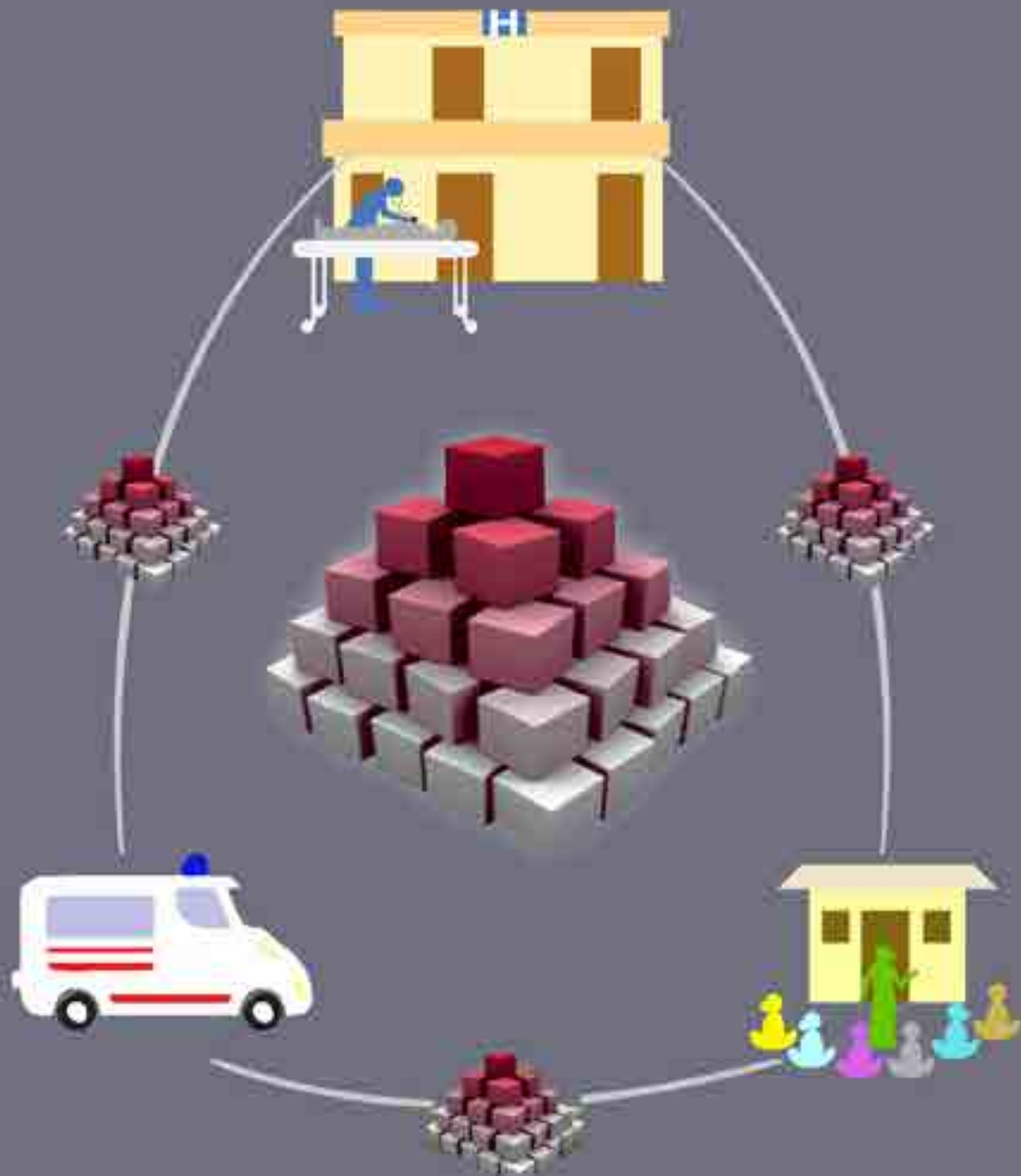# Meta Data and Data Standards for Health Domain

Part I

Overview Report of the National Committee

(Draft)

Ministry of Health & Family Welfare
Government of India

Meta Data and Data Standards for Health Domain

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Overview Report of the National Committee

(Draft)

November 2013

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Government of India

Acknowledgement

Manoj Jhalani
Chairperson
Committee on Meta Data & Data Standards in Health Domain
Ministry of Health & Family Welfare
New Delhi

Terms of Reference of the Domain Health Committee

Terms of Reference

» To identify generic data elements in the health domain, which are common across e-Governance applications within the domain as well as other domains involved in providing sectoral services delivery under e-governance.

» To study the global standards for standardising the metadata of identified generic data elements for adoption as Indian standards.

» To develop own standards / extension of global standards in Indian context, wherever required, around policy on open standards, and in synergy with other domain committees by following Institutional Mechanism for formulation of Domain specific MDDS formulation published by DietY.

» Create and maintain repository of metadata of standardised generic standards, and include the same in central repository by having liaison with e-Gov standards Div, NIC.

» Ensure enforcement of standards in the applications being developed in health domain at central/ state Government level.

» To advise for identification of suitable test suits for conformance testing of the implementation.

Health Domain MDDS Committee Members

Shri Manoj Jhalani, Joint Secretary (Policy) MoHFW	Chairperson
State IT Secretary or any nominated senior officer from States of Andhra Pradesh, Bihar & Maharashtra	Member
Shri P C Cyriac, Deputy Director General (Stats), MoHFW	Member
Dr. Himanshu Bhushan, Deputy Commissioner (MH) MoHFW	Member
Shri Vishwajeet Ringe, Senior Technical Director, NIC	Member Secretary
Shri Sunil Kumar, Senior Technical Director, NIC	Member
Ms. Gayatri Mishra, Director MoHFW	Member
Representative of Planning Commission	Member
Shri Vishwadeep Srivastava, Senior Consultant, NeGD, DietY	Member
Dr. Meenakshi Mahajan, Technical Director, eGSD(NIC)	Member
NIC State Informatics Officer from State of Gujarat/ Karnataka/ Chhattisgarh	Member
Dr. Karnick, CSE Department, IIT Kanpur	Member
Dr. S. B. Bhattacharya, Head, Health Informatics, Tata Consultancy Services	Member
Shri Gaur Sunder, Group Coordinator in-charge, Medical Informatics R&D Group at C-DAC	Member
Shri Vishal Mane, Senior Research Scientist, Media Lab Asia	Member
ED NHSRC	Member
Shri Shiban Ganju, Volunteer	Member

Executive Summary

The "Metadata and Data Standards" initiative taken by the Ministry of Communication and Technologies under National e-Governance Plan (NeGP), aims to promote the growth of e-Governance within the country by establishing interoperability across e-Governance applications for seamless sharing of data and services. Under the MDDS initiative domain specific committees have been constituted in priority areas.*

The Health Domain MDDS Committee is one such initiative, constituted on Sept 2012, under the chairmanship of Joint Secretary (Policy) with the senior technical officer of NIC as its member-secretary. The secretariat is located in the National Health System Resource Centre (NHSRC), entrusted with the task of extensive stakeholder consultations and recruiting appropriate technical agencies to support this work. The process included a study of existing systems and their interoperability issues and a study of global data and interoperability standards.

As the National Health Mission in the 12th Plan period moves towards the goal of Universal Health Coverage, one of the key challenges is to provide the information architecture for the increasingly large and growing complexity of information needs of service users, healthcare providers, of hospital and health managers and for e-governance.

Establishing nationwide metadata, data standards and interoperability standards is one of the key steps in the endeavour to better manage this complexity. The Meta Data and Data Standards are developed following the guidelines set by the DietY [#,!], and are organised in four parts:
Part I: The Overview
Part II: Data Elements: Quick Reference

Part III: Code Directory: Quick Reference; Sample Values and Meta Data:
Part IV: Data Elements Meta Data

The first of these parts is this publication, whereas the other three parts are made available only as soft copy format- in CD with this publication and on the MOHFW, NRHM and NHSRC websites.

Part I details the structure and design of the MDDS standards. It explains how based on semantic theory, the principles of design were established (see figure 1 and 2). This is essential for ordering different words and their varying interpretations and usage into a logically consistent set of data elements and their attributes with a code value for each, such that these data standards can be readily accessed and used in the development of all healthcare IT applications and products. Recognising that in the health domain, there would always be a need for incremental additions and modification, this section also describes the process by which the standards were arrived at and the institutional requirements for maintaining the very dynamic nature of these standards and ensuring their implementation across the nation.

In Part II, The Common Data Elements [CDE] provide the common standardised vocabulary for various participants in the health system – centre and state, public and private, to begin sharing meaningful information with each other in a timely manner. Approximately 1000 data elements are identified for the health domain and are grouped under 39 logical entities such as Patient, Examination, Diagnosis, Mortality, Pharmacy etc. Grouping of data elements under these entities would make MDDS better manageable and easier to use.

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* https://egovstandards.gov.in/
# Operational Manual for formulation of Domain Specific Metadata and Data Standards
! Institutional Mechanism for formulation of Domain specific Metadata and Data standards

In Part III, we provide a list of approximately 141 Code Directories that have been created to enforce data standards. For example "the identification of a facility" and the "operational status of a facility" are two distinct data elements. But there are over 200,000 facilities in the public sector alone. Moreover, the functional status of each of these facilities could correspond to following descriptions: non functional, functional, under repair, closed and so on... The code directory for facility would report the "value" provided to each facility such that it is uniquely identified and the code directory for "facility operational status" would tell us how to denote the operational status so that all systems that read it make the same meaning. Since most data elements have multiple attributes, by combining values drawn from different code directories with each data element it would be possible to provide a standard meaning and code for a universe of words and meanings. Part III therefore indicates name of each code directory, source of code directory and the ownership rights for each of the code directories. In some instances an existing code directory is referred to, providing the source and its ownership rights. In others the code directory is created by the MDDS committee or would need to be created. The metadata of each code directory is given in the Code Directory Meta Data.

Part IV has metadata for each data element developed under MDDS. Metadata includes the data type and size for each data element defined under MDDS.

In addition to the above, the document provides annexures with sample data sets for users of the Health Domain MDDS for drug inventories and blood banks. The system specific integration recommendations are also included in the annexure.

One of the challenges that this committee has addressed is the establishment of a set of *"identifiers"*- i.e. standards for identifying the Facility, the Medical Provider, Patient, and all others handling healthcare data so that information across different locations can be exchanged easily and securely.

For identification of diseases, clinical procedures, laboratory and diagnostic tests and therapeutic interventions, standards referenced by MDDS committee include ICD-10, ICD-9, SNOMED-CT, LOINC, HL7 v2.x, HL7 v3 RIM, Canadian Classification of Health Interventions (CCI), WHO Morbidity and WHO Mortality list. Domain standards currently in use in India were also referenced and incorporated. All recommendations of the EMR Committee report (Aug-2013) are incorporated in Health MDDS. Existing programmes and systems such as MCTS, IDSP, RNTCP, Drug Inventory & Distribution system of Rajasthan were also studied to identify relevant common data elements and metadata.

As the MDDS takes root, the government as well as private players, and managements and care providers would be better able to ensure the
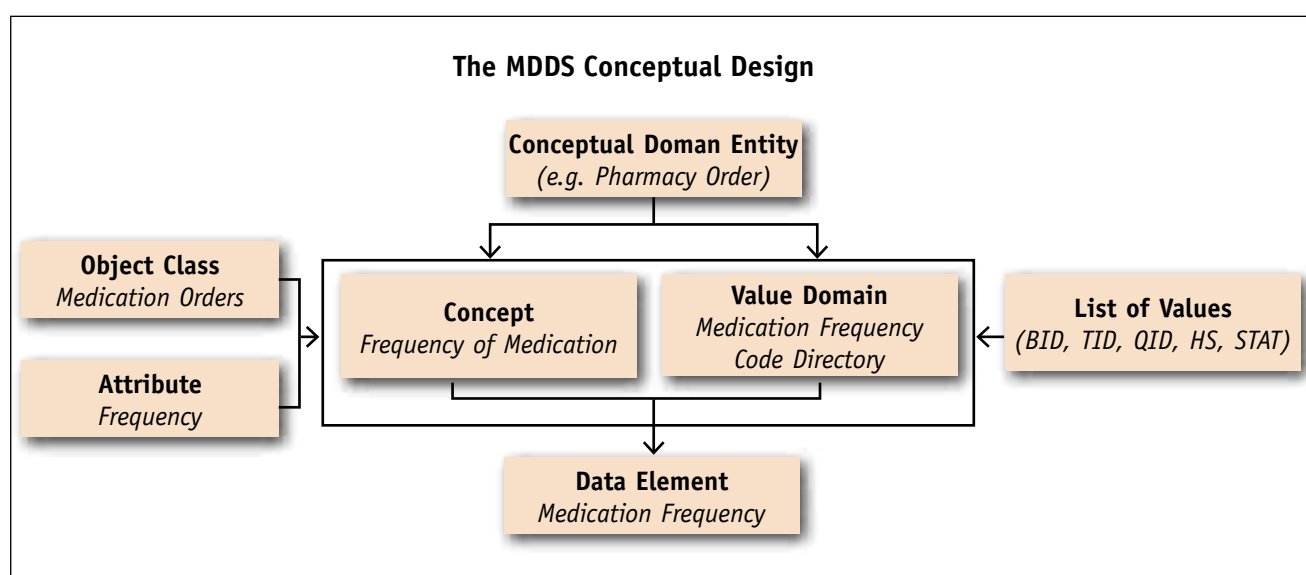
The MDDS Conceptual Design

Figure 1: Based on ISO/IEC 11179 Meta Model-I with an illustrative example relating to drug prescription

citizen's health, the delivery of services, and health expenditures and be able to more effectively identify disease patterns and their progression in the population. Such information would help in controlling disease spread, manage progression, understand public health program effectiveness and provide valuable information to researchers and medical community to help develop newer and more effective treatments and assess effectiveness of clinical pathways.

E-Governance systems for Health which are operational today include a variety of applications such as Mother and Child Tracking System (MCTS), Health Management Information System (HMIS), Hospital Information Systems (HIS), Supply Chain Management for Drugs and Vaccines, Integrated Disease Surveillance Project (IDSP), Revised National Tuberculosis Program (RNTCP) etc. There are states with over 30 distinct operational systems. With the adoption of MDDS and growing inter-operability the wealth of the data generated by these existing applications will create more meaningful and actionable information for health care providers, allowing more effective implementation and tracking of health programmes.

Implementation of these standards requires a number of institutional measures. At the apex the nation would be moving towards establishing a National Health Information Authority under the leadership of the Ministry of Health and Family Welfare. This Authority would be charged with the management, promotion, adoption and compliance with these standards. It would also ensure that the standards are constantly updated thus keeping them current and relevant. The processes required for the adoption of the MDDS would begin in parallel, and not wait the formal constitution of the authority. This would include dissemination of the standards, a helpline, reference and capacity building service that would

facilitate adoption of the MDDS by developers, linking central financing to adoption of these standards, building organizational capacity for testing and certification of compliance and provide support to upgrade existing systems to be MDDS compliant.

Though MDDS is an essential pre-condition of inter-operability it is not sufficient. Interoperability requires solutions at the semantic level, at the technical level and at the institutional level. MDDS solves the problems at the semantic level, but has only a limited contribution to the other two levels.

Inter-operability at the technical level would require specific solutions. While point to point solutions and broker systems could have immediate but limited contributions to make, in the long term a public gateway (Health Information Exchange) built on MDDS principles would be desirable. This would accelerate adoption of MDDS by public and private health programmes and systems, Health Information Exchange (HIE) would allow health systems, that may be spread across public or private sector or across different geographies, to interact with each other through this exchange, while ensuring that every system that interacts with HIE uses defined data standards.

Inter-operability at the institutional level would require a dialogue between public health organizations, to understand information needs, as well as barriers to better quality and use of information. Much of this relates to terms of collection and recording of information, the patterns of flow and aggregation and contexts of use of information rather to either semantic or technical considerations. Solving the semantic and technical barriers brings inter-operability much closer, but there would be still challenges to face. The MDDS publication is thus the first step of a long journey, not its destination.

Note to the Reader

The Common Data Element is meant for the use of Healthcare-IT Professionals involved in design, upgrade, re-engineering or interoperability of Healthcare-IT applications. Though Healthcare terminology much of which is derived from Greek and Latin, is largely limited to code directories. Some key words could have a different meaning in general English as compared to its use in Healthcare Informatics. For Example- The keyword 'Provider' has a specific meaning in healthcare i.e. Service Provider e.g. Physician, Dentist, Nurse etc.; whereas the word provider in English can mean anything e.g. main bread winner or provider of a family. Therefore non-Healthcare-IT professional while reviewing this list of Common Data Elements, would find it advisable to refer to a standard Medical Dictionary e.g. Steadman's or keep a Healthcare-IT professional handy. We also provide a Glossary of terms for the uninitiated audience.

The Meta Data & Data Standards published by DietY titled as 'Metadata and Data Standards – Demographic (Person Identification and Land Region Codification)* V1.1, Nov 2011' is referred by Health Domain for demography and other related data elements. Users are suggested to read Health Domain Meta Data & Data Standards in addition to the above mentioned publication by DieTY.

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* https://egovstandards.gov.in/sites/default/files/Published_Standards/Metadata%20and%20Data%20Standards/MDDS_Demographic_Ver_1.1.pdf

Contents

Introduction

The Metadata and Data Standards (MDDS) is an initiative taken by Ministry of Communication and Technologies under National e-Governance Plan (NeGP). The intent was to promote the growth of e-Governance within the country by establishing interoperability across e-Governance applications for seamless sharing of data and services. Under the MDDS initiative domain specific committees have been constituted in priority areas.* The Health Domain MDDS Committee was one such initiative, which was constituted on Sept 2012, under the chairmanship of Joint Secretary (Policy) in pursuance of communication received from Secretary, Ministry of Communication and Technology, DietY.

Post formation, the Committee had initial orientation meetings on Metadata and Data Standards development for health domain. After initial discussions, National Health System Resource Centre (NHSRC) was constituted as secretariat for the committee. To help develop Meta Data & Data Standards, two agencies were brought on-board following a proper selection process based on their merit on Health informatics. The due diligence was thoroughly done to study the landscape of existing health domain by involving all relevant stakeholders and knowledge partners including Program Officers and System Managers of Central and State Health IT Systems. As part of terms of reference, a thorough study of global data and interoperability standards were taken into account.

Initially generic data elements were extracted from the existing health IT systems. However these existing systems were geared towards addressing specific program requirements which was falling short to address the vast scope of health domain. The other challenge was that data elements of these systems were not aligned with global data standards. Efforts were made to adopt and modify global standards in such a way that these existing applications could easily be upgraded to MDDS standards.

The exercise yielded to approximate 1000 data elements which were regrouped and formatted into 39 entities for better assimilation and presentation. These data elements will serve as the common minimum data elements for development of IT applications for various sub domains of health care. This is intended to facilitate interoperability among various applications.

What is Common Data Element?

The Health Domain MDDS Committee provides a list of data elements that will serve as the common data elements [CDE] for any new application being built in health domain. CDE is enough to provide most of the universe of data elements for any new healthcare application to be built. This means – the new applications must have relevant data elements from CDE built-into it though they may have more data elements, above and beyond the CDE, for their local needs. CDE will then help standardise any new IT Application being built in the health domain.

Due to the inherent complexity of Health domain - It is difficult to create minimum set of data elements that every sub-domain must adhere. Each sub-domain's minimum data element may not be completely applicable to other sub-domain – meaning 'My minimum need not be your minimum'. For example the Lab Order data elements required at primary care setting will be far less than the Lab Order data elements required at secondary care and tertiary care settings.

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* https://egovstandards.gov.in/

Though the attempt is to be universal, healthcare is so vast that some specific data elements on the fringes may have been left out inadvertently. We cannot pre-empt and include everything that is out there and create space for it in CDE. Therefore we have to assume that the usage of CDE will throw up new requirements that will give inputs to the Health Domain MDDS Committee and help CDE to enhance, enrich and mature over time. When new applications do not find the relevant data element or values for their use, they will have to use 'Free Text' data element or 'Other' Value from the code directory or value list. Though the usage of 'Free Text' data element or 'Other' Values will have to be discouraged in principle; however this usage of 'Free Text' data element or 'Other' Values has to be regularly monitored by the Health Domain MDDS Committee and used as valuable feedback for the next versions of the CDE.

Therefore CDE is intended to be a living document and a designated Health Domain MDDS Committee will have the authority to add any new data elements, values or code directories that were left out at this stage or that may emerge as a result of natural evolution of the healthcare domain.

Why is Common Data Element Required?

Organizations often want to exchange data quickly and precisely between computer systems.

The need for the CDE arose because most of the Healthcare-IT applications are being developed without any standards by different agencies and vendors in public and private sector in India. Each application is developed for standalone use without much attention to semantic interoperability. Later when the thought of interoperability emerges – it becomes difficult to connect the systems and make them talk to each other because they were never designed for that purpose. Even if technical and organizational interoperability is done the semantic interoperability may remain a challenge. For example – all applications must have the same Facility Master. When Application A sends the ANC data for Facility 123, the receiving Application B should understand ANC and uniquely identify Facility 123. Another example is if a hospital application sends the insurance reimbursement bill to insurance company/government, the recipient application should be able to understand and re-present the same meaning of bill information.

Conceptual Design Principles

The holy grail of Healthcare is the Provider – Patient relationship. The entire common data elements have been designed by keeping the Provider – Patient relationship in mind rather than either entity as the centre. The CDE has been designed based on the standard ISO/IEC 11179. This standard is a result of the following principles of semantic theory, combined with basic principles of data modelling.

» **Conceptual Domain:** The first principle from semantic theory is the thesaurus type relation between wider and more specific concepts; For Example- the wider concept 'Order' has a relationship with similar more specific concept Pharmacy Order and Immunization Order. Therefore the CDE has created Pharmacy Order and Immunization Order entity.

» **Concept:** The second principle from semantic theory is the relation between a concept and its representation. Different synonyms or closely related keywords can convey the same concept. For Example – The number of times the drug/ medication has to be taken at what interval is a concept. 'Frequency of Drug' and 'Frequency of Medication' are different representations of the same concept.

» **Data Element:** The basic principle of data modelling is the combination of an Object class and an Attribute to form a more specific 'data element concept'. For example- the abstract concept 'Frequency of Medication' is combined with the object class 'Medication Order' and is associated with Attribute 'Frequency' to form the data element concept 'Medication Frequency'. The standard must select the most appropriate keyword as the representation of the concept. In the above case the
  • **Object:** is 'Medication Order' and,
  • **Attribute:** is 'Frequency'

» **Value Domain:** A value domain is the permitted range of values for a concept. If the data element concept has a single value then it will remain as a single data element. If it has a limited set of values attached to it then it will have a value list. If the data element has a long list of values that are liable to change or be modified due to the business

needs of the health domain then it is advisable to create a Code Directory for those values. For Example- For data element concept 'Medication Frequency' the related Code Directory will have values: BID, TID, QID, HS, SOS, and Stat.

There are other approaches to represent values in use by other countries. In Australia Meteor e.g. the different possible values of a data element concept are described as many related data elements. However Health Domain MDDS Committee has consciously pushed the complexity of healthcare into value lists and code directories. The Committee believes that, this is a logically more mature approach. Two more examples are given here to help users understand this concept.

Example of Conceptual Design

Example	Depicting the concept Health Condition, Chickungunea.	Depicting the concept, Facility Operational Status.
Data Element	Health Condition Code	Facility Operational Status
Object	Health Condition (Chickungunea)	Facility (Sub Centre)
Attribute	Code (ICD-10 Code)	Operational Status
Value Domain	ICD-10 Code value for Chickungunea (A92.0)	Operational Status Value List (Functional)

Figure 2: ISO/IEC 11179 Meta Model-II
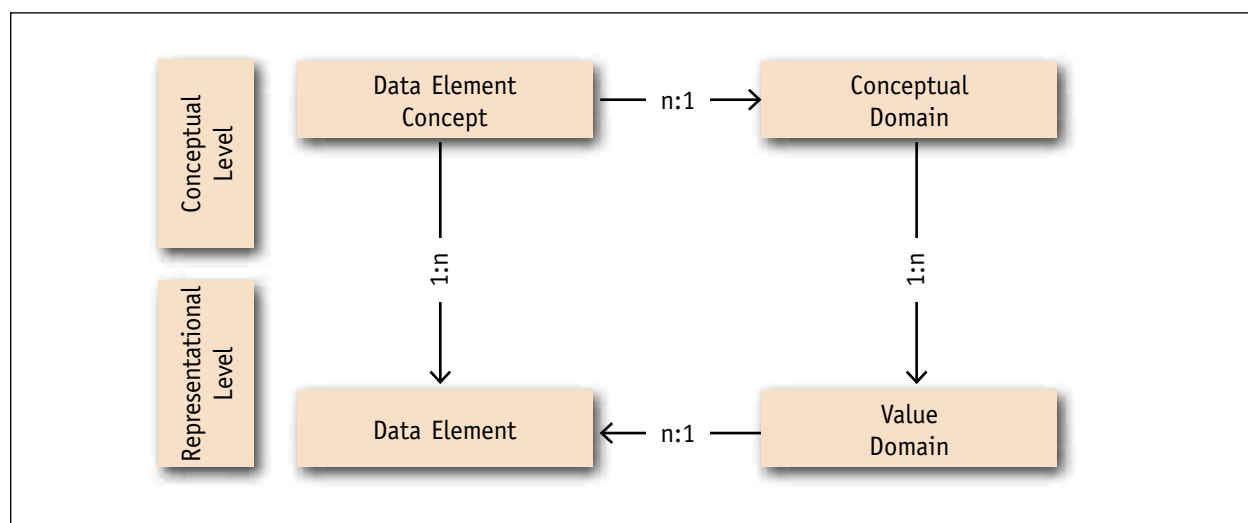
The CDE acts as the super set for the most of the sub domains in healthcare. The CDE has been designed to cover all aspects of Healthcare starting from OPD, Inpatient, Community Care, Emergency Care, Program Management to Health Finance. This is across- 1) Direct Care of the patient where the provider is providing the service directly to the patient and 2) Supporting Services to help the healthcare provider in providing the healthcare services. The details of each CDE entity have been covered in Section II.

Many of these data elements have been drawn from standards such as –

» Continuity of care document [CCD]: CCD was developed by HL7 for portability of medical records.
» HL7 v2.x: String based standard for interoperability of Healthcare data, developed by HL7.org and adopted widely across the globe.
» HL7 v3 RIM: XML based standard for interoperability of Healthcare data, developed by HL7.org and adopted widely across the globe.
» EMR Committee Report: Completely in agreement with EMR committee report.

Though the above said standards are our reference point but we have extended and modified them to apply to Indian setting. The associated Code Directories are drawn from standards such as –

» **ICD-10 for Diagnosis:** ICD is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates.

» **LOINC for Lab:** LOINC is a universal code system to identify laboratory and clinical observations to facilitate exchange and storage of clinical results or vital signs for patient care and research

» **CCI for Procedures:** CCI is a Canadian national standard for classifying health care procedures such as therapeutic, diagnostic and psychosocial interventions. CCI is available as open source with proper attribution to Canada. Whereas other similar standards e.g.

CPT of US and ACHI of Australia are licence based. In addition CPT is updated annually and thus any standard derived from CPT will need regular updating.

» **WHO Morbidity list:** The noun morbidity means "the quality of being un-healthful." The special tabulation list for morbidity published in ICD-10 volume 1 consists of 298 groups defined by their ICD-10 codes.

» **WHO Mortality list:** The noun mortality means "Death" The special tabulation list for mortality published in ICD-10 volume 1 consists of groups defined by their ICD-10 codes.

» **WHO ICF:** The International Classification of Functioning, Disability and Health (ICF) are used for defining functionality & disability.

» **WHO Verbal Autopsy Standards:** Is list of standards for causes of death with mapping to ICD-10 Codes.

Principles of Design

Structure of the MDDS Standard

The Meta Data and Data Standards are developed following the guidelines set by the DietY in form of MDDS Operational Manuals[2,3]. MDDS Standards are broadly covered under five sections as given below.

1. Data Element Quick Reference (ref: Part-II)
2. Code Directory Quick Reference (ref: Part-III)
3. Code Directory Sample Values (ref: Part-III)
4. Code Directory Meta Data (ref: Part-III)
5. Data Element Meta Data (ref: Part-IV)

Data Element Quick Reference document is the list of all the data elements created under the MDDS Health Domain (Part II). This list gives brief description about the data element in addition to the data format & size it follows. The comprehensive list of attributes of data elements is available in the Mata Data of Data Elements Document (Part IV). Under the quick reference document, each data element is classified into four categories to help identify following:

» Data elements which can be used from health domain to other domains (Prospective Generic Across Domain (Viz.: PGAD))
» Data elements which are common within health domain (Prospective Generic Within Domain (Viz.: PGWD)),
» Data elements which are customised from generic data elements of MDDS (Custom (Viz.: C))
» Data elements which are application specific in health domain (Application (Viz.: A)).

As per the conceptual design of data element (ISO/IEC 11179), each data element can have a single value or multiple values attached to it. The data element which has a single value will be complete in itself and if a data element has a limited list of values associated with it, then those values will be a part of value list for that data element. However if there is a long list of complex values for the data element, they have been put in relevant code directories. Values in the code directories can grow and mature with review and modification.

Code Directory Quick Reference document is ready reference to the code directories developed (Part III). This indicates name of code directory, source of code directory and the ownership rights for each of the code directory. The metadata of each code directory is given in the Code Directory Meta Data (Part III). The sample value for each code directory is also populated in the Part III. For some of the code directories, which are highly implementation specific, no sample values are populated and it is expected that each implementer will populate the values in these code directories and help MDDS committee to enrich these code directories.

Identifiers

This effort of Health Domain MDDS Committee includes creating an infrastructure to allow the exchange of healthcare data at the regional, state and national levels. To do this we must start with the accurate identification of each person/ facility receiving or providing healthcare services, and also anyone accessing or using this information.

As we move away from paper-based healthcare data that are controlled by physical access to buildings, rooms, and files, we need to have an infrastructure that supports strong identity and

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2 Operational Manual for formulation of Domain Specific Metadata and Data Standards
3 Institutional Mechanism for formulation of Domain specific Metadata and Data standards

security controls. The issues with establishing identity are compounded by the fact that healthcare data is used by many different organizations at the regional, state, and national levels. There must be a way to uniquely and securely authenticate each person across the healthcare infrastructure, whether that interaction is in person or over the Internet.

Healthcare Identifiers are necessary to ensure that patient related information is accessed by right persons and individual patient records are not duplicated across multiple systems – *"User U in role R who satisfies constraint C has permission P".*

Currently Identity Management is a major gap in healthcare i.e. - identification and authentication are currently uncontrolled and not standardized among medical systems, locations, and organizations within the healthcare community. There are a myriad of systems on the market today, each with its own methods for handling providers, health facilities and patients' identification, and very little attention to security and privacy controls. Many systems rely on simple usernames and passwords to identify and control access. Far fewer implement strong multi-factor authentication. This leads to a condition where one individual is identified by many identifiers without these numbers referring to each other. This condition impacts data exchange and usage among various IT applications.

It is critical that a set of standards be established for identifying the Facility, the Medical Provider, Patient, and all others handling healthcare data so that information across different locations can be exchanged easily and securely.

An Identifier could be a number, image (e.g. Bar Code or Blackberry ID), Biometrics (e.g. finger print or retinal scan), Radio Frequency Identifier Tag (RFID), Smart Card or a combination of these. Considering that none of these identifier standards exist today in Public Health space- The Health Domain MDDS Committee proposes basic number based identifiers. The standard can be upgraded to include Alternate Identifiers such as Bar Codes, RFIDs, Digital Signature etc., as the healthcare industry matures. For now appropriate Data Elements have been created to capture information about these Alternate Identifiers.

With regards to the nomenclature of the Identifiers some qualifiers were followed to maintain the uniformity.

a) Identifiers which were drawn from established sources were used as it is and no change is made in their names. e.g. Unique Identification Number (UID), PAN etc.

b) Identifiers which are proposed to be used uniquely and uniformly across states are termed as "Numbers" e.g. Unique Facility Identification Number, Alternate Unique Identification Number etc.

c) Identifiers where code directory or value list from established source is used are termed as 'Codes' e.g. Diagnosis Codes (ICD10 Codes), Procedure Codes (CCI Codes) etc.

d) Identifiers which were transaction specific are termed as "Identifiers or IDs". E.g. Employee ID, Document ID etc. However some of these can come from code directory master but are named as IDs because they are transaction identifiers to be populated at the time of implementation.

I. **Facility Identifiers**: Facility Identity management is complex – therefore a Facility Code Directory is created to give a structure to it. This Facility code directory will serve as a Master to which all the Applications will refer. Two set of identifiers are proposed/ mandated to uniquely identify each facility- GUID & UFIN.

   a) **Global Unique Identifier (GUID)** – This data element is a 16-bit number, which will be generated following a standardized algorithm by system. An example of a GUID in its standard form is 40e74fae-c0ab-11dfb090-0017f2300bf5. GUID will be used at the back-end to uniquely identify each facility. GUID will guarantee global uniqueness of each facility no matter where or by whom they are generated. All prospective systems need to follow standard algorithm in their backend to use GUID.

   b) **Unique Facility Identification Number (UFIN)-** UFIN is a 10 digit running number given for each facility (public & private) engaged in providing some form of health care services. UFIN will be used at the front-end with some form of human readability. There are two ways to do this.

» Give the facility a number with facility related information embedded in it (e.g. ABC-13-05-0001, where AB&C represents State, District & Block respectively and next two digits represent year of facility formation. Next two digits represent type of facility and last four digits represent the facility itself). However this approach has certain challenges as facilities might upgrade or facility attributes may change due to administrative, geographic or political realignments.

» The other way of doing it is by giving a unique running number to each facility without making this number dependent on any other factor. Where the facility related information can be added as an attribute to the UFIN.

The Health Domain MDDS Committee has adopted the later approach to uniquely identify each facility.

Why two identifiers for a facility?

Each facility will be given a sequential 10 digit integer number (UFIN) which will be used as a unique facility identifier by all users. However the uniqueness of these codes will be dependent on database system which generate these numbers, which still does not necessarily guarantees to be always unique e.g. if the database is ported from one Database Management System (DBMS) to another, the unique sequential number (or auto increment primary keys of tables) will change. In order to avoid this problem GUID is proposed along with UFIC.

Master Facility List (MFL): Using UFIN & GUID, a Master Facility List will be created at the centre and put up in a public domain and this will be used as reference by all prospective applications built at state or national level. At the implementation level we propose a Health Information Exchange or Intelligent Gateway with a Facility Registry to match facility identifiers given by various healthcare applications.

Facility identification and associated attributes can be categories in four major groups.

a) *Facility Signature Domain:* Information which will help in identification of each facility with its attributes is grouped under signature domain. E.g. type, geography, address etc.

i. Type of Facility Code Directory – This will contain code of the type of facility. E.g. 01 for Sub centre, 02 for PHC etc.

ii. Address- This includes address details of the facility, the district, state and area which it belongs to.

iii. Geocode - Longitude, Latitude & Altitude to identify a facility by GIS or GPRS system.

iv. Access to Facility Indicator- This will help identify the area where this facility is located as per the difficulty criteria set by MoHFW which includes -Easy/Difficult geographic area, hilly area etc.

v. Region Indicator- Indicates rural or urban setting where the facility is located.

vi. Population Covered – This will help provide a population based denominator to the facility. Each facility will be mapped with the census population of area which it covers to. e.g. Each Health Sub Centre (HSC) will be mapped to the villages it is serving currently, through the Census village data-base. Two or more HSCs which are sharing one village will use a proportionate population formula to get their piece of serving population from the census village data-base and to accommodate this Many-to- many relationships with HSC and villages would be required. This arrangement would further help identification of areas covered by the PHCs and their serving population. In the urban areas each ward will be mapped with Urban PHC through Many to many relationship. Population based catchment area would be defined for the government facilities under public health systems. For private and other ministry run facilities no population catchment area would be assigned.

The principle of defining this linkage is that the denominator of the sub-unit aggregate would provide the denominator for the administrative hierarchy e.g. all sub-centres under one PHC are linked with it.

vii. Administrative Linked Facility Type – This will include Type of Facility Code

with which this facility is linked for the administrative purposes. This relationship will help identify administrative hierarchy among facilities.

viii. Operational Status- This will indicate functioning status of the facility whether facility is functional or inactive.

ix. Referral facility – This provides details of the facility Type linked for referral. There can be multiple facilities to which a facility may refer their patients. However this data element will define only referral facility linkage and during implementation many facilities can be linked for referral.

x. Code Directory Ownership Authority & Type: This data element and related code directories together will indicate the ownership status for the facility. A facility can be owned by individual, public, private or combination of these. There can be multiple type of ownership within public & private. All these combinations can be addressed by using this data element.

b) *Facility Services Domain*: Each facility in India provides a set of services as mandated by the respective administration. In addition set of facilities also provide services from alternate system of medicine. E.g. Ayurvedic, Homeopathy etc. For Allopathic system of medicine list of services will come from LOINC & CCI. However in the case of alternate system only name of system of medicine would be applicable as the standard list of services from alternate system of medicine are not available.

i. Code Directory Facility System of Medicine Type: This will indicate which type of medicine system related services are provided from this facility. There is more than one system of medicine in our country. Services of more than one system of medicine are also provided from one facility and this data element will help define these combinations.

ii. Code Directory Facility Services Master: Indicates the services rendered by the facility- This gives the detailed list of services that a facility can provide. Any facility can select list of services that it can provide from this code directory.

c) *Facility Human Resource Domain*: Code directory Facility Human Resources Type Master: Indicates the number of human resources available with the facility with their designations.

d) *Facility Infrastructure Domain*:

i. Facility Bed Master: This will indicate number of beds available with facility.

ii. Facility Bed Type Master: This will indicate the type of beds available with the facility- sanctioned, functional and available.

II. **People Identifiers**: These are the identifiers used to identify individual patients, relatives and various providers in the health system.

a) *Patient Identifiers*: Currently multiple patient identifiers are used across applications in health care space in India. There is also a massive program allocating unique identification number to individuals i.e. Aadhar Number. Aadhar number is 12 digit integer allocated by Unique Identification Authority of India (UIDAI). The Health Domain MDDS Committee proposes to use Aadhar Number as unique patient identifier. However in case patient does not have Aadhar Number a provision has been made for the use of Alternate ID, issued by any other competent authority e.g. Election ID, Driving License ID, Ration Card ID, PAN Card ID, BPL ID etc. Provision has also been made to identify unknown persons/dead bodies coming to emergency hospital wards in case of emergency or Mass Casualty Incident (MCI) e.g. John Doe and Jane Doe (widely used placeholder for unidentified persons in emergency).

b) *Provider Identifiers:* Each provider would be given a unique identifier and for this purpose individual registration number from respective registration councils would be used. E.g. for Allopathic Doctors registration number given by MCI, for Ayurvedic Physicians registration number from Central Council of Indian Medicine, and for Nurses registration number given by Nursing council. Those providers who do not have any registration authority (i.e. physiotherapist, paramedic workers, and

community health volunteers) - individual person UID or alternate UID would be used for this purpose. Later on when a competent registration authority is put in place the number can be captured just like other Providers after appropriate values in relevant code directory has been updated.

    c) *Other People Identifiers* – e.g. Identifiers for Patients relative and next of kin.

III. **Disease Identifiers**: Each procedure and service is uniquely identified by a standard code.
    i. *Diagnosis Identifiers*: e.g. ICD10 codes for diseases
    ii. *Procedure Identifiers*: e.g. CCI codes for procedures
    iii. *Output Identifiers*: e.g. WHO Morbidity and Mortality list based on ICD10 codes, and WHO ICF codes for functionality and disability.

IV. **Clinical Event Identifiers**: This indicates Document Registry to match Encounter and Episode identifiers given by various healthcare applications.
    a) *Encounter Identifiers* - Every time the patient meets a provider it is documented as an Encounter with a new Encounter ID. Encounter identifiers would apply to clinical, lab, radiology encounters. Physical examination done by the Helth Service Provider is considered as an Encounter and documented as clinical notes with a specific Encounter Identifier.
    b) *Episode Identifiers* – A group of closely related encounters for the same patient will get an Episode ID.

V. **Drug and Inventory Identifiers**: Each drug whether generic or brand is given a unique identifier. For generic names– drug list from National Formulary of India (NFI) is used as the code directory. For brand names – the brand name code directory structure has been defined but it is left to the application to take the code

directory values from appropriate source e.g. MIMS or CIMS.
   » *Item Identifiers*: As discussed above, all items - consumables, semi-durables, durables and equipment will also be given unique identifiers in the code directories.

VI. **Lab identifiers**: For laboratory procedures LOINC codes are proposed for use as identifiers.

VII. **Radiology Identifiers**: For Radiology Diagnostic and Radiology Interventional procedures - the identifiers will be taken from CCI.

VIII. **Financial Identifiers**
   » *Source of Payment Identifiers* e.g. Insurance Provider Identifier.
   » *Billing Identifiers*: Identifiers for services, procedures and medications billing.

IX. **Other identifiers**- For identifying each entity or event separately a unique ID is proposed i.e. Medical Registration board ID, ambulance service providers ID, ambulances ID, hospital departments ID etc.

Common Data Element Entities

Health Domain is very vast and to make it more readable, Health Domain MDDS Committee has created 39 logical grouping of data elements named as entities. For example emergency patient rescue related data elements were bundled together in Ambulance entity and emergency hospital care related data elements were bundled together in Emergency entity.

Entities were created to help users to locate their data elements from the entire list. However this grouping should not be confused with data sets. Data sets are list of data elements required for certain program or application to function and should be created choosing relevant data elements from various entities e.g. Diabetes Data Set, Family Planning Data Set, Inpatient Care Data Set. This grouping does not act as a binding to further development, regrouping or change in the Common Data Element list. Description of each entity is given below.

Table-1: Description of Entities

SN	Entity	Description*
1	Generic	Generic Entity contains data elements which can be applicable to various applications used in health domain. E.g. Time
2	Person	Person is an individual with certain attributes associated with it. These relates to identity management of an individual in health care. E.g. Alternate Unique Identification Number(UID)
3	Patient	A patient is any recipient of health care services. This entity list patient attributes as data elements. E.g. Patient Age
4	Employee	An Employee is a person who is hired to provide health care services to a health delivery organisation in exchange for compensation under the ambit of a contract. Human Resource Management Related data elements are grouped under this entity. E.g. Employment Status, Employment Type.
5	Provider	A health care provider is any individual that provides preventive, curative, promotional or rehabilitative health care services to individuals, families or communities. Under this entity Individual health service provider related data elements are grouped together. E.g. Unique Individual Health Care Provider ID
6	Source of Payment	Source of Payment in healthcare indicates who is paying for the services given to the patient. This can be out of pocket by patient, insurance (public, private) or provisioned through government budget, government reimbursement. Relevant data elements are grouped under this entity. E.g. Insurance Policy Type.
7	Bill	A bill is a commercial document issued by a seller to a buyer, indicating the products, quantities, and agreed prices for products or services the seller has provided to the buyer. This entity contains list of data elements which are related to billing for hospital purposes and for insurance purposes. E.g. Bill ID, Bill Type.
8	Facility	Any institution which is engaged in the delivery of health care services to the individuals, families or communities. This entity contains list of data elements which are related to health facility identification. E.g. Unique Facility ID, Facility Type Code.
9	Episode	Any health condition for which an individual is provided care by a health service provider for a certain period of time is considered as episode of care. E.g. Episode ID
10	Encounter	A patient encounter is a record of a patient's arrival in the health facility for any form of diagnostic and/or therapeutic event. This indicates interaction between a patient and health service provider irrespective of place of interaction for the purpose of diagnosis, care & treatment. An episode can contain multiple related encounters. E.g. Encounter ID, Encounter Type.
11	Advance Directives	An advance health care directive is a set of written instructions that a person gives that specify what actions should be taken for their health, if they are no longer able to make decisions due to illness or incapacity. E.g. Advance Directive Type
12	ADT	ADT refers to Admission, Discharge & Transfer of a patient in a health facility. E.g. Admission Date, Admission Type
13	Emergency	Emergency care relates to the inpatient emergency care provided to the patient reaching to the emergency department of the health facility. E.g. Patient Status, Ambulatory Status

* http://en.wikipedia.org

SN	Entity	Description*
14	Outreach	Outreach is an activity of providing services to populations who might not otherwise have access to those services. A key component of outreach is that the groups providing it are not stationary, but mobile; in other words they are meeting those in need of outreach services at the locations where those in need are. E.g. Outreach Service Provider, Outreach Service Type etc.
15	Disaster Response	Disaster response is the health care response to the disaster and consist data elements which are part of rescue, first aid, triage, transport to the facility and deceased management. E.g. Mass Casualty Incident Type.
16	Examination	Medical examination or clinical examination is the process by which a medical professional investigates the body of a patient for signs and symptoms of disease. Patient examination related data elements are grouped under this entity. E.g. Examination Type etc.
17	Vital Signs	Vital signs are measures of various physiological statistics, often taken by health professionals, in order to assess the most basic body functions. i.e. Body Temperature, Blood Pressure. Relevant Data Elements are covered under this entity. E.g. Vital Sign Result Status
18	Allergy	An allergy is a hypersensitivity disorder of the immune system. Allergic reactions occur when a person's immune system reacts to normally harmless substances in the environment. A substance that causes a reaction is called an allergen. Relevant Data Elements are grouped under this entity. E.g. Adverse Event Type.
19	Clinical Notes	Clinical Note is documentation of patient conditions, by medical service provider - which helps to reach diagnosis, acts as communication between two providers for medical care and also acts as historical reference document in patient case file. E.g. treatment summary, discharge notes etc
20	Diagnosis	Diagnosis is the process of reaching to a conclusion by determining which disease or condition is affecting human health. Health Conditions (Diseases) related data elements are placed under this entity. E.g. Health Condition Type
21	Lab	Lab entity covers data elements related for ordering laboratory services. E.g. Lab Order Code
22	Radiology	Radiology entity covers data elements related for ordering Radiology services. E.g. Radiology Procedure Code
23	Pharmacy	Pharmacy entity covers data elements related for ordering Pharmacy services. E.g. Medication Frequency, Dose
24	Immunisation Order	Orders are indication for execution of certain tasks related to patient care, medication administration, disease prevention etc. Immunisation Order Entity covers data elements related for ordering Immunisation services. E.g. Immunization Administered Date, Immunisation product code
25	Clinical Order	Clinical Order Entity covers data elements related for Clinical Orders. E.g. Order to admit date
26	Procedure	A medical procedure is a course of action intended to achieve a result in the care of person with health problems. In this entity health care procedure related data elements are listed. E.g. Procedure Code, Procedure Type

SN	Entity	Description*
27	Blood Bank	A blood bank is a bank of blood or blood components, gathered as a result of blood donation or collection, stored and preserved for later use in blood transfusion. The term "blood bank" typically refers to a division of a hospital where the storage of blood product occurs and where proper testing is performed. However, it sometimes refers to a collection center, and indeed some hospitals also perform collection. Relevant data elements are grouped under this entity. E.g. Blood Bank ID, Blood Group.
28	Nursing	Nursing care is the care of individuals, families, and communities so they may attain, maintain, or recover optimal health and quality of life. In-patient nursing care related data elements are grouped under this entity. E.g. Bed Side Procedure Indicator
29	OT	Operation Theatre is a facility within a hospital where surgical operations are carried out in a sterile environment. Relevant data elements are grouped under this section. E.g. Anaesthesia Type, Procedure Priority
30	CSSD	Central Sterile Supply Department (CSSD) is essential department in the hospital and supports sterile supply, processing, distribution for various departments especially Operation Theatre. Relevant data elements such as Sterilization Test ID are grouped under this section.
31	Inventory	Inventory management is primarily about managing supplies and stocks that are required at different locations within a facility or within many locations of a supply network. This entity includes data elements required for inventory management for drug and non drug items in health facilities. E.g. Drug ID, Supplier Name etc.
32	Remission	Remission is a condition of being healthy after an episode of disease. Relevant data elements are grouped under this entity. E.g. Remission Type.
33	Complications	Complication is an unfavourable evolution of a disease or a health condition or a therapy. Relevant Data Elements are grouped under this entity. E.g. Complication Code
34	Relapse	Relapse is recurrence of past disease or condition. Relevant data elements are grouped under this entity. E.g. Relapse Type
35	Morbidity	Morbidity is a diseased state, or poor health due to any cause in a person or in a population. Relevant data elements are grouped under this entity. E.g. Morbidity Code
36	Disability	Disability is the consequence of an impairment that may be physical, cognitive, mental, sensory, emotional, developmental, or some combination of these. Relevant data elements are grouped under this entity. E.g. Disability Code.
37	Mortality	Mortality refers to the death of an individual or incidence of Death in a population. Relevant data elements are grouped under this entity. E.g. Mortality Code.
38	Ambulance	An ambulance is a vehicle for transportation of sick or injured people to, from or between places of treatment for an illness or injury and in some instances will also provide out of hospital medical care to the patient. Relevant data elements are grouped under this entity. E.g. Ambulance ID, Ambulance Distance Covered, Ambulance en route event.
39	Indicator	Indicator entity is created as placeholder for the aggregate data elements and for reporting from population-based indicators. E.g. Infant Mortality Rate etc.

Standards Rollout

Data Sets

Data sets are list of data elements required for certain program or application to function and should be created by choosing relevant data elements from various entities. Each sub-domain, e.g. Disease Control Program, will not require all of the CDE therefore they must create its own minimum data sets from the CDE. The details of few sample data sets are given in the Annexure e.g. Drug Inventory, Blood Bank, School Health Program Data Set etc.

Due to the inherent complexity of Health domain, it is difficult to create a minimum data set that every sub-domain must adhere - Meaning 'My minimum need not be your minimum'. The CDE therefore acts as the super set for the most of the sub domains in Healthcare.

Standards Adoption for Historical Systems

Adoption of the Standards will vary by organisation and IT system. Some organisations will be early movers owing to their leadership and HR capacity to adopt the standard and undergo a rapid transformation, whereas others will lag behind, and then there will be few those may completely resist the change.

Historical Applications: Some of the resistance to change will be genuinely rooted in necessity to keep the past data and maintain the current operations. The leadership has to make a hard decision about the duration of status-quo pending an imminent upgrade. For such necessities point-to-point integration maybe considered in the interim e.g. MCTS-HMIS.

Upgraded Systems: For this systems will have to map their data elements to the CDE so that they can send the data in a standard format for interoperability. Slow movers will update/ upgrade the systems as per the standard wherever necessary e.g. non-compliant data elements, non-compliant modules, and periodicity of reporting, facility masters, and other masters. They have to fulfil the gaps between their data elements and related master, and those required as per MDDS CDE and Code Directories. Meanwhile the paper based records have to change their formats to match with upgraded systems and build capacity to feed patient data & aggregate data to upgraded systems.

For Example – MCTS has data elements such as Hb < 7 and Hb > 7; Whereas CDE has data elements such as Result Type, Result Status, Result Value and Result Reference Range. Over time MCTS will have to upgrade such that it can accept data inputs as per MDDS standard, aggregate it and convert it into outputs such as HB < 7 & HB > 7 without having entry of this as separate data elements. Institutional capacity will have to be built to support this change. Another Example – Peripheral paper based records will have to change their formats as per MDDS to feed IDSP.

Clean Slate Systems: New systems to be built on MDDS standards. These systems will be fully geared for Interoperability with all applications built on MDDS standard. Though they will also go through a maturation cycle to completely comply to the standard and in many ways may help the MDDS Health domain standard to grow. Meanwhile as paper based recording shifts to e-recording based on MDDS standards, it would be able to feed patient data & aggregate data to clean slate systems.

Given such a context, a Health Information Exchange using an Intelligent Gateway is a preferred interoperability solution for an imperfect world of healthcare including, where historical, upgraded and clean slate applications, would all continue and converge.

Table-2: Standards Roll-out across Systems

	Enabling provider for Quality of care	Reporting Aggregate Data	Recording Systems
Historical Systems	MCTS can function as is.	HMIS can take inputs from MCTS in the interim.	Paper based records fed into MCTS at block level.
Upgraded Systems	Modify Data Elements and Masters as per MDDS standard. E.g. MCTS upgraded as per CDE. Technical workarounds for integration.	HMIS can take inputs from Upgraded MCTS in the interim.	All entries are granular to patient level aggregate data. Build capacity to feed patient data.
Clean Slate Systems	Fully geared for Interoperability with all applications built on MDDS standard.	Create logical Aggregate Data Elements [MIS] from common data elements.	Recording of data in EHR format. Automate aggregation as per local reporting requirements

Prospective Applications – Drug Distribution Network

Given the diversity of India, historical and clean state applications will coexist at any point of time since the existing applications cannot be retired overnight. For Example – TN and Delhi states have their own Drug Inventory and Distribution systems and over a course of time, they have familiarized themselves with the operation and usage of the system; Whereas Rajasthan, Maharashtra and Punjab are adopting the e-Aushadhi system being developed by C-DAC. Also each of these e-Aushadhi implementations has a different code base owing to extreme differences in masters e.g. organisation hierarchy, drug procurement and distribution processes and implementation methodology. Even if C-DAC upgrades e-Aushadhi to MDDS standards, there are other disparate drug inventory systems (e.g. systems functional in Tamil Nadu & West Bengal etc.) which may not be able to completely interoperate e-Aushadhi.

To make these disparate systems interoperable, following three options can be explored:

Point-to-point, Broker based, and Exchange based patterns.

However, point to point will be expensive to maintain, broker systems may not be able to lookup a registry to locate the source of data. This requires to setup a centralised data warehouse model for reporting, which is a costly proposition in terms of maintainability and feasibility. Exchange based pattern can be achieved by introducing an intelligent gateway to define concept, code mapping and transformations at dynamic run time for all historical applications and clean slate applications. This will lead to feasible interoperable solution.

Institutional Framework

For implementing Meta Data & Data Standards some institutional mechanism needs to be put in place which will ensure participation from stakeholders and partners. There are various mechanism which can enable standards roll-out in prospective and existing systems. Standard's institution role and framework are described in section V.

Interoperability Solution

Different Models for Interoperability

There could be numerous ways of integrating disparate applications; however the approaches are logically grouped into the following main categories of application integration. Each one has its own pros and cons-

a) *Point-to-point model:* This approach by design is too expensive to write and maintain because the resultant solution could end up with a spaghetti of approximately $(X)^n$ point-to-point connections for 35 States and UTs.

b) *Broker Model:* This model has some know inherent design challenges e.g. generating a report on demand from a broker based model is not possible. The broker may not have a Registry lookup access to locate the source of the data. The solution may not know the location of data and cannot discover all applications. For Example - If drug distribution related data is spread across three e-Aushadhi applications, the Non Intelligent Broker will have challenges to access the data from these three systems. This challenge can be resolved if the logic of integration and data retrieval for all three applications is defined in the Broker in advance during the design phase. The data need and integrating logic are not static in nature in the given context so this design will always have a maintainability and feasibility issue.

In the broker based system the only option is to have a centralised data warehouse model for reporting. Given the size [~1.2 Billion] of India's population and the daily transactions e.g. drug distribution is sure to become a bottleneck for any centralised data warehouse model and will push it above and beyond its limit.

c) *Health Information Exchange Model:* The concept of intelligent broker and Registry architecture pattern appears to be better suited in the given context. This approach allows to dynamically locate the data records and the application locations. This will allow applications to serve requested data in a more optimal way. Also, this model allows connecting throughout an array of heterogeneous applications removing the need for complex point-to-point connectivity.

Recommended Model: Health Information Exchange

In a long run all public and private Health IT systems have to converge to a Health Information Exchange to realize the objective of Universal Health Coverage as laid down in 12th Five Year Plan.

This model addresses MDDS standards to ensure semantic interoperability across all applications, their data storage, privacy, security, integration, data retrieval, analysis and information usage.

This model envisages the creation of local, regional and state Health Information Exchanges [HIE] that feed the National Health Information Network [NHIN]. A centralised Health Information Exchange [HIE] has to emerge for every state that will be used for exchanging health information. All public and private Health IT applications will be integrated with the HIE exchange following a decentralized model leaving their respective data repositories intact within application data centres/ premises and applications exchanging their data using constellation of intelligent gateways and centralized registries.

The HIE will have a data warehouse to analyse the consolidated public health data. A federated structure should be adopted where the data is pulled on-demand. Central data repository model is not a suggested route as it becomes unwieldy and too expensive over a period of time. By design, the HIE pulls up only a part of data that is required for consolidated data analysis or health record portability. The patient registry will have entries

for the diseases being tracked and will also cater to population migrations where the portability of patient-based health record is important.

The HIE will support the centralized Metadata registry and register the standard Metadata specifications for all Health domain concepts. The data from Different integrating applications will be transformed to these standard concepts based on Metadata registry lookups inside the intelligent gateways before passing the data to the requesting application. Intelligent Gateway will have the built in logic to discover the applications which will provide the requested data based on the type of request generated from a requesting application or person. The gateway will be able to locate the records from different application repositories, apply dynamic transformations, codes and concept translations, data aggregation logic, based on the predefined rules in the Intelligent Gateway.

The HIE model will specify data analytics framework so that it can be flexible and capable of catering to local, District, State and National analysis and reporting requirements. This includes:

a) National Data Warehouse – Define a National level data warehouse in the NHIN to analyse the consolidated data and produce indicator based reports from source systems.

b) Local Data Analytics -Define a local data mart in every State HIE. The exchange should provide online analytical processing [OLAP] for the users at all levels to generate their own reports needed for local action. The users should be able to save the report format and define the frequency at which the reports should be populated with data. This will significantly enhance acceptability, usability and adoption.

Figure 3: State Health Information Exchange [HIE]- Conceptual Architecture

The HIE will provide the flexibility to allow inputs in consolidated [District-wise or facility-wise] as well as granular [patient-based] models. Based on readiness, HIE will allow the States to decide the mode of data entry – consolidated, facility-wise or patient-based; as long as the published architecture and standards for vocabulary, data, input/output, storage, integration, hardware and network are followed. The HIE model envisages all public health IT systems to follow integration based on known standards such as HL7, DICOM, XML etc.

Registries: - The heart of the HIE is a registry based model that has district and state level

Figure-4: National Health Information Network [NHIN]- Conceptual Architecture
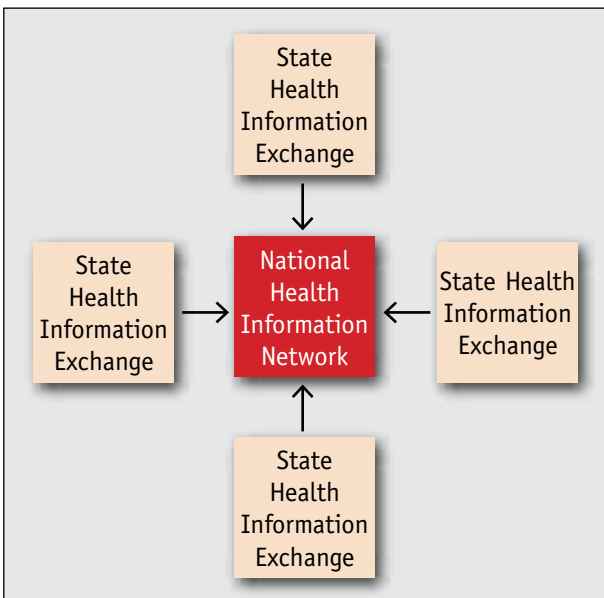
registries about disease, facility and patient. The registry may be indexed and searched by using unique identifiers. The registry will have metadata that points to the details in the source system. The indicators derived from the state disease registries should be rolled up to the central disease registry for reporting. However drill down should be available to get granular data on demand.

Benefits of Health Information Exchange

i.   Historical applications can never be done away due to their current wide-spread usage, substantially large database, user adoption and heavy investment. Using this model all existing Historical and Clean state applications can be integrated to form a unified Health Information Exchange based on a federated data model without any disruption or application design changes in existing historical applications.

ii. The semantic interoperability in different applications can be ensured using a centralized metadata registry using HIE based intelligent gateways having functions to register, discover, transform, notify, query and retrieve concepts and their meta data from centralized metadata registry. This model has already been successfully implemented in Canada Infoway.

iii. Integration with other domain applications is quite easy.

iv. Lack of awareness in India towards the need of a HIE which is apprehended by many as a complex thing to achieve which is just a negative perception and need to be corrected by proper education of this model.
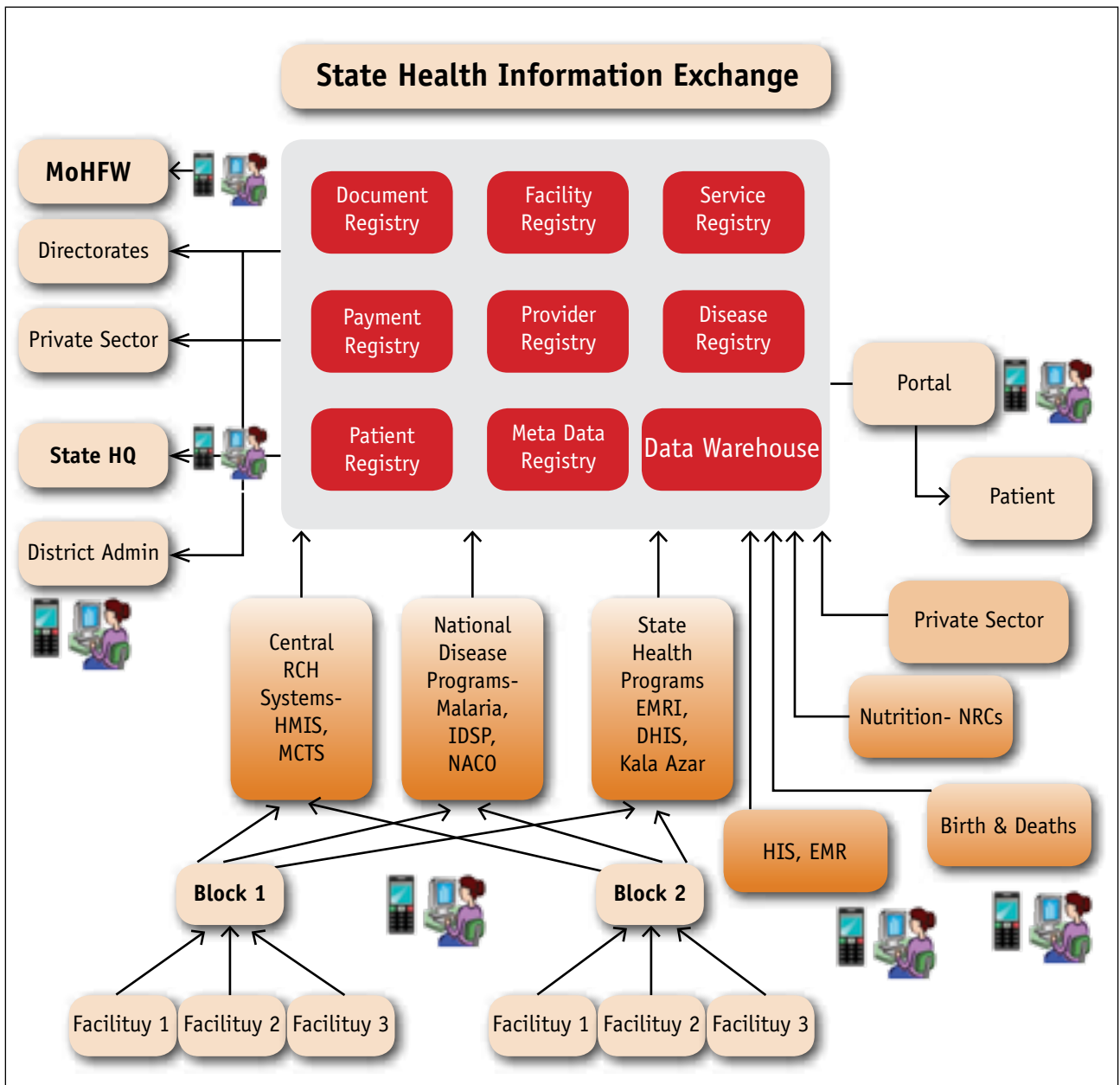
Institutional Framework

The Need

As compared to other domains, information requirement in health domain changes more rapidly and today's information systems and standards slowly becomes obsolete if not updated on a regular basis. There has been a surge in public health IT systems development under NRHM both by states and centre as noted by various Common Review Mission (CRM) reports. However each system was developed to cater local requirements and have followed their own standards leading to a situation where systems were not being able to exchange data. This adversely affects use of information. In addition data from private sector was not available for generation of population-based analytics as required to assess universal health coverage.

There is great need to make systems interoperate at various levels for seamless flow of information, which has been documented by various study reports. Mission Mode Project recently has also documented the challenges of IT silos in health care and suggested that systems should be able to speak to each other using standards of interoperability. 12th five year plan document has also recommended health IT standards to achieve interoperability among various systems. In addition plan document also mentions creation of set of indicators through which information would be shared across systems.* All this necessitates an institutional structure to be in place for information sharing among various systems and between various providers (public & private), supported by frameworks for standards implementation, certification and management. The institution should be Apex statutory body in form of National Health Information Authority (NHIA)

The nature and scope of work necessitates that this standards management institution should be placed halfway between IT and health domain with participation from IT, Health & Management professionals. The leadership would be drawn from the Ministry of Health & Family Welfare.

The Mandate

The Authority shall be responsible for,

i. Maintaining the repository of standards
ii. Update and upgrade standards
iii. Ensuring compliance to standards.
iv. Facilitate adoption/ implementation

I. Managing repository of standards
Healthcare is a very diverse domain and to address standardization, it needs a large set of data standards. . It is an error prone and difficult task to manage these standards manually and would require automated management of standards. DietY has a framework to address this purpose and it suffices the need of health domain as well.

II. Update & Upgrade Standards
a) *Documenting specific standards request*: As an iterative process the standards management organisation has to work closely with the state public health departments and private health sector to document various standards requirements originating with new program and with new areas as they open up.
b) *Organising standards consultations*: The organisation has to arrange specific standards consultations with participation from various stakeholders which will discuss and recommend updation in the standards list.

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* http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol3.pdf

c) ***Decision making:*** Once thorough deliberation is done on the prospective standards and legitimate feedbacks are absorbed, a decision should be made on the shape, size and form of standards. The decision can include the timelines and mode of releasing the standards and guidelines for implementation.

d) ***Notifying the standards***: All the competent stakeholders should be dully notified using the prevalent mode of communication by standards organization. The standards once notified should be available in public space for usage.

III. Ensuring Compliance to standards

a) ***Certification***: Prospective health IT applications have to undergo auditing and testing to ensure compliance with the standards. This task should be done by a 'Standards Auditor Group' in which external empanelled experts should participate with internal consultants. If any incentive mechanism is put in place for standards compliance, the applications which are not compliant can be disqualified for incentive schemes.

b) ***Accreditation***: Authority can accredit different health IT systems based on series of evaluations and audits ensuring compliance with the standards.

c) ***Voluntary association:*** Currently private health sector is unregulated and does not participate in information sharing. Private sector may voluntarily come forward and adopt standards for recognition and certification.

IV. Facilitate adoption/implementation:

a) ***Incentive Mechanism***: The authority can provide incentives for system design, implementation and maintenance if they comply with the MDDS standards.

b) ***Legislations***: To ensure that systems collaborate and participate in information sharing and exchange, a legal support needs to be in place in form of an 'act'. This 'act' should also indicate creation of a National Health Information Authority and information sharing mechanism across providers (public & private).

c) ***Others***: Other mechanism should be carved out in consultation with various stakeholders.

Figure 6: Standards Organization: Roles & Functions
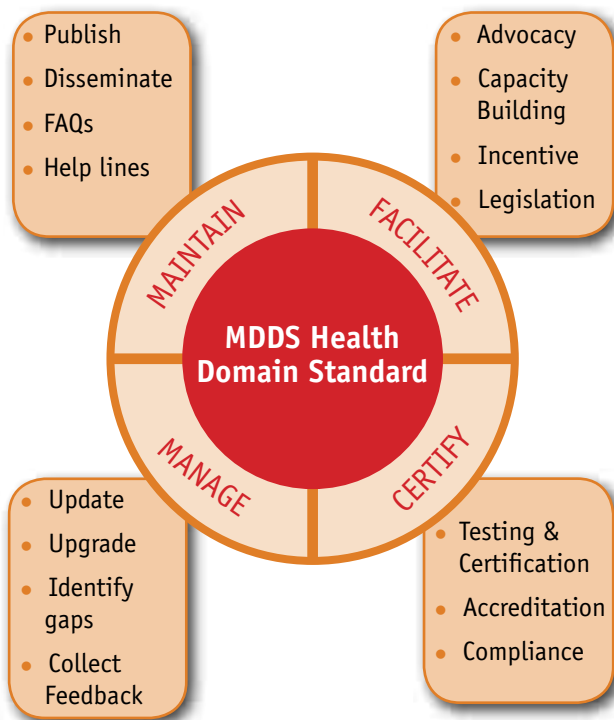
Governance

An organisation needs to be established initially by MoHFW, & later by an 'act' as the apex institution for carrying out its task as defined in mandate. One suggestion that was discussed that the current Health Domain MDDS Committee, could after some changes in composition as considered necessary, would be the National Health Information Authority. The regular function could be executed by constituting a secretariat, that could be placed in one of the existing apex public institutions or a new one created for the same.

Organisation Structure & Processes

1. **Structure at Centre:** The proposal that has been mooted visualizes a central organisation headed by Chief Executive Officer (CEO) supported by three major professional groups- a **'functional group'** comprising of health care experts with IT systems experience., a a **'technical group'** comprising of technical architects with expertise in health IT and a

management group. These groups with support of other stakeholders should collectively form three working clusters for following three specific purposes *- policy formulation, standards implementation and management of standards.*

2. **Structure at State:** In addition to the structure at the centre a similar structure with less number of consultants should be created at the state level and placed in the form of **'State Health Information Councils.'** These councils can be placed with the state level resource centres or equivalent institutions.

At both centre and state one would need a mix of consultants, some drawn on deputation basis from government services or from academic institutions with a minimum of 2-3 years of working contract and the rest drawn as independent consultants with a 2-3 years of

contract. The organisation has to be supported by budgetary allocation to meet its mandates.

3. **Processes:**

a. All sanction of funds from NHM/MOHFW for development of health IT applications and software would require compliance with these standards as conditionality.

b. Suggestions, complaints, technical snags will continue to emerge. These should be sent to the chief technical officer, NIC, who is the member- secretary of the MDDS committee. He would then have to reply to each of these queries within a one month time standard. The response could include a modification in the standards. Any such modification in standards would be notified on the website of MoHFW, NHSRC and the main portal of the standards.

Figure 7: Standards Management Organisation: Organisational Structure
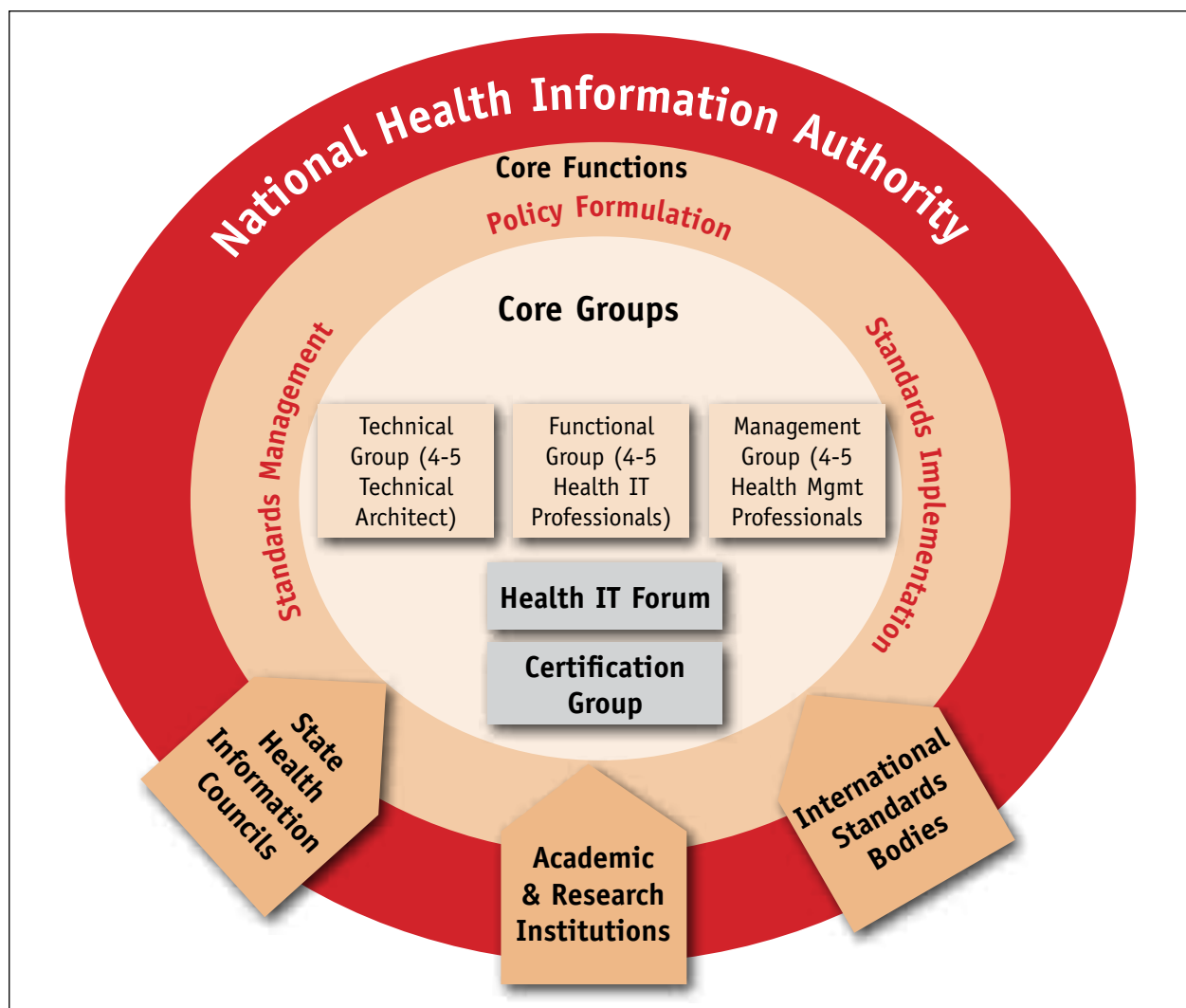
List of changes made would be available alongside standards as modified.

c. Specific proposals received to reengineer available health IT products to confirm to standards including those of state level systems but not originally financed by NRHM would be favourably considered under NRHM. However this is to be taken up on case to case basis but this is not to be done for new applications.

d. The government/ MDDS committee would accredit and rate contract suitable testing agencies and for testing and a

third party assurance of compliance with these standards.

e. Investment would be made in attending all major health IT symposia and seminars to explain and popularise standards so that industry voluntarily adopts the standards even solely for private purposes. Workshops for capacity building wherever required would also be organized.

f. All existing systems which are publicly financed and owned by MoHFW or any statutory body under MoHFW can request any other system for specific information that it

Figure 8: Standard Development Process
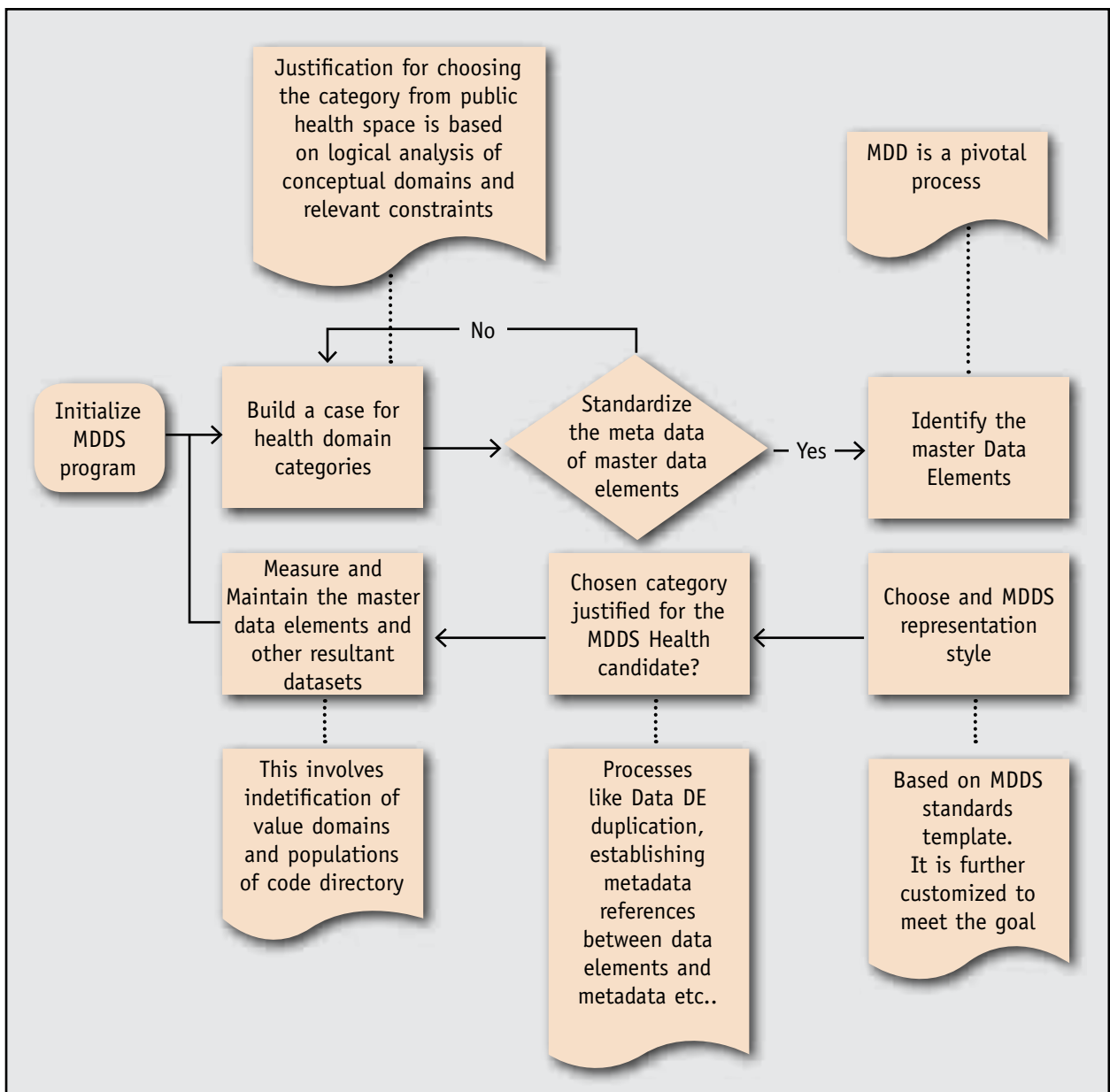
needs giving justification. The other system would then be obliged to provide the same in the interoperability syntax 'indicator'. Where necessary MDDS committee can take initiatives to find technical partners who can arrange integration between systems. Such interoperability is desirable between state financed and central financed systems however due to lack of capacity to do so it is not made mandatory as of now.

g. For standards development and updation, participation of various stakeholders is required. There needs a **'Health IT Forum'** which can provide a platform for various stakeholders from industry, academia & implementers to participate and provide suggestions and feedbacks on standards. The State organisations/councils will document the standards requests and forward these to NHIA and shared with the Health IT Forum which would provide its inputs on these requests. The final decision on standards would be made by NHIA.

Knowledge Resources

Vast amount of work has been globally done for the health IT standards development by governments, private organisation and by international NGOs. However keeping pace with these developments is only possible when the NHIA works closely with these institutions through partnerships from inception. In addition the NHIA should have easy access to documented studies, research publications on health IT standards. The authority should also collaborate with the other sectors such as insurance, IT, hospitals etc. to understand their needs and demands.

Concluding Remarks

As the MDDS takes root, the government as well as private players, and managements and care providers shall be able to better ensure the citizen's health, the delivery of services, and health spend, and be able to more effectively identify disease patterns and their progression within our population. Such information shall help in controlling disease spread, manage progression, understand public health program effectiveness as well as provide valuable information to researchers and medical community to help develop newer and more effective treatments and assess effectiveness of clinical pathways.

E-Governance systems for Health which are in operation today include a variety of applications such as Mother and Child Tracking System (MCTS), Health Management Information System (HMIS), Hospital Information Systems (HIS), Supply Chain Management for Drugs and Vaccines, Integrated Disease Surveillance Project (IDSP), Revised National Tuberculosis Program (RNTCP) etc. There are states with over 30 distinct systems which are operational. With adoption of MDDS and growing inter-operability the richness of the data generated by these existing applications will create more meaningful and actionable information for health care providers, allowing more effective implementation and tracking of health programmes. MDDS will enable decision makers to look across the vertical programme silos such as RCH, Malaria, TB, HIV and help to bring more meaningful decisions to the table with respect to resource planning & optimisation.

Multiple Disease specific applications are neither economical nor a good implementation design. Inter-operability between systems will make it possible not to burden field workers with reporting on multiple systems. Multiple systems can grow in parallel in a decentralised manner with each system having the flexibility to define its own data elements, forms, workflow, reporting frequency and report formats- but at the same time allowing for aggregations, integration and use of information at any level.

Though MDDS is an essential pre-condition of inter-operability, it is not a sufficient condition. Interoperability requires solutions at the semantic level, at the technical level and at the institutional level. MDDS solves the problems at the semantic level, but has only a limited contribution to the other two levels.

Inter-operability at the technical level would require specific solutions. While point to point solutions and broker systems could have immediate but limited contributions to make, in the long term a public gateway (Health Information Exchange) built on MDDS principles would be desirable. This would accelerate adoption of MDDS by public and private health programmes and systems, Health Information Exchange (HIE) would allow health systems, that may be spread across public or private sector or across different geographies, to interact with each other through this exchange, while ensuring that every system that interacts with HIE uses defined data standards.

Inter-operability at the institutional level would require a dialogue between public health organizations, to understand the information needs, and the barriers to better quality and use of information- much of it relates to terms of collection and recording of information, the patterns of flow and aggregation and contexts of use of information rather to either semantic or technical considerations. The MDDS standard fills an unmet need to provide semantic standardisation across the Health domain and provides a framework or interoperability. Though the implementation and adoption will take time and there are more steps to be taken, the effort to get there will be worth it. The MDDS publication is thus the first step of a long journey, not its final destination.

Glossary

Terms	Definitions	Reference	Remarks
ADT	Patient Administration, also known as Admit, Discharge and Transfer (ADT), supports many of the core administrative functions in healthcare such as person and patient registration and encounter management.	HL7	http://www.hl7.org/implement/standards/product_brief.cfm?product_id=92
Adverse Event	In medicine, an adverse effect is a harmful and undesired effect resulting from a medication or other intervention such as surgery. An adverse effect may be termed a "side effect", when judged to be secondary to a main or therapeutic effect. If it results from an unsuitable or incorrect dosage or procedure, this is called a medical error and not a complication.	Wikipedia	http://en.wikipedia.org/wiki/Adverse_event
Allergy	An allergy is a hypersensitivity disorder of the immune system. Allergic reactions occur when a person's immune system reacts to normally harmless substances in the environment. Example : Dust, pollen, certain medications like aspirin etc.	Wikipedia	http://en.wikipedia.org/wiki/Allergy
Advance Directives	An advance health care directive, also known as living will, personal directive, advance directive, or advance decision, is a set of written instructions that a person gives that specify what actions should be taken for their health, if they are no longer able to make decisions due to illness or incapacity.	Wikipedia	http://en.wikipedia.org/wiki/Advance_directives
Blood Bank	A blood bank is a cache or bank of blood or blood components, gathered as a result of blood donation or collection, stored and preserved for later use in blood transfusion. The term "blood bank" typically refers to a division of a hospital where the storage of blood product occurs and where proper testing is performed. However, it sometimes refers to a collection center, and indeed some hospitals also perform collection.	Wikipedia	http://en.wikipedia.org/wiki/Blood_bank

Terms	Definitions	Reference	Remarks
Blood Donor Registration	Blood Donor registry refers to the collection and sharing of data about donated blood and ineligible donors.	Online Medical Dictionary	http://medical-dictionary. thefreedictionary.com/ Blood+Donation+and+Registry
Blood transfusion	Blood transfusion is generally the process of receiving blood products into one's circulation intravenously. Transfusions are used in a variety of medical conditions to replace lost components of the blood.	Wikipedia	http://en.wikipedia.org/ wiki/Blood_transfusion
Common Data Element	Data Elements which are mostly needed across sub-domains for their information systems development are known as Common Data Elements.		
Code Directory	Code Directory is group of Common Data Elements where each data element is indexed based on their codes. Code Directory enhances indexing and search of data elements.		
Comorbidity	Comorbidity is the simultaneous presence of two or more medical conditions	Wikipedia	http://en.wikipedia.org/ wiki/Morbidity#Morbidity
Clinical/ Progress Notes	Notes made by a nurse, physician, social worker, physical therapist, and other health care professionals that describe the patient's condition and the treatment given or planned.	Online Medical Dictionary	http://medical-dictionary. thefreedictionary.com/ progress+notes
CSSD	The central sterile services department (CSSD) is an integrated place in hospitals and other health care facilities that performs sterilization and other actions on medical devices, equipment and consumables; for subsequent use by health workers	Wikipedia	http://en.wikipedia.org/ wiki/Central_sterile_ services_department
Disaster Management	Disaster management is the discipline of dealing with and avoiding both natural and manmade disasters. It involves preparedness, response and recovery in order to lessen the impact of disasters	Wikipedia	http://en.wikipedia.org/ wiki/Disaster_relief
Disability	Disability is the consequence of an impairment that may be physical, cognitive, mental, sensory, emotional, developmental, or some combination of these. A disability may be present from birth, or occur during a person's lifetime.	Wikipedia	http://en.wikipedia.org/ wiki/Disability
Data Element	A data element refers to the name of a particular event or factor that must be counted or measured. In context of Healthcare, a data element is a record of health event or health related event.		_

Terms	Definitions	Reference	Remarks
Data Standard	Data Standards denotes to the formal documented principles for representation, format, definition, structuring, tagging, transmission, manipulation, use, and management of data.		
Diagnosis	Medical diagnosis refers to both the process of attempting to determine or identify a possible disease or disorder and to the opinion reached by this process.	Wikipedia	http://en.wikipedia.org/wiki/Medical_diagnosis
Donor Screening	Potential donors are evaluated for anything that might make their blood unsafe to use. The screening includes testing for diseases that can be transmitted by a blood transfusion, including HIV and viral hepatitis. The donor must also answer questions about medical history and take a short physical examination to make sure the donation is not hazardous to his or her health	Wikipedia	http://en.wikipedia.org/wiki/Blood_donation
Drug Plan Monitoring	Monitoring and administering of drug to the patient by the nurse in accordance to the dose, route of administration, frequency and any other instructions as prescribed by the physician		
Direct Care	The provision of services to a patient that require some degree of interaction between the patient and the health care provider. Examples include assessment, performing procedures, teaching, and implementation of a care plan.	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/direct+care
Emergency care	Emergency medicine is a medical specialty involving care for patients with acute illnesses or injuries which require immediate medical attention	Wikipedia	http://en.wikipedia.org/wiki/Emergency_care
Facility	Healthcare institutions that include hospitals, clinics, primary care centres, and other healthcare service delivery points.	Wikipedia	http://en.wikipedia.org/wiki/Health_care_provider
HEENT	A HEENT examination is a portion of a physical examination; it principally concerns the Head, Ears, Eyes, Nose and Throat.	Wikipedia	http://en.wikipedia.org/wiki/HEENT_examination
Identifier	An identifier is a sequence of characters or words that uniquely identify an object within a particular context or domain. Identifiers can be unique within the environment of use or they can be unique across all settings. E.g. UID, ICD Codes.		

Terms	Definitions	Reference	Remarks
ICD 10	ICD-10 is the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD), a medical classification list by the World Health Organization (WHO). It codes for diseases, signs and symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases. It permits the tracking of new diagnosis.	Wikipedia	http://en.wikipedia.org/wiki/ICD-10
Immunization	Immunization, or immunisation, is the process by which an individual's immune system becomes fortified against an agent. Immunization is done through various techniques, most commonly vaccination	Wikipedia	http://en.wikipedia.org/wiki/Immunization
LOINC	Logical Observation Identifiers Names and Codes (LOINC) is a database and universal standard for identifying medical laboratory observations. It was developed and is maintained by the Regenstrief Institute, a US non-profit medical research organization, in 1994. LOINC was created in response to the demand for an electronic database for clinical care and management.	Wikipedia	http://en.wikipedia.org/wiki/LOINC
Mass Casualty	(MCI) Any large number of casualties produced in a relatively short period of time, usually as the result of a single incident such as a military aircraft accident, hurricane, flood, earthquake, or armed attack that exceeds local logistic support capabilities	Wikipedia	http://www.thefreedictionary.com/mass+casualty
Meta Data	The term metadata refers to "data about data". International standards apply to metadata.	Wikipedia	http://en.wikipedia.org/wiki/Data
Master Data	These are the Data elements that are of master nature and are going to be static in nature for the scope of the standards.	Wikipedia	http://en.wikipedia.org/wiki/Master_Data
Morbidity	Morbidity is a diseased state, disability, or poor health due to any cause. The term may be used to refer to the existence of any form of disease, or to the degree that the health condition affects the patient	Wikipedia	http://en.wikipedia.org/wiki/Morbidity#Morbidity
Mortality	the death rate, which reflects the number of deaths per unit of population in any specific region, age group, disease, or other classification	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/mortality

Terms	Definitions	Reference	Remarks
OT Management	Operation Theatre or Operational operating room management focuses on maximizing operational efficiency at the facility, i.e. to maximize the number of surgical cases that can be done on a given day while minimizing the required resources and related costs	Wikipedia	http://en.wikipedia.org/wiki/Operating_room_management
Outcome	the condition of a patient at the end of therapy or a disease process, including the degree of wellness and the need for continuing care, medication, support, counselling, or education.	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/outcome
Outreach Services	Outreach is an activity of providing services to populations who might not otherwise have access to those services. A key component of outreach is that the groups providing it are not stationary, but mobile; in other words they are meeting those in need of outreach services at the locations where those in need are in addition to delivering services, outreach has an educational role, raising the awareness of existing services. E.g. mobile medical unit, health camp, Village health and nutrition day.	Wikipedia	http://en.wikipedia.org/wiki/Outreach
Pain Assessment	Pain assessment is an evaluation of the reported pain and the factors that alleviate or exacerbate it, as well as the response to treatment of pain. Responses to pain vary widely among individuals, depending on many different physical and psychological factors, such as specific diseases and injuries and the health, pain threshold, fear, anxiety, and cultural background of the individual involved, as well as the way the person expresses pain experiences	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/pain+assessment
Physical Examination	A physical examination, medical examination, or clinical examination (more popularly known as a check-up or medical) is the process by which a medical professional investigates the body of a patient for signs of disease. It generally follows the taking of the medical history — an account of the symptoms as experienced by the patient. Together with the medical history, the physical examination aids in determining the correct diagnosis and devising the treatment plan	Wikipedia	http://en.wikipedia.org/wiki/Physical_examination

Terms	Definitions	Reference	Remarks
Post op recovery monitoring	Keeping an eye on patients who are at serious risk of complications, and on more standard recovery floors in the hospital. They are usually responsible for changing dressings, monitoring vital signs, looking for signs of complications, and administering medications. The care of an attentive surgical nurse ensures that a patient's recovery goes as smoothly as possible.	Wikipedia	http://en.wikipedia.org/wiki/Surgical_nursing
Pre-Anesthetic checks	Evaluation of anesthesia risk of a patient prior to administering anesthesia, which includes review of medical history, drug/allergy history, interview and examination of patient.		
Pre-operative checks	In pre-operative care, a surgical nurse helps to prepare a patient for surgery, both physically and emotionally. Surgical nurses may explain the procedure to the patient, and ease fears about the upcoming surgery and recovery. They also check the patient's vitals, administer medications, and help to sterilize and mark the surgical site.	Wikipedia	http://en.wikipedia.org/wiki/Surgical_nursing
Provider	A health care provider is an individual or an institution that provides preventive, curative, promotional or rehabilitative health care services in a systematic way to individuals, families or communities.	Wikipedia	http://en.wikipedia.org/wiki/Health_care_provider
Palliative Care	Palliative care is an area of healthcare that focuses on relieving and preventing the suffering of patients.	Wikipedia	http://en.wikipedia.org/wiki/Palliative
Rehabilitative Care	Rehabilitation is a treatment or treatments designed to facilitate the process of recovery from injury, illness, or disease to as normal a condition as possible. The purpose of rehabilitation is to restore some or all of the patient's physical, sensory, and mental capabilities that were lost due to injury, illness, or disease.	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/Rehabilitation
Remission	Remission is the state of absence of disease activity in patients with a chronic illness, with the possibility of return of disease activity	Wikipedia	http://en.wikipedia.org/wiki/Remission
Relapse	A relapse is a recurrence of a past medical condition	Wikipedia	http://en.wikipedia.org/wiki/Relapse
Recipient	In context of blood transfusion, a recipient is a person who receives blood from a blood donor.		

Terms	Definitions	Reference	Remarks
RxNorm	RxNorm is a name of a US-specific terminology in medicine that contains all medications available on US market.	Wikipedia	http://en.wikipedia.org/wiki/RxNorm
RFID	Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects.	Wikipedia	http://en.wikipedia.org/wiki/RFID
Sterlization	Sterilization (or sterilisation) is a term referring to any process that eliminates (removes) or kills all forms of microbial life, including transmissible agents (such as fungi, bacteria, viruses, spore forms, etc.) present on a surface, contained in a fluid, in medication, or in a compound such as biological culture media. Sterilization can be achieved by applying heat, chemicals, irradiation, high pressure, and filtration or combinations thereof.	Wikipedia	http://en.wikipedia.org/wiki/Sterilization_(microbiology)
Supportive Care	Supportive care interventions that help the patient achieve comfort but do not affect the course of a disease.	Online Medical Dictionary	http://medical-dictionary.thefreedictionary.com/supportive+care
Supply Chain Management	Supply chain management (SCM) is the management of an interconnected or interlinked between network, channel and node businesses involved in the provision of product and service packages required by the end customers in a supply chain. Supply chain management spans the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption	Wikipedia	http://en.wikipedia.org/wiki/Supply_chain_management
Vital Signs	Vital signs are measures of various physiological statistics, often taken by health professionals, in order to assess the most basic body functions. The act of taking vital signs normally entails recording body temperature, pulse rate (or heart rate), blood pressure, and respiratory rate, but may also include other measurements.	Wikipedia	http://en.wikipedia.org/wiki/Vital_Signs

References

1. E-Governance Standards Accessed from https://egovstandards.gov.in/ on 15th July 2013.

2. MDDS Demographics v1.1 Accessed from https://egovstandards.gov.in/sites/default/files/Published_Standards/Metadata%20and%20Data%20Standards/MDDS_Demographic_Ver_1.1.pdf on 11th July 2013.

3. Website of Ministry of Health & Family Welfare (http://mohfw.nic.in/) Accessed on 20th July 2013.

4. Website of National Health Systems Resource Centre (www.nhsrcindia.org) Accessed on 1st August 2013.

5. Website of Medical Council of India (http://www.mciindia.org/) Accessed on 17th August 2013.

6. Website of Rajasthan Medical Services Corporation (http://www.rmsc.nic.in/) Accessed on 15th August 2013.

7. Website of IRDA. Accessed from www.irda.gov.in *on 21st September 2013.*

8. Website of National Disaster Management Authority, Government of India (http://ndma.gov.in/ndma/index.htm) Accessed on 19th August 2013.

9. NRHM HMIS Web Portal, www.nrhm-mis.nic.in Accessed on 11August 2013.

10. NRHM Mother Child Tracking System, www.nrhm-mcts.nic.in/MCH *Accessed on 18th September 2013.*

11. Website of Integrated Disease Surveillance Project (IDSP), (www.idsp.nic.in/) *Accessed on 9th September 2013.*

12. Strategic Information Management System, National AIDS Control Organization (www.naco-sims.nic.in) Accessed on 12th September 2013.

13. Master Facility List Guidelines, WHO 2012 Accessed from http://www.who.int/healthinfo/systems/WHO_CreatingMFL_draft.pdf on 6th August 2013.

14. Master Facility List- Implementation Guide, Division of Health Information Systems Department of Standards and Regulatory Services Ministry of Medical Services, Kenya February 2010 http://www.ehealth.or.ke/facilities/ Accessed on 11 August 2013.

15. HITSP Data Dictionary Component, Healthcare Information Technology Standards Panel. Jan 2010. Accessed from http://wiki.siframework.org/file/view/HITSP_V1.0_2010_C154_-_Data_Dictionary.pdf on 8th August 2013.

16. International Statistical Classification of Diseases and Related Health Problems 10th Revision, WHO Accessed from http://apps.who.int/classifications/icd10/browse/2010/en on 20th July 2013.

17. Canadian Classification of Health Interventions (CCI Codes) Accessed from http://www.cihi.ca/cihi-ext-portal/pdf/internet/cci_vol3_2009_en on 18th July 2013.

18. International Classification of Functioning, Disability and Health (ICF),WHO 2001, Accessed from http://apps.who.int/classifications/icfbrowser/ on 17th August 2013.

19. LOINC Standards Accessed from https://loinc.org/ on 11th August 2013.

20. Website of Standards International Accessed from http://www.standardsinternational.net/ on 26th August 2013.

21. Public Health Guide for Emergencies, Centre for Refugee & Disaster Response, John Hopkins Bloomberg School of Public Health, Accessed from http://www.jhsph.edu/research/centers-and-institutes/center-for-refugee-and-disaster-response/publications_tools/   publications/_CRDR_ICRC_Public_Health_Guide_Book/Public_Health_Guide_for_Emergencies   on 10th September 2013.

22. Additional Information Specification 0001: Ambulance Service Attachment Release 2.0, Based on HL7 CDA Standard Release 1.0, with supporting LOINC® Tables, CDA Ballot, August 2003 Accessed from http://www.hl7.org/documentcenter/public/wg/ca/AMBULANCE%20Additional%20Information%20Specification%20(Jan%202012%20Draft%20Copy).doc 8th September 2013.

23. Management of Dead Bodies after Disasters: A Field Manual For First Responders, Pan American Health Organization, Washington 2006. Accessed from http://www.paho.org/disasters/ on 18th August 2013.

24. Data Against Natural Disasters: *Establishing Effective Systems for Relief, Recovery, and Reconstruction.* The World Bank, Washington DC 2008. Accessed from www.ipcc-wg2.gov/njlite_download.php?id=6686 *on 8th September 2013.*

25. Impact of Public Health Emergencies on Modern Disaster Taxonomy, Planning, and Response, Frederick M. Gregg G, Special Focus 2008 Accessed from http://www.ncbi.nlm.nih.gov/pubmed/18562943   on 9th September 2013.

26. Special tabulation lists for mortality and morbidity, ICD-10, WHO. http://apps.who.int/classifications/icd10/browse/2010/en on 20th July 2013.

27. Report on Medical Certification of Cause of Death 2008, Office of The Registrar General, India, Government of India, Accessed from http://www.censusindia.gov.in/2011-Documents/mccd_Report1/Report%20on%20Medical%20Certification%202.pdf on 8th August 2013.

28. NSSO -71- the List of ailments with codes and working definitions. NSSO.

29. Verbal Autopsy Standards: Ascertaining and attributing causes of death, The 2012 WHO verbal autopsy instrument, WHO Accessed from http://www.who.int/healthinfo/statistics/verbalautopsystandards/en/ on 23 August 2013.

30. Institutional Mechanism for Formulation of Domain specific Metadata and Data Standards in e-Governance, eGSI-IM:02, Version 1.0, April 2012, Department of Electronics and Information technology Ministry of Communications and Information Technology Government of India, Accessed from http://egovernance.gov.in/policy/institutional-mechanism on 8th September 2013.

31. The Signature Domain and Geographic Coordinates: A Standardized Approach for Uniquely Identifying a Health Facility Health Facility Assessment Technical Working Group January 2007, WP-07-91, WHO. Accessed from http://www.cpc.unc.edu/measure/publications/wp-07-91/at_download/document on 11 September 2013.

32. United States of America Food and Drug Administration (FDA) - Medication Physical Form http://www.fda.gov/ForIndustry/DataStandards/StructuredProductLabeling/ucm162038.htm   Accessed   on 12th September 2013.

33. United States of America Food and Drug Administration (FDA) - Pharmaceutical Unit of Measurement http://www.fda.gov/forindustry/datastandards/structuredproductlabeling/ucm168397.htm   Accessed on 8th September 2013.

34. United States of America Food and Drug Administration (FDA) - Medication Package Type http://www.fda.gov/ForIndustry/DataStandards/StructuredProductLabeling/ucm162034.htm Accessed on 3rd September 2013.

35. United States of America Food and Drug Administration (FDA) - Route of Administration http://www.fda.gov/Drugs/DevelopmentApprovalProcess/FormsSubmissionRequirements/ElectronicSubmissions/DataStandardsManualmonographs/ucm071667.htm Accessed on 3rd September 2013.

36. Rajasthan Medical Service Corporation for Equipments or Instruments http://www.rmsc.nic.in/pdf/eel.pdf Accessed on 18th August 2013.

37. API Textbook of Medicine Volume-I & II, Ninth Edition.

38. National Formulary of India. Accessed from http://www.cdsco.nic.in/NFI_2011.pdf on 12th September 2013.

39. Website of Canada Health Infoway Accessed from https://www.infoway-inforoute.com/ on 11th October 2013.

40. Metadata Online Registry METeOR, Australia Accessed from http://meteor.aihw.gov.au/content/index.phtml/itemId/181162 on 12th October 2013.

41. Website of Society of Health Information Systems Program (http://hispindia.org/) Accessed on 28th August 2013.

42. DHIS 2 Software Accessed from http://www.dhis2.org/downloads on 13th September 2013.

43. iHRIS Software Accessed from http://www.ihris.org/ on 13th September 2013.

44. National eHealth Transformation Authority, NEHTA http://www.nehta.gov.au/ Accessed on 18th October 2013.

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