An Ontology For Formal Representation Of Medication Adherence-Related Knowledge: Case Study In Breast Cancer

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I. INTRODUCTION

Medication non-adherence is a major healthcare problem that negatively impacts the health and productivity of individuals and society as a whole. Reasons for medication non-adherence are multi-faced, with no clear-cut solution [1]. Adherence to medication remains a difficult area to study, due to inconsistencies in representing medication-adherence behavior data that poses a challenge to humans and today's computer technology related to interpreting and synthesizing such complex information. Medication adherence among breast cancer patients exemplifies the challenges mentioned above. Two types of hormone-based therapies, tamoxifen (TAM) and aromatase inhibitors (AIs), have been shown to slow down disease recurrence and mortality rates among women with breast cancer if the regimens are adhered to for a minimum of five years[1]. However, studies show that around 50% of breast cancer patients did not adhere to hormone treatment, thus risking clinical responses below the expected standards[1]. Developing a consistent conceptual framework to medication adherence is needed to facilitate domain understanding, sharing, and communicating, as well as enabling researchers to formally compare the findings of studies in systematic reviews. The goal of this research is to create common language that bridges human and computer technology by developing a controlled structured vocabulary of medication adherence behavior—"Medication Adherence Behavior Ontology" (MAB-Ontology) using breast cancer as a case study to inform and evaluate the proposed ontology and demonstrating its application to real-world situation.

II. METHODS

The design process for MAB-ontology carried out using the METHONTOLOGY method [2] incorporated with the Basic Formal Ontology (BFO) principles of best practice [3] as shown in figure 1. This approach introduces a novel knowledge acquisition step that guides capturing medication-adherence-related data from different knowledge sources, as shown in table 1. These sources were analyzed using a systematic approach that involved some questions applied to all source types to guide data extraction and inform domain conceptualization. A set of intermediate representations involving tables and graphs was used to allow for domain evaluation before implementation.

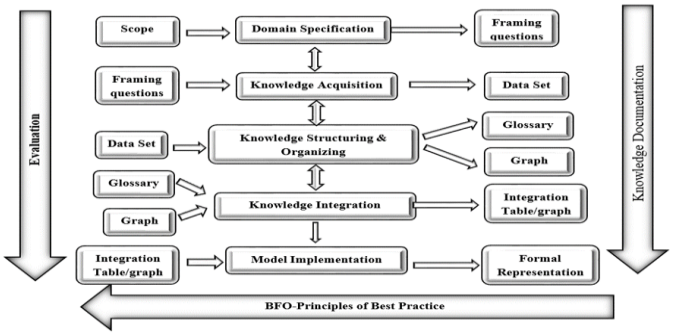

Figure1.MAB Ontology Methodology Overview

III. RESULT

A. Domain Specification

MAB-Ontology is a reference ontology that comprehensively represents the domain of medication adherence using breast cancer as a case study. This ontology includes factors that impact medication adherence, the methods used to assess adherence, and the interventions used to improve adherence.

B. Knowledge Acquisition

Table_1 shows the category of knowledge source types, resources description, and the number included under each category, use of each source type, and examples of the source extracted under the mentioned category.

Table 1: Knowledge acquisition

Knowledge Source Type	Resources & Number	Use	Source Example
Medication Adherence Assessment Literature	Journal articles (51)	Terms, definitions, components, interventions	Sawesi et al. (2016) [4]

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Determinants of Medication Adherence Literature	Journal articles (26)	Characterization of medication adherence among breast cancer	Sawesi et al. (2014) [5]
Theory of Adherence Change	Book (2), Journal articles (1057)	Theoretical concepts (terms/phrases)	Sawesi et al. (2016) [4]
Medication Adherence Data Standard	Research, project (3), and book (1)	Categorization, taxonomy of MAB	Michie et al. (2014) [6]
Medication Adherence-Related Terms	Ontology repositories: Bioportal OBO foundry, and Ontobee	Related terms, data structure, and levels of granularity	Human disease ontology
Tacit Knowledge	Domain experts (3)	Terminology, data structure	JC and JJ

C. Knowledge Organizing and Structuring

Terms extracted from the previous step were organized, structured, and represented informally using tables and graphs. A glossary of terms was created after de-duplication and synonym-specification. Definition of the terms was adopted or created, type of terms defined (e.g., noun or verb), and source of the definition cited. The terms represented in a hierarchy and further terms added to ensure coherence. In order to facilitate interoperability, an upper-level ontology—BFO adopted.

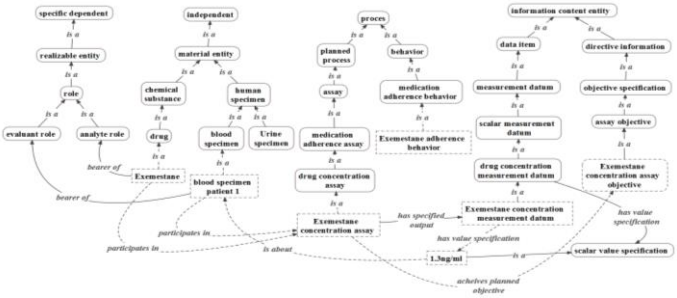

Figure2: Assessing adherence to Aromatase Inhibitors

D. Model Integration

Several terms in MAB-Ontology were built based on other ontologies' categories. For instance, medication adherence assessment was built by expanding the planned process class in the Ontology of Biomedical Investigation. The mental function anatomical structure and the psychological factors were built based on the Mental Functioning Ontology. Breast cancer was built based on the Disease Ontology. The breast cancer regimens were built based on the Drug Ontology.

E. Model Formalization

The resulting model was built manually using Protégé to formalize the entities and relations into an OWL for computation.

F. Model Evaluation

1) Face validity of intermediate representation: This method was carried out by two experts who assessed the domain entities and relationships.

2) Competency questions: The MAB-Ontology was validated against the sample list of questions.

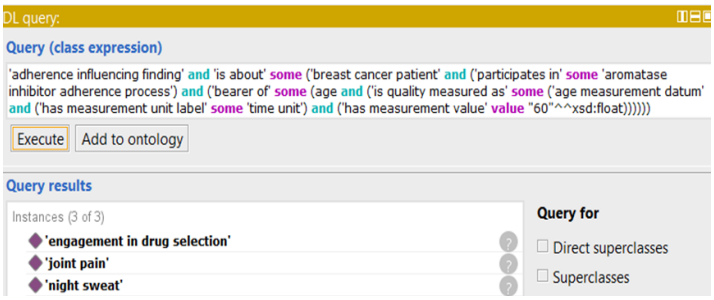

Figure4: Factors *influence 60 years old patient taking tamoxifen*

IV. Impact of the Research

- This study provides a unified method for developing a computerized-based adherence model that can be applied among various disease groups and different drug categories.
- This approach has been developed to deliver explicit knowledge related to medication adherence that can be utilized in areas such as healthcare decision-making, intervention development, detection risk for non-adherence, capturing current and future findings from medication adherence-related publications.

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