

Towards a Clinical Analytics Adoption Maturity Framework for Primary Care

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Abstract. Clinical decision support systems are evolving with growing analytics capabilities towards pervasive use of artificial intelligence. Maturity models can guide the adoption of these new technologies in clinical practice to improve patient outcomes in primary care settings. Our literature survey identified the "Health Analytics Adoption Maturity Model" by Canada Health Infoway as a suitable basis for developing an adoption maturity framework with primary care focus. We follow a design-science research paradigm to develop a scientifically-validated mixed-method approach for assessing and guiding the evolution of clinical analytics capabilities in primary care. This paper summarizes the first phase of our research in progress.

Keywords. clinical analytics, decision support systems, maturity models, technology adoption, primary care

1. Introduction

Advances in patient-centered technologies and clinical decision support (CDS) systems have the potential to improve and automate elements of the diagnosis and treatment processes in primary care. This is made possible by a gradual shift from human-centered to machine-supported decision making through use of analytics capabilities that are evolving from descriptive, diagnostic, predictive, to prescriptive analytics. A new generation of "cognitive" systems is expected to further extend prescriptive analytics capabilities with pervasive use of artificial intelligence [1].

Several studies have shown that the implementation of new technologies does not always lead to adoption and improved patient outcomes in clinical practice [2]. Maturity models can offer tools to measure, evaluate, and guide the evolution of organizational capabilities, such as the use of analytics in CDS. There is a need to have implementable maturity models for CDS, so potential benefits of these tools can be achieved.

This paper describes research in progress towards a clinical analytics adoption maturity measurement methodology for CDS in primary care.

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2. Methods

Our study follows the seven guidelines of a design-science research paradigm to ensure an appropriate theoretical foundation for maturity model development. Design-science research seeks to achieve knowledge and understanding of a problem domain through creation, application, and evaluation of a designed artifact [3]. We reviewed several procedure models for the development of maturity models using design-science principles [4]-[6] and selected Becker et al.'s [5] procedure model for maturity model development to guide our approach while incorporating design decision parameters from Mettler's comparative study of maturity model development processes [6]. Methodologically, we will conduct research in three broad phases:

1. Research and development of adoption maturity model and methods

We will define the problem and conduct a literature survey to identify relevant prior work. The results of the literature survey will inform our development strategy and provide requirements for development of the initial maturity model and methods.

2. Application and evaluation of model and methods through socio-technical evaluation of analytics adoption maturity

We will apply and evaluate model and methods in a field study of a real-world primary care clinical analytics environment.

3. Reflection and refinement of model and methods

Working with feedback from the field study, we will make suggestions for refinement and extension of the model and methods for future work.

3. Initial Results

We have completed the first three steps of phase 1 (problem definition, literature survey, development strategy). Below is a summary of our initial results to date.

3.1. Problem Definition

Evaluation of system maturity and adoption in healthcare is complex as the domain is highly context sensitive. Healthcare has adopted maturity models for information systems in general terms with a specialized emerging area of research that focuses on health analytics maturity [7], [8]. Canada Health Infoway surveyed the state of clinical analytics in Canadian primary care based on interviews with a range of subject matter experts [9]. Infoway found that several existing analytics maturity assessment models had limited applicability for Canadian primary care settings, in part due to smaller primary care practice settings in Canada and different terminologies used by the mostly US-centric models. Clinical leaders interviewed by the authors felt that their profession could benefit from a customized framework that would (1) help primary care clinicians understand the target state for the use of analytics and the levels of maturity along its pathway; (2) recognize the capabilities that are required to progress along the pathway to each new level; (3) assess their organization's adoption and use of analytics to measure progress over time; and (4) plan for investments in capital and/or operations to advance

their organization toward the target state [9]. Based on these four requirements, Infoway proposed the “Health Analytics Adoption Maturity Model for Primary Care” and recommended further research and scientific validation to evolve the model to a state of readiness for adoption. However, the Infoway model needs tools to support operationalizing the model in the form of an adoption measurement framework, methodology, and guidance for improving adoption. Our research seeks to validate and operationalize the Infoway model for application in Canadian primary care environments.

3.2. Literature Survey of Maturity Models

Expanding on a systematic literature survey conducted earlier [8], [10], we reviewed relevant health information system (HIS) maturity models to determine suitability for primary care health analytics environments. Our intent was to identify primary care-focused maturity models that could form a basis for our adoption measurement framework and methodology. The models were grouped by their clinical focus areas and reviewed for specific mention of primary care maturity aspects.

Table 1. Summary of HIS Maturity Models with Analytics Elements and Primary Care Focus

Maturity Model Designation (Author, Year)	Main Field	Analytics Elements	Primary Care Focus
Quintegra Maturity Model for electronic Healthcare (Sharma, 2008)	Gen. Healthcare	No	No
IDC Healthcare IT Maturity Model (IDC, 2008)	Gen. Healthcare	No	No
IDC Mobility maturity model for healthcare (IDC, 2013)	mHealth	No	No
HIMSS Electronic Medical Records Adoption Model (HIMSS, 2017)	EMR	Yes	No
HIMSS Continuity of Care Maturity Model (HIMSS, 2017)	Gen. Healthcare	No	No
Forrester Patient records/content management maturity model (Forrester Research, 2010)	EMR	Yes	No
Maturity Model for Electronic Patient Record (Priestman, 2007)	EMR	Yes	No
NEHTA Interop. Maturity Model (NEHTA, 2007)	Interoperability	No	No
NHS Infrastructure Maturity Model (NHS, 2011)	Infrastructure	No	No
Hospital Cooperation Maturity Model (Mettler & Blondiau, 2012)	Networking / Cooperation	No	No
PACS Maturity Model (Wetering & Batenburg, 2009)	PACS	No	No
Telemedicine Service Maturity Model (van Dick & Schutte, 2013)	Telemedicine	No	No
Healthcare Usability Maturity Model (HIMSS, 2011)	Usability	No	No
Adoption Model for Analytics Maturity (HIMSS, 2013)	Health Analytics	Yes	No
Infoway Health Analytics Adoption Maturity Model (Infoway, 2016) [9]	Health Analytics	Yes	Yes
TDWI Analytics Maturity Model (TDWI, 2014)	Gen. Analytics	Yes	No
Healthcare Data Quality Maturity Model (Pinto-Valverde et al., 2013)	Health Analytics	Yes	No
Business Intelligence Maturity Model for Healthcare (Brooks et al., 2013)	Health Analytics	Yes	No
Healthcare Analytics Adoption Model (Sanders et al, 2013)	Health Analytics	Yes	No

Only some of the models originated in academia providing access to the underlying development methodology. Most models were developed by private sector or national health organizations that limit the scope details and supporting methodology that are publicly accessible. In those instances, we relied on secondary sources to make our determination. We found that only a subset of models surveyed incorporate health analytics elements and only one model, the Infoway-proposed Health Analytics Adoption Maturity Model, specializes in a primary care context. While the Infoway model describes maturity stages and some associated characteristics for each maturity level in theory, it does not currently include any of the assessment methods required for practical application and evaluation in a real-world project. The model has not been applied and validated in field research yet.

3.3. Development Strategy

Based on our review of existing maturity models and prior research, we opted to design an adoption measurement methodology that aligns with and can be used to refine Infoway’s Health Analytics Adoption Maturity Model. Our development strategy seeks to operationalize Infoway’s model, to develop a mixed-method assessment approach that aligns with the model, and to evaluate and refine model and methods based on learnings from field research and application in a real-world project. We will also make recommendations on how to improve adoption maturity in target organizations. Through appropriate engagement, we will leverage the expertise of a panel of subject matter experts to help define requirements and to guide the evaluation of developed artifacts.

3.4. Iterative Maturity Model Development

Development will follow an iterative approach and it will incorporate several design decisions. Maturity models can be differentiated by maturity concepts of process-, object-, or people-focused maturity [6]. Infoway’s model combines elements of all three concepts. It is multi-dimensional and has followed a practitioner-based design process which we will combine with a theoretical approach to merge knowledge bases for maturity levels, metrics, and corresponding improvement recommendations. The initial model for the first development iteration will incorporate maturity levels assigned across six dimensions. Separate maturity levels in the dimensions of Data, Analytics, Governance, IT Infrastructure, Skills / Capability, and Privacy & Security will contribute to an overall maturity level assessment. Table 2 shows model descriptions for maturity characteristics exhibited across six dimensions of the model.

Table 2. Health Analytics Adoption Maturity Model Dimensions (Infoway, 2016)

Maturity Level	Data	Analytics	Governance	IT Infrastructure	Skills / Capability	Privacy & Security
Level 3	All data available, optimized for use	Comprehensive data analytics including predictive & prescriptive, near and real-time	Shared, broad based ecosystem governance (connected health information network)	Enterprise data warehouse (EDW), business intelligence & visualization tools (e.g., SaaS)	Highly skilled and specialized resources	Risk management framework optimized for expanding use cases
Level 2	Most data are of high quality,	Standardized and automated	Formal, mature at local level;	Reporting tools, outsourced benchmarking	Designated leads for governance,	Data de-identification, risk

	computable and comparable	metric reporting, benchmarking	shared governance for analytics networks	to external solution provider	informatics, privacy; analysis & reporting support	management framework & data sharing agreement(s)
Level 1	Data silos, some data standardization	Limited and basic, local, possibly multiple truths, and manually intensive	Immature at local level	EMR, other applications (e.g. Excel)	Basic analytical capability; practice improvement leadership	Training in relation to privacy and security obligations for handling PHI
Level 0	Inconsistent data capture, unstructured, inaccessible	Limited to none	Governance for analytics is not in place	Early EMR adoption (with focus on data entry)	Data entry	Limited to none in relation to analytics

4. Discussion and Conclusion

There is a clear need to understand and promote adoption of analytics capabilities in primary care. Maturity models can help identify capability gaps between a current state and a desired future state to guide further capability development. Our review of existing maturity models has shown that the field of analytics adoption research in healthcare is in its early stages with limited published results to date, only one model had an explicit primary care focus. This multi-phase research project will operationalize Infoway's model, develop a scientifically-validated mixed-method assessment approach, and provide recommendations for improving analytics adoption maturity in target organizations. We presented our initial results from the first project phase. Subsequent project phases will seek to empirically validate our proposed framework and to identify opportunities for future work. Analytics capabilities are expected to incorporate growing elements of artificial intelligence which will provide new opportunities for maturity research and future model evolution.

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