# Research on Coronary Heart Disease Knowledge Organization Based on Follow-up Data

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**Abstract:** Coronary heart disease was the main reason behind the millions of deaths caused by heart attacks in patients over the last decades. This study is a knowledge organization study of coronary heart disease based on follow-up data. Firstly, we refer to some medical ontologies on the Bioportal webpage and extract some entities and define them based on the BFO top-level ontology, then summarize their attributes and construct semantic model to form semantic relationships, and finally use Protégé to form a coronary heart disease ontology based on follow-up data, and store and visualize it with the help of GraphDB. The visualization graph finally formed in this study enables the data of each

follow-up visit to be reflected on a visualization interface in a centralized and systematic way at the same time, thus helping physicians to browse patient information comprehensively, intuitively and quickly in order to find the key factors affecting the treatment outcome.

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## 1.0 Introduction

With the continuous improvement of modern people's living standards and the acceleration of the pace of life, there are more and more patients with coronary heart disease, and there is an increasing trend year by year. Coronary heart disease (CHD) not only causes disability, has a high fatality rate, but also seriously consumes medical and social resources. CHD has become a public health problem facing many countries. In recent years, significant progress has been made in the treatment of CHD, but the patient's prognosis and quality of life have not been significantly improved, and studies have found that the incidence of chest pain after percutaneous coronary intervention (PCI) is increasing, and problems such as in-stent restenosis seriously threaten human health and life safety (Efremov 2020). Therefore, the follow-up treatment of these patients after initial treatment has become an indispensable part of the treatment of patients with CHD. The acquisition of follow-up data can record various complications in a timely manner and can also effectively evaluate the clinical efficacy and safety of patients. Further, doctors can improve the treatment methods and promote the recovery of patients.

The World Health Organization once pointed out in a report that chronic diseases are the world's leading cause of death, and their impact is steadily increasing. The World Health Organization also states that, contrary to popular belief, chronic disease prevalence is most severe in low-income and middle-income countries. China, as a country with a large population, is urgently required to actively prevent and control chronic diseases. The Chinese government attaches great importance to the health management of chronic diseases such as coronary heart disease, diabetes, hypertension and the promotion and application of information technology in the field of health care. The Chinese government proposes to implement comprehensive prevention and control of chronic diseases, and to make full use of information technology to enrich chronic diseases prevention and treatment methods (Tang 2019).

At the same time, according to the DIKW (Data-Information-Knowledge-Wisdom) model, we know that there is a trend for information to transform into Knowledge. Currently, the core content of many literatures about follow-up data on CHD is data analysis, not knowledge organization; Winkel et al. (2018) had a 10-year follow-up of patients sampled at random times during their disease course to verify the prognostic value of routinely available data in patients with stable coronary heart disease. There are other relevant studies, such as the diagnosis of CHD (Bosner et al. 2011), major coronary risk factors (Mensah et al. 2005) and assessment of clinical course, prognosis and effectiveness of drug and nondrug treatment (Evstifeeva et al. 2006) Therefore we propose a question: How can the follow-up data of CHD be organized into knowledge to help physicians?

Based on the above question, the objective of this article is to organize the follow-up data of CHD to form a knowledge organization system (KOS). Firstly, we extract entities and attributions from follow-up record forms, then find relations among entities, construct a semantic model, and then construct a coronary heart disease ontology based on the follow-up data. The visual ontology graph can become a doctors' reference to help doctors easily observe the correlation of follow-up records. The correlation of follow-up records can provide credible decision support for ongoing treatment, improve treatment methods, etc. Doctors can prevent the disease from recurring again, since the visual graph can help doctors predict patients' disease development and find out the key factors affecting that development.

## 2.0 Literature review

### 2.1 Domain ontology

Currently, in order to meet the needs of knowledge organization in various domains in the big data environment, the creation of a knowledge organization system (KOS) that can quickly incorporate domain-specific terminology is an important goal in this field. There are various fields of ontology building research, including the medical field, Shen et al. (2019) explore CBN, a Clinical Bayesian Network construction for medical ontology probabilistic inference, to learn high-quality Bayesian topology and complete the ontology directly from electronic medical records (EMRs). In addition, there are other domain ontologies such as those for digital humanities (Wei et al. 2021), artificial intelligence (Blagec et al.2022), the education domain (Das et al. 2022), product review (Wei et al. 2020), and diet management (Clunis 2019). This study hopes to establish a domain ontology in the field of CHD to organize follow-up data forming a KOS that can quickly incorporate follow-up data on coronary heart disease.

### 2.2 Medical field knowledge organization systems

MeSH is currently one of the most prominent KOS in the biomedical sciences. It has a large collection of domain terms that can be found in the MeSH browser representing all research subfields in the field (Huangfu et al. 2020). Other similar KOS include Disease Ontology (DO) (Maghawry et al. 2022) and Gene Ontology (GO) (Merino et al. 2022). In addition, the National Center for Biomedical Ontology (NCBO) has been promoting the construction of BioPortal since 2005. After recent years of development, BioPortal has become the largest and comprehensive international ontology repository for life sciences, covering medical, microbiological, agricultural etc. BioPortal is powerful with open source code, and several international organizations use this framework for ontology services in specialized fields (Ochs et al. 2017) constructed the coronary heart disease knowledge organization system based on follow-up data in this study based on an in-depth understanding of these medical KOS.

Current research in the medical field on electronic medical records (EMR) and chronic disease KOS includes Esposito (2008) who presented an Ontology-based approach to detect abnormalities and malformations due to CHD. Xu et al. (2007) designed and completed an ontology-based medical knowledge base in the category of coronary heart disease using Stanford's Protege 2000. Clunis (2019) developed an ontology for managing the diet of hypertensive patients based on online recipes. Foufi et al. (2019) aimed to express a study of entities related to chronic diseases and their relation in user-generated text posts. Bell et al. (2020) introduced GO ontology and accomplished gene function classification and gene term association by forming a graph structure.

In summary, there are no studies related to the organization of knowledge about coronary heart disease based on follow-up data. CHD is mostly a chronic disease, and patients usually have a long treatment and management process. During this process, the patient's recovery, pathological condition observation, poor lifestyle correction, treatment adherence, clinical trial adherence, and secondary prevention directly affect the patient's quality of life. In other words, the patient's pathological condition is dynamic; it may become better or worse. In order to keep track of the patient's disease progression, it is necessary to follow up and record the patient's indicators after medical treatment. Therefore, follow-up visits occupy an important place in treatment as an important means of observing the efficacy of treatment. Therefore, this paper investigates a coronary heart disease knowledge organization system based on follow-up data, constructs a coronary heart disease ontology based on follow-up data and visualizes it, and further investigates the storage and query of ontology knowledge. This research is of great significance for knowledge organization about coronary heart disease ontology based on follow-up data, and forms the foundation for a CHD medical knowledge base based on follow-up data in the future.

## 3.0 Ontology construction

### 3.1 Data collection

In order to collect data, we collaborated with the Jiangsu Famous Medicine Technology Company Limited, which has established a Clinical-Research-Follow-up management data platform for chronic coronary heart disease in China; this includes follow-up data from nearly 100 hospitals across the country, including Jiangsu Province Hospital of Chinese Medicine, Nanjing BenQ Medical Center and so on. Participating patients are allowed to go to the hospital for follow-up at the 3rd, 6th, 9th, 12th, 15th, 18th, 21st and 24th months after initial diagnosis. During this period, the patients need to go to the hospital for follow-up on time, and fill out follow-up record forms, then upload data to Clinical-Research-Follow-up management data platform. Therefore, in this data platform, the data is from follow-up record forms. Therefore, this research mainly collects follow-up record forms, which are provided by the partner medical company. The company provided a total of 1410 patient follow-up record forms from different hospitals. Then we refer to these follow-up record forms and extract various entities from them.

### 3.2 Entities definition

After extracting the entities, consulting with relevant doctors, and based on BFO, and drawing on some medical ontologies on Bioportal, the following entities are summarized, which are defined below.

i. Information content entity: A generically dependent continuant that is about something.
ii. Data item: A data item is an information content entity that is intended to be a truthful statement about something.
iii. Basic information: It introduces some basic information of the patient, such as follow-up number, age, telephone number, address, etc. The basic information is the basis of establishing the patient's follow-up record.
iv. Lifestyle: Some habits developed by patients over a long period of time. The multiple effects of long-term bad living habits, such as smoking, drinking, and excessive work, may indirectly lead to coronary heart disease. Patients must be corrected in time and actively cultivate other lifestyle that is beneficial to treatment.

v. Clinical history: A series of statements representing health-relevant qualities of a patient and of a patient's family. It can help the doctor know the disease course, as well as whether the patient has a family history, allergy history, and past disease history. It is very important to understand the past diseases history. Through it, the doctor not only can know the cardiovascular-related diseases that the patient has suffered from, but also can know whether the patient has suffered from other non-cardiovascular diseases, such as diabetes, hypertension, fatty liver, and thyroid hypofunction, etc., these diseases make it more difficult to cure coronary heart disease.

vi. Clinical finding: A representation that is either the output of a clinical history taking or a physical examination or an image finding, or some combination thereof.

vii. Vital signs: It includes body temperature, pulse, heart rate, etc., which are indicators used by doctors to judge the severity and criticality of patients with coronary heart disease.

viii. Laboratory finding: A representation of a quality of a specimen that is the output of a laboratory test and that can support an inference to an assertion about some quality of the patient.

ix. Diagnosis: The representation of a conclusion of a diagnostic process.

x. Western medicine diagnosis: is mainly reflected by: doctors can inquire about the patient's angina pectoris, such as, the type of angina, frequency, duration, pain degree, nitroglycerin usage, etc.; or inquire about the limitation degree of normal physical activity, which can determine the New York Heart Association cardiac function level; or inquire of the patient if he has heart failure, and if so, to what extent, which can determine the Killip level; doctors also can diagnose according to the diagnostic criteria of Western medicine, such as the *Guidelines for the Diagnosis and Treatment of Chronic Stable Angina Pectoris*; *Guidelines for the Diagnosis and Treatment of Unstable Angina Pectoris and Non-ST-Segment Elevation Myocardial Infarction*; *Guidelines for the Diagnosis and Treatment of Acute ST-Segment Elevation Myocardial Infarction*, etc.

xi. TCM diagnosis: traditional Chinese medicine mainly refers to "looking", "smelling", "asking" and "feeling", which are mainly reflected in observing the patient's tongue color, coated tongue, etc., and asking about the patient's heart, liver, spleen, lung, kidney and other disease signs , asking about Qi deficiency, blood deficiency and other deficiency syndrome elements, and asking about Qi stagnation, blood stasis and other solid syndrome elements, and feeling the patient's pulse conditions. At the same time, it can also be diagnosed according to the TCM diagnostic criteria *Guidelines for the Diagnosis and Treatment of Common Diseases in Traditional Chinese Medicine.*

xii. Textual entity: A textual entity is a part of a manifestation, a generically dependent continuant whose concretizations are patterns of glyphs intended to be interpreted as words, formulas, etc.

xiii. Follow-up title: The title of each follow-up record form, such as the first follow up.

xiv. Organization: An entity that can bear roles, has members, and has a set of organization rules. Members of organizations are either organizations themselves or individual people.

xv. Follow-up institution: Follow-up location for each patient follow-up visit.

xvi. Symptom: A symptom is a perceived change in function, sensation, loss, disturbance or appearance reported by a patient indicative of a disease.

xvii. Risk factor: Any aspect of an individual's life, behavior, an environmental exposure, or an inborn or inherited characteristic that increases the likelihood of a disease, condition or injury.

xviii. Role: A realizable entity the manifestation of which brings about some result or end that is not essential to a continuant in virtue of the kind of thing that it is but that can be served or participated in by that kind of continuant in some kinds of natural, social or institutional contexts.

xix. Patient: Patients who participated in the follow-up.

xx. Attending physician: Attending physicians who perform diagnoses for patients participating in follow-up visits.

xxi. Process: An occurrent that has temporal proper parts. It includes bodily process, planned process and health care process.

xxii. Bodily process: A process in which at least one bodily component of an organism participates.

xxiii. Planned process: A processual entity that realizes a plan which is the concretization of a plan specification.

xxiv. Health care process: A planned process with the objective of improving the health status of a patient that directly involves the treatment, diagnosis, or prevention of disease or injury of a patient.

xxv. Multiple risk factor management: Studies have confirmed a series of risk factors for coronary heart disease, including hypertension, hyperglycemia, hyperlipidemia, insomnia, etc. Now the risk factors for CHD have been clarified, these risk factors must be actively managed and controlled to reduce the incidence and mortality of coronary heart disease.

xxvi. Mental health management: Current studies have shown that patients are undergoing double psychological stress from surgery and underlying diseases, such as the increased incidence of anxiety and depression. Such adverse psychological reactions will directly affect the treatment effects, recovery after surgery and disease relapse, and eventually become risk factors of cardiovascular diseases. TAYLOR research shows that three psychosocial risk factors of depression, social isolation and emotional abnormality are closely related to the onset of cardiovascular disease.

xxvii. Medical intervention: Medical intervention is a planned process that has the goal of diagnosing, preventing or relieving illness or injury.

xxviii. Drug administration: A medical intervention where a patient is administered with a drug.

xxix. Western medicine: Common Western medicines for the treatment of coronary heart disease include nitrates, β-blockers, antiplatelet drugs, anticoagulants, Angiotensin-converting enzyme inhibitors (ACEIs), etc.

xxx. Chinese herbals: Mainly use Chinese medicine decoction, Chinese patent medicine, Chinese medicine intravenous injection, etc. for treatment.

xxxi. Combination treatment of Chinese and Western medicine: At present, with the development of traditional Chinese medicine in China, more and more TCM hospitals begin to combine traditional Chinese medicine and western medicine to treat coronary heart disease. It includes strong TCM exposure, which refers to the cumulative treatment time of TCM which reaches more than 80% of the total treatment course; It also includes middle TCM exposure, which refers to the cumulative treatment time where TCM reaches 30%-79% of the total treatment course; And it includes weak TCM exposure, which refers to the cumulative treatment time where TCM is less than 30% of the total treatment course.

xxxii. Medical procedure: A medical intervention that refers to any series of pre-defined steps that should be followed to achieve a desired result.

xxxiii. Surgical procedure: Mainly includes percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG), etc. The surgical treatment has significantly reduced disability and mortality in coronary heart disease, and safety has also been significantly improved.

xxxiv. Hospitalization: Patients are often required to be hospitalized after surgery or other conditions. During the hospitalization period, some physical conditions of the patient need to be observed, such as whether there are recurring myocardial infarction, cardiogenic shock and other in-hospital complications, whether there are cerebrovascular events, gastrointestinal hemorrhage and other in-hospital hemorrhage events, whether there are all-cause deaths, non-fatal myocardial infarctions, strokes and other in-hospital end events.

xxxv. Occurrence time: the start and end time of an event.

### 3.3 Attributes definition and semantic relations

After defining the entities, next we need to define the entity properties as shown in Table 1.

At the occurrence of the follow-up visit, the people involved, the time and place of occurrence constitute its basic information. Relating to the attending physician, whose role is to diagnose the patient, and the unit where he or she works is where the follow-up occurs. The patient's basic information, symptoms, risk factors, process, etc. need to be recorded. The process, the start and end time of the event are to be recorded. Based on the above analysis, the basic semantic model can be formed, as in Figure 1.

According to the BFO top-level ontology, and borrowed from some medical ontologies on Bioportal, and according to the semantic model, the semantic relationships are shown in Table 2.

### 3.4 Protégé visualization

According to the entities and attributes, we constructed the coronary heart disease ontology based on follow-up data using Protégé software; its entities, relationships, and a visualization graph are respectively shown in Figures 2a, 2b and 2c.

We then created individuals as in the following example: in the first follow-up, the participating patient is LiZhen, the attending physician is WangZhili, the follow-up organization is Liaoning University of Chinese Medicine Affiliate Hospital, and the follow-up date is November 10, 2018. The patient's basic information was sex, male, age 62, and the date of initial construction of follow-up was August 10, 2018; the patient's clinical history was disease course of 4 years; the past disease history was fatty liver; the patient's clinical findings were blood pressure 152/69, breath 20, and temperature 36.4 degrees Celsius; the patient's lifestyle habits include: smoking daily, drinking once or twice a week, and preferring sweets; Western medicine diagnosed the patient with coronary artery atherosclerotic heart disease; exhaustion and excessive worry are risk factors for the patient; the patient's symptoms include angina pectoris and chest pain; the patient needs to take nitroglycerin for three months (from November 11 2018 to February 11 2019), along with health management, including quitting smoking, quitting drinking, quitting sweets and keeping a happy mood.

| **Entities** | **Attributes** |
|---|---|
| Follow-up title | The first follow-up, The second follow-up, The third follow-up, and so on |
| Follow-up institution | Liaoning University of Chinese Medicine Affiliate Hospital, Jiangsu Province Hospital of Chinese Medicine, Nanjing BenQ Medical Center, and so on |
| Role | Patient, Attending physician |
| Basic information | Number, Name, Sex, Date of initial construction, Birthday, Age, BMI, ID number, Telephone number, Marital status, Fertility, Education, Occupational category, Now address |
| Lifestyle | Smoking, Drinking, Sport, Work, Diet, Temperament, Schedule, Self-management, Acknowledge of disease |
| Clinical history | Date of initial diagnosis of coronary heart disease, Disease course, Past disease History, Family History, Allergy History, Disease is due, Season of aggravation |
| Vital signs | Body temperature, Pulse, Breath, Heart Rate, Blood pressure |
| Laboratory finding | LBB, LBU, LBC, CRUOR, BE, ECG, UCG, CAG, Other tests |
| Western medicine diagnosis | Angina pectoris, NYHA or Killip, Cardiovascular diseases, Western medicine diagnostic criteria |
| TCM diagnosis | Tongue color, coated tongue, Pulse Conditions, Ecchymosis, Chinese Medicine Syndrome Types, TCM diagnostic criteria |
| Symptom | Systemic symptoms, Head and Face, Chest and Abdomen, Sleep Diet, Two Limbs |
| Risk Factor | Life factors, Natural factors, Emotional and Mental factors |
| Bodily process | Angina pectoris attack, Bleeding events, Endpoint events |
| Multiple risk factor management | Quit smoking and limit alcohol, Reasonable Diet, Regulate blood pressure, Regulate blood lipids, Regulate blood sugar, sleep management, regular exercise |
| Mental health management | Anxiety, Depression, Social isolation, emotional disorders, Other adverse psychological reactions |
| Western medicine | Anti-ischemic drugs, Antiplatelet drugs, Anticoagulant drugs, Statins, Anti-arrhythmic drugs, Diuretics, Hypoglycemic agents, Western medicine- intravenous fluid, other oral drugs |
| Chinese herbals | Chinese patent medicine, Traditional Chinese Medicine decoction, Chinese herbal-intravenous fluid |
| Combination treatment of TCM and Western medicine | Strong exposure to Chinese medicine, exposure to Chinese medicine, weak exposure to Chinese medicine |
| Surgical procedure | PC, CABGYN, Other Surgery |
| Hospitalization | Case source, In-hospital prognosis, Hospital Complications, Bleeding events In Hospital, Endpoint Events In Hospital |
| Occurrence time | Start time, End Time |

*Table 1.* Entity attributes.

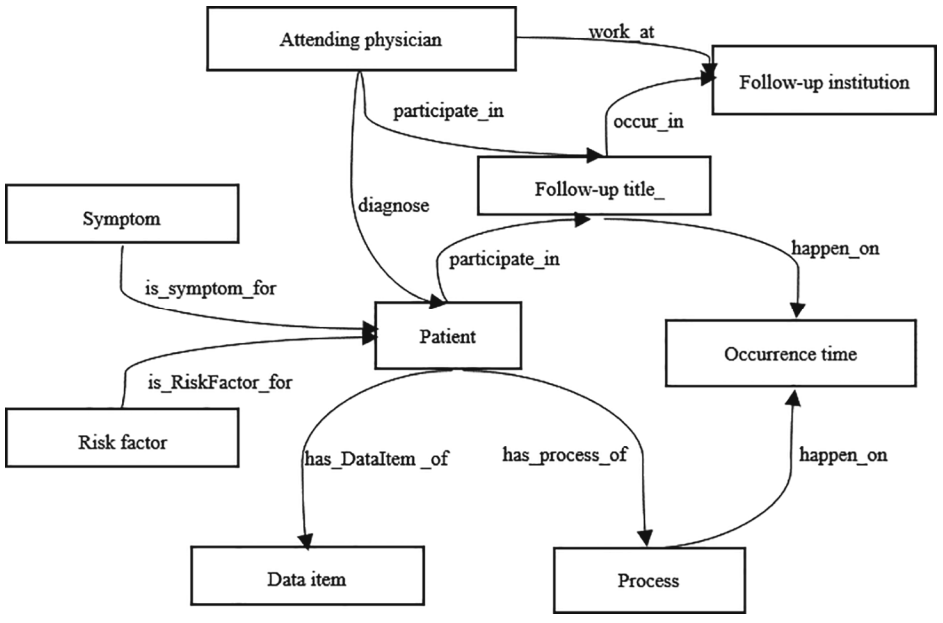


*Figure1*. Semantic model of CHD based on follow-up data.

| Subject | Predicate | Object |
|---|---|---|
| Follow-up title | occur_in | Follow-up institution |
| Follow-up title | happen_on | Occurrence time |
| Attending physician | participate_in | Follow-up title |
| Attending physician | work_at | Follow-up institution |
| Attending physician | diagnose | Patient |
| Patient | participate_in | Follow-up title |
| Patient | has_DataItem_of | Data item |
| Patient | has_process_of | Process |
| Risk factor | is_RiskFactor_for | Patient |
| Symptom | is_symptom_for | Patient |
| Process | happen_on | Occurrence time |

*Table 2.* Semantic relations.

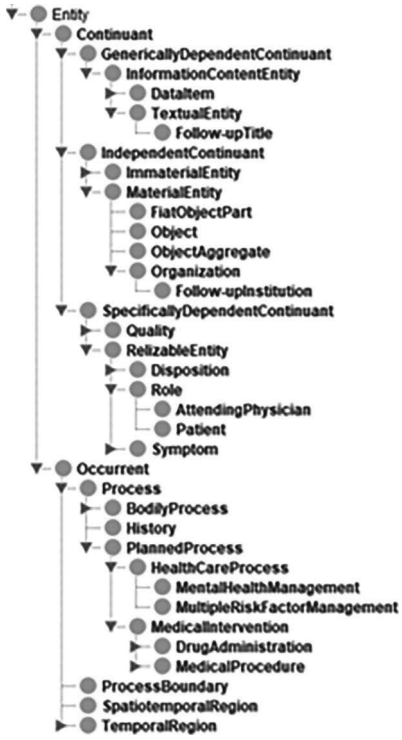


*Figure 2a*. Entity classes in the ontology.

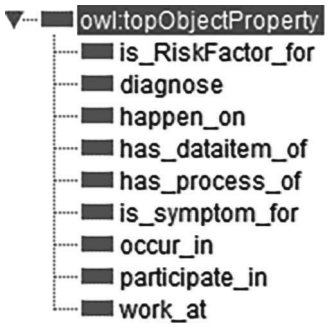


*Figure 2b*. Relationships in the ontology.

For individuals, the previous ontology semantic relations need to be mapped to the individual relations, as sho583wn in Table 3.

Then individuals were added in Protégé software, as shown in Figure3.

### 3.5 Ontology storage and query

In the face of large-scale complex correlated data, traditional relational databases often suffer from slow query speed, response delays, complex links and other shortcomings, while graph databases address these shortcomings. GraphDB is a representative graph database that is easy to understand and has flexible scalability, good portability, and efficient accessibility. Therefore, the study used GraphDB to store the CHD ontology. The final visualization graph is shown in Figure 4.

Regarding the query, on the one hand, we can directly click an entity to query all the subject, predicate and object contents about the entity, such as "First Follow-up", and the query results are shown in Table 4.

Alternatively, we can use SPARQL to query the related ontology information. If querying the patient's lifestyle, the

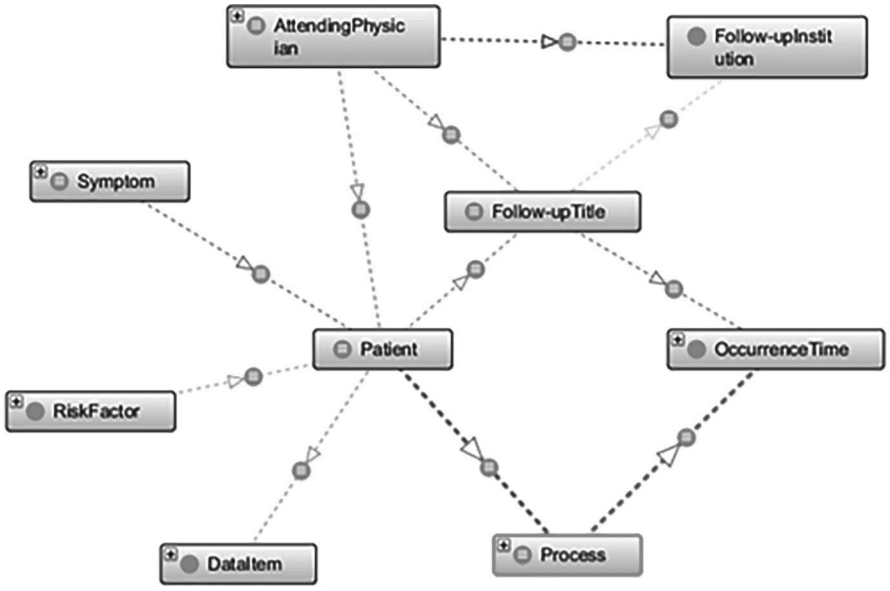


*Figure 2c*. Visualization graph of CHD ontology.

| **Semantic relations in ontology** | **Semantic relations in individuals** |
|---|---|
| occur_in | occur_in |
| happen_on | start_at |
| | end_at |
| participate_in | participate_in |
| work_at | work_at |
| diagnose | diagnose |
| has_DataItem_of | has_age_of |
| | has_sex_of |
| | has_BloodPressure_of |
| | has_breath_of |
| | has_lifestyle_of |
| | has_ DateOfInitialConstruction _of |
| | has_ DiseaseCourse _of |
| | has_diagnosis_of |
| | has_PastDiseaseHistory_of |
| has process of | has_DrugAdministration_of |
| | has_MentalHealthManagement_of |
| | has_MultipleRiskFactorManagement_of |
| is_RiskFactor_for | is_RiskFactor_for |
| is_symptom_for | is_symptom_for |

*Table 3*. Semantic relations mapping.


*Figure 3*. Individual data added with Protégé software.

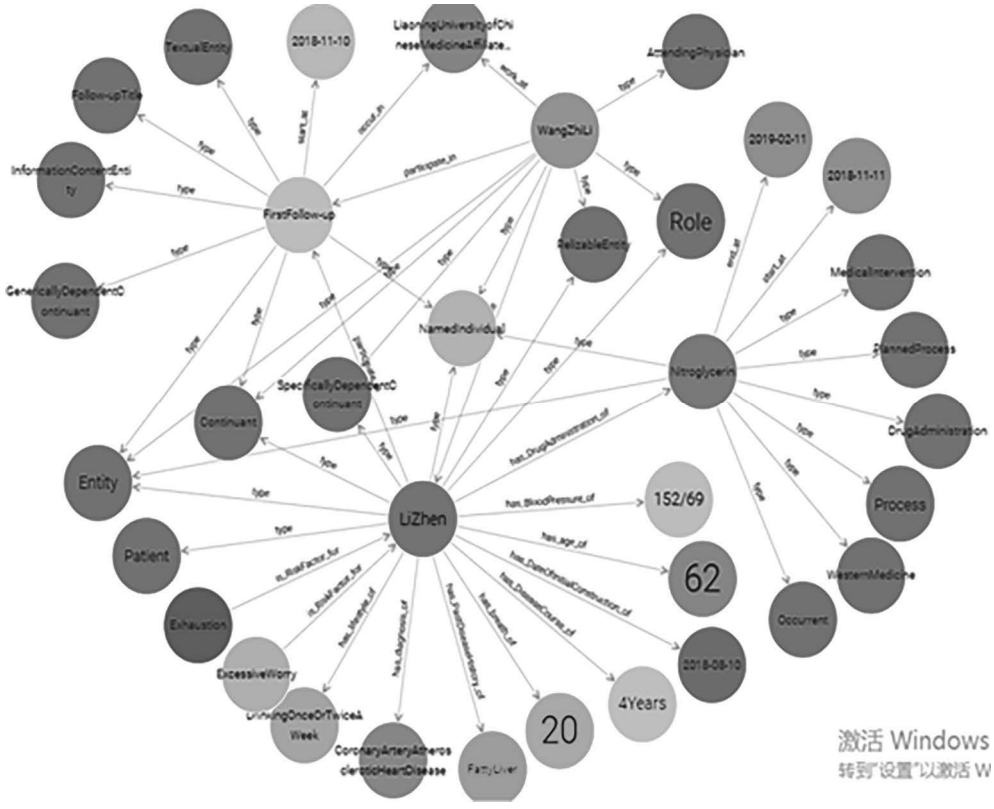


*Figure 4.* The visualization graph for an individual.

| | subject | predicate | object | context |
|---|---|---|---|---|
| 1 | :FirstFollow-up | :occur_in | :LiaoningUniversityofChineseMedicineAffiliatedHospital | http://www.ontotext.com/explicit |
| 2 | :FirstFollow-up | :start_at | :2018-11-10 | http://www.ontotext.com/explicit |
| 3 | :FirstFollow-up | rdf:type | :Follow-upTitle | http://www.ontotext.com/explicit |
| 4 | :FirstFollow-up | rdf:type | owl:NamedIndividual | http://www.ontotext.com/explicit |
| 5 | :LiZhen | :participate_in | :FirstFollow-up | http://www.ontotext.com/explicit |
| 6 | :WangZhiLi | :participate_in | :FirstFollow-up | http://www.ontotext.com/explicit |

*Table 4.* "First Follow-up" query results.

| | s |
|---|---|
| 1 | :DrinkingOnceOrTwiceAWeek |
| 2 | :PreferringSweets |
| 3 | :SmokingDaily |

*Table 5.* "Lifestyle" query results.

| | | |
|---|---|---|
| 28 | :Lifestyle | :DataItem |
| 29 | :Lifestyle | :Continuant |
| 30 | :Lifestyle | :Entity |
| 31 | :Lifestyle | :InformationContentEntity |
| 32 | :Lifestyle | :GenericallyDependentContinuant |
| 33 | :Age | :BasicInformation |
| 34 | :Age | :DataItem |
| 35 | :Age | :Continuant |
| 36 | :Age | :Entity |
| 37 | :Age | :InformationContentEntity |
| 38 | :Age | :GenericallyDependentContinuant |

*Table 6.* Partial query results.

query language is as follows, and the query results are shown in Table 5.

```
prefix onto:<http://www.ontotext.com/>
select ?s { ?s a <http://www.semanticweb.org/
windows/ontologies/2022/11/untitled-ontology-34
#Lifestyle> . }
```

We can also use the SPARQL query language for the following query; intercepted part of the query results are shown in Table 6.

```
prefix rdf: <http://www.w3.org/1999/02/22-rdf-
syntax-ns#>
prefix owl: <http://www.w3.org/2002/07/owl#>
prefix rdfs: <http://www.w3.org/2000/01/rdf-
schema#>
prefix xsd:
<http://www.w3.org/2001/XMLSchema#>
select ?subject ?object
where { ?subject rdfs:subClassOf ?object }
```

Comparing the graphs constructed by the study with those of the Clinical-Research-Follow-up management data platform reveals that coronary heart disease ontology based on follow-up data constructed by the study is systematic. The CHD ontology based on follow-up data includes entities and the relations among them, such as Basic information,

Symptom, Process, etc., which are systematic and are not separated from each other. However, in the Clinical-Research-Follow-up management data platform, its modules are separated and independent of each other. For example, in the case of Chinese herbals and Western medicine, these two modules do not show up in one interface, as seen in Figure 5 below, where the Chinese herbals module is independent and does not show information about other modules, which is not conducive for doctors to find the key factor that affects the modules' indexes.

Therefore, it is particularly important to establish association relations among modules and the conversion from data to knowledge. The CHD ontology constructed in this study can be stored in a graph database and visualized. In this way, the data of each follow-up can be centrally and systematically reflected in a visualization, which can be seen in Figure 4. Compared with Figure 5, Figure 4 contains more comprehensive and systematic knowledge.

## 4.0 Conclusion

This study is a knowledge organization study of coronary heart disease based on follow-up data. The study is based on the BFO top-level ontology and refers to the medical ontology on the Bioportal website, extracts some entities and defines them, then summarizes the attributes of these entities and constructs a conceptual semantic model to form semantic relationships, and finally uses Protégé to form a coronary heart disease ontology based on follow-up data, and stores and visualizes it with the help of GraphDB. The visualization graph finally formed in this study reflects that the coronary ontology constructed in the study is systematic compared with each independent module of the data platform. This study is a collaboration with Jiangsu Famous Medicine Technology Company Limited, which has established a Chinese Clinical-Research-Follow-up management data platform for chronic coronary heart disease. In the future, the Company will organize relevant technical staff to interface with our researchers, hoping to implement the study on the data platform, so that it can further optimize its data platform and increase the knowledge service function of this data platform to provide a more systematic and comprehensive visualization mapping for doctors and patients.

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*Figure 5.* "Chinese herbals" module in Clinical-Research-Follow-up management data platform.

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