Reference Architecture Frameworks

For

Chronic Disease Management Solutions

by

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MSc. Sharif University of Technology – Kish Island, 2009

A project Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

School of Health Information Science

University of Victoria

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To My Beloved Father

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Abstract

Background: Chronic diseases have beaten acute and infectious diseases as Canada's primary cause of illness, disability, and death. Considering the growing and aging population, chronic diseases are expected to climb in the short term. As a result, to achieve the best outcomes possible for those living with chronic diseases and minimize the cost burden on the health and social care systems, effective chronic disease management solutions are critical.

Aim: This project aimed to establish a general reference architecture that offers guidelines, including the business processes and information required for developing the chronic disease management solutions as a white-label platform, prompting the quality and interoperability with existing e-health systems, low coupling, and reusability.

Methods: The Department of Defense Architecture Framework (DODAF) and its suggested methodology were used to create the architecture descriptions, viewpoints, and models required for building our general reference architecture for chronic disease management solutions. Analysis was conducted based on PubMed articles published from 2002 to the present. The key terms used to filter the searches were “Chronic disease model,” “Chronic care model,” “Chronic disease management infostructure,” “Chronic disease management system,” or “Chronic disease management guidelines.”

Outcomes: Based on the research study done around the chronic disease management guidelines, standards, care models, and infostructure, the following outcomes suggested by DODAF were built to shape the business and information architecture frameworks: capability model, operational activity model, conceptual data model, logical data model, and the maps between the capabilities, operational activities, and data entities.

Conclusion: The development of a general reference business and information architecture frameworks targeting all chronic conditions will facilitate the development of future systems and services in the domain of chronic disease management through the advantages that come with the architecture-based modeling approach offered by this project such as capability-driven system development, interoperability, reusability, semantically unambiguous descriptions, and comprehensive specifications.

Glossary of Terms and Abbreviations Used

Terms	Definition
Activity	An Activity organizes and specifies the participation of subordinate behaviors, such as sub-Activities or Actions, to reflect the control and data flow of a process.
Application Architecture	An application's architecture describes the behavior of applications used in a business, focused on how they interact with each other and with users. The application's architecture is specified on the basis of business and functional requirements. This involves defining the interaction between application packages, databases, and middleware systems in terms of functional coverage. This helps identify any integration problems or gaps in functional coverage. A migration plan can then be drawn up for systems that are at the end of the software life cycle or which have inherent technological risks and a potential to disrupt the business as a consequence of a technological failure.
Architecture Framework	An architecture framework establishes a common practice for creating, interpreting, analyzing, and using architecture descriptions within a particular domain of application or stakeholder community—examples of Architecture Frameworks: DODAF, MODAF, TOGAF, etc.
Architecture Description	An Architecture Description is a work product used to express an architecture, a collection of architecture views and models that together document the architecture.
Artifact	Architectural artifacts are created in order to describe a system, solution, or state of the enterprise.
Business Architecture	Business architecture defines the business strategy, governance, organization, and key business processes of the organization.
Capability	Capability is the ability to achieve the desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks.
Conceptual Data Model	A conceptual data model or conceptual schema is a high-level description of informational needs underlying the design of a database. It typically includes only the main concepts and the main relationships among them. Typically this is a first-cut model with insufficient detail to build an actual database.
Information Architecture	An information architecture describes the structure of an organization's logical and physical data assets and the associated data management resources.

Logical Data Model	A logical data model or logical schema is a data model of a specific problem domain expressed independently of a particular database management product or storage technology but in terms of data structures such as relational tables and columns, object-oriented classes, or XML tags.
Model	Visualizing architectural data is accomplished through models.
Process	A process is a series or set of activities that interact to produce a result.
Viewpoint	Organized collections of views (often representing processes, systems, services, standards, etc.) from the perspective of a related set of concerns are referred to as viewpoints. The viewpoints consist of different models.

Abbreviation	**Description**
ATC	Anatomical Therapeutic Chemical Classification
CCI	Canadian Classification of Health Interventions
CDM	Chronic Disease Management
DODAF	Department of Defence Architecture Framework
FEAF	Federal Enterprise Architecture Framework
HL7	Health Level Seven
ICD	International Classification of Diseases
LOINC	Logical Observation Identifiers Names and Codes
RMIM	Refined Message Information Model
SNOMED CT	Systematized Nomenclature of Medicine--Clinical Terms
TOGAF	The Open Group Architecture Framework

Chapter One. Introduction

Background

Health systems have had great success in controlling infectious diseases and their mortalities all around the world during the past decades. This has brought 'chronic disease' to the top of the leading causes of death and morbidities in developed and developing countries (Stuckler, 2008). According to WHO, chronic diseases are defined as "diseases of long duration and generally slow progression." Laboratory, clinical and population-based studies suggest that unhealthy diet and high energy intake, lack of physical activity, and tobacco use are the few risk factors responsible for most chronic diseases. The other factors that can play a role will be alcohol intake, environmental pollutants, age, and hereditary factors. These risk factors are not under the influence of any specific gender and are detected across all regions.

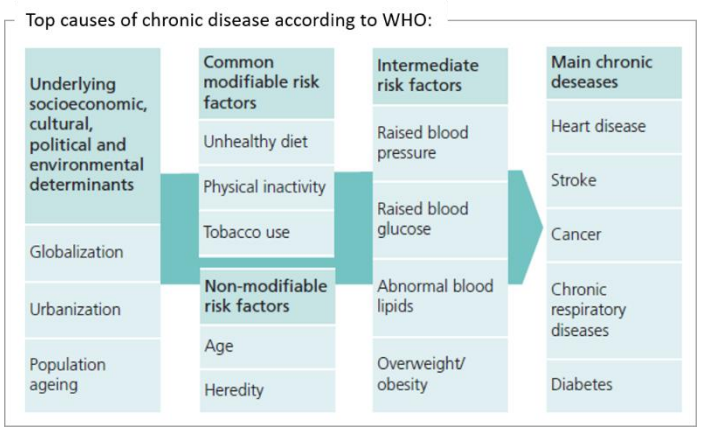


Figure 1. Top Causes of Chronic Disease

In Canada, four types of chronic diseases, including cardiovascular disease, cancers, chronic obstructive pulmonary disease, and diabetes, kill an estimated 153,000 Canadians every year. At the same time, medical costs for people with chronic diseases account for 42% of total direct medical care expenditure, or $39 billion a year in Canada. Therefore the strategies and policies of health care governors and researchers have been shifted from confining infectious diseases to managing chronic non-infectious conditions.

Motivations

Effective chronic disease management is important in different aspects (Western Health Infostructure Canada, 2005):

- Optimizing the quality of life for patients with chronic diseases and their families
- Improving the satisfaction of the clinical care providers
- Decreasing the costs to the health and social care systems

Also, chronic disease management is deeply different from infectious disease treatment, which needs multiple but limited doses of antibiotics and short-term yet intensive vital support.

Chronic disease patients are often elderly patients with multiple co-morbidities that make them frailer and make their treatment more demanding in many ways:

1. Chronic disease management is teamwork. Patients benefit from more eyes and the insights of different specialists, especially with the aging population and the existence of comorbidities. But communication and coordination of care are major obstacles when it comes to multidisciplinary care. Who should be included in the team? What are the responsibilities of each member? Who defines the boundaries? How do ensure effective communication between team members to prevent reworks and guarantee patient safety? (Wagner, 2000)
2. Patients are less compliant due to their older age and multi-provider care. Relational continuity has been proved to be a major determinant of outcome in chronic disease management. Many research has shown the effect of continuity of care on reduced mortality and improved quality of life.
3. Engagement promises a better outcome for chronic disease patients. Engaging patients of higher age and multiple comorbidities is a serious challenge for healthcare providers in the absence of a shared care plan and holistic view of the patient's problems and also a deep understanding of the patient about the existing issues, treatment goals, and plans. (Osborn & Squires, 2012)

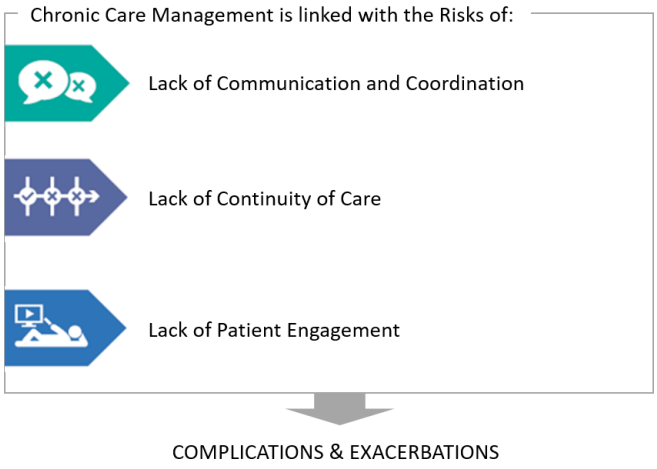


Figure 2. Chronic Care Management Risks

In other words, chronic disease management requires a long-term care plan and treatment adherence is critical to achieving improved health outcomes. The frequent need for continuous monitoring and the long-term nature of chronic disease management caused developments in telehealth and telemonitoring (Hamine et al., 2015). These innovations in telehealth and telemonitoring, which seek to improve chronic disease management and prevent death and disability, are improved by ongoing technological advancements. One such advancement is mHealth. Popularity, availability, portability, and technological capacity, are the factors that cause mobile technologies to play an essential role in chronic disease management around the

globe. Communication, data collection, patient monitoring, education, and facilitating adherence to chronic disease management are the reasons for using mobile technologies such as phones and wireless monitoring devices in health care and public health practice. Context-awareness features and sensors enable real-time information submission delivery and individualization. Moreover, the tendency people have to carry them everywhere creates opportunities for connecting patients with providers outside of health care facilities and continuous symptom monitoring(Hamine et al., 2015).

As a result, during these years, different solutions based on Mobile Applications were developed for monitoring and coaching patients for a specific chorionic disease. Some of the solutions were designed for patient self-management, and some facilitated the communication between the clinical care providers and the patients. These solutions can be EHR-Connected or independent of EHR.

Studies about the architecture of such solutions present some common functionalities independently of the chronic disease which the solution has been designed for. These common areas of the functionalities can be presented in three major components: Chronic Disease Management System, Mobile Application, Data Analytics, and Reports. The figure below presents the interactions between these components (http://www.scnsoft.com).

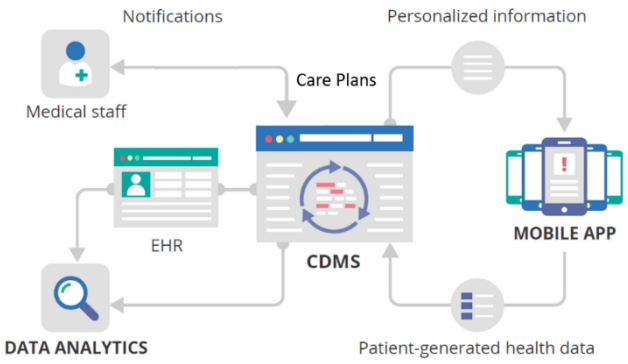


Figure 3. Chronic Disease Management Solution

The Chronic Disease Management System is the central system that deals with several chronic conditions. It processes the data received from the EHR and the patients, analyzes the health data, and alerts care team members or the patient.

Mobile applications that can be designed separately for patients and clinical care providers provide User Interfaces for both parties to send and receive the data. The data which is sent from clinical care providers to the patients can be care plans, instructions (for example, medication intake schema), recommendations, or reminders. The data which is sent from the patients to the clinical care providers can include subjective data (for example, pain, fever), objective data (for example, blood pressure, glucose level), medication intake data, and so on. Also, we can develop

specialized mobile applications for each chronic condition like diabetes, asthma, cardiovascular disease, chronic obstructive pulmonary disease, behavioral disorders, and so on.

Data Analytics and Reporting system will be responsible for generating reports and charts by analyzing data received from the Chronic Disease Management System.

The advantages achieved through such solutions will be ongoing patient-clinical care provider communication, systematic uninterrupted care through automated scheduling and reminders, advanced patient education and engagement, clinical signs monitoring, and access to reports and charts, which all result in reduced risk of complications and readmissions to the hospitals.

Reviews and studies indicate that the solutions designed for chronic disease management are mostly targeted at specific chorionic conditions. Cardiovascular diseases (CVDs), Diabetes mellitus (DM), and chronic lung diseases (CLDs) are the ones that were targeted by mobile health solutions based on their high global burden. Few approaches look at the chronic disease management system as a white-label platform that includes any chronic disease condition.

Objectives

The development of the general systems targeting the management of all chronic disease conditions requires the usage of the universal guidelines and standards identifying the systematic, organized processes, methods, terms, and definitions used by the specialists and sites of care in the domain of chronic disease management.

Considering the challenges associated with collecting the standards applied for the processes and information which are consistent across the specialists and sites of care, this important research question can be implied:

Can we represent knowledge through building a general reference architecture as a blueprint, including holistic clinical processes, services, and information in the domain of chronic disease management?

As a result, the aim of this project is to establish a general reference architecture including the business processes and information required for the development of the chronic disease management system as a white-label platform, improving the quality and interoperability with existing e-health systems, low coupling, and reusability. To accomplish the project aim, the following specific objectives were defined:

1. Building the Business Architecture Framework related to Chronic Disease Management for enabling successful clinical business transformation.
2. Building the Information Architecture Framework related to Chronic Disease Management for providing standard definitions for all the information that flows through the solution and between clinical service providers and their patients.

The Business Architecture Framework will be a multi-layered view of the key clinical business processes required to run efficient, effective, and agile services related to Chronic Disease Management solutions. It is a hierarchical catalog of the key clinical business processes required to run a service-focused business.

The Information Architecture Framework will be a reference model and common vocabulary for all the information required to implement a Chronic Disease Management solution. It reduces complexity in service and system integration and can be adopted by all involved communities.

For building all the artifacts and Architectural Descriptions concerning the above-mentioned frameworks, we require to select a candidate methodology suggested by the well-known architecture frameworks. The candidate architecture framework and its responsive methodology were discussed in the following chapter.

Chapter Two. Literature Review

To cover the objectives of this project, a literature review was done in the domain of the existing chronic care models, and the existing chronic disease management data standards and infostructures applied for the information exchange. Studying the existing chronic care models facilitated the extraction of the capabilities and the processes required for this solution, while studying the existing chronic disease management data standards facilitated the design of the conceptual and logical data models required for this solution. This section summarized the result of this review.

Chronic Care Models Review

Clinical information systems (CIC) are key components of effective chronic disease management. Wagner, Austin, and Von designed their Chronic Care Model (CCM) on 1996, introducing clinical information systems as an integral element of chronic disease care. They argued that real improvement in outcomes would occur only when clinical systems reconfigure themselves specifically to address the needs and concerns of chronically ill patients (Wagner et al., 1996). CIS has been shown to facilitate the exchange of health information between providers and patients. The provision of flag alerts (Wellingham et al., 2003), reminders of routine events and visits (Siminerio et al., 2004; Wellingham et al., 2003) computerized clinical records like the Medical Archival Retrieval System (MARS) (Siminerio et al., 2004; Tracey & Bramley, 2003; Chin et al., 2004), and chart audits(Piatt et al.,2011; Piatt et al., 2010; Siminerio et al., 2006; Piatt et al., 2006), electronic medical records(Piatt et al.,2011; Piatt et al., 2010; Siminerio et al., 2006; Piatt et al., 2006) and internet access to contact physicians (Schmittdiel et al., 2006) are few of the mechanisms to implement CIS for chronic disease management. Patient appointment schedules can be prioritized based on their situation and can help improve communication with general practitioners (GP) (Frei et al., 2010). Patients' diseases registry can also help to track the care management of the patients (Pearson et al., 2005; Nutting et al., 2007; Chin et al., 2004). The CIS is an important and crucial way to provide tailored feedback on the performance of the organization's chronic disease management program from the patient and provider perspective (Pearson et al., 2005; Schmittdiel et al., 2006).

Self-management support is another important component of all the chronic disease models designed between the years 2003 to 2013. Wagner, Austin, and Von established self-management techniques such as mutual goal setting and action planning that have focused on various methods of teaching such as group classes, skill development, and various lifestyle behaviors (Wagner et al., 1996). Personalized healthcare plans, medications, action plans, lifestyle goals, and feedback for the providers to deliver tailored feedback have been studied (Pearson et al., 2005; Nutting et al., 2007; Tracey & Bramley, 2003; Chin et al., 2004; Sperl-Hillen et al., 2004; Ciccone, 2010; Glasgow et al., 2004). Incentives have been offered to increase patients' participation in self-management programs (Siminerio et al., 2004), Patient education and patient activation/ psychological support (Piatt et al., 2011; Piatt et al., 2010; Siminerio et al., 2006; Piatt et al., 2006; Vargas et al., 2007; Nutting et al., 2007; Schmittdiel et al., 2006; Smith

et al., 2008), access to self-management resources and tools (Vargas et al., 2007; Wellingham et al., 2003; Ciccone, 2010; Schmittdiel et al., 2008; Askew et al., 2010) and collaborative decision making are some of the other common components of the self-management support element of CCM(Pearson et al., 2005). Individuals with chronic diseases are provided with training to improve their skills for blood glucose monitoring (Frei et al., 2010; Schmittdiel et al., 2006), adjusting insulin, and modifying diet and exercise (Schmittdiel et al., 2006), review medical charts (Schmittdiel et al., 2006) and track self-management behavior (Sperl-Hillen et al., 2004) are some of the techniques employed to improve self-management in these individuals. Only one study used the Stanford model to improve self-management in individuals with chronic diseases (Franks et al., 2009).

The transitional care model (TCM) presented by Naylor on 2004 is defined as a set of actions designed to enable the coordination and continuity of healthcare when patients transfer between different levels of care or different locations within the same facility (Naylor et al., 2004). Facilities include hospitals, sub-acute and post-acute nursing locations, primary and specialty care offices, the patient's home, and long-term care facilities. Transitional care is based on an integrated plan of care and the availability of healthcare providers who have current information about the patient's preferences, goals, and clinical status (Naylor et al., 2004). The transitional care model (TCM) addresses gaps in all care transitions, including hospital to home, home to hospital, physician office to home, chronic care to palliative care, and palliative care to hospice care. The TCM addresses patients' chronic care needs over time, including the Identification of patient-specific concerns related to the transition process.

- Medication adherence and persistence.
- Assessing and supporting health literacy between physician visits/treatments.
- The utilization of remote patient monitoring specifically to facilitate problem-solving, confidence-building, and the promotion of needed behavior changes for optimal condition management.

Chronic Disease Management Infostructure Initiative Review

There have been different efforts to develop an information model for chronic disease management at different geographical locations. McGuire (McGuire,2004) proposed such an information model considering the business processes required and involved in chronic conditions. However, this model is more business-oriented than technology-based and thus lacks some important implementation details, such as standard coded values for data elements.

There have also been initiatives taken at different geographical locations (e.g., Germany, the Netherlands, Switzerland, Australia, British Columbia, etc.) to emphasize the information needs of that particular region. We found the one proposed by Western Health Infostructure Canada to be the most complete in terms of implementation. British Columbia, Alberta, Saskatchewan, and Manitoba were the four western provinces in Canada that started building the Chronic Disease Management Infostructure Initiative on 2005. The primary purpose of this project was

to develop chronic disease management data standards which facilitate the exchange of data between the related stakeholders and to support the implementation of this infostructure within the participating provinces. In other words, their effort was focused on defining a standard for "what" information will exchange. The scope of the data standards was around the clinical information most relevant to clinicians managing individuals with chronic disease. They were successful in designing the chronic disease conceptual model as a critical step in building a framework for defining the data elements that would be captured in the data standards and subsequently exchanged in the HL7 message specifications. WHIC proposed its own vocabulary for chronic disease management while using six external vocabulary standards: HL7 (for demographical codes), LOINC (for diagnostic tests, physical exams, medical problems, procedures, medications, immunizations, etc.), ICD-10 (for some medical problems and physical exams), DSM-IV (for other medical problems), CCI (for some procedures), ATC (for some medications and immunizations). They also provided detailed implementations of mapping with HL7 and designed a RMIM for their proposed CDM.

The conceptual data model designed by this group will be explained in chapter six and applied as a reference for the creation of our own developed-logical data model.

Summary

Based on our findings of the literature review about the key processes required for effective chronic disease management considering the three important elements common between the different chronic care models, including clinical information services, self-management, and remote patient management, in addition to the conceptual information model presented by WHIC, we offer our own designed business and information reference frameworks for chronic disease management through the following chapters.

Chapter Three. Methodology, Key Outcomes, and Materials

Methodology

For building all the artifacts and Architectural Descriptions concerning the project required frameworks, we require to select a candidate methodology suggested by the well-known Architecture Frameworks. For this purpose, an overall review of the famous Architecture Frameworks besides a comparison for selecting the candidate methodology is done, and the details can be found in appendix one. According to the review, it can be seen that the Department of Defense Architecture Framework (DoDAF) is leading and will be selected as a reference architecture framework for supporting the objectives defined for this project.

For creating a reference architecture framework including Clinical Business Framework and Information Framework related to Chronic Disease Management, inspiring the methodology proposed by DoD Enterprise Architecture Community, the high-level six steps architecture development process will be applied.

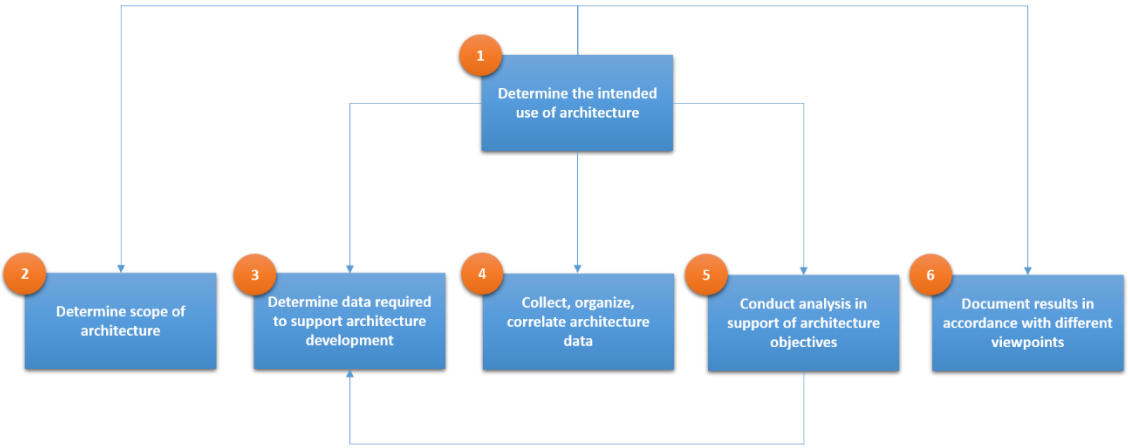


Figure 4. Architecture Development Methodology

Step 1: Determine the intended use of architecture: Defines the purpose and intended use of the architecture; how the Architectural Description effort will be conducted; the data categories needed; the potential impact on involved clinical communities and patients.

Step 2: Determine the scope of architecture: The scope defines the boundaries that establish the depth and breadth of the Architectural Description. Clarity of scope can be determined by defining and describing the outcomes and viewpoints.

Step 3: Determine data required to support architecture development: Determines the type of data required to gather aligned with the selected outcomes and viewpoints.

Step 4: Collect, organize, and correlate architectural data: Based on the outcomes and viewpoints defined in steps 2 and 3, the review will be undertaken of the well-known mHealth intervention solutions used to facilitate adherence to chronic disease management, published research, and studies conducted in the domain of presenting Chronic Disease Management Models, and clinical standards exist in this domain specifically HL7, SNOMED CT, ICD, LOINC and other related standards to collect, organize and correlate the architectural data.

Step 5: Conduct analyses in support of architecture objectives: Determines the level of adherence to process requirements. This step also identifies additional process steps and data collection requirements needed to complete the Architectural Description and better facilitate its intended use. Changes are required from the validation process, resulting in the iteration of the architecture process (repeat steps 3 through 5 as necessary).

Step 6: Document results following different viewpoints: The final step in the architecture development process involves the creation of architectural views based on different outcomes and viewpoints defined in step 2. This is facilitated by the data requirements determined in Step 3 and the data collection during Step 4.

Key Outcome

According to the mentioned methodology, different viewpoints will be generated to shape the Clinical Business Framework, Application Framework (out of scope of this project), and Information Framework related to Chronic Disease Management. The figure below indicates different viewpoints will be applied concerning the mentioned frameworks:

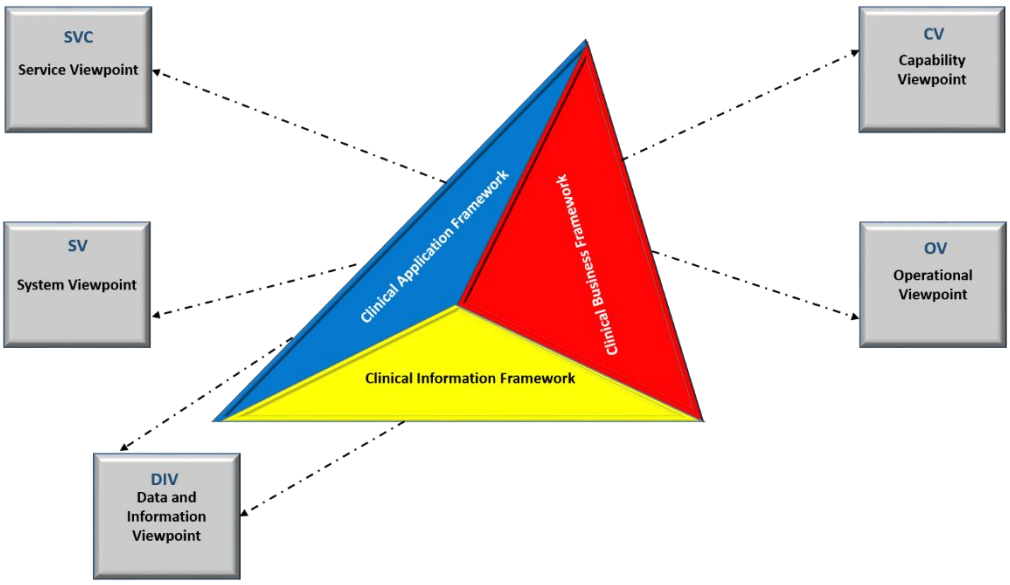


Figure 5. Solution Architecture Viewpoints

Here the description of each viewpoint and the corresponding Models are presented:

CV - Capability Viewpoint: The Capability Viewpoint and the corresponding Models within the viewpoint are introduced to address the capabilities required in the Clinical Business Framework related to Chronic Disease Management. This viewpoint includes the following models:

Model	Description
CV1- Vision	Provides a high-level scope for the Architectural Description.
CV2- Capability Model	Captures capability taxonomies. The model presents a hierarchy of capabilities.
CV3- Capability to Operational Activities Mapping	A mapping between the capabilities required and the operational activities that those capabilities support.

DIV – Data and Information Viewpoint: The Data and Information Viewpoint and the corresponding Models within the viewpoint are introduced to address the data relationships and alignment structures in the architecture content for the capability and operational requirements, systems, and services. This viewpoint includes the following models:

Model	Description
DIV1- Conceptual Data Model	The required high-level data concepts and their relationships.
DIV2- Logical Data Model	The documentation of the data requirements and structural business process (activity) rules.

OV – Operational Viewpoint: The Operational Viewpoint and the corresponding Models within the viewpoint are introduced to address the operational scenarios, activities, and requirements that support capabilities. This viewpoint includes the following models:

Model	Description
OV1- Operational Activity Model	The capabilities and activities (operational activities) are organized in a hierarchal structure.
OV2- Operational Activity to Data Mapping	The context of capabilities and activities (operational activities) and their relationships among activities, inputs, and outputs.

Materials

In order to extract data to use as a reference for the creation of the mentioned models to shape the business and information architecture frameworks, the research conducted in this domain was reviewed and studied. The database that was applied for this purpose was Pubmed, and the searches were done based on the following limits: date range from 1/1/2002 to Present, search

terms used were “Chronic disease model,” “Chronic care model,” “Chronic disease management infostructure,” “Chronic disease management system,” or “Chronic disease management guidelines”**;** studies should be in English and should be either journal article, practice guideline, or government publications. The inclusion criteria included articles that described the origin of the chronic disease model, its rationale, and its elements. Exclusion criteria for the search terms included duplicate terms not related to chronic diseases. Besides studying the research with the mentioned criteria, the different standards, including SNOMED CT, LOINC, ICD 10CA, and HL7 FHIR, were reviewed and applied to define how healthcare information, specifically in the domain of chronic diseases, can be exchanged between the different stakeholders.

Chapter Four. Architecture Vision

Vision

The vision we imagine for creation of the architectural descriptions offered by this project is conducting the architecture-based method for establishing a framework including the required and standard-based capabilities, processes, activities, and data consistent between the care providers and the site of cares, for implementing chronic disease management solutions considering interoperability with other existing e-health systems.

Goals

The following goals are designed in alignment with our vision:

- Optimizing the quality of life for patients with chronic diseases and their families
  - Improve patient engagement and adherence
  - Enable the delivery of the personalized treatment plans to patients, digitally
  - Facilitate intervention management
- Improving the satisfaction of the clinical care providers
  - Improve communication across care team members
  - Build meaningful insights for a holistic view of a patient's health
  - Gain real-time access to data for timely interventions
- Decreasing the costs to the health and social care systems
  - Reduce readmissions and ED utilization

Scope

All the core functionalities required for implementing a coaching solution for Chronic Disease Management in different domains of Assessment, Diagnosis, Planning, Execution of the Planning, and Monitoring, besides the Communication required to maintain the adherence between the patient and the provider, will be covered through the different models of the Business and Information viewpoints. Some of the supportive functionalities domains, such as financial concerns related to patient accounting or User Access, including authentication and authorization, scheduling, and content management, will be out of the scope of this project.

Three specific chronic diseases, including diabetes, hypertension, and chronic kidney disease, were selected to be the focus of this project, but the solution has been designed as a single generic solution that applies to all chronic diseases.

Stakeholders

The stakeholders who will be interested in the outcomes of this project will be divided into two categories: Patients and Providers. On the patient side, we will have patients with one or multiple chronic conditions; besides all the caregivers who take the responsibility of caring for the patients, such as the family members, friends, etc., on the provider side, we will have all the clinical care providers who shape the treatment team in relation with all the chronic conditions such as primary or secondary physicians, nurses, etc.

Summary

In response to step one and two of our discussed methodology, the intent, the scope, and the stakeholders related to this architectural effort were defined. Also, the first key outcome of this project, called ” CV1- Vision,” was defined in this chapter. The next chapter will discuss the capabilities, processes, and activities required for chronic disease management solutions.

Chapter Five. Business Architecture Framework

What is CDM Business Architecture Framework

A business architecture framework is a reference framework that represents a holistic business view of capabilities, business processes, and operational activities required for a chronic disease management solution (CDM) and the relationships among these business views and involved stakeholders.

Capability Model

The figure below presents the key stakeholders and high-level capabilities that are common among all the CDM solutions. These core capabilities include Assessment, Diagnosis, Planning, Planning Execution, Outcome and Result Monitoring, and continuous communication between the care provider and the patient. Also, some other capabilities support the core capabilities known as supportive capabilities. Below are the detailed definitions for each of the mentioned capabilities:

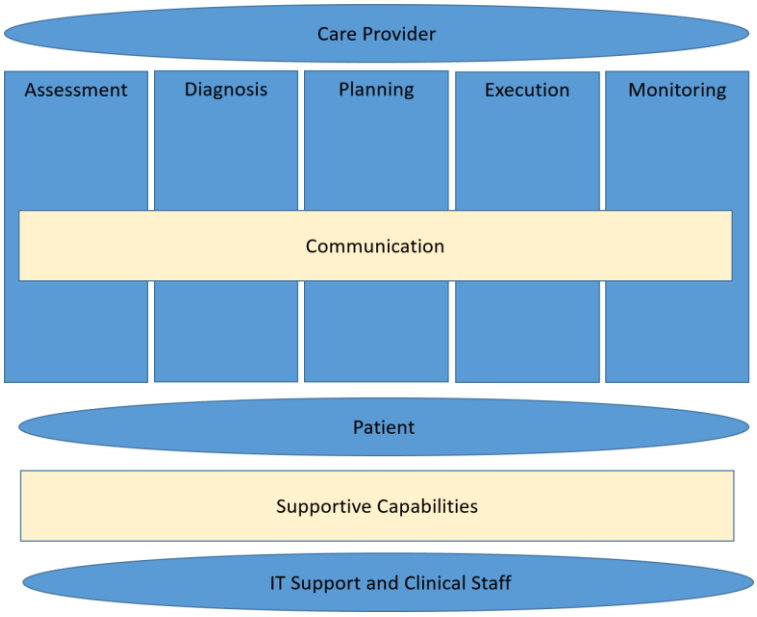


Figure 6. CDM Solution Capabilities

Assessment: This capability provides the ability to collect information that gets to know the patient in detail, evaluating their risks and the nature of problems to be identified. It can help gather information about the alerts and risks such as allergy, adverse drug reactions, or any medication concerns that exist for the patient. Also, it provides knowledge about some of the characteristics which are relevant to the chronic patient condition and important for any clinical decision-making, such as a person or family history, ethnicity, height, weight, etc.

Diagnosis: This capability provides the ability to identify a disease, condition, or injury based on the signs and symptoms a patient is having and the patient's health history and physical exam. It also includes the diagnosis of the existing complications or any comorbidities relevant to the main diagnosis. Further testing, such as blood tests, imaging tests, and biopsies may be done after a clinical diagnosis is made.

Planning: This capability provides the ability to plan how the care provider intends to deliver care for a particular patient, possibly limited to care for a specific condition or set of conditions. Based on the data gathered through assessment and diagnosis processes such as condition, condition characteristics, patient history, and treatment guidelines, the care provider develops the best package of care for the patient, including the orders required for laboratory tests, Imaging, and medications, procedures, and referrals. The goal setting and the actions required for achieving the goals are also defined through this capability.

Planning Execution: This capability provides the ability to execute whatever is planned by the health care provider for the patient considering the chronic condition, complications, and the co-morbidities diagnosed. The realization of the planned items will happen through performing a Laboratory test or procedure, medication administration, or even executing the exercises, instructions, or whatever action planned for the patient, such as a specific diet or A1C measuring with a specific routine.

Monitoring: This capability provides the ability to monitor the results attained through the execution of the planned items. Manual or systematic result entry by the patient, care provider, or the interfaces will provide the ability of data presentation and triggering the alerts or planning the further required actions.

Communication: This capability provides the ability to facilitate different types of interactions that can happen between the care providers and the patients. Effective communication plays a key role in adherence improvement between the care provider and the patient, which causes better monitoring and controlling of the treatment progress. Interactions can be initiated by alerts or reminders, text messages, requests for a call, or setting the appointments for the virtual or physical visit.

Supportive Capabilities: This group of capabilities provides the ability to support the core capabilities mentioned earlier.

Operational Activity Model

In response to the capabilities required for a CDM solution, different levels of processes and activities are needed to be designed. The figure below presents the high level of processes that are in alignment with realizing the capabilities described in the previous section. As the figure presents, there are eleven process areas for covering the requirements needed for a CDM solution which are categorized into two groups of core and foundation processes:

- Core Processes
  - Assessment Management
  - Diagnosis Management
  - Planning Management
  - Result Entry Management
  - Monitoring and Control Management
  - Communication Management
- Foundation Processes
  - Registration Management
  - Scheduling Management
  - Core Data Management
  - Content Management
  - Supportive Services Management

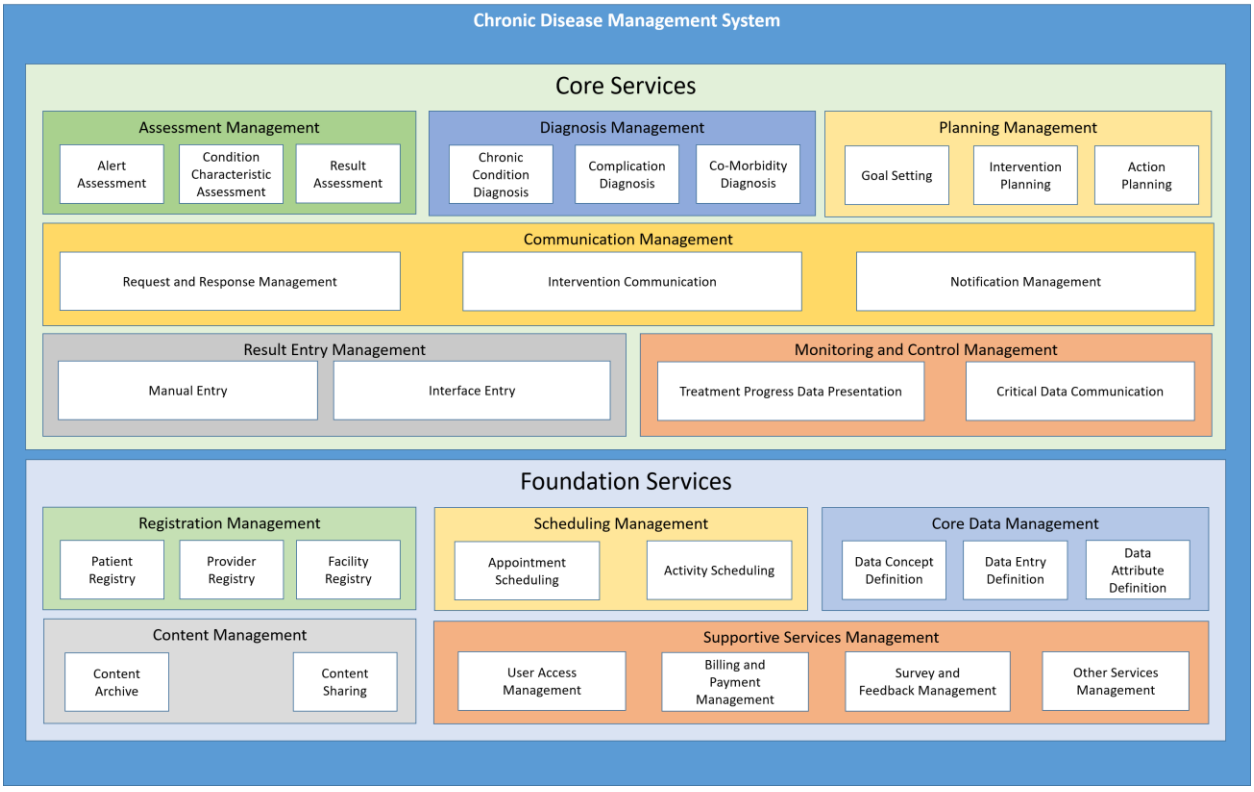
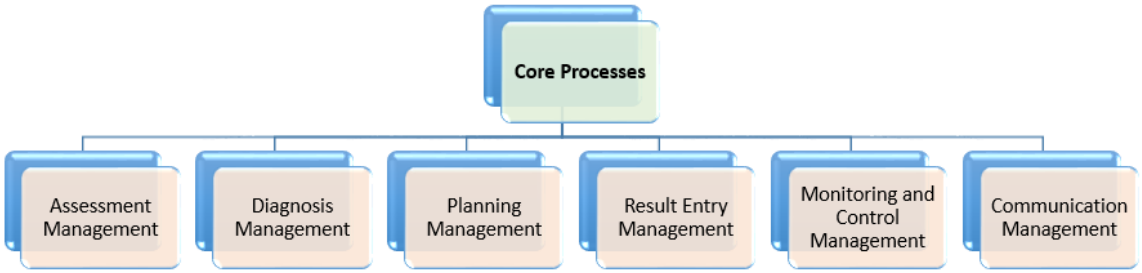


Figure 7. CDM Business Process Decomposition

Core Processes

Core processes include business process groupings that are directly in alignment with the capabilities considered for a CDM solution.



Objectives:

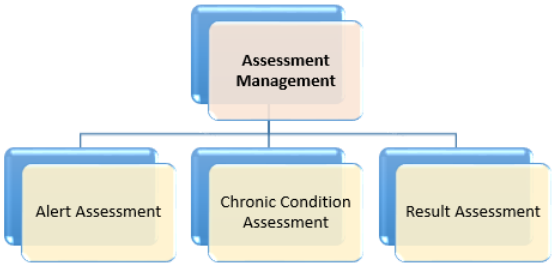
- Chronic condition assessment and diagnosis
- Setting up a treatment plan, including an action plan for the patient
- Monitoring and controlling the outcomes achieved through the execution of the plan
- Setting up effective communication between the care provider and the patient

Process Groups:

- Assessment Management
- Diagnosis Management
- Planning Management
- Result Entry Management
- Monitoring and Control Management
- Communication Management

Assessment Management

This process group provides the ability to collect information that gets to know the patient in detail, evaluating their risks and the nature of the problems to be identified. It can help gather information about the alerts and risks such as allergy, adverse drug reactions, or any medication concerns that exist for the patient. Also, it provides knowledge about some of the characteristics which are relevant to the chronic patient condition and important for any clinical decision-making, such as a person or family history, ethnicity, height, weight, etc.



Objectives:

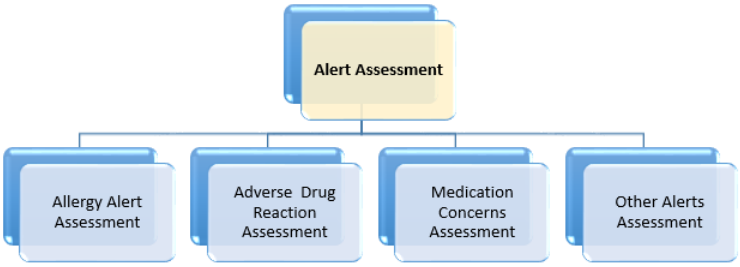
- Identifying the alerts that exist related to patient allergy, adverse drug reaction, medication, etc.
- Assessment of all characteristics relevant to the patient's condition that may affect the overall management of their chronic disease
- Assessment of the results achieved through the execution of the treatment plan

Processes:

- Alert Assessment
- Chronic Condition Assessment
- Result Assessment

Alert Assessment

This process provides the ability to identify the situations where a life threat could arise for an individual or the care providers. Such a threat could pose a risk to patient health or affect the management of the chronic disease. Examples of such situations are allergies, acute medical conditions, hypoglycemia, family violence, etc.



Objectives:

- Identifying patient’s Allergies and adverse drug reactions

- Identifying the patient's medications concerns or any other treats existing around the patient

Activities:

- Allergy Alert Assessment
- Adverse Drug Reaction Assessment
- Medication Concerns Assessment
- Other Alerts Assessment

Allergy Alert Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	111	Alert Assessment
Activity ID and Title	1111	Allergy Alert Assessment
Activity Description		
This Activity provides the ability to identify the alerts that describe a significant allergy. An allergy is an inappropriate and harmful response of the immune system to normally harmless substances (e.g., anaphylactic shock is an extreme example of an allergic reaction).		
Performer	Care Provider	

Adverse Drug Reaction Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	111	Alert Assessment
Activity ID and Title	1112	Adverse Drug Reaction
Activity Description		
This Activity provides the ability to identify the subset of adverse drug events which contain any clinical manifestation that is unintended, undesired, or unexpected, which is consequent to and caused by the administration of medications.		
Performer	Care Provider	

Medications Concerns Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	111	Alert Assessment
Activity ID and Title	1113	Medication Concerns Assessment

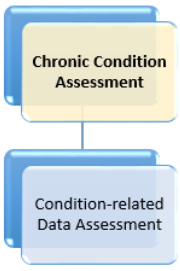
Activity Description	
This Activity provides the ability to identify the important considerations for the safe use of medications, such as the use of reminder devices, individual dose packaging, polypharmacy issues, etc.	
Performer	Care Provider

Other Alerts Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	111	Alert Assessment
Activity ID and Title	1114	Other Alert Assessment
Activity Description		
This Activity provides the ability to identify anything that is considered noteworthy about the management of the person; examples of possible other alerts include family violence and social alerts such as poverty.		
Performer	Care Provider	

Chronic Condition Assessment

This process provides the ability to identify the information needed about the chronic disease. These include the presence of conditions that increase the possibility of developing chronic diseases such as a person's behavior or lifestyle, which can be related to environmental exposure, inborn or inherited characteristics including family history, low activity level, poor eating habits, obesity, and high blood pressure.



Objectives:

- Gathering and assessment of risk factors that increase the possibility of developing chronic disease

Activities:

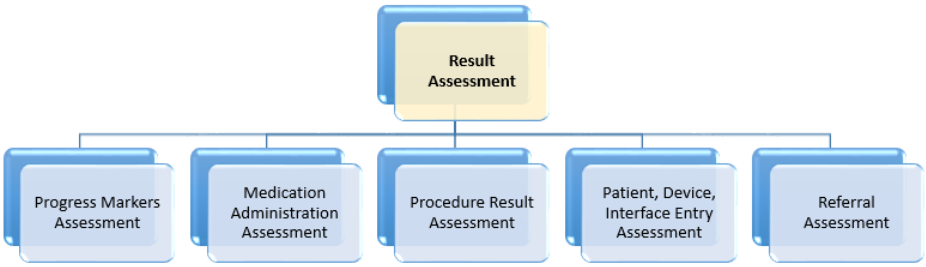
- Condition-related Data Assessment

Condition-related Data Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	112	Chronic Condition Assessment
Activity ID and Title	1121	Condition-related Data Assessment
Activity Description		
This Activity provides the ability to identify the information needed about the chronic disease. Some of the examples include Patient history, family history, ethnicity, first nation status, smoking status, alcohol status, height, weight, heart rate, heart rhythm, etc.		
Performer	Care Provider	

Result Assessment

This process provides the ability to assess the outcomes achieved through the execution of the plan. The outcomes will be the result of the laboratory test orders, images, procedures, and the effect of medications administered.



Objectives:

- Assessment of the outcomes and plan results
- Changing effectively the plans and required interventions based on the achieved outcomes

Activities:

- Progress Markers Assessment
- Medication Administration Assessment
- Procedure Result Assessment
- Patient, Device, Interface Entry Assessment
- Referral Assessment

Progress Markers Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	113	Result Assessment
Activity ID and Title	1131	Progress Markers Assessment
Activity Description		
This Activity provides the ability to assess the result of laboratory tests and images that were ordered during the planning process.		
Performer	Care Provider	

Medications Administration Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	113	Result Assessment
Activity ID and Title	1132	Medications Administration Assessment
Activity Description		
This Activity provides the ability to assess the effectiveness of the administered medications which were ordered during the planning process.		
Performer	Care Provider	

Procedure Result Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	113	Result Assessment
Activity ID and Title	1134	Procedure Result Assessment
Activity Description		
This Activity provides the ability to assess the result and satisfaction of the procedures which were planned during the planning process.		
Performer	Care Provider	

The patient, device, interface entry Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	113	Result Assessment

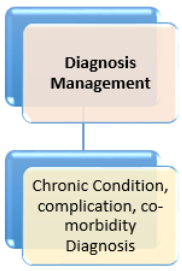
Activity ID and Title	1135	The patient, device, interface Entry Assessment
Activity Description		
This Activity provides the ability to assess the result which was entered into the system by the patient or through the wearable or IoT devices or any other system interfaces in response to the designed action plan.		
Performer	Care Provider	

Referral Assessment

Process Category ID and Title	1	Core Processes
Group Process ID and Title	11	Assessment Management
Process ID and Title	113	Result Assessment
Activity ID and Title	1136	Referral Assessment
Activity Description		
This Activity provides the ability to assess the result of the referrals which were requested during the planning process.		
Performer	Care Provider	

Diagnosis Management

This process group provides the ability to identify a disease, condition, or injury based on the signs and symptoms a patient is having the patient's health history and physical exam. It also includes the diagnosis of the existing complications or any comorbidities relevant to the main diagnosis. Further testing, such as blood tests, imaging tests, and biopsies may be done after a clinical diagnosis is made.



Objectives:

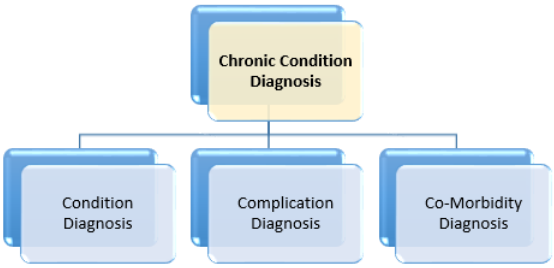
- Diagnosis of the main chronic condition
- Diagnosis of the complications caused by the chronic condition besides the other existing co-morbidities

Processes:

- Chronic Condition, complication, co-morbidity Diagnosis

Chronic Condition, complication, co-morbidity Diagnosis

This process provides the ability to diagnose the chronic condition of the patient. Through this process, based on the assessments and evidence, all the details about the condition, problem, or diagnosis will be determined.



Objectives:

- Diagnosis of the main chronic condition
- Diagnosis of the complications caused by the chronic condition besides the other existing co-morbidities

Activities:

- Condition Diagnosis
- Complication Diagnosis
- Co-Morbidity Diagnosis

Condition Diagnosis

Process Category ID and Title	1	Core Processes
Group Process ID and Title	12	Diagnosis Management
Process ID and Title	121	Chronic Condition Diagnosis
Activity ID and Title	1211	Condition Diagnosis
Activity Description		
This Activity provides the ability to diagnose the chronic condition and all the detailed information about it. Based on this diagnosis, other activities such as treatment planning will be designed.		
Performer	Care Provider	

Complication Diagnosis

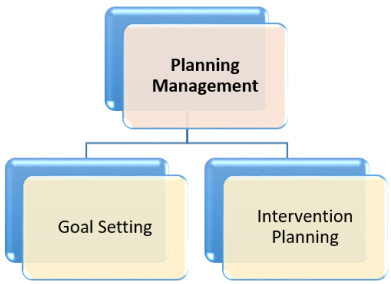
Process Category ID and Title	1	Core Processes
Group Process ID and Title	12	Diagnosis Management
Process ID and Title	121	Chronic Condition Diagnosis
Activity ID and Title	1212	Complication Diagnosis
Activity Description		
This Activity provides the ability to diagnose the complications caused by the chronic condition. Complication refers to a medical condition or a significant disease that is causally related to the index condition. The number and type of complications provide an indicator of how well the person's chronic disease is being managed.		
Performer	Care Provider	

Co-Morbidity Diagnosis

Process Category ID and Title	1	Core Processes
Group Process ID and Title	12	Diagnosis Management
Process ID and Title	121	Chronic Condition Diagnosis
Activity ID and Title	1213	Co-Morbidity Diagnosis
Activity Description		
This Activity provides the ability to diagnose co-morbidities. Co-morbidities refer to the existence of other medical conditions that may or may not be related to the original chronic disease. Co-morbidities must be confirmed either by the clinical diagnosis made by a physician or a laboratory confirmation. The number of co-morbid conditions indicates a person's overall health status or risk of death.		
Performer	Care Provider	

Planning Management

This process group provides the ability to plan how the care provider intends to deliver care for a particular patient, possibly limited to care for a specific condition or set of conditions. Based on the data gathered through assessment and diagnosis processes such as condition, condition characteristics, patient history, and treatment guidelines, the care provider develops the best package of care for the patient, including the orders required for laboratory tests, Imaging, and medications, procedures, and referrals. The goal setting and the actions required for achieving the goals are also defined through this capability.



Objectives:

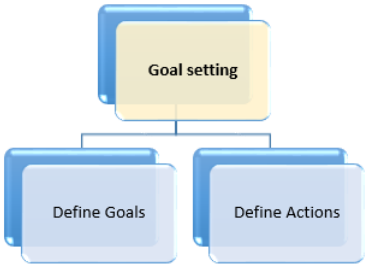
- Planning the required interventions such as laboratory tests, images, procedures, medications, or referrals
- Defining and communicating the goals
- Defining and communicating the action plan

Processes:

- Goal Setting
- Intervention Planning

Goal Setting

This process provides the ability to define the goals for achieving progress aligned with chronic disease treatment planning. Based on the deals defined for the goals, the specifications of the corresponding actions will also be defined.



Objectives:

- Enables patients and physicians to focus healthcare on the outcomes that are most important to the patient
- Design the corresponding action plan to achieve the goals

Activities:

- Define Goals
- Define Actions

Define Goals

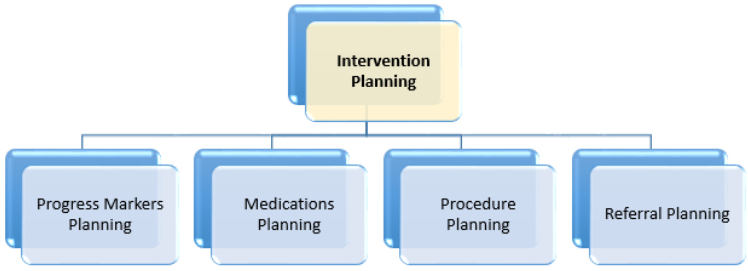
Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	131	Goal Setting
Activity ID and Title	1311	Define Goals
Activity Description		
This Activity provides the ability to share the realistic goals of health professionals and patients and agreement on the best course of action.		
Performer	Care Provider	

Define Actions

Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	131	Goal Setting
Activity ID and Title	1312	Define Actions
Activity Description		
This Activity provides the ability to define the Action plans which are created jointly by clinicians and patients and spell out realistic and small steps to take to achieve a health goal. In addition to making changes to diets and physical activity routines, action plans can be used for a wide variety of goals—including stopping smoking, reducing stress, and improving sleep habits.		
Performer	Care Provider	

Intervention Planning

This process provides the ability to define the interventions that refer to any health action (e.g., primitive, preventive, curative, rehabilitative activity) where the intent is to improve health or minimize or avoid health problems.



Objectives:

- Effective intervention to improve health or minimize or avoid health problems

Activities:

- Progress Markers Planning
- Medications Planning
- Procedure Planning
- Referral Planning

Progress Markers Planning

Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	132	Intervention Planning
Activity ID and Title	1321	Progress Markers Planning
Activity Description		
This Activity provides the ability to order the required clinical laboratory tests and imaging to assess the progress of markers related to the chronic disease.		
Performer	Care Provider	

Medications Planning

Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	132	Intervention Planning
Activity ID and Title	1322	Medications Planning
Activity Description		
This Activity provides the ability to order the required medications in alignment with the treatment of the chronic disease.		
Performer	Care Provider	

Procedures Planning

Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	132	Intervention Planning
Activity ID and Title	1323	Procedures Planning
Activity Description		

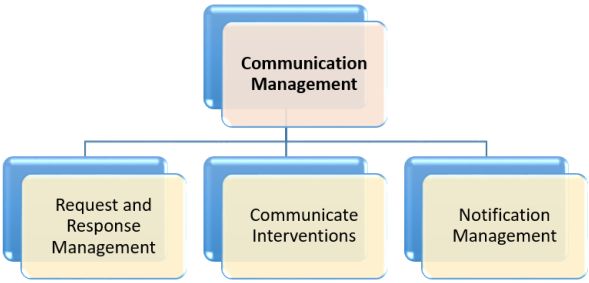
This Activity provides the ability to order the required Procedures in alignment with the treatment of the chronic disease.	
Performer	Care Provider

Referral Planning

Process Category ID and Title	1	Core Processes
Group Process ID and Title	13	Planning Management
Process ID and Title	132	Intervention Planning
Activity ID and Title	1324	Referral Planning
Activity Description		
This Activity provides the ability to introduce the patient to other healthcare providers for receiving special services in alignment with the treatment of the chronic disease.		
Performer	Care Provider	

Communication Management

This process group provides the ability to communicate between the different parties, specifically the patient and the care providers. These communications will be conducted in the form of sending and receiving the requests and communicating around the interventions, notifications, and alerts.



Objectives:

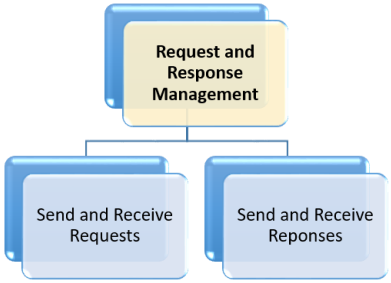
- Mutual Communicating through sending and receiving information
- Communicating around the requested interventions and the results
- Communication through the notifications and alerts

Processes:

- Request and Response Management
- Communicate Interventions
- Notification Management

Request and Response Management

This process provides the ability for the patients and care providers to ask for any information in the format of requests and accessing to responses.



Objectives:

- Conducting mutual communication through the requests and responses

Activities:

- Send and Receive Requests
- Send and Receive Responses

Send and Receive Requests

Process Category ID and Title	1	Core Processes
Group Process ID and Title	14	Communication Management
Process ID and Title	141	Request and Response Management
Activity ID and Title	1411	Send and Receive Requests
Activity Description		
This Activity provides the ability to send and receive the request for asking any required information between the patients and care provider.		
Performer	Care Provider, Patients	

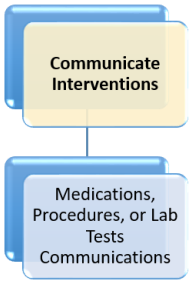
Send and Receive Responses

Process Category ID and Title	1	Core Processes
Group Process ID and Title	14	Communication Management
Process ID and Title	141	Request and Response Management
Activity ID and Title	1412	Send and Receive Responses
Activity Description		
This Activity provides the ability to send and receive the responses corresponding to the requests between the patients and care providers.		

Performer	Care Provider, Patients

Communicate Interventions

This process provides the ability to conduct the required communications around the interventions and results defined for the patients.



Objectives:

- Conducting mutual communication around the requested interventions such as medications, procedures, or lab tests in the format of follow-ups

Activities:

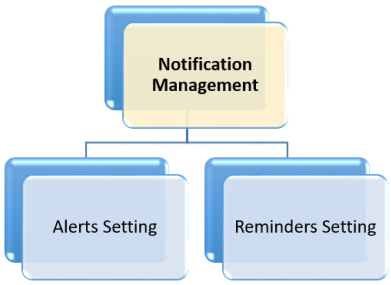
- Medications, Procedures, or Lab Tests Communications

Medications, Procedures, or Lab Test Communications

Process Category ID and Title	1	Core Processes
Group Process ID and Title	14	Communication Management
Process ID and Title	142	Communicate Interventions
Activity ID and Title	1421	Medications, Procedures, or Lab Tests Communications
Activity Description		
This Activity provides the ability to conduct communications around the interventions planned for the patients in the format of the follow-ups. The subjects for such communications include medications, procedures, and lab test interventions.		
Performer	Care Provider, Patients	

Notification Management

This process provides the ability for the care providers to set alerts, and reminders, besides sending notifications to the patients.



Objectives:

- Setting and sending notifications in the format of alerts and reminders

Activities:

- Alerts Setting
- Reminders Setting

Alerts Setting

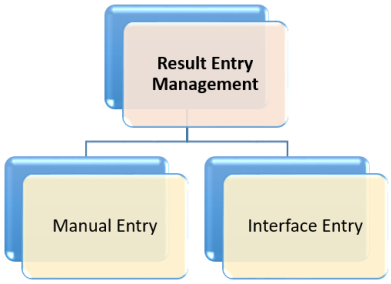
Process Category ID and Title	1	Core Processes
Group Process ID and Title	14	Communication Management
Process ID and Title	143	Notification Management
Activity ID and Title	1431	Alerts Setting
Activity Description		
This Activity provides the ability to set alerts in different areas, such as missed medications, missed activities, out-of-range test results, etc., and send corresponding notifications to the patients.		
Performer	Care Provider, Patients	

Reminders Setting

Process Category ID and Title	1	Core Processes
Group Process ID and Title	14	Communication Management
Process ID and Title	143	Notification Management
Activity ID and Title	1432	Reminders Setting
Activity Description		
This Activity provides the ability to set reminders in different areas, such as medications, activities, appointments, etc., and send corresponding notifications to the patients.		
Performer	Care Provider, Patients	

Result Entry Management

This process group provides the ability to collect the data resulting from the requested lab tests or any activities planned for the patients. These data can be entered into the system in a manual manner or through the interfaces created to send data from devices or other systems.



Objectives:

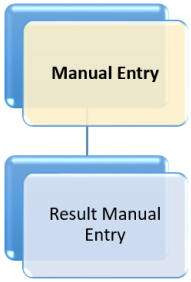
- Result entry to provide transparency for the care provider about the treatment progress and further decision makings

Processes:

- Manual Entry
- Interface Entry

Manual Entry

This process provides the ability for the patient to enter the result of the planned activity or the lab test manually through the options provided with the solution.



Objectives:

- Provide transparency for the care provider about the treatment progress and further decision makings

Activities:

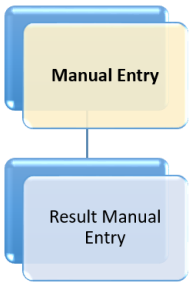
- Result Manual Entry

Result Manual Entry

Process Category ID and Title	1	Core Processes
Group Process ID and Title	15	Result Entry Management
Process ID and Title	151	Manual Entry
Activity ID and Title	1511	Result Manual Entry
Activity Description		
This Activity provides the ability for the patient to enter the result of the planned activity or the lab test manually through the options provided with the solution.		
Performer	Patients	

Manual Entry

This process provides the ability for the patient to enter the result of the planned activity or the lab test manually through the options provided with the solution.



Objectives:

- Provide transparency for the care provider about the treatment progress and further decision makings

Activities:

- Result Manual Entry

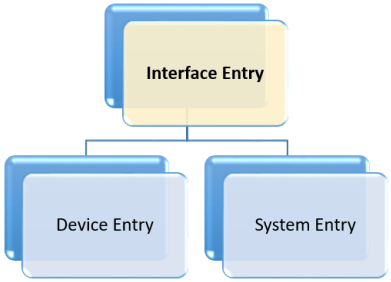
Result Manual Entry

Process Category ID and Title	1	Core Processes
Group Process ID and Title	15	Result Entry Management
Process ID and Title	151	Manual Entry
Activity ID and Title	1511	Result Manual Entry
Activity Description		
This Activity provides the ability for the patient to enter the result of the planned activity or the lab test manually through the options provided with the solution.		

Performer	Patients

Interface Entry

This process provides the ability for data entry through the interfaces designed for a specific system or specific device. The device can be a wearable watch that sends the data such as the daily steps, and the system can be any other EMR in the health care environment.



Objectives:

- Provide transparency for the care provider and the patients about the treatment progress and further decision makings

Activities:

- Device Entry
- System Entry

Device Entry

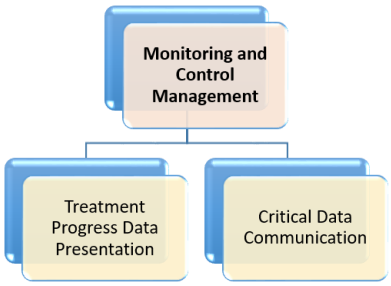
Process Category ID and Title	1	Core Processes
Group Process ID and Title	15	Result Entry Management
Process ID and Title	152	Interface Entry
Activity ID and Title	1521	Device Entry
Activity Description		
This Activity provides the ability for data entry through the interfaces designed for a specific Device. This would be done automatically. For example, through the interface, the wearable watch will send the number of the steps taken daily into our system.		
Performer	Device	

System Entry

Process Category ID and Title	1	Core Processes
Group Process ID and Title	15	Result Entry Management
Process ID and Title	152	Interface Entry
Activity ID and Title	1522	System Entry
Activity Description		
This Activity provides the ability for data entry through the interfaces designed for a specific System. This would be done automatically. For example, through the interface, a lab EMR will send the test result into our system.		
Performer	Other Systems	

Monitoring and Control Management

This process group provides the ability to monitor the treatment progress by providing different types of reports, graphs, and analytics made from the expected and actual data that exists in the system. The format and the contents of these data presentations won't be the same for the care providers and the patients. With the help of these data, the care provider can apply the required control over the patient's treatment progress and use that for further planning or decisions making.



Objectives:

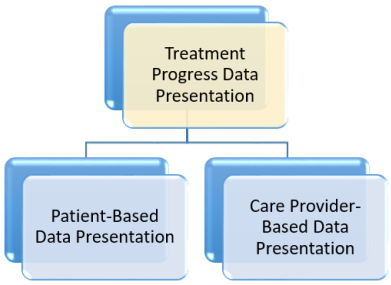
- Presenting the data to provide transparency around the treatment progress and applying the required controls

Processes:

- Treatment Progress Data Presentation
- Critical Data Communication

Treatment Progress Data Presentation

This process provides the ability to present the data collected about patient treatment progress. This presentation will be done based on different reports, graphs, and analytics designed for care providers and patients.



Objectives:

- Provide transparency for the care provider and the patients about the treatment progress and further decision makings

Activities:

- Patient-Based Data Presentation
- Care Provider-Based Data Presentation

Patient-Based Data Presentation

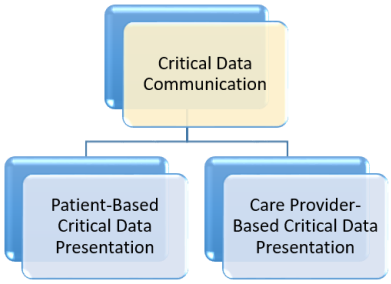
Process Category ID and Title	1	Core Processes
Group Process ID and Title	16	Monitoring and Control Management
Process ID and Title	161	Treatment Progress Data Presentation
Activity ID and Title	1611	Patient-Based Data Presentation
Activity Description		
This Activity provides the ability to present the collected data about the treatment progress from the patient's point of view through different designed reports, graphs, and analytics.		
Performer	Patients	

Care Provider-Based Data Presentation

Process Category ID and Title	1	Core Processes
Group Process ID and Title	16	Monitoring and Control Management
Process ID and Title	161	Treatment Progress Data Presentation
Activity ID and Title	1612	Care Provider-Based Data Presentation
Activity Description		
This Activity provides the ability to present the collected data about the treatment progress from the care provider's point of view through different designed reports, graphs, and analytics.		
Performer	Care Providers	

Critical Data Communication

This process provides the ability to present the critical data collected about the patient's treatment progress. Critical data are the ones that don't seem normal and are out of the expected range. Presenting these data through the specific designed reports, graphs, and analytics will help care providers apply the required controls aligned with the patient's treatment.



Objectives:

- Provide transparency for the care provider and the patients about the treatment progress and further decision makings

Activities:

- Patient-Based Critical Data Presentation
- Care Provider-Based Critical Data Presentation

Patient-Based Critical Data Presentation

Process Category ID and Title	1	Core Processes
Group Process ID and Title	16	Monitoring and Control Management
Process ID and Title	162	Critical Data Communication
Activity ID and Title	1621	Patient-Based Critical Data Presentation
Activity Description		
This Activity provides the ability to present the critical data collected about the patient's treatment progress. Critical data are the ones that don't seem normal and are out of the expected range. These data will be presented through designed specific reports, graphs, and analytics from the patient's point of view.		
Performer	Patients	

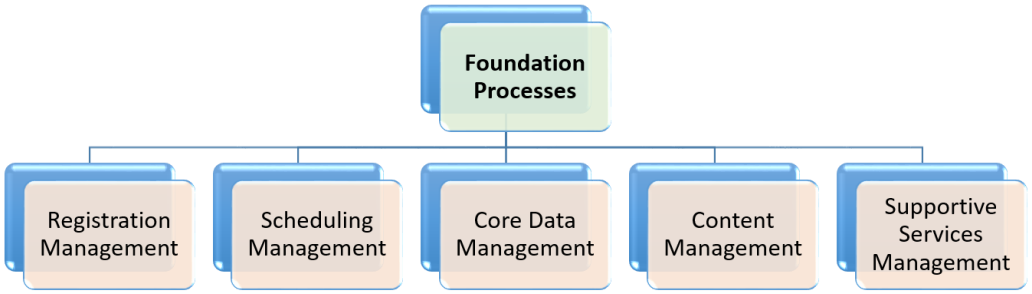
Care Provider-Based Critical Data Presentation

Process Category ID and Title	1	Core Processes
Group Process ID and Title	16	Monitoring and Control Management
Process ID and Title	162	Critical Data Communication

Activity ID and Title	1621	Care Provider-Based Critical Data Presentation
Activity Description		
This Activity provides the ability to present the critical data collected about the patient's treatment progress. Critical data are the ones that don't seem normal and are out of the expected range. These data will be presented through designed specific reports, graphs, and analytics from the care provider's point of view.		
Performer	Care Providers	

Foundation Processes

Foundation processes include business process groupings that support the core processes.



Objectives:

- Supporting the mission of the CDSM solution, which will be realized through the core processes

Process Groups:

- Registration Management
- Scheduling Management
- Core Data Management
- Content Management
- Supportive Services Management

Registration Management

This process group provides the ability to complete all the registrations that are required, including the registration of the patients, care providers, facilities, and the association between the patients, providers, and facilities, besides all the details required as essential information such as contact information, patient caregiver information, etc.

Objectives:

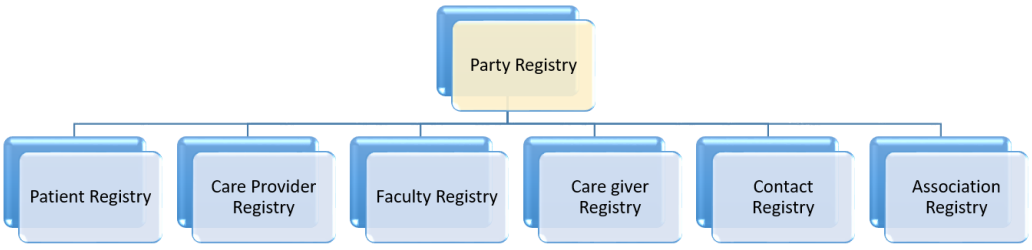
- Registering all the involved parties, such as patients, providers, and facilities

Processes:

- Party Registry

Party Registry

This process provides the ability to register all the involved parties, such as the patients, the care providers, the facilities, and all the essential data about each party, such as contact information, associations, etc.



Objectives:

- Registration of the involved parties with all the essential information

Activities:

- Patient Registry
- Care Provider Registry

- Facility Registry
- Caregiver Registry
- Contact Registry
- Association Registry

Patient Registry

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2111	Patient Registry
Activity Description		
This Activity provides the ability to register the patients.		
Performer	Care Provider, Staff	

Care Provider Registry

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2112	Care Provider Registry
Activity Description		
This Activity provides the ability to register the care providers; Care providers can be any member of the clinical care team from the primary physician, secondary physician, nurse, etc.		
Performer	Care Provider, Staff	

Facility Registry

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2113	Facility Registry
Activity Description		
This Activity provides the ability to register the clinical facilities such as clinics, hospitals, etc.		
Performer	Care Provider, Staff	

Caregiver Registry

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2114	Caregiver Registry
Activity Description		
This Activity provides the ability to register the patient's caregivers, who are allowed to have access to the patient's records.		
Performer	Care Provider, Staff	

Contact Registry

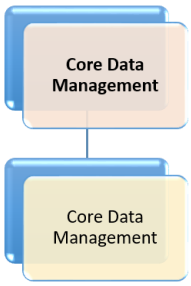
Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2115	Contact Registry
Activity Description		
This Activity provides the ability to register the contact information, including the mail address, email address, phone, and fax numbers of all the involved parties, such as the patients, the providers, the facilities, and the caregivers.		
Performer	Care Provider, Staff	

Association Registry

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	21	Registration Management
Process ID and Title	211	Party Registry
Activity ID and Title	2116	Association Registry
Activity Description		
This Activity provides the ability to define all the associations that exists between the patient and the providers, the providers and the facilities, the patients and the facilities, and the patients and the caregivers.		
Performer	Care Provider, Staff	

Core Data Management

This process group provides the ability to create the required data entity and the responsive data attributes dynamically by the authorized end users. Some of the clinical data entities can be alerts, markers, procedures, medications, etc.



Objectives:

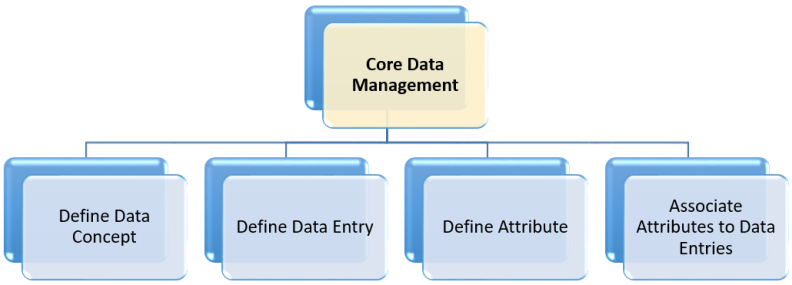
- Providing the ability to create the clinical data concepts and the responsive data entities and data elements based on the chronic condition by the authorized care provider independently and in a dynamic manner

Processes:

- Core Data Management

Core Data Management

This process provides the ability to create the clinical data concepts and the responsive data entities and data elements based on the chronic condition by the authorized care provider independently and dynamically.



Objectives:

- Provide independence from the developers on the creation of the required data entities and data attributes based on the different chronic conditions

Activities:

- Define Data Concept
- Define Data Entry
- Define Attribute
- Associate Attributes to Data Entries

Define Data Concept

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	22	Core Data Management
Process ID and Title	221	Core Data Management
Activity ID and Title	2211	Define Data Concept
Activity Description		
This Activity provides the ability to create the required data concepts. Some examples of the data concepts can be the alert indicators, characteristics relevant to the conditions, co-morbidities and complications, markers, interventions, etc.		
Performer	Care Provider, Staff	

Define Data Entity

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	22	Core Data Management
Process ID and Title	221	Core Data Management
Activity ID and Title	2212	Define Data Entity
Activity Description		
This Activity provides the ability to create the required data entities in response to the data concepts. These data entities can be associated with specific chronic conditions or can be general. For example, for the alert indicators as the data concept, the data entities will be allergy alert, adverse drug reaction, medication concern, and other alerts.		
Performer	Care Provider, Staff	

Define Attribute

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	22	Core Data Management
Process ID and Title	221	Core Data Management
Activity ID and Title	2213	Define Attribute
Activity Description		
This Activity provides the ability to create the set of attributes and the responsive attribute elements. For example, one attribute set can be “type,” which can have different attribute elements such as observation type, medication type, procedure type, etc.		
Performer	Care Provider, Staff	

Associate Attributes to Data Entities

Process Category ID and Title	2	Foundation Processes
Group Process ID and Title	22	Core Data Management
Process ID and Title	221	Core Data Management
Activity ID and Title	2214	Associate Attributes to Data Entities
Activity Description		
This Activity provides the ability to assign the attribute elements to the defined data entities. For example, if we have allergy alert as a data entity, what attribute elements will define that?		
Performer	Care Provider, Staff	

It is needed to mention here that the other process groups, such as **scheduling management**, **content management**, and **supportive services management,** will be out of the scope of this project.

Summary

In order to shape our CDM Business Architecture Framework and in response to our discussed methodology, the other two key outcomes of this project were created, including the "CV2- Capability Model" and "OV1- Operational Activity Model". Designing the conceptual and logical data models for this solution will be discussed in the next chapter.

Chapter Six. Information Architecture Framework

What is CDM Information Architecture Framework

An information architecture describes the structure of an organization's conceptual, logical, and physical data assets and data management resources concerning information and communication technology solutions. The goal of information architecture is to translate business needs into data and system requirements and to manage data and its flow through the enterprise (Olavsrud, 2022).

Conceptual Data Model: A conceptual data model or conceptual schema is a high-level description of informational needs underlying the design of a database. It typically includes the main concepts and the main relationships between them. Typically this is a first-cut model with insufficient detail to build an actual database (Wikipedia, 2015).

Logical Data Model: A logical data model or logical schema is a data model of a specific problem domain which is expressed independently of a particular database management product or a storage technology but in terms of data structures e.g. relational tables and columns, object-oriented classes, or XML tags (Wikipedia contributors, 2021).

Physical Data Model: A physical data model is a representation of a data design as implemented or intended to be implemented in a database management system. The lifecycle of a project, typically derives from a logical data model (Hoang, 2018).

Based on these definitions, in the next sections, we try to present the conceptual and logical information architecture for our CDM solution.

Conceptual Data Model

The chronic disease conceptual data model is a representation of data groupings to facilitate clinical understanding of the data needed to be captured and exchanged in HL7 messages (Western Health Infostructure Canada, 2005).

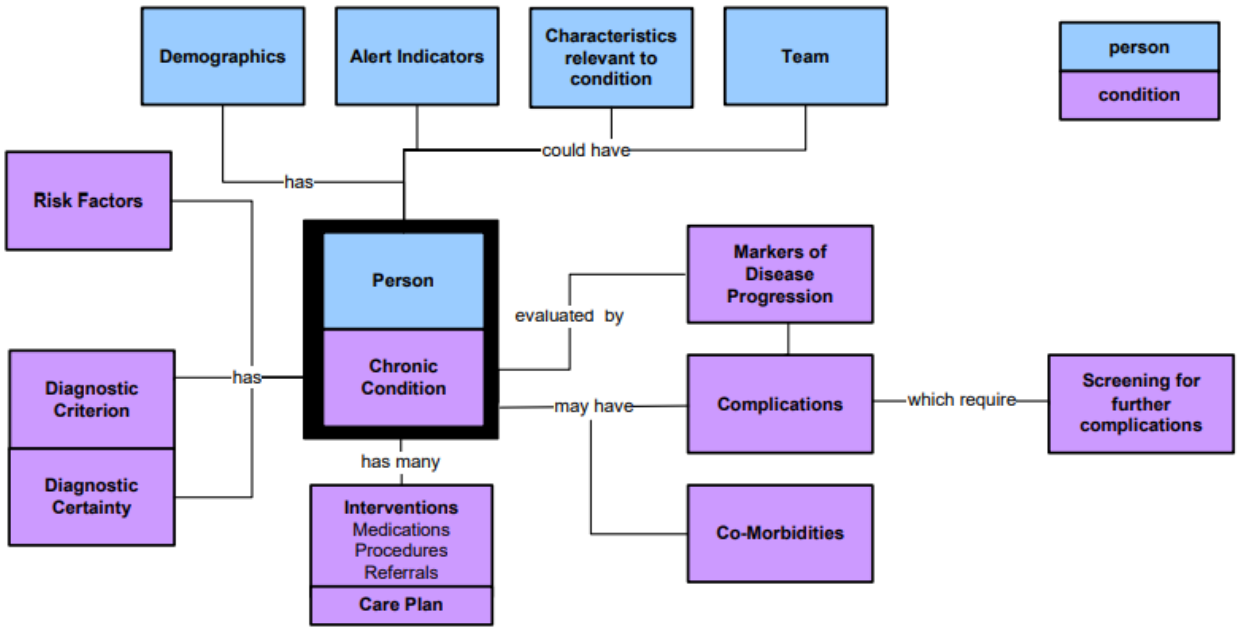


Figure 8. Conceptual Chronic Disease Model

The figure above presents an overview of the data groupings in relation to chronic disease management. The data groupings are organized by:

- Person: Data related to the individual having the chronic disease.
- Condition: Data related to chronic diseases) diagnosed for the individual.

Person-Related Data

A person is the individual diagnosed with a condition / chronic disease and is the focus of chronic disease management. Person-related data provide the information needed about the individual with the chronic disease.

Demographic

All the information that helps to identify the person's identity, including the identifier, name, date of birth, gender, language, address, phone numbers, e-mail, date of death, etc., will be accounted for as demographics.

Alert Indicator

Alert indicators refer to situations where a life-threatening or potentially life-threatening situation could exist for the patient or the service providers. A person may have conditions that could impose a risk to his health and affect the management of his chronic disease. Alert indicators are categorized in four areas:

Allergy Alert: indicating if a person has any allergies.

Adverse Drug Reaction: Indicating if a person has experienced any clinical manifestation that is unexpected or undesired and is caused by the administration of medications.

Other Alerts: Indicating if other situations may pose a risk to a person, such as acute health issues, family alerts, and/or social alerts.

Medication Concerns: Indicating if a person has experienced any issues regarding the use of medications or has special needs. These issues can include the use of reminder devices, individual dose packaging, polypharmacy issues, etc.

Characteristics Relevant to the condition

The overall management of the chronic disease will be under the influence of the person's health status and environment. Multiple assessments done by the members of the CDM team will help gather information on the person's health status and environment. Members of the CDM team include physicians, registered nurses, clinical specialists, social workers, mental health workers, dietitians, rehabilitation therapists, etc. Information gathered from these assessments is important in providing comprehensive and holistic care to detect the range of complexities and needs presented by a person with chronic disease.

Team

An interdisciplinary team of service providers will be involved in a person's chronic disease management. The role of team-based delivery approaches in providing and managing the care required by individuals with chronic diseases is emphasized by the chronic disease management models. The composition, role, and responsibilities of the CDM team may vary by jurisdiction and within jurisdictions. Articulating the respective roles and responsibilities of team members and how these are related to proactive care of individuals with chronic disease is key to successful chronic disease management programs.

Condition-Related Data

Chronic Condition is related to the diagnosed chronic disease(S) of the person, and condition-related data gives information needed about the chronic disease. These include risk factors, diagnostic criteria, diagnostic certainty, markers of disease progressions, complications, co-morbidities, and screening for further complications, interventions, and care plans.

Risk Factors

Whatever refers to the presence of conditions that increase the possibility of developing the chronic disease will be accounted for as risk factors. These may include an aspect of an individual's behavior or lifestyle and/or may be related to environmental exposure, inborn, or inherited characteristics. In chronic disease management, the condition can no longer be prevented cause the diagnosis of a chronic disease or condition had already occurred. The scope of risk factors is focused on those that continue to raise risks to a person's health and the management of their condition with the possibility of adversely affecting the outcome of the disease or condition.

Diagnostic Criterion

The diagnostic criteria applied to identify a specific chronic disease are accounted as a diagnostic criterion. This includes symptoms, signs, and distinguishing features that are used to

support the evidence in making a diagnosis of chronic disease or other objective or subjective observations. The modeling related to this data entity is out of the scope of this project.

Diagnostic Certainty

The degree of certainty of the information obtained about a person's medical condition will help the classification of the diagnosis. Modeling related to this data entity is out of the scope of this project.

Interventions

Interventions refer to any health action where the intent is to minimize or avoid health problems or improve health. Interventions are categorized into three key areas :

- **Medications** refer to treatments using drugs. Vaccinations are also included in this category.
- **Procedure** refers to clinical activities conducted to manage the conditions of the patients.
- **Referrals** refer to recommendations made by a provider to consult with another provider or to obtain additional information from another source.

Care Plan

A care plan consists of the activities or interventions planned to manage the chronic disease of the patient.

Markers of disease progression

Markers of disease are the tools to evaluate the progression of chronic diseases. The markers can include tests or other clinical assessments done to evaluate the extent or progression of chronic disease. The marker data is temporal, represents a unit of measurement, and has a normal range and a critical value.

Complications

A person with a chronic disease experiences additional complications or health problems in relation to their chronic disease. Complications refer to medical conditions or a significant disease related to the index condition. The type and number of complications provide an indicator of how well the person's chronic disease is being managed.

Co-Morbidities

A person with a chronic disease also experiences other medical problems or conditions that are related to the management of the index chronic condition or the original. Co-morbidities refer to the presence of other significant medical conditions that may not be related to the original chronic disease. Co-morbidities must be confirmed either by clinical diagnosis made by a physician or by laboratory confirmation. The number of co-morbid conditions indicates a person's overall health status or risk of death.

Logical Data Model

To cover the capabilities mentioned in the business architecture framework and the data entities in the conceptual data model, the CDM logical data model will be presented, including the responsive classes and their relationships for the following functional areas:

- Core Data Management
- Communication Management
- Assessment Management
- Diagnosis Management
- Planning Management
- Registry Management

Before starting the details of the designed class diagrams for each functional area, introducing the core data elements presented in the following table is required. These core data elements will define the existing types used for the data attributes of each class related to the solution.

Data Elements	**Type**
DE_PK_ID	Number(10)
DE_Type	Number(10)
DE_Short_String	Varchar(300)
DE_Long_String	Varchar(3000)
DE_Date	Date
DE_Name	Varchar(50)
DE_Code	Varchar(15)
DE_Numeric	Number(10,9)
DE_Boolean	Boolean

Core Data Management

This process group provides the ability to create the required data entity, and the responsive data attributes dynamically by the authorized end users. Some of the clinical data entities can be alerts, markers, procedures, medications, etc.

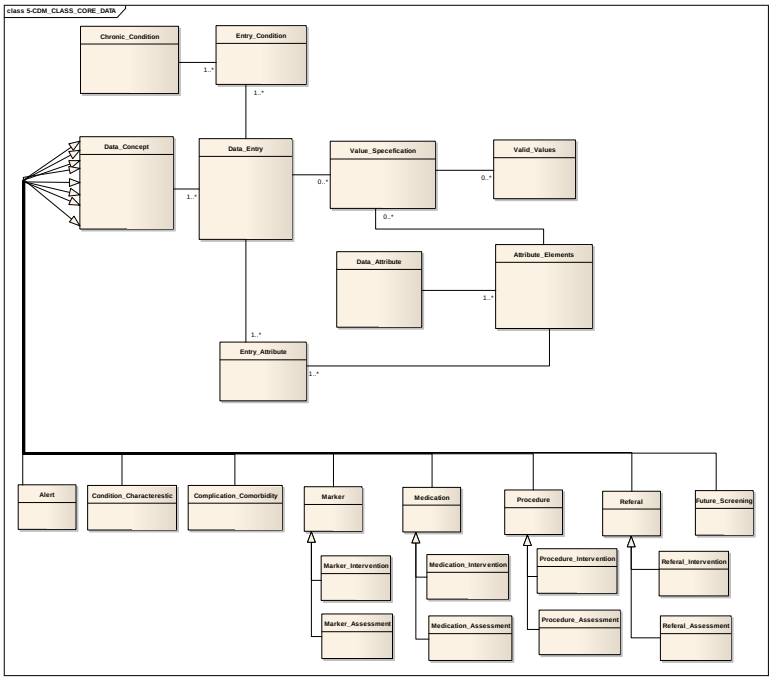


Figure 9. Core Data Management Data Model Diagram

Entity Name	Data Concept			
Entity Description	This data entity will provide the ability to define the data concept for which the user is interested to create other data entities. This concept can be around the definition of alerts, chronic condition characteristics, markers, medications, procedures, referrals, etc.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Data_Concept_ID	Yes	DE_PK_ID		Primary Key
Code		DE_Code		
Name	Yes	DE_Name		
Description		DE_Long_String		
Data_Concept_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		

Entity Name	Data Entity			
Entity Description	This entity will provide the ability to define the data entities required for a defined data concept. For example, four data entities can be defined for Alert as a data concept: 1) Alert Allergy, 2) Adverse Drug Reaction, 3) Medication Concerns, 4) Other Alerts.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Data_Entity_ID	Yes	DE_PK_ID		Primary Key
Name	Yes	DE_Name		
Definition		DE_Long_String		

Type_Code		DE_Type	Yes	
Type_Code_Name		DE_Short_String		
Type_Code_Value		DE_Code		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Data_Concept_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Value Specification			
Entity Description	This entity will provide the ability to define the specifications for the set of values that are supposed to be assigned to a data entity or an attribute.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Value_Specefication_ID	Yes	DE_PK_ID		Primary Key
Value_Type	Yes	DE_Type	Yes	
Unit_Of_Measure		DE_Type	Yes	
Code_Set_Source		DE_Long_String		
Data_Entry_ID		DE_PK_ID		Foreign Key
Attribute_Elements_ID		DE_PK_ID		Foreign Key

Entity Name	Valid_Values			
Entity Description	This entity will provide the ability to define the list of valid values related to a code set.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Valid_Value_ID	Yes	DE_PK_ID		Primary Key
Name	Yes	DE_Type		
Description		DE_Type		
Value_Specefication_ID		DE_PK_ID		Foreign Key

Entity Name	Data Attribute			
Entity Description	This entity will provide the ability to define all the data attributes that will be assigned to the data entities. These attributes can have one or more attribute elements.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Data_Attribute_ID	Yes	DE_PK_ID		Primary Key
Name	Yes	DE_Name		
Description		DE_Long_String		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		

Entity Name	Attribute_Elements			
Entity Description	This entity will provide the ability to define the elements related to one attribute.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Attribute_Element_ID	Yes	DE_PK_ID		Primary Key
Name	Yes	DE_Name		
Data_Type	Yes	DE_Type	Yes	
Description		DE_Long_String		
Status	Yes	DE_Type	Yes	

Status_Date	Yes	DE_Date		
Data_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Entity_Attribute			
Entity Description	This entity will provide the ability to assign the attribute element to the data entities.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Entity_Attribute_ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Data_Entity_ID	Yes	DE_PK_ID		Foreign Key
Attribute_Element_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Chronic_Condition			
Entity Description	This entity will provide the ability to define all chronic diseases.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Chronic_Condition _ID	Yes	DE_PK_ID		Primary Key
Code		DE_Code		
Name	Yes	DE_Name		
Description		DE_Long_String		

Entity Name	Entity_Condition			
Entity Description	This entity will provide the ability to assign the defined data entities to one or more chronic conditions.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Entity_Condition _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Code		
Status_Date	Yes	DE_Name		
Chronic_Condition _ID	Yes	DE_PK_ID		Foreign Key
Data_Entity_ID	Yes	DE_PK_ID		Foreign Key

Communication Management

This process group provides the ability to communicate between the different parties, specifically the patient and the care providers. These communications will be conducted in the form of sending and receiving the requests and communicating around the interventions, notifications, and alerts.

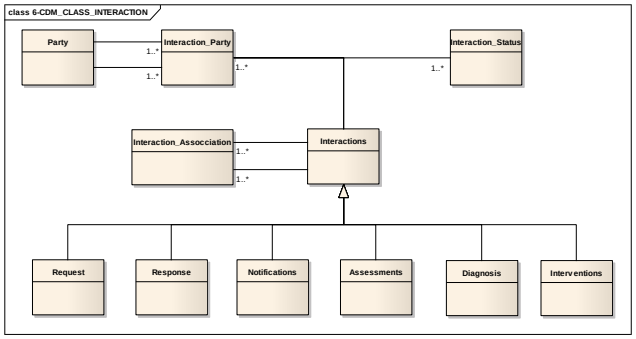


Figure 10. Communication Management Data Model Diagram

Entity Name	Interactions			
Entity Description	This data entity will provide the ability to define all the interactions that happened between the care providers and the patients. The interactions will be in the format of requests, responses, and notifications. Also, the assessment, diagnosis, or intervention records all be accounted for as a kind of interaction between the care providers and the patients.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Interaction_ID	Yes	DE_PK_ID		Primary Key
Interaction_Type	Yes	DE_Type	Yes	
Interaction_Code	Yes	DE_Code		
Interaction_Date	Yes	DE_Date		

Entity Name	Interaction_Party			
Entity Description	This data entity will provide the ability to assign the interactions to the parties as senders and receivers.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Interaction_Party_ID	Yes	DE_PK_ID		Primary Key
Interaction_ID	Yes	DE_PK_ID		Foreign Key
Party_ID_Sender	Yes	DE_PK_ID		Foreign Key
Party_ID_Receiver	Yes	DE_PK_ID		Foreign Key

Entity Name	Interaction_Assocciasion			
Entity Description	This data entity will provide the ability to define the associations between the interactions. In this way, the ability of traceability between the interaction records such as requests and responses will be provided.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Interaction_Assocciasion_ID	Yes	DE_PK_ID		Primary Key
Interaction_ID_Parent	Yes	DE_PK_ID		Foreign Key
Interaction_ID_Child	Yes	DE_PK_ID		Foreign Key

Entity Name	Interaction_Status			
Entity Description	This data entity will provide the ability to define the interaction status. Each interaction can have multiple statuses.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**

Interaction_Status_ID	Yes	DE_PK_ID		Primary Key
Interaction_Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Request			
Entity Description	This data entity will provide the ability to create a request and send that to the other party. This request can have a different subject.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Request_ID	Yes	DE_PK_ID		Primary Key
Subject	Yes	DE_Short_String		
Request_Body	Yes	DE_Long_String		
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Response			
Entity Description	This data entity will provide the ability to create a response for a receiving request.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Response_ID	Yes	DE_PK_ID		Primary Key
Response_Body	Yes	DE_Long_String		
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Notification			
Entity Description	This data entity will provide the ability to create a notification in the format of an alert or reminder.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Notification_ID	Yes	DE_PK_ID		Primary Key
Notification_Type	Yes	DE_Type	Yes	
Notification_Body	Yes	DE_Long_String		
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessments			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider. Assessment can be done in domains of alerts, condition characteristics, markers, procedures, medications, and referrals.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_ID	Yes	DE_PK_ID		Primary Key
Assessment_Type	Yes	DE_Type	Yes	
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Diagnosis
Entity Description	This data entity will provide the ability to create a diagnosis record for a patient done by a care provider. Diagnosis will be about the main problem or the complications and co-morbidities.

Attribute Name	Is Mandatory	Data Type	Code Set Assigned	Key Type
Diagnosis_ID	Yes	DE_PK_ID		Primary Key
Dianosis_Type	Yes	DE_Type	Yes	
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Interventions			
Entity Description	This data entity will provide the ability to create an intervention record for a patient done by a care provider. The intervention can be about the goals, medications, procedures, referrals, or requesting the lab markers.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_ID	Yes	DE_PK_ID		Primary Key
Intervention_Type	Yes	DE_Type	Yes	
Interaction_ID	Yes	DE_PK_ID		Foreign Key

Assessment Management

This process group provides the ability to collect information that gets to know the patient in detail, evaluating their risks and the nature of the problems to be identified. It can help gather information about the alerts and risks such as allergy, adverse drug reactions, or any medication concerns that exist for the patient. Also, it provides knowledge about some of the characteristics which are relevant to the chronic patient condition and important for any clinical decision-making, such as a person or family history, ethnicity, height, weight, etc.

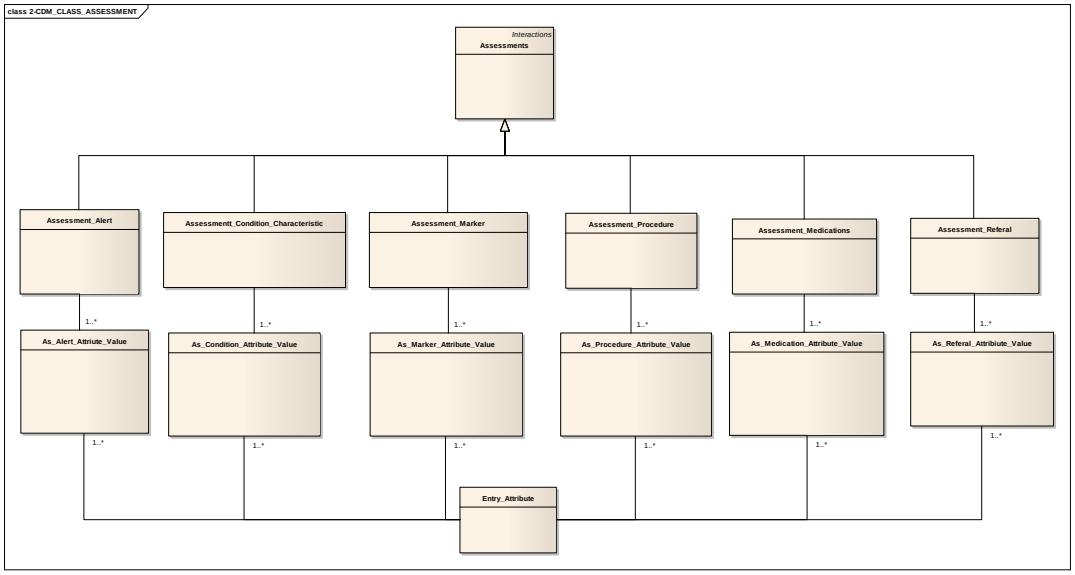


Figure 11. Assessment Management Data Model Diagram

Entity Name	Assessment_Alert			
Entity Description	This data entity will provide the ability to create an assessment alert record for a patient done by a care provider. Assessment of the alerts can be done in domains of allergies, adverse drug reactions, medication concerns, or other alerts.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Alert_ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Alert_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the alert data entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
As_Alert_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Alert_ID	Yes	DE_PK_ID		Foreign Key

Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessment_Condition_Characterestics			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider concerning the condition characteristics. The assessment of the condition characteristics can be done in the domains of Patient history, family history, ethnicity, smoking status, etc.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Condition_Characterestics _ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Condition_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the condition characteristics entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
As_Condition_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Condition_Characterestics _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessment_Marker			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider about the markers. The assessment of the markers can be done in domains of lab test markers which present the progression of the chronic condition such as A1C for diabetes.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Marker_ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Marker_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the marker entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
As_Marker_Attribute_Value_ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		

Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Marker_ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessment_Procedure			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider about the procedures. The assessment of the procedures can be done in domains of the history of the procedure that was done for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Procedure _ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Procedure_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the procedure entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
As_Procedure_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Procedure _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessment_Medications			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider about the medications. The assessment of the medications can be done in domains of the current medications that are used by the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Medication_ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Medication_Attribute_Value
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the medication entity.

Attribute Name	Is Mandatory	Data Type	Code Set Assigned	Key Type
As_Medication_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Medication_ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Assessment_Referal			
Entity Description	This data entity will provide the ability to create an assessment record for a patient done by a care provider about the referrals. The assessment of the referrals can be done in domains of the result of the referrals ordered for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Assessment_Referal _ID	Yes	DE_PK_ID		Primary Key
Alert_Type	Yes	DE_Type	Yes	
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	As_Referal_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the referral entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
As_Referal_Attribute_Value_ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Short_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Assessment_Referal _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Diagnosis Management

This process group provides the ability to identify a disease, condition, or injury based on the signs and symptoms a patient is having, considering the patient's health history and physical exam. It also includes the diagnosis of the existing complications or any comorbidities relevant to the main diagnosis.

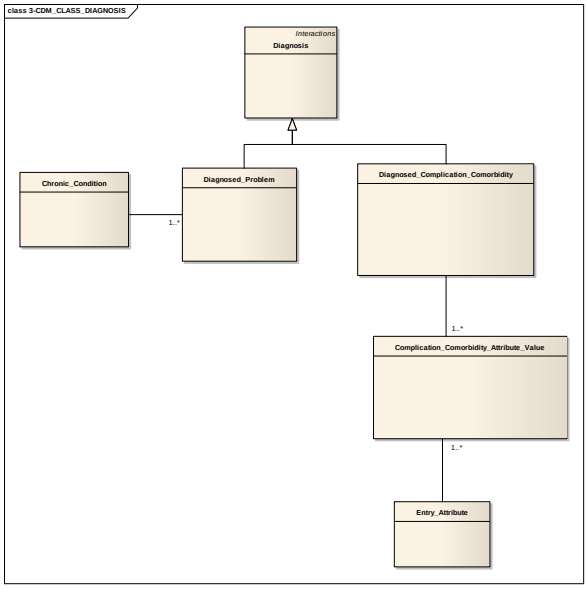


Figure 12. Diagnosis Management Data Model Diagram

Entity Name	Diagnosed_Problem			
Entity Description	This data entity will provide the ability to create a record about the chronic condition diagnosed for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Diagnosed_Problem _ID	Yes	DE_PK_ID		Primary Key
Diagnosis_Code	Yes	DE_Code		
Diagnosis_Name	Yes	DE_Name		
Description		DE_Long_String		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Diagnosis _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Diagnosed_Complication_Comorbidity			
Entity Description	This data entity will provide the ability to create records about the complications or co-morbidities that exist for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Diagnosed_Complication_Comorbidity _ID	Yes	DE_PK_ID		Primary Key
Is_Complication		DE_Boolean		
Is_Co-Morbidity		DE_Boolean		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Diagnosis _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Complication_Comorbidity_Attribute_Value

Entity Description	This data entity will provide the ability to archive the assessment values for different elements of the attributes related to the complication and co-morbidity entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Complication_Comorbidity_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Diagnosed_Complication_Comorbidity _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Planning Management

This process group provides the ability to plan how the care provider intends to deliver care for a particular patient, possibly limited to care for a specific condition or set of conditions. Based on the data gathered through assessment and diagnosis processes such as condition, condition characteristics, patient history, and treatment guidelines, the care provider develops the best package of care for the patient, including the orders required for laboratory tests, Imaging, and medications, procedures, and referrals. The goal setting and the actions required for achieving the goals are also defined through this capability.

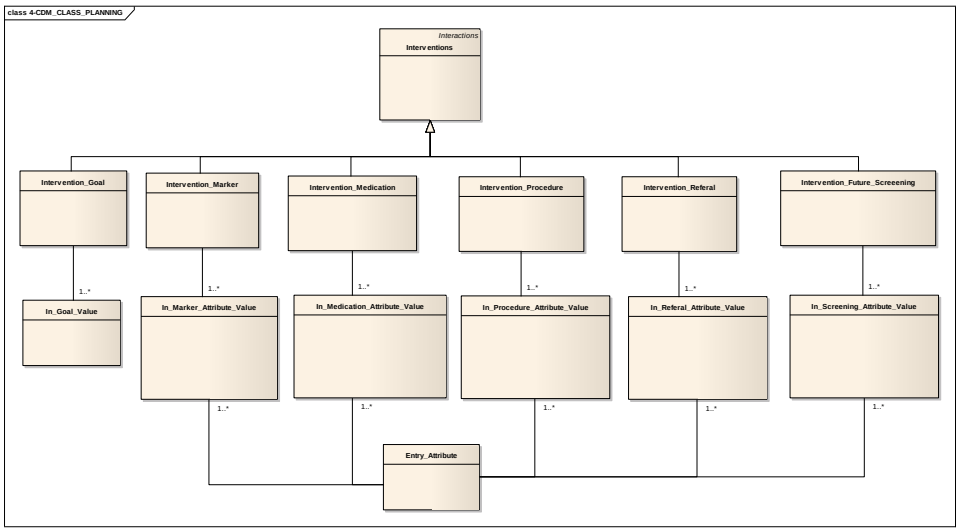


Figure 13. Planning Management Data Model Diagram

Entity Name	Intervention_Goal			
Entity Description	This data entity will provide the ability to define goals for the patient. These goals are aligned with the treatment plans and will expect specific actions.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Goal _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Goal_Value			
Entity Description	This data entity will provide the ability to archive the values of the goals defined for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Goal_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Goal _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Intervention_Marker			
Entity Description	This data entity will provide the ability to define the lab tests required for the patient to assess the chronic condition status and progress.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Marker _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Marker_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the values for different elements of the attributes related to the marker entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Marker_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Marker _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Intervention_Medication			
Entity Description	This data entity will provide the ability to define the medications required for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Medication _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Medication_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the values for different elements of the attributes related to the medication entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Medication_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Medication _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Intervention_Procedure			
Entity Description	This data entity will provide the ability to define the procedures required for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Procedure _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Procedure_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the values for different elements of the attributes related to the procedure entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Procedure_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Procedure _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Intervention_Referal			
Entity Description	This data entity will provide the ability to define the referrals required for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Referal_ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Referal_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the values for different elements of the attributes related to the referral entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Referal_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Referal_ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Intervention_Future_Screening			
Entity Description	This data entity will provide the ability to define the referrals required for the patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Intervention_Future_Screening _ID	Yes	DE_PK_ID		Primary Key
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	In_Screening_Attribute_Value			
Entity Description	This data entity will provide the ability to archive the values for different elements of the attributes related to the referral entity.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
In_Screening_Attribute_Value _ID	Yes	DE_PK_ID		Primary Key
Text_Value		DE_Shor_String	Yes	
Numeric_Value		DE_Numeric		
Date_Value		DE_Date		
LOV_Value		DE_Numeric		
Status	Yes	DE_Type	Yes	
Status_Date	Yes	DE_Date		
Intervention_Future_Screening _ID	Yes	DE_PK_ID		Foreign Key
Entity_Attribute_ID	Yes	DE_PK_ID		Foreign Key

Registration Management

This process group provides the ability to complete all the registrations that are required, including the registration of the patients, care providers, facilities, and the association between the patients, providers, and facilities, besides all the details required as essential information such as contact information, patient caregiver information, etc.

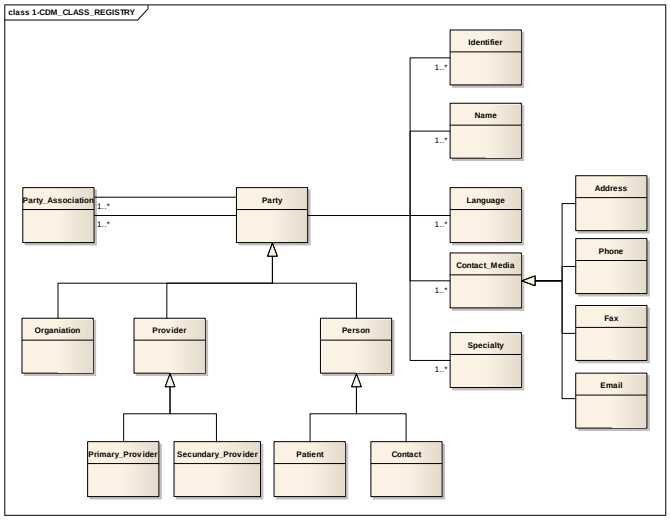


Figure 14. Registration Management Data Model Diagram

Entity Name	Party			
Entity Description	This data entity will provide the ability to define all the parties who can be involved in this solution. The parties can be the patient or their caregiver, the primary or the secondary care provider, or the facility where the patient receives the services.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Party _ID	Yes	DE_PK_ID		Primary Key
Party_Type	Yes	DE_Type	Yes	
Status		DE_Type	Yes	
Status_Date	Yes	DE_Date		

Entity Name	Person			
Entity Description	This data entity will provide the ability to define all the service receivers who can be a patient or their caregivers.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Person _ID	Yes	DE_PK_ID		Primary Key
Person_Type	Yes	DE_Type	Yes	
Party _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Patient			
Entity Description	This data entity will provide the ability to define the patients.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Patient _ID	Yes	DE_PK_ID		Primary Key
Date_of_Birth	Yes	DE_Date		
Person _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Contact			
Entity Description	This data entity will provide the ability to define the patient's caregivers.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Contact _ID	Yes	DE_PK_ID		Primary Key
Relationship_Type	Yes	DE_Type	Yes	
Person _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Provider			
Entity Description	This data entity will provide the ability to define the care providers who are involved in this solution.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Provider _ID	Yes	DE_PK_ID		Primary Key
Provider_Type	Yes	DE_Type	Yes	
Party _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Primary_Provider			
Entity Description	This data entity will provide the ability to define the primary providers of a patient.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Primary_Provider _ID	Yes	DE_PK_ID		Primary Key
Date_of_Birth	Yes	DE_Date		
Provider _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Secondary_Provider			
Entity Description	This data entity will provide the ability to define the secondary providers of a patient. The secondary providers can be the other physicians or other clinical providers such as nurses who are involved in the process of the patient treatment.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Secondary_Provider _ID	Yes	DE_PK_ID		Primary Key
Date_of_Birth	Yes	DE_Date		
Provider _ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Organization			
Entity Description	This data entity will provide the ability to define facilities, including the hospitals or clinics where the patients receive their services.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Organization _ID	Yes	DE_PK_ID		Primary Key
Party _ID	Yes	DE_PK_ID		Foreign Key
Entity Name	Party_Association			
Entity Description	This data entity will provide the ability to define the relationships between the parties. This relationship can be defined between the patient and the provider, the patient and the caregiver, the patient and the organization, etc.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Party_Association _ID	Yes	DE_PK_ID		Primary Key
Parent_Party_ID	Yes	DE_PK_ID		Foreign Key
Child_Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Identifier			
Entity Description	This data entity will provide the ability to define all the identifiers required for the different parties. For example, the patient can include the patient's healthcare number or any other IDS.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Identifier _ID	Yes	DE_PK_ID		Primary Key
Identifier_Type	Yes	DE_Type	Yes	
Identifier	Yes	DE_Code		
Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Name			
Entity Description	This data entity will provide the ability to define whatever ever related to the name of a party, such as first name, middle name, last name, title, etc.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Name _ID	Yes	DE_PK_ID		Primary Key
First_Name		DE_Name		
Middle_Name		DE_Name		
Last_Name		DE_Name		
Title		DE_Name		
Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Language			
Entity Description	This data entity will provide the ability to define the preferred language of the parties.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Language _ID	Yes	DE_PK_ID		Primary Key
Language_Type	Yes	DE_Type	Yes	
Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Specialty			
Entity Description	This data entity will provide the ability to define the specialty of the providers.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Specialty _ID	Yes	DE_PK_ID		Primary Key
Spetialty_Type		DE_Type	Yes	
Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Contact_Media			
Entity Description	This data entity will provide the ability to define the different methods for connecting to the parties, which include the address, phone, email, etc.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Contact_Media _ID	Yes	DE_PK_ID		Primary Key
Contact_Type		DE_Type	Yes	
Party_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Address			
Entity Description	This data entity will provide the ability to define the address of the parties.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Address _ID	Yes	DE_PK_ID		Primary Key
Address_Line_One	Yes	DE_Short_String		
Address_Line_Two		DE_Short_String		
Postal_Code	Yes	De_Code		
City	Yes	DE_TYPE	Yes	
State	Yes	DE_TYPE	Yes	
Country	Yes	DE_TYPE	Yes	
Contact_Media_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Phone			
Entity Description	This data entity will provide the ability to define the phone numbers of the parties.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
Phone _ID	Yes	DE_PK_ID		Primary Key
Phone_Type	Yes	DE_Type	Yes	
Phone_Number		DE_Short_String		
Contact_Media_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Fax			
Entity Description	This data entity will provide the ability to define the Fax numbers of the parties.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**

Fax _ID	Yes	DE_PK_ID		Primary Key
Fax_Number		DE_Short_String		
Contact_Media_ID	Yes	DE_PK_ID		Foreign Key

Entity Name	Email			
Entity Description	This data entity will provide the ability to define the email address of the parties.			
Attribute Name	**Is Mandatory**	**Data Type**	**Code Set Assigned**	**Key Type**
email _ID	Yes	DE_PK_ID		Primary Key
Email_Address		DE_Short_String		
Contact_Media_ID	Yes	DE_PK_ID		Foreign Key

Summary

In order to shape our CDM Information Architecture Framework and in response to our discussed methodology, the other two key outcomes of this project were created, including “DIV1- Conceptual Data Model” and “DIV2- Logical Data Model”. The next chapter will present the mapping between the designed capabilities, processes, activities, and data to keep the traceability of all the architectural descriptions required for this solution.

Chapter Seven. Viewpoints Mapping Reference

The purpose of this chapter is to map the capabilities and activities (operational activities) and their relationships among activities, and the logical data model elements used as their input or output. The mapping logic based on the analysis was done during the building of the models presented earlier. The tables below are aligned with the two models expected for this project, capability to operational activity and operational activity to data.

Capability, Process, Operational Activity, and Data Mapping

Assessment Management

Capability	Assessment Management									
Process	Alert Assessment				Condition Characteristics Assessment	Result Assessment				
Activity	Allergy Alert Assessment	Adverse Drug Reaction	Medication Concerns Assessment	Other Alert Assessment	Condition Characteristics Assessment	Progress Markers Assessment	Medications Administration Assessment	Procedure Result Assessment	Patient, Device, interface Entry Assessment	Referral Assessment
Data										
Assessment	•	•	•	•	•	•	•	•	•	•
Assessment_Alert	•	•	•	•						
As_Alert_Attribute_Value	•	•	•	•						
Assessment_Condition_Characterestics					•					
As_Condition_Attribute_Value					•					
Assessment_Marker						•			•	
As_Marker_Attribute_Value						•			•	
Assessment_Procedure								•	•	
As_Procedure_Attribute_Value								•	•	
Assessment_Medications							•		•	

Capability	Assessment Management									
Process	Alert Assessment				Condition Characteristics Assessment	Result Assessment				
Activity	Allergy Alert Assessment	Adverse Drug Reaction	Medication Concerns Assessment	Other Alert Assessment	Condition Characteristics Assessment	Progress Markers Assessment	Medications Administration Assessment	Procedure Result Assessment	Patient, Device, interface Entry Assessment	Referral Assessment
Data										
As_Medication_Attribute_Value							●		●	
Assessment_Referal									●	●
As_Referal_Attribute_Value									●	●
Assessment_PDI									●	
As_PDI_Attribute_Value									●	

Diagnosis Management

Capability	Diagnosis Management		
Process	Chronic Condition, complication, co-morbidity Diagnosis		
Activity	Condition Diagnosis	Complication Diagnosis	Co-Morbidity Diagnosis
Data			
Diagnosis	•	•	•
Diagnosed_Problem	•		
Diagnosed_Complication_Comorbidity		•	•
Complication_Comorbidity_Attribute_Value		•	•

Planning Management

Capability	Planning Management					
Process	Goal Setting		Intervention Planning			
Activity	Define Goals	Define Actions	Progress Markers Planning	Medications Planning	Procedure Planning	Referral Planning
Data						
Intervention	•	•	•	•	•	•
Intervention_Goal	•	•				
In_Goal_Value	•	•				
Intervention_Marker			•			
In_Marker_Attribute_Value			•			
Intervention_Medication				•		
In_Medication_Attribute_Value				•		
Intervention_Procedure					•	
In_Procedure_Attribute_Value					•	
Intervention_Referal						•
In_Referal_Attribute_Value						•

Result Entry Management

Capability	Result Entry Management		
Process	Manual Entry	Interface Entry	
Activity	Result Manual Entry	Device Entry	System Entry
Data			
Assessment	●	●	●
Assessment_Marker	●	●	
As_Marker_Attribute_Value	●	●	
Assessment_Procedure			●
As_Procedure_Attribute_Value			●
Assessment_Medications			●
As_Medication_Attribute_Value			●
Assessment_Referal			●
As_Referal_Attribute_Value			●
Assessment_PDI	●	●	
As_PDI_Attribute_Value	●	●	

Communication Management

Capability	Communication Management				
Process	Request and Response Management		Communicate Interventions	Notification Management	
Activity	Send and Receive Requests	Send and Receive Responses	Communicate Medications, Procedures, or Lab Tests	Alerts Setting	Reminders Setting
Data					
Interactions	•	•	•	•	•
Interaction_Party	•	•	•	•	•
Interaction_Assocciasion	•	•	•	•	•
Interaction_Status	•	•	•	•	•
Request	•				
Response		•			
Notification				•	•
Assessments			•		
Diagnosis			•		
Interventions			•		

Registration Management

Capability	Registration Management					
Process	Party Registry					
Activity	Patient Registry	Care Provider Registry	Facility Registry	Caregiver Registry	Contact Registry	Association Registry
Data						
Party	•	•	•	•	•	•
Person	•			•	•	•
patient	•				•	•
Caregiver	•			•	•	•
Provider		•			•	•
Primary_Provider		•			•	•
Secundary_Provider		•			•	•
Organization			•		•	•
Party_Association						•
Identifier	•	•	•	•		
Name	•	•	•	•		
Language	•	•		•		
Contact_Media					•	
Address					•	
Phone					•	
Fax					•	
Email					•	

Capability	Registration Management					
Process	Party Registry					
Activity	Patient Registry	Care Provider Registry	Facility Registry	Caregiver Registry	Contact Registry	Association Registry
Data						
Specialty		•	•			

Core Data Management

Capability	Core Data Management				
Process	Data Concept Definition	Data Entry Definition	Data Attribute Definition		
Activity	Data Concept Definition	Data Entry Definition	Data Attribute Definition	Attribute Element Definition	Attribute Element to data Entry association
Data					
Chronic_Condition		•			
Data_Concept	•	•			
Data_Entry					
Data_Attribute			•	•	
Attribute_Elements					
Entry_Attribute					•
Entry_Condition		•			
Value_Specefication		•		•	
Valid_Values		•		•	

Summary

In order to shape the mapping between all the designed architectural descriptions and in response to our discussed methodology, the other two key outcomes of this project were created, including “CV3- Capability to Operational Activities Mapping” and “OV2- Operational Activity to Data Mapping” which are merged and presented in one table for different capabilities. The last but not the least chapter will be the discussion around the outcomes of this project and the conclusion.

Chapter Eight. Discussion and Conclusion

Discussion

Chronic diseases have beaten acute and infectious diseases as the major cause of death in Canada (Western Health Infostructure Canada, 2005). The creation of health information systems such as desktop, web, or mobile applications considering patient self-management will play an essential role in effective chronic disease management.

Reviews and studies indicate that the clinical systems designed for chronic disease management are mostly targeted at specific chronic conditions. Few approaches look at the chronic disease management system as a white-label or general platform that includes any chronic disease condition.

Considering the challenges associated with developing such systems, the main objective of this project is to conduct an architecture-based approach to establish a general reference architecture for the development of such systems, improving the quality and interoperability with existing e-health systems with low coupling and reusability.

Based on the viewpoints and models introduced by the Department of Defense Architecture Framework (DoDAF), the business and information architecture frameworks were developed to define the standard capabilities, processes, activities, and data required for the chronic disease management solutions.

Existing chronic care models and chronic disease management infostructure besides the standard Canadian chronic disease management guidelines were the main resources for extracting the data required to shape our business and information frameworks.

The key models developed in this project are as follows:

- The models developed in the Business Architecture Framework:
  - Capability Viewpoint – CDM Vision
  - Capability Viewpoint – CDM Capability Model
  - Operational Viewpoint – CDM Operational Activity Model
- The models developed in the Information Architecture Framework:
  - Data and Information Viewpoint – CDM Conceptual Data Model
  - Data and Information Viewpoint - CDM Logical Data Model
- Other models:
  - Capability Viewpoint – CDM Capability to CDM Operational Activities Mapping
  - Operational Viewpoint – CDM Operational Activity to CDM Data Mapping

To provide a better understanding of the different structures and models which were introduced in this project, appendix two tried to provide the core clinical data required for three chronic sample conditions, diabetes, hypertension, and chronic kidney disease, as a prototype to

show how the content as the data concepts, data entities, and attribute elements can be produced dynamically, without any dependency to the system developers.

Limitations

Here are the limitations we encounter during the building our reference architecture:

- Limited research and initiatives exist in domain of chronic disease management Infostructure
- Limited research and initiatives define a generalized structure of information targeted all chronic conditions
- Coded data elements were found mostly for limited chronic conditions
- (Diabetes, Hypertension, and Chronic Kidney Disease)
- Lack of evidences exist about successful real-world coaching applications for chronic disease management

Conclusion

The development of the general systems targeting the management of all chronic disease conditions requires the usage of the universal guidelines and standards identifying the systematic, organized processes, methods, terms, and definitions, used by the specialists and sites of care in the domain of chronic disease management.

Considering the challenges associated with collecting the standards applied for the processes and information which are consistent across the specialists and sites of care, we need to have a reference architecture as a blueprint, including holistic clinical processes, services, systems, and information in the domain of chronic disease management. This project tried to develop such a general reference for chronic disease management solutions through the development of two architecture frameworks in the domain of business and information, applying the existing guidelines and standards.

This effort was an architecture-based approach that tried to collect all the important requirements in domains of processes and data required for chronic disease management, with the hope of providing some potential for facilitating and improving the development of chronic disease management solutions.

The advantages that come with the architecture-based modeling approach and the offered architectural frameworks presented in this project can be summarized as follows:

Capability-Driven System Development: Systems and services are no longer developed in an ad hoc manner (to satisfy urgent needs), but their requirements are derived systematically from high-level operational capabilities. With an architecture-based modeling approach, first, the potential that is already available in the reference architecture can be analyzed. Next, one can compare this to desired capabilities and identify critical gaps. By having a look at the changes in the capabilities when adjusting specific screws of one's system design, one is able to identify the points where adjustments offer the greatest benefit.

Interoperability: An architecture-based approach ensures that systems and services will be truly interoperable.
Semantically Unambiguous Descriptions: The formal models of an architecture framework facilitates the semantically unambiguous and comprehensive description of operational activities, system properties, etc.
Comprehensive Specification: A framework allows for the description of all relevant aspects of architecture.
Reuse of Architecture Models: Architectural models can be reused in other contexts/architectures. There is no need to remodel the same systems. Instead, viewpoints can be restored from an architecture library. That offers two advantages: Elder projects get inexpensive quality assurance, and additional work is decreased.
Continues Evaluation: the models enable repeatable evaluations of architectures and guarantee comparability because the same algorithm can be applied to different architectures.

Future Work

The Application Architecture Framework, including the related viewpoints and models in relation to the systems and services, will be open for the developers to design based on their specific requirements and apply the business processes and the information presented in this document as a reference.

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Appendix

Appendix One – Architecture Framework Selection Process

For building all the artifacts and Architectural Descriptions of the above-mentioned frameworks, we require to select a candidate methodology suggested by the well-known Architecture Frameworks. For this purpose, an overall review of the famous Architecture Frameworks, besides a comparison for selecting the candidate methodology, will be presented in the following section.

ARCHITECTURE FRAMEWORKS REVIEW

An architecture framework is required to establish a common methodology to create, interpret, analyze, and also to use architecture descriptions in a particular domain for a specific community of practice. Examples of Architecture Frameworks are DODAF, TOGAF, Zachman, FEAF, etc. (Owuato, Kang, & Ko, 2012).

Zachman Framework (ZF)

Philosophy: ZF introduces architectural artifacts and focuses on business value and suppleness. ZF also addresses traceability of requirements, builds useful and tangible functionalities, and defines communication among stakeholders.

The Open Group Architecture Framework (TOGAF)

Philosophy: TOGAF is a general architecture development methodology which is used for reviewing preparation, checking the architecture completeness, etc. It has a common framework to create, maintain, and use architectures in the industry. TOGAF provides a structure for planning, assessing, and constructing architectures for the organization.

Department of Defense Architecture Framework (DoDAF)

Philosophy: DoDAF, on the other hand, offers a guideline on structure breaking to develop products. DoDAF can be used for enterprise, system, and system of systems architectures. It acts as a universal concept for creating systems in DoD to enable the comparison of created systems and to support transformation of goals through universal guidance. DoDAF also supports armed warfare operations, business functions, and procedures. It establishes an information-sharing architecture for managing data and decision-making.

Federal Enterprise Architecture Framework (FEAF)

Philosophy: FEAF is a planning model for performance improvement, identifying potential investment areas, supporting goal realization, and providing guidance on segmenting system structure. FEAF also establishes an integrated organizational roadmap for achieving objectives and puts agencies' functions under single enterprise architecture.

ARCHITECTURE FRAMEWORKS COMPARISON

Several perspectives from past research papers have been identified to enhance the accuracy of selecting the Architecture Framework. "Perspectives" are the comparison criteria between objects and are used to classify the content of the objects by categorizing them based on their related aspects. "Aspects" on the other hand are the contents connected to the perspective i.e. the attributes of the criteria. The table below identifies the perspectives and aspects used in the previous comparison works (Owuato, Kang, & Ko, 2012).

PERSPECTIVES	ASPECTS
P1. Goals	P1.1 Architecture definition and understanding P1.2 Architecture development process P1.3 Architecture evolution support P1.4 Architecture analysis P1.5 Architecture models P1.6 Design rationale P1.7 Design tradeoff P1.8 Standardization P1.9 Architecture knowledge base P1.10 Architecture verifiability
P2. Inputs	P2.1 Business drivers P2.2 Technology inputs P2.3 Business requirements P2.4 Information system environments P3.5 Current architecture P2.6 Non-functional requirements
P3. Outcomes	P3.1 Business model P3.2 System model P3.3 Information model P3.4 Computation model P3.5 Software configuration model P3.6 Software processing model P3.7 Implementation model P3.8 Platforms P3.9 Non-functional requirements design P3.10 Transition design P3.11 Design rationale
P4. Views	P4.1 Planner P4.2 Owner P4.3 Designer P4.4 Builder

PERSPECTIVES	ASPECTS
	P4.5 Subcontractor P4.6 User
P5. Abstractions	P5.1 What P5.2 How P5.3 Where P5.4 Who P5.5 When P5.6 Why
P6. System development life Cycle	P6.1 Planning P6.2 Analysis P6.3 Design P6.4 Implementation P6.5 Maintenance
P7. Guide	P7.1 Metamodel P7.2 Procedure model P7.3 Modeling technique P7.4 Role P7.5 Specification document P7.6 Process completeness P7.7 Maturity model P7.8 Reference model guidance P7.9 Practice guidance P7.10 Governance guidance P7.11 Partitioning guidance P7.12 Prescription catalog P7.13 Providing guidance architecture descriptions P7.14 Product definitions P7.15 Architecture development P7.16 Information reference resources P7.17 Tool builders P7.18 compliant architecture views P7.19 EA development process P7.20 Transition strategy and plan P7.21 Product and repository issues
P8. Quality	P8.1 Alignment P8.2 Integration P8.3 Value creation P8.4 Change management P8.5 Compliance P8.6 Taxonomy completeness P8.7 Vendor neutrality P8.8 Time to value P8.9 Information availability P8.10 Business focus

The significance of the listed perspectives

1) Goals: Specific goals should be identified so that they are accomplished. Identification of goals describes the specific reasons, purpose, or benefits of those goals. Identified goals enable the establishment of concrete criteria for measuring progress toward the attainment of each set goal by measuring, and keeping track of progress, meeting target dates, and realizing the motivation gained from previous accomplishments in a way that future encouragements are possible for achieving future goals. Set goals enable prioritization and allow configuration of means to achieve them; and create attitudes, skills, abilities, and financial capacity to accomplish them. Setting goals enables planning and taking the steps wisely and establishes a time frame for performing the steps. Known goals make enables the teams to determine if they are realistic by representing objectives that create eagerness and ability to achieve those goals.

2) Inputs: The inputs of Enterprise Architecture are the outlines that integrate processes and goals in a business enterprise in order to provide core components of the business process including strategic planning, organizational design, business process reengineering, and systems delivery. Inputs also help to exploit the intellectual capital effectively. Otherwise, intellectual capital will have less meaning and value without inputs.

3) Outputs: Outputs are views and models that describe the existing environment. They are used to understand the existing gaps when planning for the future ideal environment. Outputs are the design guidelines and patterns that are used in the activities to govern IT tasks in the most efficient and shortest path to develop a future ideal environment. Lack of output makes the current status undefined as well as the path to developing a future environment.

4) Views: Views are depictions of the architecture that are meaningful to concerned stakeholders. Views facilitates communication and understanding of architecture by all stakeholders. They also verify that the future system will tackle the existing concerns.

5) Abstractions: Abstractions facilitate a progressive decomposition and help the team to track the development from the conceptual design to the detailed implementation. It allows to remove the artifacts of complicating factors, to incrementally refine the details in order to manage the enterprise complexity. Lack of abstractions will produce complex systems that are difficult to manage as risks of systems failure due to the inability to efficiently and effectively understand and communicate among concerned stakeholders.

6) System development life cycle: The architecture delivery process allows the implementation of a standardized design methodology that consists of well-defined artifacts, roles, processes, and responsibilities. Implicit process definition shortens design cycles, clears handoffs, and reduces costs.

7) Guide: The guiding process is intended to help in defining, maintaining, and implementing EAs by providing them with a disciplined and thorough approach to Enterprise Architecture life cycle management. The guide will describe EA maintenance, implementation, oversight, and control. This guidance is critically important, improves the chance of an organization to effectively produce a complete and enforceable EA for optimizing its systems for value.

8) Quality: Failure to develop good quality software may result in making changes to the software, may increase costs in unexpected ways, and IT can become unmanageable. Attaining quality attributes are the rightful indication of knowing whether the job has been done or not.

Architecture Frameworks must be compared because their application concepts, strengths, and weaknesses differ. As shown in the table below, "0" indicates that the Architecture Framework does not entirely address an aspect. "1" indicates that it does not adequately address an aspect. And "2" indicates that it does address an aspect adequately (Owuato, Kang, & Ko, 2012).

Comparison perspectives/Aspects	**ZF**	**DoDAF**	**TOGAF**	**FEAF**
P1. Goals				
P1.1 Architecture definition and understanding	1	2	2	2
P1.2 The architecture development process	1	2	2	2
P1.3 Architecture transition strategy	0	2	2	1
P1.4 Architecture evolution support	0	2	2	2
P1.5 Architecture assessment	2	2	2	2
P1.5Architecture models	2	2	2	2
P1.6 Design tradeoffs	1	2	1	1
P1.7 Design rationale	1	1	2	1
P1.8 Standardization	0	2	2	1
P1.9 The architecture knowledge base	0	2	2	2
P1.10 Architecture verifiability	0	0	2	0
Subtotal	**8**	**19**	**21**	**16**
P2. Inputs				
P2.1 Business drivers	1	2	2	2
P2.2 Technology inputs	0	2	2	2
P2.3 Business requirements	2	2	2	2
P2.4 Information system environment	1	2	2	2
P2.5 Current architecture	1	2	2	2
P2.6 Quality requirements	1	1	2	1
Subtotal	**6**	**11**	**12**	**11**
P3. Outcomes				
P3.1 The business model	2	2	2	2
P3.2 System model	2	2	2	2
P3.3 The information model	2	2	2	2
P3.4 The computation model	2	2	2	2
P3.5 The software configuration model	0	0	2	0
P3.6 The processing model	2	2	2	2
P3.7 The implementation model	1	2	2	1
P3.8 The platform	2	2	2	2
P3.9 The quality design	1	1	2	1
P3.10 The transition design	0	2	2	2
P3.11 The design rationale	0	1	1	0
Subtotal	**14**	**18**	**21**	**16**

Comparison perspectives/Aspects	ZF	DoDAF	TOGAF	FEAF
P4. Views				
P4.1 The scope	2	2	0	2
P4.2 The owner	2	2	2	2
P4.3 The designer	2	2	2	2
P4.4 The builder	2	2	0	2
P4.5 The subcontractor	2	2	0	2
P4.6 The user	2	2	0	0
Subtotal	**12**	**8**	**4**	**10**
P5. Abstractions				
P5.1 The what	2	2	0	2
P5.2 The how	2	2	1	2
P5.3 The where	2	2	0	2
P5.4 The who	2	2	1	0
P5.5 The when	2	0	0	0
P5.6 The why	2	0	0	0
Subtotal	**12**	**8**	**2**	**6**
P6. System development life cycle				
P6.1 Domain identification	1	2	1	2
P6.2 Planning	1	2	0	2
P6.3 Analysis	1	2	1	2
P6.4 Design	1	2	1	2
P6.5 Implementation	1	1	1	2
P6.6 Maintenance	0	0	1	1
Subtotal	**5**	**9**	**5**	**11**
P7. Guide				
P7.1 Metamodel	1	1	0	0
P7.2 Procedure model	1	2	2	2
P7.3 Modeling Technique	0	2	1	0
P7.4 Role	0	1	0	2
P7.5 Specification document	2	2	1	2
P7.6 Process completeness	1	1	2	1
P7.7 Maturity model	0	1	1	1
P7.8 Reference model guidance	0	2	1	2
P7.9 Practice guidance	0	2	1	1
P7.10 Governance guidance	0	0	1	1
P7.11 Partitioning guidance	1	1	1	2
P7.12 Prescription catalog	1	1	1	2
P7.13 Providing guidance on architecture descriptions	1	2	2	1
P7.14 Product definitions	1	2	1	1
P7.15 Architecture development	2	1	2	0
P7.16 Information reference resources	2	0	2	0
P7.17 Tool builders	1	1	2	1
P7.18 compliant architecture views	0	2	2	0
P7.19 EA development process	1	2	2	1
P7.20 Transition strategy and plan	0	1	2	1

Comparison perspectives/Aspects	ZF	DoDAF	TOGAF	FEAF
P7.21 Product and repository issues	1	1	0	1
Subtotal	**16**	**28**	**27**	**21**
P8. Quality				
P8.1 Alignment	2	2	2	2
P8.2 Integration	2	1	2	2
P8.3 Value creation	2	0	2	2
P8.4 Change management	2	2	2	1
P8.5 Compliance	1	2	2	2
P8.6 Taxonomy completeness	2	1	1	1
P8.7 Vendor neutrality	2	2	1	2
P8.8 Time to value	1	1	1	2
P8.9 Information availability	1	2	2	1
P8.10 Business focus	2	1	1	2
P8.11 EA focus	2	2	1	2
P8.12 Explicit detail of products	1	2	1	1
Subtotal	**20**	**18**	**18**	**20**
Total	**94**	**119**	**108**	**105**

CANDIDATE ARCHITECTURE FRAMEWORK

As presented in the table above, all the perspectives and aspects were presented as if they had equal importance. In this case, we were convinced that DoDAF is leading and will be selected as a reference architecture framework for supporting the objectives defined for this project.

Appendix Two – Core Data Prototype for Three Chronic Conditions

Data Entities Prototype

In this section, we will provide the data entities which are required for the management of three chronic conditions, diabetes, hypertension, and chronic kidney disease, as a prototype for this solution. It must be mentioned that these are the sample content or data required for the data structure presented in the Core Data Management section in the logical data reference of this document. In this effort, we used the findings of the initiative conducted by the western health infostructure Canada, 2005, as our reference.

Alert

Allergy Alert

Name	Allergy Alert
Definition	An alert is describing a significant allergy.
Type Code	LOINC
Type Code Value	10155-0
Type Code Name	History of Allergies
Value – Not Applicable	

Adverse Drug Reaction

Name	Adverse Drug Reaction
Definition	A subset of adverse drug events includes any clinical manifestation that is undesired, unintended, or unexpected that is consequent to and caused by the administration of medications.
Type Code	LOINC
Type Code Value	X40007
Type Code Name	Adverse Drug Reaction
Value – Not Applicable	

Other Alerts

Name	Other Alerts
Definition	A broad definition allows for anything that is considered noteworthy about the management of the person.
Type Code	LOINC
Type Code Value	X40006
Type Code Name	Other Alerts
Value – Not Applicable	

Medication Concerns

Name	Medication Concerns

Definition	Important considerations for the safe use of medications such as the use of reminder devices, individual dose packaging, etc.
Type Code	LOINC
Type Code Value	28174-1
Type Code Name	Medication Risk
Value – Not Applicable	

Characteristics Relevant to the Conditions

Person History

Name	Person History
Definition	The history of the person for chronic care and any other clinically relevant events in the past.
Type Code	LOINC
Type Code Value	35090-0
Type Code Name	Person History
Value – Not Applicable	

Family History

Name	Family History
Definition	Record of the medical history of a group of persons sharing common ancestry.
Type Code	LOINC
Type Code Value	10157-6
Type Code Name	History of Family Member Diseases
Value – Not Applicable	

Ethnicity

Name	Ethnicity
Definition	Relating to large groups of people classed according to common racial, national, tribal, and religious background.
Type Code	LOINC
Type Code Value	21838-8
Type Code Name	Ethnicity
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	Health Canada First Nations and Inuit Health Branch

First Nations Status

Name	First Nations Status
Definition	A status indicator is used to determine whether the individual lives or does not live on an Indian Reserve.
Type Code	LOINC
Type Code Value	X40008

Type Code Name	First Nations Status
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	Health Canada First Nations and Inuit Health Branch

Smoker

Name	Smoker
Definition	The person's use of and exposure to tobacco both in the past and currently.
Type Code	LOINC
Type Code Value	11367-0
Type Code Name	History of Tobacco Use
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	User-Defined

Cigarette Packs per Day

Name	Cigarette Pack per Day
Definition	The average number of cigarettes the person currently smoke is measured in packs per day, based on 25 cigarettes per pack.
Type Code	LOINC
Type Code Value	8663-7
Type Code Name	Cigarette Smoked Current (Pack/Day)
Value	
Value Type	Physical Quantity
Unit of Measure	Packs / Day
Code Set Source	Not applicable

Cigarette Exposure in Pack Years

Name	Cigarette Pack per Day
Definition	The average number of cigarettes consumed over the person's lifetime.
Type Code	LOINC
Type Code Value	8664-5
Type Code Name	Cigarette Smoked over Lifetime in Pack Years
Value	
Value Type	Physical Quantity
Unit of Measure	(Packs / Day) * Years
Code Set Source	Not applicable

Alcohol Drinks per Week

Name	Alcohol Drinks per Week
Definition	Self-reported usual or an average number of standard alcoholic drinks the person consumes per week.
Type Code	LOINC

Type Code Value	X40001
Type Code Name	Alcoholic drinks/week
Value	
Value Type	Physical Quantity
Unit of Measure	Standard drinks/week
Code Set Source	Not applicable

Height

Name	Height
Definition	The height of the person was measured without shoes.
Type Code	LOINC
Type Code Value	3137-7
Type Code Name	Measured Height
Value	
Value Type	Physical Quantity
Unit of Measure	Metric or British Imperial
Code Set Source	Not applicable

Waist Circumference

Name	Waist Circumference
Definition	The circumference of the abdomen is at the greatest girth.
Type Code	LOINC
Type Code Value	8280-0
Type Code Name	Circumference at Umbilicus
Value	
Value Type	Physical Quantity
Unit of Measure	Metric or British Imperial
Code Set Source	Not applicable

Heart Rate

Name	Heart Rate (Pulse)
Definition	The measurement of the number of heartbeats per minute.
Type Code	LOINC
Type Code Value	8893-0
Type Code Name	Peripheral artery by palpation
Value	
Value Type	Physical Quantity
Unit of Measure	Beats per Minutes
Code Set Source	Not applicable

Heart Rhythm

Name	Heart Rhythm
Definition	Heart rhythm is described in two parts: the rate of the heart and the regularity in the rhythm of the heartbeats.
Type Code	LOINC

Type Code Value	8884-9
Type Code Name	Heartbeat Rhythm
Value	
Value Type	Coded Value
Unit of Measure	Not applicable

Systolic Blood Pressure

Name	Systolic Blood Pressure
Definition	The measurement of blood pressure is expressed in millimeters of mercury (mmHg). The higher number, systolic pressure, is the maximum pressure that occurs when the heart contracts.
Type Code	LOINC
Type Code Value	8459-0
Type Code Name	Intravascular Systolic Pressure ^ Sitting
Value	
Value Type	Physical Quantity
Unit of Measure	mmHg – Millimeters of mercury (Pressure)
Code Set Source	Not applicable

Diastolic Blood Pressure

Name	Diastolic Blood Pressure
Definition	The measurement of blood pressure is expressed in millimeters of mercury (mmHg). The bottom number, diastolic pressure, is the pressure in the system while the heart is relaxed.
Type Code	LOINC
Type Code Value	8453-3
Type Code Name	Intravascular Diastolic Pressure ^ Sitting
Value	
Value Type	Physical Quantity
Unit of Measure	mmHg – Millimeters of mercury (Pressure)
Code Set Source	Not applicable

Co-Morbidities / Complications

Foot Disorders

Name	Foot Disorders
Definition	Any one of several abnormalities affecting the foot.
Type Code	LOINC
Type Code Value	29308-4
Type Code Name	Diagnosis
Value	
Value Type	Coded Value
Unit of Measure	Not applicable

Congestive Heart Failure (CHF)

Name	Congestive Heart Failure (CHF)
Definition	A condition of generalized fluid retention causing swelling and shortness of breath.
Type Code	LOINC
Type Code Value	29308-4
Type Code Name	Diagnosis
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	ICD-10-CA

Depression

Name	Depression
Definition	Depression is a common mental disorder that presents with depressed mood, loss of interest or pleasure, etc.
Type Code	LOINC
Type Code Value	29308-4
Type Code Name	Diagnosis
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	ICD-10-CA

These are three examples of the data entities we can have for the concept of Co-morbidities or complications. There is no limitation to having any other diagnosis in this field. The data structure will be the same as presented.

Markers of Disease Progression

A1C

Name	A1C
Definition	A type of hemoglobin that has been bound to glucose.
Type Code	LOINC
Type Code Value	4548-4
Type Code Name	Hemoglobin A1C/Hemoglobin.Total
Value	
Value Type	Physical Quantity
Unit of Measure	% - Percent
Code Set Source	Not applicable

Total cholesterol (TC)

Name	Total cholesterol (TC)
Definition	The total amount of cholesterol carried in the blood.
Type Code	LOINC
Type Code Value	14647-2

Type Code Name	cholesterol
Value	
Value Type	Physical Quantity
Unit of Measure	Mmol/L – Millimoles per Liter
Code Set Source	Not applicable

Triglycerides

Name	Triglycerides
Definition	Triglycerides are fatty substance in the body that acts as a major form of stored energy.
Type Code	LOINC
Type Code Value	14927-8
Type Code Name	Triglycerides
Value	
Value Type	Physical Quantity
Unit of Measure	Mmol/L – Millimoles per Liter
Code Set Source	Not applicable

These are Three examples of the data entities we can have for the concept of markers. There is no limitation to having any other markers in this field. The data structure will be the same as presented.

Interventions - Procedures

Dialysis

Name	Dialysis
Definition	The mechanical process partly performs the work that healthy kidneys normally do.
Type Code	CCI
Type Code Value	1.PZ.21.^^
Type Code Name	Dialysis
Value - *Not Applicable*	

Kidney Transplant

Name	Kidney Transplant
Definition	The surgical procedure in which a healthy donated kidney is transplanted into the body of a person with renal failure.
Type Code	CCI
Type Code Value	1.PC.85.^^
Type Code Name	Kidney Transplant
Value - *Not Applicable*	

Islet Cell Transplant

Name	Islet Cell Transplant

Definition	Insulin-producing beta cells are taken from a donor's pancreas and transferred into a person with diabetes.
Type Code	CCI
Type Code Value	1.OJ.85.^^
Type Code Name	Transplant Pancreas
Value - *Not Applicable*	

These are Three examples of the data entities we can have for the concept of procedures. There is no limitation to having any other procedures in this field. The data structure will be the same as presented.

Interventions - Medications

Medications (Class – Specify)

Name	Medications (Class – Specify)
Definition	A group of medications has a similar therapeutic effect.
Type Code	LOINC
Type Code Value	29551-9
Type Code Name	Medication Prescribed
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	ATC

Medications (Individual – Specify)

Name	Medications (Individual – Specify)
Definition	Listing of individual medications currently being taken by the person.
Type Code	LOINC
Type Code Value	29551-9
Type Code Name	Medication Prescribed
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	Health Canada Drug Products Database

Vaccinations (Individual – Specify)

Name	Vaccinations (Individual – Specify)
Definition	Listing of individual vaccinations given to the person.
Type Code	LOINC
Type Code Value	X40003
Type Code Name	Vaccination Given
Value	
Value Type	Coded Value
Unit of Measure	Not applicable
Code Set Source	Health Canada Drug Products Database

Interventions - Referral

Referral

Name	referral
Definition	A request by one health care provider to another for assistance in the care of the person.
Type Code	LOINC
Type Code Value	34140-4
Type Code Name	Transfer of Care Referral Note
Value – Not Applicable	

Screening for Further Complications

Foot Exam

Name	Foot Exam
Definition	Physical examination of the foot, including the 10gram monofilament test.
Type Code	LOINC
Type Code Value	11397-7
Type Code Name	Physical Findings (Foot) Narrative
Value – Not Applicable	

Retinal Exam

Name	Retinal Exam
Definition	Physical examination of the retina.
Type Code	LOINC
Type Code Value	32468-1
Type Code Name	Physical Findings Retina
Value – Not Applicable	

Attribute Elements Prototype

The detailed data attributes give additional specifics on the clinical data entities. The attribute describes the characteristics or details to be captured on a person's history, physical exams, lab tests, medications, procedures, etc. This section provides the data definition and identifies the data type for each of the attribute elements related to the data entities mentioned earlier.

Type

Procedure Type

Name	Procedure Type
Definition	Indicate the type of procedures performed or to be performed.
Data Type	Coded Value
Code Set Source	CCI

Medication / Vaccine Type

Name	Medication / Vaccine Type
Definition	A code uniquely identifies the medication or vaccine.
Data Type	Coded Value
Code Set Source	Therapeutic Products Directorate; Health Canada

Observation Type

Name	Observation Type
Definition	Indicates what sort of test or observation was performed or to be performed.
Data Type	Coded Value
Code Set Source	User-Defined

Value Code	Value Name
EXO	Exam / Observation
OMP	Other Medical Problems
LRPG	Lab Results, Plans, Goals

Diagnostic Image Type

Name	Diagnostic Image Type
Definition	Identifies the type of image that was taken or to be taken.
Data Type	Coded Value
Code Set Source	LOINC

Goal Type

Name	Goal Type
Definition	The type of measurement for which the target is being set.
Data Type	Coded Value
Code Set Source	LOINC

Identifier

Procedure Identifier

Name	Procedure Identifier
Definition	A unique identifier is assigned to a particular occurrence of a procedure.
Data Type	String
Code Set Source	Not Applicable

Medication / Vaccine prescription or Dispense Identifier

Name	Medication / Vaccine prescription or Dispense Identifier
Definition	A unique identifier is assigned to the prescription or dispense record.
Data Type	String
Code Set Source	Not Applicable

Observation Identifier

Name	Observation Identifier
Definition	A unique identifier for the observation.
Data Type	String
Code Set Source	Not Applicable

Diagnostic Image Identifier

Name	Diagnostic Image Identifier
Definition	A unique identifier for the diagnostic image.
Data Type	String
Code Set Source	Not Applicable

Referral Identifier

Name	Referral Identifier
Definition	A unique identifier for the referral.
Data Type	String
Code Set Source	Not Applicable

Value, Interpretation, and Detail

Observation Value

Name	Observation Value
Definition	The observed value of the variable being tested. It may be expressed as a numeric quantity, as a code, or as free text.
Data Type	Any
Code Set Source	Not Applicable

Observation Interpretation

Name	Observation Interpretation
Definition	Even when there is a value, interpretation is often offered to help convey the significance of a particular result.
Data Type	Coded Value
Code Set Source	HL7

Procedure Details

Name	Procedure Details
Definition	Provides additional details about the procedure.
Data Type	String
Code Set Source	Not Applicable

Procedure Details

Name	Procedure Details
Definition	Provides additional details about the procedure.

Data Type	String
Code Set Source	Not Applicable

Medication / Vaccine Details

Name	Medication / Vaccine Details
Definition	Provides additional details about the medication therapy.
Data Type	String
Code Set Source	Not Applicable

Observation Details

Name	Observation Details
Definition	Provides additional details about the observation.
Data Type	String
Code Set Source	Not Applicable

Diagnostic Image Details

Name	Diagnostic Image Details
Definition	Provides additional details about the Diagnostic Image.
Data Type	String
Code Set Source	Not Applicable

Referral Details

Name	Diagnostic Image Details
Definition	Provides additional details about the referral.
Data Type	String
Code Set Source	Not Applicable

Method Code

Observation Method Code

Name	Observation Method Code
Definition	Indicated the means or technique used to perform the test or observation.
Data Type	Coded Value
Code Set Source	User-Defined

Value Code	Value Name
AU	Auscultated
ES	Estimated
ME	Measured
MECG	Measured by ECG
OB	Observed
PA	Palpated
RE	Reported
ST	Stated
DL	Dilated
ND	Non-Dilated

Diagnostic Image Method Code

Name	Diagnostic Image Method Code	
Definition	Indicated the means or technique used to perform the imaging.	
Data Type	Coded Value	
Code Set Source	User-Defined	
Value Code		**Value Name**
CINELOOP		Cine-Loop
WAVEFORM		Waveform

Date

Procedure Date

Name	Procedure Date
Definition	The calendar date on which the person received health services from a provider.
Data Type	Timestamp
Code Set Source	Not Applicable

Observation Date

Name	Observation Date
Definition	The relevant date at which the observation was measured, performed, or collected.
Data Type	Timestamp
Code Set Source	Not Applicable

Diagnostic Image Date

Name	Diagnostic Image Date
Definition	The date the diagnostic image was performed.
Data Type	Timestamp
Code Set Source	Not Applicable

Entered, Recorded Date

Name	Entered, Recorded Date
Definition	The date the information was entered or recorded.
Data Type	Timestamp
Code Set Source	Not Applicable

Y/N Indicator

Procedure Occurred Indicator

Name	Procedure Occurred Indicator
Definition	An indication of whether the procedure occurred or not.
Data Type	Boolean
Code Set Source	Not Applicable

Medication / Vaccine Occurred Indicator

Name	Medication / Vaccine Occurred Indicator
Definition	An indication of whether the medication is being taken or not.
Data Type	Boolean
Code Set Source	Not Applicable

Observation Occurred Indicator

Name	Observation Occurred Indicator
Definition	An indication that a clinical observation was made or not.
Data Type	Boolean
Code Set Source	Not Applicable

Diagnostic Image Occurred Indicator

Name	Diagnostic Image Occurred Indicator
Definition	An indication that the diagnostic image was done or not.
Data Type	Boolean
Code Set Source	Not Applicable

Non-Performance Reason Code

Procedure Non-Performance Reason

Name	Procedure Non-Performance Reason
Definition	The reason the procedure wasn't performed as expected.
Data Type	Coded Value
Code Set Source	User-Defined

Value Code	Value Name
01	Patient Refused
02	Clinically Inappropriate
03	Absolute Contraindication
04	Relative Contraindication
05	Not Accessible
06	Not Asked

Medication / Vaccine Non-Performance Reason

Name	Medication / Vaccine Non-Performance Reason
Definition	The reason the medication wasn't taken.
Data Type	Coded Value
Code Set Source	User-Defined

Value Code	Value Name
01	Patient Refused
02	Clinically Inappropriate
03	Absolute Contraindication
04	Relative Contraindication
05	Not Accessible

06	Not Asked

Observation Non-Performance Reason

Name	Observation Non-Performance Reason
Definition	The reason the action wasn't taken.
Data Type	Coded Value
Code Set Source	User-Defined
Value Code	**Value Name**
01	Patient Refused
02	Clinically Inappropriate
03	Absolute Contraindication
04	Relative Contraindication
05	Not Accessible
06	Not Asked

Diagnostic Image Non-Performance Reason

Name	Diagnostic Image Non-Performance Reason
Definition	The reason the action wasn't taken.
Data Type	Coded Value
Code Set Source	User-Defined
Value Code	**Value Name**
01	Patient Refused
02	Clinically Inappropriate
03	Absolute Contraindication
04	Relative Contraindication
05	Not Accessible
06	Not Asked

Referral

Referral Reason Code

Name	Referral Reason Code
Definition	The reason the referral was made according to the guidelines.
Data Type	Coded Value
Code Set Source	User-Defined
Value Code	**Value Name**
01	Specialized Medical Assistance
02	Other Care Requirements

Referral Encounter Occurred Indicator

Name	Referral Encounter Occurred Indicator
Definition	An indicator of whether the referral encounter occurred or did not occur.
Data Type	Boolean
Code Set Source	Not Applicable

Referral Encounter Date

Name	Referral Encounter Date
Definition	It indicated the date of the first point of contact between the referred-to provider and the patient.
Data Type	Timestamp
Code Set Source	Not Applicable

Referral Encounter Non-Performance Reason

Name	Referral Encounter Non-Performance Reason
Definition	The reason the referral encounter did not occur.
Data Type	Coded Value
Code Set Source	User Defined

Value Code	Value Name
01	Patient Refused
02	Clinically Inappropriate
03	Absolute Contraindication
04	Relative Contraindication
05	Not Accessible
06	Not Asked

Medication / Vaccine

Medication / Vaccine Name

Name	Medication / Vaccine Name
Definition	A generic drug name is humanly readable for the medication.
Data Type	String
Code Set Source	Not Applicable

Medication / Vaccine Dose

Name	Medication / Vaccine Dose
Definition	The amount of medication prescribed by the service provider for the person.
Data Type	String
Code Set Source	Not Applicable

Medication / Vaccine Frequency

Name	Medication / Vaccine Frequency
Definition	It indicates the frequency with which a vaccine dose is administered.
Data Type	String
Code Set Source	Not Applicable

Medication / Vaccine Route

Name	Medication / Vaccine Route
Definition	It indicates the route of the administration of the medication.
Data Type	Value Coded
Code Set Source	HL7

Medication / Vaccine Flag

Name	Medication / Vaccine Flag
Definition	An indicator of whether the record represents a medication or vaccine.
Data Type	Coded Value
Code Set Source	User Defined

Value Code	Value Name
01	Medication
02	Vaccine

Plan

Goal Value

Name	Goal Value
Definition	The value of the measurement is targeted to be achieved.
Data Type	String
Code Set Source	Not Applicable

Goal Value Target Date

Name	Goal Value Target Date
Definition	The specific date the target should be achieved.
Data Type	Timestamp
Code Set Source	Not Applicable

Reassessment Date

Name	Reassessment Date
Definition	It indicates when a particular planned activity or type of activity is intended to be reviewed.
Data Type	Timestamp
Code Set Source	Not Applicable

Medication / Vaccine Dispense Date

Name	Medication / Vaccine Dispense Date
Definition	The date the medication was dispensed to the person by a service provider.
Data Type	Timestamp
Code Set Source	Not Applicable

Date Ordered

Name	Date Ordered
Definition	It indicates when the order for a specified event was created.
Data Type	Timestamp
Code Set Source	Not Applicable

Planned Observation Diagnosis Value

Name	Planned Observation Diagnosis Value
Definition	This identifies the specific diagnosis to be reviewed.
Data Type	Value Coded
Code Set Source	ICD-10-ca

Data Entities and Attribute Mapping Prototype

The table below will present the mapping between the data entities and the attributes mentioned earlier. Although the focus during the development of the prototypes for the data entities and attributed were on the three selected chronic diseases, diabetes, hypertension, and chronic kidney disease, the presented logical data model developed in the context of a single generic model that applies to all chronic diseases.

Clinical Data Elements	Disease (D, H, K)	Type	Identifier	Observation Value	Observation Interpretation	Method Code	Date (Measured, Performed)	Date (Entered, Recorded)	Y/N Indicator	Non-Performance Reason Code	Observation Normal Range	Details	Created By	Ordered By	Medication / Vaccine Flag	Medication / Vaccine Name	Medication / Vaccine Dose	Medication / Vaccine Frequency	Medication / Vaccine Route	Medication / Vaccine Dispense Date	Referred To	Referral Reason Code	Referral Encounter Occurred Indicator	Referral Encounter Date	Referral Encounter Non-Performance Reason	Goal Value	Goal Value Target Date	Re-Assessment Date	Frequency	Diagnosis Value	Medication / Vaccine Name	Medication / Vaccine Type	Medication / Vaccine Flag
Alert Indicators	**D, H, K**	**X**	**X**			**X**	**X**	**X**	**X**	**X**		**X**	**X**																**X**					
Allergy Alert	D, H, K	X	X			X		X	X	X		X	X																					
Adverse Drug Reaction	D, H, K	X	X			X	X	X	X	X		X	X																					
Other Alerts	D, H, K	X	X					X	X	X		X	X																					
Medication Concerns	D, H, K	X	X						X	X		X	X																X					
Characteristics Relevant to the Condition	**D, H, K**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**														**X**	**X**	**X**	**X**				
Person History	D, H, K	X	X			X		X	X	X		X	X																					
Family History	D, H, K	X	X			X		X	X	X		X	X																					
Ethnicity	D, H, K	X	X	X				X	X	X		X	X																					
First Nation Status	D, H, K	X	X	X				X	X	X		X	X																					
Smoker	D, H, K	X	X	X		X		X	X	X			X																X					
Cigarettes Packs/Day	D, H, K	X	X	X		X		X	X	X		X	X														X	X	X					
Cigarette Exposure in Pack Years	D, H, K	X	X	X		X		X	X	X		X	X														X	X	X					
Alcohol Drinks / Week	D, H, K	X	X	X		X		X	X	X			X														X	X	X					
Height	D, H, K	X	X	X		X	X	X	X	X			X																					
Weight	D, H, K	X	X	X		X	X	X	X	X			X														X	X	X					
Waist Circumference	D, H, K	X	X	X	X	X	X	X	X	X			X														X	X	X					
Heart Rate	H, K	X	X	X			X	X	X	X		X	X														X		X					
Heart Rhythm	H, K	X	X		X	X	X	X	X	X		X	X																X					
Systolic Blood Pressure	D, H, K	X	X	X	X	X	X	X	X	X		X	X														X	X	X	X				
Diastolic Blood Pressure	D, H, K	X	X	X	X	X	X	X	X	X		X	X														X	X	X	X				
Co-Morbidities / Complications	**D, H, K**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**																**X**		**X**			
Foot Disorders	D, H	X	X	X			X	X	X	X		X	X																X		X			
Congestive Heart Failure (CHF)	D, H, K	X	X	X			X	X	X	X		X	X																X		X			
Depression	D, H, K	X	X	X			X	X	X	X		X	X																X		X			
Markers of Disease Progression	**D, H, K**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**														**X**	**X**	**X**	**X**				
A1C	D, H, K	X	X	X	X	X	X	X	X	X	X	X	X														X	X	X	X				
Total cholesterol (TC)	D, H, K	X	X	X	X	X	X	X	X	X	X	X	X														X	X	X	X				

Clinical Data Elements	Disease (D, H, K)	Type	Identifier	Observation Value	Observation Interpretation	Method Code	Date (Measured, Performed)	Date (Entered, Recorded)	Y/N Indicator	Non-Performance Reason Code	Observation Normal Range	Details	Created By	Ordered By	Medication / Vaccine Flag	Medication / Vaccine Name	Medication / Vaccine Dose	Medication / Vaccine Frequency	Medication / Vaccine Route	Medication / Vaccine Dispense Date	Referred To	Referral Reason Code	Referral Encounter Occurred Indicator	Referral Encounter Date	Referral Encounter Non-Performance Reason	Goal Value	Goal Value Target Date	Re-Assessment Date	Frequency	Diagnosis Value	Medication / Vaccine Name	Medication / Vaccine Type	Medication / Vaccine Flag
Triglycerides	D, H, K	X	X	X	X	X	X	X	X	X	X	X	X														X	X	X	X				
Interventions - Procedures	**D, H, K**	**X**	**X**				**X**	**X**	**X**	**X**		**X**	**X**																**X**	**X**				
Dialysis	D, H, K	X	X				X	X	X	X		X	X																X	X				
Kidney Transplant	D, H, K	X	X				X	X	X	X		X	X																					
Islet Cell Transplant	D, H, K	X	X				X	X	X	X		X	X																					
Interventions - Medications	**D, H, K**	**X**	**X**						**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**						**X**		**X**	**X**		**X**	**X**	**X**
Medication (Class - Specify)	D, H, K	X	X						X	X		X	X	X					X									X			X	X	X
Medication (Individual - Specify)	D, H, K	X	X						X	X		X	X	X	X	X	X	X	X	X	X					X		X			X	X	X
Vaccine (Individual - Specify)	D, H, K	X	X						X	X		X	X	X	X	X	X	X	X	X	X								X		X	X	X
Interventions - Referrals	**D, H, K**	**X**	**X**					**X**	**X**	**X**		**X**	**X**								**X**	**X**	**X**	**X**	**X**									
Referral	D, H, K	X	X					X	X	X		X	X								X	X	X	X	X									
Screening for Future Complications	**D, H, K**	**X**	**X**			**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**															**X**	**X**				
Foot Exam	D	X	X				X	X	X	X		X	X																X	X				
Retinal Exam	D, H, K	X	X			X	X	X	X	X		X	X	X															X	X				