

# Quality of Care Domain Modeling in Cancer: A Semantic Approach

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**Abstract.** There is an increasing demand from heterogeneous organizations to collect and report healthcare quality metrics. To create an overarching model of quality that captures all stakeholders' perspectives of care and compare quality of care metrics consistently, clinical data elements should be modeled and represented unambiguously. We propose to use semantic web technologies in the domain of cancer care to build such a harmonized model and generate explicit, consistent, and comparable reports.

## 1 Background and Significance

The Institute of Medicine reports a growing demand in recent years for quality improvement within the healthcare industry [1-4]. In response, numerous organizations have been involved in the development of *quality measurement metrics*. However, the quality metrics development is subjective in nature [5] and competing interests exist among developer organizations. As a result, conflicting data definitions from such organizations shift the burden of accurate and reliable metrics extraction and reporting upon healthcare providers [6-8]. Furthermore, manual abstraction of quality metrics [8,9], diverse implementation of Electronic Health Record (EHR) Systems [8,10], and the lack of standards for integration across disparate clinical and research data sources [11] deepens the complexity of *consistent, valid, explicit, and comparable* quality measurement reporting task within healthcare provider organizations.

A successful model for healthcare quality measurement must represent an integrated and comprehensible view for all stakeholders from payers to providers to patients [12]. In order to construct such an overarching model, concepts should be defined explicitly, such that heterogeneous information from different sources can be reliably mapped and compared based on those concepts. While a reference information model, like the proposed National Quality Forum (NQF) Data Model [13] or eMeasures [8], can be used for deriving a

*syntactic* data model [14], it does not represent such a shared and comparable data semantics [15] for *harmonized representation* of heterogeneous schemas [14, 16]. In addition, neither is there a well defined interface between such information models and the EHR systems [17] nor can cancer quality concepts be represented solely by such a complex syntactical standard [18, 19]. Hence, quality metrics developed by diverse organizations, as well as provider's own internal metrics, cannot be modeled exclusively, compared explicitly, and *represented unambiguously* by standards such as the proposed reference information models [19].

## 2 Research Method and Design

*In the first phase* of this study, we will explore all existing quality measurement metrics and their definitions in the domain of breast cancer (eight metrics). We intend to use a formal method to construct an unambiguous semantic nomenclature from explored definitions. The method will explicitly define all concepts, show mappings among concepts, validate the model, normalize attributes, bind concepts into standard terminologies [16], provide a holistic view, and facilitate federated query functionalities [20]. *In the second phase* we will create a comprehensive conceptualized model using a standard semantic specification [21] for harmonized representation of concepts. The build process will include formal definitions of concepts and their relationships from the explored components in the previous phase. *In the third*

*phase* we will perform a series of semantic queries on a target group of quality metrics instances from federated data and compare the results against current query techniques for *functional* validation of the model. Similar comparison will be made between components of the model and the existing manual collection of the metrics by domain experts for validating completeness of the *domain coverage*. Finally, available semantic rule engines will be used for *structural* validation of the model. The host institution for this proposal, MD Anderson Cancer Center, is the largest freestanding cancer center in the world. There were 105,000 patients who visited MD Anderson in 2010 [22], thus providing the primary investigator with a large amount of data for validation of the proposed model.

The specific aims of this proposal are the following:

- 1. Explore existing quality of care measurement models in breast cancer.** Identify components, relationships, and stakeholders within and across models.
- 2. Create a conceptual model of the quality metrics in the breast cancer care domain.** Formally define model components and relationships. Propose a comparative mapping across various metrics and their components.
- 3. Evaluate the model.** Validate structure, function, and domain coverage of the model.

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