



香港特別行政區政府 HKSARGOVT

Position Paper on Terminology Management for Electronic Health Record

Version 1.1

July 2024

eHR Information Standards Office

Document Summary

Document Item	Current Value
Document Title	Position Paper on Terminology Management for Electronic Health Record
Creation Date	2 July 2010
Date Last Modified	25 July 2024
Current Document Issue	Version 1.1
Document Description	The paper identifies the issues in terminology management in Hong Kong, recommends the standard terminologies to be adopted to facilitate building an interoperable eHR and proposes a mechanism in terminology management.
Prepared by	eHR Information Standards Office

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Version Tracking

Issue No.	Summary of Change	Date
V1.0	Original version	2 July 2010
V1.1	<ul style="list-style-type: none">● Change of eHealth logo● Change of reference link following the re-organisation of Office of the Government Chief Information Officer (OGCIO) and Efficiency Office (EffO) and set-up of the Digital Policy Office on 25 July 2024	25 July 2024

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Summary

- 1 Standard terminology is the foundation for supporting the development of an interoperable electronic health record (eHR). It ensures shared health data can be accurately interpreted, and thus can be reused to improve care delivery and optimize workflow. Standard terminology also supports disease surveillance to improve population health; generates medical knowledge to facilitate decision support and health services planning.
- 2 Despite the importance of standard terminology has received great attention from the health informatics field in recent two decades, its development in Hong Kong is still at the embryonic stage. There are some developments at individual organizations at specific domain areas. For example, the Hospital Authority has developed her corporate tables to support documentation of diagnoses, procedures, and drug data. The Department of Health is also maintaining a Compendium of Registered Pharmaceutical Products (Drug Compendium) which includes all registered drugs in Hong Kong. These small steps lay the foundation for building a standard terminology to support the eHR development – the Hong Kong Clinical Terminology Table (HKCTT).
- 3 The HKCTT will be built by integrating the international terminologies which are commonly used in Hong Kong, including SNOMED CT, ICD 10, and the Hospital Authority Clinical Vocabulary Table. Each concept in the HKCTT is mapped to SNOMED CT. For laboratory tests, they will be mapped to LOINC. The drug data will be built on the existing Drug Compendium which will be mapped to SNOMED CT. Mechanism, including establishing editorial policy and advisory group, will be established to ensure the quality of the table. It is planned that the basic version of the HKCTT will be ready by 2012. Once developed, the HKCTT will be updated and released on a regular basis.
- 4 Related management tools will be developed to facilitate the eHR Information Standards Office (eHRISO) to manage the table and also the ehealth community to use the table. The Hong Kong healthcare providers may provide data to the eHR through various means, including a) adopt the HKCTT and send the HKCTT code and concept to the eHR; b) adopt the recognized terminology set and send their code and description to the eHR; c) map their local terms to the HKCTT and send both the local and HKCTT codes and descriptions to the eHR; and d) send their own local terms to the eHR. Options a, b and c will support an interoperable eHR. For option d, data send to the eHR can only support record viewing and cannot be reused for other purposes, e.g. decision support, disease surveillance.
- 5 The development of HKCTT is a consolidated effort from the ehealth community. Mechanism will be established to facilitate the ehealth community to recommend improvements to the HKCTT.

1. Introduction

- 1.1. Standard terminology is the foundation for supporting the development of an interoperable electronic health record (eHR). Terminologies are medical terms and concepts used to describe, classify, and code the data elements and data expression languages and syntax that describe the relationships among terms/concepts [1]. Terminology is used to record clinical information; to facilitate the storage of clinical information; to support sharing and reuse of clinical information; to support efficient query formulation; to create a natural language output from manual structured input; and to support the application of decision support algorithms [2]. With the proliferation of applying computer technology in healthcare environment, using structured terminology to capture clinical data becomes an inevitable element in health informatics development.
- 1.2. Despite numerous terminologies have been developed, e.g. UMLS has included over 100 terminologies in her system [3], no single set is able to represent all clinical concepts. Various factors affect the development and management of clinical terminology. Health service is complex, so as the health information that captured during the healthcare process. With the continuous advancement in health science, new illnesses are identified, new therapies are invented, knowledge about the disease and how it can be treated keeps evolving. There are multiple ways to represent one single concept. In relation to this, the terminology required to support the documentation has to be dynamic, and becomes complex in structure and content.
- 1.3. Historically, terminology is evolved from classification systems which were developed to serve a specific purpose, e.g. statistics (ICD), literature retrieval (MeSH), or reimbursement (DRG) [4]. These purposes only require a terminology with clinical concepts being represented at a high level, or even accept terminology at nonspecific level. They are far from ideal to support clinical documentation. On the other hand, healthcare professionals record patient data in free format using their own expression (some even invented their own abbreviations). Same clinical concept can be represented by different terms. Same term could mean different concepts. These invite great challenges to the management of and using the terminology.

2. Current Situation

Adoption of standard terminology in Hong Kong is still at an embryonic stage. Apart from reporting mortality and inpatient morbidity data to the Department of Health in ICD 10, no standard terminology has been adopted on territory basis.

2.1. Diagnosis & Procedure

2.1.1. Originating from a statistical language, the deficiency in supporting clinical documentation using the ICD series is well accepted amongst the terminology community [5].

2.2. A study in 1995 considered SNOMED was more complete, has a compositional nature and a richer taxonomy when comparing with READ Codes and UMLS [6]. Subsequent marriage of SNOMED and READ in 2001 gave birth to the largest terminology covering all major domain areas of healthcare – SNOMED CT. Currently, SNOMED CT consists of over 300,000 active concepts. There is a trend to move towards using SNOMED CT as the standard for eHR development in various countries, e.g. US, UK, Australia, Canada, New Zealand. The major differences between SNOMED CT and the other types of clinical terminologies include :

- a) covering other areas of clinical data instead of one single domain as in the other clinical terminology
- b) defining clinical concepts through the relationship between concepts to clarify the meaning of it
- c) adopting a polyhierarchical structure to facilitate data retrieval from various dimensions
- d) supporting capturing of clinical concepts up to the granularity as desired
- e) supporting compositional terminology - building new concepts from the existing ones
- f) allowing unlimited expansion of any hierarchy under SNOMED CT by using a meaningless identifier to facilitate expansion [7]

2.2.1. The Hospital Authority (HA) has adopted the principle that management information should be generated as a byproduct of clinical documentation. There is a HA Clinical Vocabulary Table (HACVT) which is incorporated in the HA Clinical Management

System. Every term in the HACVT is mapped to ICD 9CM (HA version) and ICD 10. Doctors select an appropriate diagnosis and procedure and the ICD code is automatically generated at the backend. Currently, the HA is undergoing an exercise to map her HACVT terms to SNOMED CT (the largest terminology in the world) to facilitate multi-dimensional data retrieval.

- 2.2.2. At most private hospitals, data capturing is done by the medical record clerk based on the discharge diagnosis written by the doctor. A few hospitals also code the procedure data, and a few of them capture multiple diagnoses for each admission, as appropriate.
- 2.2.3. Some primary care service use ICPC to report the patient diagnosis. With around 1,000 clinical terms, ICPC is less granular than the ICD.

2.3. Laboratory Data

- 2.3.1. Laboratory data consists of a range of data which could be used by clinicians and pathologists who would have different interests in the dataset. Clinicians are more patient care oriented and pathologists are also interested in the other details that are relevant to the operation of the laboratory, e.g. how the laboratory test is being done. A laboratory order could be done by multiple methods, depending on which one the laboratory is adopted.
- 2.3.2. Both ‘question’ (laboratory test) and ‘answer’ (laboratory result) of the laboratory data need to be standardized. For serum sodium = 137 mmol/l, serum sodium is the question, and 137 mmol/l is the answer. At the international level, LOINC is the reference for the question and SNOMED CT is used for the answer.
- 2.3.3. LOINC is a naming standard for ‘questions’. Its attributes describe how data is collected, and specific nature of the involved observation, e.g. type of property (e.g., mass concentration), timing (e.g., 24-hour specimen), specimen (e.g., urine), data type of the data field (e.g. narrative, ordinal). To date, LOINC also includes clinical observations, e.g. head circumference, blood pressure. However, LOINC does not have a hierarchy structure, causing difficulties to group different tests for same substance together at the eHR level to facilitate general clinicians to view the data. Currently, the IHTSDO (owner of SNOMED CT) and Regenstrief Institute, Inc. (owner of LOINC) are exploring ways to harmonise these two terminologies.
- 2.3.4. There is no standard reference terminology being used for the laboratory data in Hong Kong. The hospitals and private laboratories have their own list. The HA is currently

standardizing the laboratory data based on LOINC and SNOMED CT. The standardized set will form the basis for the Hong Kong eHR laboratory test list.

2.4. Drug Data

- 2.4.1. Drug data consists of a hierarchy of concepts at various levels of granularities. From the coarsest to the finest levels, these are: therapeutic groups, drug ingredients, therapeutic moieties, routed therapeutic moieties, generic drug products, branded drug products, and saleable pack of branded drug products. Different actors may be interested in using drug data at different levels. For example: a statistician looks at groups of drugs at the therapeutic group level; a clinician writes prescriptions at the routed therapeutic moiety level; hospital pharmacies track stock levels at the generic drug product level; while a retail pharmacy records sales at the saleable pack level.
- 2.4.2. Currently there is no standard reference terminology being used for drug data in Hong Kong. Both the Department of Health, in compiling the Drug Compendium, and the HA, in maintaining its drug database, strive to adhere to the WHO's International Nonproprietary Names (INN) for drug nomenclature, but the INN is merely a collection of names at the therapeutic moiety level without a concept hierarchy that links to coarser or finer levels.
- 2.4.3. The Department of Health's Drug Compendium assigns a Hong Kong Registration Number for all pharmaceutical products requiring registration. This number is legally required to be present on all sales packs of pharmaceutical products and is well-known in the health industry in Hong Kong. The number can potentially serve as a "de facto" common identifier at the branded drug product level.
- 2.4.4. Unlike laboratory and other clinical data where LOINC and SNOMED CT dominate the market, it appears that there is a dichotomy of approach in adopting a reference terminology set for drug in overseas countries. In US, RxNorm is being chosen as the standard terminology for drug data. SNOMED CT is being adopted for Australia, New Zealand and the UK.
- 2.4.5. Both RxNorm and SNOMED CT provide analogous drug concept hierarchies. However, RxNorm uses US Approved Names as its basis for drug nomenclature at the therapeutic moiety level, while SNOMED CT uses INN.
- 2.5. The lack of terminology standards make it difficult to support the development of an interoperable eHR, disease surveillance, nor other purposes which require terminology to further the advance of healthcare knowledge of any particular area. Thus, the Steering Committee on eHealth Record Sharing recommended the development of standard terminology to support the eHR development. Discussion on terminology management for Hong Kong eHR should consider the following areas : purpose, content, application and management.

3. Purposes of Standard Terminology for Hong Kong eHR

- 3.1. It is recommended to build a Hong Kong Clinical Terminology Table (HKCTT) to support sharing of clinical data for ongoing patient care. It should facilitate clinicians to document and review patient's condition. In addition, the table should be able to assist users to retrieve data at the granularity level as desired to support building the decision support system and other purposes, such as, conducting research, reporting data to various authorities.

4. Content of the Hong Kong Clinical Terminology Table

- 4.1. To serve the above purposes, the following criteria are recommended for the future HKCTT with reference to the well accepted desiderata for controlled medical vocabularies [8] :
- a) The terminology should have sufficient breadth and depth to cover various domain areas of health science, e.g. clinical findings, procedures, laboratory data, pharmacy data, including their related attributes
 - b) The created concept has a consistent meaning and identification
 - c) The standard is expandable and will keep abreast of the development of medical science
 - d) HKSAR is able to contribute to its development such that there is an ongoing mechanism for our requirements to be incorporated in the recommended terminology
 - e) Concepts in the chosen standard has explicit formal definition that can be manipulated symbolically to facilitate terminology management
 - f) The chosen standard will support multi-hierarchy structure to represent the complexity of medical knowledge and future multi-dimensional data retrieval
 - g) Users can based on the recommended terminology to retrieve data at the granularity level of one's desire
 - h) The terminology will support composition of concept that does not exist to meet the different demands of clinical documentation
 - i) Synonyms and colloquial terms are uniquely identified and mapped to the appropriate concept to facilitate searching of the appropriate concept
 - j) Concepts are mapped to common classification systems, e.g. ICD, to facilitate data reporting
 - k) Vendor neutral and technologically independent
 - l) Relatively simple and easy to understand
- 4.2. In previous study, around 40% of the HACVT terms were created by the HA, though most of them could be post-coordinated using SNOMED CT. The international terminologies are being updated on regular basis, ranging from quarterly to yearly. This would not catch up the timeframe when the local concept is being created, which could

be on monthly basis or on ad hoc basis. There is a necessity to maintain a local table to meet the demand from the local community. On the other hand, it is also not appropriate to create another terminology which actually duplicates the work at the international level.

- 4.3. It is recommended to maintain a local standard terminology which should be mapped to the international standard terminology, including SNOMED CT and ICD 10, as appropriate. Mapping is unavoidable due to the following reasons :
- a) The HA has collected over 10 years (around 8 million) patient records which are stored in her own codes. Similar situation applies to the Department of Health, private hospitals, and other private practitioners. It is impossible to provide historic patient data in SNOMED CT without undergoing the mapping process.
 - b) To support clinical documentation, there are demands on clinical concepts that are not included in the SNOMED CT, and have to be created locally. There is a time gap to incorporate the local requirement to SNOMED CT even the IHTSDO (owner of SNOMED CT) accepts the HKSAR's request. Yet, the captured data has already been kept in Hong Kong's code, and it is not recommended to change the already stored concept identifier to avoid / minimize error in data conversion.
- 4.4. For laboratory test codes, it is recommended to reference to LOINC which has been well adopted by the laboratory sectors at the international level. To facilitate reviewing tests of the same substance at the eHR, there needs a harmonization between LOINC and SNOMED CT. Such harmonization will reduce the duplication of creating laboratory terminology, improve data interoperability and also pave the road for supporting future decision support system.
- 4.5. For drug data, it is recommended to maintain reference in the local standard terminology to both the Hong Kong Registration Number found in the Drug Compendium and to SNOMED CT. This provides users a pathway to navigate from the Hong Kong Registration Number, which is a locally well-known "de facto" identifier but which lacks a fine-grained drug concept hierarchy, to SNOMED CT, which provides the connection to the concept hierarchy.
- 4.6. Since mapping is unavoidable, a mechanism is required to ensure the quality of mapped data. Discussion includes : terminology management and application of terminology.

5. Management of the Hong Kong Clinical Terminology Table

While the healthcare sector in Hong Kong has already had her local experience in managing a terminology set, it is recommended to leverage on the local experience and also make reference to the overseas ones to build the Hong Kong Clinical Terminology Table to support the eHR development. In relation to this, a set of principles have to be developed to guide the development and future management, relevant tool has to be developed to facilitate the management process. More important, a mechanism has to be established to ensure the quality of the table. Once developed, the table will be released to the Hong Kong ehealth community. It will be also updated on a regular basis.

5.1. Principles

Based on the desiderata [6], the following principles are recommended in developing and managing the table :

- a) Nonvagueness : terms must correspond to at least one meaning
- b) Nonambiguity : no more than one meaning
- c) Nonredundancy : meanings correspond to no more than one term
- d) Permanence : once created, the meaning of a concept is inviolate
- e) Expandable : A meaningless identifier is used to represent each concept
- f) Perpetual : Avoid changing of patient data even the table is updated. As there are local concepts being created which may or may not be accepted by the IHTSDO, the patient data will already be stored with a local identifier. It is recommended that the patient database will still keep the local identifier even the IHTSDO has included the concept in the SNOMED CT subsequently.

5.2. Building the Table

5.2.1. The eHR terminology table should include concepts of major domain areas, such as clinical findings, procedures, laboratory data, and drug data. This can be built from integrating the following :

- a) Diagnosis and procedure terms of the HACVT

- b) ICD 10 terms at 4 digit level (terms in physiology chapters, and selected terms from the external cause chapter)
 - c) ICPC terms
 - d) Standardized laboratory data of the HA and DH
 - e) Standardized drug data of the HA and DH Drug Compendium
- 5.2.2. These terms are mapped to the SNOMED CT. The non-mapped SNOMED CT concepts will also be loaded to the HKCVT after the mapping exercise.
- 5.2.3. As there are various methods to test the same substance in laboratory, the mapped laboratory test will be mapped to LOINC and also SNOMED CT so that tests on same substance can be grouped to facilitate the clinicians to review the laboratory results in the eHR.
- 5.2.4. It is planned that the basic table will be ready by 2012. Thereafter, more work will be done on the laboratory and drug data. Please refer to Table 1 for the proposed schedule.

Table 1 : Proposed Schedule for Building the Hong Kong Clinical Terminology Table

	09/10	10/11	11/12	12/13	13/14
Mapping HACVT diagnoses and procedures to SNOMED CT					
Loading ICD 10 terms with mapping to SNOMED CT					
Loading ICPC terms with mapping to SNOMED CT					
Cleansing of the terminology table (remove duplication, identify unwanted terms)					
Standardization of HA & DH laboratory data – basic (with mapping to LOINC)					
Standardization of HA & DH laboratory data – advanced (with mapping to					

	09/10	10/11	11/12	12/13	13/14
SNOMED CT)					
Standardization of drug data (basic – with mapping to SNOMED CT at ingredient level)					
Standardization of drug data (advanced)					

5.3. Quality of the Table

- 5.3.1. To ensure the quality of the vocabulary table, a set of editorial policy will be developed. It is recommended to establish an advisory board with representatives from various clinical specialties with consultation to the Hong Kong Academy of Medicine, and relevant professional bodies. The role of the advisory board is to clarify the definition and meaning of the concepts, and to confirm the queried mapping cases, if required.
- 5.3.2. The mapping process is conducted computer match followed by manual review. The mapped concepts will be further verified by a senior terminologist. Where in doubt, the eHR Information Standards Office will clarify the concept with the advisory board. A cleansing exercise will be conducted to ensure there is no duplication of the concepts in the table when different classification codesets are loaded to the table.

5.4. Management Tool

- 5.4.1. A system is required to manage the table. The management system will
- a) Facilitate users to browse the table (including local and common reference terminologies)
 - b) Support eHR subscribers to recommend updates and download the table via the system
 - c) Assist the eHR Information Standards Office to maintain and release the updates
- 5.4.2. Further exploration will be done to identify possibilities of linking the table with the defined eHR Contents.

5.5. Maintaining & Distributing the Table

- 5.5.1. The current HACVT is being maintained on a monthly basis. It is recommended that the future HKCVT will also be updated on a similar schedule. All Hong Kong healthcare providers who subscribe to the eHR are able to submit request new terms to the eHR Information Standards Office. These terms will be reviewed and submitted to the IHTSDO for inclusion in the SNOMED CT as core data. If the HK concept is being accepted by the IHTSDO, the SNOMED CT identifier will be added to the HKCVT as the reference without amending the initial TermID. Similar would be applied for the other reference terminologies, e.g. LOINC for laboratory data.
- 5.5.2. The HKCVT will be distributed via the eHR website on monthly basis. Subscribers may access to the website to download the table.

6. Using the Hong Kong Clinical Terminology Table

6.1. To support documentation and subsequent data retrieval, there needs a tool, a terminology service, to facilitate the users to navigate and identify the required concept(s).

6.2. A range of features should be provided by the terminology service, including :

a) Simple navigation

This is the basic function of a terminology service. The feature will facilitate users to search the required term for both documentation and data reporting. The navigation could be keyword, tree-walking or user's list.

b) Code generation

This supports a more advance method in code generation and relieves the clinicians from duplicated data entry for the purpose of reporting. The required code is generated based on a single or multiple dataset(s) in an electronic form.

c) Codeset translation

The same concept can be referred to even the user provides terms under other common terminology sets. With this feature, the system is able to interpret the concept "diabetes mellitus" whether the users send 250.00 (ICD 9 CM), E14 (ICD 10), T90 (ICPC), or 73211009 (SNOMED CT).

d) Post-coordination

One can build a new concept with the existing ones. This allows healthcare organizations to store combinatorial concepts even it is not included in the table.

e) Passage indexing

Users can index a free text document with concepts being referenced to the table.

f) Natural language processing (NLP)

As part of artificial intelligence, the computer is able to analyze, understand, and manipulate the written / spoken context.

6.3. The actual implementation would be dependent on the users' requirement and maturity of the technology.

7. Sending Data to the eHR using Standard Terminologies

- 7.1. Healthcare providers may provide data to eHR at different eHR levels. Healthcare providers may :
- a) adopt the HKCVT and send the HKCVT code and concept to the eHR, or
 - b) adopt the recognized terminology sets (see Annex 1) and send the code and description to the eHR, or
 - c) map their local terms to the HKCVT and send both their local and HKCVT codes and descriptions to the eHR, or
 - d) send their own terms to the eHR without any mapping
- 7.2. All original terms sent from the healthcare providers will be displayed at the eHR regardless of whether the healthcare provider adopt the HKCVT or not. For options a, b and c, all terms mapped to the same standard concept (including the local terms) will be grouped together in eHR to facilitate the viewing of the data, and building an interoperable eHR. For option d, the local terms can only be integrated in the eHR for viewing only but not able to further process these local terms for other purposes.

8. Conclusion

- 8.1. The lack of standard in representing clinical concepts restricts the sharing of electronic health record to improve quality of health services, and enhance healthcare efficiency. The international studies and experiences in developing, managing and maintaining standard terminology have provided good references to the development of such important eHR infrastructure. It is recommended to leverage on the local experiences, and to invite participation from various healthcare sectors to build the standard terminology to support the interoperable eHR.

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Glossary

DRG	<p>Diagnosis Related Groups</p> <p>A patient classification system group patients based on the resources they consumed</p>
eHRISO	<p>Electronic Health Record Information Standards Office</p> <p>An office contracted by the HKSAR Government to the Hospital Authority for the development and management of health information standards to support eHR</p>
HACVT	<p>Hospital Authority Clinical Vocabulary Table</p> <p>A table originally developed by the Hospital Authority to facilitate clinicians to report diagnosis and procedure. Also includes other types of data, e.g. organisms, laboratory antibiotics with more development in standardization of clinical data.</p>
HKCTT	<p>Hong Kong Clinical Terminology Table</p> <p>The future standard terminology to support the development of eHR in Hong Kong</p>
ICD	<p>International Classification of Diseases</p> <p>A classification system produced by the World Health Organisation (WHO) to facilitate countries to report both mortality and morbidity data. The WHO updates the system periodically. Current version is the 10th revision which was implemented in 1993.</p>
ICD 9 CM	<p>International Classification of Diseases, 9th revision, Clinical Modification</p> <p>A classification system modified by the US based on the WHO 9th revision</p>
ICPC	<p>International Classification for Primary Care</p> <p>A clinical coding system developed by the World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians (WONCA) to facilitate capturing of primary care data. The system includes both clinical findings and procedures. Current version is ICPC2.</p>

IHTSDO	<p>International Health Terminology Standards Development Organisation</p> <p>An organization formed in 1997 with the purpose to develop and maintain international health terminology systems, in particular SNOMED CT</p>
INN	<p>International Nonproprietary Names</p> <p>International Nonproprietary Names identify pharmaceutical substances or active pharmaceutical ingredients with the generic name. It is managed by the World Health Organisation</p>
LOINC	<p>Logical Observations, Identifiers Names and Codes</p> <p>A set of universal names and identifier codes for laboratory and clinical observations which was developed and is maintained by the Regenstrief Institute, Inc.</p>
MeSH	<p>Medical Subject Headings</p> <p>A controlled vocabulary maintained by the National Library of Medicine of US for indexing articles for MEDLINE/PubMed</p>
Read Codes	<p>A set of clinical terms developed by Dr James Read for use in clinic settings in UK. It was subsequently adapted for use in hospitals and the National Health Services took over its ownership and further developed that to Clinical Terms v.3</p>
RxNorm	<p>A standardized nomenclature for clinical drugs and drug delivery devices, is produced by the National Library of Medicine of US</p>
SNOMED CT	<p>Systematized Nomenclature of Medicine, Clinical Terms</p> <p>Currently the world largest medical terminology covering major areas of clinical information such as diseases, findings, procedures, microorganisms, pharmaceuticals etc.</p>
UMLS	<p>Unified Medical Language System</p> <p>A system designed by the National Library of Medicine (NLM) to help health professionals and researchers retrieve and integrate electronic biomedical information from a variety of bibliographic databases, factual databases, and expert systems</p>

Annex 1
Recognized Terminology Sets for eHR

Terminology / Classification	Drug	Laboratory	Diagnosis	Other health data
Compendium of Registered Pharmaceutical Products (HK Drug Compendium)	Y			
Hong Kong Clinical Terminology Table (HKCTT)	Y	Y	Y	Y
International Classification of Diseases, 10th Revision (ICD 10) #			Y	
International Classification for Primary Care (ICPC) #			Y	
Logical Observations, Identifiers Names and Codes (LOINC)		Y		
Systematized Nomenclature of Medicine, Clinical Terms (SNOMED CT)	Y	Y	Y	Y

ICD 10 and ICPC data are considered as classification system which contains terms with multiple concepts. The content coverage is also limited by its structure. A more comprehensive terminology set is required to support the eHR development. As some healthcare providers are using these systems, morbidity data in ICD 10 and ICPC terms will be accepted by the eHR till 2017. It is recommended that healthcare providers to migrate their terminology sets from ICD 10 / ICPC to the HKCTT or SNOMED CT before then. For mortality data, the eHR will adopt the classification system as recommended by the Department of Health.