Review Article

Clinical Terminologies in the NHS: SNOMED CT and dm+d

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ARTICLE INFO	ABSTRACT
	Clinical terminologies are fundamental to the successful recording of clinical data within Electronic Health Record systems and are important in enabling the sharing of data between systems. An overview of the structure and benefits of the international terminology SNOMED CT and the NHS dictionary of medicines and devices (dm+d) are described. Also discussed is a history of clinical terminologies used within the NHS.

INTRODUCTION

The Electronic Health Record (EHR) is becoming an essential means to meeting the increased challenges for healthcare professionals to provide effective care. In the UK, the recording of clinical information is already largely digital within primary care and the digital maturity of secondary care is increasingly being driven by national policies. Electronic records have a number of advantages such as facilitating improved resource management and supporting improved decision making.

Clinical terminologies are used in electronic systems and are a structured list of terms that are designed to unambiguously describe the care and treatment of patients. Terms cover clinical information like diseases, diagnoses, findings, operations, treatments, medicines, administrative items (organised in hierarchies) and can be used to support recording and reporting a patient's care at varying levels of detail. As well as achieving improvements to data entry, such as elimination of typographical (keying) errors, clinical terminologies have standardised terms and codes thus providing clinically relevant data that (unlike free text) can be processed by a computer. Modern clinical terminologies are also structured in a way that allows data to be shared between systems without loss of meaning or understanding. This allows improved analysis of data and enables decision support (e.g. drug alerts) and linkage to knowledge resources. A more detailed analysis of terminologies and principles of their design can be found in the article, Desiderata for controlled medical vocabularies in the twenty-first century (Cimino 1998).

UK NATIONAL CLINICAL TERMINOLOGIES

In the NHS, national clinical terminologies have been available since the 1980s (Benson 2011). The Read codes; Read version 1 (4-byte), Read version 2 (5-bytes) and Read version 3 (also known as Clinical Terms Version 3 or CTV3) are predecessors to the modern terminologies SNOMED CT and NHS dictionary of medicines and devices (dm+d). Although very useful and successful for their time of development, early versions of Read codes have a number of flaws that prevent them from being terminologies that meet current day requirement. For example, because of the way they were structurally

organised (fixed hierarchical relationships) some of the hierarchies are full, meaning that new terms cannot be put in the correct logical place. Also a number of terms within the terminologies are no longer current, some are actually incorrect or misspelt, and some are problematic (for example, sexual orientation being categorised as a mental disorder in the Read codes) and there is no standard mechanism to address these issues or even remove them. Read v3 (CTV3) was developed to address some of the problems with early Read code terminologies and was merged with SNOMED RT (developed by the College of American Pathologists) to create the original content for SNOMED CT which combined the richness of the two terminologies into an international product (SNOMED 2017a). In 2002, SNOMED CT was released internationally for the first time and has many advantages over the previous terminologies in the way it structures information and meets the requirements of a modern terminology including its broad health and care sector coverage (see benefits).

Unlike SNOMED CT, which has evolved from predecessor terminologies, dm+d was designed specifically to standardise the way medicines and devices were described in order to support the health and care system in the UK. It was the 1998 government white paper Information for Health (IfH) (Burns 1998) that noted "There is a lack of standardisation in the UK in describing medicines, appliances and medical devices, in how such descriptions are organised, and in linking knowledge required for decision support to these descriptions". In the exploratory phase of the ensuing programme initiated as a result of IfH it was noted that none of the then current national medicines terminologies (e.g. The Read codes Drug and Appliance Dictionary) could support the use cases identified. Based on these use cases work commenced to build a new, national medicines and devices terminology and the resultant product is now referred to as dm+d.

SNOMED CT and dm+d were designed to bring significant business benefits over existing terminologies, such as reducing ambiguity in providing for selection of product terms by clinicians, the ability to transfer coded data between applications without translating data between different coding systems, and reduce the cost of maintenance of multiple code sets. SNOMED CT and dm+d have therefore been chosen as the clinical terminologies that meet current day requirements and the existing Read terminologies are undergoing withdrawal.

SNOMED CT

SNOMED CT is a structured collection of clinical terms specifically for use by healthcare professionals in the day to day recording of patient care. SNOMED CT is owned and managed by SNOMED International formerly known as International Health Terminology Standards Development Organisation (IHTSDO) (SNOMED 2017a). The UK is one of the founder members of the organisation and continues to work collaboratively as a member to support the international maintenance and adoption of SNOMED CT as well as having its own UK extension, maintained by the NHS Digital, to enable content to be managed to meet specific UK use cases (NHS Digital 2017a). SNOMED International currently has 29 member countries (January 2017) who contribute to its development and use within their own health environments (SNOMED 2017b); this number is increasing year on year. SNOMED CT is made up of the components; Concepts, Descriptions and Relationships, described below.

SNOMED CT Concepts

Healthcare professionals in recording information can use different clinical terms e.g. myocardial infarction or heart attack, that mean the same clinical 'thought'. SNOMED CT supports this by allowing more than one clinical term (description) for the same clinical 'thought' (concept). The concept is the basic building block in SNOMED CT and each concept has a unique ID (Code).

SNOMED CT Descriptions

There are two commonly used description types, Fully Specified Name (FSN) and Synonym (S), each description has a unique ID (code). The FSN is the unique, unambiguous description of a concept's meaning, in the example (Figure 1), myocardial infarction (disorder). Synonyms allow for different descriptions to be used that have the same clinical meaning, in the example, the concept has a number

of synonyms e.g. heart attack, cardiac infarction. A Synonym that is marked as preferred for use in a particular language or dialect is referred to as a Preferred Term (PT). This is the description that most healthcare professionals will use and in the example myocardial infarction.

Concept ID 22298006

Descriptions (Terms)		Description ID
FSN	myocardial infarction (disorder)	751689013
PT	myocardial infarction	37436014
S	heart Attack	37443015
S	cardiac infarction	37442013
S	infarction of heart	37441018
S	MI – Myocardial infarction	1784872019
S	myocardial Infarct	1784873012

Figure 1. SNOMED CT Concept and Descriptions

SNOMED CT Relationships

Concepts are also associated with other concepts using relationships. These relationships are used to define and model in a logical manner the concepts, which give the concepts "meaning" that can be used by computer software to process information. There are two types of relationships that exist in SNOMED CT, the 'is-a relationship' and the attribute relationship. The 'is-a relationship' which relates a concept to more general concept(s) is often known as the parent-child relationship. Each active child concept has at least one parent concept in its hierarchy. For example, the concept that represents infective pneumonia has two parent concepts that represent pneumonia and infectious disease of lung (Figure 2). Which means infective pneumonia is-a pneumonia and is-a infective disease of lung. Also the concept infective pneumonia has other concepts that are children e.g. bacterial pneumonia, which means the concept bacterial pneumonia has an 'is-a relationship' to infective pneumonia.

Concepts can also be further defined using an attribute relationship. Attribute relationships are an association between two concepts that specifies a defining characteristic of one of the concepts (the source of the relationship).
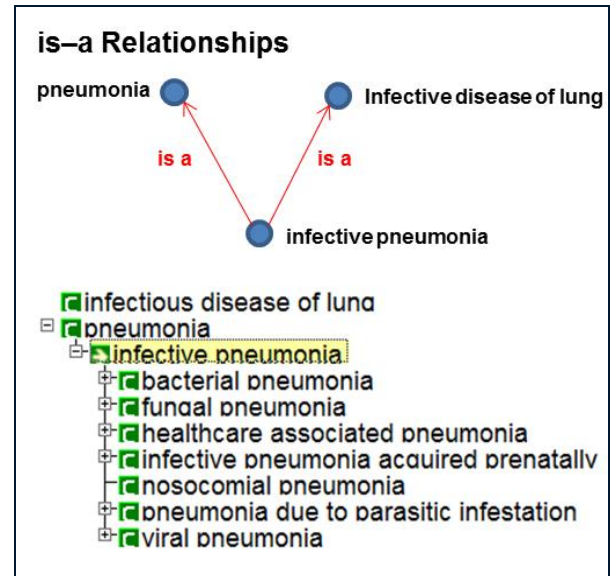

Figure 2. SNOMED CT is-a Relationships

Each attribute relationship has a name (the type of relationship) and a value (the destination of the relationship), all of which are concepts in their own right. The concept infective pneumonia has three attribute relationships, for example it has a finding site of lung structure (Table 1).

Table 1. SNOMED CT Attribute Relationships

Attribute Relationships

Concept	Relationship Type	Value
Infective pneumonia	Pathological process	Infectious process
Infective pneumonia	Associated morphology	Inflammation and consolidation
Infective pneumonia	Finding site	Lung structure

SNOMED CT Hierarchies

SNOMED CT concepts are organised into 19 distinct hierarchies, each of which cover different aspects of healthcare. The most clinically important hierarchies are shown in Table 2, with definitions and examples. Concepts are organized from the general to the more detailed. This allows detailed clinical data to be recorded and later accessed or aggregated at a more general level. The FSN description for a concept ends with a "semantic tag" in parentheses, which indicates the semantic category (hierarchy) to which each concept belongs. The "semantic tag" helps to disambiguate different concepts which may be referred to by the same commonly used word or phrase. Some concepts within the hierarchies are

used for recording information about the care of a patient e.g. asthma (disorder) whereas other concepts are used to help categorise or define concepts within the SNOMED CT structure e.g. infectious process (qualifier value) and may not be seen at the point of data entry by healthcare professionals. More information on SNOMED CT components and hierarchies can be found in the SNOMED International Starter Guide and Editorial Guide (SNOMED 2017c).

NHS dictionary of medicines and devices (dm+d)

dm+d is a dictionary of descriptions and codes which represent medicines and devices in use across the NHS. It is delivered through a partnership between NHS Digital and the NHS Business Services Authority and provides the recognised NHS standard for uniquely identifying medicines and medical devices used in patient care (NHS BSA 2017a). dm+d has five basic concept classes. Each concept class describes a product at different levels of granularity and each is designed specifically to support the use cases as identified below (Figure 3).

These 5 basic concept classes (VTM, VMP, AMP, VMPP, AMPP) make up the core dm+d model often referred to as the '5-box model'. Every concept in dm+d has a unique SNOMED CT ID (code) and a unique human readable description (term). Each of the concept classes from the 5-box model is described in more detail below.

Virtual Therapeutic Moiety (VTM)

A VTM is the abstract conceptual representation of the material defining the prescriber's therapeutic intent, divorced from formulation, dose or strength.

Examples of VTMs include: Atenolol, Co-amoxiclav, Paracetamol, Metoclopramide. The VTM can be thought of as the prescribing intent, the 'stuff' that the prescriber would like the patient to have without the need to be proscriptive of the administration requirements. The key use case that the VTM supports is secondary care prescribing where the formulation becomes an administration decision and the clinician just specifies what medicine the patient should be given combined with a separately defined dose.
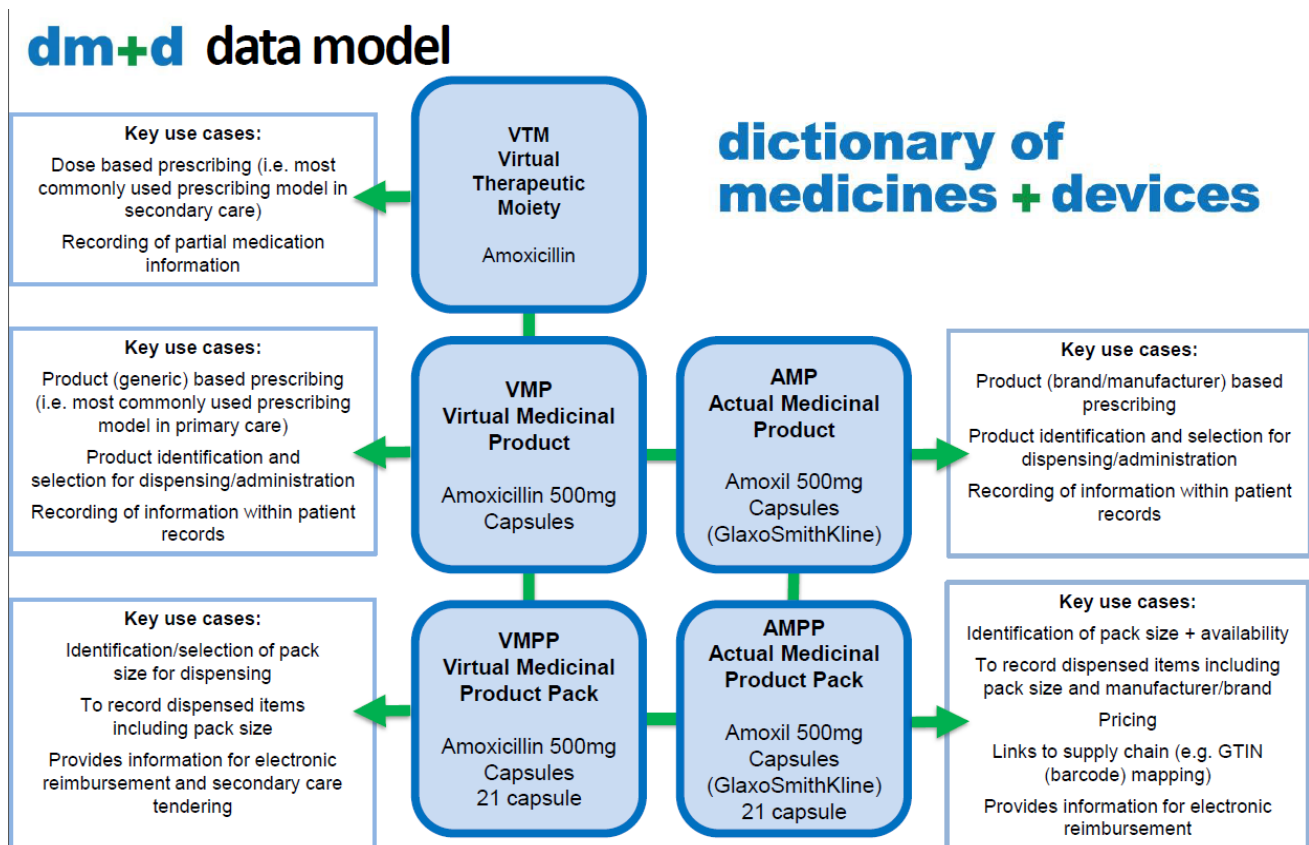

Figure 3. The dm+d data model

Table 2. SNOMED CT Hierarchies

Hierarchy	Description	Examples
Clinical finding	Represents the result of a clinical observation, assessment or judgment and includes concepts used to represent diagnoses.	Asthma (disorder), headache (finding), normal breath sounds (finding)
Procedure	Represents activities performed in the provision of health care includes not only invasive procedures but also administration of medicines, imaging, education, therapies and administrative procedures	Appendicectomy (procedure), Cervical epidural steroid injection (procedure), Education about thrombolytic therapy (procedure)
Situation with explicit context	Represents concepts in which the clinical context is specified as part of the definition of the concept itself. These include presence or absence of a condition, whether a clinical finding is current, in the past or relates to someone other than the subject of the record.	History of drug dependency (situation), Family history: Myocardial infarction (situation), Medication review done by pharmacist (situation)
Pharmaceutical / biologic product	Represents drug products	Amoxicillin 250mg capsule (product), Aspirin (product), Co-codamol 8mg/500mg tablet (product), Rituximab (product)
Substance	Represents general substances, the chemical constituents (ingredients) of pharmaceutical/biological products, body substances, dietary substances and diagnostic substances	Amoxicillin (substance), Lanolin (substance), Dust (substance), Gluten (substance), Albumin (substance)
Physical object	Represents natural and man-made physical objects	Surgical suture, device (physical object), Bandage, device (physical object)
Observable entity	Represents a question or assessment which can produce an answer or result	Systolic arterial pressure (observable entity), gender (observable entity)
Body structure	Represents normal and abnormal anatomical structures	mitral valve structure (body structure), verruca (morphologic abnormality)
Specimen	Represents entities that are obtained (usually from the patient) for examination or analysis	Bone biopsy sample (specimen), Urine specimen (specimen)
Organism	Represents organisms of significance in human medicine	Escherichia coli (organism), Human immunodeficiency virus (organism)
Staging and scales	Represents assessment scales and tumour staging systems	Glasgow coma scale (assessment scale)

Virtual Medicinal Product (VMP)

A VMP is an abstract concept representing the properties of one or more clinically equivalent Actual Medicinal Products (see below), where clinical is defined as relating to the course of a disease. VMPs will usually follow the format of name + strength + form.

Modification(s) (e.g. modified release m/r), unit dose (e.g. vial) and 'freeness' (e.g. sugar free) information are also provided where applicable.

Examples of VMPs include: Paracetamol 500mg tablets, Paracetamol 250mg/5ml oral suspension sugar free, Heparin sodium 25,000units/5ml solution for injection vials.

The key use case for the VMP is to support 'generic' prescribing or prescribing at the product (N.B. not brand) level (i.e. standard GP prescribing).

Actual Medicinal Product (AMP)

An AMP is a medicinal product that has been made available by a manufacturer / supplier.

For generic drugs the AMP description will usually be exactly the same as the VMP with the addition of the Supplier name e.g. Atenolol 100mg tablets (Almus Pharmaceuticals Ltd).

For proprietary drugs this will be the 'trade name' of the product + Supplier e.g. Tenormin 100mg tablets (AstraZeneca).

The key use case for the AMP is to support 'brand' prescribing where generic (or VMP) prescribing is not sufficient (e.g. there is a difference in release profiles and the patient must be kept on the same branded product).

Virtual Medicinal Product Pack (VMPP)

The VMPP takes the description of the VMP and provides information about the various pack sizes associated with the VMP i.e., it is the packaged representation of the VMP. The VMPP description therefore consists of VMP name + VMPP Quantity and VMPP Quantity unit of measure.

Examples of VMPP include: Paracetamol 500mg tablets + 100 + tablet, Hydrocortisone 1% cream + 30 + gram, Cotton crepe bandage 10cm x 4.5m + 1 + bandage, Clotrimazole 10% cream and Clotrimazole 2% cream + 1 + pack. The main use cases for the VMPP are to support primary care reimbursement and secondary care tendering.

Actual Medicinal Product Pack (AMPP)

An AMPP contains information concerning a medicinal product that has been made available by a manufacturer and/or supplier as a packaged entity i.e. it is the actual pack that has been made available from the supplier – the item you take off the shelf.

In simple terms the AMPP description consists of the following: AMP name + Supplier + VMPP Quantity and VMPP Quantity unit of measure.

Examples of AMPP include: Paracetamol 500mg tablets + (Almus Pharmaceuticals Ltd) + 100 + tablet + 10 x 10, Mandanol 500mg tablets + (M & A Pharmachem Ltd) + 100 + tablet, CoaguChek testing strips + (Roche Diagnostics) + 12 + strip + 1937634, (note - product order number, size, colour, subpack information and pack order number are also included for devices).

The AMPP is designed to be the actual item that is given to the patient that can be recorded in patient notes and also to link into the supply chain with a direct link to the product 'barcode'.

dm+d Relationships

Each dm+d concept class is available as a single XML file. The XML then provides links between the concepts. For example a line in a VMP entry will state the related VTM concept e.g. the VMP Atenolol 100mg tablets will have an entry in the XML stating the related VTM as 'Atenolol'. dm+d is supported by a robust, published Editorial Policy (NHS BSA 2017a) that describes in full how each component is authored and what other information (e.g. ingredients, dose form) is available to users.

SNOMED CT UK Drug Extension

dm+d was developed as a stand-alone product which could be implemented in systems independent of the strategic clinical terminology solution the NHS was committed to i.e. SNOMED CT. However in developing dm+d it was always noted as important that dm+d was integrated with the SNOMED CT solution. Therefore all unique identifiers used in dm+d are SNOMED CT codes and all core dm+d is imported into SNOMED CT to form the SNOMED CT UK Drug Extension. dm+d therefore, although a standalone product with its own branding, should always be thought of as the medicines and devices UK component of SNOMED CT.

SNOMED CT AND dm+d: THE NHS TERMINOLOGY STANDARDS

SNOMED CT is the fundamental standard for care terminology in England approved by Standardisation Committee for Care Information (SCCI) (NHS Digital 2016) and it is to be implemented as part of the electronic health record as stated in the policy document: 'Personalised Health and Care 2020: a framework for action' published by the National Information Board (NIB 2014). All organisations are expected to be using SNOMED CT in patient records by 2020; primary care is planned to have moved to SNOMED CT by April 2018. The ability to meet requirements in future national information standards, interoperability

programmes and data collections will require systems to have adopted SNOMED CT.

For medicines, dm+d has been approved as an 'Interoperability' Standard by SCCI (NHS Digital 2017b). The Standard is designed to ensure that diverse clinical systems can effectively 'talk' to each other using a common coded language for the transfer of medicines information. Where information about medicines used in the care of an NHS patient need to be transferred electronically from one system to another, those systems must be able to output and receive dm+d codes. Health and care organisations, system suppliers and pharmaceutical companies must comply by 30th June 2017.

USAGE AND BENEFITS OF SNOMED CT AND dm+d

SNOMED CT is increasingly being used in Electronic Health Records across the world (SNOMED 2017d) and as set out above in Terminology Standards there are now key dates by which the national use of SNOMED CT and dm+d are being stipulated in the different health and social care settings. dm+d has a proven track record underpinning the Electronic Prescription Services (EPS 2017) as the only allowable terminology that flows in the messages between the disparate systems in the electronic transmission of prescriptions process. SNOMED CT and dm+d are both used in the Summary Care Record (SCR 2017a) which provides healthcare professionals treating patients in different care settings with fast access to key clinical information. The data is derived from the GP systems and used across the NHS, such as A&E departments, hospital pharmacies, NHS 111 and GP out of hours services and walk in centres. The success of the SCR has led to it being rolled out to community pharmacies (SCR 2017b). SNOMED CT and dm+d are also stipulated in many NHS information standards and collections that are approved by SCCI (NHS Digital 2017c), for example, the Electronic Yellow Card Reporting Standard used for electronic reporting of suspected adverse drug reactions to the Medicines and Healthcare products Regulatory Agency (MHRA). In this standard SNOMED CT is used for adverse drug reaction term, drug indication, patient history, route of drug administration and dm+d for ingredient name, medicinal product.

The key benefits of the terminologies are summarised in Table 3.

Table 3. Benefits of SNOMED CT and dm+d

Key Benefits of SNOMED CT and dm+d
Provide clinical language for direct care across all care settings, all professionals and all clinical and care specialties.
Allow electronic recording in a consistent which reduces errors and can help to ensure record completeness.
Provide for the capture of clinical information at the different levels of detail.
Enable meaningful information exchange reducing the need to repeat health history at each new encounter and the potential for machine reading.
Reduce data transformation that is required using multiple terminologies and decrease the potential for differing interpretation of the same information.
Enable analysis of clinical data to support clinical audit and research work.
Enable decision support e.g. Alerts and knowledge linkage.
The use of both SNOMED CT and dm+d are free to the NHS.

TRAINING AND RESOURCES

For SNOMED CT and dm+d, NHS Digital provides a range of user and technical guidance, e-learning, case studies, presentations and webinars (NHS Digital 2017a,d,e; NHS BSA 2017a). The webinars provide a useful starting point for anyone wanting to learn about the core national clinical terminologies. SNOMED International also provide SNOMED CT documentation and open access e-learning including a foundation and implementation course (SNOMED 2017e). To view the data within the terminologies there are free online browsers for SNOMED CT (SNOMED 2017f) and dm+d (NHS BSA 2017b). Both terminologies are published through the NHS Digital Technology Reference data Update Distribution (TRUD 2017) and more information about distribution, licencing, change to content and

derivative products can be found on the NHS Digital website (NHS Digital 2017a).

CONCLUSION

Clinical terminologies are fundamental to the successful recording of clinical data within Electronic Health Record systems and are important in enabling the sharing of data between systems. A good understanding of SNOMED CT and dm+d enable care professionals to take advantage of the benefits of these terminologies.

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