Ontological Model for Decision Support about Bariatric Surgery

Gláuber M. O. Nunes[1], Rita C. G. Berardi[1]

[1]Departamento Acadêmico de Informática
Universidade Tecnológica Federal do Paraná (UTFPR) – Curitiba – PR – Brazil

glauber@alunos.utfpr.edu.br, ritaberardi@utfpr.edu.br

Abstract. *Bariatric surgery is a type of treatment for severe obesity but it can bring several risks to the patient. In order to evaluate those risks correctly, health professionals need to have access to the complete health history of the patients. However, information systems are not always structured so that they can extract this complete history, due to the existence of data silos and distinct vocabularies. The use of linked data, ontologies and semantic rules technologies is one of the possible solutions to this challenge. This research proposal aims to test if an ontological model can map the complete health history of patients who are candidate to bariatric surgeries, highlight risks and support decisions. The research will use data from UNIMED Paraná.*

1. Introduction

Obesity prevalence has been increasing in almost all the world in the last decades and it is considered today a global epidemic. The World Health Organization [2018] estimated that there were approximately 1.9 billion overweight adults and at least 650 million obese adults in the world in 2016. In Brazil, a national research with self-reported weight and height data showed that the obesity prevalence increased by 60% in ten years: from 11.8% in 2006 to 18.9% in 2016 [BRASIL, 2017]. Obesity is a complex disease, which requires preventive strategies in order to control and treat it.

Bariatric surgery is a type of treatment for cases of severe obesity with failure of clinical treatment, reducing the patient mortality rate and attenuating comorbid conditions, according to a thirty-year study [SJOSTROM, 2008]. However, this surgery has multiple risks, being usually indicated only if the patient cannot lose weight or sustain the weight loss even with appropriate medical care for over two years.

Bariatric surgery is offered in both the Sistema Único de Saúde (SUS) and the supplementary health system. Supplementary health has a fundamental role in the health area. In Brazil, over 47 million people have a health insurance plan [AGÊNCIA NACIONAL DE SAÚDE, 2020]. In that system, UNIMED is one of the most remembered health insurance providers and has a 37% share in the national market [UNIMED, 2020]. This research will be done using data from UNIMED do Estado do Paraná.

Doctors need to have access to the complete health history of the patients who are candidate to bariatric surgery in order to properly care for them. Some of this data is already digitalized in information systems. However, the data is not always organized so that the information can be extracted because of the use of different information

systems. Part of this data is in silos, with distinct data bases, increasing the challenge of collecting the health history in a homogenous manner. Besides that, it becomes harder to interpret the data and predict some type of risk to the patient after the surgery. It is not possible to have a vision of the complete health history of the patient to allow the health professional to understand the disease better.

In UNIMED do Estado do Paraná, data about the patients who are candidate to bariatric surgery is split into two distinct data bases: one base for the administrative data and one base for the clinical data, according to Figure 1. The bases use different vocabularies without a total standardization of the medical vocabulary.

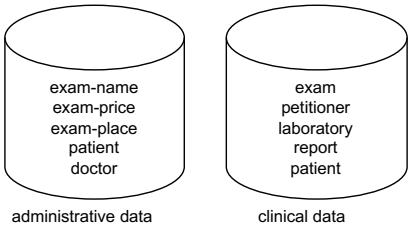

Figure 1. Integration of administrative and clinical data

Data integration using traditional technologies like SQL is not viable due to the complexity of the bases and the vocabulary involved. In a similar way, re-creating the database structures would require huge investments of time and money. Therefore, ontology technology could be an interesting alternative to unify the administrative and clinical data, helping the clinical decision-making process. The use of ontology is presented as an option because it is a data model with domain view, adding a domain layer without necessarily changing the data in their original format. That allows for flexibility in the integration format. Ontologies can be easily expanded or modified, differently from the application databases.

2. Objectives

This research proposal aims to experiment if an ontological model can provide an integrated view of the complete health history of patients who are candidate to bariatric surgery, in order to help the medical decision-making, solving the challenges of distinct databases and heterogeneous vocabularies.

Besides that, the specific objectives of the project are:

- Unify in a centralized way the administrative and clinical data of the patients;
- Compile knowledge that allows the use of the centralized data to evaluate the risks associated to bariatric surgery and its comorbid conditions;
- Verify if the model answers the competency questions with real data of patients who are candidate to bariatric surgery.

3. Justification

The obesity issue has been known since ancient times. Hippocrates said that the “sudden death is more common in those who are naturally fat than in the lean” [CHADWICK, 1950]. Nowadays, obesity is defined as “eating more food than the organism can metabolize and use, causing this excess to accumulate in the form of fat” [PORTER,

2011]. There are multiple types of obesity treatment, such as pharmacological treatment, dietetical treatment, cognitive-behavioral therapy, heterodox therapies and nutritional supplements. Bariatric surgery is usually indicated only after two years of regular medical treatment [ABESO, 2016].

This being the case, there is interest in improving the quality of decisions regarding bariatric surgery, in order to help health professionals to choose the best treatment for obesity. This theme will be initially studied in the supplementary health context because of the organized disposition of the data. The open data from SUS does not allow for the individual identification of patients, rendering the trajectory creation impossible. However, it is important to note that the research and model to be developed could be used in the public health system if the open data allows in the future.

It is also important to highlight that decision support systems were introduced in the 1960s and have been developed since that date [MCCALLIE, 2016]. When applied in the health area, their objective is to help health professionals with the patient treatment, being especially useful when it is needed to analyze big amounts of information. Even though, the health professionals need to have the final decision in the decision-making process and the system should never make the decisions alone [CRESSWELL, 2013].

4. Systematic review

A systematic review was done in order to identify scientific papers that use ontology for data integration related to obesity treatment. Besides that, it was aimed to know different perspective regarding this treatment. This allowed for evaluating solutions in this area.

The systematic review was done on February 2020. The utilized data bases were Biblioteca IEEE Xplore, Biblioteca Digital ACM, Scopus, Springer Link, Periódicos Capes and Google Scholar. The review was done using the methodology presented by Kitchenham [2004]. The search was done using the words [ontology AND “linked data" AND obesity] in any part of the text. Texts in English and Portuguese were considered. The initial search found 586 articles. After applying the filtering criteria, we selected 24 articles for reading the full-texts.

We found out that there are several articles in literature regarding the use of ontologies for data integration in the obesity treatment. However, there is no article about this theme related to the bariatric surgery context. The article that was closest to this area studied the use of ontologies for childhood obesity treatment [El-Hachem et al, 2012] and the article does not mention bariatric surgeries. An ontology similar to the OMDP by Chen et al [2012] will be developed in this research but in the context of bariatric surgery. Besides that, it was noticed that the most common challenge faced during the data use for obesity treatment in literature is the data heterogeneity. The data from multiple sources, such as administrative, utilization, social network and health data are in distinct formats and usually use its own vocabularies.

5. Methodology

Figure 2 shows a flowchart with the development steps of the methodology. Each step has a number that will be used to identify it later.

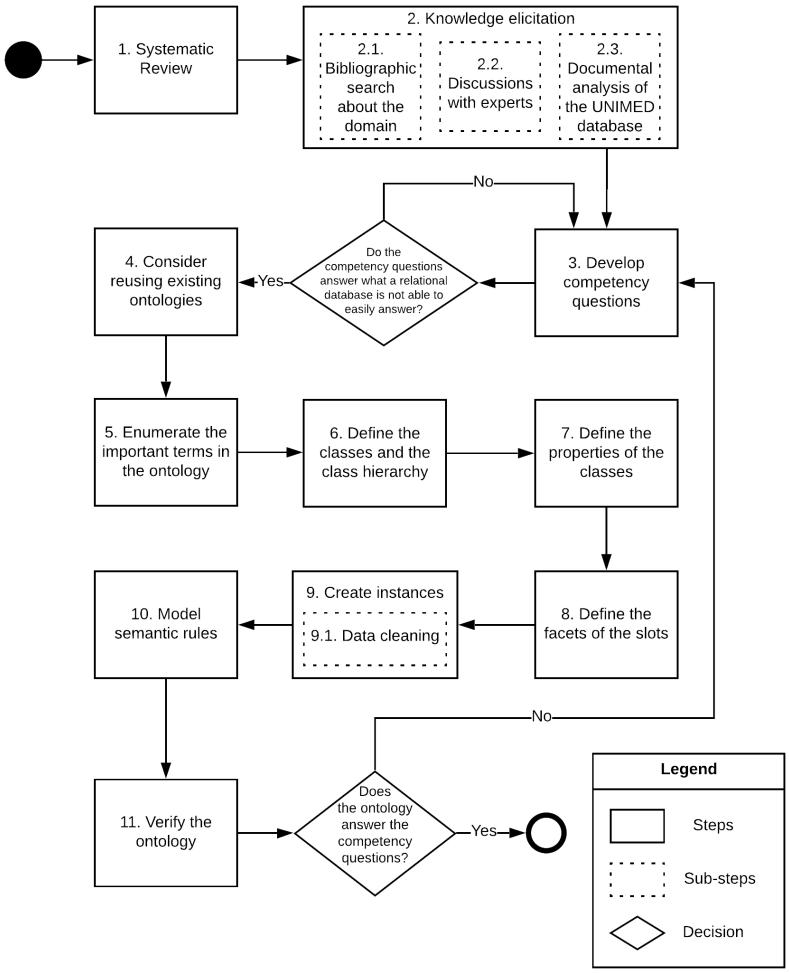

Figure 2. Methodology

Step 1 is the systematic review to identify relevant scientific papers about ontologies applied to the obesity treatment. This step has already been done and the results are a little bit detailed in section 5 of this text.

In order to define the terms and relations in the ontology, it is necessary to elicit the knowledge in step 2. Sub-step 2.1 involves a bibliographic search about the medical domain with focus on the complete health history of patients who are candidate to bariatric surgery and their risk factors. It will be searched in the literature what data should be part of the ontology about comorbid conditions. Sub-step 2.2 consists of discussions with experts, including professional from UNIMED, to gather knowledge. Sub-step 2.3 involves the documental analysis of the UNIMED database, in order to know exactly what data is available in the databases and have more information to build the ontology.

Steps 3-9 correspond to the ontology engineering and follow the ontology development process known as Ontology 101, described by Noy et al [2001]. They correspond to steps 2 to 7 of Ontology 101: Develop competency questions, consider reusing existing ontologies (for example, the terminologies SNOMED CT, LOINC and RxNorm have been developed significantly in the last decades [Bodenreider, 2018]), enumerate important terms in the ontology, define the classes and the class hierarchy, define the properties of the classes, define the restrictions of the properties and create

instances. The instance creation step involves sub-step 8.1, data cleaning. It is possible that part of the data from UNIMED is unstructured or semi-structured. In that case, a manual process of structuring and preparing the data will be needed.

Step 10 refers to the creation of semantic rules. This step will allow the creating rules to map the risks of the bariatric surgery, in order to help the health professional to make decisions. These semantic rules will be developed based on the bibliography search of the domain (step 2.1) and discussions with experts (step 2.2).

Finally, the research ends at step 11, which aims to measure the performance of the developed ontology. Two criteria will be used for this evaluation: data integration and classification of the treatment steps and treatment risk. The first criterion will measure the ontology performance in representing the health history of the patients in an integrated way. If the ontological model can answer questions that required the data that was previously split, the ontology successfully met the first evaluation criterion. The second evaluation criterion measures the capacity of the ontological model to classify the patient's trajectory as "good" or "bad", and the patient risk of complications during the bariatric surgery. In order to do that, the data will be aleatorily split in two parts, with 80% and 20% of the instances (this ratio can be changed depending on the number of instances we will have). Using that second portion of the data, the health history of the patients will be manually analyzed with help from health professionals, classifying the patient's trajectory as "good" or "bad" and classifying the risk of the patient. This manual evaluation will be compared to the automatic evaluation done by the ontology and the sensitivity and the specificity of the model will be calculated. The closer the sensitivity and specificity are to 100%, the better is the result. It is important to note that the ontology building steps are iterative, so there could be multiple iterations of the steps above.

6. Expected results

It is expected that the developed ontology will allow for integrating the data from patients who are candidate to bariatric surgery at UNIMED and highlight risks. The ontology could be used to answer competency questions that the health professional wants to answer about the data. The competency questions defined were defined by the researcher based on the systematic review of the literature and they are listed below.

- What are the risk factors that patient X has to receive a bariatric surgery?
- What are the comorbid conditions of patient X?

However, these competency questions can be incremented or changed after having access to the UNIMED data and starting developing the ontology, due to iterative nature of the ontology development process. It is also expected that this ontology could be easily expanded to include other domains in the medical field, allowing for flexibility in the semantic representation of the data and avoiding changes in the original structure of the data. All these advantages (and possible disadvantages) will be known after the research execution.

7. Conclusion

This research proposes to investigate if this specific ontological model could solve data integration challenges in the health domain and help health professionals in the decision

making. It is expected that the developed ontology, if successful, could be used as a base for future application that can help the decision making in the health area and improve the medical treatment of patients who are candidate to bariatric surgery.

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