Artifact-Supported Performance Management of Collaborative Care Teams

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Abstract

This research proposes a framework for collaborative care in which the performance of healthcare teams is measured in an objective and quantifiable manner. We call our framework the Performance Management Framework for Collaborative Care (PMFCC). The PMFCC was developed using insights from agile software engineering, business, and healthcare and consists of three Components: the Collaboration Space Ontology Template, the Agile Process Model, and the Performance Management Model. We developed a set of example Artifacts based on our framework to better support performance management of collaborative care teams: Agile Treatment Plan, Agile Collaborative Dashboard, ICF Patient Card and Collaborative Care Model Canvas.

The framework and associated Artifacts were developed iteratively using Design Science Research Methodology. Attention Deficit Hyperactivity Disorder was used as an example relevant to performance management of collaborative care teams. A Clinical Vignette drawn from the healthcare literature was used to develop a set of scenarios to test and evaluate the PMFCC and its Artifacts at each iteration. A panel of experts was established at the end of our research to review our results and provide structured and unstructured feedback based on a set of evaluation criteria drawn from the relevant academic literature. The PMFCC was also compared to related works from the literature.

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Finally, I would like to dedicate this thesis to my mother who has been a pillar of love and strength, and to my late father for his principled teachings. They taught me about hard work and the value of education. They are, in form and spirit, instrumental to the successes in my life.

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List of Acronyms

Acronym	Reference
ACD	Agile Collaboration Dashboard
ADHD	Attention Deficit Hyperactivity Disorder
APM	Agile Process Model
ATP	Agile Treatment Plan
BMC	Business Model Canvas
BSC	Balanced Scorecard
CADDRA	Canadian ADHD Resource Alliance
CBT	Cognitive Behavioral Therapy
CCM	Collaborative Care Model
CCMC	Collaborative Care Model Canvas
CFPC	College of Family Physicians of Canada
CRPO	College of Registered Psychotherapists of Ontario
CSM	Collaboration Space Model
CSOT	Collaboration Space Ontology Template
DSR	Design Science Research
DSRM	Design Science Research Methodology
EHR	Electronic Health Record
FIC	Family of International Classifications
FP	Family Physician
HIT	Healthcare Information Technology
HIS	Healthcare Information System
HTM	Healthcare Teams Manager
ICD	International Classification of Disease
ICD-10-CM	Classification of Diseases and Related Health Diseases, clinical modification, 10th revision
ICF	International Classification of Functionality
ICPC	International Classification of Primary Care
IPC	ICF Patient Card
IPU	Integrated Patient Unit
ISDT	Information Systems Design Theory
KPI	Key Performance Indicator
MRC	Most Responsible Clinician
PM	Performance Management
PMFCC	Performance Management Framework for Collaborative Care
PMM	Performance Management Model
PMMC	Performance Management Metrics Chart
SNOMED	Systematized Nomenclature of Medicine

1 Introduction

1.1 Motivation

Multi-disciplinary teams comprised of physicians, specialists, nurses, allied health professionals (such as social workers, pharmacists, and physiotherapists), as well as the patient, caregivers and educators are a reality in contemporary healthcare, and provide a collective intelligence, over multiple domains for the purposes of diagnosis and treatment. A multi-disciplinary team can be thought of as swim lanes of professionals working in parallel to achieve a task. Collaboration involves a team that is crossing swim lanes to develop shared ideas and understanding. While team collaboration has the potential to improve patient care, in many instances it can have the opposite effect if the team does not collaborate effectively (Havyer et al., 2014; Zwarenstein, Goldman, & Reeves, 2009). There are many ramifications to ineffective collaboration such as resource inefficiencies, workload mismanagement and personnel issues. One of the most serious effects of poor collaboration is medical error. *Medical errors are the third leading reason of patient deaths* in the US after cancer and heart disease (Makary & Daniel, 2016). Approximately 75% of these medical errors are the result of teamwork failures (Mayo & Woolley, 2016). Poor communication, misdiagnosis, poor judgement, and inadequate skills are all reasons flagged as problems. It follows that the ability to improve collaboration could reduce this statistic. However, while there are lots of studies on performance in healthcare; there are few studies that address how to quantitatively measure and improve performance of collaborative teams in the literature. We were looking for frameworks that could guide us on how to do performance management. One of the main reasons for this is the lack of consensus on how to measure

teamwork. (Buscemi, Steglitz, & Spring, 2012) (Havyer et al., 2014). This thesis focusses on providing a quantifiable way to measure collaboration with a view to teamwork improvement.

Collaboration can be especially challenging because, in addition to clinical domain complexity, care team members can have very different roles, perspectives and training in multiple disciplines (family health, mental health, medical specialization, therapies, nursing, for example). Resources, especially time, are varied and usually limited. Healthcare policy and regulation also pose challenges. In general, healthcare collaboration is complex, which can make coordination, cooperation, and communication difficult. These factors make measuring teamwork particularly challenging (Sicotte, D'amour, & Moreault, 2002).

Performance management aims to define and measure the processes that are performed across individuals, teams and organizations so that performance activities effectively support the goals of an organization (Madlabana, Mashamba-Thompson, & Petersen, 2020). This thesis addresses the need for a comprehensive model by identifying the factors associated with collaboration and then using these factors to create a performance management framework for collaborative healthcare delivery. In order to address a solution to the problem of collaboration, we used insights from several areas to create our framework. We began with an existing model by Eikey et. al, the Collaboration Space Model (Eikey, Reddy, & Kuziemsky, 2015). This conceptual model established the basis for our understanding of the components of collaboration in healthcare. This model breaks down collaboration into four components: process, outcomes, context, and technology. In order to develop a collaborative process, we turned towards a parallel domain that provided a successful theory for the performance management of teams. Agile methodologies have been applied to many industries. However, its application within healthcare, remains limited (Tolf, Nyström, Tishelman, Brommels, & Hansson, 2015). This researcher has

had professional experience in working in Scrum teams and drew inspiration to frame complex care within a structured context. Scrum lends itself to unpredictable challenges that require expert, sustained, and coordinated teamwork. It is especially helpful in managing cross-functional teams which are hallmarks of modern patient care. The treatment of disease is complex because it is not structured, notwithstanding clinical guidelines and pathways. This is because of the combination of diseases, patient attributes and variability in medical staff (Beverungen et al., 2020). We provide a structure to these diverse processes, using Scrum, to set the stage for measuring performance of teams involved in patient care.

Finally, we adapted the Balanced Scorecard, a widely used performance management framework, to develop our Performance Management Framework for Collaborative Care Teams. Our quadrants were inspired by Balanced Scorecard but reflect the Collaboration Space Model and support our agile collaborative process.

1.2 Thesis Contributions

The main contribution of this research is a Performance Management Framework for Collaborative Care (PMFCC). While it is hoped that patient care will be improved using this framework, our objective is not to directly improve the existing medical processes, but rather to provide a way for healthcare teams to measure quality and effectiveness of collaboration so that they may be more effective in providing care. The PMFCC consists of three Components. There are also four core Artifacts that were developed based on the framework.

1. **Components**

    a. **Collaboration Space Ontology Template**

    This will encompass factors relate to collaborative care teams related to process, outcomes, context, and technology. Concepts and linkages between these concepts will be defined, as well as a common set of terms.

    b. **Agile Process Model**

    The SCRUM process will be applied to the healthcare to highlight to demonstrate an Agile collaborative care process in which performance can be quantified and measured.

    c. Performance Management Model

    In this contribution, and using the Agile Process for Collaborative Care, quality of care key performance objectives and indicators will be described and incorporated into a Performance Management Model.

2. **Artifacts**

    a. Agile Treatment Plan

    This Artifact is a single document which provides the team with a holistic view of the care that the patient will receive from a collaboration perspective.

    b. Agile Collaboration Dashboard

    The Artifact is used to provide ongoing status information to the team.

    c. ICF Patient Card

    A tool which summarizes patient information in a simple, standardized fashion.

d. Collaborative Care Model Canvas.

This Artifact increases the team's cognitive transparency of the whole collaboration environment.

Additionally, the PMFCC represents a knowledge contribution in terms of a theory (meta-requirements and meta-design (Kuechler & Vaishnavi, 2012)) for a performance management framework for collaborative care. Our knowledge contribution is for the improvement of collaborative care, in which we develop a new solution for known problems in this space.

Other contributions comprise the following publications have been published or submitted related to the thesis as follows:

1. Lakhani, R., Peyton, L., Kuziemsky, C. (2021), Towards an Artifact-Supported Performance Management Framework for Collaborative Care Delivery, *IEEE International Conference on Healthcare Informatics*. (R Lakhani, Peyton, & Kuziemsky, 2021a)
2. Lakhani, R., Eze, B., & Peyton, L. (2020). Applying Agile Principles to Collaborative Healthcare Teams. *HEALTHINF 2020 – 13th International Conference on Health Informatics.*, 506–513. (Rubina Lakhani, Eze, & Peyton, 2020)
3. K. Sultan, U. Ruhi and R. Lakhani, "Conceptualizing Blockchains: Characteristics and Applications", 11th IADIS International Conference on Information Systems (IS 2018).
4. Lakhani, R., Garzon, M., Netterfield, C., Shah, J., & Peyton, L. (2017). *An Application for Collaborative Healthcare Monitoring*. Ottawa: CREATE-BEST and the Medical Devices Innovation Institute. (R. Lakhani, Garzon, Netterfield, Shah, & Peyton, 2017)

5. Eze, B., Kuziemsky, C., Lakhani, R., & Peyton, L. (2016). Leveraging Cloud Computing for Systematic Performance Management of Quality of Care. *The 6th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2016)*, 8. London. (Eze, Kuziemsky, Lakhani, & Peyton, 2016)
6. R. Lakhani, B. Eze, R. Valys, L. Peyton, "*Improving Healthcare Network Infrastructure Using Software Defined Networking (SDN)*", University of Ottawa Faculty of Engineering Poster Competition, Ottawa, Canada, March 2015. (Rubina Lakhani, Eze, Peyton, & Valys, 2015)
7. R. Lakhani, L. Peyton, "*A Prognosis for SDN Deployment in Healthcare*", Workshop e-Health for Humanity, MCETech 2015, Montreal, Canada, May 2015. (Rubina Lakhani & Peyton, 2015)

1.3 Thesis Organization

In Chapter 2, we provide an overview of background concepts to set the stage for this thesis. There are two grouping. The first includes Sections 2.1 to 2.8 and provide key areas of background knowledge required to understand the framework. Chapter 2.9 provides works that are related to this thesis. These Related Works will be used to compare the validity of outcomes for this thesis in Chapter 7.

In Chapter 3, we provide a detailed description of our research design.

In Chapter 4, we delve into the specific problem being addressed by this thesis and provide a visualization that helps understand the complexity of issues faced by healthcare teams (swiss cheese diagram). We also describe the result of our gap analysis on current practices and

approaches used in related works and practices. The result of the gap analysis is used to define a set of criteria for evaluating the effectiveness of our framework.

Chapter 5 provides an overview of the Performance Management Framework for Collaborative Care (PMFCC). Each element of the PMFCC is described.

In Chapter 6, we begin by describing the medical scenario, the Clinical Vignette, that is used to test and develop the Components and Artifacts in our framework. We subsequently have 3 different versions of the Clinical Vignette scenario that develop our collaborative care based on the framework.

In Chapter 7, we evaluate our framework with a structured review by a panel of experts. We also compare our framework against the other related works mentioned in Section 2. We also evaluate our framework against the three scenarios of Section 5, leveraging the evaluation criteria defined in Section 4. We also discuss the limitations and assumptions and threats to the viability of our framework.

Finally, in Chapter 8, we provide our conclusions and future work.

2 Background and Related Works

Healthcare team collaboration can include physicians, nurses, specialists, therapists, pharmacists, as well as hospitals, community care providers such as public health units, services agencies, etc. (CHCA, CFPC, 2016), as well as patients, families, and complementary professionals (social workers, teachers and guidance counselors). The purpose of healthcare performance management is to measure the success of quality of care goals (Vanhaecht et al., 2007). The mandate of community-based healthcare is to improve overall population health by managing the cycle of health – from illness to rehabilitation to end-of-life care.

2.1 Collaborative Care Teams

The World Health Organization defines health care teams as follows:

"*At its best, a health team is a group of persons who share a common health goal and common objectives, determined by community needs, towards the achievement of which each member of the team contributes, in a coordinated manner, in accordance with his/her competence and skills and respecting the functions of others"* p.44, (WHO Expert Committee, 1985).

2.1.1 Types of Healthcare Teams

Teams may be described in terms of roles and goals (Ojo, 2012):

- *Unidisciplinary* (individuals working on the same goal without knowledge of each other).
- *Multidisciplinary* (individuals practice relative independently in terms of treatment goals).

- *Interdisciplinary* (individuals focus on shared goals).
- *Transdisciplinary* (where roles are blurred, and skills transfer occurs across professional boundaries).

Each type of team has its own dynamic which is further complicated by interactions of patients and their families in the team dynamic.

Teams can also be characterized by membership. They can consist of members within an organization, or between organizations. These teams are defined as virtual teams. Duarte and Snyder describe seven types of virtual teams (Duarte & Snyder, 2006):

- *Networked* teams are cross organizational, with time zone or distance boundaries and whose members collaborate towards achieving a common goal. Team membership can be fluid and there is often a lack of clear delineation between the networked team and the organization.
- *Parallel* teams will perform tasks, functions, or special assignments what their home organization is either not interested in, or is not capable of, performing (due to barriers in geography, unavailability of skillset or expertise, or business model for example). Parallel teams are distinct from the rest of the organization, and they work together for a short period of time.
- *Project or Product Development* teams may also be separated geographically or by time zone or by organization. These teams however have a distinct charter and generally work together for an extended period of time until the project or product is complete. These teams have an important characteristic in that they can make independent decisions (as opposed to recommendations).

- *Work or Production* teams are created to carry out a specific function in a regular and on-going fashion. These teams are very distinct within an organization but can be separated geographically and over time zones. These teams can operate using technology for telecommuting for example.
- *Service* teams exist to provide service of a level of quality such that clients continue to engage in a business relationship with the organization. The main goal of such teams is customer satisfaction. Again, these teams can be geographically or time zone diverse and exist to provide support for clients with the goal of providing value.
- *Management* teams work collaboratively on an ongoing, daily basis and are often based in different locations and/or time zones.
- *Action* teams are created to deal with emergency situations. The goal of the team is immediate response to ensure that the mission is completed nominally (Opdenakker & Cuypers, 2019) (Duarte & Snyder, 2006)**.**

2.1.2 **Types of Uncertainties in Healthcare**

Tolf et al. describe three types of environmental uncertainties that face hospitals, which we be generalize to healthcare organizations:

- *General uncertainties* that deal with changing demographic, technology, political and socioeconomic realities.
- *Task uncertainties* related interaction with to other care organizations or individuals such as community care, social care, patients, and suppliers.

- *Work uncertainties* that describe scientific elements related to the nature of care itself such as certainty of diagnoses, and the ability to routinize diagnoses (Tolf et al., 2015).

2.1.3 Challenges Experienced by Healthcare Teams

We define collaboration as a planned or spontaneous engagement of team members working towards shared goals. Healthcare collaboration consists of professionals from multiple disciplines who possess domain-specific competence and skills. These professionals work towards a common goal that is determined by the needs of the community. The successful achievement of each team member's goal is coordinated and contributes to the overall success of the treatment (WHO FDRG, 2010) (Ojo, 2012).

Collaboration can be challenging for healthcare providers and support workers providing support and care to patients in the community. The logistics of coordinating home care and community care are difficult. The care team have very different roles, perspectives and training in multiple disciplines including family health, mental health, medical specialization, therapies, nursing practice, support worker practice, etc. Additionally, the amount of time they have available to meet as a group is limited. In general, healthcare teams are complex, and can be characterized as difficult from many perspectives. These factors include:

- Team communication (access to, and sharing of, information)
- Team dynamics (interaction and working relationships)
- Team processes
- Time pressures
- Work overload
- Competing goals

- Organizational silos
- Changing team membership, and
- Regulatory requirements.

2.1.4 **Community Care Strategy Example**

(Daub, Goldhar, & Purbhoo, 2016) describe the implementation of multi-level team integration strategy across an Ontario health system. The goal of the initiative, called "*One Client, One Team"*, was to improve patient outcomes as well as to address the issue of increasing healthcare costs in Canada. The design elements of the strategy placed an emphasis on three main aspects as follows.

The first was to provide a fully integrated care experience. This involves end-to-end care that is coherent and independent of the location of care in the community. It also provides a whole-person centric view of care that advocates different modalities such as social, clinical, and functional care. It also explicitly describes the need for a single support team within a neighborhood, linked to primary care. The second design element of the strategy deals with simplified access. Here the authors discuss elements such as a single assessment shared by the entire team so that patients do not repeat their stories over and over. A single access point, such as a single phone number, for patients and caregivers to reach the team was also discussed. Additionally, a single coordinated care plan was proposed in order to achieve common ground. A single emergency medical record was also suggested. Finally, in order to help identify the organizations involved in care, a common brand was suggested. The third element of the strategy dealt with understanding, and doing, what was most important to the client and their families. For this, 24/7 access to the team was suggested. Virtual (Remote) monitoring of patient's health as

well as the family's needs was discussed. Caregiver support programs and access to personalized information were part of this element.

The team applied their work to two case studies in Toronto, Ontario. The first was for Older Adults with Complex Needs (200 patients) and the second was for Palliative Care. The authors report that *One Client, One Team* was implemented in these case studies and was successful. However, the authors cited difficulties of stakeholders in buying-in and adapting to, the new program when roles, responsibilities and routines would be impacted. One tactic that they took was to not force the initiative by adopting a broad-based principled approach, thereby leaving specifics of implementation to the individual team actors.

2.2 Healthcare Collaboration Challenges

This section identifies two key aspects that are challenges for healthcare collaboration. A fuller discussion of challenges is found in Chapter 4 and the related works Section 2.9.

2.2.1 Healthcare Interoperability

Benson and Kuziemsky group healthcare interoperability into three types - technical, semantic and process (Benson, 2012; Craig Kuziemsky, 2013). Technical Interoperability relates to data exchange between senders and receivers and uses technology to solve accessibility issues with integrating healthcare processes. It addresses the problem of disparate platforms, data ontologies and communication technologies which fragment the care delivery process (Dixon, Vreeman, & Grannis, 2014; Gaynor, Yu, Andrus, Bradner, & Rawn, 2014) (Benson, 2012). Semantic interoperability deals with ensuring that senders and receivers understand data in a consistent fashion, by interpreting, sharing and using data without ambiguity through coding and

documentation exchange standards (Benson, 2012). Healthcare standards such as SNOMED and ICD fall into this category. While most interoperability discussions focus on the technical and semantic aspects of healthcare interoperability, process interoperability is the least discussed in the academic literature (Craig E. Kuziemsky & Peyton, 2016).

Collaboration is an important part of process interoperability, which deals with how technology, information, as well as guidelines and processes, affect the interactions amongst the actors. Process interoperability measures how service, quality of care, and patient hand-off are delivered; and ensures that patients and clinicians, (as well as decision makers and management) share a common understanding of the health system (Craig Kuziemsky, 2013; Mouttham, Kuziemsky, Langayan, Peyton, & Pereira, 2012).

Technical, semantic and process issues are further discussed in the context of HIT in a paper in our Related Work that describes useful model for HIT design of collaborative care solutions (Eikey et al., 2015). This is found in Section 2.9.1.

2.2.2 **Individual-Collaborative Interchange**

HIT enables collaborative care delivery to transition individual work processes into collaborative processes. This transition has been referred to as the individual collaborative-interchange (CE Kuziemsky, 2015). While many aspects of collaborative healthcare delivery have been well studied, the individual-collaborative interchange remains a challenge for HIT design to support collaborative care delivery. Specifically, the movement from individual to collaborative processes requires work practices to change. HIT can benefit connectivity and communication between providers in various settings. However, as the transformation from individual to collaborative care evolves, there may be unintended consequences of HIT implementation. For example, the loss of interpersonal communication and relationships that come from face-to-face

presence. Thus, it is not sufficient to simply deploy technology without setting out the engagement rules surrounding its use to mitigate organizational and social issues in healthcare teams (C. E. Kuziemsky, Randell, & Borycki, 2016).

2.2.3 **Medical Error**

Currently, medical errors are the third leading reason for patient deaths in the US (Makary & Daniel, 2016). Poor communication, misdiagnosis, poor judgement, and inadequate skills are all reasons cited for this statistic. Approximately 75% of these medical errors are the result of teamwork failures (Mayo & Woolley, 2016). Medical errors can occur for several reasons. We note that a medical error is an unintended act and may, or may not, harm the patient. This act may be one of commission, or omission with the result that the intended outcome is not achieved. Medical errors can also be due to using the wrong plan, or by failing to implement the intended plan. Finally, medical errors can also occur when there is a deviation from the process of care (Rubin, 2016). These errors may at a system level, as well as at the level of an individual healthcare provider (Makary & Daniel, 2016)

Elder and Dovey (Elder & Dovey, 2002) provide a useful classification of Medical errors that occur in primary care setting. Preventable Adverse Events are described are related to diagnosis, treatment, and preventative services. Process Errors describe the *why* behind the adverse event and include clinical, communication, administrative and blunt end factors. The latter includes aspects such as government regulations, insurance, staffing issues, etc. (Elder & Dovey, 2002). Whereas sharp-end medical errors are directly observable factors on the spot of the actual accident, blunt end refers to factors that are more distant or unobservable far from the situation. These can include factors related to working conditions such as communication problems, care protocol content unavailability, excessive workload, excessive fatigue, poor inter-professional

collaboration, hierarchy, and reluctance to malpractice reporting. Also included are local policy and legislation. For example, unavailability of proper equipment due to insufficient expenditure allocations are also blunt end factors (Leroy, 2011).

2.3 Healthcare Classification Standards

A classification standard in healthcare is a system that provides the ability to group diseases and processes/procedures and provides an organizational structure for easy retrieval of information. Depending on its application and use, different standards may be necessary to achieve different goals. The reason why several types of classifications exist is due to the level of detail desired for the myriad uses of healthcare data (Bowman, 2004).

2.3.1 ICD-10-CM

ICD-10-CM refers to the Classification of Diseases and Related Health Diseases, clinical modification, 10th revision. It is part of the WHO Family of International Classifications (FIC) of healthcare standards. Its purpose is to provide a terminology system for use in inpatient, outpatient, and other healthcare settings, for diagnostic information for general purposes (World Health Organization, 2016) (*Health Terminologies and Vocabularies*, 2017) (Stearns & Fuller, 2014).

2.3.2 SNOMED

SNOMED refers to the Systematized Nomenclature of Medicine – Clinical Terms. It is owned and maintained by SNOMED International. Its purpose it to provide a clinical terminology system that enables automation, reasoning and analytical approaches to the electronic health record (EHR) (*Health Terminologies and Vocabularies*, 2017) (Stearns & Fuller, 2014).

2.3.3 **ICPC**

ICPC refers to the International Classification of Primary Care. It is owned and governed by the World Organization of Family Physicians and is a related classification of the WHO FIC. The purpose of the ICPC is to provide a classification of problems and related conditions in primary care. It captures the reasons for the encounter, symptoms and associated social problems (*Health Terminologies and Vocabularies*, 2017).

2.3.4 **ICF**

The ICF is discussed in detail here since it is used as the basis of the ICF Patient Card Artifact in this thesis. One challenge of multi-disciplinary team interaction is communication. Terminology, shorthand, jargon, and perspective can be drastically different within a discipline. To address this concern, we use *functionality* as a common way to understand the overall outcomes and goals for the patient's health. The International Classification of Functioning, Disability and Health (ICF) was created after extensive testing internationally by the World Health Organization (WHO FDRG, 2010), including health-related states for any interested party. These include medical care providers and the patients. While not as well known or used as the ICD-10, SNOMED or the ICPC, the ICF is well established and used across many healthcare fields.

The ICF is a multi-purpose classification standard which is designed to serve a multiplicity of fields and subject areas such as social policy, education, and medical research, in addition to clinical practice. It is designed to provide a systematic coding scheme for HIS. It establishes a common language for relating health and related issues to improve communication between different stakeholders. A key value of the ICF is the ability to compare data across different areas such as healthcare services, across medical disciplines, geographical and political jurisdictions,

and time. Finally, the ICF enables a scientific basis for research of health and related outcomes, determinants and states. (Bowman, 2004)

The ICF provides a unified, standard language and framework for the description of health and health-related states from the view that functioning and disability are multi-dimensional, complex and have a dynamic relationship. The hierarchy of levels in the ICF includes classification, parts, components, constructs/qualifiers, and domains and categories as shown in Figure 2-1. ICF is comprised of 2 parts: Part 1 - Functional and Disability; and Part 2 - Contextual Factors. Under Parts 1 and 2, we find the following: Body Functions and Structure – these deal with physical impairments; Activities (related to limitations to actions and tasks experienced by the patient; Participation in life - restrictions; Personal and Environmental Factors – factors that may facilitate or hinder functioning. These constructs are then organized into item levels. ("WHO | International Classification of Functioning, Disability and Health (ICF)," 2017)

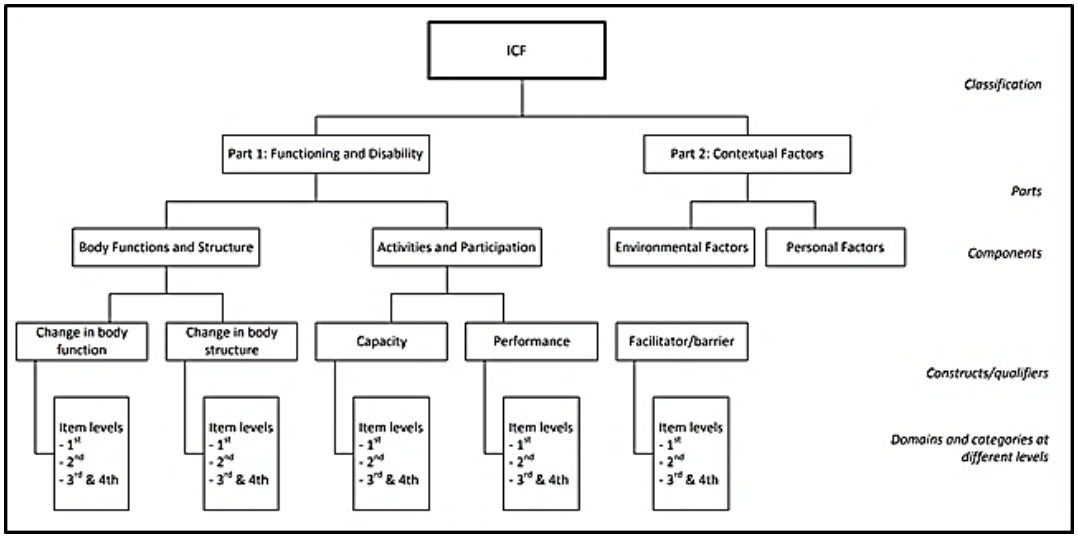


Figure 2-1: Structure of the ICF (World Health Organization, 2013)

The ICF classification is exhaustive and quite complex for use in daily practice. In order to facilitate its usability, the WHO created a series of instruments that are specific to clinical settings. Therefore, in addition to health condition-specific core sets, there are several other core sets such as the ICF Generic Set, ICF Rehabilitation Set, ICF Core Set for ADHD and others. Work is on-going to create more subsets. Figure 2-2 provides some examples of aspects that are covered in ICF.

Body Function:	**Activities and Participation:**
Mental functions	Learning and applying knowledge
Sensory functions and pain	General tasks and demands
Voice and speech functions	Communication
Functions of the cardiovascular, haematological, immunological and respiratory systems	Mobility
Functions of the digestive, metabolic, endocrine systems	Self care
Genitourinary and reproductive functions	Domestic life
Neuromusculoskeletal and movement-related functions	Interpersonal interactions and relationships
Functions of the skin and related structures	Major life areas
	Community, social and civic life
Body Structure:	**Environmental Factors:**
Structure of the nervous system	Products and technology
The eye, ear and related structures	Natural environment and human-made changes to environment
Structures involved in voice and speech	Support and relationships
Structure of the cardiovascular, immunological and respiratory Systems	Attitudes
Structures related to the digestive, metabolic and endocrine systems	Services, systems and policies
Structure related to genitourinary and reproductive systems	
Structures related to movement	
Skin and related structures	

Figure 2-2: Examples of Conditions Covered in the ICF (WHO FDRG, 2010)

2.4 Attention Deficit Hyperactivity Disorder

Dysfunction of the cerebellar-striatal/adrenergic-prefrontal brain results in the core symptoms of ADHD which involve developmentally inappropriate and functionally impairing inattentiveness and hyperactivity-impulsivity (Solanto, Arnsten, & Castellanos, 2001). ADHD is difficult to diagnose because the core and secondary symptoms of ADHD are exhibited in many childhood disorders. Additionally, many view ADHD symptoms as a kind of variation of normal childhood development. (Rapport, Timko, & Wolfe, 2006).

The prevalence of the diagnosis of ADHD/ADD has exploded over the past two decades. Parents become aware of behavioral issues that manifest in a child's or adolescent's education or social interactions and, justifiably, look for solutions to help them. The reasons for the behaviors are often attributed to poor diet, lack of exercise and poor sleep hygiene. It is often difficult or impossible for a parent to influence a better lifestyle, especially in the case of adolescents. There may also co-morbidities such as depression or autism. These impairments have a severity scale related to them. When impairments are severe, healthcare professionals will detect the problems quite easily. However, the first indications of less severe or life-threatening problems are usually noticed by parents or flagged by teachers and not physicians.

In current practice, the healthcare team for a child who has been diagnosed with ADHD is the primary care physician, parent(s), teacher, and if possible, the child. Each of these team members plays a role that yields the most effective outcomes for the child. The role of the physician is to diagnose (and rule out ADHD), prescribe medication, recommend community resources for behavior and support (such as psychologists), and on-going monitoring of the child's progress(*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). The role of the educator is to implement, enforce and document academic and behavioral strategies during school hours. The role of parents is to enforce behavioral recommendations made by a healthcare professional and/or educator at home, to monitor and report progress with the primary care physician.

Allied professionals also include social workers, speech therapists and others. There are a variety of other medical professionals who may be diagnose and treat ADHD. These include Child and Adolescent Psychiatrist, Developmental Pediatrician, Neurologist, General Pediatrician (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018).

2.4.1 **ADHD Collaborative Care Procedure for Adolescents**

The Canadian ADHD Resource Alliance (CADDRA) is an independent, not-for-profit, resource organization for medical, healthcare and research professionals with an interest in the field of ADHD. Figure 2-3 describes the current recommendation for ADHD admission, diagnosis and treatment by the CADDRA (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018) for adolescents. This document is an internationally recognized guideline for the assessment, treatment, and management of ADHD. The process is largely linear and serial, with little or no face-to-face communication between members of the care team between meetings. Concerns are brought to a family doctor who, based on his evaluation of the patient, the parent's first-hand observations, as well as the second-hand reporting of teacher's observations, refers the patient to a specialist. This specialist is a psychologist who administers diagnostic tests such as the DSM-V. To administer these tests, information is reported based on anecdotal observations of parents and teachers. Physiological, psychological and social factors are considered when performing a diagnosis in order to ensure that there is a full understanding of the patient's needs (Jellinek & Mcdermott, 2004) (Wade & Halligan, 2017). If tests are positive, the family doctor then begins treatment, usually using medication and behavioral modification therapies.

Once ADHD is successfully diagnosed, treatments with high acceptability and adherence yield the best outcomes for school aged children with ADHD. For example, there is strong evidence that primary care doctors should prescribe approved ADHD medications. There is also strong evidence that behavior therapy, implemented by a parent or teacher also yields desired outcomes (Shahidullah, 2015). ADHD is a disorder that is best treated with a combination of drugs and behavioral therapy (MTA Cooperative Group, 1999) (Subcommittee on Attention-Deficit/Hyperactivity Disorder & Steering Committee on Quality Improvement and Management,

2011). Many iterations of drug prescription occur based on type of drug and dosage. Observation of drug effects can last for several weeks. During the drug iteration process, the patient's symptoms may change as s/he reacts to the drug. Drug success occurs when an effective type and dosage of drug has been achieved, and ADHD symptoms are managed. Psychotherapy can begin immediately and is considered a separate process, with the psychotherapist an integral part of the therapy.

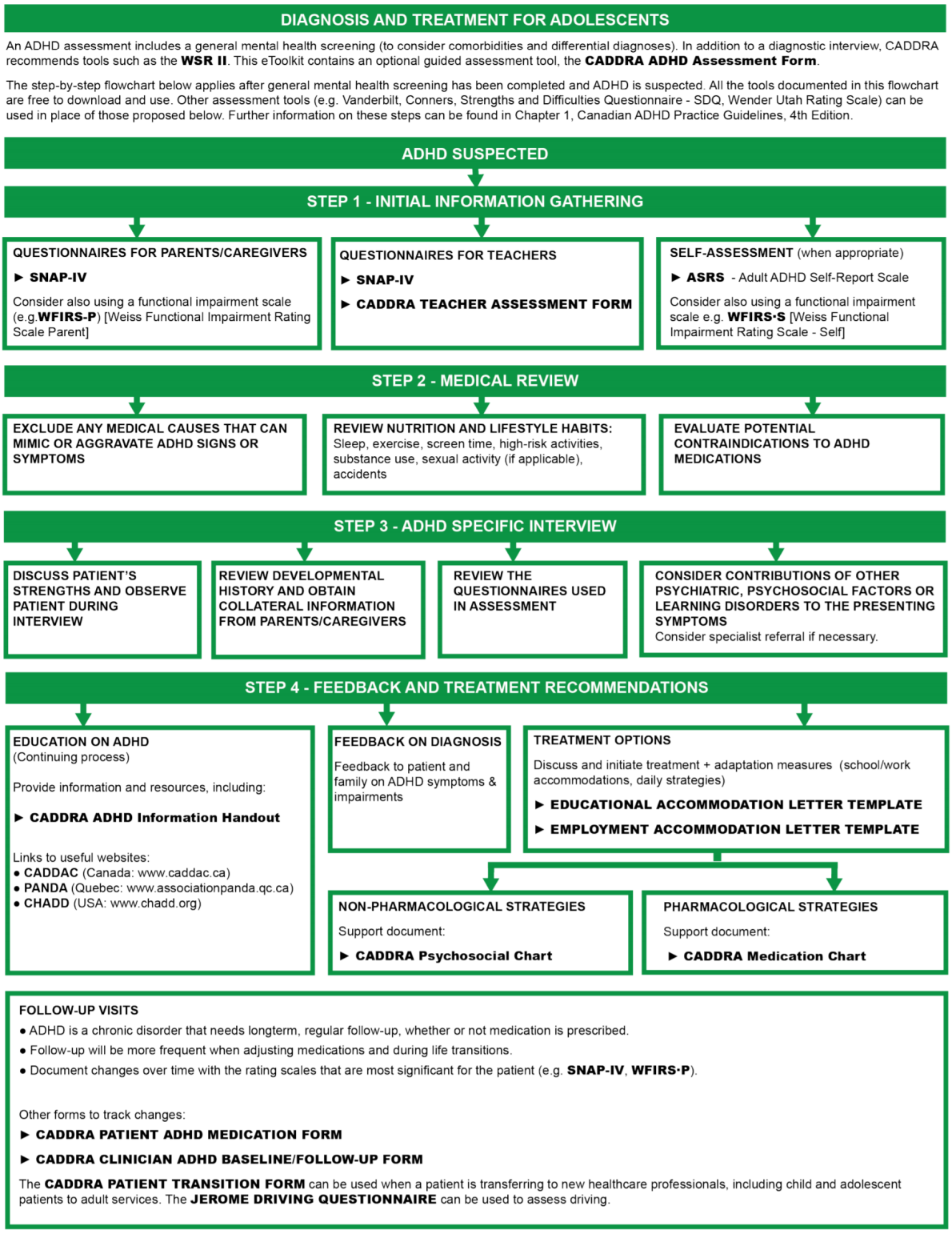


Figure 2-3: Specific ADHD Care Process for Adolescents (Canadian ADHD Practice Guidelines, Forth Edition, 2018)

2.5 **Ontologies**

Different practices in healthcare may have different terminologies for the same type of information such as procedures and processes, names of diagnosis and/or treatment, service names, equipment names, demographic data, and so on. Terminology standardization enhances the quality and effectiveness of communications among different healthcare professionals and organizations (Macedo & Isaías, 2013) and is an essential component to the implementation of successful HIT systems. We use the definition of *ontology* proposed by Thomas Gruber in which he describes an ontology as "an explicit specification of a conceptualization" (Gruber, 1993). A *conceptualization* is considered abstract and is used to represent a view of reality for some purpose, and is represented using an intentional semantic structure (Osterwalder, 2004a). The ontology, then, contains definitions related to classes, functions, relations and other objects which are associated with "human-readable text describing what the names are meant to denote, and formal axioms that constrain the interpretation and well-formed use of these terms." (Gruber, 1993). Ontologies provide a formal representation that provides for a unified understanding of elements for the various stakeholders defined within it. It also serves to make these elements reusable which is necessary in analysis. Ontologies are also used to separate domain and operational knowledge. Finally, they are useful in explaining assumptions.

2.5.1 **Design Criteria for the Development of Ontologies**

Gomez-Perez and Benjamin provided useful design criteria for the development of ontologies (Gómez Pérez & Benjamins, 1999) (Uschold & Gruninger, 1996). Key aspects include:

- Terms defined in the ontology should be expressed in natural language and be as objective as possible.
- The ontology should be designed in such a way that it is independent of a specific application or instantiation. This is to provide users of the ontology the freedom to apply or specialize as needed.
- If a new definition or term is added to the ontology, revision of the existing ontology should not be required.
- Terms defined by necessary and sufficient conditions are preferable to partial meanings in which only the necessary or sufficient condition is provided.
- The ontology should allow inferences derived from it to be consistent with its descriptions to allow for coherence.
- Classes described in the ontology should be separate and distinct.
- Naming of ontology components should be standardized.
- Ontology should be built in a modular way.
- Minimize differences in related concepts.
- Provide multipole inheritance paths through the diversification of hierarchies within the ontology.

2.5.2 General Steps for the Definition of an Ontology

Many methodologies exist to define ontologies (Casellas, 2011). In this section, we provide two approaches that are of interest to this thesis. The first is the Toronto Virtual Enterprise (TOVE) methodology described by Gruninger and Fox who provide a mechanism to guide the design of ontologies. They describe five key steps:

1. The designer of the ontology must provide a motivating scenario which may take the form of stories or examples which demonstrate its application.
2. A set of informal questions are formed. These are questions that the ontology will answer. This provides an information justification for the ontology.
3. The set of formal objects, attributes and object relationships must be provided for every informal question. These are used to provide the language, or terminology, to restate these informal questions.
4. Here we provide definitions and constraints on the terminology provided on 3.
5. Finally, we test our ontology. This is done by proving its completeness in relation to the questions defined in 3.

The second approach is by Noy and McGuinness who provide a general methodology to guide ontology definition in the context of healthcare (Noy & McGuinness, 2001). A sequence of steps is specified, but can be developed in any order, depending on the application. The ontology development methodology includes the following steps:

1. Define the domain and scope by answering these questions:
    - What is the domain covered by the ontology?
    - What is the reasoning for this definition?
    - Who are the target users of the ontology?
    - What kinds of questions are answered by the ontology?
    - What is the ontology maintenance plan?

2. Reuse existing ontologies:
    - Reuse available similar ontologies in order to leverage interoperability among different systems.
3. Identify a list of relevant terminology used to describe the domain:
    - This includes the terms we would like to discuss, and their properties. This makes it easier for the users to comprehend and use the ontology.
4. Define the entities and, if applicable, their relative hierarchy:
    - Here, we introduce the terms captured previous step. The different relationships and associations between the entities should also be articulated in this step.
5. Define the attributes of the entities identified in Step 4.
    - Once we define our entities, we must describe their internal structure.
6. Define the data types of the attributes identified in Step 5. the previous step
7. Create instances for the entities defined in these steps.

2.6 **Agile**

2.6.1 **Application of Agile to Healthcare**

Agile practices continue to evolve to address user expectations and software development team challenges but have also been adopted by non-software domains such as manufacturing, supply chain, human resources, real estate and learning organizations, and to a much lesser degree, by healthcare (Tolf et al., 2015). An agile approach encompasses well-defined methods for organizing collaborative work processes and for measuring performance in software engineering in healthcare HIT (Tang, Lim, Mansfield, McLachlan, & Quan, 2018). Some early results in the

literature show the potential benefits of applying this approach to other areas in the healthcare domain in which shared outcomes and goals for the patient's health are measured and evaluated in a methodical manner and serve to inform accountability and efficiency of the team (Williams, 2016). Williams studied how agile is applied to healthcare supply chain management and quality improvement within hospitals (Williams, 2016). Maijala et al performed a literature review that investigated Agile as a way to transform healthcare organizations through lean leadership and management (Maijala, Eloranta, Reunanen, & Ikonen, 2018). Oprins et al described how organizations are using agile to make healthcare organizations more responsive to their environments such as the Buurtzorg model applied to self-governing nursing teams in the Netherlands (B. Gray, Sarnak, & Burgers, 2015) (Oprins, Frijns, & Stettina, 2019).

2.6.2 **Agile Mindset**

Stephen Denning describes the agile mindset as encompassing values, goals and attitudes that are for the benefit of the customer, as opposed to the benefit of the bottom line (Denning, 2016). Application of agile processes to healthcare necessitates that managers/administrator empower knowledge workers to find solutions, rather than exert control and direction. An agile team is self-organized and autonomous and works within a network of other teams as needed. Coordination of work occurs in an iterative manner free of bureaucracy, while at the same time is structured. Practices are patient focused, and mission critical. The agile mindset involves continuous improvement and transparency on an ongoing and daily basis. Finally, communication is egalitarian, open, and conversational and occurs independent of hierarchy or position within the organization. The workplace, including the physical workspace is open and lends itself to collaboration (Denning, 2016).

2.6.3 **Common Features of Agile Processes**

There are many types of agile processes. Each emphasizes different aspects of software development. For example, the focus in Kanban is to reduce the amount of work and lead time, while Lean concentrates on continuous elimination of resource waste (Rigby, Sutherlan, & Takeuchi, 2016). Other methodologies include Feature Driven Design, eXtreme Programming, and Test Driven Design and Scrum. Glaiel et. al. reviewed agile processes and found that they share some common features. Their analysis revealed that teams use the same seven agile techniques (Glaiel, Moulton, & Madnick, 2013).

The first is that agile development projects divide their requirements into sets of manageable functionalities. These are also called use cases, threads, features, or stories.

The second is the incremental, or iterative manner in which development occurs in portions of time.

The third agile technique deals with how teams are managed. In an agile process, teams are empowered to respond to changes needs in a dynamic way without the need for oversight from outside the team. An assumption of agile is that teams will need to respond to frequent changes and improvement to software.

The fourth aspect deals with refactoring. Refactoring takes working code and extracts (factors out) common elements in order to refine the design and architecture of the software. The objective is to improve its flexibility and maintainability.

The fifth agile principle is continuous integration of working software updates into the testable version that contains previous features in a systematic and organized fashion. This includes policies and practices related to configuration management and automated testing.

The sixth agile principle addresses team dynamics and how the team collaborates. This encompasses a number of areas that enhance team performance such as frequent team meetings, workspace arrangement (open workspaces, team co-location), measurement of gained experience, pair programming, collective ownership of code being developed, transparency, and others. Most agile methods require the team to meet frequently to address issues and organize and prioritize around problem areas. Meeting frequently and face to face is a key factor for effective communication in agile. Glaiel et. al. also refers to an interesting dynamic that is created by daily team meetings, in Scrum for example. There is a sense of urgency and expectation that is created when teams meet to report on what they have done the day before, what they are doing, and what they plan to do. When this peer-pressure is coupled with the time pressure associated with short software iterations, higher productivity is achieved.

The seventh aspect of agile methods is viewing the customer as a team member. In this way, the team accepts changing requirement as part of the development process. Changing requirements can be communicated by the team and ensure that the product meets customer expectations during the development cycle and not at the end where problem are expensive to fix and new features are more costly to add. (Glaiel et al., 2013).

2.6.4 **Scrum**

Scrum and its variations are the most widely used implementation of an agile process (Rigby, Sutherland, & Takeuchi, 2016). It is a lightweight and adaptable process for software development and focuses on the way team members should collaborate in the context of a constantly varying business environment. Therefore, implicit in this the scrum process is that the many variables (customer requirements, delivery timeframe, resources, and technology for example) are likely to change throughout the project. Scrum is characterized as a framework in

which professionals can address complex problems that require the ability to quickly adapt to solve. These professionals are at once solving these problems and being productive to deliver products of high value in a creative way.

A key feature of scrum is the formalized mechanisms to ensure that the current status of the project is made visible to all team members. Scrum is inherently an iterative process which is divided into sprints. The goal of each sprint is to provide a shippable deliverable consisting of incremental functionality (Košinár, 2013). The scrum process is shown in Figure 2-4, which has been adapted from Baskirt (Baskirt, 2017).

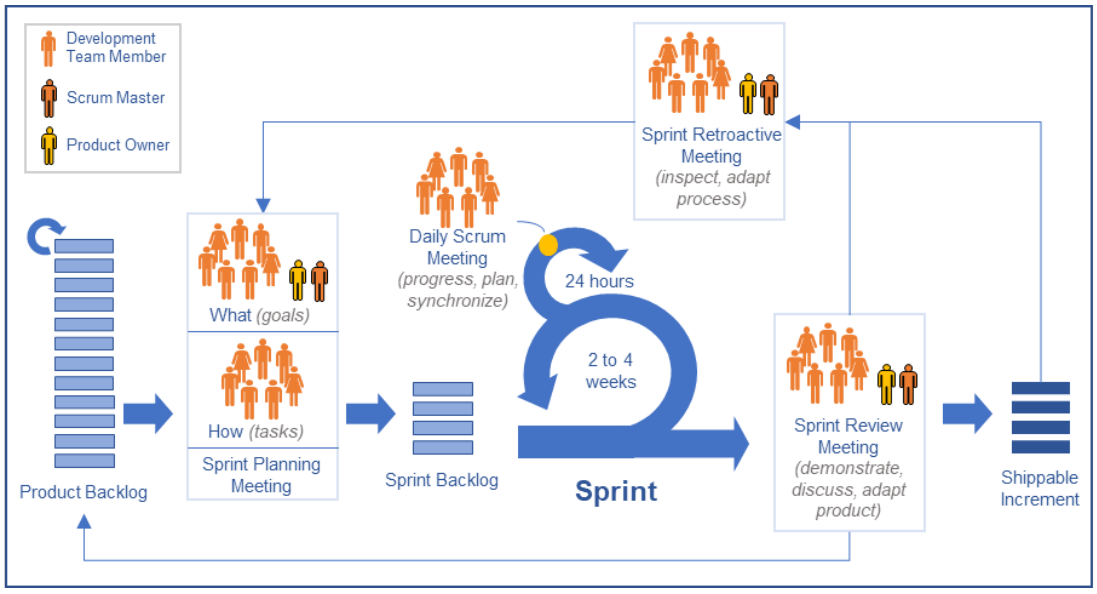


Figure 2-4: Agile Process – Scrum (adapted from (Baskirt, 2017))

2.6.4.1 Scrum Pillars

The authors of Scrum, Ken Schwaber and Jeff Sutherland articulate in their seminal document, *2020 Scrum Guide*, that a fundamental premise of Scrum is the aspect that it is based on experiential knowledge and the ability to make decisions based on what is observed through these experiences. This is what they call empiricism. Scrum is also based on lean thinking, which focusses on the essential elements of a process and the reduction of waste. Because of its emphasis

on incrementality to control risk, it relies on optimality through iteration. (Schwaber & Sutherland, 2020).

The events within a Scrum Sprint all work together because they realize the three pillars of Scrum, transparency, inspection, and adaptation. Transparency refers to requirement that all work must be visible to those doing the work, and those receiving the work. In the scrum methodology, key decisions are made based on the state of its associated artifacts (described in Section 2.6.4.1 below) and enable inspection. Inspection, the second pillar states that artifacts must be inspected often and conscientiously to identify possible undesirable discrepancies or issues. Scrum events (described in section 2.6.4.4 below) allow inspection to be built into the process. Finally, Adaption refers to the ability to react and change course once a deviation from acceptable limits has occurred. This final pillar cannot be realized without teams that are empowered or self-managing as adaptation should be swift and deliberate (Schwaber & Sutherland, 2020) (Jiles, 2021).

2.6.4.2 **Scrum Artifacts**

In the scrum process, the product is completed in a series of sprints which are time constrained to two to four weeks. The Product Backlog refers to the list of all features that are to be added to the product. The Product Backlog can change as the customer requirements change. This list is populated with short descriptions based on user stories. The Sprint Backlog corresponds to those tasks that the team has chosen to work on during the Sprint. Tasks in the Sprint Backlog deliver functionality that results in a potentially shippable product increment (Shippable Increment).

2.6.4.3 **Team Members**

The Development Team is a cross-functional team of typically six members who are responsible for the implementation of the increment. The team is responsible for all software activities including development and testing. An important agile characteristic of the Development Team is that they are self-organizing and are independently responsible for turning the Product Backlog into potential Shippable Increments (Schwaber & Sutherland, 2017). In addition to the Development Team, there are two other roles in scrum: Product Owner and the Scrum Master. The Product Owner is the owner of the Product Backlog and is a representative of customers and stakeholders. S/he is responsible determining the acceptance criteria for the increment (when the increment is "done"), chooses what to release and when, and generally provides the customer vision to the rest of the team. The Scrum Master is a team optimization role which ensures that the team is productive and functional. The Scrum Master provides guidance and support for the whole team. S/he provides regular feedback and tries to prevent problems from occurring. (Baskirt, 2017) (Schwaber & Sutherland, 2017).

2.6.4.4 **Scrum Meetings**

Scrum meetings occur at different stages of the agile process and have defined objectives and fixed maximum durations. The four meetings are depicted in Figure 2-4: Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective.

The Sprint Planning Meeting is attended by all members of the Scrum Team. Goals for the sprint are defined by the Product Owner (sprint goal) which will meet some subset of functionality in the Product Backlog. The Development Team works on tasks in fulfillment of these goals. Because they have the skills to implement software development, they are also in

charge of defining and forecasting the work that will go into realizing the goal of the sprint (Baskirt, 2017).

As the team embarks on the sprint, they commit to meeting 15 minutes per day to synchronize their work. These Daily Scrum Meetings are designed to ensure that development tasks are on track and to identify issues early in the process. In this daily face to face scrum meeting, they discuss what was done the previous day, what they are working on today, and if there are any obstacles to their progress, and what they plan to work on next.

The Sprint Review occurs once the sprint has been completed and is attended by the whole team, including any stakeholders. The Sprint Review must be completed within four hours if the sprint lasted 1 month. The objective of this meeting is to discuss and evaluate achievements made during the Sprint, items from previous sprint reviews, as well as any items still left to be performed for the existing sprint. The software increment is inspected, and the Product Backlog is updated as required. These items are likely candidates for the next sprint.

Once the Sprint Review is done, there is a final meeting in the sprint, the Sprint Retrospective. This meeting lasts at most three hours for a 4-week sprint and must be completed before the next Sprint Planning Meeting takes place. The objective of the Sprint Retrospective is to examine the working procedures used in the previous sprint cycle, and to see if there are areas of improvement for the next sprint (Schwaber & Sutherland, 2017) (Gonçalves, 2018) (Baskirt, 2017).

2.7 Performance Management

The U.S. Department of Health and Human Services provide a useful way to distinguish between performance measurement, performance measures and performance management (Health Resources and Services Administration, 2011).

- *Performance measurement* refers to the act of measuring important facets of an organization's internal processes. These are operational process that allow the ability to collect data from various areas inside an organization including its systems and programs.
- *Performance measures* are specifically measurable items within a care system and are related to best practice and clinical guidelines.
- *Performance management* ties both measurement and measures together and is a predictive process that is used to implement and monitor goals. Performance management highlights deficiencies in monitored processes and uses knowledge gained to improve processes.

Performance management, then, is a systematic process for improving organizational effectiveness towards achieving set organizational goals and missions. Performance management involves planning, setting expectations, continuous monitoring of performance, developing the capacity to perform, and periodically rating and rewarding of performance (OPM.GOV, 2017).

The primary focus of Performance Management (PM) is to identify Key Performance Indicators (KPIs) from business goals and strategic objectives, determining the methodologies for monitoring these KPIs and their relationships with other components of the systems being monitored, therefore bridging the gap between strategic objectives and business goals with

operational processes (Kemper, Rausch, & Baars, 2013). One of the characteristics of KPIs as it relates to performance management is the SMART (Specific, Measurable, Attainable, Realistic and Time- Sensitive) criteria (Shahin & Mahbod, 2007).

Therefore, the ability to keep performance management measures realistic comes from respecting the time sensitivity of KPIs through continuous monitoring. Continuous monitoring of KPIs is key to effective monitoring and management of strategic goals. However, each strategic goal also needs to be linked to these KPIs in order to measure to which extent the performance of the organization is far or near to its goals (Craig Kuziemsky, Liu, & Peyton, 2010).

In order to monitor care processes, data must be collected and reported to measure how well they are meeting quality of care goals dictated by organizational, governmental, and accreditation regulations. The aim of business analytics is to collect and monitor data generated from executing a business process and perform some sort of analysis according to the values of performance measures. The analysis indicates how well the organization is performing their business process. Analysis results can be presented to the users in a simple format such as a dashboard or report which assist them in decision making (Azvine, Nauck, & Ho, 2003). The most well-known framework for measuring performance in a systematic manner that links business processes to performance management is the balanced scorecard (Robert S; Kaplan & Norton, 1996). In the balanced scorecard, metrics are defined to measure performance for four key strategic areas of an organization using data collected from operational processes.

In near real-time business analytics, in order to support decision making, metrics, charts and alerts should be available in near real-time. The objective of near real-time analytics is to minimize the time between the occurrence of critical situation and the time when an action is initiated (Chieu & Zeng, 2008). This is critical for care process monitoring, if one wants to

effectively managed care processes in a systematic way across a large healthcare organization or large community. Near real-time analytics should provide information in a timely fashion so that care providers can respond and take corrective action if care processes are not performing as expected.

2.7.1 Performance Management Frameworks

Performance Management Frameworks are used to transform organizational strategy into performance metrics that help align a company with its strategic objectives. A framework is a tool which helps organizations outline the relationships between important concepts, variables or concepts that explain the phenomenon under study. It can be represented as a plan, a structure, system, or overview, and measures and manages performance. This can be the performance of various aspects and at various levels within the organization and can include teams, individuals, processes, projects, programs, and departments for example. Importantly, frameworks do not provide elucidations, instead they describe empirical phenomena by putting them into a set of categories (Nilsen, 2015).

There are several examples of performance management frameworks. These include:

a) **Balanced Scorecard.** Kaplan and Norton developed the Balanced Scorecard (BSC) after extensive research in a multi-client research study in 1990. The BSC is customized to an organization and links performance and action to a company's strategic measurement and management. It is balanced because the performance measures are grouped into areas critical to success, and performance is balanced accordingly (Robert S. Kaplan & Norton, 1992).

b) **Balanced Scorecards in Healthcare.** Voelker, Rakich and French apply the BSC to healthcare organizations in which they espouse the use of a limited number of metrics that align with strategic objectives. (Voelker, Rakich, & French, 2001)

c) **Outcomes Based Frameworks.** Frank and Danoff developed an outcomes-based framework of physician competencies organized around the various roles that a physician plays (Medical Expert, Collaborator, Professional, etc.). A systematic implementation plan involved outcomes for the development of standards for curriculum and assessment, faculty development, educational research and resources, and outreach (Frank & Danoff, 2007)

d) **Competency Based Frameworks.** Frank et al describe the evolution of Outcomes Based Frameworks to Competency Based Framework in medical education. Thus, Competency Based Frameworks are centered on curricular outcomes and responsibility/accountability. They are designed around competency, greater learner-centeredness and de-emphasize time-based curriculum design. (Frank et al., 2010)

e) **Decision-Making Frameworks**. Neely et al provide a framework for identifying desirable characteristics of a performance management system (Neely et al., 2000)

f) **Strategy Maps**. Kaplan and Norton describe how strategy should be represented visually, so that all the multiple components in an organization can see their role meshing with others towards a shared end. They provide an instructive catchphrase: "you can't manage what you can't measure, you can't measure what you can't describe." (Robert S. Kaplan & Norton, 2004).

2.8 Business Model Canvas

A business model describes how a company creates, delivers, and captures value. The Business Model Canvas (BMC) is a visual representation of a new or existing business model. It is a strategic, hands-on tool that allows quick and structured communication, discussion, understanding and analysis of a business and is based on Alexander Osterwalder's doctorate thesis (Osterwalder, 2004b) and his co-authored book (Osterwalder, Pigneur, Clark, & Smith, 2010). The BMC is used to provide a simple visualization of the business to gain a holistic understanding of the business and how each of its nine elements (Value Proposition, Customer Segments, Customer Relationships, Channels, Key Resources, Key Activities, Key Partners, Cost Structure and Revenue Streams) impact the other.

2.8.1 Application of the Business Model Canvas to Teams

Interestingly, in 2017 Clark and Hazen used Osterwalder's Business Model Canvas and extended it to teams and individual workers within an organization (Clark & Hazen, 2017). A conceptual depiction of this extension is shown in Figure 2-5. This figure shows the BMC at the Enterprise Level in the context of the team and individual level. The Team Service Model (Figure 2-6) depicts how a team within the company delivers value. In this model, customers can be outside or inside the organization. The Personal Business Model describes how an individual employee delivers value to those within and outside of the organization. Combined, these views provide a dynamic, systems-level view of a company's business (Clark & Hazen, 2017).

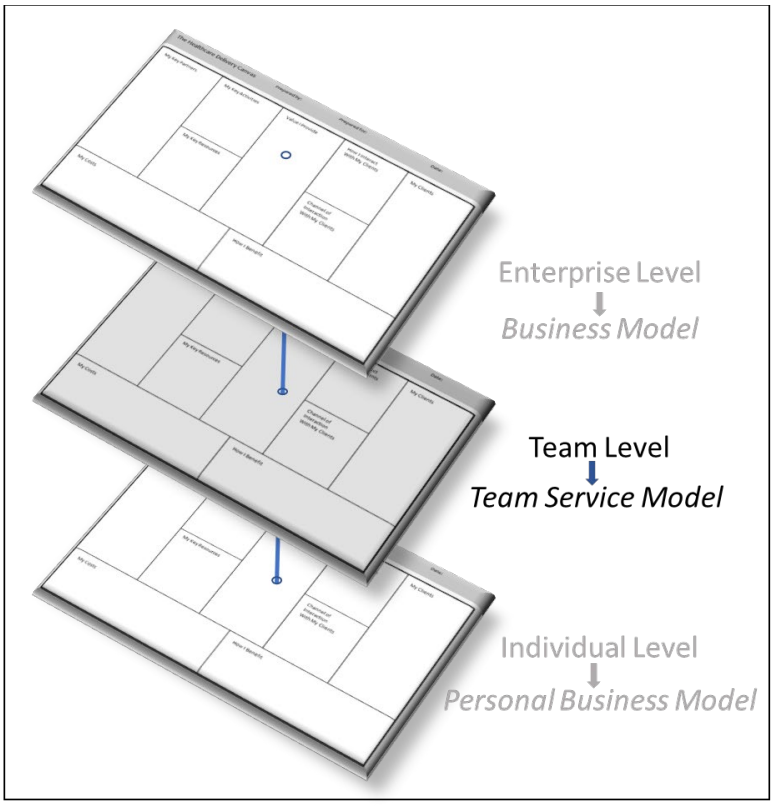


Figure 2-5: Business Model Levels (adapted from (Clark & Hazen, 2017))

2.8.2 Team Service Model Canvas

The Team Service Model Canvas in Figure 2-6 is an instantiation of the Team Service Model shown in Figure 2-4. The tool consists of nine components expressed in a succinct visual format for ease of use and are described below. The right side of the canvas represents customer-focused aspects of the business, while the left side deals with internal-facing considerations.

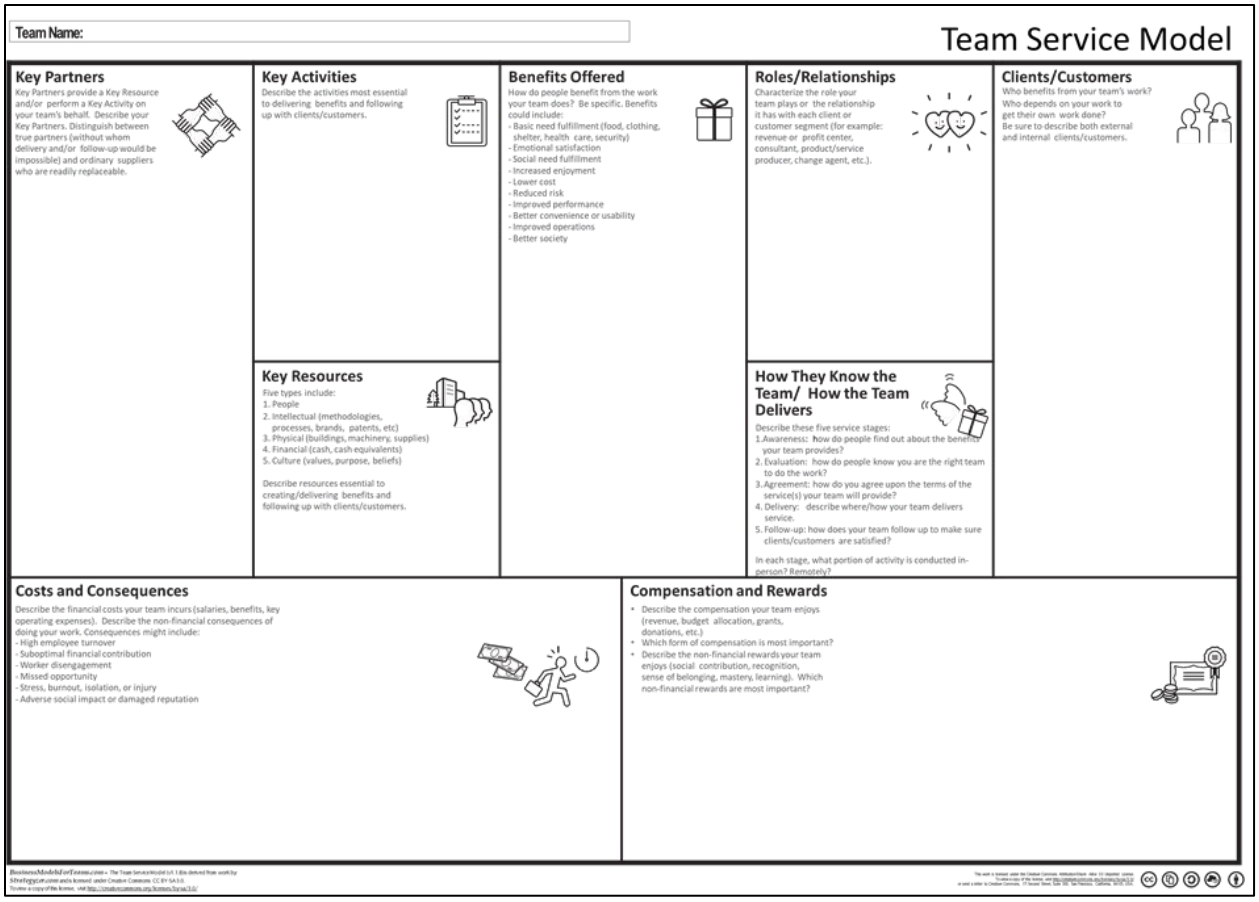


Figure 2-6: Team Service Model Canvas (Clark and Hazen 2017)

- **Benefits Offered:** Describes the way people benefit from the work the team performs. Benefits may include fulfillment of basic human needs, (food, shelter, etc.), a better society, lower costs or risks, improved performance, usability, improved operations, convenience, social, emotional fulfillment, etc. TIRES is also applicable here (Wilkins, 2013).

- **Clients/Customers:** This describes who the internal and/or external clients are that will benefit from the teamwork. Also, who is dependent on you to get their work done?

- **Roles/Relationships:** This field describes the relationship team members have with clients. For example, does the team have a role as consultants, change agents, cost or revenue center, etc.?

- **How They Know the Team/ How the Team Delivers:** This describes the stages of awareness (how are your benefits known to others), evaluation (how is it know that you are the right team for the job, agreement (how are the terms of service agreed upon), delivery (how you provide service), follow up (how do you know your customers are satisfied). Are these stages handled in person or remotely?

- **Key Activities:** These are the key activities that the team must perform in order to provide benefit, as well as for follow up.

- **Key Resources:** This field describes the most important resources required to deliver the benefits to the client, including follow up. The five types of resources a team may have are: people, physical, intellectual (patents, methodologies, processes, etc.), financial (cash, cash equivalents), culture (described by beliefs, values and purpose).

- **Key Partners:** This field is reserved to describe key partners who may provide a Key Resource and/or perform a Key Activity on behalf of the team.

- **Costs and Consequences:** The financial costs incurred by the team are noted here. This can include operating expenses, staff salaries, etc. Also described are the non-financial consequences related to the work the team performs. These includes opportunity costs, stress, burnout, injury, damaged reputation, employee turnover, worker disengagement, etc.

- **Compensation and Rewards:** This refers to the compensation the team may receive such as grants, revenue, donations, budget allocation, etc. Also included here are the non-financial benefits enjoyed by the team and include recognition, satisfaction, learning, etc.

2.9 Related Works

2.9.1 Collaboration Space Model

(Eikey et al., 2015) performed a systematic review of 25 years of research to analyze the state of knowledge of collaboration in healthcare informatics. The paper uses 98 peer-reviewed articles to propose a model for healthcare collaboration called Collaboration Space Model (CSM). The authors describe how collaboration in healthcare is complex from many perspectives. These include types of teams and how they communicate (access and sharing of information), team dynamics (interaction and working relationships, as well as the implementation of team processes), and team efficacy (how successful these teams are at achieving their goals). Collaboration as a term has been very difficult to describe and quantify since it is a term that at once contains the multiplicity of these factors, in addition to the technology that is used to facilitate them. These factors combined form a holistic view of collaboration in healthcare and are described in an organized fashion by the authors as shown in Figure 2-7.

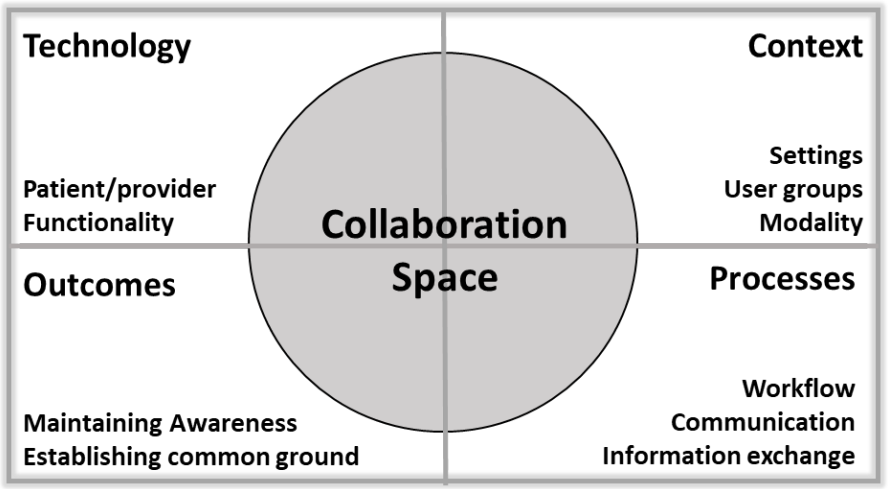


Figure 2-7: Collaboration Space Model (Eikey et al., 2015)

They provide a Collaboration Space Model that provides a simple two-dimensional view of collaboration as comprising of Technology, Context, Outcomes and Processes. These are described here.

- Technology refers to the purpose and function of HIT design. For example, the HIT may be aimed for use by a patient, or a provider. Function refers to the specific feature of the design such as reporting or analysis.
- Context provides clarity on who is working together, and in what setting. For example, the team may be comprised of medical professionals only, or allied health professionals involved. Is the setting in a community care setting, or inpatient? Another aspect of context is modality, which refers to whether the HIT system is used in a synchronous, asynchronous, or mixed fashion.
- Outcomes refers to the goals that are aimed to be achieved by using the HIT in team setting. Eikey et.al., suggest that establishing common ground and maintaining awareness must be fundamental goals in collaboration HIT.
- Finally, HIT design must take into consideration the specific collaborative process to be supported. These include aspects such as information exchange, workflow, and communication.

2.9.2 **Agile Healthcare**

In the context of healthcare, we use the work of Tolf et. al. to describe the characteristics of an agile healthcare organization (Tolf et al., 2015). Several themes emerged from a study of 60 articles as follows:

1. There is a spectrum of collaboration that exists at many levels of an organization. Links between groups can be transient, or virtual. These are teams that come together for a specific purpose or time, and then disband, forming a type of virtual network. Success of this type of team, and indeed all agile teams, requires operation in an environment where information is seamless and flows transparently between members and other stakeholders. The necessity for such transient alliances is apparent since it is not possible for one organization to serve all the needs of the customer/patient. Trust then becomes a critical component to effective collaboration.
2. Market sensitivity is the real time ability to acknowledge and respond to information from competitors, customers, regulatory bodies, and suppliers. An agile organization would be able to use this information for its advantage by reacting accordingly.
3. Focus on what the customer needs versus what the product's capabilities is an important part of agile. Agile focusses on solution to a problem, not just the product. One natural consequence of this is the creation of long-term, intimate relationships with the customer.
4. Self-organizing teams are highly successful at producing successful outcomes for the customer. In Agile, the management team serves as administrators to provide support and clear roadblocks for their teams. Managers provide goals, constraints and boundaries and trust their teams to implement the best solution.
5. Elastic and responsive team are a necessary part of an organization's capacity to be agile. Team structures are consequently less rigid, hierarchical, centralized, and formal. Teams should be able to realign and re-focus, reconfigure and diversify themselves as the opportunities present themselves (Yusuf, Sarhadi, & Gunasekaran,

1999). This applies to what goals should be pursued, as well as those which need to be modified or abandoned.

6. Human and physical resource allocation is characterized as flexible and are applied to goals that have a short life cycle, in order to respond to customer needs in a timely fashion. Capacity is based on real time customer demands and increases as demands increase and vice versa.

2.9.3 **Measuring Healthcare Outcomes**

The central theme of Michael Porter's *What is Value in Healthcare?* is that value must be centered around patient outcomes (outputs), and not services delivered (inputs) (Michael E Porter, 2010). In this seminal work, he makes the case for reform, arguing that healthcare systems should be organized around disease such as breast cancer for example. An Integrated Patient Unit (IPU) would provide all the services required to treat an ailment in one place. As an administrative unit, an IPU could be somewhat geographically disperse, but coordination is central. Porter argues that overall healthcare costs would diminish over time as decisions are made to eliminate low value services and consolidate other services. He provides a good rationale for the total cost of healthcare being related to the full cycle of care, which includes the full gamut of expenditure related to patient care: inpatient services, outpatient services, rehabilitation, pharmaceuticals, technology, non-medical services, and other equipment, etc. In order to reduce overall care, he believes that spending more on early-stage care, including preventative care, will lower the cumulative cost incurred by patients over their care. Placing an emphasis on early-stage care of a medical condition will engender use of less complex and invasive care in the long run. Note that Porter defines a medical condition as including its most common co-occurrences. For example,

for diabetes, the interrelated conditions include kidney, eye and heart disease along with hypertension. (Michael E. Porter, 2008; Michael E Porter, 2010)

Porter's main contribution, however, comes with a description of a simple framework that describes how value can be measured for a given medical condition for a patient population over the full cycle of care. This is shown in Figure 2-8 (Michael E Porter, 2010), which describes 3 tiers of the patient cycle of care and the associated measures. Each tier contains two broad classifications which encapsulate one or more dimensions related to specific patient outcomes and associated quality in healthcare. Each dimension has associated metrics or measures. Porter's model states that each of these dimensions can be measured at different times and at different frequencies. Tier 1 depicts the primary health status for patients, which is survival, followed by the health status achieved/retained for a condition. Tier 2 relates to the recovery process. Here we measure the time required (including cycles of care) to recover from the illness and return to normal, or best achievable, function. Tier 2 also describes the concept of *disutility* of the treatment process, in which discomfort and complications from treatment, the need for re-treatment, errors and complications are considered. Finally Tier 3 speaks to how sustained the health of the patient is after treatment. The first level here deals with reoccurrence of the original medical condition, or its longer-term consequences. The second level deals with any new health issues created as a result of treatment. Each of these tiers have associated metrics. A summary of the Outcome Measures Hierarchy with examples is provided in Table 2-1 (M.E. Porter, 2010a, 2010b).

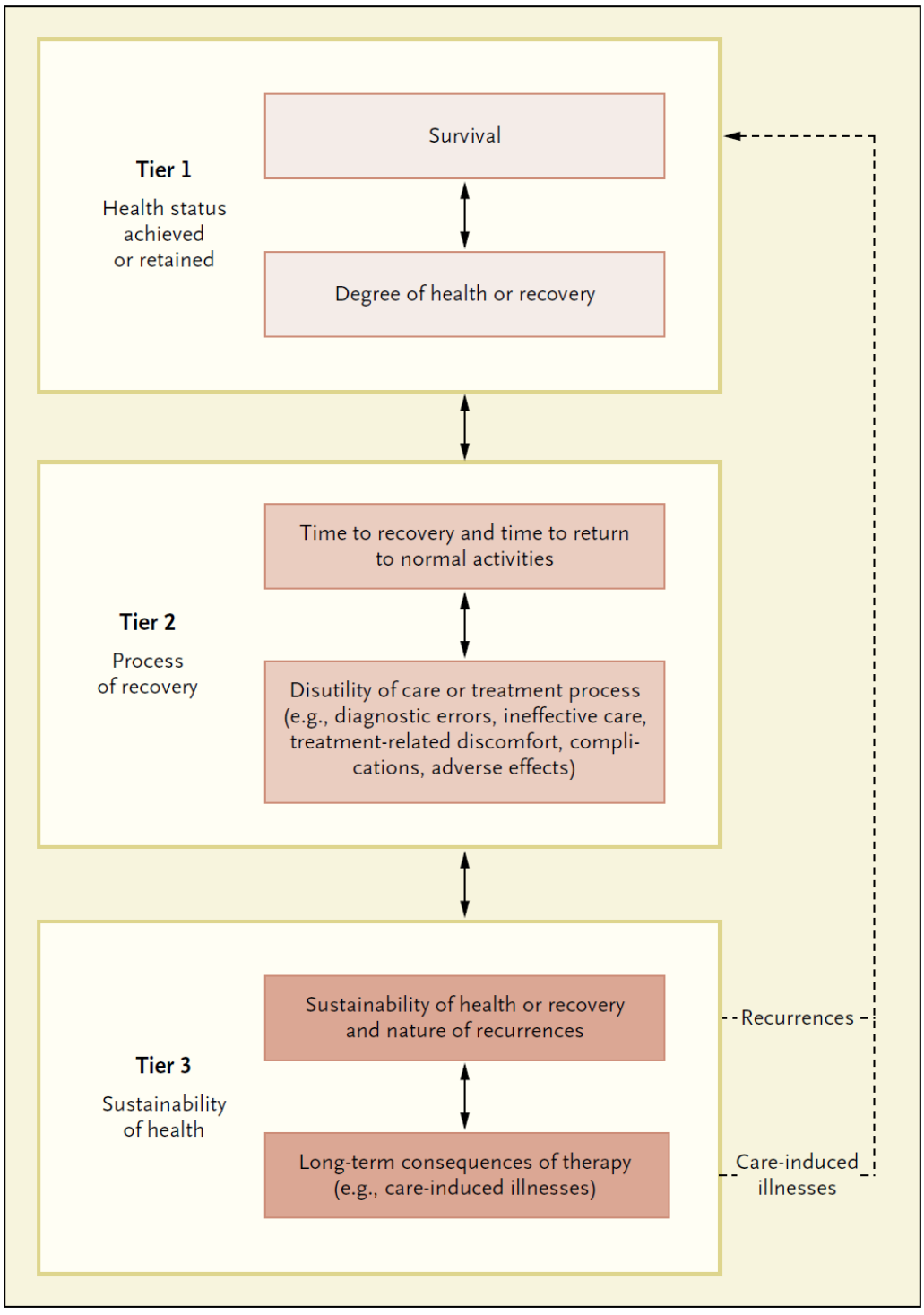


Figure 2-8: The Outcome Measures Hierarchy (Michael E Porter, 2010)

Table 2-1: Outcome Measures Hierarchy (M.E. Porter, 2010a, 2010b)

Tier	Dimension	Measure
1: Patient Health Status Achieved Measures how well the patient responded to treatment	1: Survival	Mortality rate
	2: Degree of recovery	Peak or steady state level of health achieved (defined according to condition): • Freedom from disease • Functional status
2: Process of Recovery Measures issues related to diagnosis and treatment	1: Time to recovery and best function	Time needed to achieve recovery in phases of care: • Time to diagnosis • Time to treatment plan • Time to care initiation • Duration of treatment • Cycle time
	2: Disutility of the care process	Issues with the care process such as: • Missed diagnosis • Failed treatment • Inappropriate treatment • Ineffective treatment • Discomfort • Anxiety • Short term complications • Errors • Re-treatment • Missed working days while under treatment • Inability to function normally while undergoing treatment • Consequences of above
3: Sustainability of Health Measures the degree to which health is maintained, extent and timing of recurrence, and consequences	1: Sustainability of health or recovery	Recurrence(s) of original disease or associated longer-term complication(s): • Time to recurrence • Time to severity of recurrence
	2: Long term consequences	New health problems created because of: • The treatment itself • Care-induced illnesses

2.9.4 **Teamwork and Collaboration**

Xiao, Parker and Manser, in their work entitled Teamwork and Collaboration (Xiao, Parker, & Manser, 2013), present a comprehensive treatment of the unique characteristics and requirements of teams in the hospital setting, and elsewhere. They also provide a set of concepts that may be used in improving teamwork in healthcare. These include questions related to team structure, processes, outcomes in different healthcare setting.

2.9.5 **ADHD Clinical Vignette**

We adapted Case Study 2 – Nancy to craft our Clinical Vignette in Section 6.1. The Clinical Vignette is included as a related work since it is used in our assessment the PMFCC in Section 7.3. Dr. Anslie Gray, an expert in ADHD, uses case studies to teach family physicians about best practices related to the diagnosis and treatment of this disease. She presents her workshops and seminars at conferences. One workshop, entitled *Best Practices for ADHD Across the Lifespan* was delivered at the Family Medicine Forum Canadian (A. Gray, 2016), and provided a set of Case Studies that were used to deliver important learnings to family physicians.

Case Study 2 – Nancy

Nancy is a 13 year old Grade 8 student currently living at home in Toronto with her two parents and older sister. She was referred to Springboard Clinic for an evaluation to further understand her focusing concerns and her current learning profile of strengths and concerns.

Nancy reports that she enjoys arts and crafts, and participating in social media websites such as "Tumblr." At times, she experiences mood fluctuations and irritability; she noted that anger and frustration tend to be connected with her sadness. Drawing, listening to music, and swimming help her to relax.

Since first entering school, Nancy has experienced difficulties with school work completion, inattentiveness and distractibility, disorganization, impulsivity and mood fluctuations. Nancy's teachers describe her as a hard-working, cooperative student, but they indicate that homework responsibilities have been an issue. They also note that she is a very reluctant reader, and has consistently scored lower than average on reading comprehension and vocabulary tests. Psychoeducational testing indicated average cognitive abilities.

Nancy states that she is struggling to meet expectations at home and at school, complete academic work, and communicate effectively with others who do not share her interests. Nancy indicates that she often becomes anxious when she is asked to speak in public, or to spend time with people she does not know. Her parents note that Nancy has difficulties making new friends and taking risks - she "longs to get invited, but won't make the first move." She experiences ongoing sleep difficulties, primarily with settling into routines at night.

Her parents report increased anxiety around school participation this year. Nancy reports feeling nervous when going to school because of presentations and homework. She describes hating school and experiencing difficulties completing her work on time because "she can never focus." Her parents note concerns with negative body image and self-talk.

Her older sister has been identified as "gifted" and appears to be highly motivated academically and almost "driven" to excel in all her life domains. (She later was diagnosed with a serious eating disorder). Both her parents are university graduates. Her father is a hard-working financier who stays fit, running marathons. Nancy's mother is currently a full-time homemaker.

There is an extended family history of alcoholism, marital relationship instability and possible ADHD / LD characteristics. (A. Gray, 2016)

2.10 **Chapter Summary**

This chapter provided background content on the various concepts that are fundamental to this thesis. These are: collaborative care teams, healthcare collaboration issues, healthcare standards, ADHD, ontologies, agile, performance management, and the business canvas model. Having completed these sections, we then discussed our five related works. These included the healthcare collaboration space, agile organizations, Measuring Healthcare Outcomes, Teamwork and Collaboration, and the ADHD Clinical Vignette.

3 Research Methodology

This chapter develops our Research Questions and explains our Research Design. The Research Questions section describes our motivation and how our previous experience combined with a literature survey led to our research questions. The Research Design sections identifies the methodology we followed and provides a detailed description of how we structured our research through five iterations to answer our research questions.

3.1 Research Questions

Much of the global healthcare transformation efforts have focused on improving care management by better connecting care delivery across providers and settings (Carroll, Kuziemsky, & Richardson, 2018). The design of health information technology (HIT) to support care coordination has been referred to as the next great opportunity for medical informatics (Bates D., 2015). We discovered a need for HIT design for collaborative care delivery to transition individual work processes into collaborative processes. This transition has been referred to as the individual collaborative-interchange (CE Kuziemsky, 2015). While many aspects of collaborative healthcare delivery have been well studied, the individual-collaborative interchange remains a challenge for HIT design to support collaborative care delivery.

We chose to focus on performance management of collaborative, and specifically the technology required to support it. Performance management aims to define and measure the processes that are done across individuals, teams and organizations so that performance activities effectively support the goals of an organization (Madlabana et al., 2020). While a performance

management framework could help us understand the individual-collaborative interchange so we can reconcile it as part of HIT design to support collaborative care delivery, we discovered that performance management has not been studied in the context of collaborative care delivery (Buscemi et al., 2012) (Havyer et al., 2014). More specifically, it has not been studied as a means to reconcile individual-team differences as part of HIT design to support collaborative care delivery. Thus, our research needed to address that need by identifying the factors associated with collaboration and then use these factors to create a performance management framework for collaborative healthcare delivery supported by technology Artifacts.

As we began to study performance management, it became clear that we needed to unpack collaboration into its essential components in order to identify the parts. We also needed to establish a common vocabulary to discuss collaboration. A literature study on collaboration frameworks revealed an important existing model by Eikey et. al, the Collaboration Space Model (Eikey et al., 2015). Discussing with domain expert Dr. Craig Kuziemsky helped us validate our intention and create our first research question:

1. **How can the Collaboration Space Model described by Eikey et. al. be further extended or improved-upon to address performance management of collaborative care teams?**

Next, we would need to articulate the disposition of a performance management framework. We performed a literature survey to analyze the current body of knowledge to determine if existing solutions existed – and none were found. Based on this researcher's professional experience in the telecommunications industry, there were areas outside of healthcare where collaboration had been identified as an issue, and models and methods successfully developed and applied to alleviate pitfalls. Could we apply those same models and methods (such

as Agile approaches or the Balanced Scorecard) to collaborative care team in healthcare? What were the entities that needed to be defined? This led to our second research question:

2. **What are the elements of a performance management framework for collaborative care teams?**

Finally, in order to enable the implementation of a PM HIT, we would need to articulate the design requirements of technology that could improve collaboration. This researcher participated in a Collaborative Workflow Solutions (CWS) Working Group at the University of Ottawa under the auspices of the CREATE-BEST program. The CSW was led by Dr. Cheryl Netterfield, a family physician and entrepreneur, and involved research related to an innovative software application using the ICF standard. Insights from this working group along with business experience from industry led to our third research question:

3. **How can we define better "Artifact" support for performance management of collaborative care teams in order to measure their performance?**

Thus, in answering the above three questions, our research objective became: to create a cohesive, descriptive, artifact-driven performance management framework that can be applied to improve community care collaboration.

3.2 Research Design

3.2.1 Overview

In this thesis, we followed (Peffers et al. 2007) DSR process model to conduct our research. This is depicted in Figure 7.

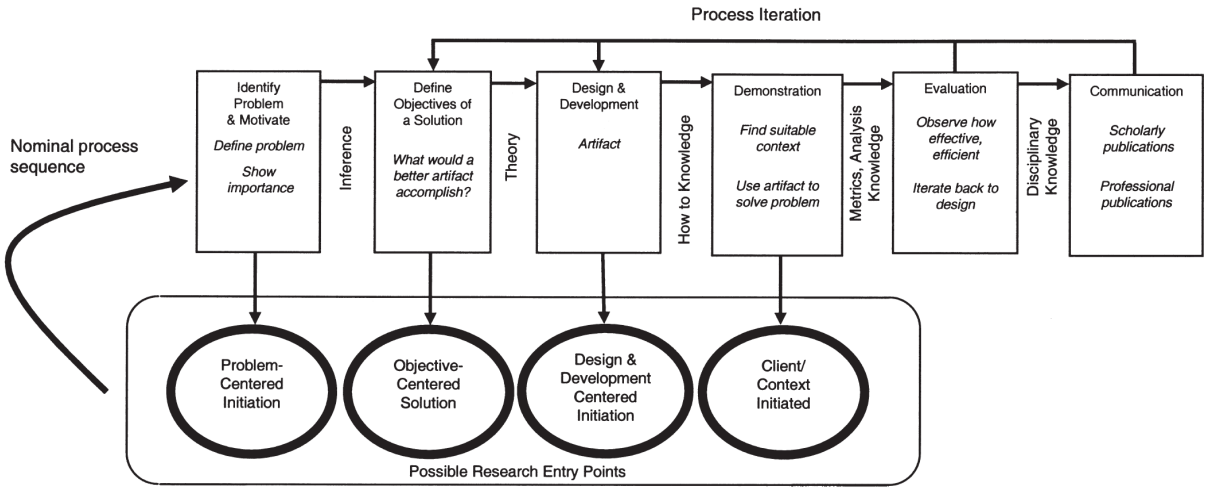


Figure 1. DSRM Process Model

Figure 3-1: DSRM Research Methodology (Peffers et. al., 2007)

Our entry point to the DSR process was through objective centered solution, involving the creation of a theory subsequent to initial investigation and inference. Our research began with the identification of this problem and its importance as shown in the top area of Figure 3-1. This was followed by preliminary research through literature surveys, readings, discussion with subject matter experts, where it became clear that there may have applicability to community collaborative care processes beyond ADHD, such as palliative care and rehabilitation. This researcher then inferred a solution by describing what a better artifact would accomplish to aid collaboration.

One research article entitled *Examining the role of collaboration in studies of health information technologies in biomedical informatics: A systematic review of 25 years of research* by Elizabeth Eikey et al (Eikey et al., 2015) provided a description of the components of a collaboration, as shown in Figure 2-7. This article provides a model, the Collaboration Space Model (CSM), which describes components of healthcare processes from a healthcare information technology (HIT) perspective. The CSM became the starting point for the development of a performance management framework. We subsequently inferred the need for an extended collaboration model, agile process model and a performance management model. We also inferred

the need for artifacts that can capture and communicate data through online technology to support the performance management framework.

Thus, design and development centered initiation was the entry point to each successive iteration. We used ADHD as a specific application domain to test and develop our framework. ADHD is a relatively simple, well defined, and understandable medical process that involves related professionals and family members working in a community care setting. The care process is well articulated in the Canadian ADHD Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). We used a case study by ADHD expert, Dr. Ainslie Gray, to create a Clinical Vignette. We applied the Clinical Vignette to the CADDRA guidelines to demonstrate that the collaboration process was insufficient and could be improved with learnings from the software engineering domain (A. Gray, 2016).

From that point, using an iterative approach, our research objective became to create a cohesive, descriptive, artifact-driven performance management framework that can be applied to improve community care collaboration. We created three base components of the PMFCC (Collaboration Space Ontology Template, Agile Process Model, Performance Management Model), and developed four example Artifacts. These Artifacts were developed to address different collaboration issues in the different versions of the ADHD scenario in Chapter 6. At the end of each scenario, a self-evaluation was performed in the Results section to determine if collaboration improvement had occurred. At each iteration of the design research process, the various elements of the framework were evaluated and updated. This feedback is then worked back into the nominal process sequence to provide a better solution for subsequent iterations.

What was learned throughout this process was used to write academic papers and gather feedback from other scholars and domain experts. Finally, the whole framework was presented to subject matter experts who validate the PMFCC and Artifacts.

3.2.2 **DSR Iterations**

This section provides details for each step of the DSR Iterations which is based on Figure 3-1, as shown in Table 3-1.

Table 3-1: DSR Iterations

DSRM Phase	Identify Problem and Motivate	Defining Objectives of a Solution	**Design and Development**	**Demonstration**	Evaluation	Communication
Iteration 0	What are the issues related to Collaborative Care of community care team?	Literature survey to analyze the current body of knowledge. Find solutions for gaps and issues.	**PMFCC**	**Collaborative Care "Strawman"**	Gap Analysis	University of Ottawa Faculty of Engineering Poster Competition 2015
Iteration 1	Can the Collaboration Space Model be further extended or improved-upon to address performance management of collaborative care teams?	Provide a common vocabulary for communication and design purposes. Design a healthcare process model which will allow performance to be quantified and measured. Design a vehicle that enables identification of KPIs for collaboration	**Collaboration Space Ontology Template (CSOT)** **Agile Process Model (APM)** **Performance Management Model (PMM)**	**Combine CSOT, APM and PMM to create the PMFCC** **(Clinical Vignette)**	Comparative study with Related Works	MCETech 2015 ICTH 2016
Iteration 2	Can we define better artifact support (technology) for performance management of collaborative care teams?	Require technology (Artifacts) to support enable PMFCC	**Agile Treatment Plan (ATP)** **Agile Collaboration Dashboard (ACD)**	**Scenario 1**	Comparative study of existing ADHD process (Clinical Vignette) with PMFCC and ATP and ADC in Iteration 1 & Related Works	CREATE-BEST Poster Competition 2017 11th IADIS International Conference on Information Systems (IS 2018).
Iteration 3	Can we create an effective way of communicating collaboration goals?	Well-defined Artifact based on the WHO ICF standard.	**ICF Patient Card (IPC)**	**Scenario 2**	Comparative study of ADHD process in Iteration 2 with ICF Patient Card & Related Works	HEALTHINF 2020

Iteration 4	Can we create a better way to understand the collaboration context?	Well defined Artifact based on the Business Model Canvas.	**Collaborative Care Model Canvas (CCMC)**	**Scenario 3**	Comparative study of ADHD process in Iteration 3 with Collaborative Care Model Canvas & Related Works Expert Panel Review	IEEE-ICHI2021 (submitted)

It should be noted that there are several outputs of this research. These are provided in the Design and Development column of Table 3.1. These correspond to DSR outputs (Vaishnaiv, Kuechler, & Petter, 2004) as follows: the PMFCC is a *Framework* (which corresponds to an Artifact as defined by Peffers (Peffers et. al., 2007)); the CSOT is a *Construct*; the APM and PMM are *Models*; the ATP, ACD, IPC and CCMC are *Instantiations*.

Iteration 0 – Design of Strawman (PMFCC)

With the initial inspiration of examining collaboration as one of the root causes of medical error, through retrospection, discussion with experts and literature surveys, we set out to investigate what a performance management system for collaborative care could look like. Hence, in Iteration 0, we narrowed down our research space to small community care team using a (relatively) simple process of diagnosing and treating an ADHD patient. We performed a literature survey to understand the issues faced by this collaborative team, and then generalized the gaps that we found in order to create a more comprehensive solution. This was followed by the development of a potential solution in the form of a strawman for a Performance Management Framework Collaborative Care.

Iteration 1 – Design of Components (CSOT, APM and PMM)

In order to develop our Components, we created a Clinical Vignette that was based on a case study by an ADHD expert (A. Gray, 2016). We applied our Clinical Vignette to our findings in Iteration 0 to refine the Collaboration Space Ontology Template (CSOT). The CSOT was the basic construct in the framework as it provided the common vocabulary for communication and further design. In this phase we made a key decision to deal with objective measures of collaboration performance management (e.g., that data which could be obtained through observation, without feelings, concerns or perceptions). This necessitated a process and a performance management model that could be quantified. This was the inspiration to use Agile SCRUM and the Balanced Scorecard as models to create the Agile Process Model (APM), and the Performance Management Model (PMM).

Iteration 2 – Design of Artifacts 1 (ATP) and 2 (ACD)

In iteration 1, we were satisfied that we had the fundamental theoretical Components required to describe and measure performance management for collaborative care teams. In order to operationalize our framework, some key artifacts would be required – which we realized when we recursively applied our Clinical Vignette. Thus, we created two key Artifacts to support our framework: the Agile Treatment Plan (ATP), and the Agile Collaboration Dashboard (ACD). We applied these Artifacts to our Components, which we refined.

Iteration 3 – Design of Artifact 3 (IPC)

With the success of integrating the ATP and the ACD into our framework, we set out to create another Artifact that addressed the aspect of goal communication within the team. We examined existing medical standards and found the International Classification of Functionality (ICF) to be suitable for our purpose. We applied the Clinical Vignette to the framework and

developed the ICF Patient Card (IPC). During this iteration, we also updated Components and Artifacts previously created.

Iteration 4 – Design of Artifact 4 (CCMC)

Using our work to date, we consolidated our knowledge and analyzed our framework for existing gaps by examining the Collaboration Space Model once again. Once again, we applied the Clinical Vignette, and a gap related to *context* emerged. In response to this, we devised a novel Artifact based on the Business Canvas Model (Osterwalder et al., 2010), which we applied to our specific application. We then updated the Artifacts and Components of our framework. It is during this final iteration that we also validated our framework with a group of professionals in an Expert Panel Review. Finally, in Iteration 4, we consolidated our learnings from previous iterations into a succinct theory as presented in Chapter 5.

3.3 Chapter Summary

In this Chapter, we provided the motivation for our research, which subsequently lead to the creation of our three research questions:

1. How can the Collaboration Space Model described by Eikey et. al. be further extended or improved-upon to address performance management of collaborative care teams?
2. What are the elements of a performance management framework for collaborative care teams?
3. How can we define better "Artifact" support (technology) for performance management of collaborative care teams in order to measure their performance?

We subsequently provided a summary of the research methodology that was followed in this thesis, Design Science Research Methodology. We also described provided a detailed description of the design iterations.

4 Problem Definition

In this chapter, we use an example from current practice to highlight current state of healthcare collaboration. We identify gaps in current practice and subsequently generalize these gaps. We then determine how related research has attempted to address those gaps. This is followed by establishing a set of evaluation criteria that is used to validate our framework.

4.1 Current State of Healthcare Collaboration

We define healthcare collaboration as a spontaneous or planned engagement in which a collaborative care team works towards common, shared goals on behalf of a patient. In this thesis we assume a collaborative care team are individuals from different organizations who come together and need to communicate as they care for the patient over a finite period of days, weeks, or months. The team can include members who are not healthcare professionals that are relevant to the care of the individual (e.g., social workers, priests, and teachers) as well as the patient.

The "Swiss cheese" model in Figure 4-1 illustrates how errors specific to healthcare collaboration can occur, and is based on the accident causation model described by Reason (Reason, 1990). The four vertical slices in Figure 4-1correspond to the four quadrants identified in the Collaboration Space Model that are critical to healthcare as described in Section 2.9.1 Reason likened human systems to layers of Swiss cheese, stacked side by side. These represent defenses against collaboration issues. There may be flaws in each of the layers, but errors are mitigated because there are subsequent layers that act as defenses. However, when the flaws in the defenses line up, it leads to collaboration error. The dark (active) holes are collaboration gaps. Examples of collaborative care issues that can lead to errors include ineffective coordination

related to Processes, misaligned goals related to Outcomes, communication breakdown related to Context, and cognitive overload related to Technology.

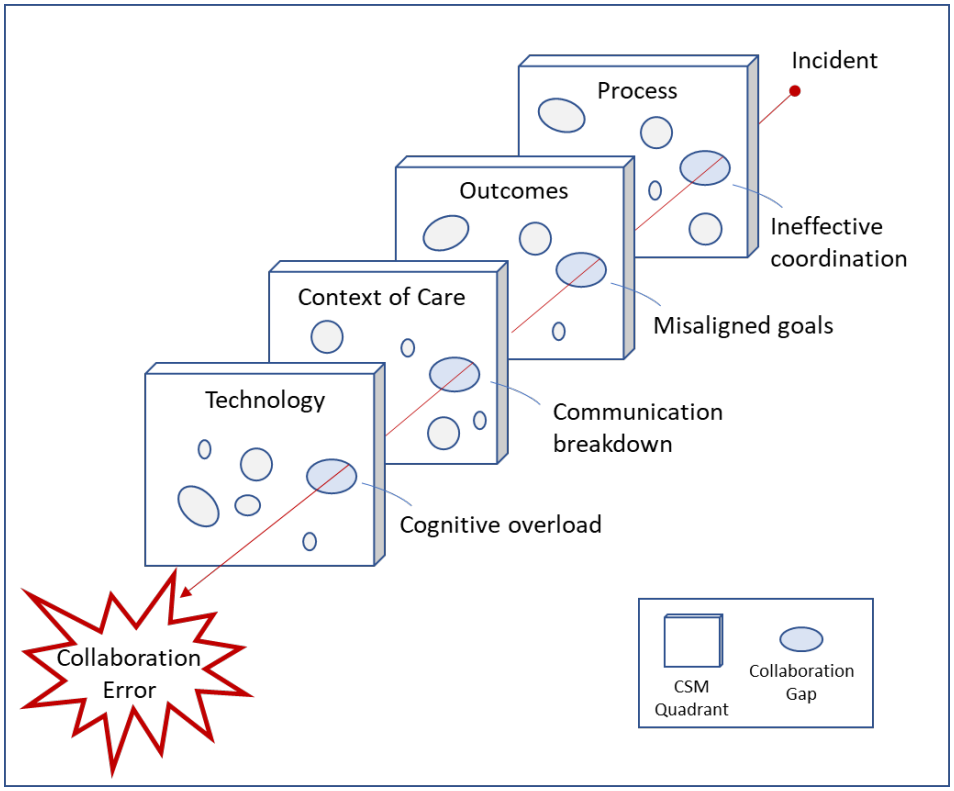


Figure 4-1: Swiss Cheese Model of Healthcare Collaboration Errors

If we take the treatment of ADHD as an example of healthcare collaboration, a collaborative care team might consist of a family physician, a psychologist, a pharmacist, a teacher, and a parent for a child who is the patient. The role of the physician is to diagnose, prescribe medication, recommend community resources for behavior and support (such as psychologists. pharmacists, teachers, and caregivers), for on-going monitoring of the patient's progress (Canadian ADHD Practice Guidelines, Third Edition, 2011). Below, we illustrate Figure 4-1 using ADHD treatment as an example.

Ineffective Coordination

The physician relies on the parent for salient information regarding the efficacy of the drug, and/or behavior treatments. The psychologist, as an allied health professional, is involved and generally communicates with the parent, the child, or with the physician on an as-needed basis. The pharmacist plays the role of a fulfiller of prescriptions and does not take active part in the process. Even if the educator, for example, is present and available, their communication is largely on an ad hoc basis with the parent for information and guidance. Coordination of treatment is ad hoc and difficult for the patient to coordinate, supported by only the occasional in-person interaction with the physician.

Misaligned Goals

There may be a bias reported by parents or teachers in the data in favor of a specific diagnosis (to medicate). Physicians may have biases towards the type of treatment. For example, some may prefer not to medicate and will try other methods before prescribing ADHD drugs. The psychologist does not consider other factors that may be impacting responses such as basic health and comorbidities, since these are the domain of the physician. Other considerations include the quality of care at home (e.g. nutrition, sleep, routine) at home, which can result in symptoms mimicking ADHD, which patients may not reveal.

Communication Breakdown

The management of the diagnosis and treatment of ADHD is unwieldy and may not necessarily include all the stakeholders when needed. For example, the educator or guidance counselor plays an important role in ensuring that in class observations are captured and reported on. Since the diagnosis and treatment cycle is typically long for ADHD, that these actors may not be part of the team over the whole process and results in communication breakdown.

Cognitive Overload

Typically, first indications of ADHD are noticed by parents, or flagged by teachers, who bring their concerns to a family doctor, who then refers the child to a specialist. This specialist is usually a psychologist who can administer diagnostic tests such as the DSM-V. To administer these tests, information is reported based on observation. While the tests are formal in that they follow a particular diagnostic method, the data used to make diagnosis is often anecdotal and is based on memory of events that have occurred in the past several months or years. Thus, both the quality and quantity of information required to be pieced together produced cognitive overload for practitioners.

Collaboration Error

The team is not optimized, and collaboration errors may result in: unnecessary exposure to drugs through parent pressure to medicate; lost time in school due to delays in treatment; possible exacerbation of underlying conditions; increased time to differential diagnosis or comorbidities; possible misdiagnosis; increased frustration for all team members especially the patient; increased mental health concerns such as depression and suicide.

4.2 Gap Analysis

Our gap analysis focuses on the lack of artifact support for performance management of collaborative healthcare, since this is our thesis focus. Healthcare is complex and we are not attempting in this thesis to address those areas that are a matter of medical knowledge (e.g., which medications to use or not use in the treatment of ADHD). Our focus in on healthcare collaboration.

4.2.1 Generalization of Gaps

The above ADHD example can be generalized to identify gaps (Kahn, 2004). The most important gaps are grouped below according to the Collaboration Space Model (Eikey et al., 2015).

1. **Technology**
    a. Current processes do not lend themselves to continuous relationships and often disrupt the patient-provider relationship because of the **cognitive load** and the amount of time available to manage each patient. We refer to cognitive load as the amount of information that working memory can hold at one time. Systems are needed to provide all members of the collaborative care team with real time information that is shared but not overwhelming.
    b. In cases where information may be available, it cannot be accessed in real time, or using convenient technology such as email (rather it is common practice to use fax as a method of communication). Records are also currently paper-based with electronic adoption slow and encumbered by policy. Currently, communications occur in person, by fax, and occasionally by phone. This can cause delays and/or critical information not being shared at all.
    c. Currently there is an assumption of quality of care, however there are very few, if any, processes/systems available to measure such progress. It is difficult to know if you are doing a good job collaborating since it is difficult to measure this.

2. **Process**
    a. Currently the model is for meetings to take place with the patient and caregiver, whereas it is far more effective for meetings to take place with the whole healthcare team. Team meetings may not be well coordinated for this reason.

b. Care tends to be mostly reactive whereas a prevention-oriented mode of care would be more beneficial.

c. We also see that care is fragmented with information and processes being out of phase and causing delays. An integrated system would be beneficial to streamline care. For example, some team members may be temporary, which results in case files begin neglected, de-prioritized, or dropped.

3. Context

a. The team does not act with a holistic view of the patient. The effect on the patient's health by their community is currently unaccounted for by current practices. For example, the mental health of a family member such as a mother may be affecting the child and causing or exacerbating ADHD symptoms.

b. In many cases, patients do not know what services or treatments are available to deal with their issues. The ability to understand the provider commitments would be beneficial. In the same way, patient commitment (an understanding of patient responsibility) to the care process is also necessary.

4. Outcomes

a. There are currently no standardized documents that allow a team view of the treatment plan in a unified, understandable, usable, and simple way.

b. Lack of collaboration also leads to haphazard management of chronic diseases, whereas collaboration could be more organized and systemic through the establishment of common goals and outcomes. Team members may be unaware of the context that each professional is working in. As a result, they are often unaware, on an ongoing basis, of each other's progress.

4.2.2 **Related Works**

The related works described in 2.9 have made some progress in addressing these gaps in performance management of collaborative care teams. That progress is summarized below.

1. **Collaboration Space Model**

   The Collaboration Space Model identifies the four essential aspects that need to be addressed to better support collaborative care: process, common ground, outcomes and technology (Eikey et al., 2015). However, more details need to be elaborated with clear guidelines for specific domains (e.g., ADHD) to follow in practice.

2. **Agile Healthcare**

   In developing guiding principles to improve healthcare based on agile approaches (Tolf et al., 2015) articulated several characteristics that are important to hospitals and their interaction with community organizations that are involved in patient care. These characteristics include: inter-organizational links that are transient and transparent; sensitivity to the business of healthcare and its "customers" (e.g. patients); support for self-organizing teams; departmental structures that can act "organically" (e.g. spontaneously and semi structured) as required; and the requirement for flexible resource capacity (especially human) to deliver timely care. However, these characteristics were described in a general fashion without application to any specific type of ailment or healthcare team. More details need to be elaborated with clear guidelines for specific spheres of care to follow in practice.

3. **Measuring Healthcare Outcomes**

   Michael Porter states that the value that healthcare practitioners provide should be based on results (outputs) and not on the volume of care services (inputs). Outputs are measured by outcomes. In order to achieve more consistent and effective performance measurement, the Outcome Measures Hierarchy (Michael E. Porter, 2010) proposed a focus on outcome measures based on a) the health status achieved, b) the process of recovery, and c) the sustainability of health. The measurements are described and organized with examples. However, there is no specific technology artifact defined for capturing, measuring, and communicating these for performance management.

4. **Teamwork and Collaboration**

   Teamwork and Collaboration related work (Xiao et al., 2013) provides a process-outcome framework for studying team performance and coordination, which integrates the structure of teams, team processes and team outcomes and measures. The framework is useful in providing a structure for addressing teamwork and collaboration. The authors also provide an existing case study of the Team Strategies & Tools to Enhance Performance and Patient Safety (TeamSTEPPS), a widely used curriculum to train healthcare worker in collaboration. The authors use TeamSTEPPS to demonstrate part of their framework in which they highlight the use of structured processes through team briefings, checklists, and other structured tools to improve team performance. While these are useful as methods to improve some aspects of collaboration, their quantification of performance enhancement is not provided.

4.3 Evaluation Criteria

This chapter documents the list of evaluation criteria we identified in order to evaluate any solution that would be relevant to artifact-supported performance management of collaborative care. Each criterion has an associated evaluation question that should be answered to determine to what extent the evaluation criteria is met. This evaluation question is used to assess our framework and related works in Chapter 6. A rubric for each question is also provided in Chapter 6. The set of evaluation criteria identified in this section were determined by:

1. A careful review of various related works and other publications on healthcare collaboration in our survey of the literature.
2. Feedback and discussions from our interactions with domain experts in healthcare, Professor Craig Kuziemsky and Dr. Cheryl Netterfield.

    a) Dr. Kuziemsky is the University Research Chair in Healthcare Innovation and the Masters in Health Administration Program Director at the University of Ottawa. His research interests involve developing new information and communication technologies for process and information effectiveness in collaborative teams involved in complex decision making and who are located at different venues. Dr. Kuziemsky is one of the authors of the Collaboration Space Model.

    b) Dr. Cheryl Netterfield is a retired family physician with decades of experience with collaborative care in the Canadian Armed Forces, who is now an active consultant, researcher and entrepreneur in functional assessment for

collaborative care using the ICF. Dr. Netterfield is an expert in applying ICF in practice.

We created three main groupings of the nine criteria: Team Effectiveness, Data Effectiveness and Coherent Care.

4.3.1 Team Effectiveness

Team Effectiveness is evaluated by those criteria that relate to the capacity of the collaborative care team to accomplish its goals or objectives. The evaluation criteria related to this criteria group is shown in Table 4-1, and is described below.

Table 4-1: Team Effectiveness Evaluation Criteria

Criteria Group	Criteria		Evaluation Question
Team Effectiveness	1	Decrease in cognitive load on team members	Theory, method, algorithm, or implementation, that will lower the cognitive load on a team, is/are provided.
	2	Measurable view of collaboration	Theory, method, algorithm, or implementation provided to capture, and report performance metrics related to team collaboration.
	3	Changes quickly assimilated into the care process.	Theory, method, algorithm, or implementation demonstrates how to characterize and respond to patient-level changes.
	4	Support for transparency of the whole collaboration environment.	Theory, method, algorithm, or implementation support the ability for relevant aspects of the collaboration environment to be available and communicated.

4.3.1.1 Decrease in cognitive load on team members

The framework should enable a decrease in the cognitive load related to collaboration of team members (Xiao et al., 2013). This can include a shared and organized understanding of the pertinent parameters related to the team's common work such as diagnosis, problem solving and treatment. Also, a shared understanding of goals and tasks is required as the division of labor in

most work settings may prevent team members from understanding other people's tasks. Yet another factor to lowering cognitive load is enabling team members to be aware of events and situations confronting others, thus allowing effective anticipatory behavior. Therefore, the framework will enable the team to coordinate without explicit communication efforts, allowing the reduction in cognitive burdens in coordination. Finally, the framework should help the team leader to enable the team to accomplish their tasks and enable the effective functioning of the group.

4.3.1.2 **Measurable view of collaboration**

The framework should have the ability to measure the performance of team collaboration using a set of key performance indicators (KPI). These metrics include aspects of collaboration such as scheduling, task completion status, etc. KPIs should be specific, measurable, attainable, realistic and time-sensitive (SMART) (Shahin & Mahbod, 2007). These KPIs should be relevant both team members and team managers.

4.3.1.3 **Changes quickly assimilated into the care process**

In an agile healthcare organization, collaborative teams are created as needed in response to patient demands (Tolf et al., 2015). Tolf et al. report that an agile organization requires less rigid, organic organizational structures that have a lower degree of centralized control. In short, support for elastic and responsive teams. We further extend this ability to the team to be able to shift its focus to respond to patient needs as they become apparent (Tolf et al., 2015). Gao et al describe collaborative care as dealing with the assortment of roles in a multidisciplinary team, along with activities and events corresponding to them. They also agree that there should be support for unexpected occurrences and exceptions (Gao, Briggs, Thiebes, & Sunyaev, 2019).

Furthermore, Gao et al describe timeliness as one of the most critical aspects of success in collaboration (Gao et al., 2019). For our framework, timeliness refers to the ability to respond in the most optimal timeframe to a variety of collaboration events in response to patient care events.

4.3.1.4 **Support for transparency of the whole collaboration environment**

Multi-level collaboration context is important as team members may be from different organizations with different cultures, interests and goals (Gao et al., 2019). Understanding the context of care allows team members, and especially patients, to assess where to place their attention, what assumptions to draw about what is being communicated, and to understand something on a deeper level. These factors allow collaboration to occur more smoothly. Team members should be aware of the roles, tasks and responsibilities of other members, as well as constraints (ex. organizational rules, capabilities, etc.) that they may be operating within. This includes support of awareness of team members' current status of activities, care milestones, goals, etc.

4.3.2 **Coherent Care**

Coherent Care in the context of team collaboration refers to the grouping of criteria that relate the team's ability to function in a seamless, consistent and effective fashion (Xiao et al., 2013) (M.E. Porter, 2010b). The evaluation criteria related to this criteria group is shown in Table 4-2, and is described below.

Table 4-2: Coherent Care Evaluation Criteria

Criteria Group	Criteria		Evaluation Question
Coherent Care	5	Concept clarity to ensure common understanding.	Theory, method, algorithm, or implementation, that will allow terms and concepts to be understood by all team members in the same way, is/are provided.
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.	Theory, method, algorithm, or implementation demonstrates that non-clinical criteria are used in diagnosis and treatment of patient.
	7	Coordinated care plan	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.

4.3.2.1 **Concept clarity**

Medical concepts, terms, statements or indicators may be difficult for all team members to grasp in the same way. A collaborative team must be able to communicate effectively with a common understanding of these (Gao et al., 2019). The solution should support media that lowers the cognitive of load of communication. Images, flowcharts and video are examples of media that can be used simplify and clarify medical explanations, patient records, and other human communication (Gao et al., 2019). For example, a treatment plan can be communicated to the team using common language charts and images.

4.3.2.2 **Whole-person view of care**

Collaborative care should encompass activities that are not just strictly medical such as reaction to drugs, but support different modalities such as social, clinical and functional care. In this way, it should support a whole-person centric view (Michael E Porter, 2010).

4.3.2.3 Coordinated care plan

The delivery of care involves a multitude of organizational units that work together to provide service for patients. These range from hospitals to physician's offices allied professionals. The way to measure performance is to integrate all of the activities that need to take place to provide care into patient outcomes (Michael E. Porter, 2010). Relevant and pertinent information must be shared by the team. This relates to the type and quality of information. Daub et al describe the need for a single coordinated care plan for patients, families and their healthcare providers, over a continuum care that is consistent regardless of geographic location of care (Daub et al., 2016). Thus, the framework should also support collaboration that is independent of location of the patient to facilitate consistent care.

4.3.3 Data Effectiveness

Data Effectiveness in the context of team collaboration refers to the grouping of criteria that relate the availability of the required data and its proper use in the context of collaborative care. We derive this criteria from the healthcare outcomes measures body of work by Porter (M.E. Porter, 2010b, 2010a; Michael E. Porter, 2008). The evaluation criteria related to this criteria group is shown in Table 4-3, and is described below.

Table 4-3: Data Effectiveness Evaluation Criteria

Criteria Group		Criteria	Evaluation Question
Data Effectiveness	8	Information is seamless and flows transparently between members and other stakeholders.	Theory, method, algorithm, or implementation support the ability for usable and relevant data to be shared between team members in a timely and effective manner.
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.

4.3.3.1 **Information is seamless and flows transparently**

Information is seamless and flows transparently between members and other stakeholders (Eikey et al., 2015) (Michael E Porter, 2010). The PMFCC should allow for the effective flow of collaboration-related information between team members (Eikey et al., 2015). Daub et al also discuss the importance for a patient to be able to communicate with the care team 24/7 (Daub et al., 2016).

4.3.3.2 **Integrated and relevant healthcare team collaboration information**

Information may be gathered from disparate and/or fragmented sources and includes support for data-active collaboration technology (Eikey et al., 2015) (Tolf et al., 2015). For example, collaboration-related information may be gathered from a variety of sources such as wearables, IoT, apps, etc. A solution should be able to gather information from geographically remote locations, as well as account for digital and analog sources of information (Eikey et al., 2015).

4.3.4 **Summary of Evaluation Criteria**

Table 4-4 provides a summary of the criteria used to evaluate our framework. Descriptions of each of the 9 criteria were provided in the previous section.

Table 4-4: Summary of Evaluation Criteria

Criteria Group	Criteria		Evaluation Question
Team Effectiveness	1	Decrease in cognitive load on team members	Theory, method, algorithm, or implementation, that will lower the cognitive load on a team, is/are provided.
	2	Measurable view of collaboration	Theory, method, algorithm, or implementation provided to capture, and report performance metrics related to team collaboration.
	3	Changes quickly assimilated into the care process.	Theory, method, algorithm, or implementation demonstrates how to characterize and respond to patient-level changes.
	4	Support for transparency of the whole collaboration environment.	Theory, method, algorithm, or implementation support the ability for relevant aspects of the collaboration environment to be available and communicated.
Coherent Care	5	Concept clarity to ensure common understanding.	Theory, method, algorithm, or implementation, that will allow terms and concepts to be understood by all team members in the same way, is/are provided.
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.	Theory, method, algorithm, or implementation demonstrates that non-clinical criteria are used in diagnosis and treatment of patient.
	7	Coordinated care plan	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.
Data Effectiveness	8	Information is seamless and flows transparently between members and other stakeholders.	Theory, method, algorithm, or implementation support the ability for usable and relevant data to be shared between team members in a timely and effective manner.
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.

4.4 Chapter Summary

In this chapter, we identified the current state of healthcare collaboration. We provided a gap analysis of the current practice of ADHD diagnosis and treatment. We then articulated gaps that were described in the related works literature. Finally, we provided criteria for evaluation of our Performance Management Framework (PMFCC) for Collaborative Care.

5 Performance Management Framework for Collaborative Care

In this chapter, we present our proposed Performance Management Framework for Collaborative Care (PMFCC). The PMFCC consists of 2 major groups: Components (Collaboration Space Ontology Template, Agile Process Model, and Performance Management Model) and Artifacts (Agile Treatment Plan, Agile Collaborative Dashboard, ICF Patient Card, and Collaborative Care Model Canvas). Section 5.1 provides an overview to the whole framework, while Section 5.2 describes each Component in detail. Section 5.3 details the Artifacts and includes Section 5.3.5 that provides an overview of the relationships between the Artifacts when they are used together.

5.1 Overview

5.1.1 Lens of Analysis

The starting point for PMFCC is the lens of analysis provided by the related work Collaboration Space Model (Eikey et al., 2015) as shown in Figure 5-1 below. "Team" aspects are covered under Context, "Working Towards" under Process, "Shared Goals" under Outcomes, and "Using Supports" under Resources. This is particularly important in Section 5.2.1 Collaboration Space Ontology Template and Section 5.2.3 Performance Management Model. We also integrate into this an agile perspective as described in Section 2.6, which is important to Section 5.2.2 Agile Process Model.

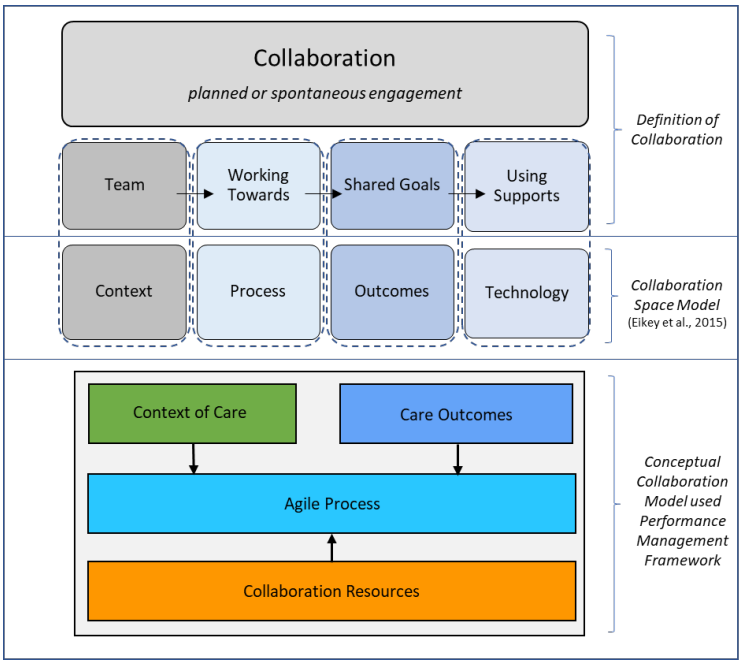


Figure 5-1: Conceptual Collaboration Model Used in PMFCC

5.1.2 Objective of the PMFCC

The PMFCC is derived from a set of concepts from medicine, engineering and business that are applied to healthcare and organized into a coherent theory. The objective of the PMFCC is to provide a way to objectively measure collaboration aspects of teams in community care. The Components and Artifacts of the PMFCC are shown in Figure 5-2.

Components	Collaboration Space Ontology Template
	Agile Process Model
	Performance Management Model
Artifacts	Agile Treatment Plan
	Agile Collaboration Dashboard
	ICF Patient Card
	Collaborative Care Model Canvas

Figure 5-2: Performance Management Framework for Collaborative Care

Collaboration Space Ontology Template (CSOT). The CSOT is a conceptual model for understanding key aspects of collaboration in healthcare. The Collaboration Space Ontology Template is intended to provide a common vocabulary and encompasses factors related to process, outcomes, context, and technology. We introduce a notation and diagram for this model which is presented in Section 5.2.1.

Agile Process Model (APM). Agile software principles are applied to healthcare to yield a process model that facilitates effective collaboration. This is provided in Section 5.2.2.

Performance Management Model (PMM). The PMM is a conceptual model that is based on Balanced Scorecard principles. Performance objectives for collaborative teams are articulated in this model in Section 5.2.3.

Artifacts. Four key Artifacts that support collaborative care are found in Section 5.3. These are the technologies that support the PMFCC: Agile Treatment Plan (ATP) in Section 5.3.1, Agile Collaboration Dashboard (ACD) in Section 5.3.2, the ICF Patient Card (IPC) in Section 5.3.3, and the Collaborative Care Model Canvas (CCMC) in Section 5.3.4.

5.2 Components

In this section we discuss the Collaboration Space Ontology Template, the Agile Process Model, and the Performance Management Model. These are the three base Components of the PMFCC.

5.2.1 **Collaboration Space Ontology Template**

We propose a Collaboration Space Ontology Template (CSOT) for artifact-supported performance management of collaborative care based on the Collaboration Space Model (as described in Section 2.9.1).

5.2.1.1 **Methodology**

Many methodologies exist to define ontologies (Casellas, 2011). Initially, we were inspired by the Toronto Virtual Enterprise (TOVE) methodology (Gruninger & Fox, 1995) who provide a mechanism to guide the design of ontologies as described in Section 2.5.2. While the TOVE methodology was informative, we decided to use the ontology development methodology proposed by Noy (Noy & McGuinness, 2001) instead. Since our framework will eventually be implemented as an HIT, Noy's methodology is more appropriate as it is a recommended method by HL7 that defines a set of standards for the exchange, sharing, retrieval and integration of electronic health information (Benson & Grieve, 2020). Furthermore, the seven steps described in the methodology were well arranged and clear cut, and more specific than other methods based on our literature search.

It is our contention that HIT for performance management to support collaborative care delivery is a complex sociotechnical endeavor and design must start well before the development and implementation of technology. Our work reaffirmed that collaborative care delivery is not a static entity and that HIT design to support it is really a negotiation across individual needs and processes that ultimately must be reconciled into a collaborative workflow, supporting the individual-collaborative interchange. It was beyond the scope of this thesis to build a complete formal ontology applicable across all healthcare domains. Our attempt was to investigate, elaborate and develop the Collaboration Space Model so that an ontology template could be

defined for artifact-supported performance management of collaborative care. That template would serve as a generic guide or example that could be used as a basis to define more comprehensive and formal ontologies in specific healthcare domains. Thus, we focused on Steps 1 to 4 of Noy's methodology as described here:

Step 1 - Define the domain and scope: The goal in this step is to clarify the domain covered by the ontology, the reasoning for it, and the target audience the kinds of questions that the ontology is responding to. We defined the domain and scope as focused on artifact-supported Performance Management. We focused on ADHD (section 2.4) and a well-defined case from the literature as an example of collaborative care in order to discover and validate the relevant terminology. The well-defined case, a Clinical Vignette, is described in section 6.1.

Step 2 - Reuse Existing Ontologies: Step 2 of Noy's methodology proposes the use of existing ontologies, taxonomies, and/or standards.

- **Collaboration Space Model:** The Collaboration Space Model (CSM) provides a set of terminology and definitions that support the model which comprises Technology, Context, Outcomes and Processes (Eikey et al., 2015). The CSM is the foundation of our CSOT.
- **Scrum:** Scrum and its variations are the most widely used implementation of an agile process (Rigby et al., 2016). We used the well-defined Scrum process to inform our Agile Process category in the CSOT.
- **The Balanced Scorecard:** Balanced Scorecard (BSC) is a tool for performance management (Robert S. Kaplan & Norton, 1992). We used the well-defined BSC to inform our understanding of the new categories of Artifacts and Goals of Care in the CSOT.
- **International Classification of Functionality:** The International Classification of Functionality (ICF), provides a standard language and framework for the description of

health and health-related states ("WHO | International Classification of Functioning, Disability and Health (ICF)," 2017). We used the ICF to inform our understanding of the new category Goals of Care in the CSOT as well as the ICF Patient Card Artifact (one of the examples in the new category Artifacts).

- **Business Model Canvas:** The Business Model Canvas (BMC) is well known tool for describing the various components of an organization's business (Osterwalder, 2004a). We used the Business Model Canvas to inform our understanding of the new categories of Supporting Services and Collaboration Technology in our CSOT as well as the Collaboration Care Model Canvas (one of the examples in the new category called Artifacts).
- **CADDRA Guidelines:** The Canadian ADHD Practice Guidelines for the diagnosis and treatment of ADHD represent the de facto standard for healthcare practitioners across multiple specialties (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). We used these guidelines extensively in our development of the Clinical Vignette (Section 6.1), which was the basis for our development and validation of much of the terminology in our CSOT.

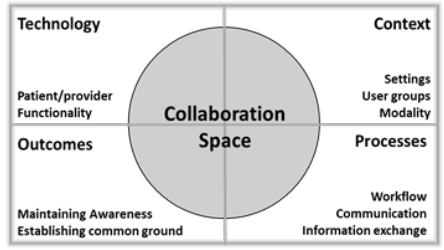
Step 3 - Identify a list of relevant terminology used to describe the domain: In this section, we provide the relevant terms we would like to discuss, and their properties. This makes it easier for the users to comprehend and use the ontology. The relevant terms are shown in Figure 5-3.

Step 4 - Define the entities and their relative hierarchy: In this step, we organize the terms captured in step 3. The CSOT is a four-level hierarchy and is shown in Figure 5-4.

Steps 5 to 7 - Define the attributes and data types of the entities identified in Step 4, and create instances: Step 4 was critical in ensuring that we had the proper structure and relationships in place for a general template. Steps 5-7 are needed to have enough detail for building specific ontologies for specific domains and for generating and building software implementations of our Artifacts described in Section 5.3. However, specific ontologies and their software implementation was beyond the scope of this thesis, so steps 5-7 are left for future work. Standard definitions found in the Fast Healthcare Interoperability Resources (FHIR) may be relevant in this future work. FHIR is a well-known standard framework used for the exchange of electronic healthcare records. It supports central and distributed networked environments (Benson & Grieve, 2020) and would be suited for our application.

5.2.1.2 Terminology and Hierarchy

In Figure 5-3 below, we show the Collaboration Space Model on the left and our proposed CSOT on the right. New additions beyond Collaboration Space Model are identified in red text. Refinements to existing elements of the Collaboration Space Model are shown in turquoise text.



Collaboration Space Model	
Processes – *essential collaborative processes*	
	Workflow
	Information Exchange
	Communication
Context - *where a system is used*	
	User Groups – *who work together*
	Settings – *ex. Inpatient, community, mixed*
	Modality – *ex. Synch. Asynch., mixed*
Outcomes – *goals of what successful HIT should do in collaborative settings*	
	Establishing Common Ground
	Maintaining Awareness
Technology – *focus of the design of the HIT*	
	Patient/provider
	Functionality

Collaboration Space Ontology Template Performance Management of Care (ADHD)		
Agile Process – essential collaborative processes		
	Workflow *consists of:*	Treating, Consulting, Tracking
	Information Exchange *occurs when we:*	Establish Patient Outcomes, Establish Treatment Plan, Implement Treatment Plan
	Communication *occurs when we engage with/in:*	Scheduled Meetings, Unscheduled Meetings, Formal Notes, Treatment Dashboard
Context of Care – where a performance management system is used		
	Role who works on the care team:	Team Leader, Team Member, Clinician, Patient, Family Member, Psychologist,, Healthcare Teams Manager
	Setting of Care *takes place at:*	Clinician's Office, Psychologist Office, Home
	Modality of Care *occurs through:*	In Person Care, Remote Care, Synchronous Communication, Asynchronous Communication
Care Outcomes – how a performance management system supports outcomes		
	Goals of Care *are defined in terms of:*	Functionality, Team Objectives
	Establishing Common Ground *is defined by availability and use of:*	Treatment Guidelines, Best Practices, Healthcare Standards, Training, Organizational Structure
	Maintaining Awareness *is achieved by:*	Protocols, Reminders, Alerts
Collaboration Resources – focus of design of performance management HIT		
	Artifact *supports collaboration with:*	Standardized Forms, Standardized Dashboards, Standardized Indicators
	Collaboration Technology *supports collaboration using:*	Telecopy (fax), Email/Calendar, Mobile App, Video Conference, Audio Conference, SMS/Text Messaging,
	Supporting Services *are provided by:*	Advocacy Groups, Professional Organizations, Regular Mail/Courier

Figure 5-3: Relationship Between CSM and CSOT Terminology

The terminology shown in Figure 5-3 was then visualized to demonstrate the relationships between the elements. Figure 5-4 shows a four-level category hierarchy, as well as the relationship between the Level 2 categories. Levels 1, 2 and 3 have been validated, are integral to the PMFCC, and cannot be modified. Elements in Level 4 will be refined, changed, or expanded depending on the healthcare domain. We provide a set of elements here that have been substantiated using the Clinical Vignette and scenarios provided in Chapter 6.

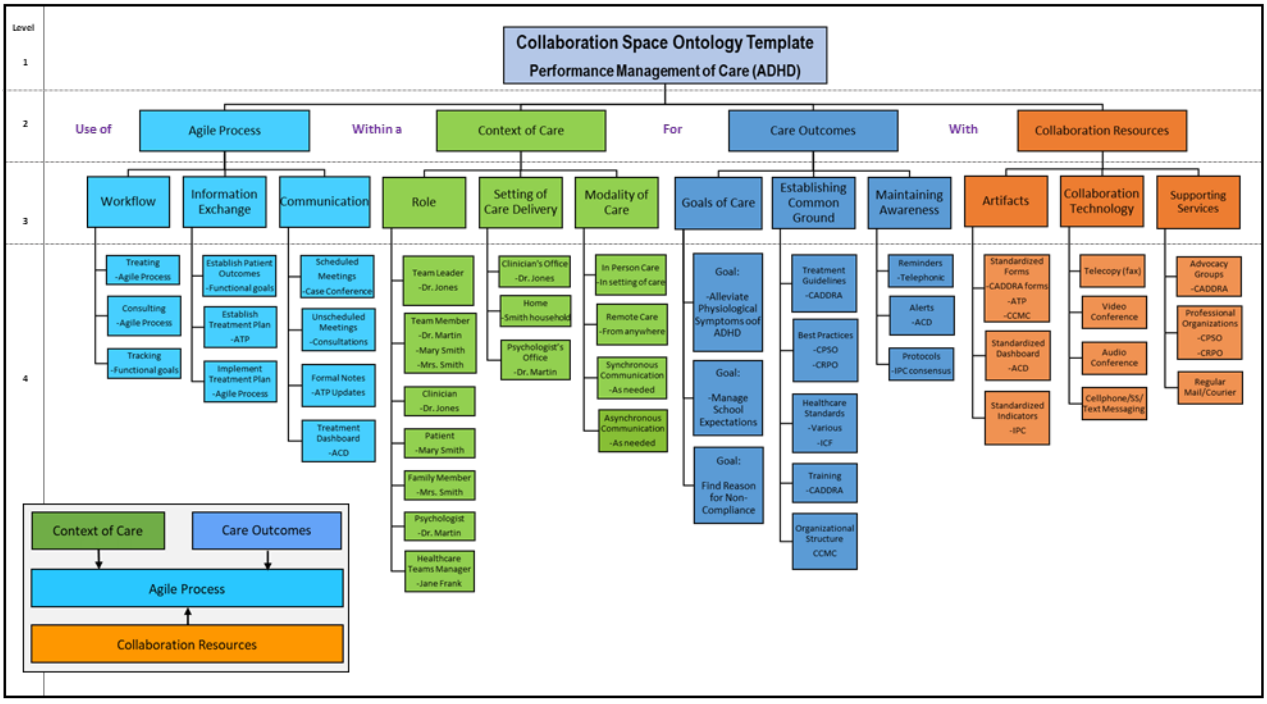


Figure 5-4: Collaboration Space Ontology Template Hierarchy

Within the context of a collaborative care engagement, the **Agile Process** category describes aspects related to: practitioners' professional activities (Workflow); the series of actions that occur in a team to provide patient care (Information Exchange); how treatment information is conveyed (Communication).

The **Context of Care** category provides the circumstances for a collaboration event: the geographic and organizational setting (Setting); the role of the team members (Role); and whether care is being administered remotely by a practitioner, on site by a practitioner, or by the patient (Modality of Care). Synchronous and asynchronous communications are also considered under Modality of Care.

The **Care Outcomes** category refers to the desired end-result of a collaborative care engagement and consists of two main categories: Establishing Common Ground and Maintaining

Awareness. Establishing Common Ground refers to the body of medical knowledge in place to ensure that all members of the team share the same ideas and have a collective understanding of desired end-result for the patient. Maintaining Awareness refers to the practical mechanisms required to ensure that team members can communicate relevant patient information on an ongoing basis.

Finally, the **Collaboration Resources** category contains three subcategories. The Collaboration Technology enumerates available technologies that enable communication between team members. Supporting Services refers to service resources and partner groups that assist in care delivery, such as advocacy groups and professional organizations. Finally, Artifacts refers to the technology instantiations that will be implemented for the specific purpose of supporting the framework. Artifacts support collaboration with standardized forms, dashboards and indicators. Artifacts are used to collect and communicate data related to the Performance Management Model.

5.2.2 Agile Process Model

We proposed an Agile Process Model to define a systematic approach for organizing, coordinating and managing the performance of collaborative care teams drawing on agile principles and the example of Scrum (as described in section 2.6.4).

The Agile Process Model coordinates and systematizes the team's work. Team interactions occur synchronously and asynchronously over a prolonged period like weeks, months or years, and handoffs between team members are often not sequential. More accurately, the team relies on iterative feedback as the patient's case evolves over the span of the medical condition. The Agile Process Model emphasizes frequent and timely communication, which is a key factor to the success of the team's goals. It emphasizes the articulation of common goals and the sharing of relevant knowledge. It also lowers one type of cognitive load on the team by enabling the team to

follow a common, structured and streamlined process. We begin our walkthrough of the APM by providing a mapping of the relevant aspects of Scrum elements (from Figure 2-4) to healthcare collaboration as shown in Table 5-1.

Table 5-1: Mapping of Scrum to Agile Process Model

Scrum		Agile Process Model
Scrum "artifacts"	Product Backlog	Treatment Guidelines
	Sprint Backlog	Agile Treatment Plan Agile Collaboration Dashboard
	Delivered Increment	Care Outcomes
Scrum events	Sprint Planning	Treatment Planning
	Sprint Review	Case Conference
	Sprint	Treatment Sprint
	Sprint Retroactive	Treatment Review
	Daily Stand-up	Consultations

The agile process described in Figure 2-4 is analyzed and adapted to collaborative care to yield the Agile Process Model (APM) for collaborative care as shown in Figure 5-5. The red labels (ATP, ACD, IPC, CCMC) refer to artifacts we will describe in section 5-3 that support the agile process and which collect and communicate data used in the Performance Management Model (PMM) that we will describe in section 5.2.3.

The APM begins in the bottom right corner with a patient who is admitted into the care of a healthcare provider who will serve as a team leader or care coordinator. It ends in the bottom right corner when treatment by the team has concluded, and the patient is discharged. In between, there is a series of Treatment Sprints which begin and end with a Case Conference in which the care team reviews and plans treatment (consulting treatment guidelines as needed) for each Treatment Sprint. The individual team members execute and monitor the treatment aspects they are responsible for during the Treatment Sprint, having individual consultations on an as needed

basis. The care team is self-organizing in that they can set and modify treatment goals and are solely responsible for patient outcomes.

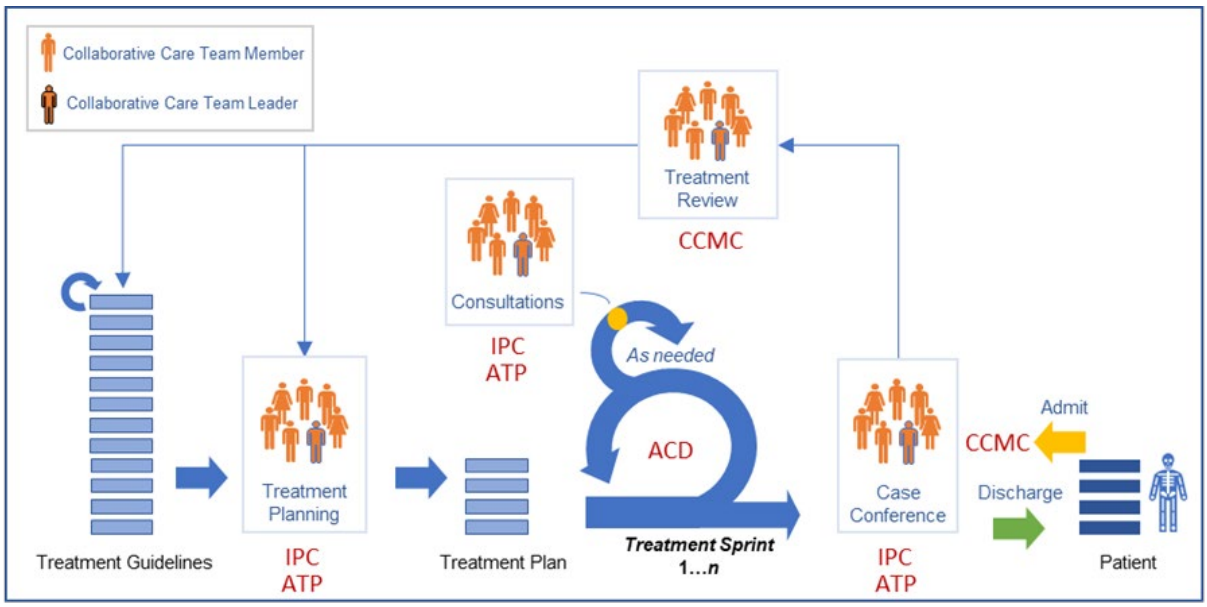


Figure 5-5: Agile Process Model for Collaborative Care

5.2.2.1 Process Walkthrough

In this section, we walk through a typical collaborative care process in more detail to illustrate how the Agile Process Model can be used to understand and structure collaborative care in a systematic manner.

The care team is assembled and convenes a Case Conference in which they discuss the patient status, how the team will organize itself, and which treatment guidelines are applicable. The patient or the patient's representative is always part of the care team in the Agile Process Model. The initial Case Conference is followed by a treatment planning meeting in which the care team decides on what specific areas of the patient care goals they will tackle. The team decides on a time frame to achieve these goals, along with how and when ongoing consultations will take place. As the team embarks on the sprint, they commit to meeting regularly to synchronize their

work, ensure that treatment tasks 1…*n* are on track and to identify issues early in the process. In these meetings, they discuss what was done previously, what they are working on currently, and if there are any obstacles to their progress, and what they plan to work on next. Each member of the team provides information or other assistance to help with obstacles as needed.

Note that the "Daily Stand-up Meeting" in Agile software development process takes place every day for 15 minutes; however, this is unfeasible in healthcare settings. Therefore, we apply this concept to our Agile Process Model by creating a way for the team to be in constant contact using an Agile Collaboration Dashboard. Consultations are described below. Furthermore, we allow the team to meet face to face on a regular basis at interim scheduled Case Conference meetings, (or as needed) to answer three questions:

1. (Agile) What did you do since our last meeting? → Review previous ATP
2. (Agile) What will you currently be working on? → Describe current challenges
3. (Agile) Are there any impediments in your way? → Employ/solicit team assistance

The team is self-organizing and governs itself around the treatment needs of the patient. Each member of the team is a source of expertise in their own disciplines, with the recognition that success can only occur when all members are fulfilling their responsibilities in a coordinated manner. In this way, a primary care physician may at times play a non-leadership/supporting role vis a vis another team member. Because meetings are held regularly, the team can be responsive to any issues that arise during treatment.

Ongoing Consultations may result in an important change to the treatment plan and may trigger a Case Conference. When this happens, the care team is notified, and an informal discussion takes place and the team may be required to pivot by moving some patient goals into the future, adding other goals, or eliminating goals completely. Therefore, whenever a substantive

change to the treatment plan is required, a Case Conference is triggered, and may occur at any time during the sprint. The patient status is evaluated at this point, along with any updates or improvements suggested to improve team collaboration (treatment review). At a Case Conference, the team assesses progress made, updates the treatment guidelines, discusses the next set of goals for the patient and establishes a treatment plan for the next sprint. This cycle continues until all the treatment goals for the patient have been met, which is discussed in a final Case Conference, and the patient is discharged from the care of the provider.

5.2.2.2 **Justification for Scrum**

As described in Section 2.6.1, agile, as a concept, has been applied to many industries. However, its application within healthcare, remains limited (Tolf et al., 2015). We have had professional experience in working in Scrum teams in other industries and drew inspiration from this to inform our Agile Process Model (APM) for collaborative care. We have had to adapt some key principles of Agile and Scrum, to fit the realities of healthcare. For example, the concept of a time-boxed iteration in which a sprint is strictly held to specified time limit is not necessarily viable when it comes to illness, although regularly scheduled follow up visits to check progress is analogous.

It is our contention that medical situations that are multifaceted could benefit from the approach and the organization of scrum. This is especially true in situations where cases are complex, and many different teams are involved in the care of a patient. Scrum is well-suited to address unpredictable challenges that require expert, sustained, and coordinated teamwork. It is especially helpful in managing cross-functional teams which are hallmarks of modern patient care. The treatment of disease is complex because of the combination of diseases, patient attributes and variability in medical staff (Beverungen et al., 2020). Our proposed Agile Process Model provides

a structure for collaborative care that sets the stage for managing the performance of collaborative care teams.

As discussed in Section 2.6.4.1, Scrum is based on experiential knowledge and the ability to make decisions based on what is observed through these experiences, or empiricism. Because of its emphasis on incrementality to control risk, it relies on optimality through iteration. (Schwaber & Sutherland, 2020). When applying these concepts to healthcare, it becomes clear that there is a direct correlation with Scrum in the way a patient's diagnosis and treatment relies on empiricism. Decisions are made incrementally regarding the patient's care based on what has been defined as treatment goals in the past (or, the previous iteration). Treatment goals are re-evaluated, and adjustments made accordingly based on the newer and better understanding of the patient's health.

In developing the Agile Process Model, we focused on the three pillars of Scrum: transparency, inspection and adaptation (Schwaber & Sutherland, 2020), as discussed in Section 2.6.4.1. Transparency refers to requirement that all work must be visible to those performing the work (various healthcare professionals), and those receiving the work (patients). In a team situation for community-based care, this is often difficult to achieve given organizational silos and loosely connected care teams. In the Agile Process Model, key decisions are made based on the state of a shared Agile Treatment Plan as shown in Table 5-1 below. In addition, the Agile Collaboration Dashboard enables real time transparency of information that is critical to awareness of updates to the patient's status. This transparency enables the ability to inspect patient status.

Inspection, the second pillar of Scrum, states that artifacts must be inspected often and conscientiously to identify possible undesirable outcomes, discrepancies, or issues. The Agile Process Model consists of events (shown in Figure 5-5) that allow this inspection to be built into

the process. These events are the Case Conference, Consultations, Treatment Planning, Treatment Review and Treatment Sprint.

Finally, Adaption refers to the ability to react and change course once a deviation from acceptable limits has occurred. This final pillar cannot be realized without teams that are empowered or self-managing as adaptation should be swift and deliberate.

5.2.3 **Performance Management Model**

We propose a performance management model for collaborative care influenced by both Balanced Scorecard (as described in section 2.7.1) and Collaboration Space Model (as described in Section 2.9.1) using the terminology and structure articulated in our CSOT (as described in Section 5.2.1).

5.2.3.1 **Definitions**

We adapt the definitions in Section 2.7 to describe the PMM.

- *Performance measurement* refers to the act of measuring important facets of a team's collaboration processes. This allows us to collect relevant data for the CSOT subject areas of Agile Process, Context of Care, Care Outcomes and Collaboration Resources.
- *Performance measures* are specifically measurable items within our PMM, which we call Key Performance Indicators (KPIs).
- *Performance management* ties both measurement and measures together and is a predictive process that is used to implement and monitor collaboration goals. Performance management highlights deficiencies in monitored processes and uses knowledge gained to improve processes.

5.2.3.2 **Objective**

The PMM enables performance in multiple collaboration areas to become visible. Measurement of performance allows the observer to determine what is working and what is not. The PMM is intended to improve collaboration-related aspects of performance in the areas of planning of care, setting team expectations, continuous monitoring of team performance, developing the capacity to perform, and evaluation of team performance, etc. (OPM.GOV, 2017). The value of the PMM is the focus on improving the efficacy of collaborative care by enabling improved team effectiveness, data effectiveness and coherent care (our criteria groupings).

5.2.3.3 **Characteristics**

There are several important characteristics of the PMM to consider:

- **Mapping to CSOT groupings.** The PMM provides a logical way to articulate performance in collaboration. We use the groupings of our CSOT as a basis for the PMM and identify the associated KPIs.
- **Patient-Centered Outcomes:** Another important focus is based on Porter's concept that value must be centered around patient outcomes (outputs), and not services delivered (inputs) (Michael E Porter, 2010). As described in Section 2.9.3, Porter asserts that outcomes can be measured and describes a three tier Outcomes Measures Hierarchy (Figure 2-8), which we have drawn upon in our analysis.
- **Presentation of Data:** To monitor care processes, data must be collected and reported to measure how well they are meeting quality of care goals. The aim of analytics is to collect, and monitor data generated and perform analysis accordingly. Analysis results can be presented to the users in a simple format such as a dashboard or report which assist them

in decision making. In the PMFCC, we use the Agile Collaborative Dashboard to present KPIs to the team. Other reports are possible and will depend on how the PMM is being used and the target audience.

5.2.3.4 **Assumptions**

- **Mapping to Larger Strategic Goals**: The ability to keep performance management measures realistic comes from respecting the time sensitivity of KPIs through continuous monitoring. Continuous monitoring of KPIs is key to effective monitoring and management of a larger strategic goals. Each strategic goal needs to be linked to these KPIs in order to measure to which extent the performance of the team meats its goals (Craig Kuziemsky et al., 2010).

- **Implementation**: Implementation and associated methodologies for monitoring these KPIs and their relationships with other components of the systems being monitored is not covered in this research but would be useful future research.
- **Candidate KPIs**: This work presents candidate KPIs that are logical and relevant to collaboration. These are candidate KPIs, and others are expected to be defined based on the specific healthcare circumstance.

5.2.3.5 **Usage**

Our framework is intended to describe empirical collaboration aspects by categorizing them in a logical and coherent way (Nilsen, 2015) which may be used both at the team level and at the healthcare organization level.

Team Level

The objective of the PMM is to provide data for near real-time analytics which is used to minimize the time between the occurrence of critical patient situation and the time when an action is initiated in a system (Chieu & Zeng, 2008). It is critical to monitor care processes continuously if they are to be managed in a systematic way. Near real-time analytics of collaboration goal information (such as the status of a patient functionality) will provide information in a timely manner so that team members may respond and take corrective action, especially if care processes are not performing as expected. In general, to support decision making, metrics, charts and alerts should be available in near real-time. Within the context of the PMFCC, the Agile Collaboration Dashboard fulfills this function.

Healthcare Organization Level

The PMFCC is also intended to be used to help a healthcare organization's care operations by aggregating and transforming source collaboration data gathered at the team level. This can be the performance of many aspects and at various levels where collaboration occurs, such as in processes, projects, programs and departments. This data can be used to model, characterize, forecast and segment to achieve tactical and strategic outcomes.

5.2.3.6 **Structure**

The best-known framework for measuring performance in a systematic manner that links business processes to performance management is the balanced scorecard (BSC) (Robert S; Kaplan & Norton, 1996). In the balanced scorecard, SMART metrics (Shahin & Mahbod, 2007) are defined to measure performance for four key perspectives (financial, customer, operational, people) which are depicted graphically as four "Quadrants". The BSC is customized to an organization and links performance and action to an enterprise's strategic measurement and

management. (Robert S. Kaplan & Norton, 1992). The PMM adapts these guidelines to collaborative care. Our "Quadrants" (four key perspectives) are exactly the four quadrants or perspectives defined in our Collaboration Space Ontology Template: Context of Care, Care Outcomes, Collaboration Resources and Agile Process. No single measure can provide a clear performance target on critical areas of Team Effectiveness, Coherent Care or Data Effectiveness. Rather, there must be a balanced set of measures in order to effectively manage collaborative care teams. The Performance Management Model responds to four important collaboration questions:

1. **How do we ensure we are we achieving expected treatment goals as a team?** These outcomes are related to goals of care, establishing common ground and maintaining team awareness. One aspect of this is the use and continuous application of ICF functionality to ensure effective patient outcomes are monitored and articulated. Changes in ICP scores should reflect the ongoing progress of the patient. From a collaboration perspective, changes in an area of functionality reported by one practitioner may impact the treatment provided by another member of the team. The ACD is also used for maintaining awareness to help achieve expected outcomes.
2. **How do we ensure that we are collaborating effectively?** Collaborating effectively can be characterized by how closely the team adheres to its objectives within the context of the Agile Process Model. This includes aspects of workflow, information exchange and communication. This question deals with changes made by the team to the Agile Treatment Plan. These changes involve updating the team to changes in patient treatment status in Agile Collaboration Dashboard. For example, the patient responds very well to a treatment and responds ahead of time. This produces a change in the treatment plan, impacting other

team members, who may be notified by an alert which directs them to the Agile Collaboration Dashboard.

3. **How do we ensure that collaboration context is effective?** The objective is to ensure that the conditions are optimal for successful treatment. Success of collaboration begins with a good plan that outlines the setting of care, roles of each team member and the modality of care (e.g., how will care occur?). This plan is visualized in the Collaborative Care Model Canvas Artifact.
4. **How do we ensure that collaboration resources are effective?** In the context of the PMM, we measure effectiveness of a collaboration resource based on how and how often it is used. Collaboration resources refers to Artifacts that support collaboration, collaboration technology and services that support the team in patient care. Services provided by partner organizations such as hospitals and schools are also included here. Our Artifacts also fall into this category.

Further to Figure 5-4, the Performance Management Model (PMM) links these questions to our Collaboration Space Ontology Template as shown in Figure 5-6.

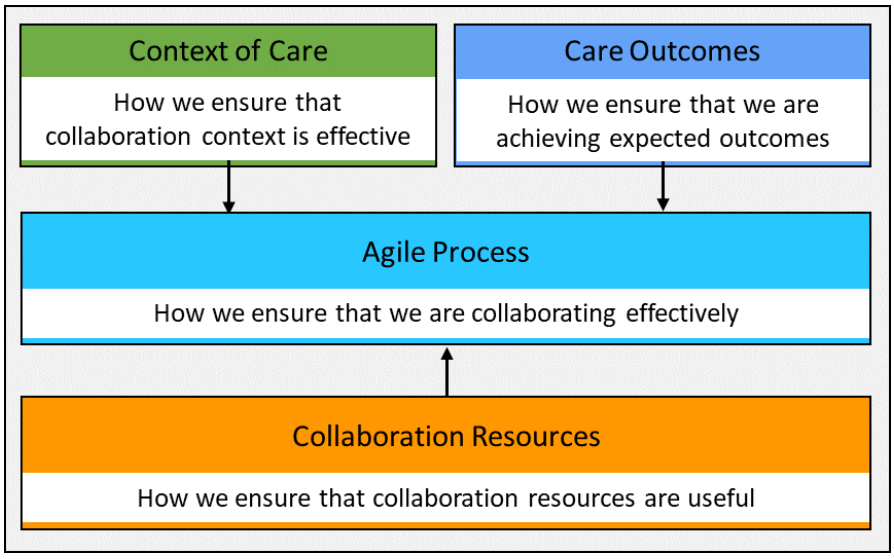


Figure 5-6: How PMM Links Performance Measures to the CSOT

The four quadrants related to Level 2 constructs of the Collaboration Space Ontology Template are grouped in the format of a balanced score card and define our Performance Management Model, a conceptual model for healthcare teams as shown in Figure 5-7. Each quadrant has an associated category and performance objective. Categories are based on Level 3 constructs of the Collaboration Space Ontology Template. Each of these has one or more associated KPIs. By examining these factors, the team can determine whether improvements can be made to improve collaboration.

The Performance Management Model (PMM) brings together, in a single construct, the seemingly disparate aspects of collaboration: focusing on patient outcomes through identification of functioning; optimizing the treatment process; improving quality of treatment planning and operations; keeping collaboration in the forefront; reducing waste in collaboration resources; and managing for improved treatment quality (for existing and future patients). The PMM safeguards

against suboptimal collaboration by requiring Team Members and/or Healthcare Team Managers to consider all important collaboration factors together.

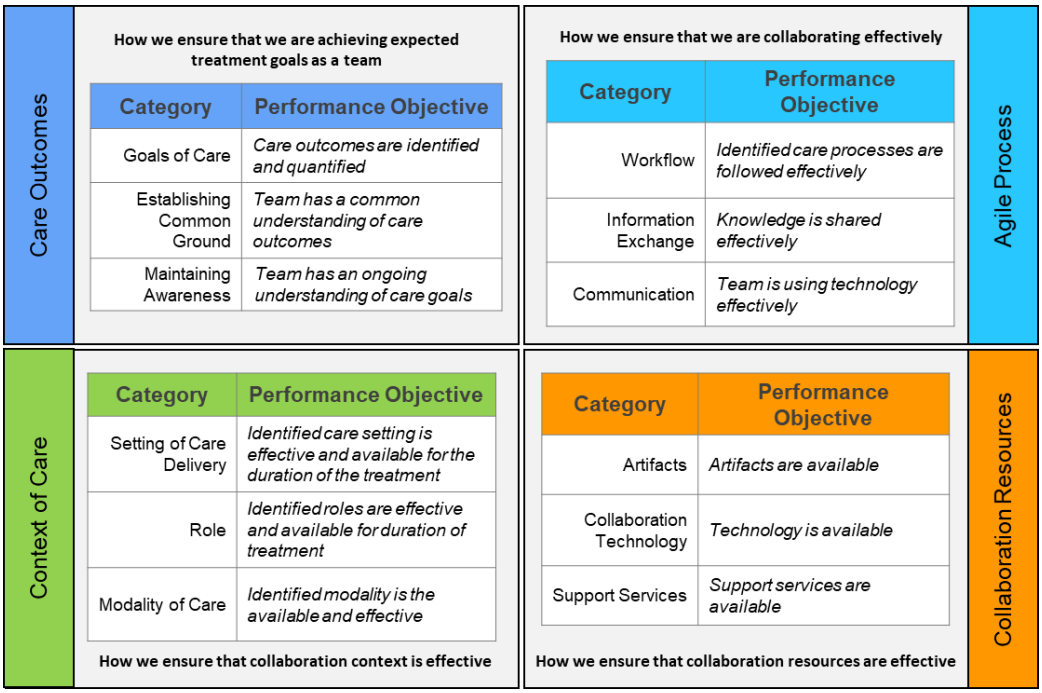


Figure 5-7: Conceptual Performance Management Model for Collaborative Care Teams

For example, if the ACD is not being used by a team member, it may be an indication of a technology failure. The PMM may also reveal if improvement in one area leads to impacts in another. Additionally, if patient goals are achieved without updating the ATP, this may demonstrate a lack of commitment to the agile collaboration process. The PMM enables the team to react to changes in a timely manner and to (perhaps) identify multiple ways to succeed and move seamlessly between obstacles. It also allows the team the ability to maintain effectiveness across a multitude of states, tasks, or circumstances and as well as the ability to continue effectively when team is in a degraded or sub-optimal state. Finally, the PMM also provides indicators that allow the team to change treatment parameters, such as timelines and team members.

5.2.3.7 **Performance Management Metrics Chart**

The PMM for a collaborative care domain can be represented by a Performance Management Metrics Chart (PMMC). The PMMC lists the performance objectives for each category in each quadrant defined in the PMM. For each performance objective the PMMC lists the KPIs that are relevant to the particular collaborative care domain. Tables 5.2 to 5.5 illustrate this for ADHD. They are based on the ADHD scenarios described in chapter 6.

The KPIs found in the **Agile Process** quadrant in Table 5-2 contribute to *how we ensure that we are collaborating effectively*. The objective in the Workflow category is to ensure that the identified care processes are being followed effectively. This could be measured by evaluating the number of treatment sprints, the time left in the current treatment sprint and the total number of months since care initiation. In the Information Exchange category, the objective is to ensure that knowledge is shared effectively. The KPIs in this category could measure aspects of the agile process such as number of Case Conferences planned, the number of consultations which are allocated (to be used as needed), the time to establish patient outcomes, and the time to establish the initial treatment plan. The objective in the Communication category is to ensure the team is using collaboration technology effectively. This includes the use of the Artifacts ATP (Agile Treatment Plan) and ACD (Agile Collaboration Dashboard), which will be described in Section 5.3, as well as training on those Artifacts. We also include the number of remote care events (implicitly supported by technology).

Table 5-2: Performance Management Metrics Chart - Agile Process

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Agile Process			
Workflow			
Identified care processes are being followed effectively	Number of Treatment Sprints (n)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time left in current Treatment Sprint (days)	45	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Total number of months since care initiation (n)	12	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Information Exchange			
Knowledge is shared effectively	Number of Case Conferences [planned] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Number of Consultations [allocated] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish ATP (weeks)	1	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish patient outcomes (weeks) using ICP	3	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Communication			
Team is using technology effectively	Total number of team members trained on ATP (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of team members trained on ACD (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ATP (n)	5	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ACD (n)	20	≤ 0 (on track), > 0 (problem)
	Total number of remote care events (n)	4	≤ 0 (on track), > 0 (problem)
	Time to establish ICP protocol (n)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)

The KPIs found in the **Care Outcomes** quadrant in Table 5-3 contribute to *how we ensure that we are collaborating effectively*. The Goals of Care category has KPIs associated with the objective of ensuring care outcomes are identified and quantified. The KPIs for the Establishing Common Ground category are associated with the objective of ensuring that the team has a common understanding of care outcomes. KPIs related to this are the number of times a change

in strategy, as described in the action codes in Table 5-12, is invoked. It also deals with evaluating the number of ineffective interventions (for example changes of medication or type of therapy) to date, the number of re-treatments for the same ailment (for example of the patient is noncompliant in following through with therapy or taking medications), as well as the time to retreatment. It also provides an indication of the number of inappropriate interventions (misdiagnosis, errors, etc.). The Maintaining Awareness category has the objective of ensuring that the team has an ongoing understanding of care goals. These can be addressed using the ICF Patient Card Artifact to provide ICF scores (which will be described in section 5.3.3).

Table 5-3: Performance Management Metrics Chart - Care Outcomes

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Care Outcomes			
Goals of Care			
Care outcomes are identified and quantified	Functionality [b1400 sustaining attention] (Target ICF score)	1	< 0 (problem), = 0 (on track)
Establishing Common Ground			
Team has a common understanding of care outcomes	Number of times care strategy has changed (n)	0	≤ 0 (on track), > 0 (jeopardy or problem)
	Number of ineffective ATP Interventions (n)	0	≤ 0 (on track), > 0 (problem)
	Number of re-treatments (n)	0	≤ 0 (on track), > 0 (problem)
	Time to re-treatment (weeks)	0	≤ 0 (on track), > 0 (problem)
	Number of inappropriate ATP Interventions (n)	0	≤ 0 (on track), > 0 (problem)
Maintaining Awareness			
Team has an ongoing understanding of care goals	Patient Functional Status	ICF Scores	Various

The KPIs found in the **Context of Care** quadrant in Table 5-4 contribute to *how we ensure that collaboration context is effective.* The Setting of Care Delivery category has the objective of ensuring the identified care setting is effective and available for the duration of care. KPIs include

the number of times location of care has changed, as well as how close the location of care is to the patient's residence. The Role category has the objective of ensuring the identified roles needed for care are effective and available for the duration of the treatment. This involves KPIs related to the number of times professionals have changed, and the length of time professionals are on the case. The Modality of Care category has the objective of ensuring that each identified modality is available and effective. These KPIs include time to care initiation and the number of times modality has changed.

Table 5-4: Performance Management Metrics Chart - Context of Care

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Context of Care			
Setting of Care Delivery			
Identified care setting is effective and available for the duration of the treatment	Number of times location of care has changed (n)	0	≥ 0 (on track), < 1 (problem)
	Proximity of care location to patient (km)	15	≥ 0 (acceptable), < 1 (unacceptable)
Role			
Identified roles are effective and available for duration of treatment	Number of times professionals have changed (n)	0	≥ 0 (on track), < 1 (problem)
	Length of time on patient care (months)	5	≥ 0 (on track), < 1 (problem)
Modality of Care			
Identified modality is the available and effective	Time to care initiation (months)	1	≥ 0 (acceptable), < 1 (unacceptable)
	Number of times modality has changed (n)	1	≥ 0 (acceptable), <1 (unacceptable)

The KPIs found in the **Collaboration Resources** quadrant in Table 5-5 contribute to *how we ensure that collaboration resources are effective.* This is described in Table 5-5 below. The Collaboration Technology has the objective to ensure appropriate technology is available such as video conferencing, cell phone, mobile apps, etc. The Artifacts category has the objective to ensure

that standardized forms, dashboards, and indicators are available. Finally, the Supporting Services has the objective to ensure the availability of supporting services such as school supports.

Table 5-5: Performance Management Metrics Chart - Collaboration Resources

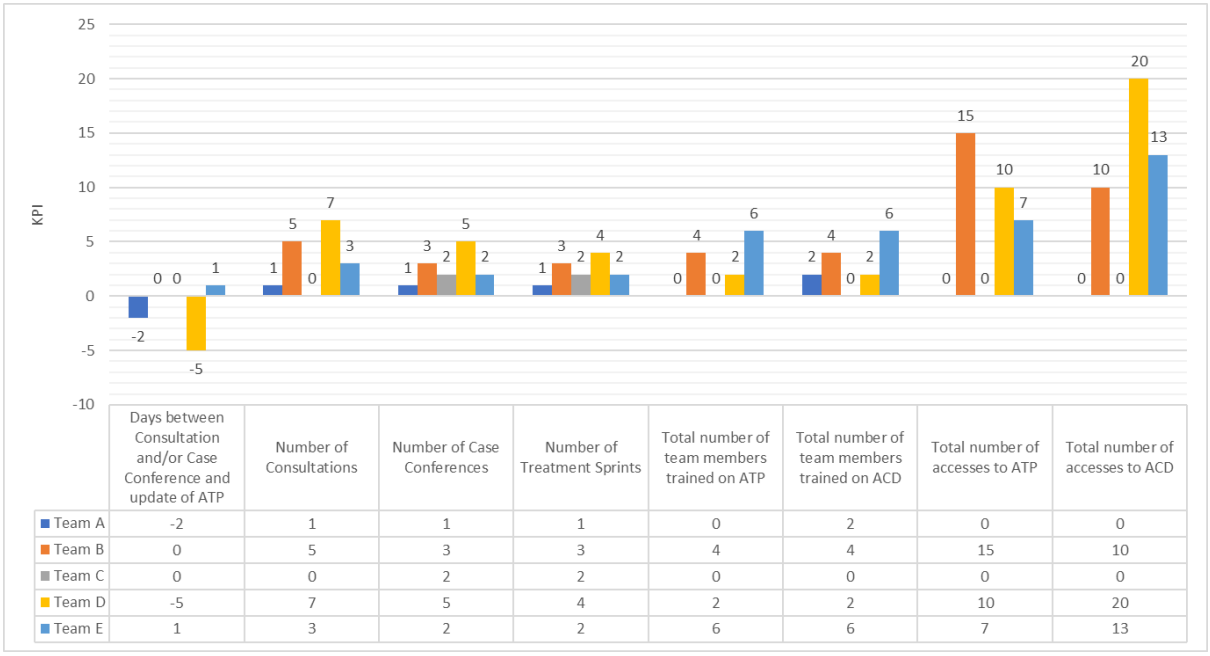
PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Collaboration Resources			
Collaboration Technology			
Appropriate technology is available	Type of technology	Video-conferencing	Yes= green, No=red
Artifacts			
Artifacts are available	Availability of Standardized Forms, Dashboard and/or Indicators	ATP	Yes= green, No=red
Supporting Services			
Support services are available	Availability of resource	School supports	Yes= green, No=red

5.2.3.8 Illustrations

The applications of the PMM are broad. We provide two illustrations to show how it may be used to demonstrate its value in performance management of collaborative care teams.

5.2.3.8.1 Illustration 1 – Healthcare Teams Manager

To illustrate a possible use of the PMM, consider the case where a Healthcare Teams Manager (HTM) is interested evaluating all teams under his management, Teams A to E. The PMM has just been installed and the organization is trying to bring the teams up to speed in the possible shortest time. Knowing that there is resistance to new technology, the HTM monitors the teams. KPIs from the PMM are shown in Figure 5-8 which identifies 8 KPIs columns and grouped by team (rows). The inset table provides the KPI measurement data that is illustrated in the graph. The HTM can draw several conclusions related to collaboration from this chart. Below are some possible observations and associated actions.



	Days between Consultation and/or Case Conference and update of ATP	Number of Consultations	Number of Case Conferences	Number of Treatment Sprints	Total number of team members trained on ATP	Total number of team members trained on ACD	Total number of accesses to ATP	Total number of accesses to ACD
Team A	-2	1	1	1	0	2	0	0
Team B	0	5	3	3	4	4	15	10
Team C	0	0	2	2	0	0	0	0
Team D	-5	7	5	4	2	2	10	20
Team E	1	3	2	2	6	6	7	13

Figure 5-8: Example of Performance Management Objectives and KPIs for Multiple Teams

- The healthcare unit has a strict policy in place regarding updating the Agile Treatment Plan within one day. Team D has missed this target by 5 days. The HTM will follow up with the Team Leader to see how he can provide assistance.
- Team A appears to have completed 1 treatment sprint in which there was 1 Case Conference. However, they have not updated the Agile Treatment Plan. We see that no team members have been trained on using the ATP. Two team members are trained on the Agile Collaboration Dashboard. However, there have been no access to either the ATP or the ACD. The HTM decides to set up training for the ATP, since he believes that both ATP and ACD usage will go up as a result.
- Team C has had 2 Case Conferences and no Consultations. They are currently in their third treatment sprint and have not had training on the ACD or ATP.

5.2.3.8.2 Illustration 2 – Porter's Measures

Porter's Outcome Measures Hierarchy provides a compelling dimension to the value of our PMM as well as the PMFCC. Our CSOT measures are directly related to many Tier 1, 2 and 3 measures provided in Table 2-1 by Porter. We provide this mapping in Table 5-6 for some key KPIs. We see from the mapping that this small subset populates mainly the Establish Common Ground, Maintaining Awareness and Workflow Categories. T1, T2 and T3 refer to Porter's Tier 1, 2 and 3. We also include Information Exchange, Setting of Care, Role and Modality of Care in the table due to the central tenet of Porter's organization of care – the Integrated Patient Unit (IPU). We deduce that the KPIs indicated in the table would also be relevant.

Table 5-6: Mapping of Porter's Measures to the PMM

Performance Management Model Category	Performance Objective	Key Performance Indicator
Goals of Care	Care goals are identified and quantified	**Care Goals:**
		T1: Functional status
		T1: Freedom from disease (the patient is free from disease)
Establishing Common Ground	Team has a common understanding of care goals	**Previous History:**
		T3: Time to recurrence of original disease
		T3: Severity of recurrence of original disease
		T2: Number of missed diagnosis (how many times, what was missed)
		T2: Failed treatment (how many times, what failed)
		T2: Inappropriate treatment (how many times, why)
		T2: Ineffective treatment (how many times, in what way)
		T2: Re-treatment (how many times)
		T4: New care-induced illness
Maintaining Awareness	Team has an ongoing understanding of care	**Ongoing Status:**
		T1: Mortality
		T1: Functional status
		T2: Missed working days while under treatment
		T2: Inability to function normally while undergoing treatment
		T2: Level of patient discomfort
		T2: Level of patient anxiety
		T2: Short term complications (number, type)
Workflow	Ability of team to follow identified care process effectively	T1: Time to diagnosis
		T1: Time to treatment plan
		T1: Time to care initiation
		T1: Duration of treatment
		T1: Cycle time
Information Exchange	Team is meeting effectively	Number of scheduled Meetings
		Number of unscheduled Meetings
		Number of scheduled meeting going over planned limit
		Number of unscheduled meetings going over planned limit
Communication	Team is using technology effectively	Use of other collaboration technologies
Collaboration Technology	Appropriate technology is available	Total number of accesses to TP or EHR
		Type of technology
Supporting Services	Support services are available and used	Type of service
Setting of Care Delivery	Identified care setting is effective and available for the duration of the treatment	Number of times location of care has changed
		Proximity of care location to patient
Role	Identified roles are effective and available for duration of treatment	Number of times professionals have changed
		Length of time on patient case
Modality of Care	Identified modality is the available and effective	Number of times modality has changed

5.3 Artifacts

In this section, we present four example Artifacts that we have designed as specific instantiations of the Artifacts category in our Collaboration Space Ontology Template in Figure 5-4. They are intended to be electronic, shareable Artifacts although a software implementation of them was beyond the scope of this thesis. They are referred to in Figure 5-2 (red labels) to as Artifacts supporting performance management based on our Agile Process Model. The two primary Artifacts are the Agile Treatment Plan (ATP) and the Agile Collaboration Dashboard (ACD). The entire care team requires visibility of these Artifacts. Two secondary Artifacts that were derived from analysis of our Scenarios (described in Chapter 6), are the Collaborative Care Model Canvas (CCMC) and the ICF Patient Card (IPC). Table 5-7 lists the Artifacts and their purpose.

Table 5-7: Purpose of Artifacts for Collaborative Care

Artifact for Collaborative Care	Purpose
Agile Treatment Plan	• To provide a consolidated collaborative treatment plan • Instantiated at the beginning of treatment • Updated as part of Treatment Planning, Consultations, and Case Conferences
Agile Collaboration Dashboard	• To provide team members with a mechanism for continuous visibility to collaboration information • Instantiated at the beginning of a treatment sprint • Updated as needed throughout treatment sprint
ICF Patient Card	• To provide the team with a common understanding of existing and target patient health states • Instantiated at the time of treatment • Updated as part of Treatment Planning, Consultations, and Case Conferences
Collaborative Care Model Canvas	• To provide a holistic view how collaboration is setup • Instantiated at the beginning of the Agile Process • Initiated when patient is admitted • Updated as part of Treatment Review

5.3.1 Agile Treatment Plan

The ATP provides a holistic view of the care that the patient will receive from a collaboration perspective. All members of the care team must agree to the Agile Treatment Plan.

During the Consultations and Case Conferences specified in the Agile Process Model the ATP is discussed and reviewed. It can be updated by individual team members in between meetings. The ATP specifically outlines what therapeutic and nontherapeutic interventions are taking place, as well as the expected results and status.

5.3.1.1 Utilization

The ATP is created after admission during the first Case Conference. It is expected that the team will use the Agile Treatment Plan in Case Conferences, Treatment Planning and Consultation meetings as shown in Figure 5-9.

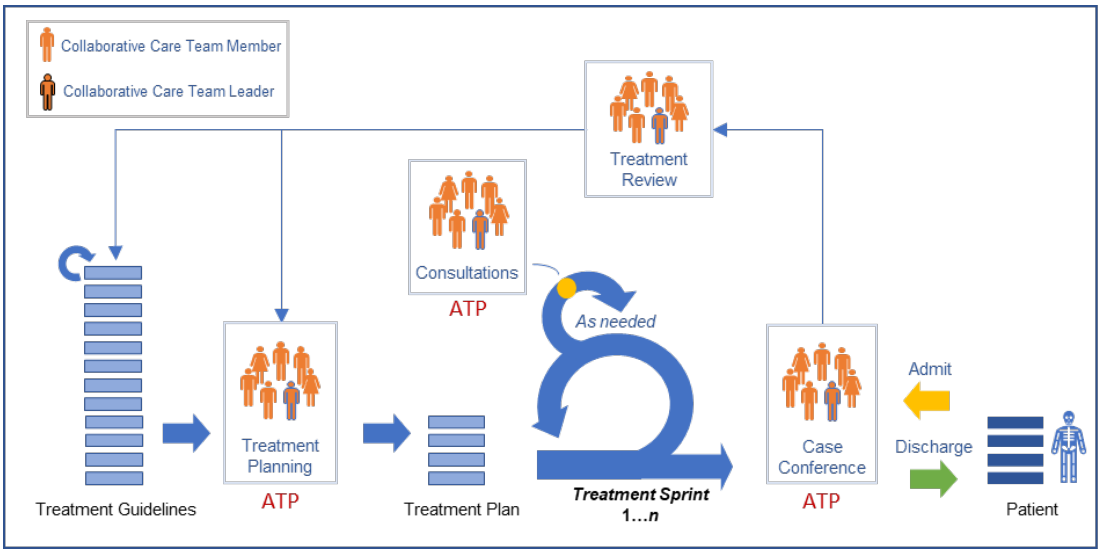


Figure 5-9: Utilization of ATP Within the Agile Process Model

5.3.1.2 Structure

An Agile Treatment Plan is an electronic document that is designed to capture the data summarized in Figure 5-10.

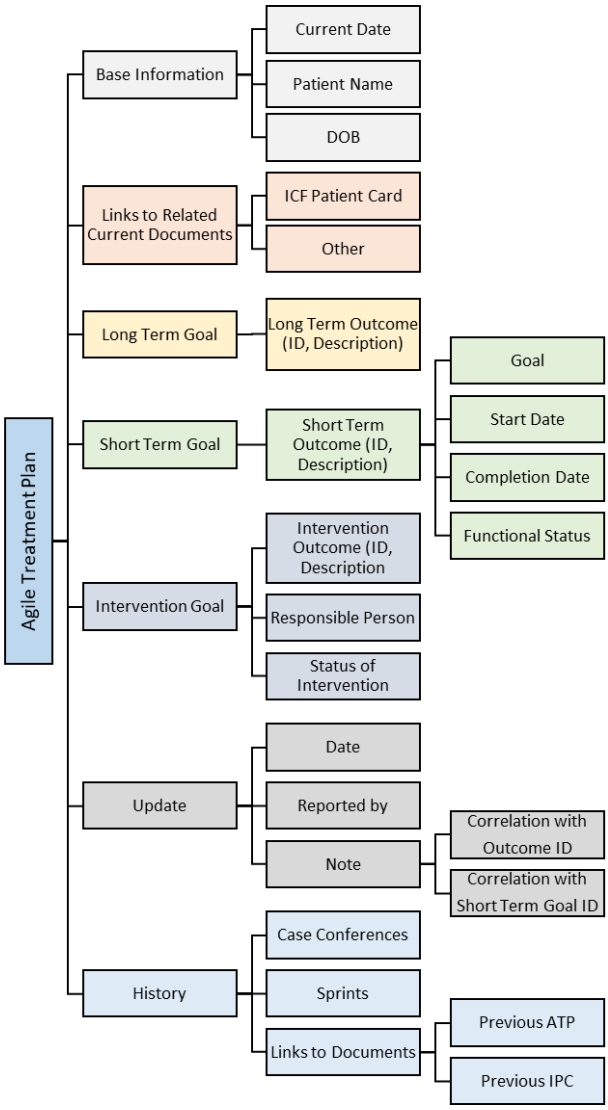


Figure 5-10: Structure of Agile Treatment Plan

- **Base Information:** current date, patient name, DOB.
- **Links to Related Current Documents:** references a link to the ICF Patient Card. Links to other documents are also possible here.
- **Long term Goal:** has associated with it a Long Term Outcome. This is a statement that describes the best expected long-term goal for this patient. The Short Term Goals and

Intervention Goals in this plan support this Long-Term Goal. The Long Term Outcome has an associated ID and description.

- **Short Term Goal:** has associated with it a Short Term Outcome that is agreed upon by the healthcare team. It has a unique identifier and a description. It has a goal, start date, completion date and a functional status. This functional status is directly related to the functionality evaluation described in the ICF Patient Card. Functional status is codified in Red=functionality is affecting patient significantly; Yellow=functionality is affecting patient somewhat; Green=functionality is no longer affecting patient.
- **Intervention Goal:** is related to one or more Short Term Goals. Specific Intervention Outcome is listed here and has an associated ID and description. These are prioritized actions that the team will take to resolve specific patient issues. We summarize here:
    - Responsible Person: this can be a medical professional, patient, parent or teacher. Essentially, anyone who takes part in the intervention.
    - Intervention Outcome: specific list of itemized interventions is given here.
    - Status of Intervention: a succinct indicator of the status of the intervention. Options are: initiated, in progress, re-opened, completed, abandoned.
- **Updates:** this is a semi-structured free-form field that allows team members to record information that they deem important for other team members to know. It is structured in that the Note field is associated to the Intervention Outcome ID and the Short Term Outcome ID. Also included here is the date and the name of the team member who is making the note.

- **History:** provides an area where all related collaboration historical information related to the patient collaboration is kept. Here we find: number of Case Conferences and associated dates; number and date range of treatment sprint; links to previous ATP and IPC.

5.3.1.3 **Data Capture and Visualization**

The ATP allows team members to have a full view of their responsibility in the context of the patient's functional assessment (which can be standardized using the ICP Patient Card described in section 5.3.3). A visualization of the Agile Treatment Plan is shown in Figure 5-11 below.

AGILE TREATMENT PLAN ATP-3				IPC-3
Name: Mary Smith	**DOB:** July 1, 2006		**Current Date:** June 28, 2019	
Presentation				
Current symptoms include periods of inattentiveness, frustration, irritability and poor self-esteem. Current symptoms include periods of inattentiveness, frustration, irritability and poor self-esteem. Additionally, in the past months Mary has had difficulty coping with stressors and loss of interest in school.				
Long Term Goals				
Symptoms of ADHD will be significantly reduced or eliminated through medication and therapy. ADHD-dependent obstacles to learning are reduced or eliminated through strategies at home and at school.				
Short Term Goals			**Start Date**	**Completion Date**	**Patient Functional Status**
1. Find reason for drug non-compliance			May 10, 2019	June 28, 2019	
2. Alleviate physiological symptoms of ADHD			May 10, 2019	June 28, 2019	
3. Help Mary manage academic expectations for current school year			Jan 4, 2019		
Interventions			**Team Member**	**Short Term Goal**	**Intervention Status**
a) Determine best medication for Mary and monitor her progress.			Dr. Jones	2	Completed
b) Mary will take medications on a regular basis as prescribed.			Mary Smith	2	Re-opened
c) Mrs. Smith will record and report effect of Rx on Mary.			Mrs. Smith	2	In progress
d) Dr. Martin will provide recommendations to help Mary succeed at school.			Dr. Martin	3	Completed
e) Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.			Mary Smith	3	Completed
f) Mrs. Smith will collaborate with Mary's teachers to monitor and report success of Dr. Martin's recommendations.			Mrs. Smith	3	In progress
g) Address reasons for noncompliance of Rx			Dr. Jones	1	In progress
Updates					
Date: June 14, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1** **Intervention: g)** **Modality: Videoconference** -Consultation with Mary and Mrs. Smith. Good Rx compliance.				
Date: May 31, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1** **Intervention: g)** **Modality: Visit** -Reports decreased symptoms of inattentiveness. Keep 40mg Vyvanse dose and observe for 4 weeks.				
Date: May 24, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1** **Intervention: g)** **Modality: Visit** -Increase dose to 40mg Vyvanse for 1 week				
Date: May 17, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1** **Intervention: g)** **Modality: Visit** -Increase Rx to 30mg Vyvanse for 1 week. -Provide training on ADHD noncompliance.				
Date: May 10, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1** **Intervention: a), g)** **Modality: Visit** -Recurrence of symptoms due to noncompliance. Begin 20mg Vyvanse for 1 week. -Discuss reasons for noncompliance.				
History					
Case Conference		**Sprint**		**ATP**	**IPC**
0	04/01/2019	0	04/01/2019 - 15/02/2019 **(43 days)**	*ATP-0*	*IPC-0*
1	15/02/2019	1	15/02/2019 – 12/04/2019 **(57 days)**	*ATP-1*	*IPC-1*
2	12/04/2019	2	12/04/2019 – 10/05/2019 **(29 days)**	*ATP-2*	*IPC-2*

Figure 5-11: Visualization of an Agile Treatment Plan

5.3.2 Agile Collaboration Dashboard

The main objective of the Agile Collaboration Dashboard (ACD) is to provide a quick view of the status of collaboration-related information for each member of the team. Because it is difficult to see what other team members are doing, a key value of the ACD is that it provides real-time access to changes patient status as situations evolve. If there are difficulties, problems can be discovered early. Another benefit is that there may be significant time lags between taking a corrective action and knowing the result. The ACD communicates key information and lowers cognitive load on team members by eliminating the need to track key status information.

5.3.2.1 Utilization

The ACD enables a team member to view and make status updates from the team while in a Treatment Sprint where practitioners are working individually with the patient. This is shown in Figure 5-12 below.

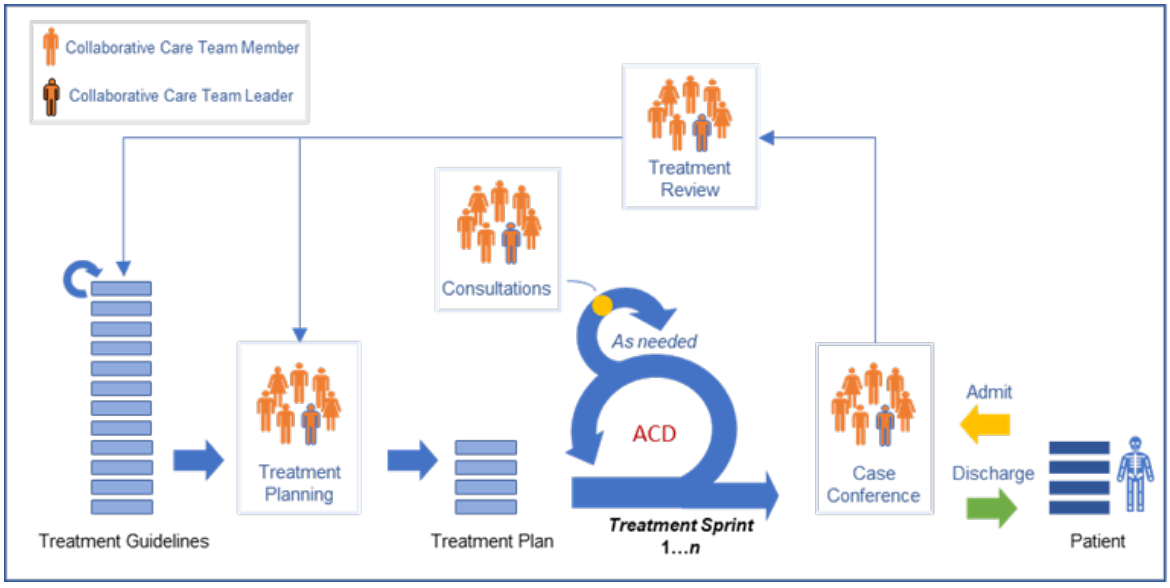


Figure 5-12: Utilization of ACD within the Agile Process Model

5.3.2.2 **Structure**

The general structure of the ACD is shown in the Figure 5-13 below. Base Information contains the current date and the patient's name. Since there may be many teams that are being managed, the team name is also included in the structure. We also find links to related current documents that may be of interest to the team. Finally, the collaboration element is provided, along with a description of the Short Term outcome as well as the status.

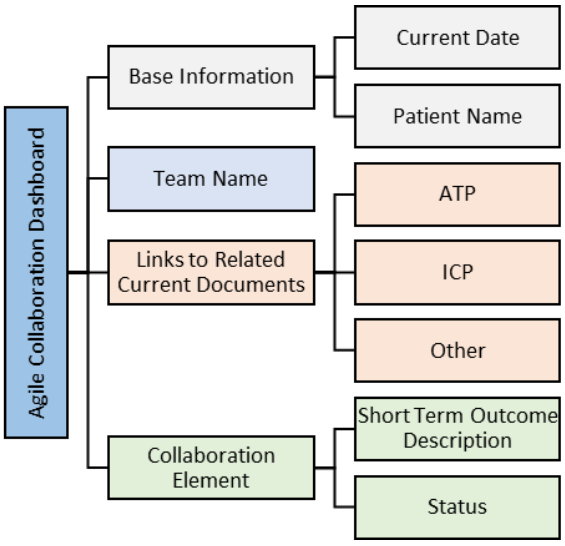


Figure 5-13: Structure of Agile Collaboration Dashboard

5.3.2.3 **Data Capture and Visualization**

Base Information contains Patient Information, the date of the next Case Conference. Access to updated collaboration artifacts is provided under Reports. The most important part of the ACD is the status information under Status. This provides key information to team members regarding changes in the patient's functional goals and includes a visual color-based goal status indicator (red, yellow, green). The ACD is intended to provide ongoing status information to the team. Data capture occurs in one of two ways. First, updates to the ACD occur when changes to the Agile Treatment Plan take place. Secondly, changes to the ACD are made directly by a team

member during a Treatment Sprint to alert others about important status information. The ACD acts as a central point to quickly access current collaboration reports. A visualization for the team and the HTM is found in Figure 5-14.

a)

Patient: Mary Smith **Date:** May 8,2019	**REPORTS**
Collaboration Element	**Status**
Status of e465 (IEP)	
Status of b1400 (Sustaining Attention)	
Status Short Term goal 1 (Alleviate physiological symptoms of ADHD)	
Time to establish patient outcomes (weeks)	
Time to establish ATP (weeks)	
Time left in current Treatment Sprint (days)	
Number of Case Conferences to date	
Number of Consultations to date	
Number of Treatment Sprints to date	
Total number of team members trained on ATP	
Total number of team members trained on ACD	
Total number of accesses to ATP	
Total number of accesses to ACD	

b)

Care Team of Patient: Mary Smith Date: May 8, 2019	**REPORTS**
Collaboration Element	**Status**
Number of times location of care has changed	
Proximity of care location to patient (km)	
Number of times professionals have changed	
Length of time on patient care (months)	
Time to care initiation (months)	
Type of technology currently used	
Availability of artifacts	
Availability of resources	
Time to establish patient outcomes (weeks)	
Time to establish ATP (weeks)	
Time left in current Treatment Sprint (days)	
Number of Case Conferences to date	
Number of Consultations to date	
Number of Treatment Sprints to date	
Total number of team members trained on ATP	
Total number of team members trained on ACD	
Total number of accesses to ATP	
Total number of accesses to ACD	

Figure 5-14: ACD Visualization for a) Team and b) HTM

5.3.3 ICF Patient Card

We have created this Artifact as a tool which summarizes patient information in a simple, standardized fashion. The ability to view patient information in a cohesive way allows all team members (called *assessors* here) to set patient goals with a holistic understanding of the patients' values and needs. Individual team members, including caregivers can communicate their assessment of the patient's functionality using the ICP with each other at meetings as well as at the point of care, synchronously and asynchronously. The ability for the patient to provide self-assessment is an important aspect of the IPC, since capturing this data is sometimes difficult. The integrity of the treatment process is maintained by consistently communicating and quantifying

the patient's status in terms of their functionality using the International Classification of Functionality (ICF) standard.

The ability to choose from a selection of functionality makes the ICF standard very useful in ensuring that team members know what each other is thinking. Using the ICF allows us to codify team goals as rubrics and systematically compare them over time, which is integral to knowing if interventions are working. Codification also helps organize the treatment management plan for the team, whereby work units/tasks may be related to the codification of the goals. Furthermore, this data can be analyzed, processed, and visualized to provide valuable information for the team.

Rationale for Use of the ICF Standard

In order to achieve common ground in the delivery of patient care, the language used to discuss patient goals needs to be standardized across the team. In our investigation we reviewed the ICD-10, SNOMED and The International Classification of Primary Care (ICPC) as possible candidates to facilitate our work. Each of these are well known and commonly used in healthcare today. However, further analysis revealed some drawbacks.

ICD-10, for example, is used to systematically record, analyze, interpret, and compare mortality data. In our PMFCC, we wanted a more holistic approach to patient issues, and ICD-10 is limited to disease related information (Bowman, 2004). The ICPC also presented a limitation within the context of our PMFCC due to its emphasis on primary care. We wanted a classification that would speak to any specialization. Some researchers have reported that SNOMED, while more comprehensive in its scope, is more complex to work with because of the necessity to "post-coordinate" concepts to either clarify context, or better capture complex clinical (disease related)

ideas (Richesson, Andrews, & Krischer, 2006). This would necessitate the need for guidance from a SNOMED expert.

Thus, we chose to work with the International Classification of Functionality (ICF) standard because it made sense to develop the PMFCC in the context of our Clinical Vignette. As discussed in Section 2.3.4., the ICF is a unified, standard language and framework for the description of health and health-related states, from the view that functioning and disability are multi-dimensional, complex and have a dynamic relationship. There is evidence in the literature that using the ICF in goal-setting is useful (Constand & Macdermid, 2014) (Dalen, Nyquist, Saebu, Roe, & Bautz-Holter, 2013).

5.3.3.1 **Utilization**

The ICF Patient Card is a tool that aids the team in gaining consensus on common goals for the patient based on functionality. The general process for creating and updating the IPC is shown in Figure 5-15 below.

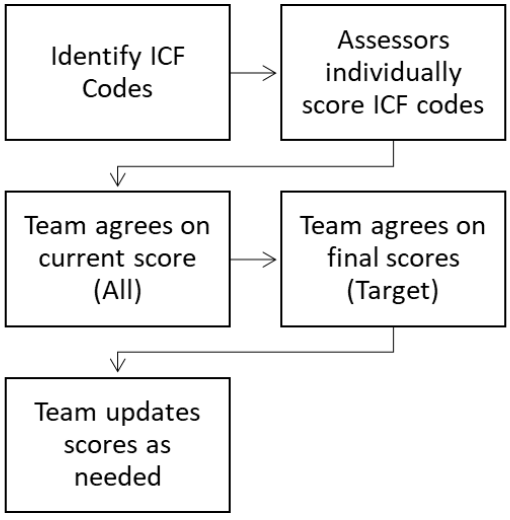


Figure 5-15: General Process for Creating and Updating IPC (Protocol)

The ATP is enhanced by the IPC. The relationship between the IPC and the ATP is shown in Figure 5-16.

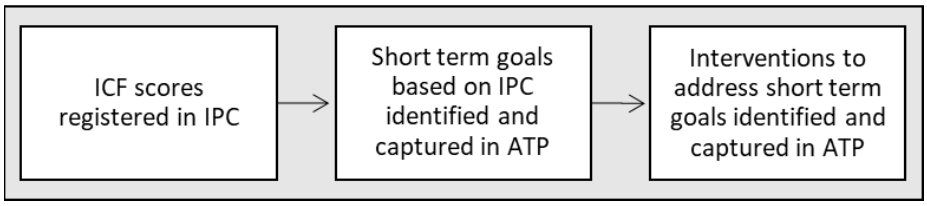


Figure 5-16: Relationship between the IPC and ATP

The status field is now linked to the IPC. Since the IPC is reviewed at the Case Conference, it accurately reflects the progress of the patient at that time. Furthermore, functionality scores are mapped to the short-term goal of the ATP as shown in the Patient Functional Status field where Red refers to a score of 4, Yellow refers to a score of 3 or 2, and Green refers to a score of 1 or 0 (as described in Section 5.3.3.2). In our example, we are correlating the Patient Functional Status with one ICF score for simplicity. However, the score can be a composite of one or more scores. In this way, the interventions (associated with each short-term goal) can also be identified and evaluated in a more systematic and complete fashion. Note that short term goals can change, as in this case, where Mary stopped taking her medication and her symptoms recurred. The IPC gives all team members a way to signal a change in the patient's functionality to the team.

Table 5-8 further elaborates how the ICF Patient Card is intended to be used in the process of collaborative goal setting in the Agile Process. Initial Assessment refers to the beginning of the Agile Process in the sprint planning stage. On-going Assessment refers to the interval between Sprint Review Meeting. Sprint Assessment occurs when the team actually meets. On-gong Assessment and Sprint Assessment are continuous until the end of the Agile Process when the patient is discharged. Note that the ICF Patient Card is accessible using the Agile Dashboard during any stage to provide all team members visibility into the treatment status of each other.

Table 5-8: How to use the ICF Patient Card

Stage	Description	When to Update
Admit	Establish consensus on parameters of ICF Patient Card by choosing what functions are the most relevant, critical, and achievable for the patient. Establish the targets and record these in the Agile Treatment Plan.	This step should occur once before the creation of the ATP in order to gain consensus for treatment by the team.
Consultations	On an ongoing basis (on previously agreed upon intervals), update the scores of the ICF Patient Card.	As needed, but definitely before Case Conferences
Treatment Planning and/or Case Conferences	Use the ICF Patient Card to review the past progress as well as to achieve consensus for the next interval's goals. Record the consensus in the ICF Patient Card. Update the Agile Treatment Plan.	At team meetings.

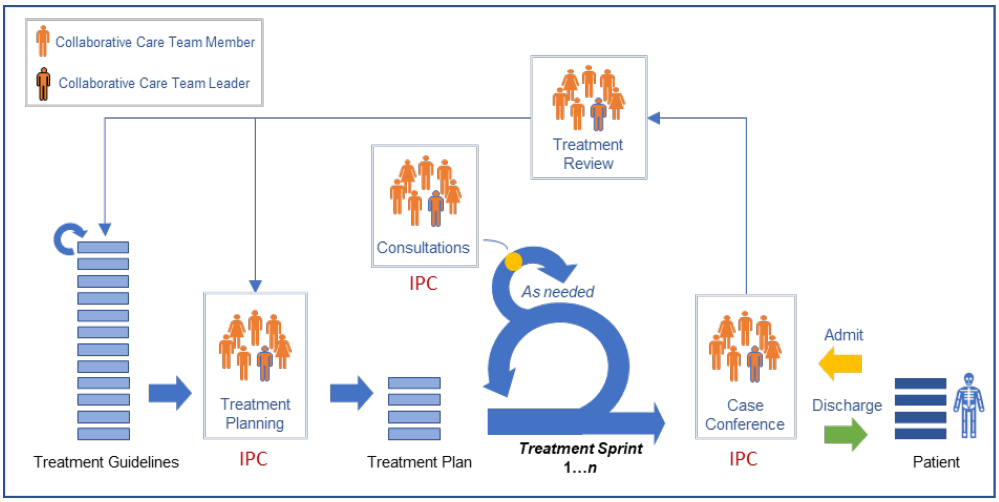


Figure 5-17: Utilization of IPC Within Agile Process Model

5.3.3.2 Structure

The ICF Patient Card is based on ICF, the WHO standard for coding functionality. We employ these definitions and enhance them to bring more precision to the dashboard. Each ICF Category has associated ICF Codes, their descriptions, and scores. Descriptions and codes are based strictly on the WHO document (*International Classification of Functioning, Disability and Health*, 2001) as discussed in Section 2.3.4. Scoring is an important part of this Artifact and represents the opinion of the assessor. Scoring is further used to gain consensus in the group and to agree on next steps because we have consistent standardized scoring. Another important reason to use the ICF is the ability to choose from a standard set of functionality choices, which makes

creating the initial ATP easier and less error prone. Figure 5-18 describes the general structure of the ICF Patient Card.

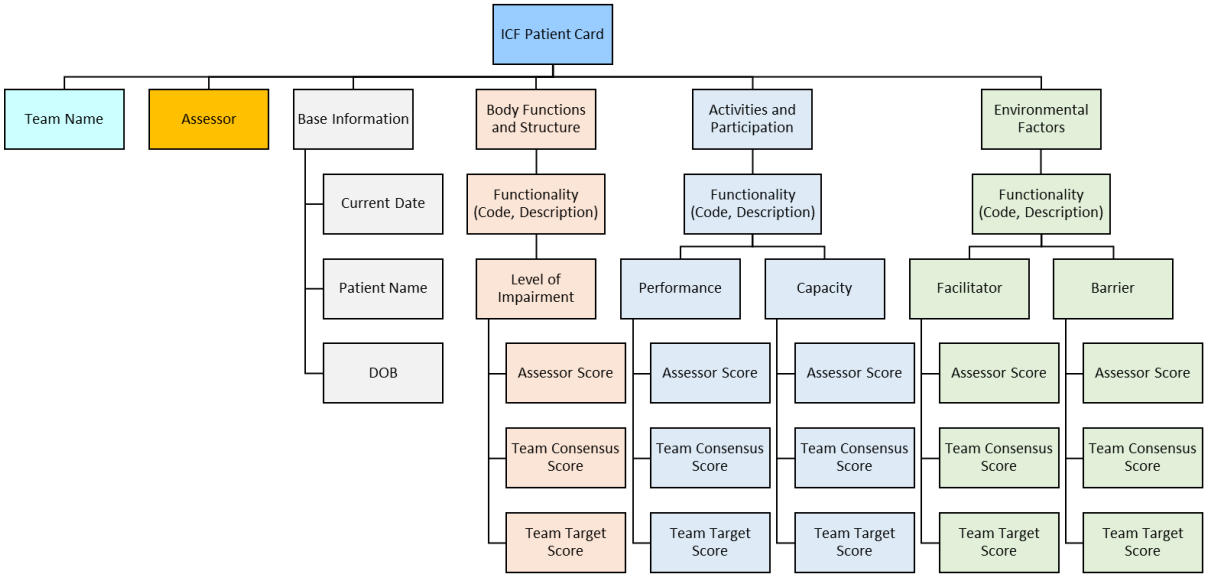


Figure 5-18: Structure of the ICF Patient Card

Specific details of the ICF Codes and ICF Code Descriptions are found in the ICF standard (*International Classification of Functioning, Disability and Health*, 2001), the ICF standard for children and youth (*International Classification of Functioning, Disability and Health Children & Youth Version*, 2007), various ICF Core Sets (Bickenbach, 2012), and others. Note that the in the ICF coding system, the letters b, s, d and e are used to denote Body Functions, Body Structures, Activities and Participation, and Environmental Factors. There are no ICF codes for Personal Factors. We opted to omit Personal Factors for simplicity.

1) **Body Functions and Structure** refers to the physiological functions of the body and include psychological functions. The assessor reflects the level of impairment the patient has using the following scoring levels:

Table 5-9: ICF Scoring for Body Functions and Structure

Score	Description
0	no impairment
1	mild impairment
2	moderate impairment
3	severe impairment
4	complete impairment
8	not specified
9	not applicable

2) **Activities and Participation** corresponds to the execution of actions and task by the patient as well as involvement in life situations. The assessor reflects the level of difficulty a person has using to parameter the current performance and the possible future performance, or capacity, of the patient. This category is expressed as N=P/C where N is the current functioning score, P is the performance, C is the capacity. For example, a score of N=3/1 indicates that the patient has severe difficulty (3) in walking, but with help can achieve a level of mild (1) difficulty. The following are possible scores:

Table 5-10: ICF Scoring for Activities and Participation

Score	Description
0	no difficulty
1	mild difficulty
2	moderate difficulty
3	severe difficulty
4	complete difficulty
8	not specified
9	not applicable

3) **Environmental Factors** consist of the overall social, physical and attitudinal environment in which the patient functions. The assessor's score refers to the how much the environmental

factor is a facilitator or barrier. Scoring is assessed on a scale of +4 to 4. An environmental factor can be either or both.

Table 5-11: ICF Scoring for Environmental Factors

Score	Description
+4	complete facilitator
+3	substantial facilitator
+2	moderate facilitator
+1	mild facilitator
0	no facilitator/barrier
1	mild barrier
2	moderate barrier
3	severe barrier
4	complete barrier
8	not specified
9	not applicable

The ICF Patent Card is used as a tool in our PMFCC. This tool can be used to provide context to the team members, as well to communicate patient assessment in a standard format. It is also a mechanism to determine if patient outcomes are being met, and therefore, may be used to track performance of the team, interventions, etc. By providing a common document where relevant barriers and facilitators are identified, the team has a common understanding of the patient.

5.3.3.3 **Data Capture and Visualization**

IPC data is captured using an electronic form. The ICP allows a team member to quickly articulate their view on the patient's functioning. An example is shown in Figure 5-19. The ICF Patient Card shown in this figure represents a snapshot in time of the patient's functionality. The patient is experiencing difficulties in all ICF Categories. Specific ICF codes and descriptions are

provided, along with three types of scores: the individual assessor's current view, the team's current view (current consensus functionality) and the team's target view (final consensus functionality).

IPC-0 ICF Patient Card – Summary of Functional Scores							
Name: Mary Smith		**DOB:** July 1, 2006			**Current Date:** February 15, 2019		
ICF Category	**ICF Code**	**Description**	**SCORE**				
Body Functions and Structure			Level of Impairment *0=no impairment → 4=complete impairment*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	b1400	Sustaining attention	3	2	4	3	0
	b126	Temperament and personality functions	3	2	3	2	1
	b152	Emotional functions	2	2	3	2	1
Activities and Participation			Performance/Capacity *0=no difficulty → 4=complete difficulty*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	d240	Handling stress and other psychological demands	+2/1	+2/1	+4/1	+3/1	+3/1
	e585	School education	+2/1	+3/1	+4/1	+3/1	+3/1
Environmental Factors			Facilitator or Barrier *+4=complete facilitator → 0=no facilitator/barrier* *0=no facilitator/barrier → 4=complete barrier*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	e130	Products and technology for education	+4	+4	+4	+4	+4
	e465	Education and training services, systems and policies	+4	+4	+3	+4	+4
Comment	**Date**	**Name**	**Description**				

Figure 5-19: ICF Patient Card Form

When the team meets initially, specific ICF functionality and corresponding codes should be chosen by the team. The team then achieves a consensus through discussion. Scores are captured in the card, while the codes and descriptions are captured in the ATP. Team members work on the patient file independently of each other during the treatment process and update their scores based on their area of expertise. Figure 5-20 shows how a score can be depicted graphically. In this example, each individual Assessor score is shown. After discussion, a consensus is reached and is recorded as the Consensus score. Finally, the target score is also shown on the same graph

to provide context for the team (the lower the number, the better the score for Body Functions and Structure).

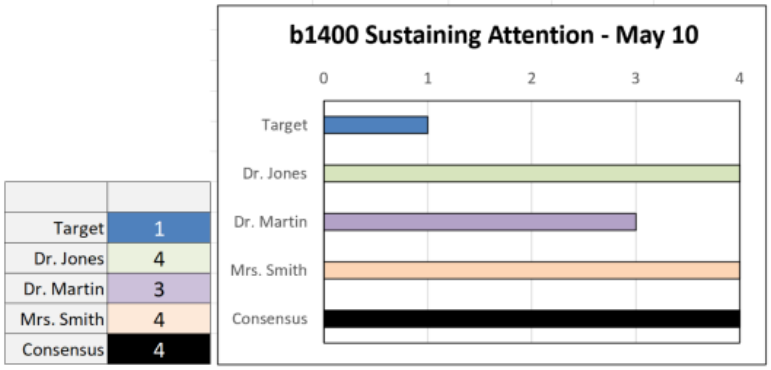


Figure 5-20: ICF Scores for a Patient

In this case, we see the assessors' scores are 4, 3, and 4 respectively. If the team consensus is 4 for May and the overall target is 1, the team has several options that they can choose from regarding their next steps. These options can range from continuing the existing interventions to abandoning this functionality goal. We categorize these options as Action Codes shown in Table 5-12.

Table 5-12: Action Codes and Descriptions

Code	Description
c1	Keep current interventions/actions (no change).
c2	Change current intervention/action.
c3	Goal complete.
c4	Goal on hold.
c5	Goal abandoned.

Historical consensus information is also useful and is shown in Figure 5-21. Here, the Action Code c2 from Table 5-12 shows that the team opted to change their interventions after they noticed that the sustaining attention function worsened in May (2 in April to 4 in May). The graph shows that the team's decision in May was successful since the score dropped to 2 in June and to 1 in October. The team decided that the intervention was working and did not change the treatment

even though the score remained at 2 from June to September. Their treatment strategy is validated since in October the patient reached the target score of 1.

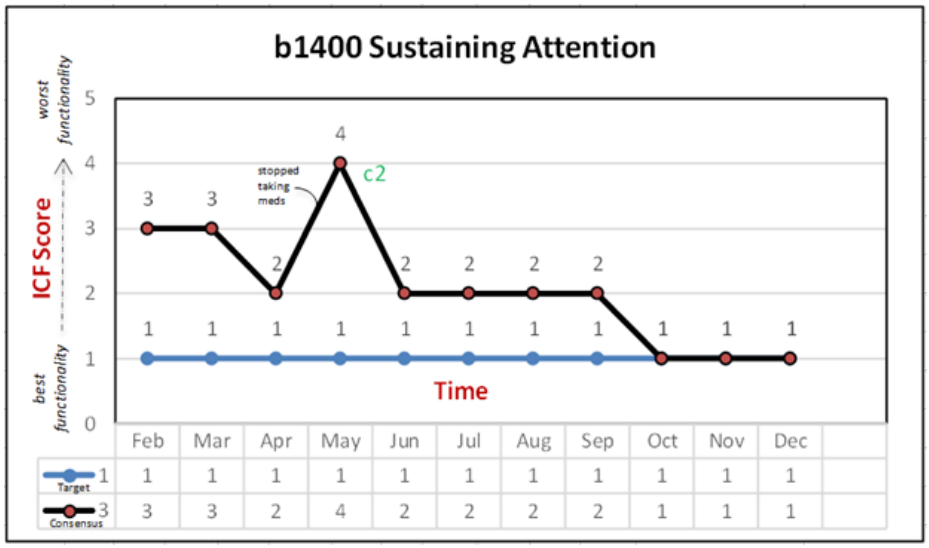


Figure 5-21: Historical Consensus Scores

5.3.4 Collaborative Care Model Canvas

Collaboration in healthcare is difficult for a number of factors that include access to resources, structure of interaction and working relationships, organizational silos (members of the team may report to different organizations), regulatory requirements and changing team membership (Xiao et al., 2013). An important predictor of team success is the team mental model which provides an organized and mutual understanding of pertinent knowledge related to the common work of the team (Xiao et al., 2013). The Collaborative Care Model (CCMC) is an Artifact that helps to identify these issues in advance in order that they may be addressed to alleviate time pressure, work, and cognitive overload. It also supports the individual-collaborative interchange as guides the individual practitioner into working as part of a team.

The Collaborative Care Model (CCMC) described in Figure 5-22 provides a way for the team to view itself as a "micro-business" with clearly articulated customers (patient, each other),

deliverables (articulated in the treatment plan) and operational configuration. This is based on the work of Clark and Hazen where the Business Model Canvas (Osterwalder et al., 2010) is applied to teams (Clark & Hazen, 2017) as described in section 2.8.2.

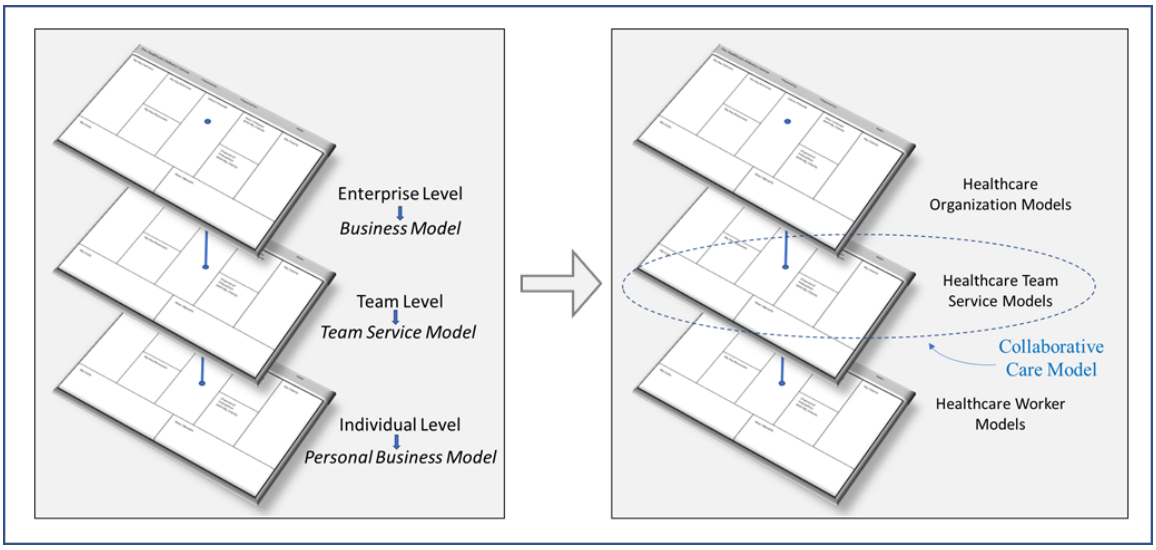


Figure 5-22: Levels of BMC Applied to Healthcare

The Collaborative Care Model Canvas (CCMC) is an instantiation of the Collaborative Care Model and is a novel Artifact based on the Team Service Model of Figure 2-6 which describes how a team within the company delivers value. We apply the Team Service Model to the medical domain, and specifically to healthcare collaboration. Collaborative care may involve coordination with a multitude of organizations, where team members are engaged in critical activities. Thus, the CCMC is an Artifact that supports our PMFCC by increasing collaborators' cognitive transparency of the whole collaboration environment. It provides a shared and organized understand of the specific and relevant factors that underpin their work as a team. Understanding the context of care allows team members, and especially patients, to assess where to place their attention, what assumptions to draw about what is being communicated, and to understand something on a deeper level. These factors allow collaboration to occur more smoothly.

5.3.4.1 **Utilization**

One of the key aspects of an agile approach is to ensure that the team has a clear understanding of its mission, tasks, resources, goals, etc. In the context of the Agile Process Model, it is expected that the team will define this collaboration model prior to patient admission. The team will review the CCMC in the Treatment Review as shown in Figure 5-23. This will occur at the very beginning of the case, as well as on an ongoing basis.

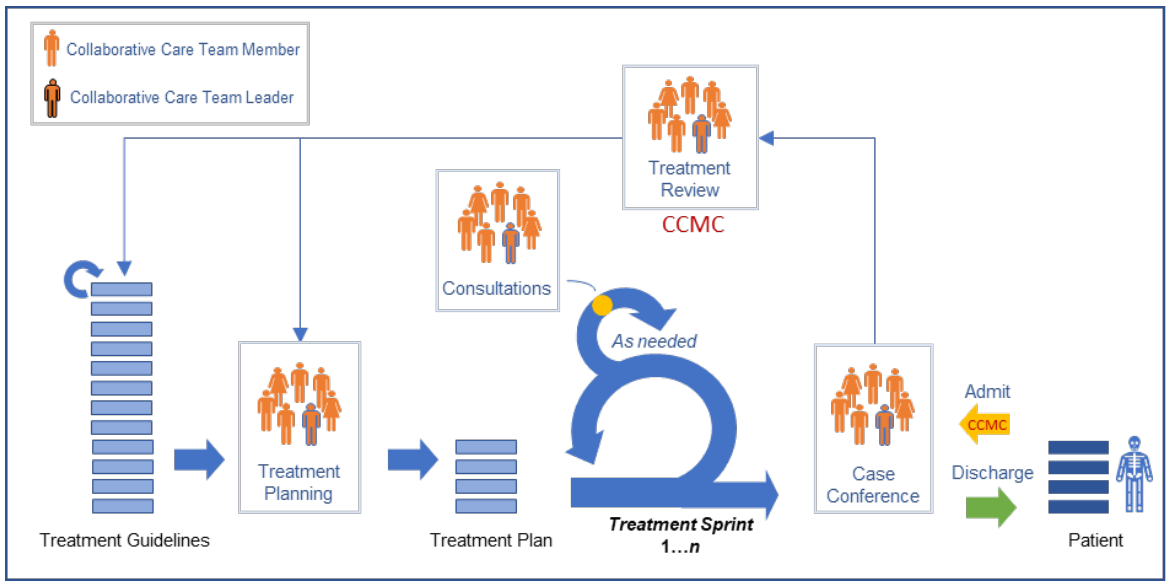


Figure 5-23: Utilization of CCMC Within the Agile Process Model

5.3.4.2 **Structure**

Figure 5-24 lays out the broad segments of the CCMC and links them to the Collaboration Space Ontology Template. The CCMC provides a template that is owned by the Team Leader (who may be not necessarily the most responsible clinician) and is agreed upon by the whole team.

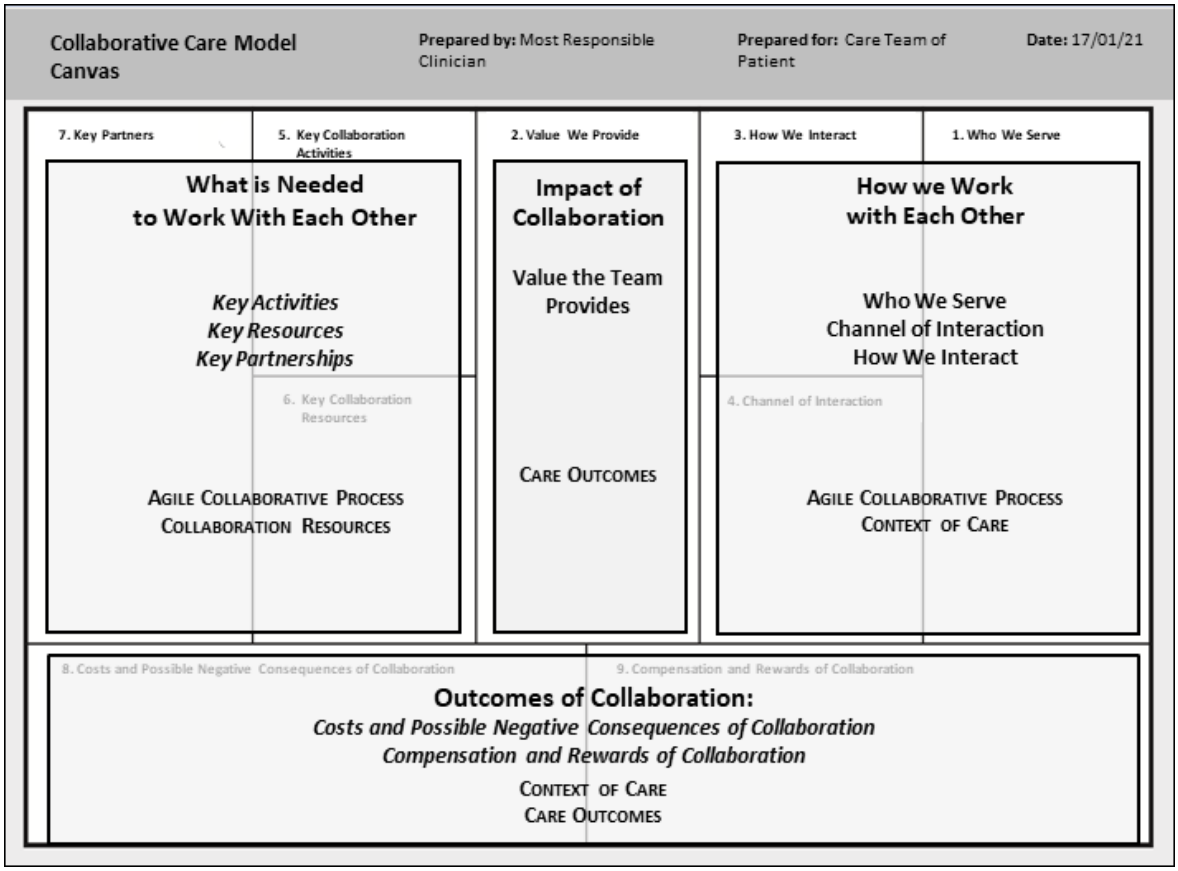


Figure 5-24: Layout of CCMC with Mapping to Collaboration Space Ontology Template

The structure of the CCMC is shown in Figure 5-25.

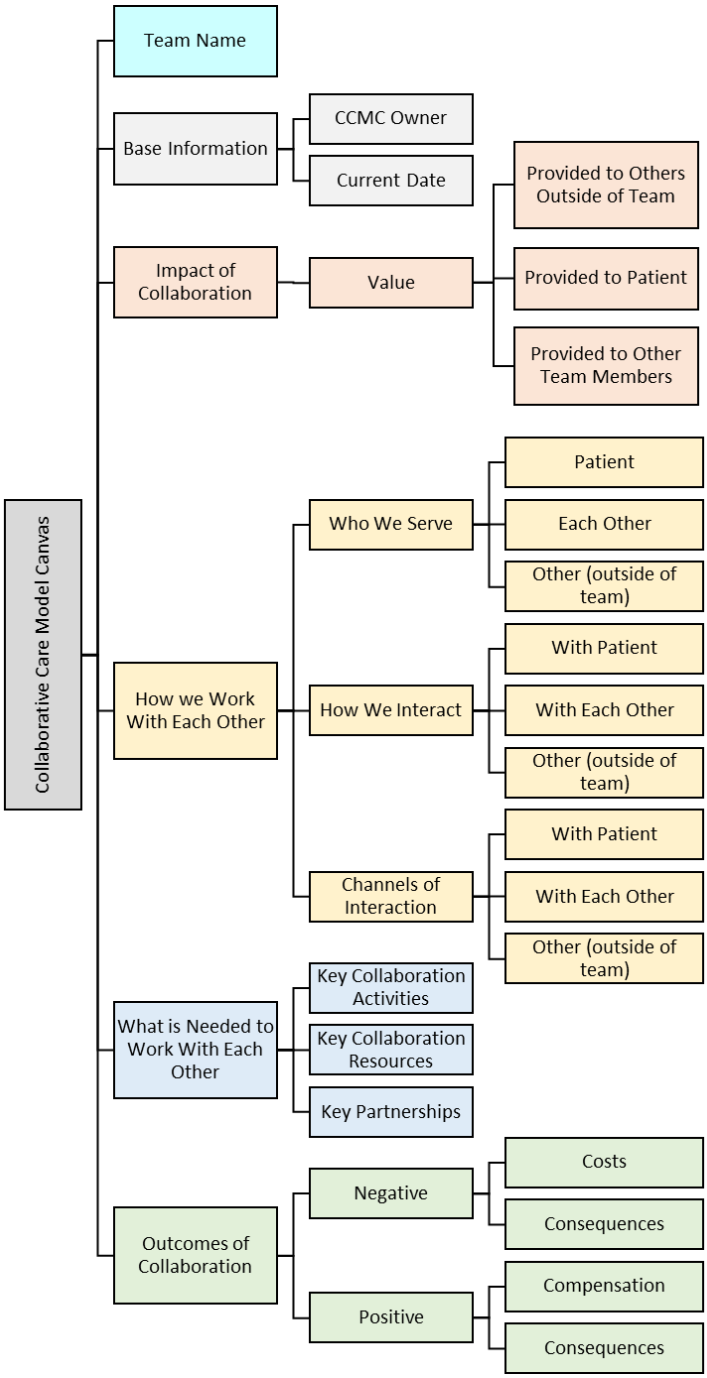


Figure 5-25: Structure of the CCMC

Description of these grouping is provided here:

- **Value:** Describes the way patients, team members and other stakeholders benefit from teamwork. Benefits to the patient relate to improved health, emotional satisfaction, feeling of inclusion and empowerment, and improved function. Value to the team includes improved performance and better operations. The outcomes of team collaboration may also provide value to external entities such as healthcare operations research departments.

- **Who We Serve:** This refers to the patient, other team members, and other stakeholders who benefit from the value provided by the team. The patient is the individual who is the subject of care. There are members who are part of the primary team who are direct team members. Indirect team members, such as family members, may also provide value to the care of the patient, but interact through indirect means with the team. This category also covers those team members who depend on another member's work to complete their own work. This refers to work between team members, who are *internal clients* to each other. External clients are other stakeholders who may depend on the team to get their work done.

- **How We Interact:** This is an important field that describes the relationship that the team has with the patient, each other, and external stakeholders. It also articulates the role that each member plays on the team, as well as the role and relationship with entities external to the team. A team member can occupy more than one role. For example, a patient can also be a team member. This is related to Role, Setting of Care in the CSOT. Interaction protocols under the Maintaining Awareness category are also found here.

- **Channels of Interaction:** This field describes the mechanism that is used to determine the terms of service provided by the team. It articulates where/how the team delivers service,

as well as how follow up is conducted. For example, service can be provided in-person or online remotely. This is related to the Modality of Care in the CSOT.

- **Key Collaboration Activities:** These are the critical team activities required to deliver healthcare and fulfill the value proposition. This is related to Workflow, Information Exchange and Communication in the CSOT.

- **Our Key Resources:** This field describes the most important resources required to deliver the benefits to the patient and each other. Team resources include: Agile Treatment Plan, Agile Dashboard, ICF Patient Card, meeting space, technology, etc. These relate to Collaboration Resources in the CSOT. We also find key healthcare information such as treatment guidelines, best practices, medical standards, training that are used for Establishing Common Ground.

- **Key Partnerships:** This refers to supporting services and organizations outside of the core team who help instantiate the team's value proposition. Any support that is provided to the team is articulated here. Key Partners may perform Key Activities on behalf of the team, or a team member. Primary Partners are partners without whom delivery of healthcare would be impossible such as an elementary or secondary school for a child being treated for cognitive impairment. Secondary Partners can be replaced by others, such pharmacists.

- **Negative (Costs and Consequences):** The team should highlight only the most important and high priority costs and consequences after an appropriate level of discussion. This makes the team aware of the importance of their collaboration.

    - Costs: The financial costs incurred by the team are noted here. This can include operating expenses, salaries as well as the cost of meeting resources such as

technology, training, meeting space, etc. Personal costs such as hours spent in meetings and travel time to meetings may also be considered. Opportunity costs may also be considered.

  - Consequences: This describes the non-financial consequences related to the work the team performs. This includes opportunity costs, stress, burnout, injury, damaged reputation, employee turnover, worker disengagement, etc. Other factors may include the negative impact on a patient's health, or on the team, if the collaboration fails. Negative patient health outcomes related to Porter's measures are enumerated here. Negative impacts from changes of location of care, or change of professional, or change of modality can also appear here.

- **Positive (Compensation and Consequences):** The team should highlight the most important and high priority ways in which team members are rewarded for their work. This also serves as a motivator for good collaboration.

  - Compensation: This refers to the compensation the team may receive such as grants, revenue, donations, budget allocation, re-assignment to the team, etc.

  - Consequences. These are the non-financial rewards enjoyed by the team and include recognition, satisfaction, learning, etc. Non-monetary rewards can include satisfaction as knowing a patient has been helped, sense of belonging to the team, mastery of subject matter, acquiring new skills and knowledge, etc. Porter's Health Outcomes are also found here.

5.3.4.3 Data Capture and Visualization

The CCMC is a visual tool as shown in Figure 5-26. A more detailed treatment of this example is provided in Section 6.4.1.1. The team is expected to fill out a blank template which should be available electronically. A library of CCMC should be available for commonly types of collaboration to lower cognitive load. This will also speed up the process of creating a CCMC.

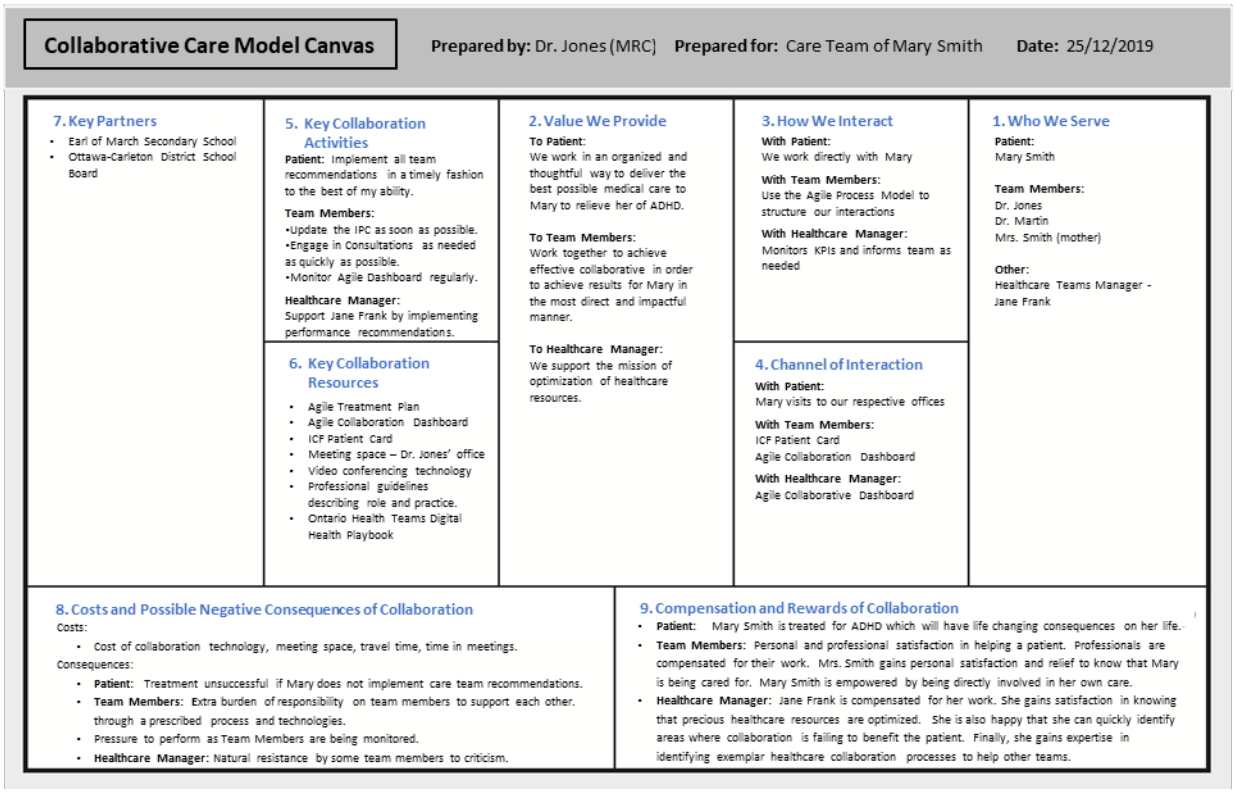


Figure 5-26: Collaborative Care Model Canvas

5.3.5 Relationship Between Artifacts and the Performance Management Model

Figure 5-27 shows some of the relationships between the Artifacts we have described in the preceding sections and the Performance Management Model. At the center of the figure is the Performance Management Metrics Chart (PMMC) which as described in 5.2.3.7 represents the PMM. Functional scores found in the IPC are collected to calculate the indicators specified in the PMMC. These and other indicators can represent status information and are shown in the ACD

to alert team members. These and other indicators are also used in the Agile Treatment Plan. The CCMC specifies which indicators are used, and where. Many examples are possible and depend on the collaborative care team and domain. Here we provide a simple visualization to illustrate their relationship with the PMM in order to demonstrate artifact supported performance of collaborative care teams.

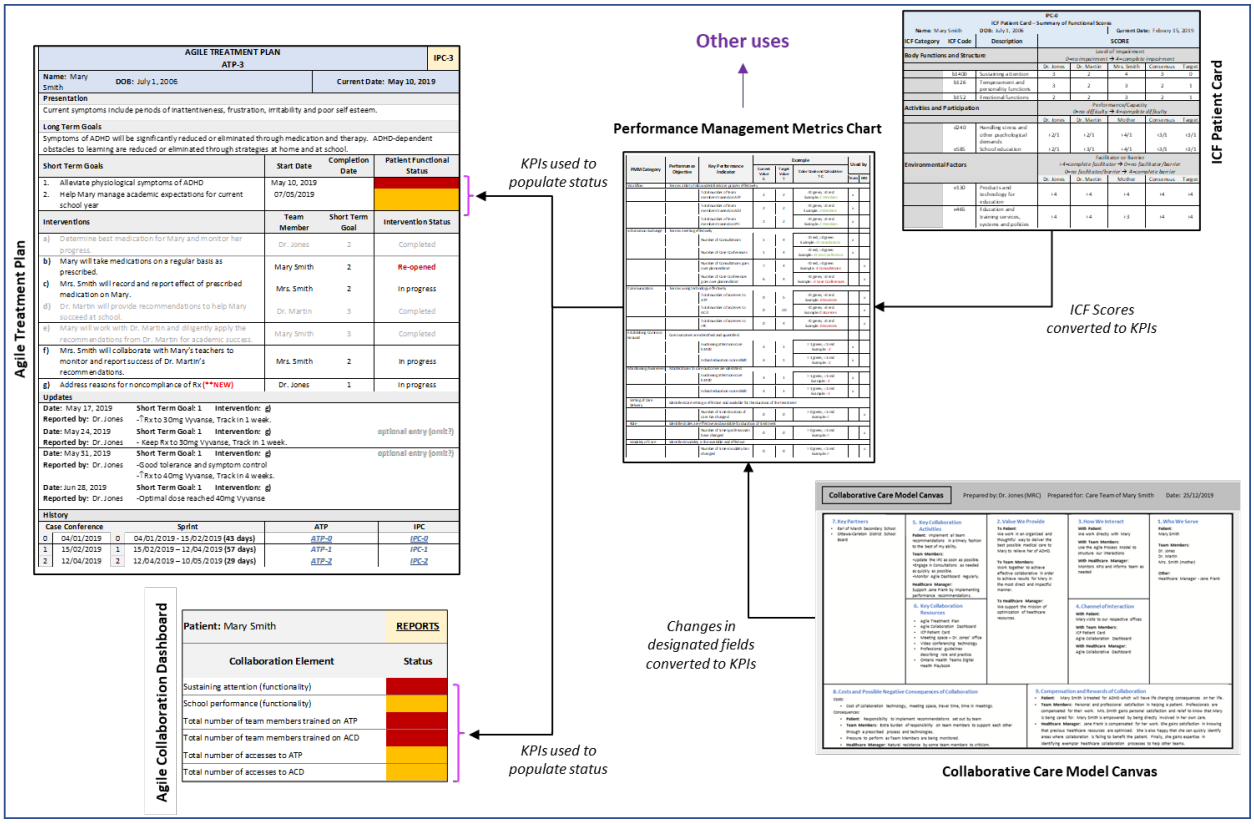


Figure 5-27: Example of Relationships Between Artifacts and the PMMC

5.4 Chapter Summary

In this chapter, we provided a theoretical description of the Performance Management Framework for Collaborative Care. The important constructs of Components and Artifacts that comprise the PMFCC were discussed. Components refer to the Agile Process Model, Collaboration Space Ontology Template, and the Performance Management Model. Artifacts discussed were the Agile Treatment Plan, Agile Collaboration Dashboard, the ICF Patient Card and the Collaborative Care Model Canvas.

6 Artifact-Driven Scenarios

In this Chapter, we build a Clinical Vignette, based on ADHD clinical guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018) and a well-documented case for ADHD treatment from the literature (A. Gray, 2016) to evaluate our proposed PMFCC iteratively through the development of Artifacts to support performance management of collaborative care. During each iteration of our design science methodology, as described in section 3.2.2, we evaluate our PMFCC in terms of how it addresses and improves performance management of collaborative care for the Clinical Vignette and identify any gaps that can be improved. This gap analysis informs the next iteration of the methodology.

In the first iteration, we introduce the Clinical Vignette and assess the effectiveness of artifact-supported performance management in terms of the base Components we envisioned for our PMFCC and to understand the gaps that need to be addressed in our subsequent iterations of our research method. In the next iteration, Scenario 1, tests two key Artifacts (the Agile Treatment Plan and the Agile Collaboration Dashboard) that are related to the Agile Process Model. After that, Scenario 2 takes the results of Scenario 1 and addresses functionality-based communication using the ICF as a tool for collaborative care using an Artifact called the ICF Patient Card. In the final iteration, Scenario 3 builds on the results of the previous iterations and addresses the aspect of collaboration context using a novel tool, the Collaborative Care Model Canvas.

6.1 **Clinical Vignette**

In this section, we present a Clinical Vignette derived from a well-known case study provided in Section 2.9.5 by Dr. Anslie Gray (A. Gray, 2016). We crafted our scenario on recommendations for robust vignette content as described by Evans et. al. (Evans et al., 2015). The Clinical Vignette was also reviewed by the expert panel described in Section 7.1. Adaptations included the simplification of Dr. Gray's case study Nancy to create Mary. These are mainly exclusions of unnecessary details that would not impact the developing our PMFCC. Our objective was to create the Clinical Vignette and apply it to the CADDRA Guidelines in order to test the PMFCC. These are shown here:

- Setting is Ottawa, Canada.
- Mary is 14 years old. Nancy is 13.
- Mary has no siblings. Nancy has a sister.
- Mary's parents educational background is omitted. Nancy's parents are university graduates.
- Mary's parents' occupations are omitted. Nancy's father is a hard-working financier Nancy's mother is currently a full-time homemaker.
- Mary's extended family history is omitted. Nancy extended family has a history of alcoholism, marital relationship instability and possible ADHD/LD characteristics.

Mary Smith is a 14-year-old female who lives in Ottawa, Canada. She was a normal birth weight of 8lbs and was delivered with no complications. Mary has no siblings. Mary had symptoms of hyperactivity when she was growing up; however, these were thought to be normal behavior. At home Mary is unable to maintain sleep and work routines, and in the past months Mary has had increasing difficulty coping with the demands of school, reacting with increased frustration and irritability. She is constantly complaining that she cannot focus. Because Mary has started to hate school, Mary's mother is concerned that she will not pass her courses this year.

Mary's teachers describe her as a hardworking and willing student; however, she experiences difficulties with meeting deadlines and completing assignments, as well as sustaining his attention at school. She has difficulties with focusing and sitting still in her Grade 8 classes. They describe her as distractible and inattentive most of the time unless she is engaged in an activity of interest. Mary's disorganization is also a cause for concern, as she often loses or forgets important work, forms and lunches at home and is generally unprepared for school. Mary is unenthusiastic about reading and this is reflected in her vocabulary and reading comprehension. Mrs. Smith was concerned that she may have a cognitive disability, but psychoeducational testing revealed that Mary is of average cognitive capability.

6.1.1 **Traditional Care Process**

We now describe the traditional care process for such a situation as it would likely exist without any support from our PMFCC. We structure this in keeping with the CADDRA ADHD Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). In this approach, Mary's mother, Mrs. Smith, presents Mary to their family doctor, Dr. Jones. After psychological testing by Dr. Martin, Mary is diagnosed with ADHD. Dr. Jones works to determine the correct medication and dose. Concurrently, Mary undergoes cognitive behavioral therapy with Dr. Martin, to establish time management and organization strategies. Mrs. Smith represents Mary and is the "glue" between Mary's school, the psychologist and Dr. Jones. She is also responsible for obtaining and paying for the medication from the Pharmacist, as well as interfacing with teachers at Mary's high school. We assume that Mary attends a public school in Ontario which has a program for special education and can obtain an Individual Education Plan which includes accommodations and technology as required.

This process is captured in detail in Table 6-1 with Dr. Jones' actions in purple and Dr. Martin's actions in green. Per CADDRA Guidelines described in Figure 2-3 (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018), Dr. Jones titrates different medications to determine effective type and dose. In this scenario Dr. Jones changes medication doses of Adderall from 5mg to 10mg; however, Mary experiences side effects. The prescription is changed to Vyvanse, with an initial dose of 20mg. This is titrated again to 40mg over several weeks and proves effective in combatting symptoms of inattentiveness. Dr. Jones agrees that this is the optimal dose and Mary is prescribed 40mg per day for 4 weeks. However, during this time, Mary discontinues usage of the Vyvanse since she experiences social stigma at school, which is occurs in 50% to 66% of patients who take ADHD medication (Charach & Fernandez, 2013).

Table 6-1: Clinical Vignette - Treatment Log

Date	Mary Smith & Mrs. Smith	Dr. Jones (Family Physician)	Dr. Martin (Psychologist)	Collaboration Notes
Jan. 4	-Visit Dr. Jones	-Referral: Dr. Martin for ADHD assessment		- Process based on CADDRA Guidelines
Jan. 11	-Visit Dr. Martin		-Set up Initial Information Gathering process (Step 1) -Schedule ADHD Specific Interview (Step 3)	- Steps based on CADDRA Guidelines - forms filled by parent, teachers, patient and mailed to Dr. Martin.
Jan 16	-Visit Dr. Jones	Medical Review (Step 2)		- Steps based on CADDRA Guidelines
Feb 8	-Visit Dr. Martin		-ADHD Specific Interview (Step 3)	- Steps based on CADDRA Guidelines
Feb 15	-Visit Dr. Martin -Agree to CBT follow-up sessions		-Begin Feedback / Treatment Recommendations (Step 4) - Mary is positive for ADHD -Follow-up sessions (CBT) scheduled	- Steps based on CADDRA Guidelines -Hard copy of Dr. Martin's report given to Mrs. Smith and sent by mail to Dr. Jones.
Feb. 18	--Visit Dr. Jones -Agree to treatment	-Confirm ADHD diagnosis -Begin Feedback and Treatment Recommendations (Step 4) -Rx: 5mg Adderall q.AM		-Prescribing medication by Dr. Jones and psychological follow-up by Dr. Martin. They do not communicate.. Mrs. Smith is responsible for coordinating Mary's care
Feb 22 Mar 8 Mar 22 Apr 5	-Visit Dr. Martin		-CBT - time management and organization.	-CBT recommendations based on CADDRA Guidelines and CRPO
Apr 19	-Visit Dr. Martin		-End Treatment Dr. Martin	
Feb. 22	-Visit Dr. Jones	-s.e. headache, stomach-ache @5mg Adderall. Maintain current Rx to determine if side effects subside.		- Rx Titration based on CADDRA Guidelines and CPSO directives

Mar 1	-Visit Dr. Jones	-s.e. not subsided. Rx 20mg Vyvanse q.AM. Track in 2 weeks.		
Mar 15	-Visit Dr. Jones	-Good tolerance. ↑Rx to 30mg Vyvanse -Track in 2 weeks.		
Mar 29	-Visit Dr. Jones	-Good tolerance. ↑Rx to 40mg Vyvanse -Track in 2 weeks.		
Apr 12	-Visit Dr. Jones	-Optimal dose. Maintain Rx -Track in 4 weeks.		
May 8	-Mrs. Smith calls Dr. Jones.	-Appointment scheduled		Mary not taking meds
May 10	-Visit Dr. Jones	-Symptoms due to noncompliance. -Rx 20mg Vyvanse for 1 week. -Address reasons for noncompliance		
May 17	-Visit Dr. Jones	-↑Rx to 30mg Vyvanse. Provide training -Track in 1 week.		- Rx Titration based on CADDRA Guidelines and CPSO directives -Training provided using CADDRA Guidelines to explain impacts of noncompliance. -Follow up visits as per CADDRA guidelines
May 24	-Visit Dr. Jones	-Good tolerance and symptom control -↑Rx to 40mg Vyvanse -Track in 4 weeks.		
May 31	-Visit Dr. Jones	-Optimal dose/ Maintain Rx 40mg -Track in 4 weeks.		
June 28	-Visit Dr. Jones	-Patient on track -Maintain Rx		

6.1.1.1 Collaboration Space Ontology Template

A detailed mapping, performed by this researcher, of the Collaboration Space Ontology Template to the Clinical Vignette is shown in Table 6-2 below. **Bolded** items in the table are developed in the scenarios that follow.

Table 6-2: Clinical Vignette - Mapping to Collaboration Space Ontology Template

Collaboration Space Ontology Template		Clinical Vignette
Agile Process		
Workflow	Treating	Treatment of Mary Smith by Dr. Jones and Dr. Martin.
	Consulting	Meetings on an as-needed basis between healthcare professionals Dr. Martin and Dr. Jones.
Information Exchange	Establish Patient Outcomes	Information related Relief of ADHD symptoms occurs with Dr. Jones. CBT report (for school improvement) is provided to parent. Ongoing status (improvement or decline in health) for Mary is not captured unless there is a doctor's visit.
Communication	Scheduled Meetings	Follow up visits
	Unscheduled Meetings	Meetings occur on an as-needed basis
Context of Care		
Role	Patient	Mary Smith
	Family Member	Mrs. Smith (Mother)
	Family Physician	Dr. Jones
	Psychologist	Dr. Martin
Setting of Care	Clinician's office	Dr. Jones's office
	Psychologist's office	Dr. Martin's office
Modality	In Person Care	Mary receives care in person at offices of Dr. Jones and Dr. Martin
	Synch. Communication	Appointments with Dr. Jones and Dr. Martin
	Asynch. Communication	Care team communications happen over time
Care Outcomes		
Goals of Care	Goal	Treatment goals established by Dr. Jones

Establishing Common Ground	Treatment Guidelines	Canadian ADHD Practice Guidelines (CADDRA)
	Healthcare Standards	Various (ex. SNOMED, ICD-10)
Maintaining Awareness	Reminders	Telephone reminders for appointments with Dr. Jones and Dr. Martin
	Professional Organizations	College of Physicians and Surgeons of Ontario
		College of Registered Psychotherapists of Ontario
	Training	ADHD training using CADDRA resources
Collaboration Resources		
Artifacts	**Standardized Forms**	Canadian ADHD Practice Guidelines (CADDRA forms) (See Figure 2-3)
		Agile Treatment Plan developed in Scenarios 1, 2
		Collaborative Care Model Canvas developed in Scenario 3
	Standardized Dashboard	**Agile Collaboration Dashboard developed in Scenarios 1, 2, 3**
	Standardized Indicators	**ICF Patient Card developed in Scenarios 2**
Collaboration Technology	Fax, Regular Mail	Communication between Dr. Jones and Dr. Martin
	Cellphone/SMS/Text Messaging	Cellphone used by Mrs. Smith to communicate with Dr. Jones' office
Supporting Services	**All**	**Developed in Scenario 3**

6.2 Scenario 1: Agile Treatment Plan & Agile Collaboration Dashboard

In this section, we apply our PMFCC to the Clinical Vignette through the introduction of two key Artifacts. The main focus of this scenario is to determine if Team Effectiveness (as described in section 4.3.1) is improved.

6.2.1 Artifacts

We discuss two key Artifacts that are applied to this Clinical Vignette: The Agile Treatment Plan and the Agile Collaboration Dashboard.

6.2.1.1 Agile Treatment Plan

The objective of the ATP is to provide a single document which provides the team with a holistic view of the care that the patient will receive from a collaboration perspective. Figure 6-3 provides an example of an ATP used in our ADHD scenario. Field descriptions are provided in Chapter 5.3.1. Further details on the sequence of the care process used to populate the fields in Figure 6-3 are found in the diagnosis and treatment log in Table 6-5. Note that the Short-Term Goals Status field is expected to be entered manually and simply refers to completion status of the goal.

AGILE TREATMENT PLAN
ATP-3
Sprint: 28/06/2019 - present

Name: Mary Smith	**DOB:** July 1, 2006	**Current Date:** June 28, 2019

Presentation

Current symptoms include periods of inattentiveness, frustration, irritability and poor self-esteem. Additionally, in the past months Mary has had difficulty coping with stressors and loss of interest in school.

Long Term Goals

Symptoms of ADHD will be significantly reduced or eliminated through medication and therapy. ADHD-dependent obstacles to learning are reduced or eliminated through strategies at home and at school.

Short Term Goals	**Start Date**	**Completion Date**	**Status**
1. Address reason for drug non-compliance	May 10, 2019	June 28, 2019	Completed
2. Alleviate physiological symptoms of ADHD	May 10, 2019	June 28, 2019	Completed
3. Help Mary manage academic expectations for current school year	Jan 4, 2019		In progress

Interventions	**Team Member**	**Short Term Goal**	**Status**
a) Determine best medication for Mary and monitor her progress.	Dr. Jones	2	Completed
b) Mary will take medications on a regular basis as prescribed.	Mary Smith	2	Re-opened
c) Mrs. Smith will record and report effect of Rx on Mary.	Mrs. Smith	2	In progress
d) Dr. Martin will provide recommendations to help Mary succeed at school.	Dr. Martin	3	Completed
e) Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.	Mary Smith	3	Completed
f) Mrs. Smith will collaborate with Mary's teachers to monitor and report success of Dr. Martin's recommendations.	Mrs. Smith	3	In progress
g) Address reasons for noncompliance of Rx	Dr. Jones	1	In progress

Updates

Date: June 14, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Videoconference** -Consultation with Mary and Mrs. Smith. Good Rx compliance.
Date: May 31, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Reports decreased symptoms of inattentiveness. Keep 40mg Vyvanse dose and observe for 4 weeks.
Date: May 24, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Increase dose to 40mg Vyvanse for 1 week
Date: May 17, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Increase Rx to 30mg Vyvanse for 1 week. Provide training on ADHD noncompliance.
Date: May 10, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: a), g) Modality: Visit** -Recurrence of symptoms due to noncompliance. Begin 20mg Vyvanse for 1 week. -Address reasons for noncompliance.

History

Case Conference		**Sprint**		**ATP**
0	04/01/2019	0	04/01/2019 - 15/02/2019 **(43 days)**	***ATP-0***
1	15/02/2019	1	15/02/2019 – 12/04/2019 **(57 days)**	***ATP-1***
2	12/04/2019	2	12/04/2019 – 10/05/2019 **(29 days)**	***ATP-2***

Figure 6-1: Scenario 1 - Agile Treatment Plan

6.2.1.2 Agile Collaboration Dashboard

The objective of the Agile Collaboration Dashboard (ACD) is to provide a quick view of the status of collaboration-related requirements for each member of the team by providing a simple visualization. The ACD provides a user-friendly view of elements of the Performance Management Model which are discussed in 6.2.2.3. as shown in Table 6-3. The information that appears on the ACD comes from KPIs in Table 6-6 that are derived from the Performance Management Model discussed in Section 6.2.2.3. A link to the current Agile Treatment Plan is provided in the dashboard.

Table 6-3: Scenario 1 - Agile Collaborative Dashboard

Patient: Mary Smith	**Date:** May 8, 2019	**ATP**
Collaboration Element		**Status**
Time to establish patient outcomes (weeks)		
Time to establish ATP (weeks)		
Time left in current Treatment Sprint (days)		
Number of Case Conferences to date		
Number of Consultations to date		
Number of Treatment Sprints to date		
Total number of team members trained on ATP		
Total number of team members trained on ACD		
Total number of accesses to ATP		
Total number of accesses to ACD		

6.2.2 Components

6.2.2.1 Collaboration Space Ontology Template

The goal of the Collaboration Space Ontology Template as shown in Figure 6-2 is to provide a set of collaboration concepts in the healthcare domain that shows categories and the relationship between them. Circled items in Figure 6-2 and **bold red** items in Table 6-4 highlight the aspects addressed in this scenario when supported by the ATP and ACD.

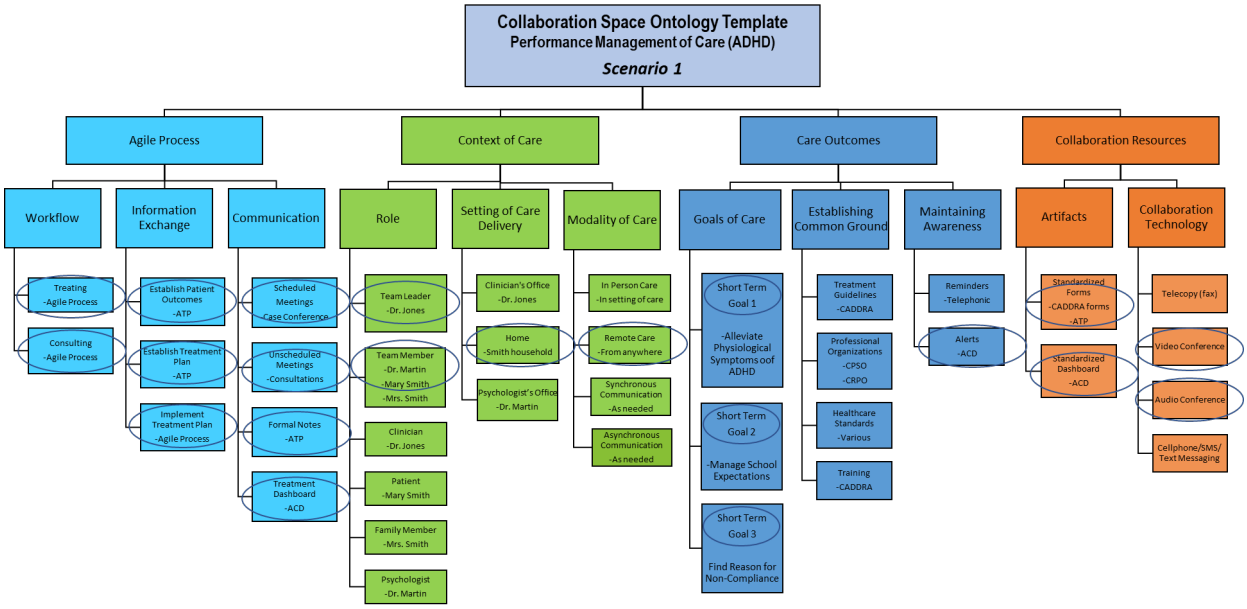


Figure 6-2: Scenario 1 - Application of Agile Process Model to CSOT

The Agile Process category describes aspects related to the series of actions related to treatment and ongoing management of ADHD. In the case of Mary Smith, the Workflow category consists of treating ADHD with medication and cognitive behavioral therapy (CBT). This includes the establishment of a treatment plan, treatment, how communication takes place between team members, etc. Consulting occurs in the context of the agile process between any team members. In the Information Exchange category, scheduled or unscheduled meetings occur within the structure of the Agile Process. Formal notes are captured in the Agile Treatment Plan. Another aspect of the Agile Process is the use of technology such as video or audio conferencing to facilitate communication. This allows other, sometimes more efficient, ways to treating Mary. For example, Mary can be treated from home using video conferencing technology if a simple follow up appointment to monitor the effects of medication is required. Also, the use of cellphones to receive ACD alerts is also shown. The ATP is considered a standardized form under Artifacts, while the ACD is a standardized dashboard.

Table 6-4: Scenario 1 - Application of Agile Process Model to CSOT

Collaboration Space Ontology Template		Clinical Vignette in Scenario 1
Agile Process		
Workflow	**Treating**	**Treatment of ADHD in context of APM**
	Consulting	**Meeting between any team member during Treatment Sprint**
Information Exchange	**Establish Treatment Plan**	**Coordinated using Agile Treatment Plan**
	Establish Patient Outcomes	**Coordinated using Agile Treatment Plan**
	Implement Treatment Plan	**Coordinated using Agile Treatment Plan**
Communication	**Scheduled Meetings**	**Case Conferences**
	Unscheduled Meetings	**Consultations**
	Formal Notes	**Coordinated using Agile Treatment Plan**
	Treatment Dashboard	**Agile Collaboration Dashboard**
Context of Care		
Role	**Team Leader**	**Team Leader of the Agile Process, Dr. Jones**
	Team Members	**Team Members of Agile Process, Dr. Martin, Mary Smith, Mrs. Smith**
	Patient	Mary Smith
	Family Member	Mrs. Smith (Mother)
	Family Physician	Dr. Jones
	Psychologist	Dr. Martin
Setting of Care	Clinician's office	Dr. Jones's office
	Psychologist's office	Dr. Martin's office
	Home	**Mary can consult with care team from home**
Modality	In Person Care	Mary receives care in person with Dr. Jones and Dr. Martin
	Asynchronous Communication	Care team communications happen over time
	Synchronous Communication	Care team meets at one time together
	Remote Care	**Mary can be monitored without office visit**
Care Outcomes		
Goals of Care	ATP Short Term Goals	Treatment goals established by Team
Establishing Common Ground	Treatment Guidelines	Canadian ADHD Practice Guidelines (CADDRA)
	Professional Organizations	College of Physicians and Surgeons of Ontario
		College of Registered Psychotherapists of Ontario
	Healthcare Standards	Various (ex. SNOMED, ICD-10)
	Training	ADHD training using CADDRA resources
Maintaining Awareness	**Alerts**	**Agile Collaboration Dashboard**
Collaboration Resources		
Artifacts	**Standardized Forms**	Canadian ADHD Practice Guidelines (CADDRA forms) (See Figure 2-3)
		Agile Treatment Plan developed in Scenarios 1, 2
		Collaborative Care Model Canvas developed in Scenario 3
	Standardized Dashboard	**Agile Collaboration Dashboard developed in Scenarios 1, 2, 3**
	Standardized Indicators	**ICF Patient Card developed in Scenarios 2**
Collaboration Technology	Fax, Regular Mail	Communication between Dr. Jones and Dr. Martin
	Audio/Video Conference	**Patient and team meetings**
	Cellphone/SMS/Text Messaging	**Used to receive alerts**

The **Context of Care** category provides the circumstances for a collaboration event, in terms which can be fully understood and assessed by all team members. The roles in our Scenario are Dr. Jones (Family Physician), Dr. Martin (Psychologist), Mary Smith (Patient) and Mrs. Smith (Family Member). Context of Care also includes geographic and organizational setting (Setting).

These are the offices of Dr. Jones and Dr. Martin. Modality refers to whether care is being administered remotely by a practitioner, on site by a practitioner, or by the patient (self-care). This also refers to synchronous and asynchronous methods. In our case, Mary Smith is treated in person (In Person Care). She is also treated remotely by videoconference.

The **Care Outcomes** category refers to the desired end-result of a care process and consists of two main categories: Establishing Common Ground and Maintaining Awareness. Establishing Common Ground refers to the body of knowledge and experience in place to ensure that all members of the team share the same ideas and have a collective understanding of desired end-result for the patient. Dr. Jones' ADHD practice is informed by the Canadian ADHD Practice Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). Dr. Jones provides education (Training) to Mary Smith and Mother regarding the causes, treatment, and expectations for treatment of Mary's condition. Dr. Martin also uses the Canadian ADHD Practice Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018) Maintaining Awareness refers to the practical mechanisms required to ensure that team members can communicate relevant patient information on an ongoing basis (in current practice there are no agreed upon mechanisms in place to maintain awareness). Alerts are provided in an ad hoc fashion.

Finally, the **Collaboration Resources** category contains two categories. Collaboration Technology includes fax and regular mail. The Electronic Health Record Manager which maintains Mary's medical history as it is only available to Dr. Jones. Artifacts used in this scenario include forms, assessments and questionnaires mentioned in Figure 2-3, as well as the Agile Treatment Plan and the Agile Collaboration Dashboard.

6.2.2.2 **Agile Process Model**

The Agile Process Model for our Scenario is shown in Figure 6-3. Several Treatment Sprints are normal and expected. The Agile Process commences with Mary and her mother presenting to Dr. Jones for treatment (Admit). Dr. Jones is the Family Physician and Team Leader and initiates healthcare delivery. The Agile Process sees the creation of a networked team consisting of the Family Physician, Psychologist, Parent, and Patient. The team consists of members who are directly associated with the healthcare delivery team. As a minor, Mary is unable to perform certain tasks, which Mrs. Smith is responsible for. Mrs. Smith performs interventions that implement recommendations from Dr. Jones and Dr. Martin. Mrs. Smith interacts with the Pharmacist, the Guidance Counselor and Mary herself (to ensure medication compliance, for example) and reports progress to the care team. Her role in this scenario is to represent the interests of Mary from a familial, social, and educational capacity. Pharmacist and Guidance Counselor are omitted from the scenario for simplicity.

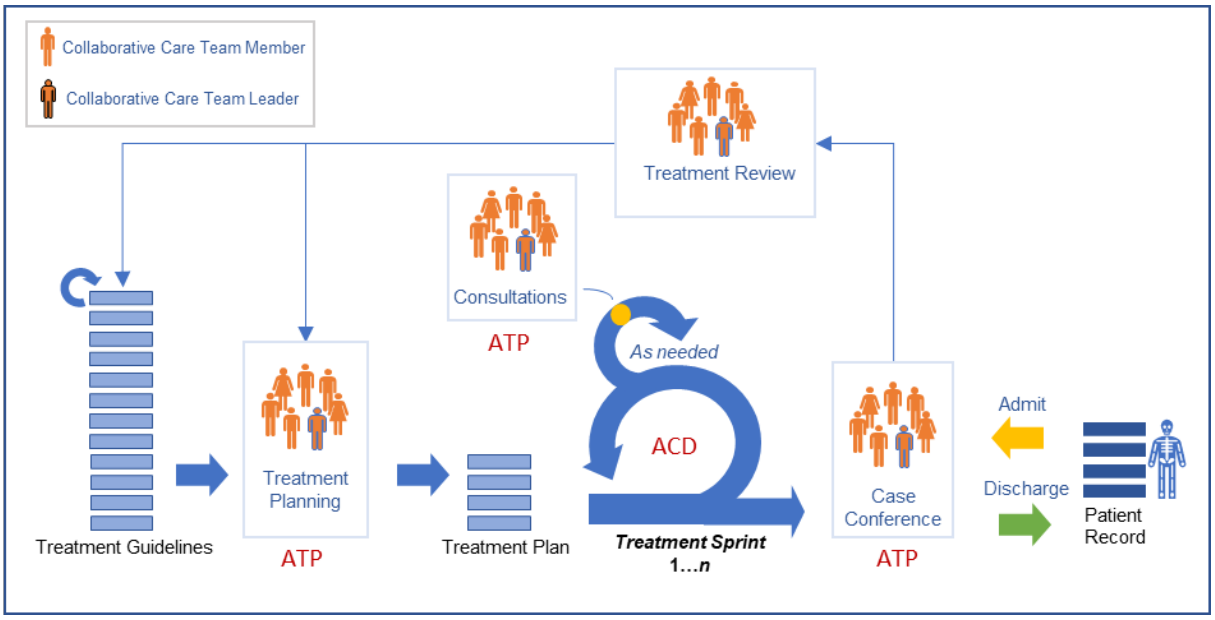


Figure 6-3: Scenario 1 - Agile Process Model

The team agrees on an initial course of action at an initial Case Conference meeting (Case Conference 0) and discusses the interventions and actions required to diagnose Mary. An Agile Treatment Plan (ATP-0) is created and implemented. Subsequent Case Conferences are held at logical times during Mary's treatment, after which an ATP is created. The specific sequence is described in the treatment log in Table 6-5 below. The team decides on a time frame to achieve these goals, along with how and when ongoing Consultations will take place if required. As the team embarks on the Sprint, they commit to checking the Agile Collaboration Dashboard as needed to ensure that interventions are on track and to identify issues early in the process. They agree that if required, a Consultation meeting will be convened ideally within 24 hours.

Each member of the team provides information or other assistance to help with impediments as needed. Mrs. Smith's role is critical as she is reports on Mary's reactions to medication and helps to implement time management and organization recommendations by Dr. Martin. Because it is agile, the care team is results-oriented, flexible and governs itself around Mary's care goals. Note that each member of the team becomes a source of expertise in their own

disciplines, with the recognition that success can only occur when all members are fulfilling their responsibilities to the patient as well as each other. In this way, at times the Dr. Jones can play a non-leadership while remaining the Team Leader as needed – a key feature of agile methodologies.

The ATP is updated according to the results of the Case Conferences as needed. Treatment Sprints occur until all short-term goals are satisfied. The final Case Conference will be held where there will be an agreement that all long-term patient goals have been successfully achieved. The following is also summarized in Table 6-5 below:

- ATP-0 is the first document that contains initial diagnosis information and is created at Case Conference 0.
- ATP-1 refers to the document that is created at the end of Case Conference 1. It is updated by the team during Treatment Sprint 1.
- ATP-2 refers to the document that is created at the end of Case Conference 2. It is updated by the team during Treatment Sprint 2.
- APT-3 refers to the document that is created at the end of Case Conference 3. It is updated by the team during Treatment Sprint 3.
- APT-4 refers to the document that is created at the end of Case Conference 4. It is updated by the team during Treatment Sprint 4 (Treatment). Note that Sprint 4 refers to the indefinite follow up by Dr. Jones, since this is required for ADHD.
- Note that once closed, an ATP cannot be modified and becomes a permanent record.

Steps refer to CADDRA Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). As in Table 6-1, Dr. Jones' actions are shown in purple while Dr. Martin's are shown in green. Blue text indicates Case Conferences. Consultations are shown in orange. Creation, review, edits, closure, or update of the Agile Treatment Plan is shown in red. Changes to Interventions in the ATP generates alerts to team members through the Agile Collaboration Dashboard and are shown in turquoise. Finally, all changes from Table 6-1 are shown in **bold**

font. The log demonstrates greater participation of Mary Smith and Mrs. Smith in the care process. We also see greater communication between Dr. Jones and Dr. Martin. The use of technology facilitates this collaboration through use of audio and videoconferencing. This allows remote monitoring of Mary.

Table 6-5: Scenario 1 -Treatment Log Depicting Use of Agile Process Model

Date	Mary Smith & Mrs. Smith	Dr. Jones (Family Physician)	Dr. Martin (Psychologist)	Collaboration Notes
Jan. 4	-Visit Dr. Jones	-Referral: Dr. Martin for ADHD assessment		-- Process based on CADDRA Guidelines **-Patient Admit** **-Case Conference 0** **-Treatment Sprint 0 begins**
		-Create ATP-0		**-Dr. Jones adds Dr. Martin, Mary Smith and Mrs. Smith with ATP-0 to create team.**
Jan. 11	-Visit Dr. Martin		-Set up Initial Information Gathering process (Step 1) -Schedule ADHD Specific Interview (Step 3)	-- Steps based on CADDRA Guidelines
Jan 16	-Visit Dr. Jones	Medical Review (Step 2)		-- Steps based on CADDRA Guidelines
Feb 8	-Visit Dr. Martin		ADHD Specific Interview (Step 3)	-- Steps based on CADDRA Guidelines
Feb 9			**Dr. Martin requests Consultation with Dr. Jones**	
Feb 12		**-Audioconference with Dr. Martin**		**Consultation 1: Dr. Jones and Dr. Martin review findings of Steps 2 and 3. This is required since in the next step, all team members are present, and the treatment is kicked off.**
Feb 15	-Visit Dr. Jones -Receive diagnosis -Begin treatment	-Confirm ADHD diagnosis -Begin *Feedback and Treatment Recommendations* (Step 4) -Mary and Mrs. Smith agree to pharmacological treatment -Rx: 5mg Adderall q.AM	-Begin Feedback and Treatment Recommendations (Step 4) -Dr. Martin's report provides suggestions for school success as part of psychoeducation treatment -Follow-up sessions scheduled -Hard copy of report given to Mrs. Smith and sent by mail to Dr. Jones.	- Steps based on CADDRA Guidelines **-Case Conference 1: Dr. Jones, Dr. Martin (video conference), Mary and Mrs. Smith.** **-Feb 15 and Feb 18 meetings combined into one Case Conference on Feb 15 in which all members of the care team are present. Pharmacological treatment begins earlier as a result. CBT dates remain.**
		- Close ATP-0 **- Create ATP-1**		**--Team reviews ATP-0, sets up treatment goals, and agrees to ATP-1** **-Treatment Sprint 1 begins**
~~Feb 18~~				**Meeting not needed (combined with Feb. 15)**
Feb 22 Mar 8 Mar 22 Apr 5	-Visit Dr. Martin -Visit Dr. Martin -Visit Dr. Martin -Visit Dr. Martin		-CBT - time management and organization.	-CBT recommendation based on CADDRA Guidelines
Apr 19	-Visit Dr. Martin		-CBT - time management and organization.	--CBT recommendation based on CADDRA Guidelines and CRPO
			-Update ATP-1	**-Dr. Martin reports ATP-1: Intervention d): *Dr. Martin will provide recommendations to help Mary succeed at school.* Is complete.** **Intervention e): *Mary will work with Dr. Martin and diligently apply the***

				recommendations from Dr. Martin for academic success. **Is complete.** **-ACD updated**
Feb. 22	-Visit Dr. Jones	-s.e. headache, stomach-ache @5mg Adderall. -Maintain current Rx to determine if side effects subside. **- Update ATP-1**		- Rx Titration based on CADDRA Guidelines and CPSO directives **-ACD updated**
Mar 1	-Visit Dr. Jones	-s.e. not subsided -Rx 20mg Vyvanse q.AM -Track in 2 weeks. **- Update ATP-1**		
Mar 15	-Visit Dr. Jones	-Good tolerance. -↑Rx to 30mg Vyvanse - Track in 2 weeks. **- Update ATP-1**		
Mar 29	-Visit Dr. Jones	-Good tolerance. -↑Rx to 40mg Vyvanse - Track in 2 weeks. **- Update ATP-1**		
Apr 12	-Visit Dr. Jones	-Audioconference -Optimal dose -Maintain Rx - Track in 4 weeks. **- Update ATP-1**	**-Audioconference**	**-Case Conference 2: In person with Dr. Jones, Mary and Mrs. Smith, audioconference with Dr. Martin.**
		- Close ATP-1 **- Create ATP-2**		**-Team reviews ATP-1.** **-Interventions complete:** **a) *Determine best medication for Mary and monitor her progress.*** **b): *Mary will take medications on a regular basis as prescribed.*** **c): *Mrs. Smith will record and report effect of prescribed medication on Mary.*** **-Treatment Sprint 2 begins**
May 8	-Phone Dr. Jones	**-Update status of ATP-2** **-View alert on ACD**	**View alert on ACD**	**-Dr. Jones changes Intervention b) status of ATP-2 after Mrs. Smith's alert that Mary's symptoms have recurred.** **-ACD updated**
May 10	-Visit Dr. Jones	**-Videoconference** -Recurrence of symptoms due to noncompliance. -Begin Rx 20mg Vyvanse for 1 week. -Address reasons for noncompliance	**-Videoconference**	**-Case Conference 3: Dr. Jones, Dr. Martin (videoconference), Mary and Mrs. Smith** **-Pharmacological treatment begins earlier as a result.**
		-Close ATP-2 **-Create ATP-3**		**-Team reviews ATP-2 and decide to re-open Interventions:** **a) *Determine best medication for Mary and monitor her progress.*** **b) *Mary will take medications on a regular basis as prescribed.*** **e) *Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.*** **f). *Mrs. Smith will collaborate with Mary's teachers to monitor and report success of Dr. Martin's recommendations.*** **-A new Intervention is created: g) *Address reasons for noncompliance of Rx.*** **-Treatment Sprint 3 begins**
May 17	-Visit Dr. Jones	-↑Rx to 30mg Vyvanse - Provide training - Track in 1 week. **- Update ATP-3**		- Rx Titration based on CADDRA Guidelines and CPSO directives

May 24	-Visit Dr. Jones	-↑Rx to 40mg Vyvanse - Track in 1 week. **- Update ATP-3**		**-Dr. Jones fills in Update section of ATP-3 from May 17 to 31 to provide team awareness.** -Training provided using CADDRA Guidelines to explain impacts of noncompliance. **-ACD updated**
May 31	-Visit Dr. Jones	-Optimal dose achieved -Maintain Rx -Track in 4 weeks. **- Update ATP-3**		
June 14	**-Videoconference**	**-Videoconference** **-Good Rx Compliance** **- Update ATP-3**		**-Dr. Jones checks in on Mary (Consultation)** **-ACD Updated**
Jun 28	**-Videoconference**	**-Videoconference**	-Videoconference	-Case Conference 4: Dr. Jones, Dr. Martin, Mary Smith and Mrs. Smith
		-Close ATP-3 **-Create ATP-4**		**-Team reviews and closes Interventions a), b), e), f), g).** **-Treatment Sprint 4 begins**

6.2.2.3 **Performance Management Model**

The Performance Management Model is applied to Scenario 1 which correlates Collaboration Resources to the Agile Process to derive performance management KPIs. This is shown in Figure 6-4. Scenario 2 will capture KPIs related to Care Outcomes, and Scenario 3 will capture KPIs related to Context of Care.

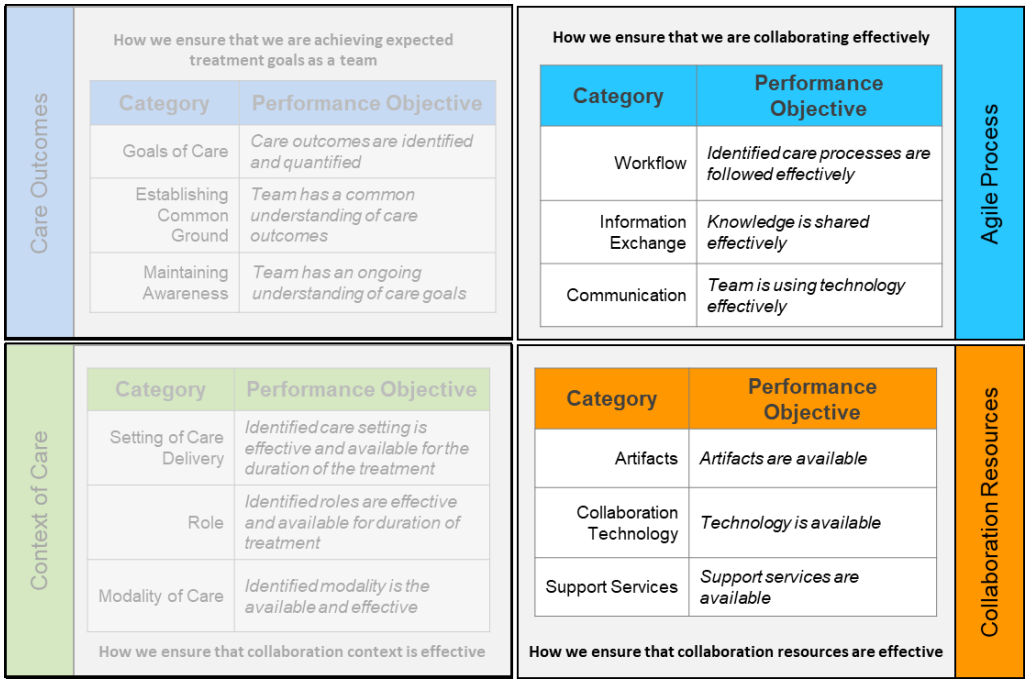


Figure 6-4: Scenario 1 - Parts of Performance Management Model Used to Develop KPIs

The Performance Management Metrics Chart is shown in Table 6-6 below and provides a set of KPIs for the performance objectives of the Agile Process category as described in section 5.2.3.7. We measure key aspects of team collaboration using a simple difference calculation between the current and target value. We have provided some target values as illustrations based on our Clinical Vignette. The indicator flags change depending on the current value of the KPI.

Table 6-6: Scenario 1 - Performance Management Metrics Chart (Agile Process)

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Agile Process			
Workflow			
Identified care processes are being followed effectively	Number of Treatment Sprints (n)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time left in current Treatment Sprint (days)	45	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Total number of months since care initiation (n)	12	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Information Exchange			
Knowledge is shared effectively	Number of Case Conferences [planned] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Number of Consultations [allocated] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish ATP (weeks)	1	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish patient outcomes (weeks) using ICP	3	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Communication			
Team is using technology effectively	Total number of team members trained on ATP (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of team members trained on ACD (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ATP (n)	5	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ACD (n)	20	≤ 0 (on track), > 0 (problem)
	Total number of remote care events (n)	4	≤ 0 (on track), > 0 (problem)
	Time to establish ICP protocol (n)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)

6.2.3 **Assessment**

The main focus of Scenario 1 was to determine if Team Effectiveness is improved. addition Coherent Care and Data Effectiveness are considered as well.

Team Effectiveness

1. Scenario 1 confirms that the APM and associated Artifacts ATP and ACD allow team members to interact in a structured way which decreases the cognitive load for team members to collaborate. In general, there was an easing of cognitive load and greater efficiency due to standardized artifacts and process. This corresponds to Criteria 1.
2. The format of the ATP provided a cohesive view of the plan of care by the whole team. Being able to view it in this way gave structure and allowed a temporal view of care. This was useful in identifying organization and timing issues such as the school cycle and its relationship to ADHD care outcomes. This corresponds to Criteria 4.
3. Use of the Agile Process Model resulted in fewer steps and meetings, a shorter treatment time, greater participation of the patient, and more communication between practitioners. Use of the Agile Treatment Plan and the Agile Collaboration Dashboard facilitated this collaboration. This corresponds to Criteria 3.
4. The Agile Treatment Plan does not have sufficient granularity in terms of patient outcomes. This makes the Agile Collaboration Dashboard very high level and limited in its usefulness. Scenario 2 responds to this deficiency.
5. A common language for articulating Interventions is required which will enable the fundamental Agile principle of continuous communication between team members. We use the IPC in Scenario 2 to further articulate interventions within a Treatment Sprint.

Coherent Care

1. The Collaboration Space Ontology Template was deemed useful and valid because it provides a way to view imprecise aspects of collaboration in a more defined, wholistic, and standard way. This corresponds to Criteria 5 where terminology is clarified so that terms and concepts are easily understood in the same way by all team members. However, concept clarity is required on for treatments goals. This is addressed in Scenario 2.
2. Through application to the ADHD Clinical Vignette, a key learning is that there are several Category 4 components that must be part of every collaborative care process.

Data Effectiveness

1. Scenario 1 provides the basic requirement for the of support usable and relevant data to be shared between team members in a timely and effective manner. The confirms Criteria 8.
2. Analysis of the PM model KPIs reveals that care outcomes were too general to be useful to the team. Due to the multidisciplinary nature of the team, a new way to communicate care outcomes is needed. This leads to the creation of a new Artifact which is demonstrated in Scenario 2, the ICF Patient Card.
3. The applicability of our PMFCC to healthcare organizations emerged as a key finding in Scenario 1 when we realized that a Healthcare Teams Manager could be a key user of PM KPIs.

These results are summarized in Table 6-7 below.

Table 6-7: Scenario 1 - Results

	Criteria	Evaluation Question	CSOT	APM	PMM	ATP	ACD	ICP	CCMC
Team Effectiveness	1	Decrease in cognitive load on team members		Scenario 1		Scenario 1	Scenario 1		
	2	Measurable view of collaboration							
	3	Changes quickly assimilated into the care process.		Scenario 1					
	4	Support for transparency of the whole collaboration environment.		Scenario 1					
Coherent Care	5	Concept clarity to ensure common understanding.	Scenario 1						
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.							
	7	Coordinated care plan							
Data Effectivene	8	Information is seamless and flows transparently between members and other stakeholders.				Scenario 1	Scenario 1		
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Scenario 1						

6.3 Scenario 2: ICF Patient Card

The main focus of this scenario is to determine if Data Effectiveness is improved by application of ICF scoring to our scenario. Team Effectiveness and Coherent Care are also considered. Scenario 2 addresses deficiencies in the PMFCC as identified in Section 6.2.3. We create an Artifact, the ICF Patient Card (IPC), derived from the International Classification of Functionality (ICF) (WHO FDRG, 2010) as described in Section 5.3.3. The IPC is used to articulate and score short term and long-term goals in terms of patient functionality. The IPC is created at the beginning of the Agile Process and continues to be updated as there are material changes in the patient's function. Because the team works from a single "playbook", the Artifact normalizes communication from the different professional perspectives of the team. The IPC also allows the ability to create a better consensus between all the assessors regarding the progress of the patient and whether a change in intervention is required. The assessments of Dr. Jones, Dr. Martin and Mrs. Smith are used in this scenario and enhances the process logged in Table 6-5 in Scenario 1.

6.3.1 Artifacts

In this section we apply the ICF Patient Card (IPC) to our Clinical Vignette. We subsequently show how the IPC impacts and evolves the base Components and Artifacts of Scenario 1.

6.3.1.1 ICF Patient Card

The ICF Patient Card is used throughout the collaborative care process. This section describes how this Artifact is applied to our Clinical Vignette for Mary Smith.

Setup

The care team uses the protocol described in Figure 5-15 to fill out the IPC form. The initial choice of ICF functionality in our scenario is determined by the owner of the ATP, Dr. Jones. Since Mary Smith is a 14-year-old female who presents with symptoms of ADHD, Dr. Jones works with the ICF ADHD Core Set for adolescents by using the online tool at https://www.icf-core-sets.org/. This tool contains the most up-to-date codes and is maintained by the World Health Organization. He also consults the Handbook International Classification of Functioning, Disability and Health: Children and Youth Version (*International classification of functioning, disability and health: children and youth version: ICF-CY*, 2007). Mappings of elements captured in the ATP in Scenario 1 to the ICF code are shown in Table 6-8.

Table 6-8: Scenario 2 - Mapping of Clinical Vignette to ICF and ATP

Symptoms/ Factors	ICF Category	ICF Code	ICF Description	ATP Intervention	ATP Short Term Goal
Periods of inattentiveness	Body Functions and Structure	b1400	Sustaining attention	a),b),c)	1,2
Frustration and irritability	Body Functions and Structure	b126	Temperament and personality functions	a),b),c)	1,2
Poor self esteem	Body Functions and Structure	b152	Emotional functions	a),b),c)	1,2
Difficulty coping with stressors	Activities and Participation	d240	Handling stress and other psychological demands	d),e),f)	3
Frustration at school	Activities and Participation	e585	School education	d),e),f)	3
Educational technology	Environmental Factors	e130	Products and technology for education	d),e),f)	3
IEP	Environmental Factors	e465	Education and training services, systems and policies	d),e),f)	3

We use the ATP in Scenario 1 which includes Interventions and Short Term Goals to demonstrate the application of the IPC. The main update to the ATP in Scenario 2 is change of Status to Patient Functional Status which now uses a color-coded system linked to a calculation of composite ICF Scores as shown in Figure 6-7. For example, Short Term Goal 1 is a composite score of b1400, b126 and b152. This is discussed further in Section 6.3.1.2.

Initial Assessment (IPC-0)

The next step is to populate the ICF Patient Card. As mentioned, we use the protocol described in Figure 5-15 for filling out the IPC. As shown in Table 6-9, each assessor assigns a score to Mary's functional code according to the functionality that Dr. Jones proposes (based on the ICF ADHD Core Set). For simplicity we have excluded Mary's self-assessment scores and assume that Mary's mother represents her daughter's score. After a discussion at the Case Conference/Treatment Planning Meeting, the team achieves agreement on a consensus score, which is articulated as Consensus in the table. They also agreed on a target score, which represents the final goal for treatment. Descriptions for score levels are found in 5.3.3.2.

Table 6-9: Scenario 2 - ICF Patient Card

IPC-0 **ICF Patient Card – Summary of Functional Scores**							
Name: Mary Smith		**DOB:** July 1, 2006			**Current Date:** February 15, 2019		
ICF Category	**ICF Code**	**Description**	**SCORE**				
Body Functions and Structure			Level of Impairment *0=no impairment → 4=complete impairment*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	b1400	Sustaining attention	3	2	4	3	0
	b126	Temperament and personality functions	3	2	3	2	1
	b152	Emotional functions	2	2	3	2	1
Activities and Participation			Performance/Capacity *0=no difficulty → 4=complete difficulty*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	d240	Handling stress and other psychological demands	+2/1	+2/1	+4/1	+3/1	+3/1
	e585	School education	+2/1	+3/1	+4/1	+3/1	+3/1
Environmental Factors			Facilitator or Barrier *+4=complete facilitator → 0=no facilitator/barrier* *0=no facilitator/barrier → 4=complete barrier*				
			Dr. Jones	Dr. Martin	Mrs. Smith	Consensus	Target
	e130	Products and technology for education	+4	+4	+4	+4	+4
	e465	Education and training services, systems and policies	+4	+4	+3	+4	+4

Ongoing Assessments

The addition of the IPC within the Agile Process Model is described in the treatment log in Table 6-12 in section 6.3.2.2 which shows how the IPC card is created, updated, and used throughout treatment and diagnosis. It demonstrates an important advantage of the IPC: all team members can communicate care status without directly accessing the ATP. That is, the IPC scores can be updated by any team member, which is identified in the ACD, which may trigger an action for the team. In Scenario 1, Mrs. Smith reported that Mary's symptoms had recurred. In Scenario 2, an alert is sent to the team via the ACD (see Table 6-10) when the IPC is updated by Mrs. Smith on May 8th. This causes the team to initiate a Case Conference on May 10th where Mary reveals that she had stopped taking her meds in April, ultimately leading to a recurrence of symptoms. When the team met, a specific discussion regarding b1400 Sustaining Attention occurrs. The results of this interaction are shown in Figure 6-5.

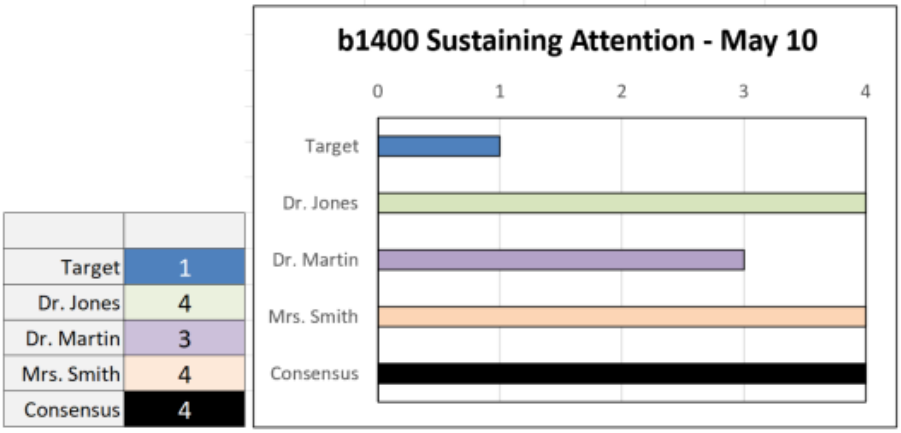


Figure 6-5: Scenario 2 - Results of Consensus Meeting

At this meeting, they decided to change their current intervention, which corresponds to action code c2 in Table 5-12. Once the treatment was restarted, Mary's symptoms subsided, and her functionality improved. We see that her target was not achieved immediately; however, she

reached the target laid out by the team by October. Mary's functional scores over time are shown in Figure 6-6.

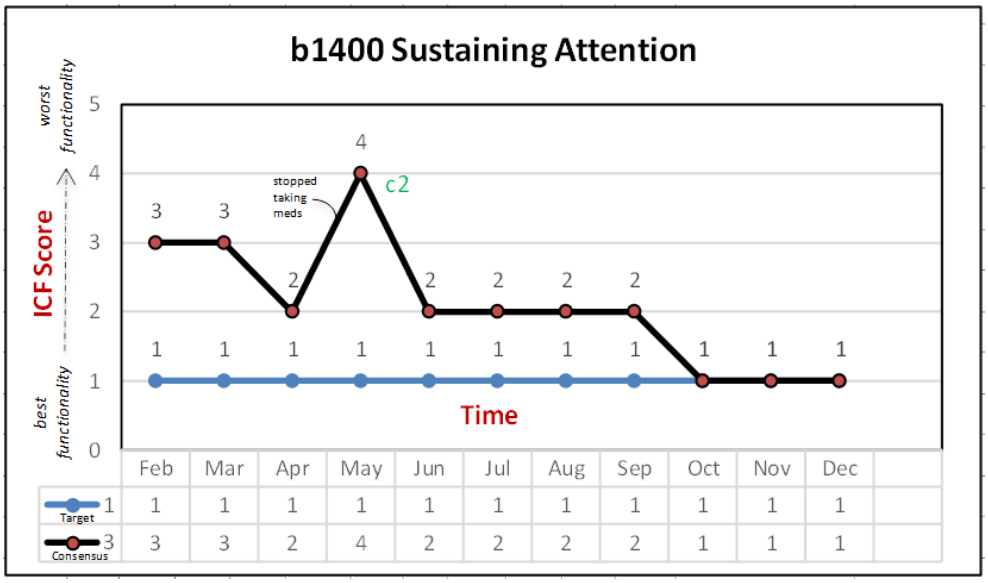


Figure 6-6: Scenario 2 - Graphical Representation of b1400 Functionality Scores Over Time

6.3.1.2 Agile Treatment Plan

The relationship between the IPC and the ATP is shown in Figure 5-16. As described in Table 6-8, the Short-Term Goal Status field in Scenario 1 is now linked to the IPC. Since the IPC is reviewed at the Case Conference, it accurately reflects the progress of the patient at that time. Furthermore, functionality scores are mapped to the short-term goal of the ATP as shown in the Patient Functional Status field. For example, for Short Term Goal 1, Red refers to a score of 4, Yellow refers to a score of 3 or 2, and Green refers to a score of 1 or 0 (as described in Section 5.3.3.2). In this way, specific Interventions (associated with each Short-Term Goal) can also be identified and evaluated to determine their effectiveness. Note that Short Term Goals can change, as in this case, where Mary stopped taking her medication and her symptoms recurred. The IPC gives Mary Smith a way to signal a change in Mary's functionality to the team. This is shown in Figure 6-7 below.

AGILE TREATMENT PLAN ATP-3				IPC-3
Name: Mary Smith	**DOB:** July 1, 2006		**Current Date:** June 28, 2019	
Presentation				
Current symptoms include periods of inattentiveness, frustration, irritability and poor self-esteem. Current symptoms include periods of inattentiveness, frustration, irritability and poor self-esteem. Additionally, in the past months Mary has had difficulty coping with stressors and loss of interest in school.				
Long Term Goals				
Symptoms of ADHD will be significantly reduced or eliminated through medication and therapy. ADHD-dependent obstacles to learning are reduced or eliminated through strategies at home and at school.				
Short Term Goals		**Start Date**	**Completion Date**	**Patient Functional Status**
1. Find reason for drug non-compliance		May 10, 2019	June 28, 2019	
2. Alleviate physiological symptoms of ADHD		May 10, 2019	June 28, 2019	
3. Help Mary manage academic expectations for current school year		Jan 4, 2019		
Interventions		**Team Member**	**Short Term Goal**	**Intervention Status**
a) Determine best medication for Mary and monitor her progress.		Dr. Jones	2	Completed
b) Mary will take medications on a regular basis as prescribed.		Mary Smith	2	Re-opened
c) Mrs. Smith will record and report effect of Rx on Mary.		Mrs. Smith	2	In progress
d) Dr. Martin will provide recommendations to help Mary succeed at school.		Dr. Martin	3	Completed
e) Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.		Mary Smith	3	Completed
f) Mrs. Smith will collaborate with Mary's teachers to monitor and report success of Dr. Martin's recommendations.		Mrs. Smith	3	In progress
g) Address reasons for noncompliance of Rx		Dr. Jones	1	In progress
Updates				
Date: June 14, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Videoconference** -Consultation with Mary and Mrs. Smith. Good Rx compliance.			
Date: May 31, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Reports decreased symptoms of inattentiveness. Keep 40mg Vyvanse dose and observe for 4 weeks.			
Date: May 24, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Increase dose to 40mg Vyvanse for 1 week			
Date: May 17, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: g) Modality: Visit** -Increase Rx to 30mg Vyvanse for 1 week. -Provide training on ADHD noncompliance.			
Date: May 10, 2019 **Reported by:** Dr. Jones	**Short Term Goal: 1 Intervention: a), g) Modality: Visit** -Recurrence of symptoms due to noncompliance. Begin 20mg Vyvanse for 1 week. -Discuss reasons for noncompliance.			
History				

Case Conference		Sprint		ATP	IPC
0	04/01/2019	0	04/01/2019 - 15/02/2019 **(43 days)**	*ATP-0*	*IPC-0*
1	15/02/2019	1	15/02/2019 – 12/04/2019 **(57 days)**	*ATP-1*	*IPC-1*
2	12/04/2019	2	12/04/2019 – 10/05/2019 **(29 days)**	*ATP-2*	*IPC-2*

Figure 6-7: Scenario 2 - Updated Agile Treatment Plan Linked with the IPC

6.3.1.3 Agile Collaboration Dashboard

We introduce new KPIs in the ACD. This is shown in Table 6-10 which reflects some KPIs that are found in Table 6-13. The KPIs were derived from the Performance Management Model which is discussed in 6.2.2.3. The Status field is a color representation of a KPI and remains the same as in Scenario 2.

Table 6-10: Scenario 2 - Agile Collaboration Dashboard

Patient: Mary Smith	**Date:** May 8,2019	**REPORTS**
Collaboration Element		**Status**
Status of e465 (IEP)		
Status of b1400 (Sustaining Attention)		
Status Short Term goal 1 (Alleviate physiological symptoms of ADHD)		
Time to establish patient outcomes (weeks)		
Time to establish ATP (weeks)		
Time left in current Treatment Sprint (days)		
Number of Case Conferences to date		
Number of Consultations to date		
Number of Treatment Sprints to date		
Total number of team members trained on ATP		
Total number of team members trained on ACD		
Total number of accesses to ATP		
Total number of accesses to ACD		

6.3.2 Components

6.3.2.1 Collaboration Space Ontology Template

The ICF Patient Card impacts the Collaboration Space Ontology Template in several ways. Based on our evaluation, we update the CSOT with the ICF Patient Card as an Artifact where functional goals are measured to provide Standardized Indicators. Workflow is impacted in that now tracking of Mary's functionality may be quantified and analyzed over time. Goals of Care outlined in the ATP are now directly mapped to ICF functional goals. This allows us to create a status field that is directly associated with each Short Term goal, color coded for quick evaluation.

A new Level 4 category, Protocol, was added to this scenario to address the procedure and set of rules that the team will use to achieve functional goals assessments, consensus, and targets in the IPC. These results are shown in Figure 6-8 below.

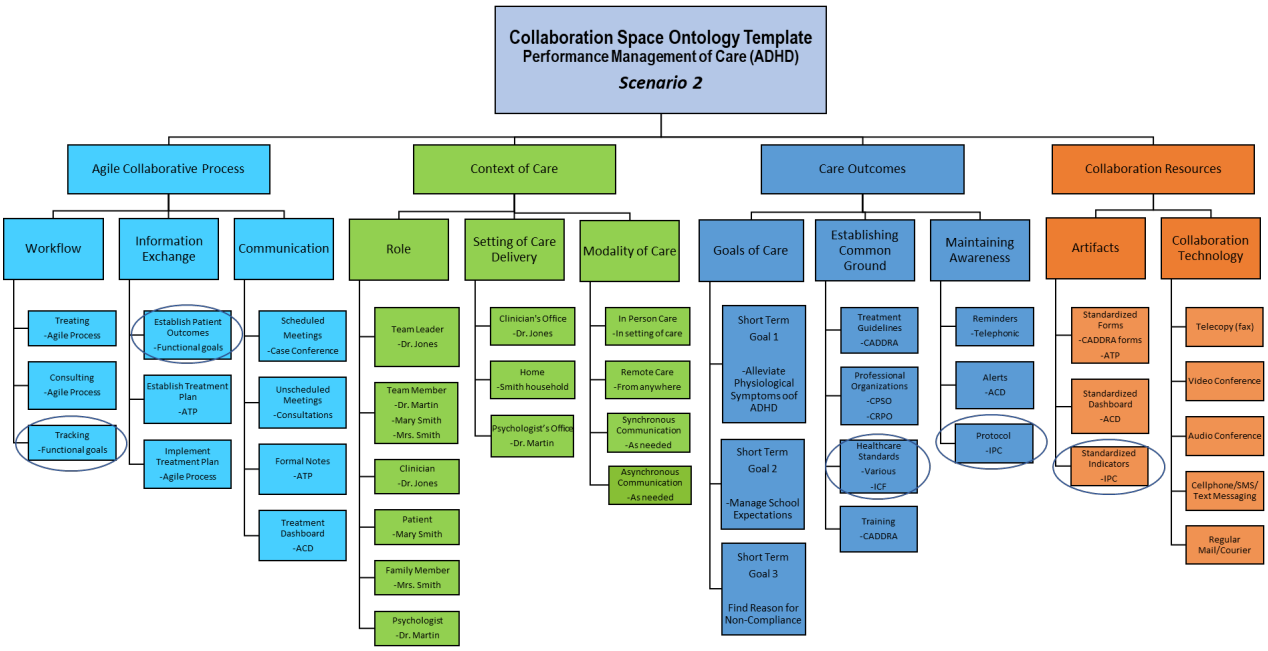


Figure 6-8: Scenario 2 - Addition of IPC to CSOT

Table 6-11 shows the specific additions and impacts to the CSOT. These are marked in **bold red**.

Table 6-11: Scenario 2 - Addition of IPC to CSOT in Scenario 1

Collaboration Space Ontology Template		Clinical Vignette in Scenario 2
Agile Process		
Workflow	Treating	Treatment of ADHD in context of ICF
	Consulting	In context of Agile Process Model, a meeting with any team member
	Tracking	**Track ICP functional goals**
Information Exchange	**Establish Patient Outcomes**	**Establish patient functional outcomes (ICF)**
	Establish Treatment Plan	Agile Treatment Plan
	Implement Treatment Plan	Agile Treatment Plan
Communication	Scheduled Meetings	Case Conference
	Unscheduled Meetings	Consultation
	Formal Notes	Captured in Agile Treatment Plan
	Treatment Dashboard	Agile Collaboration Dashboard
Context of Care		
Role	Team Leader	Team Leader of the Agile Process, Dr. Jones
	Team Members	Team Members of Agile Process, Dr. Martin, Mary Smith, Mrs. Smith
	Patient	Mary Smith
	Family Member	Mrs. Smith (Mother)

	Family Physician	Dr. Jones
	Psychologist	Dr. Martin
Setting of Care	Clinician's office	Dr. Jones's office
	Psychologist's office	Dr. Martin's office
	Home	Mary can consult with care team from home
Modality	In Person Care	Mary receives care in person with Dr. Jones & Dr. Martin
	Asynchronous Communication	Care team communications happen over time
	Synchronous Communication	Care team meets at one time together
	Remote Care	Mary can be monitored without office visit
Care Outcomes		
Goals of Care	ATP Short Term Goals	Treatment goals established by Team
Establishing Common Ground	Treatment Guidelines	Canadian ADHD Practice Guidelines (CADDRA)
	Healthcare Standards	Various (ex. SNOMED, ICD-10) **International Classification of Functionality (ICF)**
	Professional Organizations	College of Physicians and Surgeons of Ontario
		College of Registered Psychotherapists of Ontario
Maintaining Awareness	Alerts	Agile Collaboration Dashboard
	Training	ADHD training using CADDRA resources
	Protocols	**Procedure to establish assessments, consensus and targets of functional goals in the IPC**
Collaboration Resources		
Artifacts	Standardized Forms	Canadian ADHD Practice Guidelines (CADDRA) (See Figure 2-3)
		Agile Treatment Plan using ICP functionality
		-Collaborative Care Model Canvas (Developed in Scenario 3)
	Standardized Dashboard	Agile Collaboration Dashboard using ICP indicators
	Standardized Indicators	**ICF Patient Card**
Collaboration Technology	Telecopy (Fax)	Communication between Dr. Jones and Dr. Martin
	Cellphone/SMS/Text Messaging	Used to receive alerts

6.3.2.2 **Agile Process Model**

The Agile Process Model is modified as a result of this Scenario and is shown in Figure 6-9. We see the addition of establishing patient goals using the ICF Patient Card at various stages of the APM. The updates to the Collaboration Space Ontology Template support the Agile Process Model.

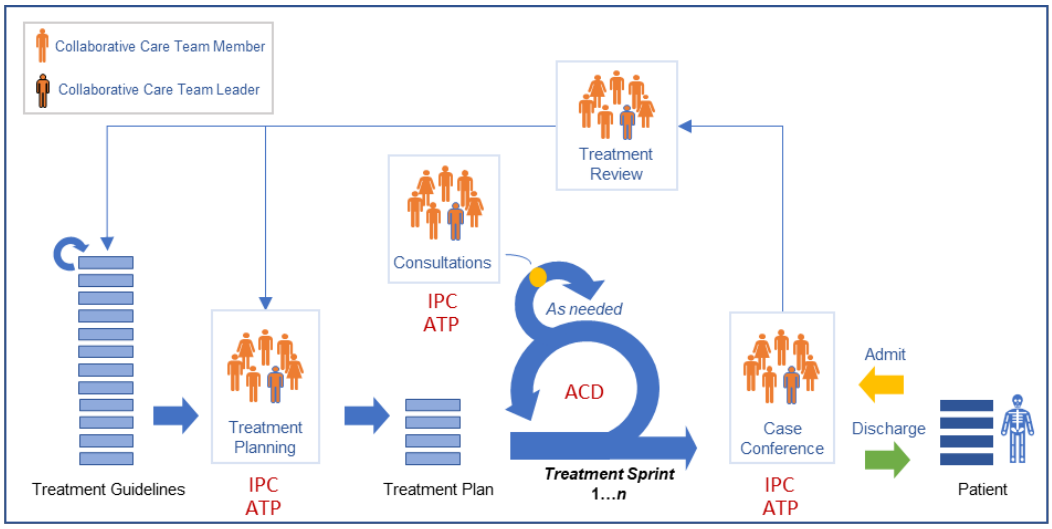


Figure 6-9: Scenario 2 - Agile Process Model

Changes to the process are shown in Table 6-12. The ICF Patient Card is updated on Jan. 4, Feb. 15, Apr. 12, May 10 and Jun. 28. These are the only changes to Table 6-5 and are shown in bright green.

Table 6-12: Scenario 2 - Updated Treatment Log Depicting IPC

Date	Mary Smith & Mrs. Smith	Dr. Jones (Family Physician)	Dr. Martin (Psychologist)	Collaboration Notes
Jan. 4	-Visit Dr. Jones	-Referral: Dr. Martin for ADHD assessment		-- Process based on CADDRA Guidelines **-Patient Admit** **-Case Conference 0** **-Treatment Sprint 0 begins**
		-Create ATP-0 **-Create IPC-0**		**-Dr. Jones adds Dr. Martin, Mary Smith and Mrs. Smith with ATP-0 to create team.** **-Team implements protocol to fill out IPC**
Jan. 11	-Visit Dr. Martin		-Set up Initial Information Gathering process (Step 1) -Schedule ADHD Specific Interview (Step 3)	-- Steps based on CADDRA Guidelines
Jan 16	-Visit Dr. Jones	-Medical Review (Step 2)		-- Steps based on CADDRA Guidelines
Feb 8	-Visit Dr. Martin		ADHD Specific Interview (Step 3)	-- Steps based on CADDRA Guidelines
Feb 9			**Dr. Martin requests Consultation with Dr. Jones**	
Feb 12		**-Audioconference with Dr. Martin**		**-Consultation 1: Dr. Jones and Dr. Martin review findings of Steps 2 and 3. This is required since in the next step, all team members are present, and the treatment is kicked off.**
Feb 15	-Visit Dr. Jones -Receive diagnosis -Begin treatment	-Confirm ADHD diagnosis -Begin *Feedback and Treatment Recommendations* (Step 4)	-Begin Feedback and Treatment Recommendations (Step 4) -Dr. Martin's report provides suggestions for school success	- Steps based on CADDRA Guidelines **-Case Conference 1: Dr. Jones, Dr. Martin (video conference), Mary and Mrs. Smith.** **-Feb 15 and Feb 18 meetings combined into one Case Conference on Feb 15 in which all members of the care team are present.**

		-Mary and Mrs. Smith agree to pharmacological treatment -Rx: 5mg Adderall q.AM	as part of psychoeducation treatment -Follow-up sessions scheduled -Hard copy of report given to Mrs. Smith and sent by mail to Dr. Jones.	**Pharmacological treatment begins earlier as a result. CBT dates remain.**
		- Close ATP-0 **- Create ATP-1** **-Create IPC-1**		**--Team reviews ATP-0, sets up treatment goals, and agrees to ATP-1** **-Treatment Sprint 1 begins**
~~Feb 18~~				**Meeting not needed (combined with Feb. 15)**
Feb 22 Mar 8 Mar 22 Apr 5	-Visit Dr. Martin -Visit Dr. Martin -Visit Dr. Martin -Visit Dr. Martin		-CBT - time management and organization.	-CBT recommendation based on CADDRA Guidelines and CRPO
Apr 19	-Visit Dr. Martin		-CBT - time management and organization.	--CBT recommendation based on CADDRA Guidelines
			-Update ATP-1	**-Dr. Martin reports ATP-1:** **Intervention d): *Dr. Martin will provide recommendations to help Mary succeed at school.* Is complete.** **Intervention e): *Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.* Is complete.** **-ACD updated**
Feb. 22	-Visit Dr. Jones	-s.e. headache, stomach-ache @5mg Adderall. -Maintain current Rx to determine if side effects subside. **- Update ATP-1**		- Rx Titration based on CADDRA Guidelines and CPSO directives **-ACD updated**
Mar 1	-Visit Dr. Jones	-s.e. not subsided -Rx 20mg Vyvanse q.AM -Track in 2 weeks. **- Update ATP-1**		
Mar 15	-Visit Dr. Jones	-Good tolerance. -↑Rx to 30mg Vyvanse - Track in 2 weeks. **- Update ATP-1**		
Mar 29	-Visit Dr. Jones	-Good tolerance. -↑Rx to 40mg Vyvanse - Track in 2 weeks. **- Update ATP-1**		
Apr 12	-Visit Dr. Jones	-Audioconference -Optimal dose -Maintain Rx - Track in 4 weeks. **- Update ATP-1**	**-Audioconference**	**-Case Conference 2: In person with Dr. Jones, Mary and Mrs. Smith, audioconference with Dr. Martin.**
		- Close ATP-1 **- Create ATP-2** **-Create IPC-2**		**-Team reviews ATP-1.** **-Interventions complete:** **a) *Determine best medication for Mary and monitor her progress.*** **b): *Mary will take medications on a regular basis as prescribed.*** **c): *Mrs. Smith will record and report effect of prescribed medication on Mary*.** **-Treatment Sprint 2 begins**
May 8	**-Update IPC**	**-View alert on ACD**	**View alert on ACD**	**-Mrs. Smith updates ICF score in IPC** **-ACD updated**
May 10	-Visit Dr. Jones	**-Videoconference** -Recurrence of symptoms due to noncompliance.	**-Videoconference**	**-Case Conference 3: Dr. Jones, Dr. Martin (videoconference), Mary and Mrs. Smith** **-Pharmacological treatment begins earlier as a result.**

		-Begin Rx 20mg Vyvanse for 1 week. -Address reasons for noncompliance		
		-Close ATP-2 **-Create ATP-3** **-Create IPC-3**		**-Team reviews ATP-2 and decide to re-open Interventions:** **a) *Determine best medication for Mary and monitor her progress.*** **b) *Mary will take medications on a regular basis as prescribed.*** **e) *Mary will work with Dr. Martin and diligently apply the recommendations from Dr. Martin for academic success.*** **f). *Mrs. Smith will collaborate with Mary's teachers to monitor and report success of Dr. Martin's recommendations.*** **-A new Intervention is created: g) *Address reasons for noncompliance of Rx.*** **-Treatment Sprint 3 begins**
May 17	-Visit Dr. Jones	-↑Rx to 30mg Vyvanse - Provide training - Track in 1 week. **- Update ATP-3**		- Rx Titration based on CADDRA Guidelines and CPSO directives **-Dr. Jones fills in Update section of ATP-3 from May 17 to 31 to provide team awareness.** -Training provided using CADDRA Guidelines to explain impacts of noncompliance. **-ACD updated**
May 24	-Visit Dr. Jones	-↑Rx to 40mg Vyvanse - Track in 1 week. **- Update ATP-3**		
May 31	-Visit Dr. Jones	-Optimal dose achieved -Maintain Rx -Track in 4 weeks. **- Update ATP-3**		
June 14	**-Videoconference**	**-Videoconference** **-Good Rx Compliance** **- Update ATP-3**		**-Dr. Jones checks in on Mary (Consultation)** **-ACD Updated**
Jun 28	**-Videoconference**	**-Videoconference**	**-Videoconference**	**-Case Conference 4: Dr. Jones, Dr. Martin, Mary Smith and Mrs. Smith**
		-Close ATP-3 **-Create ATP-4** **-Create IPC-4**		**-Team reviews and closes Interventions a), b), e), f), g).** **-Treatment Sprint 4 begins**

6.3.2.3 **Performance Management Model**

The Performance Management Model is applied to Scenario 2 which correlates Collaboration Resources to the Care Outcomes to derive performance management KPIs. This is shown in Figure 6-10.

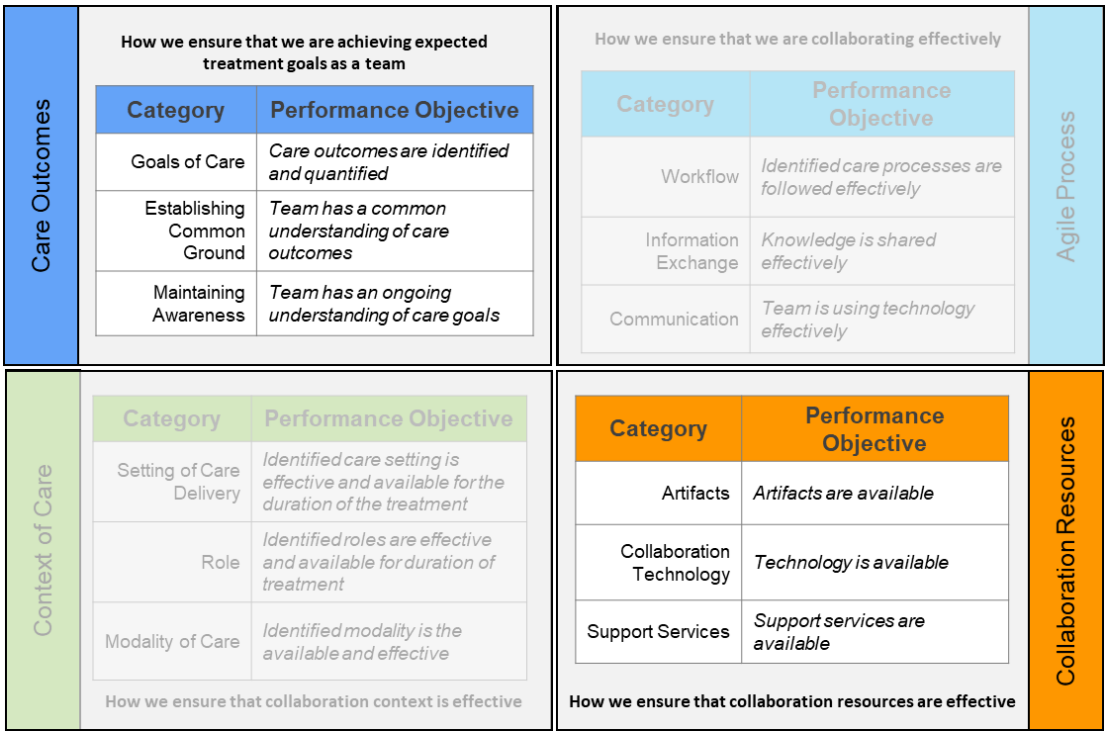


Figure 6-10: Scenario 2 - Parts of the Performance Management Model Used to Develop KPIs

The Performance Management Metrics Chart is shown in Table 6-13 and Table 6-14 below and provides a set of KPIs for the performance objectives of the Agile Process and Care Outcomes categories as described in section 5.2.3.7. Updates to scenario 1 are denoted in **bold red**. We measure key aspects of team collaboration using a simple difference calculation between the current and target value. We have provided some target values as illustrations based on our Clinical Vignette. The indicator flags change depending on the current value of the KPI.

We update two KPIs in the **Agile Process** category as shown in Table 6-13. We now establish patient outcomes using the ICP. This is because the establishment of goals is now directly related to the ICP. We also introduce a new KPI, the time to establish the ICP protocol, described in Figure 5-15.

Table 6-13: Scenario 2 - Performance Management Metrics Chart (Agile Process)

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Agile Process			
Workflow			
Identified care processes are being followed effectively	Number of Treatment Sprints (n)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time left in current Treatment Sprint (days)	45	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Total number of (months) since care initiation	12	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Information Exchange			
Knowledge is shared effectively	Number of Case Conferences [planned] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Number of Consultations [allocated] (n)	4	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish ATP (weeks)	1	< 0 (problem), = 0 (jeopardy), > 0 (on track)
	Time to establish patient outcomes (weeks) using ICP	3	< 0 (problem), = 0 (jeopardy), > 0 (on track)
Communication			
Team is using technology effectively	Total number of team members trained on ATP (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of team members trained on ACD (n)	2	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ATP (n)	5	≤ 0 (on track), > 0 (problem)
	Total number of accesses to ACD (n)	20	≤ 0 (on track), > 0 (problem)
	Total number of remote care events (n)	4	≤ 0 (on track), > 0 (problem)
	Time to establish ICP protocol (days)	2	< 0 (problem), = 0 (jeopardy), > 0 (on track)

Table 6-14 provides the KPIs for the **Care Outcomes** category. As described in section 5.2.3.7, Goals of Care are now related to the ICP. In the Care Outcomes category, we tie the Goals of Care to the ICP functionality. Establishing Common Ground ensures that the team has a common understanding of care outcomes. KPIs related to this are the number of times a change in strategy, as described in the action codes in Table 5-12, is invoked. The team invoked c2 action

code which involved changing their strategy. KPIs also deal with evaluating the number of ineffective interventions (for example changes of medication or type of therapy), the number of re-treatments for the same ailment (for example of the patient is noncompliant in following through with taking medications), as well as the time to retreatment. It also provides an indication of the number of inappropriate interventions (misdiagnosis, errors, etc.), which is not applicable in Mary's case. Maintaining Awareness deals with the ensuring that the team has an ongoing understanding of care goals. Here, we again turn to the ICF to provide a functional status based on ICF scores in Table 5-9, Table 5-10, and Table 5-11.

Table 6-14: Scenario 2 - Performance Management Metrics Chart (Care Outcomes)

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Care Outcomes			
Goals of Care			
Care outcomes are identified and quantified	**Functionality (b1400 sustaining attention)**	1	< 0 (problem), = 0 (on track)
Establishing Common Ground			
Team has a common understanding of care outcomes	**Number of times care strategy has changed (n)**	0	≤ 0 (on track), > 0 (jeopardy or problem)
	Number of ineffective ATP Interventions (n)	0	≤ 0 (on track), > 0 (problem)
	Number of re-treatments (n)	0	≤ 0 (on track), > 0 (problem)
	Time to re-treatment (weeks)	0	≤ 0 (on track), > 0 (problem)
	Number of inappropriate ATP Interventions (n)	0	≤ 0 (on track), > 0 (problem)
Maintaining Awareness			
Team has an ongoing understanding of care goals	**Patient Functional Status**	Target ICF Scores	Various

6.3.3 Assessment

Data Effectiveness

Our main objective for this scenario was to enhance Data Effectiveness.

1. ICF codes are mapped to the ATP. This allows us to measure the effectiveness of the team's actions to relieving the patient's symptoms. This also allows us to determine the status of the patient's health at any given time. Since Interventions are also correlated to Short Term Goals, we updated the ATP to reflect the status using the Patient Functional Status using a color-coded system. This provided a visualization of the severity of the patient's condition in relation to the Short Term Goal. This supports Criteria 8 because it allows usable and relevant status information to be available remotely. This is also true for the ACD. This further support Criteria 1, where team members have a visual understanding of patient status, helping to decrease cognitive load.
2. The Collaboration Space Ontology Template is further validated. We added the IPC to the Artifacts Category. Relationships between components of the CSOT were validated. This corresponds to Criteria 9 where integrated and relevant collaboration information from a variety of sources is supported.
3. The ACD is enhanced since it identifies short term goals that make the Treatment Sprint more informative and relevant. This supports Criteria 1 by lowering cognitive load, as well as Criteria 8 by allowing more relevant data to be available.
4. The IPC effectively responds to increasing the granularity of care outcomes. This makes the Performance Management Model and associated KPIs more relevant and

useful. This corresponds to Criteria 2 and 9 by providing a more precise way to measure performance.

Team Effectiveness

The other advantage for using the IPC is that all team members can use it influence care outcomes without accessing the ATP directly.

Coherent Care

1. In Scenario 1, the Agile Treatment Plan was difficult to understand for some of members of the team due to medical jargon and lack of context. Since all team members have an equal footing in the team, a whole-person centric view of care that supports different modalities such as social, clinical, and functional care was made possible using the ICP. This supports a decrease in cognitive load in Criteria 1.
2. Each team member provided input from different but equally important and valid perspectives. Thus, the ATP has better substantiated care outcomes and is hence more pertinent to collaborative efforts, especially as the playing field is somewhat leveled for all team members. The ICF Patient Card was found to be an effective tool to ensure all team members to understand the patient care goals using a common language, concepts, and terms. It allowed Mary and Mother to interact more effectively with disparate medical professionals. This corresponds to Criteria 6.
3. The ability for all team members to participate in the care of the patient also lends itself to a coordinated care plan through a better use of the ATP and IPC. This refers to Criteria 7.

4. By employing the ICF Patient Card, the collaborative care process becomes more efficient and responsive because team members' approach is based on a standard vocabulary. It allowed for a shared understanding of the medical issues and a common way to interpret the ongoing status of the patient through the use of scoring. This corresponds to Criteria 5.
5. Using the ICF Patient Card ensured a level of consistency of care across different patients supported by team. This also corresponds to Criteria 3 where the team becomes more responsive changes in the patient are quickly assimilated into the care process.
6. Our analysis demonstrates improved communication using the IPC. However, there were challenges in increased cognitive load on the family physician to learn another process. The learning curve was steep for the whole team, not just the family physician. While the ICF is intuitively easy to understand, it is yet another form to fill. In order to make the PMFCC easier to use, one possible solution is to have initial templates for various types of profiles within a medical domain to be prepopulated in order to quick start a collaboration process. This would need to be investigated further. However, while process was slow and staggered initially, frustration was eventually mitigated due to common understanding of expectations. Another issue is that the proper use of the ICF requires some training, which can be a drawback.
7. We added a link in the ATP to the current IPC so that team members could easily find the IPC related to the current treatment. We also added a link for historical IPCs in the ATP which allows a convenient way to access all relevant information from one place.
8. Our analysis shows that there are certain prerequisites that are necessary to ensure collaboration success. We respond to this through a novel Artifact, the Collaborative

Care Model Canvas. This responds to the Context of Care in our PMFCC and is demonstrated next in Scenario 3.

These results are summarized Table 6-15 below:

Table 6-15: Scenario 2 - Results

	Criteria	Evaluation Question	CSOT	APM	PMM	ATP	ACD	ICP	CCMC
Team Effectivenes	1	Decrease in cognitive load on team members				Scenario 2	Scenario 2	Scenario 2	
	2	Measurable view of collaboration			Scenario 2				
	3	Changes quickly assimilated into the care process.						Scenario 2	
	4	Support for transparency of the whole collaboration environment.							
Coherent Care	5	Concept clarity to ensure common understanding.						Scenario 2	
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.						Scenario 2	
	7	Coordinated care plan				Scenario 2		Scneario 2	
Data Effectivene	8	Information is seamless and flows transparently between members and other stakeholders.					Scenario 2	Scenario 2	
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Scenario 2						

6.4 Scenario 3: Collaborative Care Model Canvas

The main focus of this scenario is Coherent Care. The Collaborative Care Model Canvas (CCMC) is a novel Artifact based on the Business Model Canvas (Osterwalder, 2004a) as described in Section 2.8. The CCMC is a Standardized Forms Artifact that will support our Collaboration Space Ontology Template by increasing the team's contextual awareness of the collaboration environment. This includes awareness of who the team members are, and their corporate affiliations, the way communication takes place, and so on. The general structure of the Collaborative Care Model Canvas is shown in Figure 5-26. Field descriptions have been provided in Section 5.3.3.

6.4.1 Artifacts

6.4.1.1 Collaborative Care Model Canvas

The CCMC serves as a reference document that helps to provide context for collaboration as we build on Scenario 2. The CCMC is of special relevance to our Performance Management Framework since it clarifies the organizational conditions under which Mary's care team operates, enabling the individual-collaborative interchange. The application of the Team CCMC to our Clinical Vignette is shown in Figure 6-11 below and is owned by Dr. Jones who creates, updates and archives it as required. The CCMC is written from the perspective of the team.

When viewed from a higher-level organizational context, we discovered that there may be other roles that may related to the team. These are stakeholders outside the team, but who have a vested interest in the activities of the team and the team's performance. We introduce the role of Healthcare Teams Manager who is responsible for coordination of community care teams that are locally based and act over systems of care, care settings and care providers (Fleming, 2018). The

Healthcare Teams Manger's main responsibility is to help in providing quality and cost-effective care. Thus, the team serves the patient, other team members, as well as the Healthcare Teams Manager, Jane Frank. Another insight from the CCMC was the addition of a new category for Supporting Services to our CSOT. This gap was identified when we evaluated the place of key partners who were provided the necessary supports outside of the team.

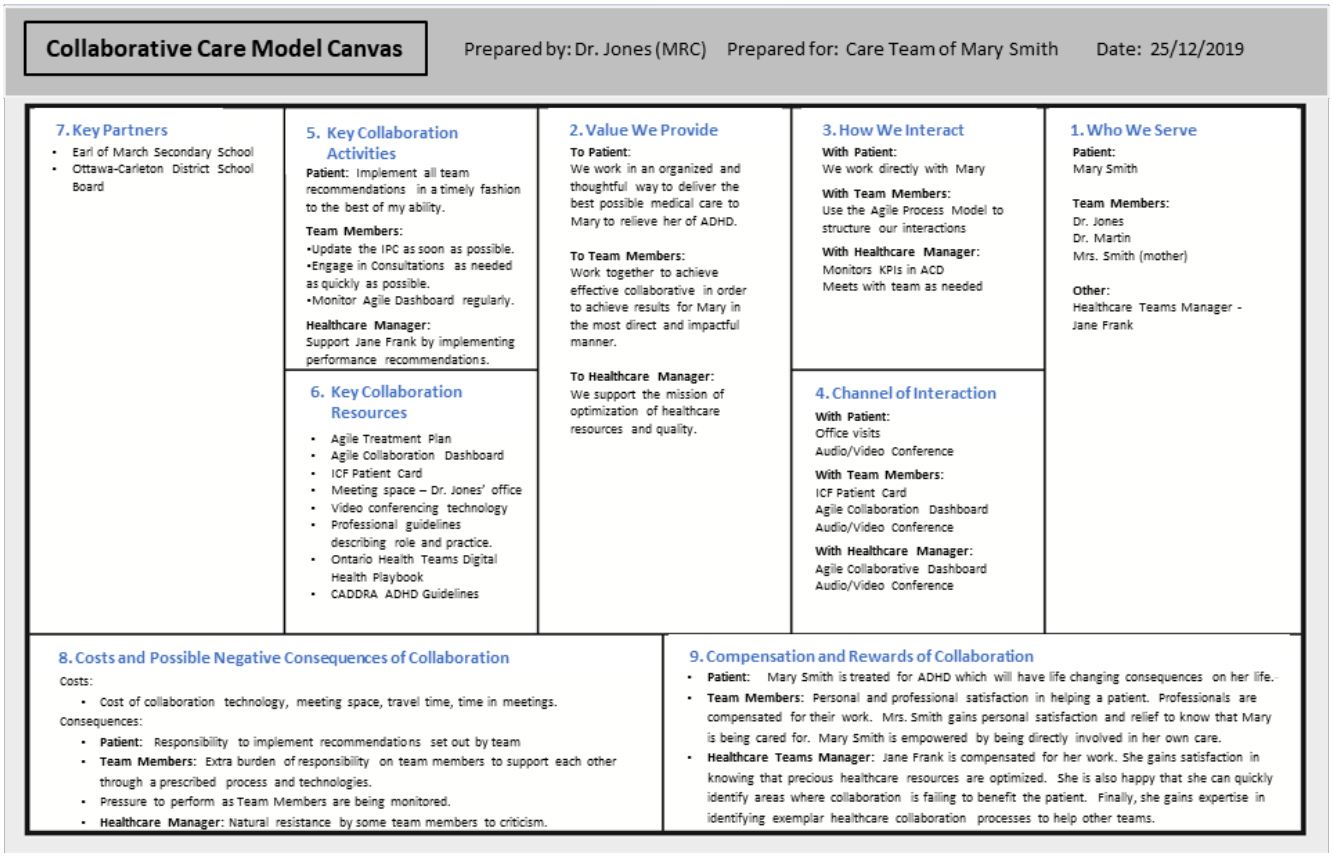


Figure 6-11: Scenario 3 - the Collaborative Care Model Canvas for Mary Smith's Care Team

6.4.1.1.1 Description of CCMC Fields

1. Who We Serve

This field describes 3 roles:

- Patient: *Mary Smith.*
- Team Members: *Dr. Jones, Dr. Martin, Mrs. Smith.*

- Healthcare Teams Manager: *Jane Frank.*

2. Value We Provide

This field describes the way in which the patient and team members benefit from collaboration. The statements of value are:

- Patient: This refers to the value provided to Mary by the team. *We work in an organized and thoughtful way to deliver the best possible medical care to Mary to relieve her of ADHD.*
- Team Members: This is value direct members provide to each other. *Work together to achieve effective collaborative in order to achieve results for Mary in the most direct and impactful manner.*
- Healthcare Teams Manager: This is the value team members provide to the Healthcare Manager. *We support the mission of optimization of healthcare resources and quality.*

3. How We Interact

This refers to the relationship team members have with the patient and each other.

- Patient: *We work directly with Mary on a one-to-one basis.*
- Team Members: *We use the Agile Process Model collaborate to structure our interactions.*
- Healthcare Teams Manager: *Monitors KPIs and meets with team as needed.*

4. Channel of Interaction

This refers to the way in which team will collaborate both physically and virtually.

- Patient: *Mary visits to our respective offices. Mary is also able to access our services remotely using audio or video conferencing.*

- Team Members: *We interact electronically using the ICF Patient Card and the Agile Collaboration Dashboard.*
- Healthcare Teams Manager: Uses the *Agile Collaboration Dashboard* to monitor collaboration activities.

5. Key Collaboration Activities

Mary's team will conduct several activities to fulfill the value proposition described in the CCMC. Note that Mary, in her role as the patient, is clear in her responsibility to the team in executing treatment recommendations. This is to highlight the patient's responsibility in the care process.

- **Patient:** *Implement all team recommendations in a timely fashion to the best of my ability.*
- **Team Members:** *Update the IPC as soon as necessary. Engage in Consultations as needed as quickly as possible. Monitor Agile Dashboard regularly.*
- **Healthcare Teams Manager:** *Support Jane Frank by implementing performance recommendations.*

6. Key Collaboration Resources

The resources available to Mary's team are:

- *Agile Treatment Plan.*
- *Agile Dashboard.*
- *ICF Patient Card.*
- *Meeting space at Dr. Jones' office.*
- *Video conferencing technology.*

- *Professional guidelines relating to the role and practice of team members.* For Dr. Jones, these refer to existing procedures suggested or mandated by the College of Physicians and Surgeons of Ontario related to bioethics. This includes profession-specific recommendations such as Conflict Resolution (Marshall & Robson, 2020) and the Legal Regulation of the Physician-Patient Relationship (Miller, Choudhry, & Campbell, 2020). For Dr. Martin, this is the Standard for Professional Conduct (*Standards of Professional Conduct*, 2017). Team resources include the Ontario Government's Digital Health Playbook (*Ontario Health Teams: Digital Health Playbook*, 2019).
- *Healthcare practice guidelines:* CADDRA Canadian ADHD Practice Guidelines (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018).

7. Key Partners

Refers to members outside of the core team who help instantiate the team's value propositions. Mary's Team's primary partner is her high school since treatment would not be possible without the assistance of her teacher and guidance counselor in implementing education success guidelines:

- *Earl of March Secondary School*, *Ottawa-Carleton District School Board*, as articulated in the Special Education Plan ("2018-2019 Special Education Plan," 2019).

8. Costs and Possible Negative Consequences of Collaboration

Costs: Here we cover costs in terms of resources such as time, space and spend.

Costs: *Cost of collaboration technology, meeting space, travel time, time in meetings.*

Consequences:

- **Patient:** *Responsibility to implement recommendations set out by team.*

- **Team Members:** *Extra burden of responsibility on team members to support each other. through a prescribed process and technologies. Pressure to perform as Team Members are being monitored, and the team's actions measured.*
- **Healthcare Teams Manager:** Natural resistance by some team members to oversight or critique.

9. Compensation and Rewards of Collaboration

These are personal and professional rewards for good collaboration.

- **Patient:** *Mary Smith is treated for ADHD which will have life changing consequences on her life.*
- **Team Members:** *Personal and professional satisfaction in helping a patient. Professionals are compensated for their work. Mrs. Smith gains personal satisfaction and relief to know that Mary is being cared for. Mary Smith is empowered by being directly involved in her own care.*
- **Healthcare Teams Manager:** *Jane Frank is compensated for her work. She gains satisfaction in knowing that precious healthcare resources are optimized. She is also happy that she can quickly identify areas where collaboration is failing to benefit the patient. Finally, she gains expertise in identifying exemplar healthcare collaboration processes to help other teams.*

6.4.1.2 ICF Patient Card

The structure of the IPC in Scenario 2, as shown in Table 6-9, is not impacted directly by the Collaborative Care Model Canvas and remains the same.

6.4.1.3 Agile Treatment Plan

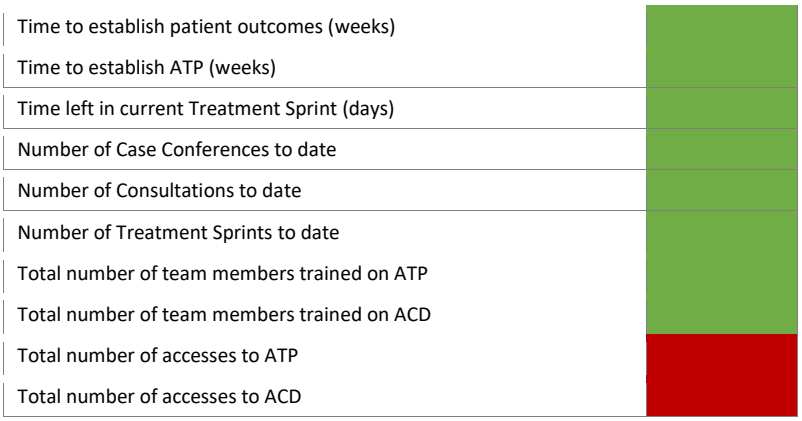
The addition of the CCMC to our PMFCC allows us to specify the context for collaboration. We expect that the CCMC is used in the beginning of the Agile Process before the ATP is established, as shown in Figure 6-13. It will also be used at the Treatment Review to determine if the team is functioning as agreed upon in the CCMC. Thus, the ATP does not change from Scenario 2.

6.4.1.4 Agile Collaboration Dashboard

Many of the KPIs found in our Performance Management Metrics Chart may be of interest to the Healthcare Teams Manager role. Table 6-16provide an example of an ACD for the Healthcare Teams Manager. Changes from Scenario 2 are denoted in **bold red**. As an example, these KPI can be used to determine the availability of resources for an individual patient. When collected and analyzed over multiple teams, the KPIs can help in the (re)distribution or allocation of resources. For example, proximity of location may result in the creation of new care locations, or the enhancement of existing ones due to capacity. The number of times location of care has changed, or the number of times professionals have changed may be a flag that scheduling needs to be addressed.

Table 6-16: Example of an ACD for a Healthcare Teams Manager

Care Team of Patient: Mary Smith	Date: May 8, 2019	**REPORTS**
Collaboration Element		**Status**
Number of times location of care has changed		
Proximity of care location to patient (km)		
Number of times professionals have changed		
Length of time on patient care (months)		
Time to care initiation (months)		
Type of technology currently used		
Availability of Artifacts		
Availability of resources		



6.4.2 **Components**

6.4.2.1 **Collaboration Space Ontology Template**

We added the CCMC to Scenario 2, which enriched the CSOT and resulted in several updates. These are shown as circled items in Figure 6-12. We add the CCMC as an instance of Standardized Forms. We also add a new Level 4 category to Establishing Common Ground called Organizational Structure. We added a new role which is revealed through application of the CCMC to the Clinical Vignette: the Healthcare Teams Manager. This role allows us to extend the utility of our PMFCC to other stakeholders of the healthcare organization. Finally, a significant addition to the CSOT is a new Level 3 category that details Supporting Services. We move Regular Mail/Courier from Collaboration Technology into this category as it fits better here. Details can be found in Table 6-17. Changes are denoted in **bold red**.

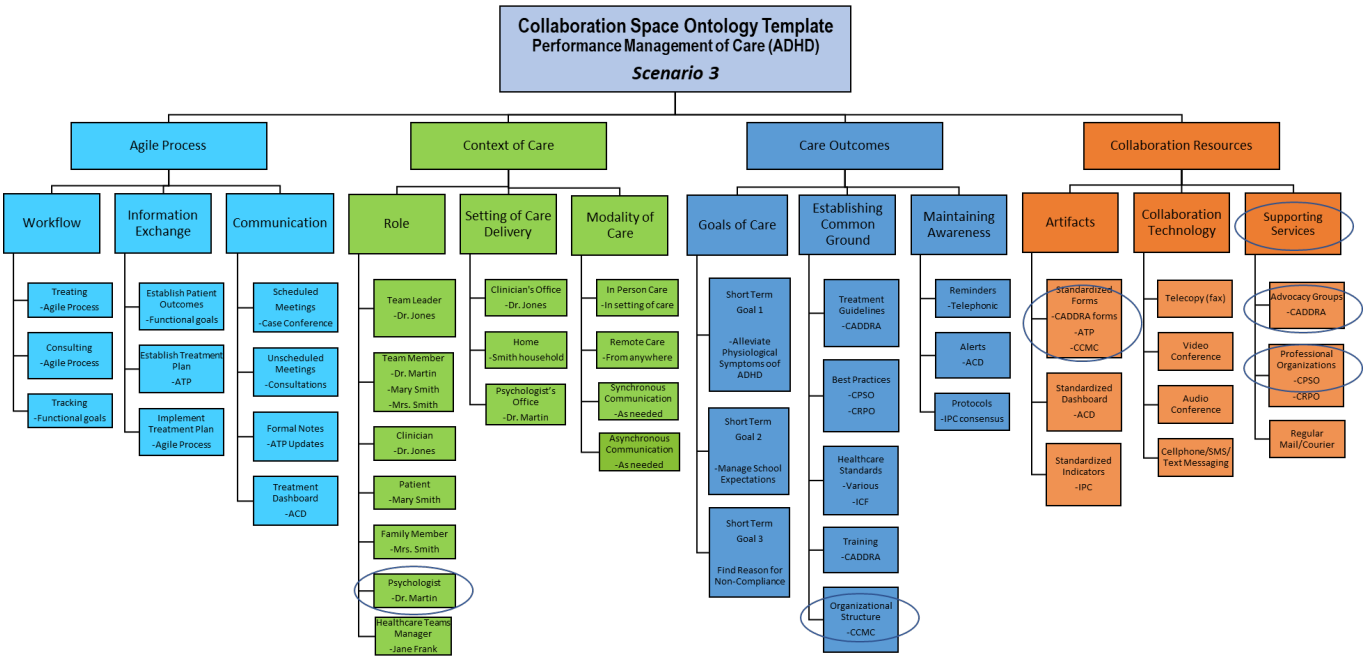


Figure 6-12: Scenario 3 - Addition of CCMC to CSOT

Table 6-17: Scenario 3 - Addition of CCMC to CSOT

Collaboration Space Ontology Template		Clinical Vignette in Scenario 3
Agile Process		
Workflow	Treating	Treatment of ADHD in context of ICF
	Consulting	In context of Agile Process Model
	Tracking	Track ICP functional goals
Information Exchange	Establish Patient Outcomes	Establish patient functional outcomes (ICF)
	Establish Treatment Plan	Agile Treatment Plan
	Implement Treatment Plan	Agile Treatment Plan
Communication	Scheduled Meetings	Case Conference
	Unscheduled Meetings	Consultation
	Formal Notes	Captured in Agile Treatment Plan
	Treatment Dashboard	Agile Collaboration Dashboard
Context of Care		
Role	Team Leader	Team Leader of the Agile Process, Dr. Jones
	Team Members	Team Members of Agile Process, Dr. Martin, Mary Smith, Mrs. Smith
	Patient	Mary Smith
	Family Member	Mrs. Smith (Mother)
	Family Physician	Dr. Jones
	Psychologist	Dr. Martin
	Healthcare Teams Manager	**Manages team within the context of a healthcare organization**
Setting of Care	Clinician's office	Dr. Jones's office
	Psychologist's office	Dr. Martin's office
	Home	Mary can consult with care team from home
Modality	In Person Care	Mary receives care in person with Dr. Jones & Dr. Martin
	Asynchronous Communication	Care team communications happen over time
	Synchronous Communication	Care team meets at one time together
	Remote Care	Mary can be monitored without office visit

Care Outcomes		
Goals of Care	ATP Short Term Goals	Treatment goals established by Team
Establishing Common Ground	Treatment Guidelines	Canadian ADHD Practice Guidelines (CADDRA)
	Healthcare Standards	Various (ex. SNOMED, ICD-10) International Classification of Functionality (ICF)
	Professional Organizations	College of Physicians and Surgeons of Ontario
		College of Registered Psychotherapists of Ontario
	Organizational Structure	**Collaborative Care Model Canvas**
Maintaining Awareness	Alerts	Agile Collaboration Dashboard
	Training	ADHD training using CADDRA resources
	Protocols	Procedure to establish assessments, consensus and targets of functional goals in the IPC
Collaboration Resources		
Artifacts	Standardized Forms	Canadian ADHD Practice Guidelines (CADDRA forms) (See Figure 2-3)
		Agile Treatment Plan using ICP functionality
		Collaborative Care Model Canvas
	Standardized Dashboard	Agile Collaboration Dashboard using ICP indicators
	Standardized Indicators	ICF Patient Card
Collaboration Technology	Telecopy (Fax)	Communication between Dr. Jones and Dr. Martin
	Cellphone/SMS/Text Messaging	Used to receive alerts
Supporting Services	**Resource Organizations**	**Canadian ADHD Resource Alliance (CADDRA)**
	Professional Organizations	**College of Physicians and Surgeons of Ontario**
		College of Registered Psychotherapists of Ontario

6.4.2.2 **Agile Process Model**

The Agile Process Model is modified as a result of this Scenario and is shown in Figure 6-13. The addition of the CCMC to our PMFCC allows us to create a context to teamwork and is reflected in the Agile Process. This global view becomes important by allowing a new team member to quickly come up to speed on how the team operates. We expect that the CCMC is used in the beginning of the Agile Process as shown in Figure 6-13. It will also be used at the Treatment Review on an ongoing basis to determine if the team is functioning as agreed upon in the CCMC. For simplicity, we assume that there are no changes as a result of the Treatment Review and the Treatment Log of Table 6-12 remains unaffected.

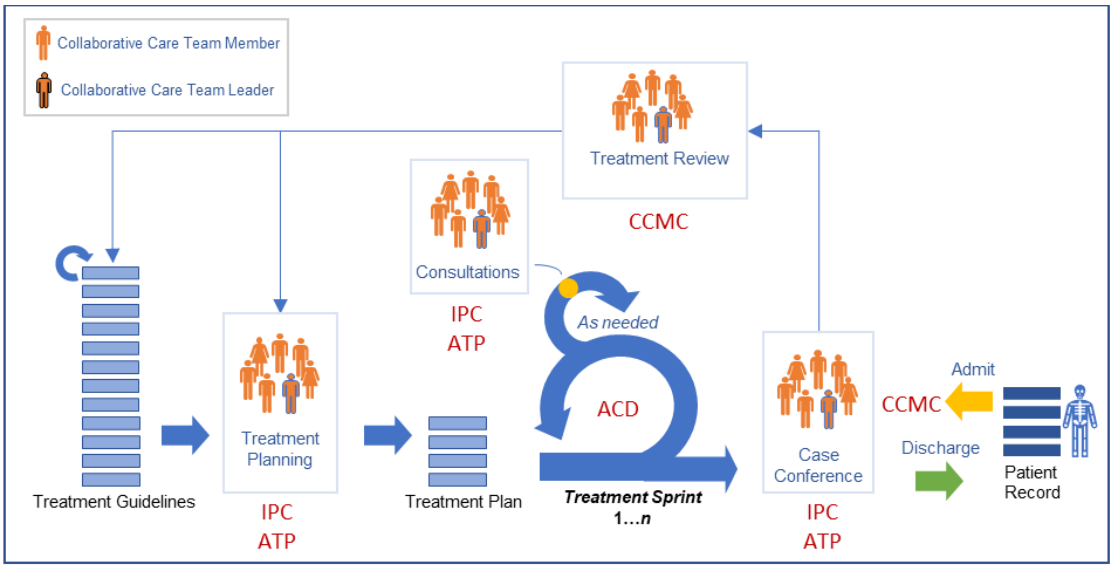


Figure 6-13: Scenario 3 - Updated Agile Process Model

6.4.2.3 Performance Management Model

The Performance Management Model is applied to Scenario 3 which correlates Collaboration Resources to the Context of Care category to derive performance management KPIs. This is shown in Figure 6-14.

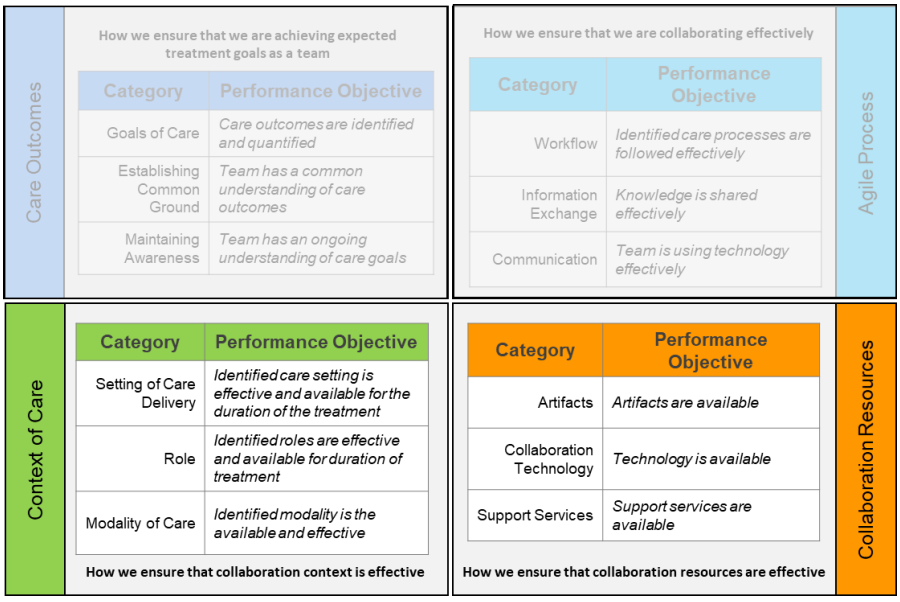


Figure 6-14: Scenario 3 - Parts of Performance Management Model Used to Develop KPIs

There are no changes to the Care Outcomes and Agile Process quadrants. However, as shown in Table 6-18, there are many additions to the **Context of Care** quadrant. As described in 5.2.3.7, this quadrant is concerned with *how we ensure that collaboration context is effective.* The KPIs for Setting of Care Delivery include the number of times location of care has changed, as well as how close the location of care is to the patient's residence. Role involves KPIs related to the number of times professionals have changed, and the length of time professionals are on the case. KPIs under Modality of Care include time to care initiation and the number of times modality has changed.

Table 6-18: Scenario 3 - Performance Management Metrics Chart (Context of Care)

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Context of Care			
Setting of Care Delivery			
Identified care setting is effective and available for the duration of the treatment	**Number of times location of care has changed (n)**	0	≥ 0 (on track), < 1 (problem)
	Proximity of care location to patient (km)	15	≥ 0 (acceptable), < 1 (unacceptable)
Role			
Identified roles are effective and available for duration of treatment	**Number of times professionals have changed (n)**	0	≥ 0 (on track), < 1 (problem)
	Length of time on patient care (months)	5	≥ 0 (on track), < 1 (problem)
Modality of Care			
Identified modality is the available and effective	**Time to care initiation (months)**	1	≥ 0 (acceptable), < 1 (unacceptable)
	Number of times modality has changed (n)	1	≥ 0 (acceptable), <1 (unacceptable)

Collaboration Resources is concerned with *how we ensure that collaboration resources are effective.* This is shown in Table 6-19 below. The KPI in the Collaboration Technology category measures availability of video conferencing. The Artifacts category ensures that standardized forms like the ATP are available. Finally, the addition of the CCMC had a major

impact on the CSOT through due to addition of the Supporting Services category. The KPI for the Supporting Services category measures the availability of supporting services such as school supports.

Table 6-19: Scenario 3 - Performance Management Metrics Chart (Collaboration Resources)

PMM Category	Key Performance Indicator	Target Value	Indicator Flags (Target Value – Current Value)
Collaboration Resources			
Collaboration Technology			
Appropriate technology is available	**Type of technology**	Videoconfer-encing	Yes= green, No=red
Artifacts			
Artifacts are available	**Availability of Standardized Forms, Dashboard and/or Indicators**	ATP	Yes= green, No=red
Supporting Services			
Support services are available	**Availability of resource**	School supports	Yes= green, No=red

6.4.3 Assessment

Coherent Care

The main objective of this scenario was to determine if Coherent Care was improved.

1. The Collaboration Space Ontology Template was significantly impacted with the creation of a new branch called Support Services. The CCMC also improved the CSOT by describing linkages and relationships between its various components. This corresponds to Evaluation Criteria 5.
2. While the CCMC is intuitively easy to understand, it requires special training. This may cause teams to be reluctant to use it. One possible solution is to have pre-populated templates for various types of roles and teams. This would need to be investigated further as future work.

Team Effectiveness

1. The CCMC describes team members as clients to each other, with responsibilities to each other. This helps in establishing expectations between team members. This supports Criteria 1 by decreasing cognitive load on team members by providing them with the context is which they are operating.
2. The CCMC is a visual tool, once understood, it is not cognitively overloading, supporting Criteria 1.
3. CCMC provided an important tool for the team to ensure common ground during the Treatment Review in the Agile Process Model. Also, Identification of team members' context led to better relationships within the team. This context included: roles and responsibilities, churn of team members, timeline and restrictions/limitations, expectations set. Since the parameters of engagement were discussed in advance, all members of the circle of care for the patient were included in the team. This included with external organizations such as the school and the pharmacist. Focus was placed on the goals the team had to accomplish. This supports Criteria 4 by allowing transparency of the whole collaboration environment.

Data Effectiveness

1. Performance Management Model remained the same, and 3 new KPIs were added. This provides further information for the Healthcare Teams Manager to effectively manage resources.
2. Further work is required to determine KPIs that relate to how each segment, and interactions between segments, of the CCMC can be measured.

These results are summarized in Table 6-20 below.

Table 6-20: Scenario 3 - Results

	Criteria	Evaluation Question	CSOT	APM	PMM	ATP	ACD	ICP	CCMC
Team Effectivenes	1	Decrease in cognitive load on team members							Scenario 3
	2	Measurable view of collaboration			Scenario 3				
	3	Changes quickly assimilated into the care process.							
	4	Support for transparency of the whole collaboration environment.	Scenario 3						Scenario 3
Coherent Care	5	Concept clarity to ensure common understanding.	Scenario 3						Scneario 3
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.							
	7	Coordinated care plan							
Data Effectivene	8	Information is seamless and flows transparently between members and other stakeholders.							
	9	Integrated and relevant collaboration information from a variety of sources is supported.							

6.5 Chapter Summary

In this chapter we have demonstrated three scenarios that leverage the Clinical Vignette to develop the PMFCC. In Section 6.1, we created a baseline scenario in which we applied our Clinical Vignette to the current ADHD care process. In Section 6.2, we built on the previous section to develop the APM using the ATP and ACD Artifacts. In Section 6.3, we capitalized on insights from the previous sections to introduce the IPC. Finally, Scenario 3 responded to the need for collaboration context through the creation of the CCMC. We summarized each results section by correlating the learnings with our evaluation criteria. A summary is provided here in Table 6-21 below.

Table 6-21: Summary of Results

	Criteria	Evaluation Question	CSO	APM	PMM	ATP	ACD	ICP	CCMC
Team Effectiveness	1	Decrease in cognitive load on team members		Scenario 1		Scenario 1 Scenario 2	Scenario 1 Scenario 2	Scenario 2	Scenario 3
	2	Measurable view of collaboration			Scenario 3 Scenario 2				
	3	Changes quickly assimilated into the care process.		Scenario 1				Scenario 2	
	4	Support for transparency of the whole collaboration environment.	Scenario 3 Scenario 1	Scenario 1					Scenario 3
Coherent Care	5	Concept clarity to ensure common understanding.	Scenario 3					Scenario 2	Scenario 3
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.						Scenario 2	
	7	Coordinated care plan				Scenario 2		Scenario 2	
Data Effectivene	8	Information is seamless and flows transparently between members and other stakeholders.				Scenario 1	Scenario 1 Scenario 2	Scenario 2	
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Scenario 1 Scenario 2						

7 Evaluation

This chapter discusses the overall evaluation of our thesis beyond the self-assessment of each iteration that was done using the DSR methodology described in Section 3.2. The self-assessments were summarized in Sections 6.2.3, 6.3.3 and 6.4.3 for each iteration. In this section, we examine to what extent the research questions we specified in Section 3.1 have been answered, based on the evaluation criteria we identified in Section 4.3. We consulted with a group of colleagues to perform an assessment of the PMFCC based on the Clinical Vignette in order to have a more objective assessment of the PMFCC (rather than a self-assessment). Then we compared the PMFCC to related works, based on our assessment of those works as described in the literature. Finally, this chapter ends with a discussion of assumptions, limitations, and potential threats to viability of this work.

7.1 Expert Panel

7.1.1 Overview

We organized a panel session of colleagues from our professional network with relevant expertise to evaluate the PMFCC based on our criteria. The objective of the meeting was for the expert panel, introduced in section 7.1.2, to discuss, provide feedback and evaluate our PMFCC in a structured, live, review session. The meeting took place on January 21, 2021, 17:00-18:30 EST, over Zoom. Prior to the meeting, the panel was provided with documents, described in section 7.1.3 to help them prepare for the meeting. In order for our colleagues to have a thorough background of the research, we commenced our evaluation session with an overview of the performance management PMFCC and Artifacts. We then presented the Clinical Vignette from

section 6.1, as an example of current practice for collaborative care for ADHD. This was followed by a clinical walkthrough, described in in Section 7.1.3 and depicted in Figure 7-1, of the complete Artifact-supported scenario using our PMFCC, which included showing how the Artifacts were filled in and used at each step in the scenario. During the overview of the PMFCC and the clinical walkthrough of the Artifacts, there was ongoing freeform, questions, feedback, and discussion. Finally, the panel was given an evaluation questionnaire, described in Section 7.1.4., to fill in.

The panel decided that they would like more time beyond the scheduled session to complete the questionnaire, so they took the questionnaires off-line. All but one expert emailed their response within a few days. All questionnaires were received by February 2, 2021.

In addition to the questionnaires, which are summarized in detail in Sections 7.1.5 and 7.1.6, detailed notes were taken of the live session to record all feedback and discussion that was received. All experts were sent a copy of this chapter and given a chance to review and verify what is written here.

7.1.2 **Panel of Experts**

The panel was comprised of two Family Physicians, two academic researchers / thought leaders in the area of collaborative care team who have years of experience working such teams, and a senior healthcare administrator who has had years of experience working with collaborative care teams.

1. **Cheryl Netterfield, MD, CCFP, FCFP**

Dr. Cheryl Netterfield is a Family Physician with clinical interests in sports, occupational, and disability medicine and cognitive-based psychotherapy. Having served for over 24 years in

the Canadian Armed Forces as a Medical Officer, she has lived and worked in many provinces across Canada and has deployed overseas multiple times. She is the Founder and CEO of POMMe-Health, a digital healthcare platform to track functional outcomes and measure the value of healthcare delivery. Her passion lies in empowering healthcare providers to efficiently collaborate with complex patient care.

2. Craig Kuziemsky, PhD

Dr. Craig Kuziemsky currently Associate Vice-President, Research, at MacEwan University. Dr. Kuziemsky also holds the rank of professor in the School of Business. Prior to joining MacEwan, he was a full professor and University Research Chair in Healthcare Innovation in the Telfer School of Management at the University of Ottawa. He also served as director of the M.Sc. in Health Systems program (2010-16) and the Master of Health Administration Program (2017-19). Craig's research has developed innovative approaches to model collaborative health care delivery to support the design of information and communication technology (ICT) to support different contexts of collaboration. His studies of collaboration have used approaches such as complexity theory to understand the nature of collaborative interactions in different healthcare settings such as clinical health care and public health for disaster management.

3. Cleo Mavriplis MD, CCFP, FCFP

Dr. Cleo Mavriplis, a Family Physician and Adjunct Professor of Family Medicine in the Faculty of Medicine, University of Ottawa. Dr. Mavriplis also works with an interdisciplinary team of family physicians, nurse practitioners, and students from the University of Ottawa, Faculty of Engineering, on a healthcare app, http://icanbewell.ca. This app was recently launched and is a Canadian, evidence-based, bilingual, mobile application for preventive care. This interactive app

has interfaces for patients and one for health care providers providing videos, risk calculators and links to more health information.

4. Douglas Archibald, PhD

Dr. Douglas Archibald is the Director of Research and Innovation and an Associate Professor in the Department of Family Medicine with a cross-appointment to the Department of Innovation in Medical Education and the Faculty of Education. Dr. Archibald holds a PhD in Education (University of Ottawa) and is an alumnus of TUTOR-PHC. His research interests are in medical education, inter-professional education, research methodology, and eLearning. Dr. Archibald is the lead for the Program for Research Innovation and Medical Education (PRIME) and works to support research development, evaluation of research projects designed to enhance undergraduate and postgraduate medical education as well as faculty development in the Department of Family Medicine. His research areas of focus are program evaluation and educational technologies.

5. Shoba Ranganathan, LLM, MHSA, MSc, CHE

Shoba Ranganathan is the Chief Quality and Patient Safety Officer for the Canadian Forces Health Services (CFHS) within the Department of National Defense and has been in this position since August 2011. She has spent the majority of her career working with and for DND, first starting as a healthcare placement coordinator with the health services support contract and then joining the Public Service in 2006 as the Quality Improvement (QI) Manager in Greenwood, Nova Scotia and then in Kingston, Ontario. She completed her Masters in Science in Anatomy and Cell Biology from Queen's University and then completed her Masters in Health Services Administration from Dalhousie University in 2003. With a keen interest within quality and patient safety, Shoba completed a Master of Laws at Queen's specializing in Health Law in 2012. Her

project compared the national regulatory structure of flight safety in Canada and determined if a national patient safety framework could find similar successes.

7.1.3 **Review Session**

Prior to the review session, we provided the following documents to the colleagues:

a) Expert_Review_Meeting_v2.5.pdf - This is the presentation given at the meeting.
b) Expert Review Panel Questionnaire.docx - This is the document that was used to capture feedback.
c) SEH2021_paper_18.pdf – (R Lakhani, Peyton, & Kuziemsky, 2021b) IEEE paper providing background to our PMFCC.

The review session started with 5-6 slides explaining the theory behind our performance management framework and Artifacts (Chapter 5). We then presented our clinical vignette (Chapter 6.1) as an example of current practice which is based on one of the case studies from "Across the Lifespan" by Dr. Ainslie Gray, given at a workshop entitled "Best Practices for ADHD" the 2018 Family Medicine Conference (A. Gray, 2016) and we highlighted how we had adapted it to Canadian guidelines described in the Canadian ADHD Resource Alliance (CADDRA) (*Canadian ADHD Practice Guidelines, Forth Edition*, 2018). We alluded to the gaps in the current process, which included the facts that each role in our scenario (Physician, Psychologist, and Parent) operates independently, never meets as a group, and only shares information verbally or by written notes. We related these to the generalization of gaps (cognitive overload, misaligned goals, suboptimal communication, and ineffective coordination) shown in Figure 4-1.

The main focus of the review session, though, was a detailed walkthrough of a scenario, shown in Figure 7-1 below, which summarized all the key elements of Sections 6.2 – 6.4. This walkthrough sequence follows the agile process model and starts with admitting and demonstrates how Artifacts support coordination of care through 4 Case Conferences. There were slides showing the detailed contents of each Artifact listed in red in Figure 7-1. At the bottom of the figure, based on the KPIs, we have a visualization of how treatment is proceeding. Sad face indicate that the patient is not doing well; yellow indicate that treatment is going as planned; green happy face indicates that the patient is doing well.

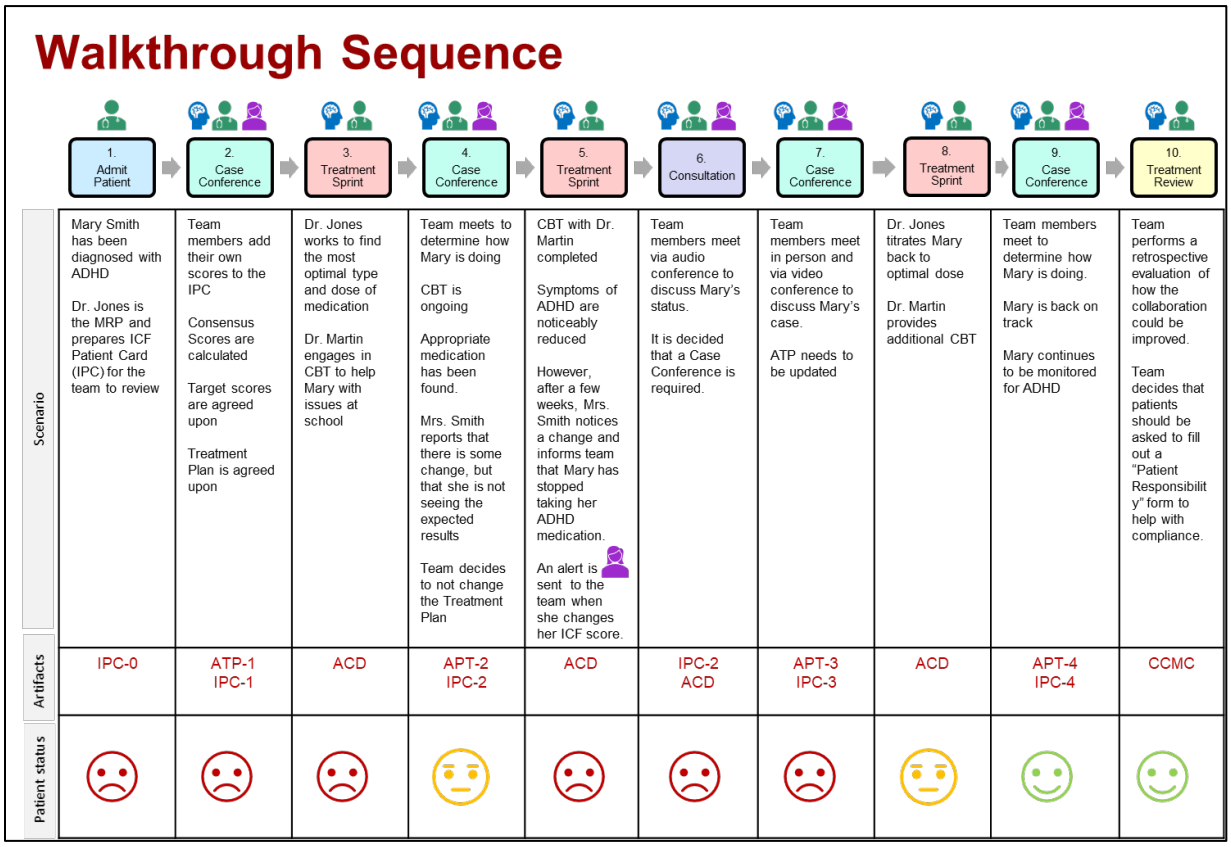


Figure 7-1: Expert Panel Review Session - Clinical Walkthrough Sequence

Our colleagues were able to ask questions if they required any clarifications or make small comments during the presentation. The session that allowed for more free-form discussion,

questions, and comments. The entire session was captured in audio format. The recording captured in an MPEG-4 audio file entitled Expert Panel Session.m4a. Detailed notes based on the audio recording were later captured in an MSWord file entitled Unstructured Verbal Feedback.doc.

Additionally, we created an MS Excel spreadsheet that captures all the raw data and summary of the structured and unstructured feedback from the questionnaires that were filled out by the experts after the review session. This file is entitled Expert Panel Feedback v6.xlsx.

7.1.4 Expert Panel Questions

We modified our evaluation questions from Section 4.3 into a Likert-formulated question in order to provide greater clarity and context and to be more descriptive and instructional for our evaluators to answer. The format of the questions is shown in Table 7-1. The questions were provided to the expert panel in the form of MS Word document. The colleagues provided their 5-point Likert rating as well as written feedback.

Table 7-1: Format of Questions

	Expert Panel Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
Q1	The Artifacts and Agile Process Model allow team members to interact in a structured way which decreases the cognitive load for team members to collaborate.					
Please explain the reason(s) for your response:						

The mapping of the Evaluation Question to Expert Panel Question is found in Table 7-2. The Expert Panel Question is a Likert formulated question and differs slightly from the Evaluation

Question. We did this do ensure that the question would be understandable in the context of the Clinical Walkthrough. Since the experts were not familiar with the theoretical aspects of our PMFCC, we modified the question to encompass, as much as possible, the Artifacts presented in the Clinical Walkthrough. Thus, we transformed the generic questions that contain theoretical concepts into reasonable questions related to the ADHD clinical scenario presented to the Expert Panel.

Table 7-2: Mapping of Evaluation Questions to Expert Panel Questions

Number	Evaluation Question (from Section 4.3)	Expert Panel Question (Likert Formulated Question)
Q1	Theory, method, algorithm, or implementation, that will lower the cognitive load on a team, is/are provided.	The Artifacts and Agile Process Model allow team members to interact in a structured way which decreases the cognitive load for team members to collaborate.
Q2	Theory, method, algorithm, or implementation, that will allow terms and concepts to be understood by all team members in the same way, is/are provided.	The Collaboration Space Ontology Template, ICF Patient Card and Collaborative Care Model Canvas are useful in **clarifying the terminology** so that terms and concepts are easily understood in the same way by all team members.
Q3	Theory, method, algorithm, or implementation demonstrates that non-clinical criteria are used in diagnosis and treatment of patient.	The ICF Patient Card is helpful in allowing teams to consider non-clinical criteria in the
Q4	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.	The Agile Treatment Plan is an effective way for a single coordinated care plan to be available for patients and team members, whether they are remotely located or otherwise.
Q5	Theory, method, algorithm, or implementation provided to capture, and report performance metrics related to team collaboration.	The Performance Management Model is an effective way to determine areas where collaboration performance can be measured, and consequently, where KPIs can be defined.
Q6	Theory, method, algorithm, or implementation demonstrates how to characterize and respond to patient-level changes.	The ICF Patient Card is an effective way to characterize and respond to patient-level.
Q7	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.	The Artifacts in our framework support usable and relevant data to be shared between team members in a timely and effective manner.
Q8	Theory, method, algorithm, or implementation support the ability for relevant aspects of the collaboration environment to be available and communicated.	The Performance Management Model allows relevant aspects of the collaboration environment to be available and communicated.

Q9	Theory, method, algorithm, or implementation support the ability to support relevant collaboration-related information data from a variety of media (paper, electronic, etc.) and geographies.	The Collaboration Space Ontology Template and the Collaborative Care Model Canvas effectively identify relevant collaboration-related information data from a variety of media (paper, electronic, etc.) and geographies.

Table 7-2 shows the mapping of the Expert Panel Questions for the Team Effectiveness criteria group (defined in section 4.3.1). Team Effectiveness is the grouping of criteria that provide the collaborative care team with the capacity to accomplish its goals or objectives.

Table 7-3: Team Effectiveness Mapping

Criteria Group	Criteria	Expert Panel Question (Likert Formulated Question)
Team Effectiveness	Decrease in cognitive load on team members	Q1) The Artifacts and Agile Process Model allow team members to interact in a structured way which decreases the cognitive load for team members to collaborate.
	Measurable view of collaboration	Q5) The Performance Management Model is an effective way to determine areas where collaboration performance can be measured, and consequently, where KPIs can be defined.
	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.	Q6) The ICF Patient Card is an effective way to characterize and respond to patient-level.
	Information is seamless and flows transparently between members and other stakeholders.	Q8) The Performance Management Model allows relevant aspects of the collaboration environment to be available and communicated.

Table 7-4 provides the Expert Panel Questions related to the Coherent Care criteria group (defined in section 4.3.2). Coherent Care in the context of team collaboration refers to the grouping of criteria that relate the team's ability to function in a seamless, consistent, and effective fashion.

Table 7-4: Coherent Care Mapping

Criteria Group	Criteria	Expert Panel Question (Likert Formulated Question)
Coherent Care	Concept clarity to ensure common understanding.	Q2) The Collaborative Care Ontology, ICF Patient Card and Collaborative Care Model Canvas are useful in **clarifying the terminology** so that terms and concepts are easily understood in the same way by all team members.
	Changes quickly assimilated into the care process.	Q3) The ICF Patient Card is helpful in allowing teams to consider non-clinical criteria in the
	Support for transparency of the whole collaboration environment.	Q4) The Agile Treatment Plan is an effective way for a single coordinated care plan to be available for patients and team members, whether they are remotely located or otherwise.

Table 7-5 provides the Expert Panel Questions related to the Data Effectiveness criteria group (defined in section 4.3.3). Data Effectiveness in the context of team collaboration refers to the grouping of criteria that relate the availability of the required data and its proper use in the context of collaborative care.

Table 7-5: Data Effectiveness Mapping

Criteria Group	Criteria	Expert Panel Question (Likert Formulated Question)
Data Effectiveness	Coordinated care plan	Q7) The artifacts in our framework support usable and relevant data to be shared between team members in a timely and effective manner.
	Integrated and relevant collaboration information from a variety of sources is supported.	Q9) The Collaborative Care Ontology and the Collaborative Care Model Canvas effectively identify relevant collaboration-related information data from a variety of media (paper, electronic, etc.) and geographies.

7.1.5 **Assessment Scores**

The assessment scores provided by the panel are shown in Table 7-6 using the color coding provided in Table 7-1. The table also provides an average for each criterion. The median for all the criterion except Q1 is 4, which reflects general positive agreement in the evaluation of our

PMFCC and Artifacts based on the review session by the experts. The table also shows the range of consensus of the colleagues, which is discussed next.

Table 7-6: Raw Scores

Expert	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1	3	3	5	4	4	5	4	4	4
2	4	4	4	4	3	4	4	4	4
3	3	3	2	4	4	2	4	4	3
4	3	4	4	4	5	4	4	3	5
5	4	4	5	5	4	5	4	4	5
Average	**3.4**	**3.6**	**4**	**4.2**	**4**	**4**	**4**	**3.8**	**4.2**

A detailed analysis of the evaluation and level of consensus across our three evaluation criteria groups is shown in Table 7-7.

Table 7-7: Summary of Expert Panel Scores

Criteria Group	Expert Panel Question	Evaluation Criteria	Average Score	Min Score	Max Score	Overall Score	Overall Consensus
Team Effectiveness	Q1	Decrease in cognitive load on team members	3.4	3	4	Neutral	Consensus
	Q5	Measurable view of collaboration	4	3	5	Positive	No Consensus
	Q3	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.	4	2	5	Positive	Extreme no consensus
	Q7	Information is seamless and flows transparently between members and other stakeholders.	4	4	4	Positive	Consensus
Coherent Care	Q2	Concept clarity to ensure common understanding.	3.6	3	4	Neutral	Consensus
	Q6	Changes quickly assimilated into the care process.	4	2	5	Positive	Extreme no consensus
	Q8	Support for transparency of the whole collaboration environment.	3.8	3	4	Positive	Consensus
Data Effectiveness	Q4	Coordinated care plan	4.2	4	5	Positive	Consensus
	Q9	Integrated and relevant collaboration information from a variety of sources is supported.	4.2	3	5	Positive	No Consensus

When a criterion was scored with a score variability (difference between the highest score and the lowest score given) of less than 2 among experts, we deemed that criterion as having experts' consensus, and when there was 2 score variability, we assumed that the experts had no

consensus about that criterion. If there was the score variability was 3, we assumed extreme no consensus. If the average score was less than 4, the overall score was deemed neutral. If it was 4 or more, the overall score was deemed positive. The exception is Q8, where all but one expert scored the question as 4, which we deemed to be a positive result.

For Q4, Q7, and Q8, we see that the overall score was positive, and there was overall consensus between all members of the expert panel. There were two cases, Q5 and Q9, where there was a positive overall score, but there was overall no consensus. In both of these cases, there was only one score of 3 in that caused this categorization; that is, 4 of the 5 experts scored either 4 or 5. It is also worth noting that two different experts scored the questions as 3. Two questions, Q3 and Q5 had a positive overall score, but has an overall extreme no consensus between the panel members. In this case, Expert 3 scored these questions as 2, while all others scored with either a 4 or 5. The two questions Q1 and Q2 yielded a neutral overall score with an overall consensus. In general, we conclude that the overall scores were predominantly positive with overall consensus, and that the Expert Panel Review resulted in positive validation for each criteria group of the PMFCC.

7.1.6 **Key Comments and Recommendations**

Unstructured feedback consisted of verbal comments made by the experts during the session, as well as written comments provided in the questionnaire. The panel provided key comments and recommendations in a number of areas. While the experts validated the PMFCC and provided many positive affirmations, this section highlights key comments provided by the experts. It is worth noting that all these comments are related to the either a limitation in understanding the Artifact, or to the implementation of the PMFCC.

1. Experts appreciated the value of numerical scores in the ICF Patient Card but would like a place for written comments if a new factor comes up and the team member is not sure how to quantify it. This could be discussed at next Case Conference. We updated the IPC by adding a comment field with a date, name of team member and description as shown in Section 5.3.3.
2. One expert asked how the data from the Artifacts would be shared across the team. We have identified the lack of a technical implementation as a limitation in section 7.4.2
3. The same expert also stated that the ICF is not particularly well known as a standard data source. It will take some education for team members to use. We identified in Section 7.4.1 that we assumed all team members are trained. Furthermore, in the future, other Artifacts could be developed for more common standards such as SNOMED, as explained in Section 5.3.3.
4. Some experts found it difficult to understand the Agile Process Model. They suggested that the arrows get labelled as steps and described in the text of the thesis. We opted not to label steps as we felt that it would clutter the APM and render it more confusing.
5. One expert expressed that navigating the CCMC was a "bit strange" because they are not used to progressing from left to right in a nonlinear fashion. However, the CCMC has more than one point of entry. For example, we may approach the canvas from the middle under the Values section. We believe that familiarization with the CCMC will alleviate this concern. We identified in Section 7.4.1 that we assumed all team members are trained.
6. One expert suggested that when implemented, hiding the ICF Code would be useful since it is not necessary for them to fill in the functional scores in the ICF Patient Card.

We believe that this is an excellent idea and should be adopted when implemented. We have identified the lack of a technical implementation as a limitation in section 7.4.2

7. An expert said, regarding the Collaborative Care Model Canvas, that it provides a high-level overview of the care provided, ensuring that all team members share a similar approach in caring for the patient. However, their concern was that the CCMC may be a bit too strategic in nature for some of the team members. Also, some of its content may be too broad and intangible for it to add value to the care team. We believe that this is a valid comment; however, it may not be necessary for all team members to be fully familiar with the CCMC. The objective of our research was to provide tools that could be used as needed. We do not stipulate how they are implemented.
8. In order to enable more informed use of the ICF Patient Card, one expert suggested a mouse-over or hyperlink to provide more information on the definition of a function for example. Another comment related to this is how people will use the rating system. That is, how does one account for the subjective nature of the responses. Yet another expert was concerned about how clear the descriptors of functionality are. The concern is that if they are too general, then scoring will not be effective. Conversely, if they are too detailed, it will take too long to complete. We believe that all these comments are valid but are related to how the Artifacts will be implemented. We have identified the lack of a technical implementation as a limitation in section 7.4.2.
9. Capturing the patient's self-assessment is often challenging in healthcare and the ICF Patient Card may be an effective way to do so. The expert suggested highlighting this in the thesis. We updated Section 5.3.3 to include the value of the IPC for self-assessment.

10. One expert suggested articulating inclusions and exclusions to a coordinated care plan (referring to the ATP). We have identified the lack of a technical implementation as a limitation in section 7.4.2.
11. One colleague recommended changing the questions in the PMM to "How" questions. We updated the PMM questions using this valuable suggestion in Figure 5.7 in Section 5.2.3.6.

7.1.7 Additional Insights

There were other important considerations provided by the experts. Additional insights were derived from the unstructured discussion during the meeting as well as through an analysis of the written feedback. These are described here.

1. **Defining Cognitive Load:** The experts had difficulty answering whether our PMFCC decreases cognitive load. There was a flaw in the question since the precise definition of cognitive load was not provided. Furthermore, the mechanism by which cognitive load was to be measured was also not defined. Yet another aspect to this question is that unless one measures before and after using the Artifact, is it difficult to say whether cognitive load has been decreased. Also, reducing cognitive load is a function of the other processes in which our PMFCC is used. One expert commented that inputting data into our Artifacts would increase cognitive load because they we are asking healthcare workers to do something that they would not ordinarily do. A better question might be whether the Artifacts/Components help team members manage a patient case.
2. **Measuring Subjective Aspects of Collaboration:** Our thesis articulates clearly that subjective measurements of collaboration were not part of the research. In order to

simplify the analysis, our assumption is that all team members agree to use the PMFCC, and that they can work together without interpersonal issues. However, we neglected to explain this assumption in the Expert Review Panel. The result was that the experts had many comments about the difficulty in actually measuring performance of team. Team dynamics can be measured by existing tool, such as IPT Metrics, which provides a data-driven tool to assess teamwork and behavior for building self-awareness and teamwork effectiveness. Evaluating the value of this kind of tool may be considered in future work.

3. **Evaluating Unintended Impacts:** An interesting point related to balancing our approach to collaboration with unintended impacts on other aspects of healthcare delivery. While this is clearly beyond the scope of this thesis, and is dependent on implementation context, it is nonetheless interesting as a concept. Along the same line of reasoning, another expert stressed the need for simplicity and minimalism in data and forms. These comments affect the research in that they point to the need to design the PMFCC such that implementation minimizes user input requirements and measures performance, as much as possible, in the background, serving up results only to those who need them, at the time when they are needed. This will not only reduce unintended consequences but may also alleviate cognitive load.
4. **Linking Criteria to Medical Error:** One of the experts suggested to state specifically how our Artifacts/Components will reduce medical error (e.g. "*better real-time communication, clear enunciation of facts, progress, roles, etc.*"). Our evaluation criteria is comprised of a list of items that is used in performance management; however, the evaluator stated that we do not make a direct link between them and

medical error. This was a useful insight to help position the value of the PMFCC to the underlying motivation of the research.

5. **Explicit Support for Asynchronous Teams:** The clinical walkthrough assumed synchronous Case Conferences. The Expert Panel pointed out that asynchronous teams need to be supported. Complex care in a remote or synchronous fashion will be harder to support than face-to-face care, synchronous care. While support for asynchronous teams is already part of the Collaboration Space Ontology Template, it may be useful to highlight how the ATP may be used remotely, as opposed to on site.

7.2 Artifact Driven Scenarios

This section presents a summary of how our PMFCC was conceived and developed iteratively, using an evaluation at the end of each iteration to motivate development and refinements of the PMFCC and Artifacts in the next iteration as shown in in Table 7-8.

Table 7-8: Development of PMFCC by Iteration

Performance Management Framework for Collaborative Care		Iteration 0	Iteration 1	Iteration 2 Scenario 1	Iteration 3 Scenario 2	Iteration 4 Scenario 3
Compo-nents	Collaboration Space Ontology Template	Create Strawman	Set up			Refine
	Agile Process Model		Set up	Refine		
	Performance Management Model		Set up		Refine	Refine
Artifacts	Agile Treatment Plan		Create Strawman	Set up	Refine	
	Agile Collaborative Dashboard		Create Strawman	Set up		Refine
	ICF Patient Card			Create Strawman	Set up	
	Collaborative Care Model Canvas				Create Strawman	Set up & Refine

As described in the DSRM Iterations, Table 3-1, we created a strawman for the PMFCC in Iteration 0. Iteration 1 was the setup phase of the PMFCC included the definition of the Collaboration Space Ontology Template, the Agile Process Model and the Performance Management Model. This stage also included identifying the Clinical Vignette that would be used in future work. We derived these from inductive analysis of literature surveys and the author's empirical knowledge of the domain. Once these Components were defined, we focused on developing the supporting Artifacts by applying the PMFCC to the Clinical Vignette. These were developed in the scenarios defined in Sections 6.2, 6.3 and 6.4 (Iterations 2, 3 and 4). In Section 6.2, we developed the Agile Treatment Plan and Agile Collaboration Dashboard and further refined and enhanced the Agile Process Model. An identification of a deficiency in the PMFCC led to the introduction of the ICF Patient Card in Section 6.3. This impacted both the Agile Treatment Plan and led to the further development of the Performance Management Model. Section 6.4 was introduced to deal with an identified PMFCC deficiency to provide tool support for understanding the overall context in which the team operates. This led to the development of the Collaborative Care Model Canvas. We found that the CCMC was very useful in helping to negotiate with parts of the Collaboration Space Ontology Template were relevant (and not relevant) to the scenario under consideration. The CCMC was also instrumental in uncovering the benefit of the PMFCC for healthcare managers. This necessitated an update to the Performance Management Model as well as the Agile Collaboration Dashboard.

Furthermore, our Artifact driven scenario of 6 were designed to address the three Criteria Groups as shown in Table 7-9, which shows that we achieved coverage of all our criteria.

Table 7-9: Results of Scenario Development

	Criteria	Evaluation Question	CSO	APM	PMM	ATP	ACD	ICP	CCMC
Team Effectiveness	1	Decrease in cognitive load on team members		Scenario 1		Scenario 1 Scenario 2	Scenario 1 Scenario 2	Scenario 2	Scenario 3
	2	Measurable view of collaboration			Scenario 3 Scenario 2				
	3	Changes quickly assimilated into the care process.		Scenario 1				Scenario 2	
	4	Support for transparency of the whole collaboration environment.	Scenario 3 Scenario 1	Scenario 1					Scenario 3
Coherent Care	5	Concept clarity to ensure common understanding.	Scenario 3					Scenario 2	Scenario 3
	6	Whole-person centric view of care that supports different modalities such as social, clinical and functional care.						Scenario 2	
	7	Coordinated care plan				Scenario 2		Scenario 2	
Data Effectivene	8	Information is seamless and flows transparently between members and other stakeholders.				Scenario 1	Scenario 1 Scenario 2	Scenario 2	
	9	Integrated and relevant collaboration information from a variety of sources is supported.	Scenario 1 Scenario 2						

7.3 Related Works

In this section we evaluate how our proposed PMFCC addresses each criterion introduced in Section 3.3 in comparison to the related work identified in Section 2.6. We use the same evaluation criteria as the ones used in our Expert Panel Review Session.

7.3.1 Evaluation Rubric

The following is a comparison of our PMFCC to: the Collaboration Space Model (Eikey et al., 2015); the Healthcare Outcomes Measures (M.E. Porter, 2010b); Teams and Collaboration; and Tolf et al who maps the characteristics of agile to a healthcare organization (Tolf et al., 2015). We first present the Evaluation Rubric, shown in Table 7-10. The rubric lists the criteria and precise conditions for each possible value and color code (green=Acceptable, yellow=Partial, red= Not Applicable).

Table 7-10: Related Works Evaluation Rubric

Criteria Group	Evaluation Criteria	Expert Panel Question	Related Works Question	Acceptable (A)	Partial (P)	Not Applicable (NA)
Team Effectiveness	Decrease in cognitive load on team members	The Artifacts and Agile Process Model allow team members to interact in a structured way which decreases the cognitive load for team members to collaborate.	Theory, method, algorithm, or implementation, that will lower the cognitive load on a team, is/are provided.	Cognitive load is decreased.	Cognitive load is somewhat decreased.	Cognitive load is not decreased; or not discussed.
	Measurable view of collaboration	The Performance Management Model is an effective way to determine areas where collaboration performance can be measured, and consequently, where KPIs can be defined.	Theory, method, algorithm, or implementation provided to capture, and report performance metrics related to team collaboration.	Many relevant KPIs are captured and reported.	Some relevant KPIs are captured and reported.	No relevant KPIs are captured and reported; or not discussed.
	Changes quickly assimilated into the care process.	The ICF Patient Card is an effective way to characterize and respond to patient-level changes.	Theory, method, algorithm, or implementation demonstrates how to characterize and respond to patient-level changes.	Teams are responsive most of the time.	Teams are responsive some of the time.	Teams are not responsive; or responsiveness not discussed.
	Support for transparency of the whole collaboration environment.	The Performance Management Model allows relevant aspects of the collaboration environment to be available and communicated.	Theory, method, algorithm, or implementation support the ability for relevant aspects of the collaboration environment to be available and communicated.	All relevant aspects of the collaboration environment available and communicated most of the time.	All relevant aspects of the collaboration environment are sometimes available and communicated.	All relevant aspects of the collaboration environment are never available and communicated some of the time; or not discussed.
Coherent Care	Concept clarity to ensure common understanding.	The Collaboration Space Ontology Template, ICF Patient Card and Collaborative Care Model Canvas are useful in clarifying the terminology so that terms and concepts are easily understood in the same way by all team members.	Theory, method, algorithm, or implementation, that will allow terms and concepts to be understood by all team members in the same way, is/are provided.	Terms and concepts are clearly understood in the same way by all team members most of the time.	Terms and concepts are clearly understood in the same way by all team members some of the time.	Terms and concepts are never clearly understood in the same way by all team members; or not discussed.
	Whole-person centric view of care that supports different modalities such as social, clinical, and functional care.	The ICF Patient Card is helpful in allowing teams to consider non-clinical criteria in the treatment of the patient.	Theory, method, algorithm, or implementation demonstrates that non-clinical criteria are used in diagnosis and treatment of patient.	Additional non-clinical criteria are used to diagnose and treat the patient most of the time.	Additional non-clinical criteria are used to diagnose and treat the patient some of the time.	Additional non-clinical criteria are never used to diagnose and treat the patient; or not discussed.

	Coordinated care plan.	The Agile Treatment Plan is an effective way for a single coordinated care plan to be available for patients and team members, whether they are remotely located or otherwise.	Theory, method, algorithm, or implementation describes a single coordinated care plan that includes remotely located team members and patients.	A coordinated care plan exists and includes remotely located patients and team members most of the time.	A coordinated care plan exists and includes remotely located patients and team members some of the time.	A coordinated care plan exists and never includes remotely located patients and team members.
Data Effectiveness	Information is seamless and flows transparently between members and other stakeholders.	The Artifacts in our framework support usable and relevant data to be shared between team members in a timely and effective manner.	Theory, method, algorithm, or implementation support the ability for usable and relevant data to be shared between team members in a timely and effective manner.	Usable and relevant data is shared most of the time.	Usable and relevant data is shared some of the time.	Usable and relevant data is never shared.
	Integrated and relevant collaboration information from a variety of sources is supported.	The Collaboration Space Ontology Template and the Collaborative Care Model Canvas effectively identify relevant collaboration-related information data from a variety of media (paper, electronic, etc.) and geographies.	Theory, method, algorithm, or implementation support the ability to support relevant collaboration-related information data from a variety of media (paper, electronic, etc.) and geographies.	Integrated and relevant collaboration information from a variety of sources, mediums and geographies is mostly supported.	Integrated and relevant collaboration information from a variety of sources, mediums and geographies is somewhat supported.	Integrated and relevant collaboration information from a variety of sources, mediums and geographies is never supported.

7.3.2 **Evaluation Results**

The results of our evaluation are shown in Table 7-11. Table 7-11 is based on our evaluation criteria and shows each of the related works in a column, along with our Expert Panel evaluation in the last column (Table 7-7). We also added the Clinical Vignette to demonstrate how our criteria has improved the current process. The table lists each of the evaluation criteria from chapter 3 in the rows. Using these criteria, we evaluate our proposed PMFCC as well as each of the systems from our related work in Section 2.6 according to the rubric in Table 7-10. Note that for Q5 and Q9, there was a positive overall score, but an overall no consensus. We labeled these as “Positive?”.

Table 7-11: Related Works Evaluation

Criteria Group	Evaluation Criteria	Clinical Vignette	Agile Orgs. (Tolf)	Collab. Space (Eikey et. al.)	Teamwk. and Collab. (Xiao et. al.)	Healthcare Outcome Measures (Porter)	Expert Panel Evaluation
Team Effectiveness	Decrease in cognitive load on team members	Not Applicable	Not Applicable	Partial	Acceptable	Acceptable	Neutral
	Measurable view of collaboration	Not Applicable	Not Applicable	Partial	Partial	Acceptable	Positive?
	Changes quickly assimilated into the care process.	Not Applicable	Partial	Partial	Acceptable	Acceptable	Positive?
	Support for transparency of the whole collaboration environment.	Not Applicable	Partial	Partial	Acceptable	Acceptable	Positive
Coherent Care	Concept clarity to ensure common understanding.	Partial	Not Applicable	Partial	Partial	Partial	Neutral
	Whole-person centric view of care that supports different modalities such as social, clinical, and functional care.	Partial	Not Applicable	Partial	Partial	Acceptable	Positive
	Coordinated care plan.	Not Applicable	Not Applicable	Partial	Not Applicable	Partial	Positive
Data Effectiveness	Information is seamless and flows transparently between members and other stakeholders.	Partial	Not Applicable	Acceptable	Partial	Partial	Positive?
	Integrated and relevant collaboration information from a variety of sources is supported.	Partial	Not Applicable	Acceptable	Partial	Partial	Positive?

7.3.2.1 Team Effectiveness

Decrease in cognitive load on team members

As discussed in Section 7.1.5, the Expert Panel provided a neutral overall score to this question due the way the question was posed. They responded to this question understanding that physicians are already cognitively (and otherwise) overloaded, and that the PMFCC may add an additional overhead to existing processes. Decreasing cognitive load relates to the repeatability of processes, communication, and technology for collaboration. Porter and Xiao align with this view. Porter talks about the creation of integrated care units that contain teams that are responsible for the patient over the life of a medical condition. These patient-centered teams collaborate in a similar way to our agile process since teams are specialized around a medical condition which

reduces time and resources and results in reduced cognitive load. This is also in alignment with the idea of Team Mental Models presented in the paper by Xiao et.al. That is, a shared and organized understanding of the pertinent parameters related to the team's common work such as diagnosis, problem solving and treatment is a key predictor of team effectiveness by reducing cognitive load. Eikey et. al. alluded to decreased cognitive load, however, did not provide any extensive analysis of the same. It was not considered in the work by Tolf, or in the Clinical Vignette.

Measurable View of Collaboration

As discussed in Section 7.1.5, the Expert Panel provided a provided a positive overall score to this question, but we have added a question mark in the table above as there was not complete consensus amongst the experts. Porter has a very strong view of how collaboration should be understood and measured in his Outcome Measures Hierarchy. As in our PMFCC, he provided a compelling and clear view of a 3-tier model that contained outcome measures over the span of a medical condition which includes how well the interventions worked, time to recovery and functionality as well as any issues caused by the treatment itself, and finally how sustainable the health condition was. Our PMFCC is certainly complementary to Porter's model in that it focusses on objective measures of collaboration. Porter advocates for measurement of outcomes in a direct way. Metrics such as *functional level achieved*, *time to treatment*, *time to return to physical activities*, *time to return to work* are specifically provided. These are in direct agreement with our PMFCC, which includes these and many more measurements in our Performance Management Model. No significant treatment of this factor was provided by Xiao or Eikey. There were no teamwork related measurements in the Clinical Vignette or by Tolf.

Changes Quickly Assimilated into the Care Process

As discussed in Section 7.1.5, the Expert Panel provided a provided a positive overall score to this question, but we have added a question mark in the table above as there was not complete consensus amongst the experts. In Agile Organizations, Tolf et. al. allude to need for elastic and responsive teams. However, they do not provide a way to measure collaborative aspects of such teams. This also true for the paper by Eikey et.al. One of Porter's main drivers for the integrated patient unit, is the ability to responsive to patient's needs. Finally, Xiao et.al. speak to the idea of adaptive coordination, in which teams respond to factors such as uncertainties, stress, and extreme workload. They discuss the need for timely, accurate, and frequent problem-solving communication, as well as shared goals, knowledge and mutual respect. All of these factors align with our Agile Process Model. Our Clinical Vignette highlighted the unwieldy nature of the current process and is therefore not applicable.

Support for transparency of the whole collaboration environment.

As discussed in Section 7.1.5, the Expert Panel provided a provided a positive overall score to this question. In Agile Organizations, Tolf et. al. allude to need for understanding the context in which the team functions from an organizational point of view (Tolf et al., 2015). However, they do not provide a way to measure collaborative environment aspects of such teams. This also true for the paper by Eikey et.al. (Eikey et al., 2015). Additionally, transparency is not part of the Clinical Vignette. However, Xiao et.al. in Teamwork and Collaboration inject the idea of an *organizational shell* which allows the evaluation and improvement of a team within the structural context of the organization in which they function (Xiao et al., 2013). This allows the ability of understanding factors that contribute to team performance. The authors also identify how the well-defined operating procedures help to scaffold the team to perform better. These aspects are in agreement with both the Collaborative Care Model Canvas, as well as our Agile Process Model.

The concept of transparency is embedded in Porter's integrated patient units, in which the administrative unit is responsible for the overall care of the patient. In this way, the environment in which the team functions is bounded and is very strictly defined, with all the services required for the patient available in one place. In this way, transparency is normal and natural as it is a part of the organization design of care. Our PMFCC supports this view and provides the tools and Artifacts that will support this type of organization.

7.3.2.2 Coherent Care

Concept clarity to ensure common understanding.

As discussed in section 7.1.5, the Expert Panel provided a provided a neutral overall score to this question. All experts did indeed feel that the ontology would be useful in clarifying terminology, and that communication would be improved as a result. One expert felt that it was not the objective of the ICP or the CCMC to reconcile terminology across diverse sources and provided a score of 3. Another expert did not agree that the CCMC should be included because it requires training to understand, and that it will be more useful in clarifying strategic interrelationships than terminology. This expert also scored the question as a 3. All others scored the question with a 4, resulting in an average score of 3.4, or neutral.

Whole-person centric view of care that supports different modalities such as social, clinical, and functional care.

As discussed in section 7.1.5, the Expert Panel provided a provided a positive overall score to this question, but we have added a question mark in the table above as there was not complete consensus amongst the experts. Porter handles this criterion through a thorough examination of the patient in a holistic fashion in his Outcome Measures Hierarchy (Michael E. Porter, 2010). Because of his comprehensive view of the patient in terms of the functionality, he tries to

encompass all aspects of what affects the patient, and as such, surpasses our PMFCC in scope, which is limited to team collaboration. However, within the rubric of team collaboration, our PMFCC provides a specific way to incorporate a whole-person centric view by using the ICF Patient Card in the evaluation of patient functionality. The International Classification of Functionality itself is design to include different modalities of social, clinical and functional care (Functioning and Disability Reference Group, 2010). The other related works, including the Clinical Vignette, only partially address this criterion.

Coordinated care plan.

As discussed in section 7.1.5, the Expert Panel provided a provided a positive overall score to this question. Eikey et. al allude to a coordinated care plan (Eikey et al., 2015). Neither our Clinical Vignette, or the papers by Xiao et. al., or Tolf et.al discuss a coordinated care plan. In the case of Porter, his paper deals with the overall care of the patient without speaking specifically about a coordinated care plan (Michael E. Porter, 2010). However, within the structure of the integrated patient unit, this author would argue that a coordinated care plan is inherent to the model that Porter has proposed. In our PMFCC, the Agile Treatment Plan is a coordinated care plan.

7.3.2.3 Data Effectiveness

Information is seamless and flows transparently between members and other stakeholders.

As discussed in section 7.1.5, the Expert Panel provided a provided a positive overall score to this question. Porter's paper addresses the overall care of the patient without speaking directly about this criterion (Michael E. Porter, 2010). However, within the structure of the integrated patient unit, we would infer that it is inherent in the model that Porter has proposed. Eikey et. al. describe the case for the seamless flow of information for the purposes of establishing common ground as well as maintaining awareness. The Collaboration Space Model is premised on this

capability (Eikey et al., 2015). In our PMFCC, which is based on the Collaboration Space Model for HIT implementation, all our Components and Artifacts enable the seamless flow of information in a coordinated fashion. All other authors provide on a partial reference this criterion.

Integrated and relevant collaboration information from a variety of sources is supported.

As discussed in section 7.1.5, the Expert Panel provided a provided a positive overall score to this question, but we have added a question mark in the table above as there was not complete consensus amongst the experts. Porter does not refer directly to this criterion. However, within the structure of the integrated patient unit, we would again argue that the relevant data would be available from a variety of sources in the proposed model (Michael E. Porter, 2010). Eikey et. al. also describe the case for integrated and relevant collaboration information for the purposes of establishing common ground as well as maintaining awareness (Eikey et al., 2015). In our PMFCC, this criterion is covered in the Collaboration Space Ontology Template. All other authors provide only a partial reference this criterion.

7.4 Assumptions, Limitations and Threats to Validity

7.4.1 Assumptions

Assumptions represent simplifying criteria that allow the researcher to focus on key aspects of the PMFCC. To focus our scenarios on the development of the Components and Artifacts, we make the following assumptions:

- The clinical walkthrough assumed synchronous Case Conferences.
- Team members have been trained on the ICF.

- All team members have agreed to participate in the Agile Process and have "bought in" to working within the PMFCC and have a good knowledge of the Components and Artifacts.
- All team members would have the requisite technology and skills and to use the PMFCC if it were implemented technically.
- All team members are cooperative with each other, and team members work in the Norming or Performing stage of Tuckman's model (Tuckman, 1965).
- All professionals are working in the context of the Ontario healthcare system.
- There are no data privacy or ownership concerns.

7.4.2 **Limitations**

Limitations represent weaknesses of this research which result from assumptions and limitations of resources.

- There was a flaw in Q1 of the expert panel questions. The precise definition of cognitive load was not provided. Furthermore, the mechanism by which cognitive load was to be measured was also not defined. Yet another aspect to this question is that unless one measures before and after using the Artifact, is it difficult to say whether cognitive load has been decreased. A better question might be whether the Artifacts/Components help team members manage a patient case.
- This research has described a conceptual PMFCC for performance management with Artifact support. No part of the PMFCC has been implemented technically.
- Our research has been implemented and evaluated in the context of ADHD according to Canadian guidelines in the province of Ontario. Further research is

required to determine its applicability to other jurisdictions, as well as other domains.

- The PMFCC should be validated for other conditions such as rehabilitation to validate its applicability to other community care processes.

7.4.3 **Threats to Validity**

Threats to validity are weaknesses of this research which result from assumptions, limitations of resources and research method chosen.

- The work done on this thesis was done by the author only. The research presented is considered early exploratory work and has not been validated in the field.
- While a simple validation exercise has been conducted with an Expert Panel with expertise in ADHD, further validation by healthcare professionals in different domains will be required, especially healthcare administrators.
- As the Expert Panel was chosen from amongst our colleagues, we may have introduced a bias in the assessment. This was deemed acceptable for early exploratory work, but nevertheless represents a threat to the validity of our research results.
- Our research was strictly focused on HIT design of performance management of collaborative care. Unintended consequences of deployment of such an HIT were not considered. These include workflow modifications to existing processes, changes in communication, etc.

8 Conclusion and Future Work

8.1 Conclusion

This thesis represents a knowledge contribution created using Design Science Research Methodology for a performance management framework for collaborative care (PMFCC). This knowledge contribution is for the improvement of collaborative care, in which we developed a new solution for known problems in this space. We provided three Components and four Artifacts that comprise this PMFCC. We developed and demonstrated this PMFCC using a simple community care process for ADHD. This illustrative case study of ADHD acted as a proof-of-concept of how our PMFCC enables us to model and understand collaborative care delivery as part of the HIT design process.

Our PMFCC started with the need to design a common structure and set of terminology for collaborative care delivery. We developed the Collaborative Space Ontology Template (CSOT) to accomplish this task. The CSOT expanded the Collaboration Space Model (Eikey et al., 2015) by defining a set of concepts, sub-concepts and relationships of the essential features of collaborative care delivery. The value of the CSOT is that it provides the structure, concepts and relationships which be configured to support the complexity of collaborative care delivery in other areas (outside of ADHD). Subsequent work will be required to enable articulation of how its elements would be configured to support different instantiations of collaborative care delivery.

After the CSOT, our next action in the development of the PMFCC was to develop the optimal care process model that would be used to provide measure team effectiveness. We applied the agile SCRUM methodology to collaborative care to develop the Agile Process Model. We confirmed that it provides structure to the interactions that occur between team members when

applied to ADHD, and that the supporting ATP and ACD Artifacts are useful and applicable in supporting collaboration effectiveness. We believe that the PMM is also applicable to other instantiations of community care processes, and this should be addressed in future work.

Our next task was to develop our performance management model (PMM) using the CSOT and the APM. The PMM is the heart of the PMFCC because it is used to yield the KPIs relevant to performance management. The PMM responds to the difficult task of quantifying key aspects of team performance, which has not been discussed before in the literature in a cohesive way.

We also articulated additional types of system design Artifacts, other than the ATP and the ACD, needed to support HIT design for collaborative care delivery. The CCMC is one such novel Artifact that allows us to understand the contextual complexity of collaborative care delivery within a specific environment and allows us to model the behavioral aspects of a collaborative system. This is an important benefit of a performance management framework because it allows processes performed by individual team members to be reconciled with collaborative goals at the team level. This is part of solving the team-collaborative interchange problem in HIT design, which had not been studied in the context of performance management before (Buscemi et al., 2012)(Havyer et al., 2014).

Another Artifact that was key in creating a common and ongoing understanding of care outcomes was the ICP. Incorporation of a standardized language and terminology (provided by the ICP) that could be used by all team members, along with standardized forms, dashboard, and indicators, operationalized and completed the PMFCC.

In summary, this research provides early evidence that our PMFCC is viable. The agile process model clearly acts as the driver for the style of interaction required by collaborative care teams to be performant. When linked with the performance management model, it provides key

indicators that allow measurement of performance. The ontology template is clearly useful; however, application to new healthcare domains is required. This is also true for our example Artifacts, although there is early evidence that these types of Artifacts are useful. Further work is required and is described in the next, and final, section of this thesis.

8.2 Future Work

The following are key areas that we believe are required to further develop the PMFCC:

- **Ontology:** Terminology standardization is an essential component to the implementation of successful HIT systems (Macedo & Isaías, 2013). Future work will develop our ontology template into a proper ontology. This ontology would provide a formal representation of classes, functions, relations, and other objects, and would provide for a unified understanding of elements for the various stakeholders defined within it.
- **Technology implementation:** In order to qualify the usefulness of the PMFCC, it will need to be instantiated as an HIT and then applied to specific healthcare implementations.
- **Long term study:** A long term study of a technology implementation with ADHD practitioners is required. This would further validate our PMFCC, as well as fill in any gaps that may not be visible in a theoretical exercise. For example, identification of other KPIs that might be relevant and useful could be one such gap.
- **Application to other domains:** Another aspect for future work is the further determination of specific Artifacts and KPIs for domains other than ADHD.

- **New Artifacts:** Future work is required to continue to create new Artifacts that support other areas of the Collaboration Space Ontology Template. For example, our PMFCC used the ICF standard to create the IPC. However, the PMFCC supports the creation of other Artifacts using different standards. For example, the PMFCC could be used with other medical standards such as SNOMED.
- **Incorporation of other indicators:** One interesting investigation would be to further analyze the application of KPIs in Porter's Outcome Measures Hierarchy. Another is the incorporation of subjective collaboration measures for teamwork, such as those used in ITP Metrics (O'Neill, 2020).
- **Data analytics:** Finally, a very important future work will be the capture and analysis of collaboration metrics. Application to teams as well as organizations will be very interesting. We foresee that, with enough data collected, the ability to create models, methods, patterns, and other expertise that inform the collaboration of community care teams is possible.

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