to a specific SNOMED CT-AU reference set.
- It should display or record the version of the local or proprietary code system and the release of SNOMED CT-AU.

3.7.1 Automatic mapping

Automatic mapping is the process where software automatically compares the descriptions of the local code system to those used in SNOMED CT. Where the terms are the same, the build of the map can be automatic, including the concept identifiers and descriptions from the local or proprietary code system as well as the concept ID and description from SNOMED CT-AU. This process can significantly reduce the effort required to map and has the potential to improve the accuracy of the map.

Though a tool may have been used in the past it is necessary to confirm that the tool is current and relevant to the task on each occasion it is used to build a map.

Automatic mapping is undertaken to reduce the amount of manual mapping required. It is therefore conducted before manual mapping. Pre-processing of the source data should also be undertaken before automatic mapping is done.

Consideration should be given to how accurate the automatic mapping process will be.

The following example quality assurance processes may help to improve automatic mapping results:

- Establish a threshold to consider an item to be a match (must match one and only one entry in SNOMED CT).
- Establish filters to consider map results only from a hierarchy or reference set of SNOMED CT-AU.

As the automated mapping function may not be guaranteed to be 100% accurate, each automatically mapped source term should be manually validated against the result from SNOMED CT. A record should be kept of any automatic mapping errors to assist in improvement of the process in future.

After the automap function is run, the remainder of the file is manually mapped.

3.7.2 Manual mapping

Manual mapping requires the use of a browser to manually search SNOMED CT to find the matching local code system concept. The result is then manually recorded in the build table (often a spreadsheet). This method is very time-consuming and prone to error due to copying and pasting from the browser into the build table. The use of a mapping tool, which integrates a terminology browser together with a mechanism for recording the mapping results, can increase the efficiency and accuracy of the mapping process.

A mapping tool may allow automap and manual map functionality and allow the production of a consolidated output.

After each stage of the process, including automatic mapping processes, it is advisable to check that the number of items in the build table is the same.

3.8 Risk management approach

The mapping of terminologies has obvious patient safety implications. Where local or proprietary terms are incorrectly or in some cases imprecisely mapped to SNOMED CT concepts, or the maps are incorrectly used:

- The clinical system may display clinical information inappropriately or in a manner that is unclear or misleading in the context in which it is presented.
- The inappropriate medication and preparations may be prescribed, recorded, dispensed, or administered, potentially causing harm to patients.
- Misleading or inaccurate information may appear in a patient's clinical record, which may lead to decisions which cause harm to the patient.

Examples:

Different systems may use slightly different variations in the terms used to describe a concept. The variations between clinical systems and how they represent and register data can cause confusion with clinicians.

SNOMED CT: Borderline glaucoma

Local codeset term: Glaucoma suspect

These concepts do not have exactly the same meaning. If the map is to be used for non-direct care reporting purposes this would not represent a risk to the patient, but if used in clinical care could lead to inappropriate assumptions by the receiving clinician.

AMT TPP: Protamine Sulphate (Sanofi-Aventis) 50 mg/5 mL injection, 10 x 5 mL ampoules

Local codeset term: Aventis (Protamine 1%, 5 ml) Injection, 10

In this case, the products are identical, however, the discrepancy arises due to the source description not capturing the level of detail found in the AMT Preferred Term.

To minimise patient safety risks associated with the usage of SNOMED CT maps, a risk management approach or plan for patient safety risks should be clearly defined prior to commencing the mapping activity and should be followed throughout the entire mapping process through to validation, production release and ongoing maintenance. The developer may use any risk management methodology that is relevant to the context of their organisation. At a minimum, the developer should:

- Clearly identify all patient safety risks that may arise from using the developed maps in clinical settings.
- Perform and document risk assessment including definition of the likelihoods and these impacts.
- Formulate, document, and implement risk mitigation measures.
- Undertake and document the risk management activities not only during the mapping process but also for ongoing maintenance of maps.

Risk scoring and classification should form a part of risk assessment so that the level of effort in addressing each risk can be prioritised. It also provides consistency in ongoing risk management. Table 11 includes an example of a risk scoring and classification framework for patient safety risks [9]. This is an example only and the developer should use a risk scoring scheme that is most relevant to their mapping process.

Table 11: Example of a risk scoring scheme for patient safety risks

Risk scoring Risk score is obtained by multiplying the likelihood score by the consequence score.			**Likelihood score**				
			1	**2**	**3**	**4**	**5**
			Rare	**Unlikely**	**Possible**	**Likely**	**Almost certain**
Consequence/ impact score	**5**	**Catastrophic**	5	10	15	20	25
	4	**Major**	4	8	12	16	20
	3	**Moderate**	3	6	9	12	15
	2	**Minor**	2	4	6	8	10
	1	**Negligible**	1	2	3	4	5

Extreme risk	15 to 25
High risk	8 to 12
Moderate risk	4 to 6
Low risk	1 to 3

3.9 Pre-processing source terms

The terms to be included in a map need to be determined. Exclusion of concepts which are not current, or restriction to terms in a specific hierarchy are common requirements when first establishing what is to be included in the map.

Variations are likely to exist in the way that a concept is described between the local termset (or proprietary code system) and SNOMED CT. In order to support automated mapping processes, the more similar the structure and representation of data between the descriptions in each system the more likely matching is to be accurate.

Example:

Local system: Viagra (sildenafil (as citrate) 100mg) tablet: film-coated, 1 tablet

AMT: Viagra (sildenafil 100 mg) tablet (trade product unit of use)

Viagra (sildenafil 100 mg) tablet, 1 tablet (trade product pack)

Pre-processing modifies the local system description so that it will match the format used in SNOMED CT, and provided that the mapping tool is able to be restricted to the appropriate part of the hierarchy, increased success in automapping can be achieved.

3.9.1 Is pre-processing required?

To support automated comparison, the text that describes the code in the source may be modified to match the target better. However, pre-processing must not change the meaning of the term in any way.

For this reason, there are advantages to 'pre-processing' the local system code data for mapping. All changes made to the local system code descriptions must be recorded. This not only supports

compliance and risk assessment but also maintenance of the map content as the process can be repeated when either the local code system or SNOMED CT are changed.

Pre-processing may be undertaken in the build map, which as a result would not affect the descriptions used in the local system, or the local system can be modified to make it more consistent with SNOMED CT, which will improve the potential for automapping into the future.

Pre-processing may be required to cater for the following potential differences between the termsets and SNOMED CT:

- The use of dashes, slashes and other symbols in the source terms.
- The use of numerical symbols in the source terms.
- Abbreviations in the source terms.

Pharmaceuticals are complex concepts with many attributes. Different systems structure their representation of these concepts in different ways. In order to automate the mapping process as much as possible, it is best if the source terms and relationships are able to be consistently compared to those in the AMT.

3.9.2 Pre-processing rule guidance

Making definitive recommendations about what pre-processing shall or should be done is impossible, and most existing termsets that need to be mapped will have to be dealt with on an individual basis, accounting for their distinctive characteristics.

A range of areas that can be considered. These will not apply to all termsets, nor will all the recommendations be valid or necessary for mapping each of them. These recommendations and methods need to be considered alongside the context and purpose of the mapping as well as the features of local systems.

Some characteristics of local termsets might carry implicit meaning and this should be understood and accounted for in selecting SNOMED CT target concepts.

The following recommendations and examples are provided to outline what needs to be considered when undertaking pre-processing and are not intended to be an exhaustive list.

3.9.2.1 What do dashes mean?

The use of dashes is common. What these dashes represent may vary within a single termset as they may or may not have been used consistently throughout. The meaning implied by dashes will vary between different termsets. Some examples are given in Table 12.

Table 12: Example mapping of terms with dashes

Local term description	Possible meaning of dash	Possible pre-processed local term description	Possible mapping target from SNOMED CT
Fracture – femur	‘of’	Fracture of femur	71620000 Fracture of femur
Concussion – LOC	‘with’	Concussion with loss of consciousness	62564004 Concussion with loss of consciousness
Back pain – chronic	‘course’	Chronic back pain	134407002 Chronic back pain
Calcinosis – acne	‘following’	Calcinosis following acne	402493009 Calcinosis following acne

Recommendation: Do not assume that the use of dashes within a termset means the same thing for every term within that termset. If there is evidence of 'mixed' use of dashes to convey different meanings, then data cleaning and normalisation may have to be performed manually with associated review processes.

3.9.2.2 What do slashes mean?

Slashes within term names are also common in local termsets. Again, the use of a slash can have a variety of meanings, and the original meanings will make a difference to how accurately and completely maps are constructed to SNOMED CT target concepts. Some examples are given in Table 13.

Table 13: Example mapping of terms with slashes

Local term description	Possible meaning of slash	Possible pre-processed local term description	Possible mapping target from SNOMED CT
Laceration – head/neck	'and'	Laceration of head and neck	283358007 Laceration of head and neck
L3/4	'between'	Between L3 and L4	244532004 Entire joint between bodies of L3 and L4
6/52	'fraction of'	Six weeks	224916004 weeks/year
Depression/Anxiety	'or'	Depression or anxiety	35489007 Depression 197480006 Anxiety disorder

Recommendation: Ascertain whether slashes are used within terms in your existing termset in a consistent way. If slashes denote a variety of meanings or are intended to (variously) convey combinations, choices, groupings, then pre-processing or manual data cleaning techniques may be worthwhile and might facilitate more accurate and comprehensive automapping approaches.

3.9.2.3 Other symbols

Many existing termsets were built by clinical practitioners, and the termset content has 'inherited' a great many of the representations that clinicians routinely used in their traditional paper-based medical documentation practices. Noted below are some of the terms common in existing systems which contain a variety of symbols. It is also noted that while these symbols may be broadly understood by human readers, they are difficult to parse and compute and do not necessarily convey the same meaning to each human reader, nor each computer system. Some examples are given in Table 14.

*Table 14: Example interpretations of various symbols**

Symbol	Possible meaning
#	fracture, break, broken
@	at, for each
+	onset, acute, mild, low
++	onset, moderate, medium

Symbol	Possible meaning
+++	severe, extreme pain, high
?	possible, suspected, probably, differential, investigate further
~	approximately, about, not sure, estimated
↑	Increasing
↓	Decreasing
>	greater than
<	less than
,	and, also, as well as, included together

*Note: This list is neither exhaustive nor definitive.

Recommendation: Determine the extent of use of symbols within the existing termset descriptions before commencing mapping efforts. If symbols are used consistently in the termset and (for example) every occurrence of '#' does indeed mean 'fracture', then programming or scripting techniques (or find and replace methods) can transform the symbols into words. This might increase the likelihood of accurate and comprehensive maps production.

3.9.2.4 Numbers

Numbers within local termset descriptions are another area requiring consideration. Are the numbers represented numerically or are they described using text? Numbers are used to quantify, as well as to describe items such as:

- Age.
- Time.
- Temporal aspects of disorders.
- Anatomical features.

Where numbers are concerned it is important to understand how SNOMED CT approaches numbers. SNOMED CT does have some number-based terms and concepts, though as a rule these numbers cannot be used for any sort of arithmetic or mathematical functions. Since 2020, SNOMED CT supports concrete domains which allow representation of numbers for calculations. Please contact the NCTS if you would like more information about this feature.

From a pre-processing point of view, it might be helpful to transform numerals to words if automap tools are unable to use indexing tables to search for numerical/word equivalence. Some examples are given in Table 15.

Table 15: Example mapping of terms with numbers

Local termset description	Possible pre-processed local term description	Possible mapping target from SNOMED CT
4th nerve palsy	Fourth nerve palsy	20610004 Trochlear nerve palsy
2nd O burn	Second degree burn	403191005 Partial thickness burn
3 point gait	Three-point gait	88471006 Three-point gait

Given how SNOMED CT deals with numbers, there are areas where pre-processing would not provide any value and below are two examples that could require manual mapping. Some examples are given in Table 16.

Table 16: Example terms with numbers requiring manual mapping

Local termset description	Possible mapping target from SNOMED CT
95% disabled	82303003 Disability evaluation disability 95 percent
Birth weight >2.5kg	310539009 Baby birth weight above 2.5kg

Recommendation: Be aware of existing termset content and determine whether numerical representations are consistent or not regarding age ranges, percentages etc. Given the variations in the way that SNOMED CT expresses numerical concepts, it may not be beneficial to pre-process your terms to support automapping techniques. However, initial review and some guidance will help humans to manually map in a more consistent fashion if they understand the way in which the existing local termset content is represented, and what they can expect to find (or not) in the SNOMED CT target content.

3.9.2.5 Abbreviations

Abbreviations are common in local termsets, as they are commonly used by clinicians. SNOMED CT does contain some abbreviations within synonyms, and automapping tools may be able to make matches based on this. The SNOMED CT policy regarding abbreviations is to include the abbreviation, followed by the full description of that abbreviation as an acceptable synonym. This policy exists because there are multiple meanings for some abbreviations. Some examples are given in Table 17.

Table 17: Example interpretations of abbreviated terms

Abbreviation	Possible SNOMED CT target concepts
PVD	400047006 PVD – Peripheral vascular disease 76267008 PVD – Pulmonary valve disease 236078003 PVD – Post-vagotomy diarrhoea 247081001 PVD - Posterior vitreous detachment
IC	10743008 IC – Irritable colon 63491006 IC – Intermittent claudication 197834003 IC – Interstitial cystitis 227708009 IC – Ice cream
PAC	225359006 PAC – Pressure area care 284470004 PAC – Premature atrial contraction

It is important to note that there are many more abbreviations in use than are covered in SNOMED CT, and thus some pre-processing to expand out these abbreviations may be required again after the initial automap is performed.

3.9.2.6 Overall pre-processing of textual representations

Note that there will be human effort required either in pre-processing or in (later) manual mapping. Vendors and custodians are advised to determine which approach is most beneficial to their efforts, given the characteristics of their existing term set.

You will have noticed that many of the examples given above in relation to possible local termsets reveals that some terms have more than one feature which would need to be addressed. Some examples are given in Table 18.

Table 18: Example terms with multiple features to be considered during mapping

Multiple features	Example
a dash and slash	Laceration – head/neck
a number and a slash	6/52
a symbol and a number	Birth weight >2.5kg

This will mean that there may be several review iterations or run-throughs of the existing termset, each time addressing each of these characteristics in turn, and applying 'transforms' to increase the likelihood of finding equivalent meanings in SNOMED CT via automapping or manual mapping techniques.

It should be noted that even if mappers decide to manually map by human review and selection techniques they will be assisted in their task if there is consistency in the existing local (source) termset. If there is no consistency in the form of words, they will be less able to make consistent judgments about meaning.

Note: **None** of the above examples are exhaustive. Existing local termsets cannot be expected to be uniform and may well display other characteristics not addressed here.

Resources that should be considered when understanding pre-processing source terms for mapping to SNOMED CT include:

- SNOMED CT starter guide [10].
- SNOMED CT editorial guide [11].
- The Australian Dictionary of Clinical Abbreviations, Acronyms and Symbols [12].

3.9.3 Document pre-processing process

Where pre-processing is undertaken, the methods used to modify concept descriptions must be documented in order to be included in risk assessment, and to ensure that the process can be accurately duplicated the next time the map is updated.

3.9.4 Carry out the pre-processing process

When all pre-processing rules have been established, each of the rules should be automatically processed to change the descriptions of the local code system descriptions.

Precautions should be taken to ensure that any automated changes made to the data do not have unexpected consequences. For example, the addition of a space before 'mg' should not result in a space in a word which includes the letters 'mg'.

For each case the actual changes should be verified and the rationale behind them must be recorded. This supports the maintenance of the map in future as well as evaluation of the quality of the mapping processes. Table 19 and Table 20 show examples of table change documentation.

3.9.4.1 Example pre-processing for mapping to the AMT

Units of measure in the local code system are different to the units of measure used in the AMT.

It was possible to automatically modify the text describing a medication to represent the unit of measure (UOM) associated with the strength of a medication to match the AMT. The local system displays medication strength with no space between the strength and UOM, for example, 25mg, in contrast to the AMT which has a space between both components (25 mg). Where appropriate, spaces were created before the UOM in the local code system descriptions.

Table 19: Pre-processing documentation for changes to unit of measure

Change Made	Change made to	Reason for change
Where the units were found, a single space was added in front of the text.	• mL • mg • kg • cm	The AMT has a space between the units of measure indicated here. A space was added to make the source and target consistent.

In another example, the AMT is more specific than the local code system but the local system has the year of manufacture in a separate field which is to be used to gather the additional information.

Example:

Local code system: Fluvax (influenza virus vaccine) injection: 0.5mL syringe

AMT: Fluvax 2011 (A/California/7/2009 (H1N1)-like strain (A/California/7/2009 (NYMC X-181)) 15 microgram + A/Perth/16/2009 (H3N2)-like strain (A/Victoria/210/2009 (NYMC X-187)) 15 microgram + B/Brisbane/60/2008-like strain (B/Brisbane/60/2008) 15 microgram) injection: suspension, 0.5 mL syringe (trade product unit of use)

Table 20: Preprocessing documentation for changes to vaccine names

Change Made	Change made to	Reason for change
Each medication description with an associated “year of issue” date was modified to include the date after the medication name.	• Medication description • Year of issue	Concatenate the medication name and year of manufacture into the local code system description when the pre-processing for mapping is undertaken to generate entries that can be accurately and completely mapped.

3.10 Building the map

3.10.1 Mapping source to target

Building the map includes multiple processes: the use of automated tools may be included with manual mapping, or the map may be built completely manually. Whichever process is used, the

build must include quality processes for issue resolution. Mappings should be to SNOMED CT concept IDs. For review purposes the FSN should be used, as this is the unique and unambiguous description for each concept.

3.10.2 Performing automated mapping

If an automated mapping tool is being used and data has been pre-processed, the build table source terms will be processed using the tool with appropriate filters specified to identify a single match in SNOMED CT. A record must be kept of the tool used (including the version of the tool), filters used, and the number of matches achieved through the automatic mapping process. Any verification of the mapping process employed must also be indicated.

3.10.3 Performing manual mapping

Even the best automated mapping process is likely to leave some concepts that require manual mapping.

Each term should be mapped and checked by a mapping specialist. The mapping specialist completes or confirms automated mapping results for each individual entry in the source table, building individual entries in the map for each concept and inserting relevant values.

The mapper may use terminology browsers to find the equivalent term in SNOMED CT and should record the concept identifier, the description, the map type (level of equality between the terms), any relevant rules applied, and where the terms are not equivalent or could be clinically misleading, and any potential issues with the map that should be discussed. In this last case a target concept might not be included in the build map. The status of the map should be updated to indicate whether the original concept has been mapped, awaiting clinical adjudication or a decision made not to map the concept. The range and progression through different map statuses should be clearly documented as a map life cycle.

3.10.4 Documentation of issues

Issues may arise where it might not be clear whether the concepts match or not, or where clinical clarification is required. In this case the person undertaking the manual mapping or checking must clearly document the issue. A record of all issues and how they are resolved should be maintained.

Example:

Local system: Nut allergy

SNOMED CT: Food allergy peanuts

Issue: A nut allergy in SNOMED CT specifically refers to ‘tree nuts’ whereas a peanut allergy is considered a ‘legume’ allergy. Clarification is required as the exact intent of this term in the clinical information system; otherwise, the less specific concept must be used.

Example:

Local system: Aventis (Protamine 1%, 5 ml) Injection, 10

AMT: Protamine Sulphate (Sanofi-Aventis) 50 mg/5 mL injection, 10 x 5 mL ampoules

Issue: The manufacturer variation may cause confusion. Please advise whether for the purpose of this map this should be considered a match or not.

3.11 Conflict resolution

This process requires clinical input and is usually led by the mapping manager to ensure consistent application of mapping decisions developed during the mapping process. The objective is to reach a decision on the appropriate map from the source to the target for each relevant concept that is terminologically sound and clinically safe.

All decisions must be documented, and this document should be generic where possible.

Suitably experienced and qualified clinical expertise is required to provide clinical governance and to resolve issues identified when mapping. The conflict resolution process requires clinical adjudication on the appropriate action.

Actions might include:

- Advice on the match type – deciding that the concepts can be considered to be the same (and therefore allocate a match type of "2") or deciding that this concept should not be mapped as doing so would represent a clinical safety issue (map type: not mapped).
- Advice that is general and should be applied whenever a given situation occurs anywhere in the mapping process. Decisions such as these should always generate a documented record of the agreed way to handle the situation. For example, it might be agreed that the terms "oral solution" and "oral liquid" will be synonyms in all cases.

This process supports the development of a reproducible methodology that uses patient safety as the primary guide to decisions made.

3.12 Validation

There are different methods that can be used to validate the accuracy of the map content.

3.12.1 Sampling validation

This method involves selecting a sample set from the whole map and validating each sample map entry. To ensure unbiased validation, validation is performed by personnel who are not involved in developing the maps. If the sample set is considered valid for the pre-defined purpose of the map, then the whole map is assumed to be valid.

The sample size, the sampling approach and acceptable error rate should be carefully determined in advance based on the risk profile and the purpose of the map relevant to each mapping project.

One recommended example of a sampling approach is "grouped random selection". In this approach the map source terms are divided into logical groups of choice, for example by frequency of use or by product types. The product types may include single-ingredient, multi-ingredient, multi-component, sub-packs and high-risk medications such as the "PINCH" drugs – potassium, insulin, narcotics, chemotherapy, heparin and systems. Then the map entries associated with the source terms from each group are randomly selected to create the sample set, ensuring that the entries from all groups are represented in the sample set. Afterwards, each entry from the sample set is validated. Depending on the quality of the sample set, a review of the mapping process may be needed.

The sampling validation method does not necessarily validate the whole map as there may be incorrect maps that are not in the sample set. Therefore, it may only be a suitable method for ongoing maintenance of the maps with mature automated mapping processes.

3.12.2 Dual mapping

When converting data, or where assurance of a high-quality map is required, dual mapping should be employed. The use of dual mapping provides a validation mechanism reducing inadvertent manual or computer-based errors from getting through to the final map and is recommended by SNOMED International for production of a high-quality map.

This process is depicted in Figure 4. Two mapping specialists each create their own individual maps from the source to the target. Only when each mapping specialist produces the same target is the map considered to be correct. All other terms require documentation of issues and then conflict resolution by the clinical map advisor to determine appropriate action. If this approach is taken, a sample set to validate is not required.

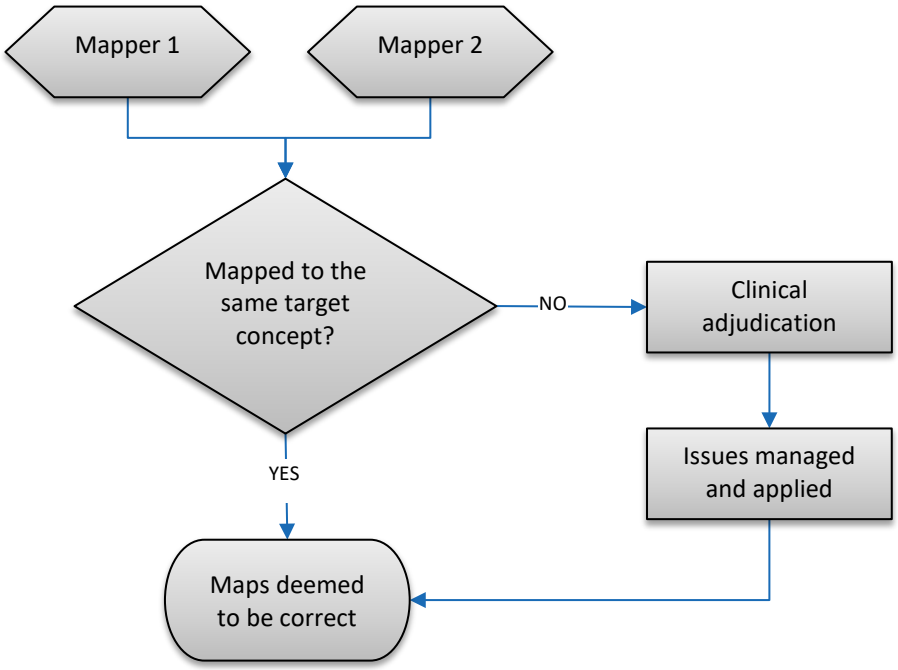

Figure 4: Dual mapping process

Dual validation is a similar process which is conducted after the individual maps have been built. This process is where more than one (usually two) validators independently review the results of the initial map as created manually or automatically. The map is only considered to be correct when both validators confirm the target AMT term. All other terms require documentation of issues and conflict resolution.

Options for mapping and validation include:

- Dual map, single (or automated) review.
- Single map, dual review.
- Dual map, dual review.

3.12.3 Backwards mapping

Backward mapping is when a map built to translate data from the local or proprietary code system to the AMT is used in the reverse order, to translate from the AMT to the local system.

This can be useful when validating the content of the map, as backward mapping can highlight typographical and other errors in the map including semantic-based rules that are not valid in the

reverse direction (and hence invalidating the map for use as a bidirectional map). This approach alone is insufficient but can be applied with either sampling or dual mapping to improve the quality of the map.

When mapping to the AMT it is recommended that only those concepts which are lexically and/or semantically equivalent be used so that patient safety is not affected by any differences between concept descriptions. Quality maps from the source to the AMT that are also valid both to and from the AMT may prove useful to translate data in both directions, thereby providing a map which can be used more extensively.

3.13 Quality review

The quality review process is undertaken to identify improvements that could be made to the mapping process for future use and to determine whether the map is fit for clinical use. It can also be used to identify improvements that could be made to the content of SNOMED CT-AU.

3.13.1 Quality review overview

The quality review process should be undertaken by all involved in development of the map and a selection of stakeholders or users of the map. The purpose of this exercise is to identify improvements that could be made to SNOMED CT and to the mapping process for future use and to determine whether the map is fit for clinical use.

The quality review process should include:

- Review of the clinical audit process to ensure consistency of advice provided and rules developed or applied to ensure that clinical risk has been appropriately assessed and minimised.
- Review of validation results to ensure appropriate accuracy of the map.
- Identification of concepts relevant for inclusion in SNOMED CT and submission of request for change or addition (see Section 3.14).
- Review of documentation to ensure completeness and clarity as well as appropriateness of instructions.
- Review of the release process to identify issues or improvements.
- Documentation of lessons learnt in the process through review of results and discussion with those involved in the development of the map and the process.

3.13.2 Process improvement

Consideration should be given to the methodology and tools used and changes made to reflect lessons learnt, so that the next production of the map will be an improvement upon this iteration.

Such changes and the rationales behind them should be documented.

3.14 Request submission

If the mapping team finds any material error or change or correction needed in SNOMED CT, or would like to recommend an improvement, they are encouraged to submit a request to the NCTS. The Australian Digital Health Agency is committed to refinement and improvement of SNOMED CT-AU content. Where a non-equivalent map is produced, the request submission process should be used where equivalent mappings would offer improvement.

The SNOMED CT-AU and AMT request submission templates are available on the NCTS website[3].

3.15 Documentation

Documentation of the mapping methodology and decisions made can be used to reproduce the mapping process when either the local or proprietary code system or SNOMED CT are changed. It also provides evidence of the mapping process undertaken and rules applied for compliance assessment. Documentation should include:

- A clear statement of the source (local or proprietary code system) including version and the target (release version of SNOMED CT-AU).
- The purpose of the map.
- Scenarios of the map's uses.
- Intended users of the map.
- The SNOMED CT-AU reference sets, or AMT product classes, to which the local or proprietary code system is mapped, including clinically appropriate reasons for this.
- Pre-processing undertaken including specification of terms not included in the map, and processes used to modify the source terms prior to mapping. (Include details of changes made and the reasons for the change.)
- Personnel – personnel involved in the mapping process and their qualifications identifying the role played by the individual as well as the skills offered by them. Any evidence of competency should be included in the documentation.
- Tools used – indication of tools used and the capabilities and limitations of these tools.
- The mapping process used.
- The issues resolution process and any common approaches incorporated, or rules to be applied to the map or the map development process, and the conflict resolution process.
- The validation process (including sampling methods).
- The risk management process.
- The risk profile of patient safety risk associated with using this map.

3.16 Release

3.16.1 Produce final SNOMED CT map

To produce the final map, the build map is used as the basis and is retained as documentation of the mapping process.

Individual map entries which are not mapped (not of sufficient accuracy to be included in the map) are excluded.

Those fields used to manage the building of the map are removed. This includes fields such as mapper, issues and status.

[3] Available at https://www.healthterminologies.gov.au/request/content-requests/.

Where the final map is intended for direct input into a specific information system, the format shall be as required by the system, so as to avoid additional transformation and the associated risks.

This results in the final SNOMED CT map. The version of the map shall be recorded.

3.16.2 Release documentation

Documentation should be provided to accompany the release of the map. This shall include details of the structure and format of the map to assist those using the map. Details of map purpose, scope etc., and decisions made when developing the map should also be included as these may impact the way that the map is used.

Version control on the documentation and the map should be consistent.

3.16.3 Release of the SNOMED CT map

The map should be released on a specified date and this date should be clearly indicated on all documentation.

3.17 Maintenance

The map should be reviewed when either the source or SNOMED CT is updated. Assessment of the update of either the source or SNOMED CT might conclude that mapped concepts have not changed, in which case the map need not be rebuilt.

However, SNOMED CT is updated regularly, and the following should be noted during the review process:

- Maps that are not equivalent (e.g. broader, inexact, etc) should be reviewed regularly through maintenance processes to ascertain if an equivalent (or more accurate) map target now exists. If a new target is identified update the mapping.
- If a SNOMED CT target concepts has been inactivated, update the map to the concept it was replaced with (after assessment).
- If a map is found to be inaccurate the mapping row should be inactivated, and a new mapping performed to a correct SNOMED CT concept.

It is necessary to assess clinical risk related to changes in the source or SNOMED CT. Rebuilding should be undertaken when mapped concepts in either the source or SNOMED CT change.

Rebuilding should follow the same process as the original build (recognising improvements identified during the quality review process). Where changes in process might impact map concepts other than those that have changed, i.e. existing mapped concepts – consideration should be given to reviewing all individual concept maps which might require change.

The update process should result in an updated map, associated documentation, final map, and associated release documentation.

Acronyms

Acronym	Description
AMT	Australian Medicines Terminology
CTPP	Containered Trade Product Pack
FSN	Fully specified name
GP	General Practitioner
IHTSDO	International Health Terminology Standards Development Organisation
ISO	International Standards Organisation
MP	Medicinal product
MPP	Medicinal product pack
MPUU	Medicinal product unit of use
NCTS	National Clinical Terminology Service
NEHTA	National E-Health Transition Authority
PCEHR	Personally Controlled Electronic Health Record
TP	Trade product
TPP	Trade product pack
TPUU	Trade product unit of use
UOM	Unit of measure

Glossary

Term	Meaning
Assessment	Determining if specified requirements relating to a product, process, system, person or body are fulfilled.
Automapping	A computational mapping task, undertaken using an algorithm. Separate files of concept content from different coding systems are compared using an algorithm to determine whether there are concepts which match each other; that is, whether each coding system has content in common.
Build map	A build map or 'working draft' contains all required maps and information required to manage the map such as who performed the map, what status the map is at any point during development.
Classification	An exhaustive set of mutually-exclusive categories to aggregate data at a pre-prescribed level of specialization for a specific purpose. Example: International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10), International Standard Classification of Occupations. Classifications include a place, though not always specific, for all concepts required for the specific purpose of the classification. They include broad catch all categories and "unspecified" sections to capture those concepts where it is not possible or practical for the purpose to be more specific [13].
Coding system	A system of code sets, coding standards and code maintenance procedures together with their authorisation and governance. Examples: ICD-10-AM Volume 1 – classification, Volume 2 – reference terminology, Volume 5 Coding standards. A generic term to describe a classification or terminology that is used to transform a representation of a concept to a coded representation. Coding systems applied in the mapping process are described as "source" and "target". The source coding system is the system that supplies the concepts to be mapped. The target coding system is the system that contains the concepts which will provide comparable meaning via the map. (Modified from [14]).
Competency	A person's ability to undertake a role or perform a task including related dimensions of ability such as underpinning knowledge.
Compliance	The adherence to the requirements of laws, industry and organisational standards and codes, principles of good governance and accepted community and ethical standards.
Concept	Related conditions and situations that provide a useful understanding and meaning of a subject. Commonly described as a 'thing' – anything which can be described, imagined, whether real or fictional, present, past or future [6].
Cross map	See: Map.

Term	Meaning
Cross map target	See: Map target.
Developer	An organisation that creates an implementation of an Agency specification. A developer may be an organisation that develops a software product, or a provider of eHealth services. Health jurisdictions, healthcare providers and systems integrators may also be developers of eHealth systems.
Equivalence	Like in significance or import; corresponding or identical in effect and function. Synonym: Semantic equivalence In controlled terminology: Two concepts are (semantically) equivalent if their domain of meanings overlap and their semantic definitions are interpreted as identical. That is, the total scope of meaning of each concept is the same and each concept is defined as the same thing [6]
Final map	The final map or published product is the file that it implemented for use and should contain history tracking to ensure backward compatibility where different versions of the same map are used across different sites or sectors.
Human mapping	The use of human knowledge and skill to build maps between concepts and/or terms in different coding systems. Each map is built singly and individually. The process requires examination of each concept and coding system. Informed judgements or decisions are made about the shared meaning of concepts. Some electronic or computational tools are used, but only in support of work process: these are not helpful in determining any equivalence of meaning.
Lexical match	Where two concepts are represented using the same word(s). The source concept matches the target concept exactly, word for word, singular to singular, plural to plural. It must be noted that just because the source and target systems have matching words, does not mean that the meaning is exactly the same. For example: High blood pressure can mean a single instance of a high reading for an individual (which could have been after strenuous exercise), while high blood pressure can also be an ongoing condition. One meaning is far more clinically significant than the other.
Map	An index from one term to another, sometimes using rules that allow translation from one representation to another indicating degree of equivalence. Synonyms: Individual map Cross map
Map source	A terminology, coding scheme or classification used as the starting point for map production (in the context of mapping). Synonym: Source
Map table	The file containing multiple individual maps which has been developed for a specific purpose.

Term	Meaning
Map target	A terminology, coding scheme or classification to which some or all of the concepts in another terminology, coding system or classification (the map source) are mapped. Synonyms: Target (in a map) Target Scheme.
Mapping	The process of defining a relationship between concepts in one coding system (Source) to concepts in another coding system (Target) in accordance with a documented rationale, for a given purpose. Quality mapping will be useable, reproducible and understandable [6].
Mapping specialist	An individual who is competent to determine whether a map concept within a source terminology has a link to a concept in the map target.
Reference set	A group of components (e.g. concepts, descriptions or relationships) that share a specified common characteristic or common type of characteristic. Synonym: Subset A reference set is a subset of the superset or complete terminology or classification [6].
Scenario	The story-based description of a situation or business instance that defines requirements, roles and processes for a given map. (Modified from [6]). Synonym: Use case It is preferred though that the term ‘use case’ be reserved for the IT-based representation of use cases and use case modelling.
Semantic match	Where two concepts represent the same meaning, even if the words used to describe them are different.
SNOMED CT	This is considered to be the most comprehensive, multilingual clinical healthcare terminology in the world.
SNOMED CT-AU	SNOMED CT Australian edition This includes the content from the International release of SNOMED CT together with Australian-developed terminology and associated documentation. It may also be referred to as the Australian extension.

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