



ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF COMPUTER AND MATHEMATICAL SCIENCES
DEPARTMENT OF COMPUTER SCIENCE

Mobile Health Advisor System: For Sexually Transmitted Infections
(MoHA System)

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List of Acronyms

AIDS	Acquired Immune Deficiency Syndrome
APDIP	Asia Pacific Development Information Programme
CADA	Chinese Aged Diabetic Assistant
DAML	DARPA Agent Markup Language
DARPA	Defense Advanced Research Projects Agency
GPRS	General Packet Radio Service
HIV	Human Immunodeficiency Virus
IDRC	International Development Research Centre
ITB	Institut Teknologi Bandung
OWL	Ontology Web Language
PCHRD	Philippine Council for Health Research and Development
PLHA	People Living with HIV/AIDS
RDFS	Resource Description Framework Schema
SIM	Subscriber Information Module
STD	Sexual Transmitted Disease
STI	Sexual Transmitted Infection
TB	Tuberculosis
UI	User Interface
UN	United Nation
UNDP	United Nation Development Programme
URI	Universal Resource Identifier
VD	Venereal Disease

Abstract

Sexually transmitted infections (STIs) are major public health problems in Ethiopia. Because of the clinical problems and complications that STIs cause in individual patients, STIs require attention. This fact becomes even more worrying if we view STIs as a proxy indicator of behaviours placing our people at higher risk of acquiring and transmitting HIV infection.

Currently there are no sophisticated laboratories for examining STI infections in Ethiopia. The patients are diagnosed based on proper analysis of patients back ground (history taking) and physical examinations with or without laboratory support. Due to the shortage of laboratories and health service providers the patients could not receive efficient and effective treatment with low cost in a short period of time.

In this work, we have proposed a Mobile Health Advisor system (MoHA system) for STI. MoHA system for STI provides mobile and personal computer based advice on STI. MoHA is simple to use, reachable, fast and confidential system. It incurs no extra cost for mobile users and PC users who have Internet access. The system allows the users to select the symptoms they are experiencing from a list of symptoms and send the symptoms to the server to get an advice on the particular health problem identified by the system. The symptoms are sent from mobile to the server through the GPRS mobile network and from PC through Internet connections. The server side web application provides advice to the users based on the knowledge stored in Ontology through reasoning process.

Keywords: MoHA system, STI, STI Ontoogy, Mobile Health

1. INTRODUCTION

1.1 BACKGROUND

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. And it is not only just a state of physical health, it also encompasses emotional stability, clear thinking, the ability to love, create, embrace change, exercise intuition and experience a continuing sense of spirituality. The absence of health in the community or individual causes health problems.

The main cause of most of Ethiopia's health problems is the relative isolation of large segments of the population from the modern sector and majority of the population resides in the rural area where there is no or limited health services. Additionally, widespread illiteracy prevents the dissemination of information on modern health practices. A shortage of trained personnel and insufficient funding also hampers the equitable distribution of health services in the country. Ethiopia's main health problems are communicable diseases caused by poor sanitation, malnutrition, Tuberculosis and HIV/ AIDS. HIV/AIDS which is one of sexually transmitted disease (STD), also known as sexually transmitted infection (STI) or venereal disease (VD). Other STIs includes the common curable STIs such as gonorrhea, Chlamydia infection, syphilis and trichomoniasis. The STI that are preventable but not curable are the viral STIs, which include HIV, hepatitis B virus and herpes simplex virus.

STIs are major public health problem in all countries, but are especially so in developing countries where access to adequate diagnostic and treatment facilities is very limited or non-existent. Even though there is only little information on the incidence and prevalence of STIs in Ethiopia, the problem of STIs is generally believed to be similar to that of other developing countries [1].

STIs are infections that can be transferred from one person to another through sexual contact. Most STIs are treatable. Other STIs, such as Herpes, AIDS, and Genital Warts, all of which are caused by viruses, have no cure. Many STIs can lead to Pelvic inflammatory disease with resulting infertility, cervical cancer and complications in pregnancy [2], while Syphilis, AIDS, genital warts, herpes, hepatitis and gonorrhoea have all been known to cause death. Majority of STIs are preventable if the patient is diagnosed and treated early.

STIs have also enormous social and economical consequences. For instance, marital disharmony may occur when one partner develops STI or infertility. The costs of STI drug may place a heavy financial burden on families, communities and the country at large.

Conventional STIs increase vulnerability for HIV infection. Moreover, similar behavioural risk factors operate in both situations where the youth, mobile populations and individuals who frequently change partners are commonly affected.

Large numbers of youngsters are vulnerable to death due to lack of information, wrong perception and less awareness about STIs like thinking that “Kissing is safe sexual contact activity and will not cause STIs”. Unfortunately, syphilis, herpes, and other diseases can be transmitted through this apparently harmless act [2]. Therefore educating the young society at higher institutions and secondary schools at large and providing easily accessible way of advising system on these diseases/infections and prevention is important. In addition, unless they are treated so early they may lead to death which increases the mortality rate of youngster in the country.

Universities and secondary schools are a places where youngsters are found in mass and they are more vulnerable to social interacts and environmental influences. It is obvious that unless they are provided with wide knowledge and access to health services there is high tendency for them to be attacked by STI. Assuming that all of the universities and some secondary schools provide internet access to their students and most of students’ mobile phone have internet connection (GPRS Mobile Network) which is currently being implemented widely in the county, we can take advantage of the wireless technology to use a mobile phone and personal computer with internet connection to deliver user friendly M-health. M-Health is the use of mobile communications and network technologies for healthcare [3]. M-Health services includes: education and awareness, data collection (for public health and clinical domain), remote monitoring, communication and training for healthcare workers, disease surveillance and epidemic outbreak tracking(malaria, HIV/AIDS, TB, Avian Flu, diabetes,...) as well as diagnostics and treatment support. This project implements M-health application; diagnostics and treatment supports. In this project, Ontology knowledge specification will be used to represent knowledge about STI on the web server to enable the system to predict and reason about the types of STI, prevention method and recommends the specialist in the area along with

the location of the specialist. A client side user interface will be adopted for any mobile phone which can support java programming and personal computer (PC) to make the communication easy for users.

1.2 STATEMENT OF THE PROBLEM

Health services in Ethiopia are among the world's worst. According to the U.S. government, Ethiopia's health care system is wholly inadequate, even after recent improvements [4]. The World Health Organization in its 2006 World Health Report gives a figure of about 2.6 physicians per 100,000 people [5]. Lack of healthcare service and limited distribution of physician are the main factors which makes the population to have less awareness about STI. As a result STI in one of the leading causes of adult death in the country. Reflecting the fact that Ethiopians have no access to modern healthcare. STI, particularly syphilis and gonorrhoea are prevalent in town and cities [6]. In addition, they will increase the risk of exposure to HIV/AIDS.

HIV/AIDS is one of Sexually Transmitted Infection (STI). According to Ministry of health report one-third of current young adult deaths are AIDS-related. According to reports shown on some researches the person infected with STI is 40% vulnerable to HIV/AIDS than the normal one [2]. This implicates that to prevent and control HIV/AIDS we need to create awareness in the youngsters at large in deep about STI to ensure the objective of HIV prevention and control. So that there should be some way that a youngster or university or Secondary school community can get access to health information and health support. Internet and mobile is the best technology for cost effective communication and to reach majority of the youngsters' community.

Majority of the community in the Universities and secondary schools have access to computers with internet connection or they have a mobile phone which supports java programming. providing a service which can be available through PC or mobile can play a vital role in creating awareness and educating the community about STI in short time with low cost. So that adult death as a result of STI can be minimized along with increasing modern health service in the country.

1.3 OBJECTIVE OF THE PROJECT

1.3.1 GENERAL OBJECTIVE

The main objective of the project is to develop a system which gives advice on sexually transmitted Infections (STI) to mobile users and to University or secondary school community for those who have access to computer with internet connection.

1.3.2 SPECIFIC OBJECTIVES

The specific objectives include:

- Analyze the current state of the art in order to propose a better and a working solution.
- Design a system that considers the current situation and the available technologies.
- Identify appropriate devices and technologies to implement the designed system
- Designing the prototype on the basis of the identified requirements
- Implement the system based on the current requirements.
- Test and evaluate the developed system.

1.4 SCOPE OF THE PROJECT

The scope of the project work is limited to the following:

- The developed mobile application for the client works only on those mobile which have the support for java programming.
- The PC based system is accessible only from computers with internet connections.
- The implementation of the project is limited to STI and doesn't include other types of infections or disease.
- The system will not recommend or prescribe any kind of medicine for the problem as it is ethically not correct rather it only provides advice on how to control the infections.

1.5 METHODOLOGY AND TECHNIQUES

To collect data used for the project development we have used interviews with health professionals to identify types of STIs with their symptoms and behaviors.

Literature review is used to identify the existing technologies and analyze the current situations and make the system faceable.

National Guidelines for STIs in Ethiopia is used to identify the behavior of STIs in Ethiopia and to treat STIs based on Syndromatic approach.

1.6 IMPORTANCE OF THE SYSTEM

The availability of health service in Universities or Schools is from limited to null specially there are no adequate professionals or budgets to provide information and create awareness for campus students about STIs. The MoHA (Mobile Health Advisor) system will overcome this problem by providing needed information through their mobile or computer. In addition the system will increase courage to the students to test and know about STI because it is highly confidential and private. And the system is easy to access from any where at any time by any one with cheap cost in a short period of time.

The system helps the students to avoid their doubts about STIs by providing them with possible STIs symptoms and any students who have one of the symptoms will be provided with possible types of STIs and notified about the prevention and control methods to control the spread of the infections and recommended for specialists who can clinically treats specific STI with the whereabouts' of the specialist which helps to save the patients time and effort.

Failures to diagnose and treat STIs at early stage may result in serious complications and squeal. The user can easily diagnose and track the problem they have at early stage with out going to medical centers simply being in their place or any where at any time with no cost.

2. LITERATURE REVIEW

2.1. Ontology and M-Health

2.1.1 Ontology

In a widely-quoted definition, Ontology is "a specification of a conceptualization" [7]. It means that Ontology allows us to specify, in an open, meaningful, way the concepts and relationships that collectively characterize some domain. The advantage of Ontology is that it is an explicit, first-class description [8]. The knowledge represented by Ontology that has been developed for one purpose can be published and reused for other purposes as well.

There are many ways of writing down Ontology or languages used to develop Ontology,

- RDFS (Resource Description Framework Schema)
- OWL (Ontology Web Language)
- DAML(DARPA) Agent Markup Language)

RDFS is the weakest ontology language and allows building a simple hierarchy of concepts, and a hierarchy of properties. While OWL allows saying everything that RDFS allows, and much more such as describing class relationship, inverse property and detail description for every classes in the domain. OWL has the ability to describe classes in more interesting and complex ways. OWL facilitates greater machine interpretability of web contents than that supported by XML, RDF, and RDF schema (RDF-S). The OWL language is sub-divided into three syntax classes: *OWL Lite*, *OWL DL* and *OWL Full*.

OWL DL supports those users who want the maximum expressiveness while retaining computational completeness (all conclusions are guaranteed to be computable) and decidability (all computations will finish in finite time). OWL DL includes all OWL language constructs, but they can be used only under certain restrictions for example, while a class may be a subclass of many classes, a class cannot be an instance of another class. OWL DL is so named due to the correspondence with description logics, a field of research that has studied the logics that form the foundation of OWL.

OWL Lite supports those users primarily needing a classification hierarchy and simple constraints. For example, while supports cardinality constraints, it only permits cardinality values of 0 or 1. OWL Lite also has a lower formal complexity than OWL DL.

OWL Full is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. For example, in OWL Full a class can be treated simultaneously as a collection of individuals and as an individual in its own right. OWL Full allows an Ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full [9].

The intent for OWL Lite and OWL DL is to make the task of reasoning with expressions in that subset more tractable. Specifically, OWL DL is intended to be able to be processed efficiently by a *description logic* reasoner. OWL Lite is intended to be amenable to processing by a variety of reasonably simple inference algorithms, though experts in the field have challenged how successfully this has been achieved.

One of the main reasons for building an ontology-based application is to use a reasoner to derive additional truths about the concepts you are modeling. In RDF every thing is represented as a resource and they are expressed as statement or triples (Subject, Property, and Object) identified through unique resources id which is known as URI (Universal Resource Identifier).

In our system, we have used Ontology to represent the concept about STIs. The language we have used to develop this ontology is OWL Full (Ontology Web Language) with Ontology reasoner.

2.1.2 M-Health

MHealth is a short version of mobile health. The original concept behind it is to support healthcare delivery via wide application of all available mobile technologies such as mobile phones, personal digital assistants (PDAs), monitoring devices, and etc. Recently, the health support of mobile citizen has also become part of the understanding of mobile health [10].

The interest towards mobile health is colossal and is facilitated by several factors such as:

- Cheap, widely available communications facilities and lower cost, higher performance computers;
- Increased public acceptance and confidence in the use of computer and communication technology;
- Up- and –coming global standards in communications;
- Necessity to ensure high quality medical care 24 hours a day, 7 days a week to all citizens, no matter where they are and what a time.

2.2 Related Works

Mobile phones are currently being used in various sectors in developing country to facilitate the countries' development and to reach the population at large. Especially in Health area mobile phone is being used effectively to improve the health service delivery and introduce modern health services in many developing countries including South Africa, Kenya, Peru, Indonesia and Philippines as piloted in [11].

Mobile applications are categorized based on the purposes they are developed for, these includes mobile application for health education and awareness, mobile application for remote data collection and monitoring, mobile application for communication and training, mobile application for remote diagnostics and treatment support and mobile application for disease and epidemic outbreak tracking. Under mobile application for remote diagnostics and treatment support there are several mobile applications developed and deployed all over the world, particularly in developing countries [11]. Some of these applications are discussed in the following sections.

2.2.1 Chinese Aged Diabetic Assistant (CADA)

CADA is the Project developed in china with participation of Saint Louis University and Peking University and is supported by Microsoft Research as a part of a 2-year grant from Microsoft to study the use of “Smart Phones” in the care of older people in China with diabetes. The system sends daily messages to elderly patients with diabetes in China. The messages will include

recommendations and guidelines related to physical activity, blood glucose monitoring, blood pressure monitoring, weight and waist measurement, and eating habits. Patients will be taught how to input daily glucose level and his/her affective state. Additionally, physicians may input the patient's measurements and health goals during office visits. A graphical representation of the trends of the various indicators and personal health goals can be displayed. This technology could change the way doctors and patients interact, and it has the potential to help older patients take charge of their own health [12].

2.2.2 Colecta-PALM and Pambazuko-PALM

Colecta-Palm and Pambazuko-Palm are Personal Digital Assistants for HIV Treatment Adherence, Safer Sex Behavior Support and Provider Training in Resource-Constrained Settings developed in Peru and Kenya respectively. The projects were developed with involvement of researchers from University of Washington, Universidad Peruana Cayetano Heredia, Centre for HIV Prevention & Research, and University of Nairobi. Colecta-PALM is used by Peoples Living with HIV/AIDS (PLHA) in Peru. The Colecta-PALM version in Spanish gives tailored behavioral messaging to PLHA to support ART adherence and safer sex. Similarly Pambazuko-Palm is also used by PLHA in Kenya. The Pambazuko-PALM version delivered in Kiswahili and English assesses HIV-patient risks in these areas, and includes a module for nurses engaged in HIV care. This module comprises an evidence-based counseling protocol used by nurses [13].

2.2.3 "Please Call Me"

Please call Me is a project piloted in South Africa which is developed by the iTEACH team with collaborators from Pop! Tech, The Praekelt Foundation, and Frog Design under the project called Project Masiluleke, also called Project M. To brought HIV awareness to the masses and improved treatment compliance through the use of text messaging. The projects sends a combined 30 million "Please Call Me" (PCM) text messages every day in South Africa reaching virtually 100% of the adult and adolescent population of South Africa at no cost to callers. The text messages contained information about HIV and TB. They connect mobile phone users to a network of government- funded HIV call centers (National helpline) where they can obtain accurate healthcare information and referral to regional healthcare centers capable of providing

voluntary HIV testing and counseling, TB screening, and treatment with antiretroviral therapies and anti-TB medication. Messages are culturally relevant and written in local languages. Upon receiving the PCM message, helpline staffs, who are HIV patients themselves, offer counseling and direct callers to HIV and TB testing centers [14].

2.2.4 M-Dok

M-Dok is Mobile Telehealth and Information Resource System for Community Health Workers at Philippines. The implementation of the project is done by UN Development Programme (UNDP) and the Philippine Council for Health Research and Development (PCHRD). M-Dok is not developed based on a personal computer connected to the Internet, or to a mobile phone using GPRS, but is dependent on programming on the subscriber information module (SIM) card or simple data transmission. M-Dok was designed to allow rural community health workers to use simple SMS technology, with a specially designed graphical user interface, to send diagnosis and treatment information to specialists in urban areas and M-Dok provides a mobile telehealth system with store-and-forward teleconsultation and offline health information resources for community health workers. M-Dok requires a Java-enabled mobile phone with Adobe Acrobat Reader software [15].

2.2.5 Mobile Telemedicine

Mobile Telemedicine is a project deployed in Indonesia. The sponsoring organization and Partners are Institut Teknologi Bandung (ITB), the International Development Research Centre (IDRC) of Canada, the United Nations Development Programme's Asia-Pacific Development Information Programme (UNDP-APDIP), Sukabumi Health Office, the Local Authority Development of Sukabumi and the Information and Communication Department of Sukabumi. The system will enable remote consultation and diagnostics and also facilitate the collection of patient data. Depending on the communications infrastructure available at a specific location radio, mobile, or landline phones, and the Internet information will be shared between patients at 'mobile telemedicine units' and doctors at 'medical service centers' [16].

2.2.6 HIV Self-Test kit

HIV Self-Test kit is a HIV self-testing with mobile support and like Please Call Me project it is piloted in South Africa under the Project Masiluleke, which is developed by the iTEACH team with collaborators from Pop! Tech, The Praekelt Foundation, and Frog Design. This kit enables South Africans to perform an HIV test in the privacy of their own homes, with the option of calling a counselor at the National AIDS Helpline via mobile phone. HIV Self-Test kit is a diagnostics model which is low cost, HIV self testing with mobile counseling support. Analogous to a pregnancy test, these distributed diagnostics would provide a free, private, and reliable way for anyone to take the critical first step of knowing his or her status, with high-quality information provided by knowledgeable counselors via mobile device. The counseling is provided by both health care workers and HIV patients as well who prefers giving counseling via cell phone. The kit is presented with clear, local-language instructions and a connection to support via mobile [14]

The proposed MoHA system for STI differs from some of the above related works in such a way that:

- The proposed system uses Ontology for back end request handling. Unlike the database back end systems the system processes the request based on the concept.
- The service is initiated by the user that means any one who wants to receive the service starts the system and sends the symptoms which is immediately processed and advice is provided accordingly.
- The system is developed not for health workers or health professionals; it can be used by any person who is able to read the symptoms.
- No health professionals are directly involved in the advising system.

3. SYSTEM ANALYSIS

3.1 Existing Health System

A shortage of doctors and health centers spells inadequate treatment for many in the developing world, especially in rural areas. The World Health Organization in its 2006 World Health Report gives a figure of about 2.6 physicians per 100,000 people [5]. As Ethiopia is one of developing country the health service is provided only in limited health organization in urban area and it is very limited or poor in rural area. The country not only has limited number of health centers but also a big shortage of health professionals to cover the health services for the nation at large [5].

To get the health service, the patient has to go to the near by health center and consult the health workers at the centers irrespective of weather the workers are specialized in the area of his diseases or not. Moreover the shortage of a well equipped laboratory services in the health services forces the health workers to use the treatment method based on syndromatic approach to treat the patients. Particularly, for patients with STIs complications and other disease which needs laboratory examinations for treatments.

A patient who wants to receive a health service must go to the health center early in the morning and get registered to get a card for medical records. Since the number of health workers are limited in numbers the user is expected to stay at the center and waits up until his\her turn comes to see the health workers. This process takes many hours and even a couple of days to a worst case. In addition to the time they waste the patient might be asked for a costly service fee which he /she might not afford.

In general the current system is not motivating system for patients to diagnosis from time to time and to consult health professionals when needed, due to the shortage of the health professionals. The possibility to get access to professional is very narrow. As well the numbers of health centers are in adequate to provide health services in short period of time with low cost.

Another important constraint is privacy. On site visit to health centers involves another person with whom the patient has to share personal data that many people think are secret. Leave alone sharing personal matters, the simple fact that they appear in and around health centers providing advise on STI may be considered as shameful act by some people. This prohibits people in this category from visiting the centers.

Patients in marginalized areas in both urban and rural area lack access to specialized medical centers, which are often the only sites where vital diagnostic tools are available, therefore it is the only preferable way to use new technologies to deliver health services for all populations living in both rural and urban areas as well. Hence Mobile technology is the powerful tool to use.

The vastly growing mobile technology has given rise to many mobile based applications which aimed to reach the population at wide. Taking improvement of this technology and highly developing wireless technology such as mobile phone Internet service we have proposed a mobile based application to provide advice for STI patients.

The proposed MoHA system provides STI advising based on the symptoms provided by users and diagnosis the types of STI they are experiencing, what they have to do to control the disease not to transmit to an other persons and recommends the specialized professionals in the area to get more sophisticated treatments with where about the Specialized persons is working or located. These will help the users to save their time and make them get the service easily being at home or any where with no cost and high privacy. Plus the system is user friendly as it will provide the users with easily selectable symptoms to select from the symptoms they are experiencing and send it to the web server to get the advising.

3.1.1 STI Behaviors and Symptoms

STIs are among the most common causes of illness in the world and have far reaching health, social and economic consequences. STIs are caused by more than 30 different pathogens including bacteria, viruses, protozoa, fungus and ecto-parasites. Although there are more than 30 kinds of organisms that can be transmitted through unprotected sex, they tend to cause similar symptoms and signs [1].

The common classical STIs are gonorrhoea, syphilis, chlamydia, genital herpes, hepatitis-B, HIV, bacterial vaginosis and trichomoniasis

As their name implies, the main mode of transmission of STI is through unprotected penetrative sexual intercourse. Other modes of transmission include: mother-to-child, blood transfusions, or contact with blood or blood products. To capture the possible symptoms and STI disease we have used national guideline for STIs and consultation with health professionals.

Table 3.1 STIs and symptoms

STI	Symptoms
Bacterial Vaginosis	Fishy_ odour_ discharge Vaginal_ pain_ and_ itching Pain_ when_ urinating
Syphilis	Sore_ throat Swollen_ lymph_ glands
Hepatitis-B	Headache_ and_ muscleache Loss_ of_ appetite
Genital herpes	Pain_ in_ legs_ buttocks_ or_ genital_ areas Ulcer_ on_ genitals
HIV	Enlarge_ lymphnodes Fever Loss_ of_ appetite
Chlamydia	Discharge_ from_ genitals Low_ back_ pain Lower_ abdominal_ pain

	<p>Pain_in_legs_buttocks_or_genital_areas</p> <p>Swelling_or_pain_in_testicles</p> <p>Pain_when_urinating</p>
Trychomonasis	<p>Excessive_foamy_diffuse</p> <p>Inflamation_of_urethra_glands_or_foreskin</p> <p>Lessions_on_penis</p> <p>Vaginal_pain_and_ittiching</p> <p>Yellow_green_vaginal_discharge</p>
Gonorrhea	<p>Bleeding_between_menustreal</p> <p>Pain_when_urinating</p> <p>Yellowish_genital_discharge</p>

3.2 Proposed System

3.2.1 Overview of the System

From the fact that the current system is not best enough to reach the population at wide and the system is time consuming and costly, we have proposed a mobile based STI diagnosis and treatment to support the current system. The proposed system allows the user to select from the lists of symptoms they are experiencing and allow them to send the symptoms to the web server and receive an advice on STI they are infected with.

The client side of the MoHA system is designed in such a way that any body who wants to get access to the service can get the advice with out any user id privilege as far as he or she has a mobile phone with internet connection or personal computer with internet access. The system can run on every mobile phone which is able to run java program and the interested user can get the jar (executable) file to run on their mobile or personal computer. As far as the system is designed considering the youth at University or Secondary schools the jar file can be placed at the ftp server of the university or the school net.

The server side of the MoHA system is designed with Ontology to represent the knowledge and concepts about STI. Ontology is used to explicitly represent knowledge and using that knowledge as a fact it will derive another facts from the knowledge domain. In MoHA system case the domain of the Knowledge is STI. The domain contains classes such as common STIs with their possible symptoms, persons infected with symptoms and specialized doctors in specific STI with the medical center name they works in and any other properties such as relationship property between different classes of Ontology, inverse relationship for symmetric classes and so on. The Ontology of MoHA system is developed by following the Ontology development guideline [17]. The symptoms selected and sent by client is used as an input for the Ontology query and using the developed Ontology and Ontology reasoning model the user requests will be processed using the predefined facts to determine which types of STI it is.

To upgrade the use of the System and to make changes on the Ontology any one with the knowledge about Ontology and having administrative right can make changes to the Ontology to

add or remove the symptoms for specific STIs, to add classes and to change relationships, based on the health knowledge and necessity.

The system is also capable of keeping records of symptoms selected by users and the proposed solutions for further works such as to help the health professionals or system administrators to take decision or make necessary changes if needed

3.2.2 Functional Requirements

This section includes the functionality the system can allow the users. The system is used by any users who want to receive advice on STI with out any requirements of user account or authentication. Once the user decides to use the system and started the service he/she can do the following tasks:

- Select symptoms
- Delete selection
- Send selected symptoms
- View advising

Another user of the system is the system administrator who is the responsible person to control and manage the back end of the system. This person can make changes to the system and is able to modify the system as needed. The tasks that system administrator can able to perform is:

- Select symptoms
- Edit symptoms
- Add symptoms
- Remove symptoms
- View reports
- Modify systems

3.2.3 Non-Functional Requirements

Non-Functional requirements describe user visible aspects of the systems that are not designated to the functional behavior of the system. This includes what types of User Interface (UI), documentation, hardware and software consideration, performance characteristics such as how responsible the system is?, how long it take to respond?, and security Issue.

User Interface (UI)

The system is being developed to be access from desktop computer and mobile phones; hence there should be two types of user interfaces considered for desktop application and for mobile phones. The user interface on desktop is simple and easily understandable by non health professionals since the user is not expected to type the names of the symptoms rather the user interface provides the user with lists of possible symptoms to select from and the display area to see selected symptoms and to make changes if needed. When we come to mobile phone user interface the interface is simple and easy like desktop application it provides the list of symptoms which can easily selectable using check boxes. The user can check as much as needed symptoms from the list moving up and down using shcrollers.

Documentation

System users and system administrators will be provided with a short and brief documentation on how to use the systems. System administrator will also receive documentation about the structure of Ontology and the code of the system. This will help the system administrator to use and make changes or modification on the system and further for troubleshooting of the system in the case of failure or when problems appear.

Hardware and Software Consideration

The server side of the system should be accessible using the well known web browsers like Internet Explorer, Firefox, Google Chrome and Opera. The client side for the personal side is accessible from any desktop computers and the client side for mobile phone is accessible on any mobile phone capable of running java programming.

Performance Characteristics

The system should be capable of handling multiple users at a time with reasonable processing time. It should have to be available all the time. The hardware of the system should have to be good enough to support the performance of the system as it is the great factor in the systems performance.

Error Handling and Extreme Conditions

Error could rise from the user of the system or from the system itself. The system should have to handle both errors when they appear. The run time error should be handled by systems and errors occurred due to wrong doing of users will be handled by appropriate exception handling mechanisms. To reduce the occurrence of error from user input the system is designed in a way that users only selects from available lists to avoid spelling error and input error. On the occurrence of error the system will identify the where about the error and informs or notify the user to take the appropriate action, but not all errors will be handled with notifications on how to fix it.

System Modification

Through the use of the system there may be the need for the system modification to update the system, to include new symptoms, to remove symptoms and so on. This modification can be done by developers or any other trained person that knows the code behind the system and have knowledge about Ontology. The modification can be possible without putting any problem on the system since the system will be developed using Object Oriented approach.

Security Issues

Since the user of the system doesn't have any access to the back end of the system or Ontology any user can use the system with out any security issue. In addition the system will not have any sensitive data that will be exposed to the user. But the server side of the system is placed in a safe place and only authorized person can access the server room and server computer.

3.3 Analysis Model

3.3.1 Actors of the System

Actors are entities that interact with the system. The system interacts with actors through mobile phone or desktop computers and web interface. In proposed system the actors are system users and system administrator. The actors and their description are listed in Table 3.1.

Table 3.2: Actors of the system

Actor	Description
System User	A system user is any user of the system who can receive advising service with out any perquisite such as user is or password. This can be any campus student or secondary school student or any one with mobile phone and desktop computer.
System Administrator	A system administrator is a responsible person for administrating the whole system and capable of modifying and making changes to the system.

3.2 Use Case Diagram

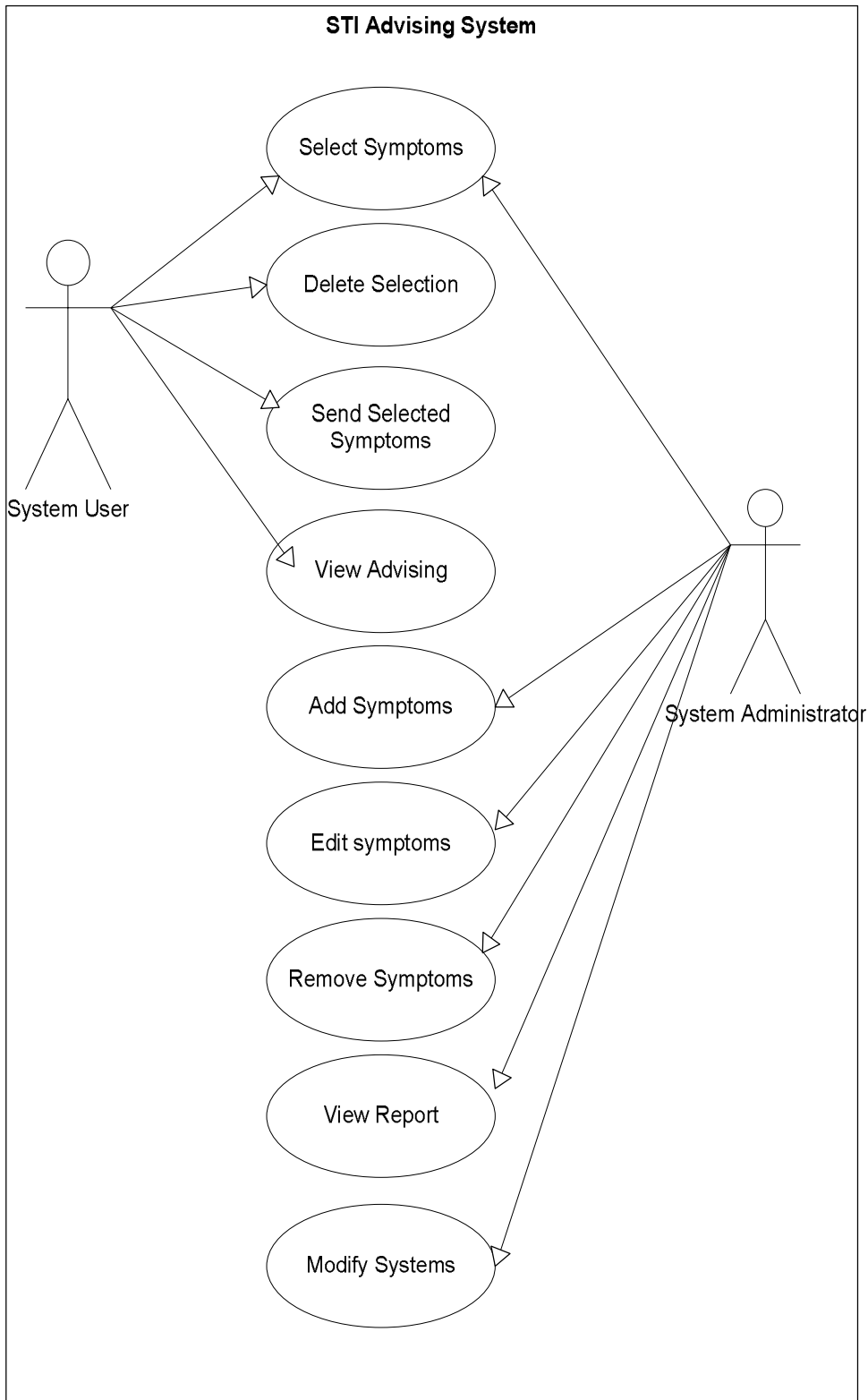


Figure 3.1: Use Case Diagram

3.3.3 Use Case Description

Use Case Name	Select Symptoms
Participating Actors	System User
Description	The system user selects the symptoms he\she is experiencing to get advising.
Entry condition	The system user starts the advising system application
Flow of events	<ol style="list-style-type: none">1. The system user wants to get advising on STI2. The system user starts the advising application3. The system displays the lists of symptoms to select from4. The system user selects the symptoms he\she is experiencing.
Exit condition	The system user selects the symptoms.

Use Case Name	Delete Selection
Participating Actors	System User
Description	The system user deletes the symptoms he\she selected if he\she wants to change the symptoms.
Entry condition	The system user starts the advising system application

Flow of events

1. The system user wants to get advising on STI
2. The system user starts the advising application
3. The system displays the lists of symptoms to select from
4. The system user selects the symptoms he/she is experiencing.
5. The system users delete the selected symptoms form Selection.

Exit condition The system user deletes the selections.

=====

Use Case Name Send Selected Symptoms

Participating Actors System User

Description The system user has to sends the selected symptoms to the server to receive advising.

Entry condition The system user starts the advising system application

Flow of events

1. The system user wants to get advising on STI
2. The system user starts the advising application
3. The system displays the lists of symptoms to select from
4. The system user selects the symptoms he/she is experiencing.
5. The system user sends the selected symptoms
6. The system sends the selections to the server.

Exit condition The system displays an acknowledgement of sending symptoms.

=====

Use Case Name	View Advising
Participating Actors	System User
Description	The system user will receive the results or advising after sending His/her symptoms to the server.
Entry condition	The system user starts the advising system application
Flow of events	<ol style="list-style-type: none"> 1. The system user wants to get advising on STI 2. The system user starts the advising application 3. The system displays the lists of symptoms to select from 4. The system user selects the symptoms he\she is experiencing. 5. The system user sends the selected symptoms 6. The system sends acknowledgement for sent symptoms. 7. The system processes the symptoms to produce results [A1]. 8. The system sends the result (advising) to system user.
A1	<ol style="list-style-type: none"> 1. The system asks the user to reselect the symptoms if the selected symptoms cause ambiguity in decision system.
Exit condition	The system user view the provided advising.

=====

Use Case Name Select Symptoms

Participating Actors System Administrator

Description The system administrator wants to select symptoms

Entry condition The system administrator need to have a privilege to view the system.

Flow of events 1. The system Administrator wants to select symptoms
 2. The system administrator opens the Ontology code.
 3. The system displays the code
 4. The system administrator selects the symptoms and save it.

Exit condition The selected symptoms highlighted in the symptoms list.

=====

Use Case Name Add Symptoms

Participating Actors System Administrator

Description The system administrator wants to add symptoms to the system

Entry condition The system administrator need to have a privilege to change the system.

Flow of events 1. The system Administrator wants to add symptoms
 2. The system administrator opens the Ontology code.
 3. The system displays the code
 4. The system administrator adds the symptoms and save it.
 5. The system adds new symptoms to existing symptoms.

Exit condition The added symptoms incorporated in the symptoms list.

=====

Use Case Name	Edit Symptoms
Participating Actors	System Administrator
Description	The system administrator wants to edit existing symptoms
Entry condition	The system administrator need to have a privilege to change the system.
Flow of events	<ol style="list-style-type: none"> 1. The system Administrator wants to edit symptoms 2. The system administrator opens the Ontology code. 3. The system displays the code 4. The system administrator edits the symptoms and save it. 5. The system saves changes made to symptoms.
Exit condition	The symptoms needed to edit is edited.

=====

Use Case Name	Remove Symptoms
Participating Actors	System Administrator
Description	The system administrator wants to remove symptoms from the system
Entry condition	The system administrator need to have a privilege to change the system.
Flow of events	<ol style="list-style-type: none"> 1. The system Administrator wants to remove symptoms 2. The system administrator opens the Ontology code. 3. The system displays the code 4. The system administrator removes the selected symptoms and save it. 5. The system removes symptoms from the symptoms list.

Exit condition The specified symptoms removed from the symptoms list.

=====

Use Case Name View Report

Participating Actors System Administrator

Description The system administrator wants to see or view the stored report.

Entry condition The system administrator need to have a privilege to see the
stored file on the server.

Flow of events 1. The system Administrator wants to see a report.
2. The system administrator attempts to open the file.
3. The system displays the file
4. The system administrator views the report.

Exit condition The system administrator views the stored file or report.

=====

Use Case Name Modify Systems

Participating Actors System Administrator

Description The system administrator wants to modify the system

Entry condition The system administrator need to have a privilege to change or
Modify the system.

Flow of events 1. The system Administrator wants to modify the system.
2. The system administrator opens the system code.
3. The system displays the code
4. The system administrator makes any modifications and
save it.

5. The system displays the performed modifications.

Exit condition

The modification applied to the system.

=====

3.3.4 Ontology Hierarchy

Ontology represents every concept as a class. The MoHA system Ontology consists of five classes which are under owl thing class namely Prevention and control, medical center, person, STI_Disease and symptoms classes. The relationships between classes are represented using property. Figure 3.2 shows the STI Ontology classes with their sub classes such as Clinic, Hospital and Health center subclass of class medical center, instance of classes or elements of a class and properties such as a class person is a victim of a class STI_Diseases.

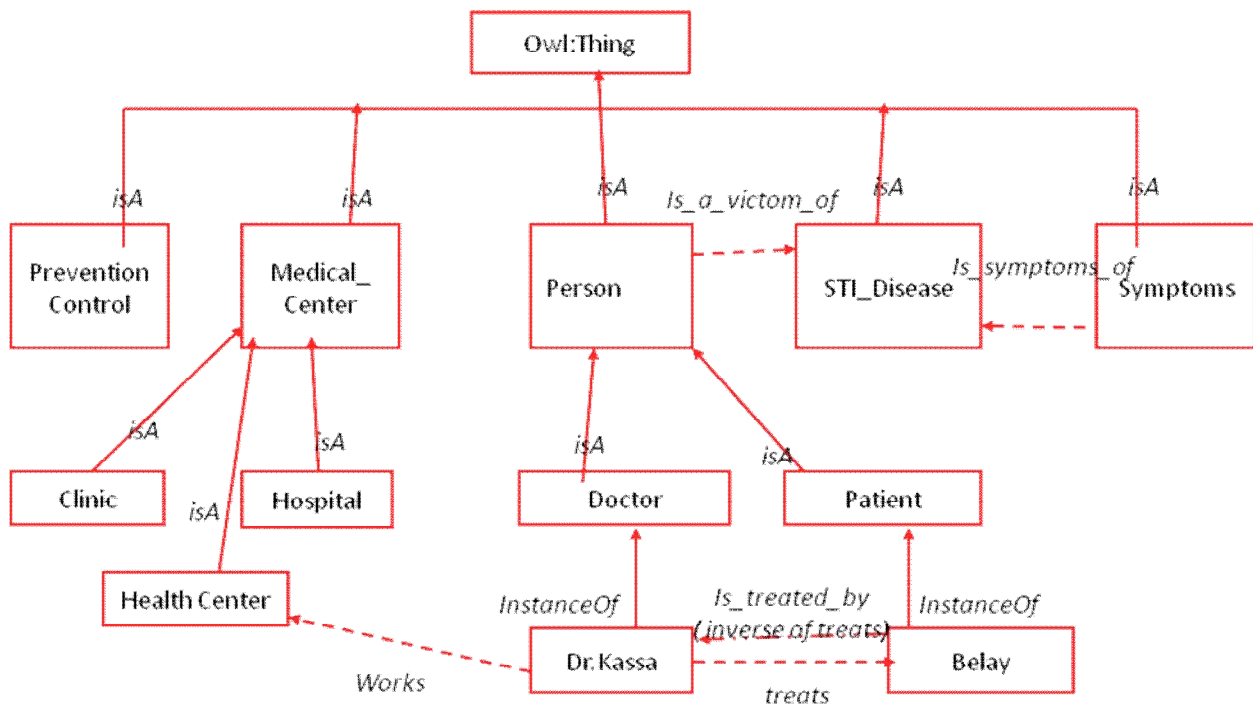


Figure 3.2: Ontology Class hierarchy diagram

3.3.5 Sequence Diagrams

Sequence diagram shows the interaction between object entities to accomplish the tasks described in use case diagram. To show the interaction, some of sequence diagram like, select symptom sequence diagram, send selected symptoms sequence diagram and add symptoms sequence diagram in figure 3.3, 3.4 and 3.5 respectively are shown below. The rest sequence diagrams are available at appendix A.

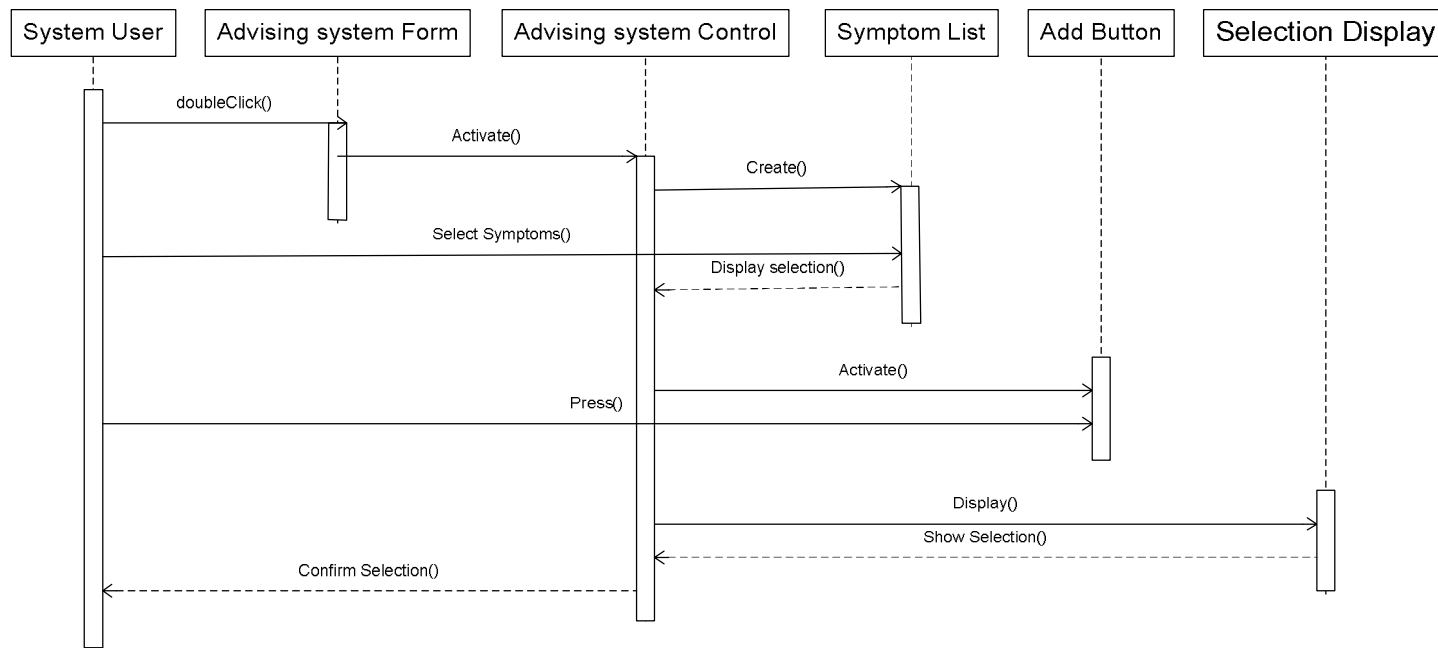


Figure 3.3: Select Symptom sequence diagram

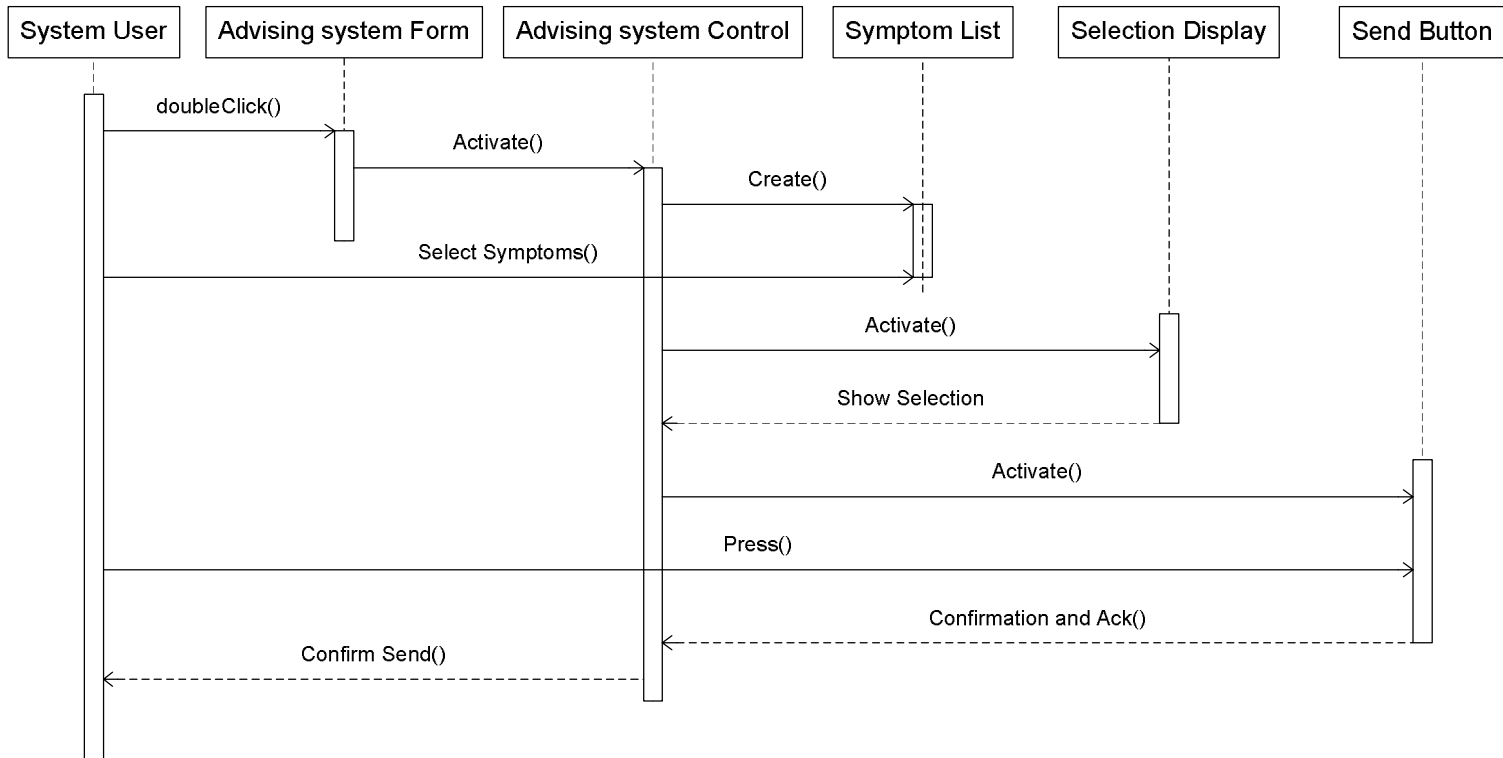


Figure 3.4: Send Selected symptom sequence diagram

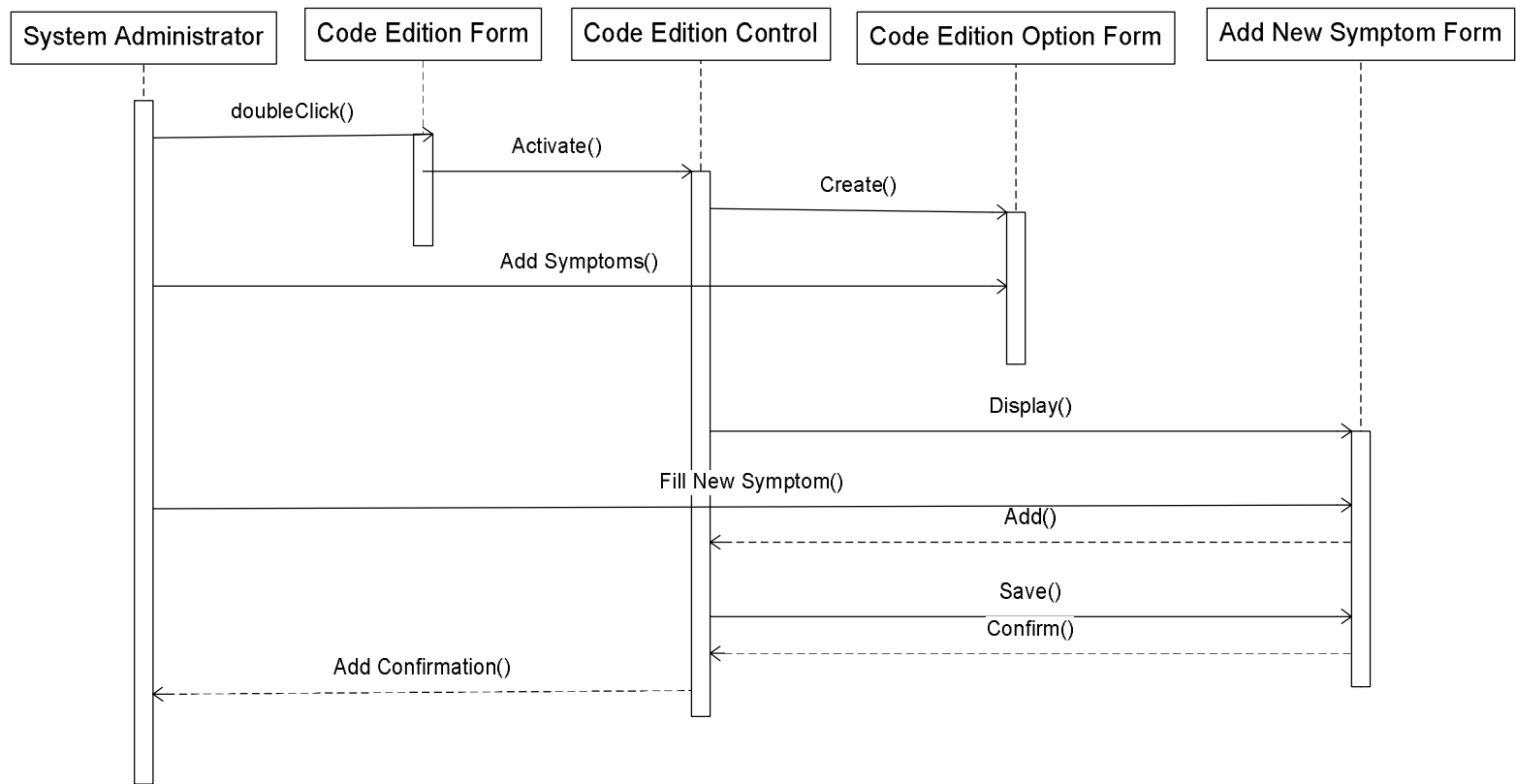


Figure 3.5: Add Symptoms sequence diagram

4. DESIGN OF THE SYSTEM

The design goals represent the desired qualities that the system should have and provide a consistent set of criteria that should be taken into consideration when making design decisions.

4.1 Design Goals

The developed system is considered successful and good system if the following design goal sets are meets.

- **User Interface:** As the system is expected to be user friendly the user interface of the system should be easy and used by users with out difficulties since the users may have less experience in using computer. The user interface on the mobile phone should have to be precise and simple as it will be displayed in small screen.
- **Documentation:** System Administrator and user of the system should be provided with proper documentation on how to use the system.
- **Performance:** since the system is available online for users there may be many users using the systems at a time and the system should have to support multiple users at a time concurrently.
- **Availability:** the system should be available at any time the user want to access that means the system should be available 24 hours to provide the service.
- **Reliability:** the output of the system should have to be always similar for the same request.
- **Modifiability:** the system should have to be easily modifiable to support changes or upgrading with out causing problem to other systems functionality and to insure this, the system should have to de designed in Object Oriented design and implemented in Object Oriented Language.

- **Portability:** the server side of the system should have to support requests coming from different platforms via standard web browsers. The client side of the system should have to run on all mobile phone capable of running java programming.

4.2 Proposed System General Architecture

The system has three major components; the mobile client, the web server and the client. The mobile client is the client side of the system which runs on mobile phone. The system user uses the application on mobile to select the symptoms they are experiencing from and send it to the web server to get advice on STI. The communication between mobile phone and web server side of the system is through GPRS mobile network. Other system users are users who use desktop computer to get the advice. The desktop users use the desktop application to select the symptoms from list available and to send the symptoms to the web server. The communication between desktop computer and the server side is through Internet. The server side application of the system with STI Ontology resides on the web server. Figure 4.1 shows the general Architecture of the proposed system. It includes the mobile client, the web server and the web client.

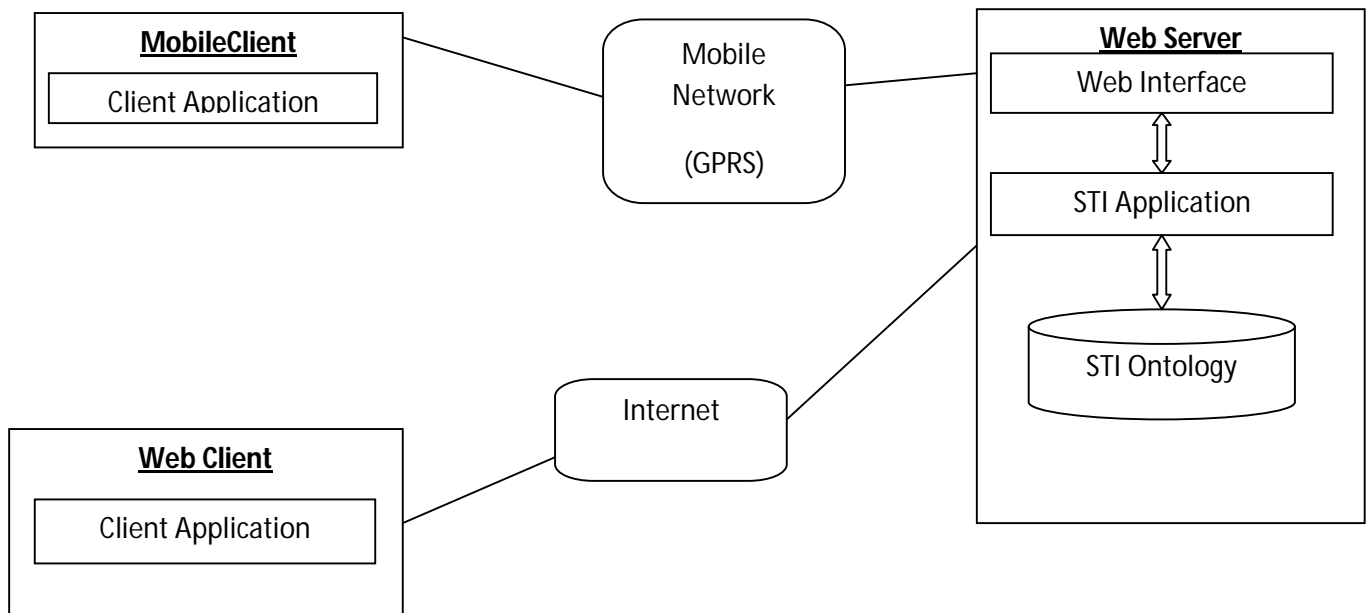


Figure 4.1: Proposed system Architecture

4.3 System Decomposition

To reduce the complexity of the system, it will be built on a layered architecture. A layered architecture enhances maintenance so that the modification of one part of the system will be handled without affecting the others. All layers should interact only with the layers right next to them. Each layer is not allowed to interact with layers it do not have direct accesses. This policy makes the code more readable and easily maintainable. The system will have four logic layers to achieve design goals of the system as shown in the figure 4.2.

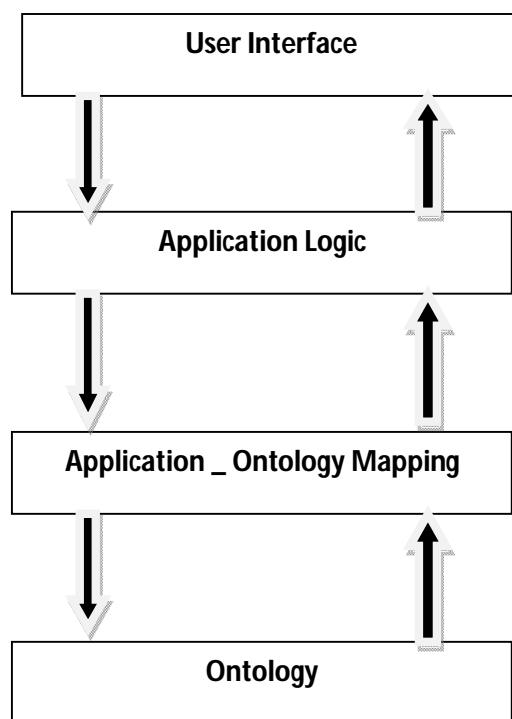


Figure 4.2: Layered Architecture of the System

The detail description about each layer will be described as follows.

The User Interface layer: This is a layer on which all the user interface codes are implemented. This makes the user interface modification easy and doesn't cause any effect on another parts of the system.

Application logic layer: This layer implements the functional requirements of the system without involvement of user interface. The application logic layer consists of two sub systems to handle functional requirements. These sub systems interact together in order to make the system functional. The application logic sub systems as indicated in Figure 4.3 are:

- User Action Management.
- Report Management

Figure 4.3 shows the application logic subsystems.

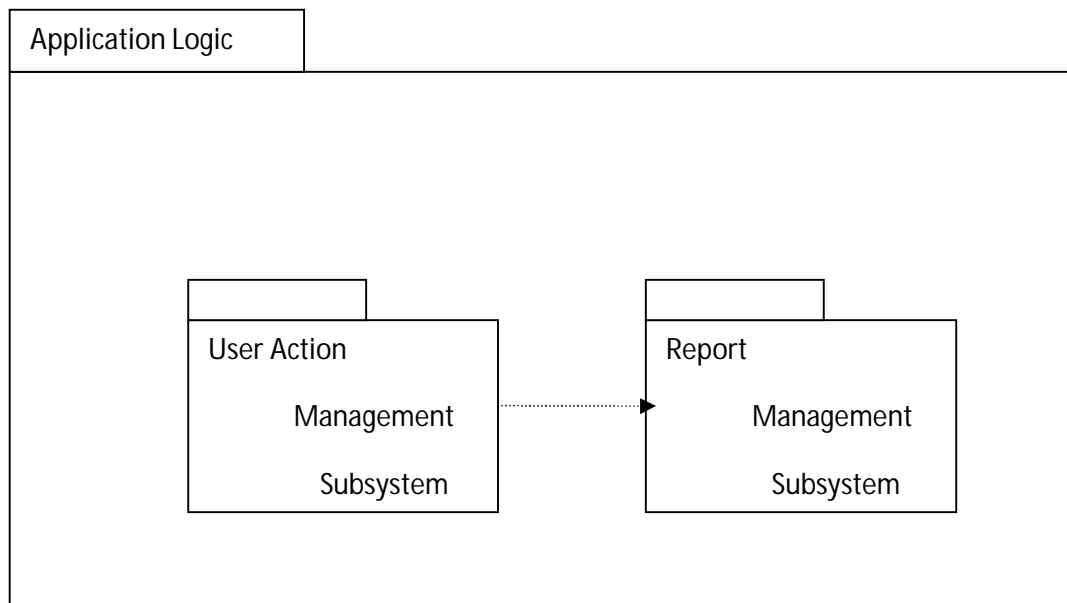


Figure 4.3 Application logic layer

The subsystems of the application logic layer contain different classes to maintain their functionality. Figure 4.4 and Figure 4.5 show the interaction of classes both in user action management subsystem and report management subsystem respectively.

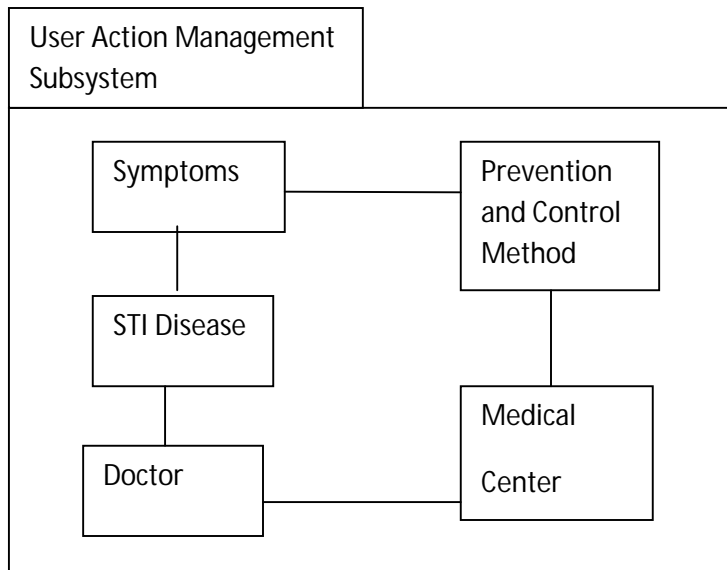


Figure 4.4: User Action Management Subsystem

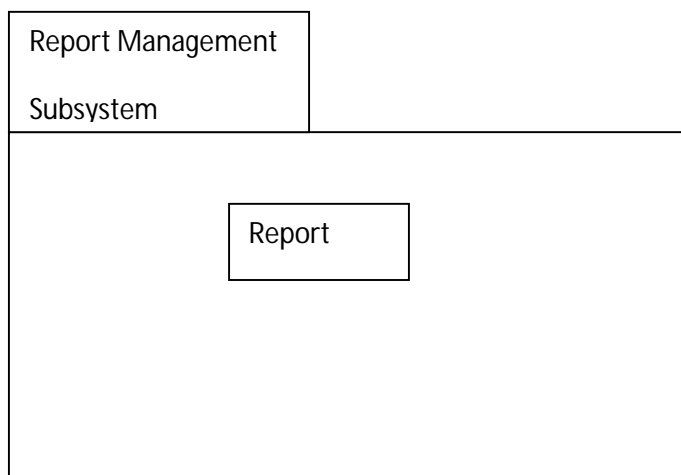


Figure 4.5: Report Management Subsystem

Application _ Ontology Mapping Layer: This layer is responsible for connecting application logic layer with Ontology layer. It is an interface between the Ontology layer and the application layer. In this layer Ontology model is used to load the Ontology used for the application and the Ontology reasoner is used to reason and produce the result from the loaded Ontology using the rules determined to govern the reasoner.

Ontology Layer: This layer is the bottom layer of the design it contains the Ontology or knowledge used for the systems. In side Ontology layer knowledge is represented in a class and the relationship between classes are kept as a property. Each class in Ontology is referenced through their URI (Universal Resource Identifier). To limit the scopes of the relationship between classes Ontology uses domain and range in relationship or property.

4.4 Hardware Software Mapping

The hardware software mapping of the system shows the relationship between nodes and independent software components. The systems client application can be deployed on mobile device and desktop computers, the application server deploys the application subsystems and the Ontology of the system resides on Ontology server. The following figure 4.6 shows the components and nodes of the system along with where they are deployed.

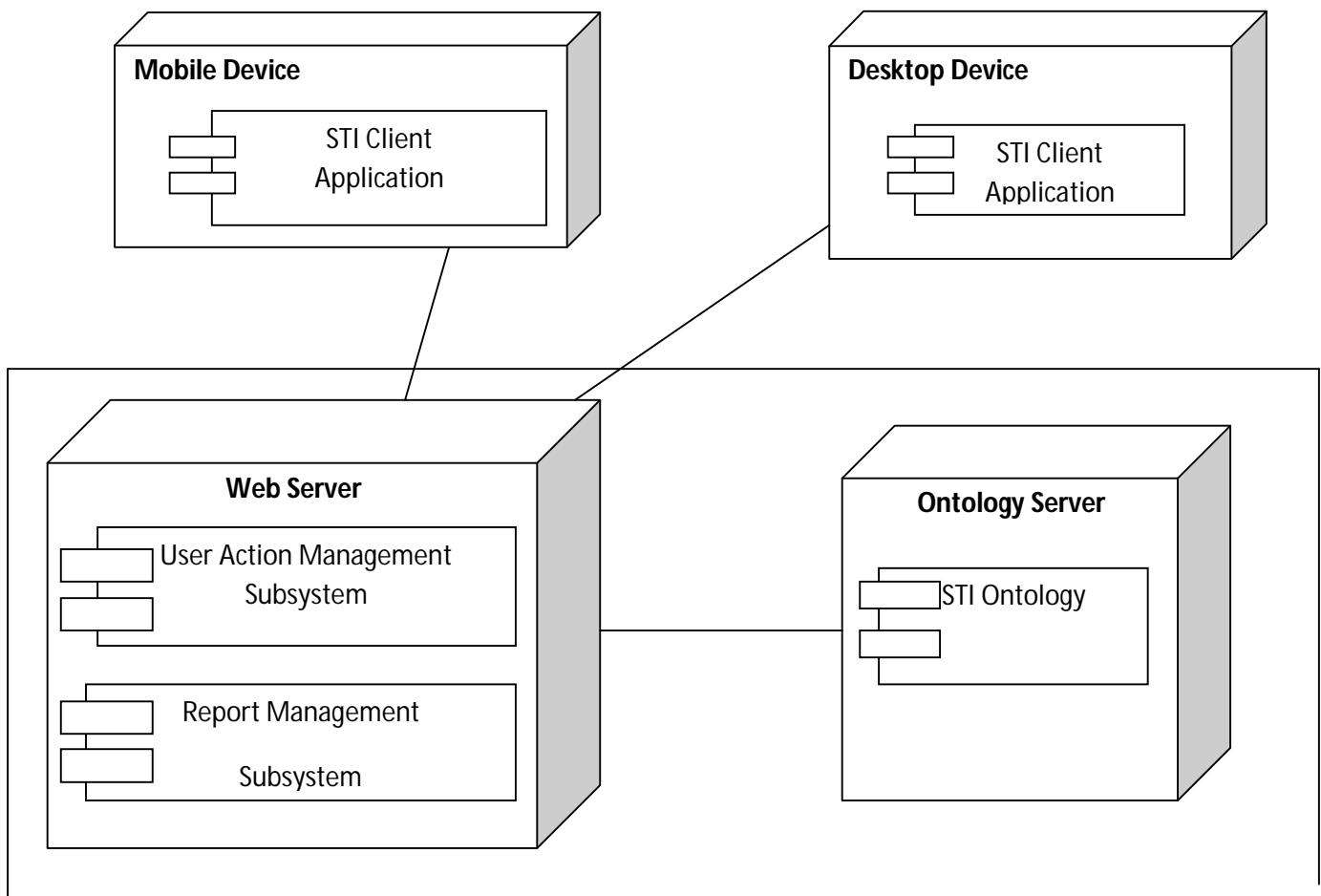


Figure 4.6 Deployment diagram

5. IMPLEMENTATION AND TESTING

This section presents the various tools used during the implementation of the system and the prototype of the proposed system.

5.1 Development Environment

Java 2 Enterprise Edition (J2EE):The java programming language is used to develop both the server side application of the system and the personal computer client side application of the system.

Java Server Pages (JSP):Java server page is used to design the web interface for the server side application of the system.

Java 2 Micro Edition (J2ME):The java 2 Micro Edition is used to develop the application running on mobile clients.

Wireless Toolkit 2.5.2:The Plug in Wireless toolkit 2.5.2 is used to facilitate the development of the mobile client side application of the system.

NetBeans 6.9.1:The netbeans 6.9.1 is used as integrated development environment for the client side application of the system and server side application of the system.

TopBraid Composer Maestro Edition: The plug in topbraid composer is used to facilitate the development of Ontology of the system being integrated in Eclipse Galileo 3.5.

Eclipse Galileo 3.5:The eclipse Galileo 3.5 is used as an integrated development environment to develop Ontology.

5.2 The Prototype

The system is composed of a client application running on mobile phone, client application running on personal computers and a server side application capable of handling user requests.

5.2.1 Mobile based Interface

The mobile client application lists symptoms with check boxes to enable users select the symptoms by simply checking the box in front of the symptoms. The user can edit his\her selection by checking and unchecking the boxes. Figure 5.1 shows the main page of mobile client application.



Figure 5.1: Mobile Client application main page

Once the user selects and sends the symptoms to the system. The system will acknowledge the user and confirms that the symptoms sent to the server. Figure 5.2 shows the confirmation message for successful submission of the symptoms.



Figure 5.2 Confirmation message

The result or advising is sent to the mobile client after sending the symptoms and receiving sent symptom confirmation message. Figure 5.3 shows the advising or result page of mobile clients.

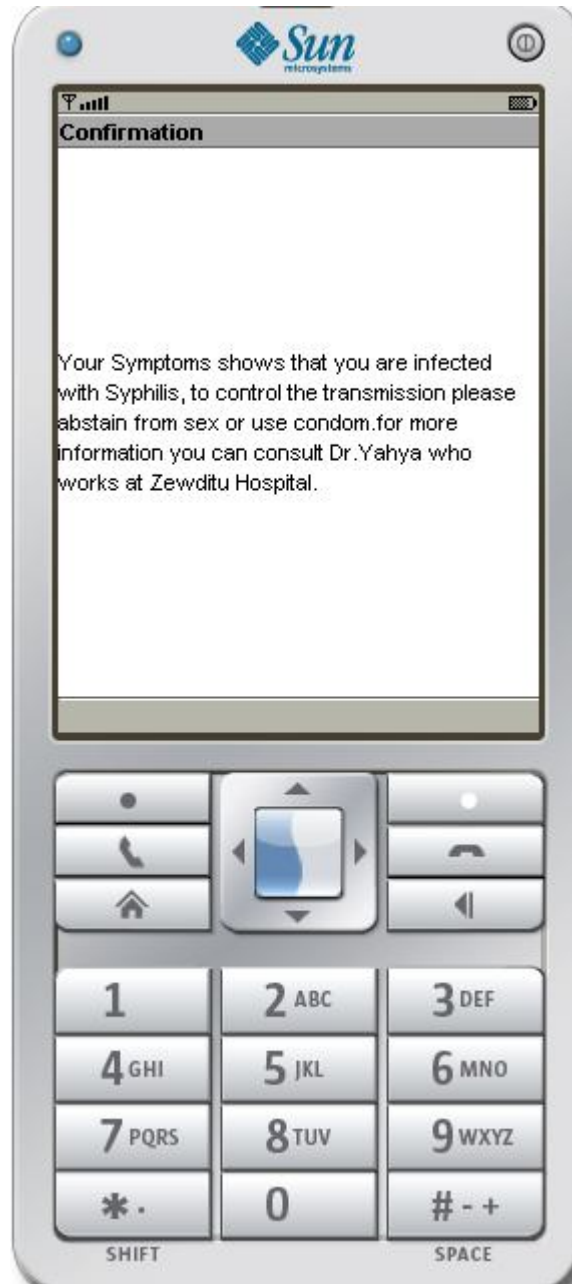


Figure 5.3: Mobile Client result or Advising screen

5.2.2 PC based Interface

As shown in Figure 5.4 the main screen of client application running on personal computers. The page displays the lists of STI symptoms that a user can select from and has also a display area which enables the user to edit their selection. The users uses add button to select a symptoms from the symptoms list and use remove button to delete selected symptoms from the display list finally the submit button is used to send the selected symptoms.

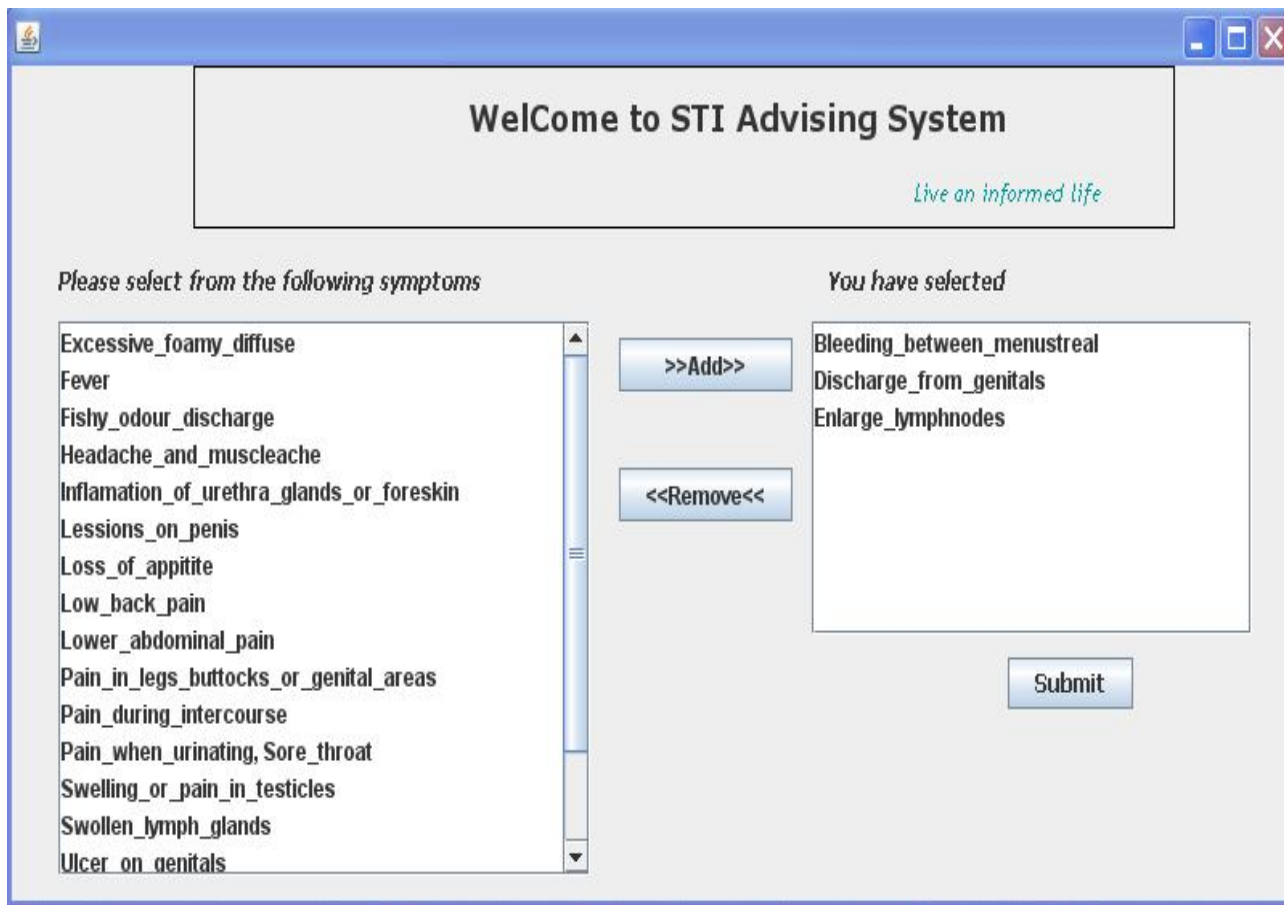


Figure 5.4 Main page of personal computer application

The system displays the confirmation message for receiving symptoms from the users and asks the user to wait until the symptom is being processed. Figure 5.5 shows the confirmation message for users of personal computers.

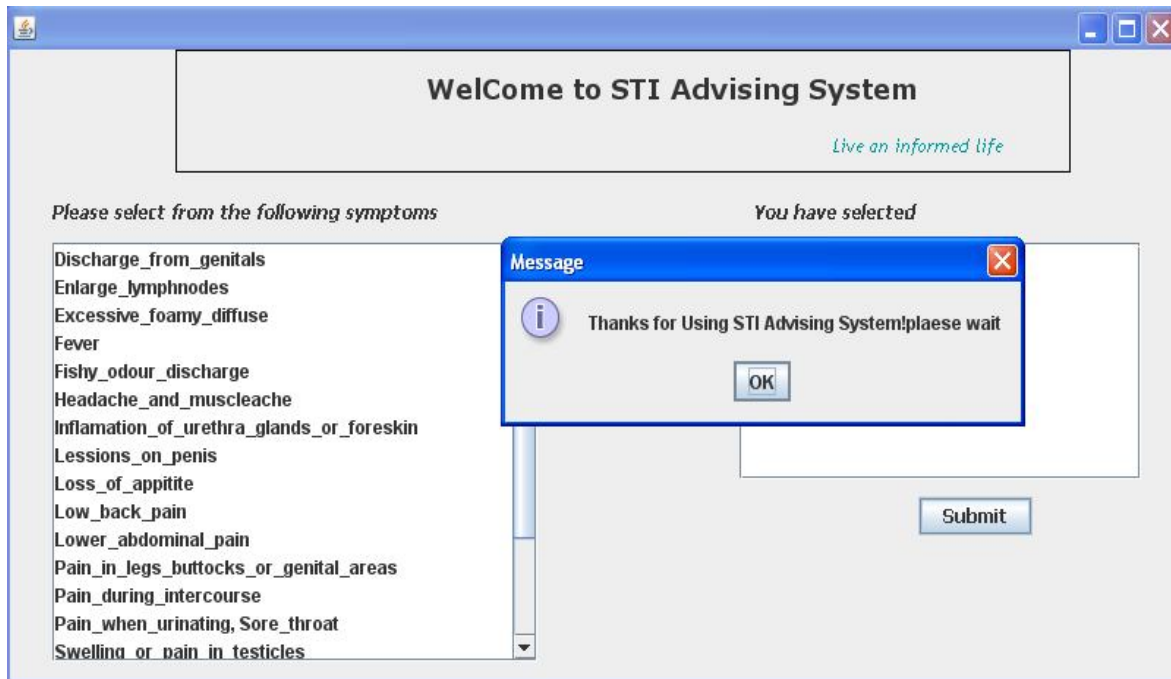


Figure 5.5: Confirmation message

If the system could not able to decide on the symptoms sent from users because of the ambiguity of the symptoms being symptoms of two or more diseases the system asks the users to re select the symptoms and send it again as shown in figure 5.6.

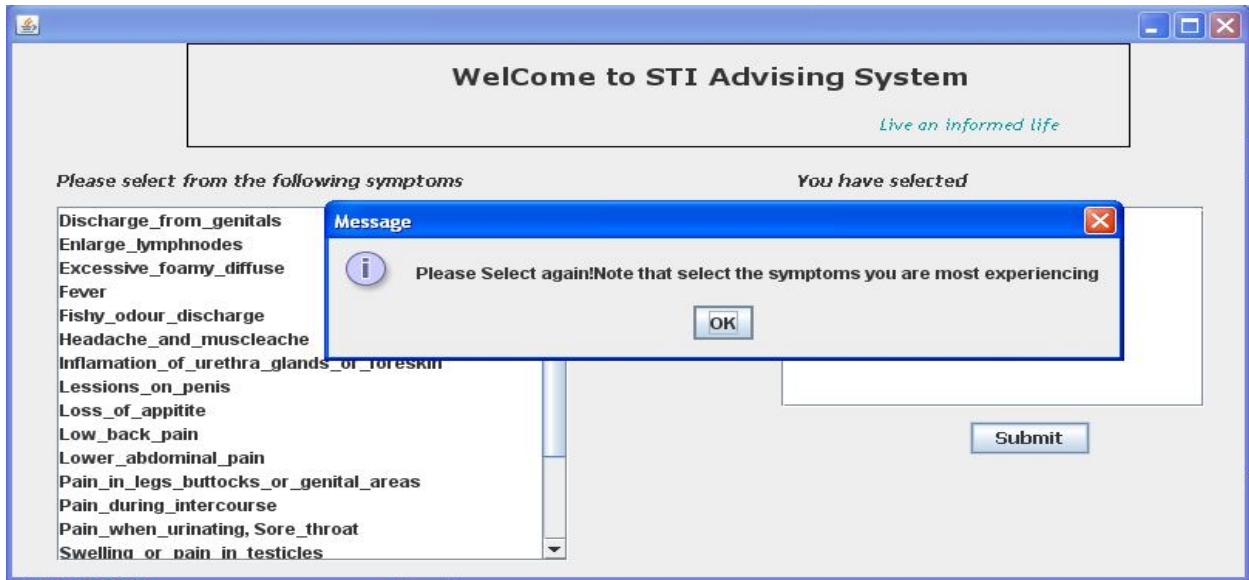


Figure 5.6: Failure message

Figure 5.7 shows the page that will display the information or advising for users.

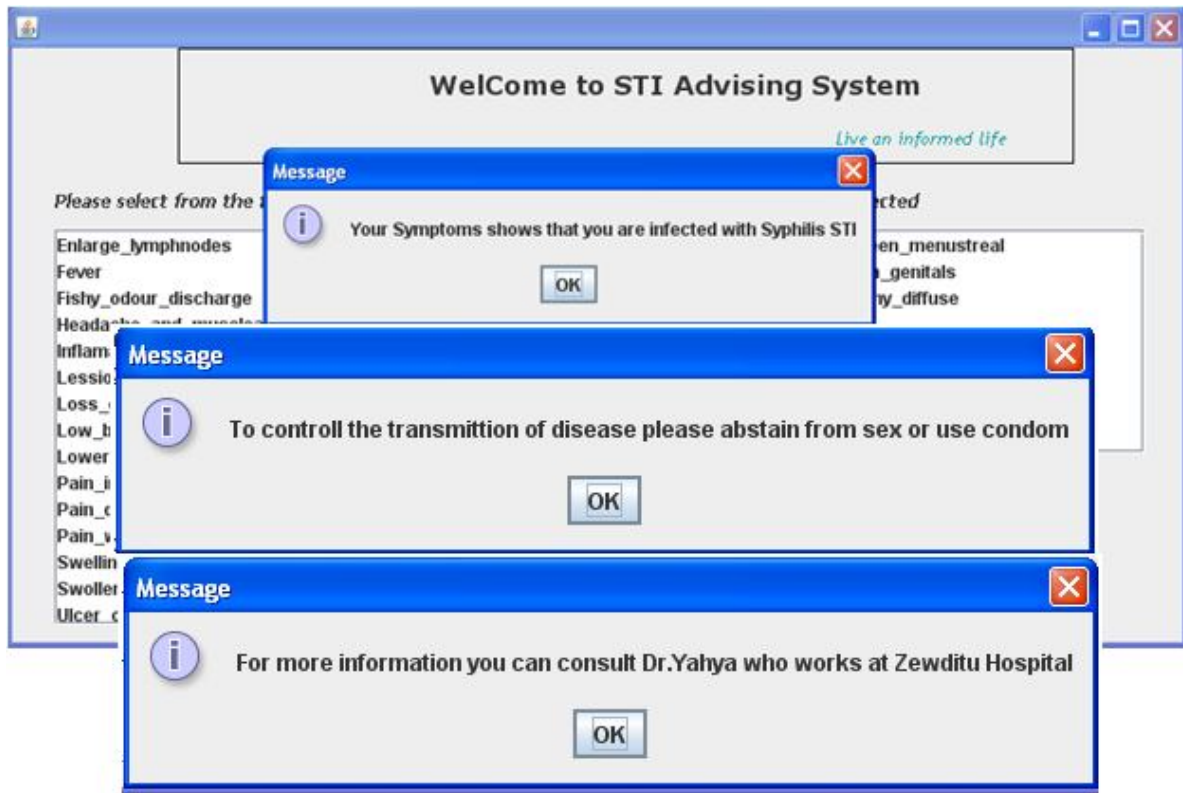


Figure 5.7 Advising and Result message

5.3 System Testing

To check the correctness of the system and user acceptability system testing has been done. Depending on the data collected from health professionals and reviewed from national health guidelines the MoHA system provides the advice for STIs after receiving a symptoms from users request. Using Ontology developed for this purpose the system determines the types of STIs the user infected with from the fact comes from the symptoms. In case of the symptoms selected by the user causes ambiguity to determine the types of STIs and need additional human decision the system asks the user to select again.

The test of the system is performed by Zewditu Hospital VCT centers and ART clinic staffs. Table 5.1 shows the data used to test the systems and the output produced by the MoHA system.

Table 5.1 MoHA system Test result

Symptoms selected	Expected result	Produced Result
Bleeding_between_menstrual Discharge_from_genitals Enlarged_lymphnodes	HIV/AIDS or Chlamydia	Please select again! Note that select the symptoms you are most experiencing
Excessive_foamy_diffuse Lession_on_penis Inflamation_of_urethra_galnds_ Or_foreskin	Trychomonasis	Trychomonasis

6. CONCLUSION AND FUTURE WORK

Ethiopia is one of the countries severely affected by the HIV epidemic. In addition, the high prevalence of STIs is fuelling the epidemic of HIV/AIDS. Individuals with STIs are at greater risk of both acquiring and transmitting HIV due to the physiological and pathological changes caused by STI and the behavioural risk factors that underlie the sexual transmission of both HIV and STIs. The first episode of STI can be a starting point for behavioural change through effective counselling in order to prevent future HIV infection. This is particularly important when STIs occur in adolescents.

In identifying the problems of the existing health system, we have found that the existing health system is not widely reaching the population. The service is limited to only some area and even though it is available it takes too much time to get the service plus the cost of the service is not affordable for most of the citizens.

In this project we tried to analyze the existing STI treatment and diagnosis methods being utilized. The Syndromic diagnosis which relies on identification of symptoms and signs is being used in the country to treat patients with STI complications. Based on the symptoms being used, we designed an advising system named MoHA for STI, to provide remote advice system on mobile phone and personal computers as an option.

Due to the fact that the expansion of mobile network in the country and decreasing prices of mobile devices, most of the youngsters specially the university students and secondary school students are the users of mobile phones. Taking advantage of this expansion of the mobile technology we have developed the system which reaches mass youngsters in easy way to provide the STI advising system which in turn reduces the prevalence of HIV/AIDS.

MoHA for STI provides advice based on the lists of symptoms being displayed by the system. These symptoms are compiled from STI treatment guidelines and by consultation with specialists in the area. The system, in this particular work is only applicable for STI not any other diseases. One of the major future works to be mentioned is to extend this service to other types of health problems and make the symptoms more interactive with users. Like allowing users to type the symptoms they are experiencing and using those symptoms for further analysis.

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Declaration

I, the undersigned, declare that this project is my original work and has not been presented for degree in any other university and that all sources of materials used for the project have been acknowledged.

Declared by:

Name Zukriya Abdella

Signature _____

date 30/ 6 / 2011

Confirmed by advisor:

Name Dr. Dejene Ejigu

Signature _____

date _____

Place and date of submission: Addis Ababa University, June 2011

Appendix A: Sequence diagram

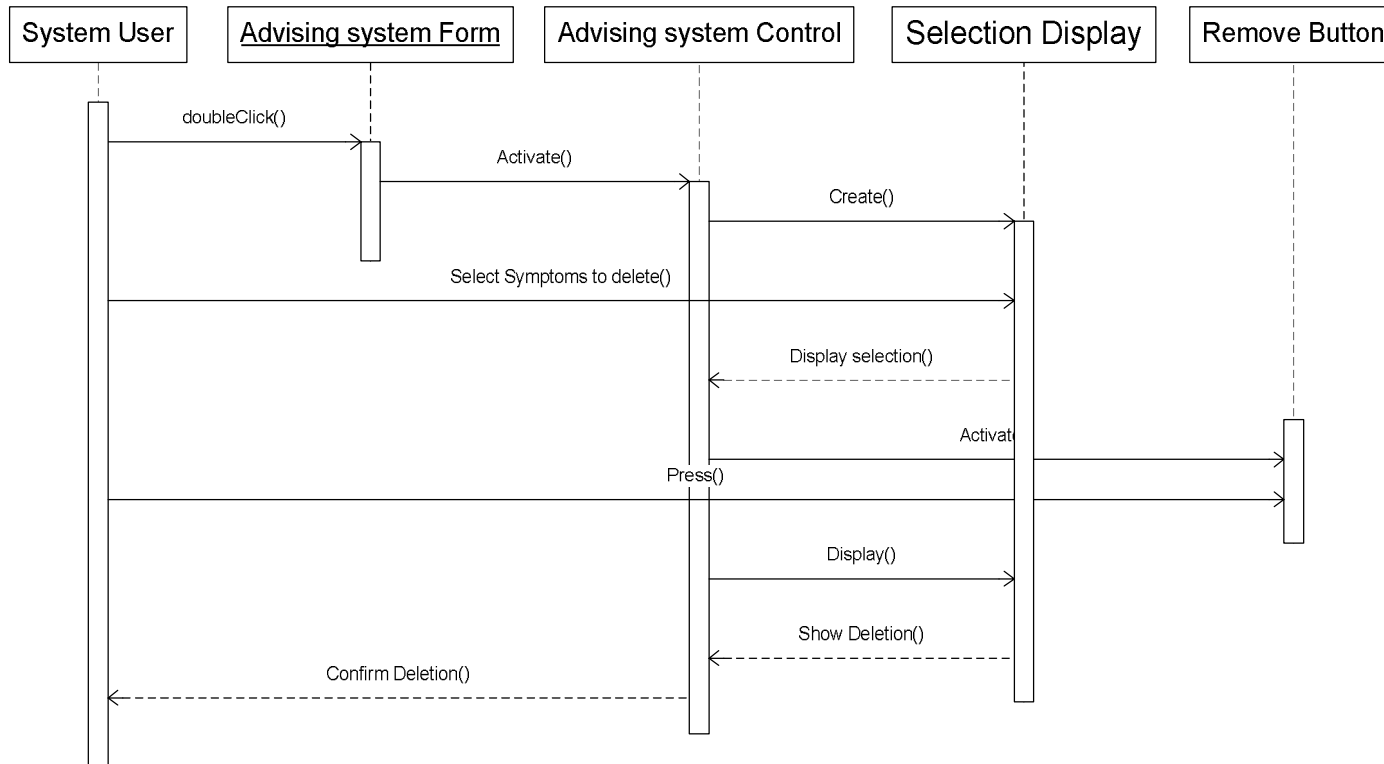


Figure 7.1: Delete Selection sequence diagram

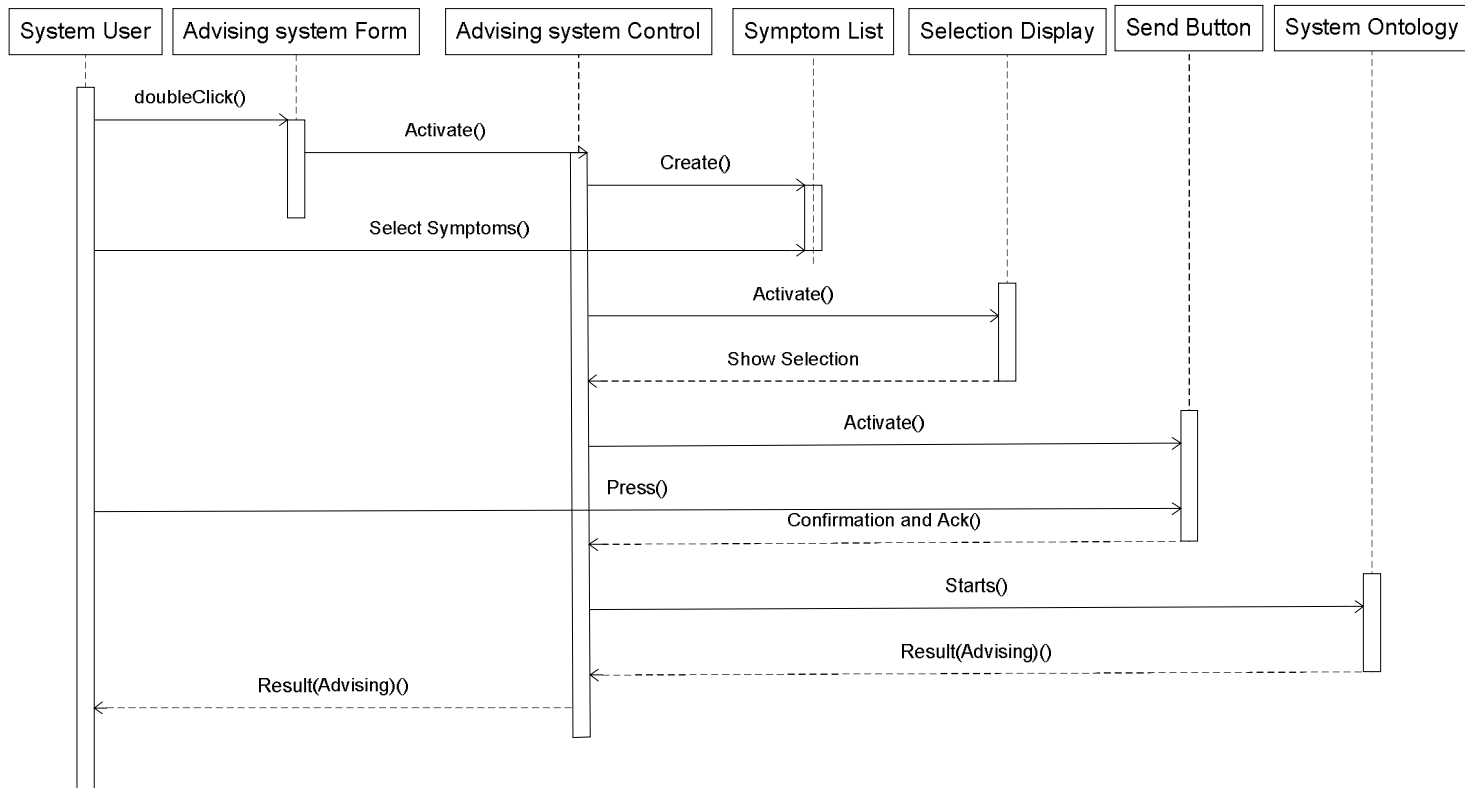


Figure 7.2: View Advising sequence diagram

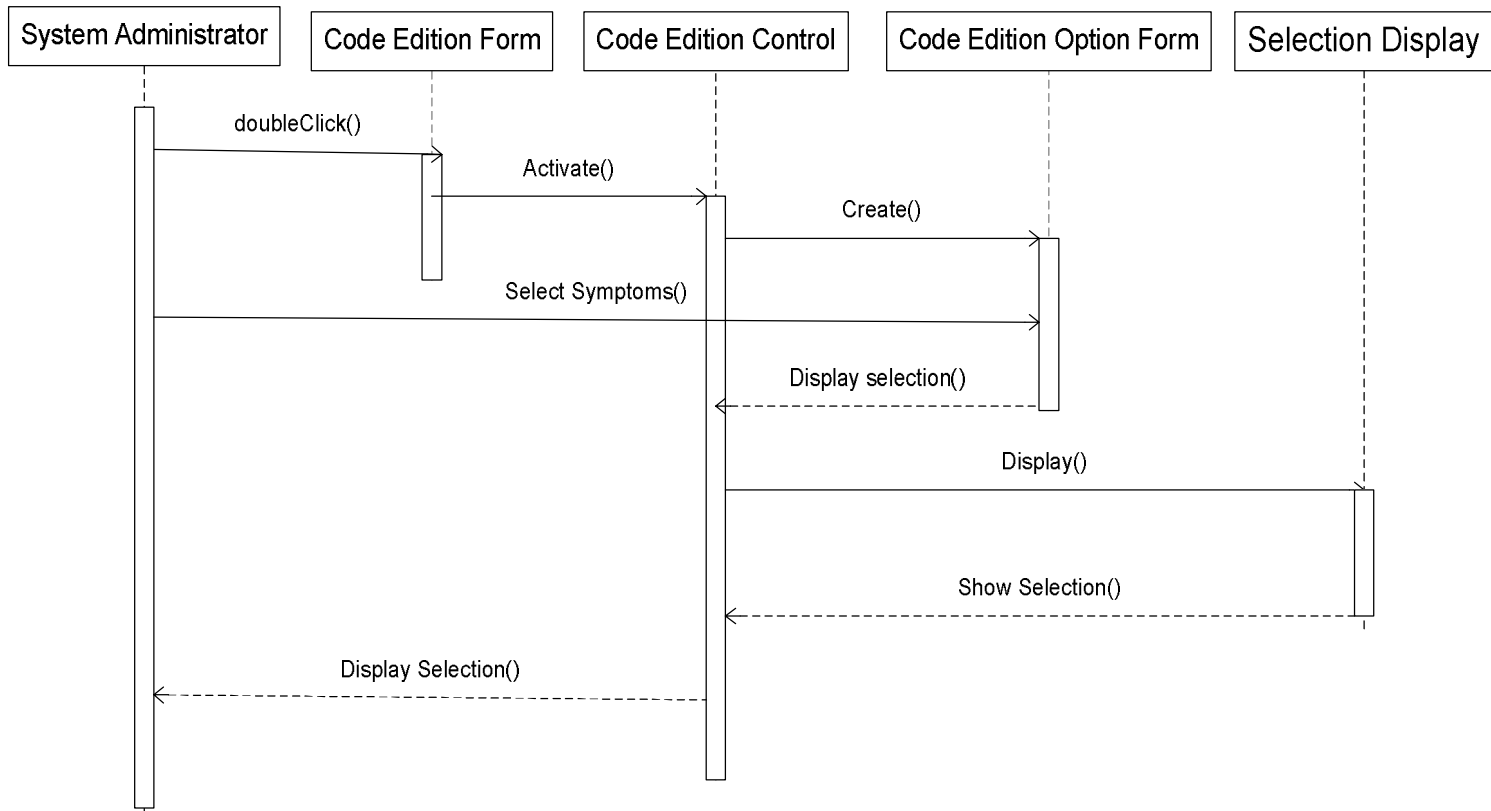


Figure 7.7: system Administrator Select symptom sequence diagram

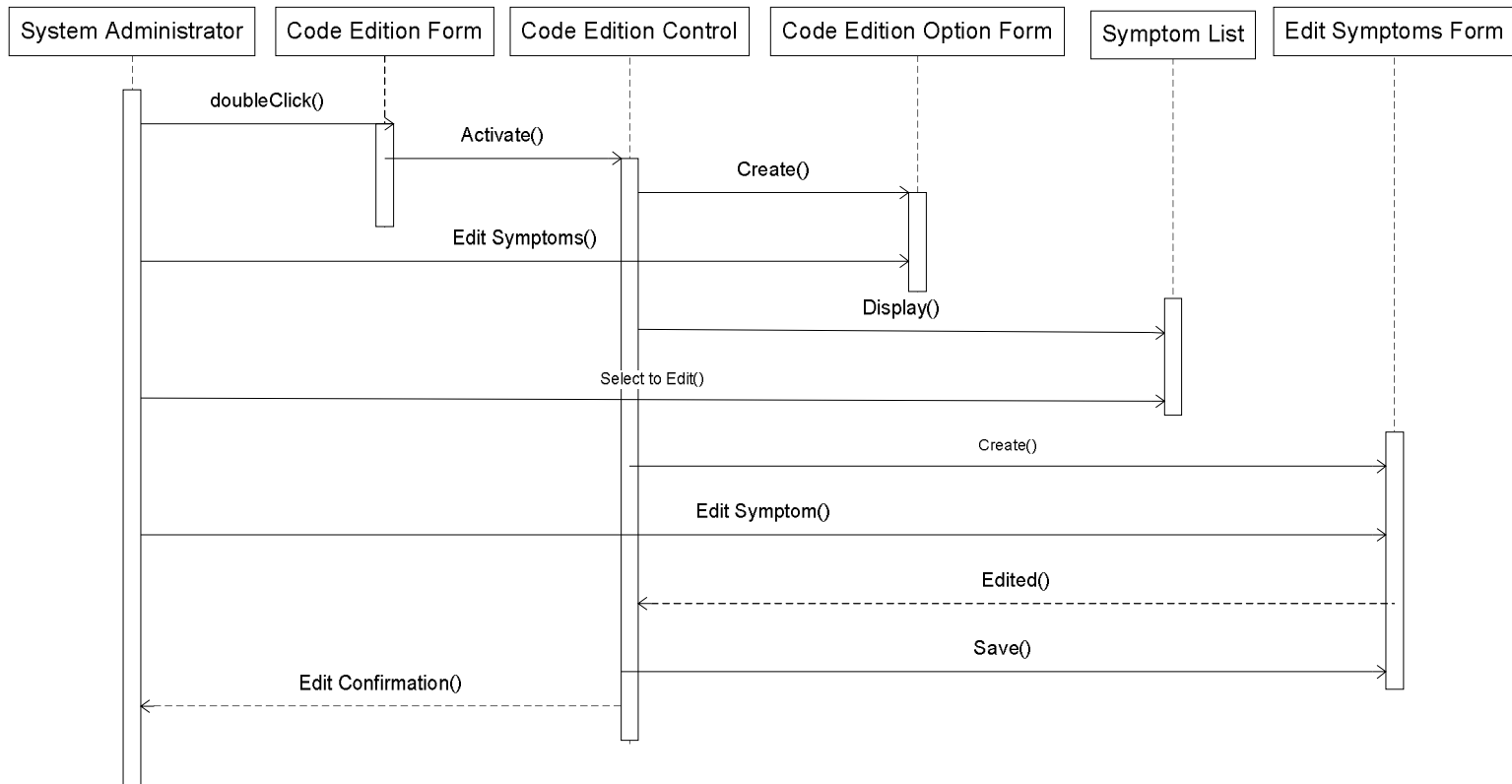


Figure 7.4: Edit symptom sequence diagram

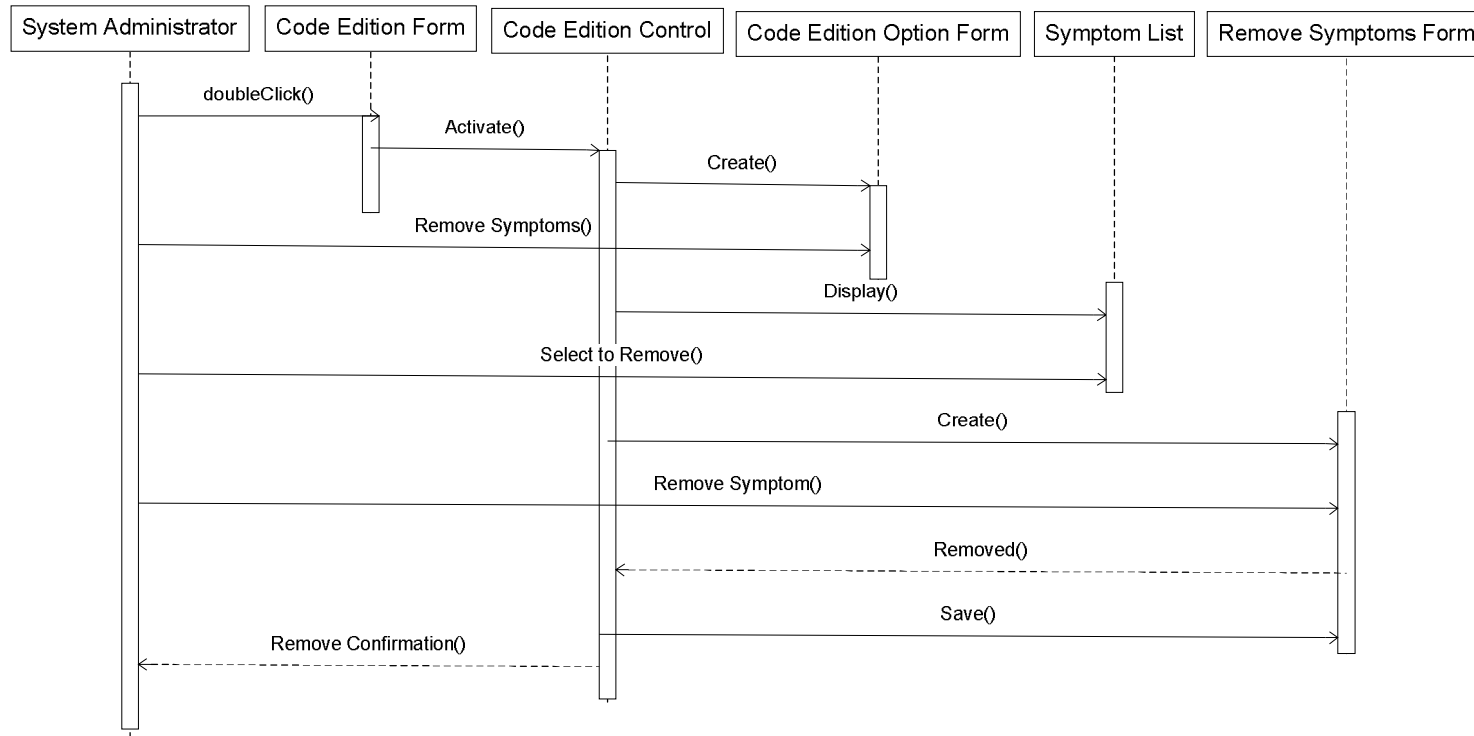


Figure 7.5: Remove symptom sequence diagram

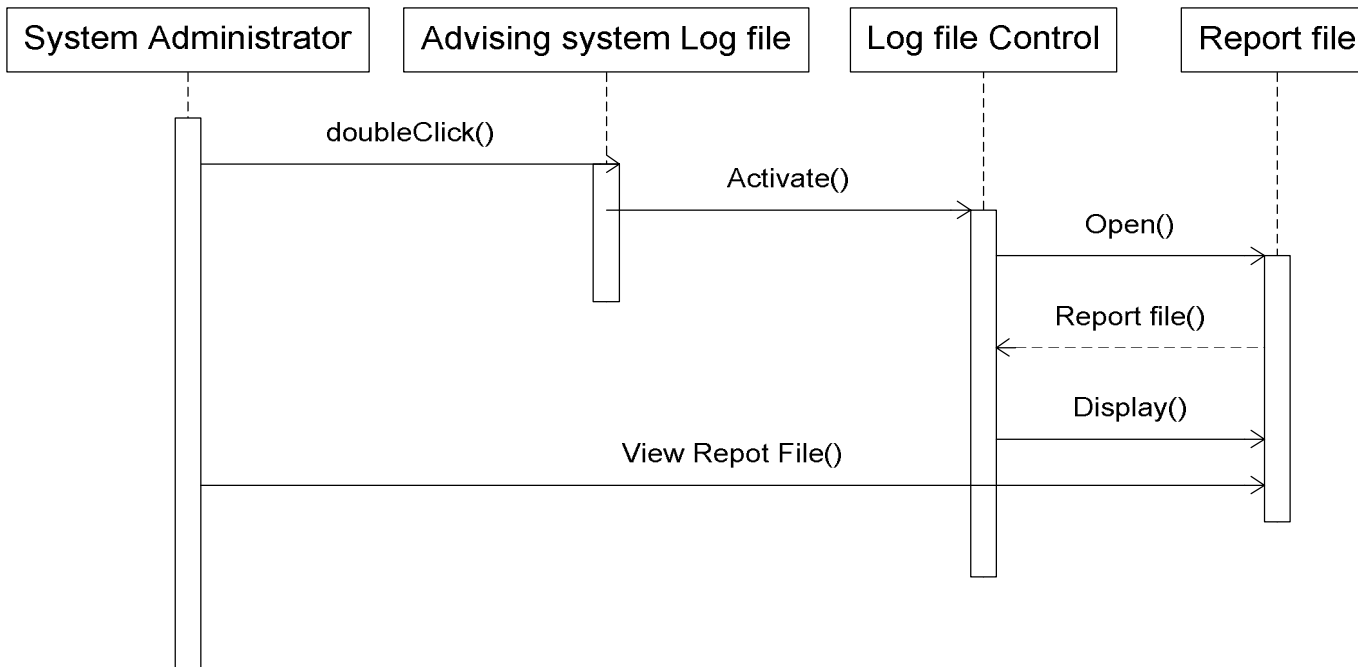


Figure 7.6: View Report sequence diagram

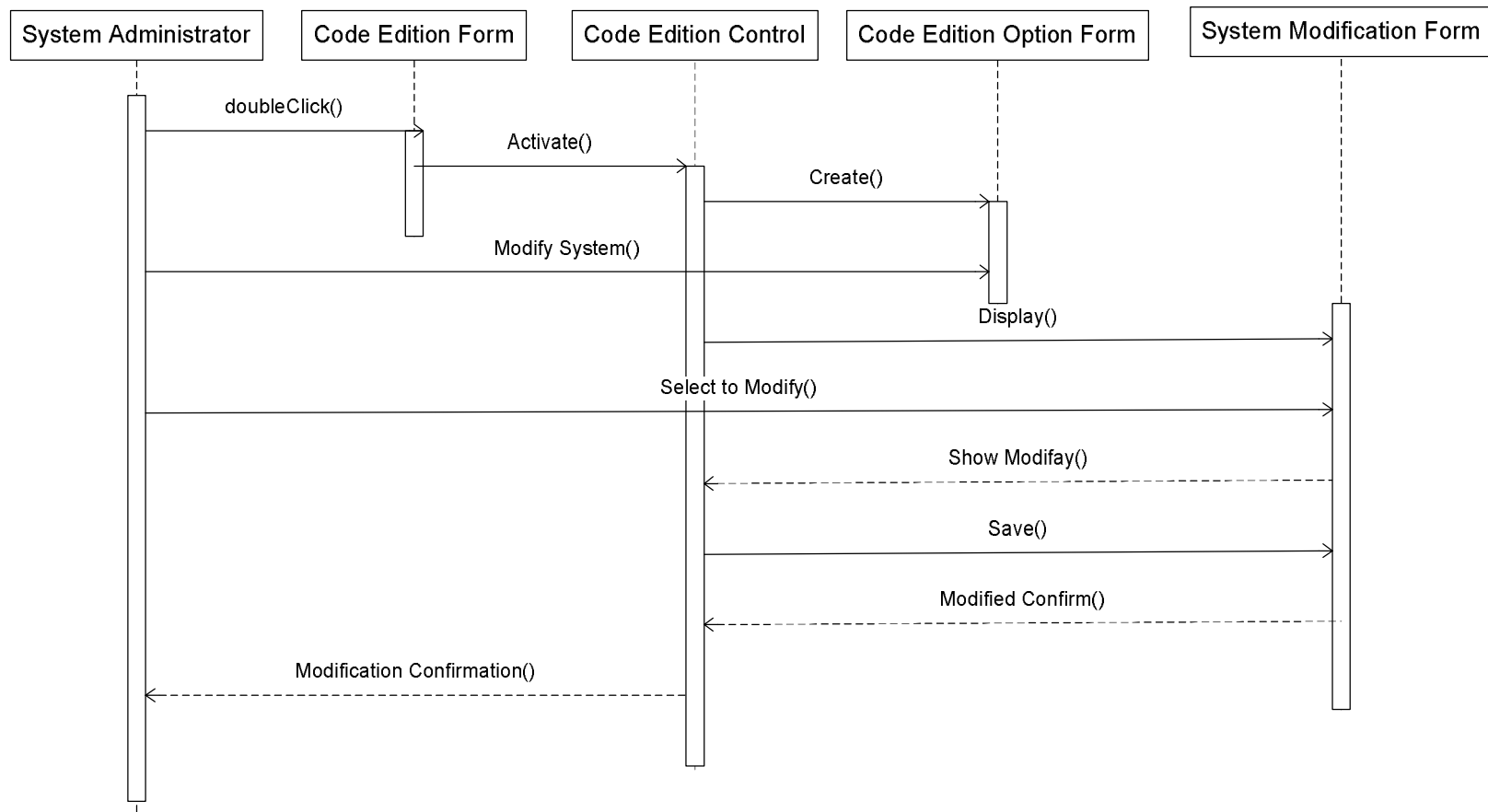


Figure 7.7: Modify System sequence diagram

Appendix B: sti Ontology

STI Ontology Owl file

```
<?xml version="1.0"?>
<rdf:RDF
  xmlns:sti="http://www.owl-ontologies.com/file1.owl#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:daml="http://www.daml.org/2001/03/daml+oil#"
  xml:base="http://www.owl-ontologies.com/stidisease.owl">
  <owl:Ontology rdf:about="">
    <owl:versionInfo rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Created with TopBraid Composer</owl:versionInfo>
  </owl:Ontology>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Doctor">
    <rdfs:subClassOf>
      <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Person"/>
    </rdfs:subClassOf>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Medical_Center">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Medical_Center</rdfs:label>
    <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Patient">
    <rdfs:subClassOf>
      <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Person"/>
    </rdfs:subClassOf>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Hospital">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Medical_Center</rdfs:label>
    <rdfs:subClassOf rdf:resource="http://www.owl-ontologies.com/file1.owl#Medical_Center"/>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#STI_Disease">
    <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Person">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Person_Name</rdfs:label>
    <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
  </owl:Class>
  <owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Clinic">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Medical_Center</rdfs:label>
    <rdfs:subClassOf rdf:resource="http://www.owl-ontologies.com/file1.owl#Medical_Center"/>
  </owl:Class>
</rdf:RDF>
```

```

</owl:Class>
<owl:Class rdf:about="http://www.owl-ontologies.com/file1.owl#Symptoms">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Symptom_Name</rdfs:label>
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
</owl:Class>
<owl:Class rdf:about="http://www.owl-
ontologies.com/file1.owl#Prevention_and_control">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Prevention_method</rdfs:label>
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
</owl:Class>
<owl:Class rdf:about="http://www.owl-
ontologies.com/file1.owl#Health_Center">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Medical_Center</rdfs:label>
  <rdfs:subClassOf rdf:resource="http://www.owl-
ontologies.com/file1.owl#Medical_Center"/>
</owl:Class>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#treats">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >treats</rdfs:label>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#is_symptoms_of">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >is_symptoms_os</rdfs:label>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#has_to_go_to">
  <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Medical_Center"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Patient"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >has_to_go_to</rdfs:label>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#has_to_do">
  <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Prevention_and_control"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Patient"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >has_to_do</rdfs:label>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#is_treated_by">
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
  <owl:inverseOf rdf:resource="http://www.owl-
ontologies.com/file1.owl#treats"/>
  <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Doctor"/>

```

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    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Patient"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>is_treated_by</rdfs:label>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#specialized_in">
    <owl:inverseOf rdf:resource="http://www.owl-
ontologies.com/file1.owl#is_treated_by"/>
    <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Doctor"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>specialized_in</rdfs:label>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#prevented_and_controlled_by">
    <owl:inverseOf>
      <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#prevents_and_controls"/>
    </owl:inverseOf>
    <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Prevention_and_control"/>
    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>prevented_and_controlled_by</rdfs:label>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#prevents_and_controls">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>prevents_and_controls</rdfs:label>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#is_victim_of">
    <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Patient"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>is_victim_of</rdfs:label>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#has_symptoms">
    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Patient"/>
    <owl:inverseOf rdf:resource="http://www.owl-
ontologies.com/file1.owl#is_symptoms_of"/>
    <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Symptoms"/>
    <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>has_symptoms</rdfs:label>

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</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#works_in">
  <rdfs:range rdf:resource="http://www.owl-
ontologies.com/file1.owl#Medical_Center"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Doctor"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>works_in</rdfs:label>
</owl:ObjectProperty>
<owl:DatatypeProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#MedicalCenterName">
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Medical_Center"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>MedicalCenterName</rdfs:label>
</owl:DatatypeProperty>
<owl:DatatypeProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#DiseaseName">
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#STI_Disease"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>DiseaseName</rdfs:label>
</owl:DatatypeProperty>
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ontologies.com/file1.owl#PersonName">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>PatientName</rdfs:label>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Person"/>
</owl:DatatypeProperty>
<owl:DatatypeProperty rdf:about="http://www.owl-
ontologies.com/file1.owl#DiseaseSymptomsName">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>DiseaseSymptoms</rdfs:label>
  <rdfs:domain rdf:resource="http://www.owl-
ontologies.com/file1.owl#Symptoms"/>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
</owl:DatatypeProperty>
<sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis">
  <sti:has_symptoms>
    <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Fishy_ouour_discharge">
      <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Fishy_ouour_discharge</sti:DiseaseSymptomsName>
      <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Fishy_ouour_discharge</rdfs:label>
    </sti:Symptoms>
  </sti:has_symptoms>
</sti:has_symptoms>

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    <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Vaginal_pain_and_ittiching">
      <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Vaginal_pain_and_ittiching</rdfs:label>
      <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Vaginal_pain_and_ittiching</sti:DiseaseSymptomsName>
    </sti:Symptoms>
  </sti:has_symptoms>
  <sti:has_symptoms>
    <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Pain_when_urinating">
      <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Pain_when_urinating</rdfs:label>
      <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Pain_when_urinating</sti:DiseaseSymptomsName>
    </sti:Symptoms>
  </sti:has_symptoms>
  <sti:DiseaseName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Bacterial_Vaginosis</sti:DiseaseName>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Bacterial_Vaginosis</rdfs:label>
</sti:STI_Disease>
  <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Sore_throat">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Sore_throat</rdfs:label>
    <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Sore_throat</sti:DiseaseSymptomsName>
  </sti:Symptoms>
  <sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Wondim">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Wondim </rdfs:label>
    <sti:is_victim_of>
      <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Genital_Herpes">
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Genital_Herpes</rdfs:label>
        <sti:has_symptoms>
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ontologies.com/file1.owl#Pain_in_legs_buttocks_or_genital_areas">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Pain_in_legs_buttocks_or_genital_areas</rdfs:label>
            <sti:DiseaseSymptomsName
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            >Pain_in_legs_buttocks_or_genital_areas</sti:DiseaseSymptomsName>
          </sti:Symptoms>
        </sti:has_symptoms>
        <sti:has_symptoms>
          <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Ulcer_on_genitals">

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        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Ulcer_on_genitals</rdfs:label>
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        >Ulcer_on_genitals</sti:DiseaseSymptomsName>
        </sti:Symptoms>
    </sti:has_symptoms>
    <sti:has_symptoms>
        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Crops">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Crops</rdfs:label>
            <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Crops</sti:DiseaseSymptomsName>
            </sti:Symptoms>
        </sti:has_symptoms>
    <sti:DiseaseName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Genital_Herpes</sti:DiseaseName>
    </sti:STI_Disease>
    </sti:is_victim_of>
    <sti:has_to_do>
        <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex">
            <sti:prevents_and_controls>
                <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B">
                    <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                    >Hepatitis_B</rdfs:label>
                    <sti:has_symptoms>
                        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Loss_of_appitite">
                            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                            >Loss_of_appitite</rdfs:label>
                            <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                            >Loss_of_appitite</sti:DiseaseSymptomsName>
                            </sti:Symptoms>
                        </sti:has_symptoms>
                    <sti:has_symptoms>
                        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Vomiting">
                            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                            >Vomiting</rdfs:label>
                            <sti:DiseaseSymptomsName
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                            >Vomiting</sti:DiseaseSymptomsName>
                            </sti:Symptoms>
                        </sti:has_symptoms>
                    </sti:has_symptoms>
                </sti:STI_Disease>
            </sti:prevents_and_controls>
        </sti:Prevention_and_control>
    </sti:has_to_do>

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        <sti:has_symptoms>
          <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Dark_colored_urine">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Dark_colored_urine</rdfs:label>
            <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Dark_colored_urine</sti:DiseaseSymptomsName>
          </sti:Symptoms>
        </sti:has_symptoms>
        <sti:has_symptoms>
          <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Headache_and_muscleache">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Headache_and_muscleache</rdfs:label>
            <sti:DiseaseSymptomsName
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            >Headache_and_muscleache</sti:DiseaseSymptomsName>
          </sti:Symptoms>
        </sti:has_symptoms>
        <sti:has_symptoms>
          <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Fever">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Fever</rdfs:label>
            <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Fever</sti:DiseaseSymptomsName>
          </sti:Symptoms>
        </sti:has_symptoms>
        <sti:DiseaseName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Hepatitis_B</sti:DiseaseName>
        </sti:STI_Disease>
        </sti:prevents_and_controls>
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Abstain_From_Sex</rdfs:label>
        <sti:prevents_and_controls>
          <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#HIVAIDS">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >HIVAIDS</rdfs:label>
            <sti:has_symptoms>
              <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Enlarge_lymphnodes">
                <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                >Enlarge_lymphnodes</rdfs:label>
                <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                >Enlarge_lympgnodes</sti:DiseaseSymptomsName>

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        </sti:Symptoms>
    </sti:has_symptoms>
    <sti:has_symptoms>
        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Weight_loss">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Weight_loss</rdfs:label>
            <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Weight_loss</sti:DiseaseSymptomsName>
        </sti:Symptoms>
    </sti:has_symptoms>
    <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Loss_of_appitite"/>
    <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Fever"/>
    <sti:DiseaseName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >HIVAIDS</sti:DiseaseName>
    </sti:STI_Disease>
</sti:prevents_and_controls>
    <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis"/>
    <sti:prevents_and_controls>
        <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Chlamydia">
            <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
            >Chlamydia</rdfs:label>
            <sti:has_symptoms>
                <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Pain_during_intercourse">
                    <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                    >Pain_during_intercourse</rdfs:label>
                    <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                    >Pain_during_intercourse</sti:DiseaseSymptomsName>
                </sti:Symptoms>
            </sti:has_symptoms>
            <sti:has_symptoms>
                <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Low_back_pain">
                    <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                    >Low_back_pain</rdfs:label>
                    <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                    >Low_back_pain</sti:DiseaseSymptomsName>
                </sti:Symptoms>
            </sti:has_symptoms>
            <sti:has_symptoms>
                <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Swelling_or_pain_in_testicles">

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        <rdfs:label
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        >Swelling_or_pain_in_testicles</rdfs:label>
        <sti:DiseaseSymptomsName
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        >Swelling_or_pain_in_testicles</sti:DiseaseSymptomsName>
        </sti:Symptoms>
        </sti:has_symptoms>
        <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Pain_when_urinating"/>
        <sti:has_symptoms>
        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Discharge_from_genitals">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Discharge_from_genitals</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Discharge_from_genitals</sti:DiseaseSymptomsName>
        </sti:Symptoms>
        </sti:has_symptoms>
        <sti:has_symptoms>
        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Lower_abdominal_pain">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Lower_abdominal_pain</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Lower_abdominal_pain</sti:DiseaseSymptomsName>
        </sti:Symptoms>
        </sti:has_symptoms>
        <sti:DiseaseName
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        >Chlamydia</sti:DiseaseName>
        </sti:STI_Disease>
        </sti:prevents_and_controls>
        <sti:prevents_and_controls>
        <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Trichomoniasis</rdfs:label>
        <sti:has_symptoms>
        <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Lesions_on_penis">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Lesions_on_penis</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Lesions_on_penis</sti:DiseaseSymptomsName>
        </sti:Symptoms>
        </sti:has_symptoms>

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    <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Vaginal_pain_and_ittiching"/>
    <sti:has_symptoms>
      <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Yellow_green_vaginal_discharge">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Yellow_green_vaginal_discharge</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Yellow_green_vaginal_discharge</sti:DiseaseSymptomsName>
      </sti:Symptoms>
    </sti:has_symptoms>
    <sti:has_symptoms>
      <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Excessive_foamy_diffuse">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Excessive_foamy_diffuse</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Excessive_foamy_diffuse</sti:DiseaseSymptomsName>
      </sti:Symptoms>
    </sti:has_symptoms>
    <sti:has_symptoms>
      <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Inflamation_of_urethra_glands_or_foreskin">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
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        <sti:DiseaseSymptomsName
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        >Inflamation_of_urethra_glands_or_forskin</sti:DiseaseSymptomsName>
      </sti:Symptoms>
    </sti:has_symptoms>
    <sti:DiseaseName
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    >Trichomoniasis</sti:DiseaseName>
  </sti:STI_Disease>
</sti:prevents_and_controls>
<sti:prevents_and_controls>
  <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Syphilis">
    <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Syphilis</rdfs:label>
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      <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Hair_loss">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Hair_loss</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"

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        >Hair_loss</sti:DiseaseSymptomsName>
    </sti:Symptoms>
</sti:has_symptoms>
<sti:has_symptoms>
    <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Skin_rash">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Skin_rash</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Skin_rash</sti:DiseaseSymptomsName>
    </sti:Symptoms>
</sti:has_symptoms>
<sti:has_symptoms>
    <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Swollen_lymph_glands">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Swollen_lymph_glands</rdfs:label>
        <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Swollen_lymph_glands</sti:DiseaseSymptomsName>
    </sti:Symptoms>
</sti:has_symptoms>
    <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Sore_throat"/>
    <sti:DiseaseName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Syphilis</sti:DiseaseName>
</sti:STI_Disease>
</sti:prevents_and_controls>
<sti:prevents_and_controls>
    <sti:STI_Disease rdf:about="http://www.owl-
ontologies.com/file1.owl#Gonorrhoea">
        <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Gonorrhoea</rdfs:label>
        <sti:has_symptoms>
            <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Yellowish_genital_discharge">
                <rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                >Yellowish_genital_discharge</rdfs:label>
                <sti:DiseaseSymptomsName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
                >Yellowish_genital_discharge</sti:DiseaseSymptomsName>
            </sti:Symptoms>
</sti:has_symptoms>
            <sti:has_symptoms rdf:resource="http://www.owl-
ontologies.com/file1.owl#Pain_when_urinating"/>
            <sti:has_symptoms>
                <sti:Symptoms rdf:about="http://www.owl-
ontologies.com/file1.owl#Bleeding_between_menstrual">

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        <rdfs:label
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        >Bleeding_between_menustreal</rdfs:label>
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        >Bleeding_between_menustreal</sti:DiseaseSymptomsName>
        </sti:Symptoms>
        </sti:has_symptoms>
        <sti:DiseaseName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Gonorrhoea</sti:DiseaseName>
        </sti:STI_Disease>
        </sti:prevents_and_controls>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Genital_Herpes"/>
        </sti:Prevention_and_control>
        </sti:has_to_do>
        <sti:has_to_do>
        <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms">
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Chlamydia"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Syphilis"/>
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Use_latex_condoms</rdfs:label>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Genital_Herpes"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Gonorrhoea"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
        </sti:Prevention_and_control>
        </sti:has_to_do>
        <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Wondim</sti:PersonName>
        </sti:Patient>
        <sti:Hospital rdf:about="http://www.owl-
ontologies.com/file1.owl#St_Paulos_Hospital">
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >St_Paulos_Hospital</rdfs:label>
        <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >St_Paulos_Hospital</sti:MedicalCenterName>
        </sti:Hospital>
        <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Vaccination">
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>

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    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Vaccination</rdfs:label>
  </sti:Prevention_and_control>
  <sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Jalata">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Jalata</rdfs:label>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
    <sti:has_to_do>
      <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Avoid_non_sexual_physical_contact_with_infectious_so
res">
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Syphilis"/>
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Avoid_non_sexual_physical_contact_with_infectious_sores</rdfs:label>
      </sti:Prevention_and_control>
    </sti:has_to_do>
    <sti:has_to_do>
      <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Avoid_sharing_of_drug_needles">
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
        <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
        <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
        >Avoid_sharing_of_drug_needles</rdfs:label>
      </sti:Prevention_and_control>
    </sti:has_to_do>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
    <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Jalata</sti:PersonName>
  </sti:Patient>
  <sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Wosen">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Wosen</rdfs:label>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Avoid_sharing_of_drug_needles"/>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Vaccination"/>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
    <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Wosen</sti:PersonName>

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</sti:Patient>
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ontologies.com/file1.owl#Woreda8_Health_center">
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  >Woreda8_Health_center</rdfs:label>
  <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Woreda8_Health_center</sti:MedicalCenterName>
</sti:Health_Center>
<sti:Hospital rdf:about="http://www.owl-
ontologies.com/file1.owl#Zewditu_Hospital">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Zewditu_Hospital</rdfs:label>
  <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Zewditu_Hospital</sti:MedicalCenterName>
</sti:Hospital>
<sti:Hospital rdf:about="http://www.owl-
ontologies.com/file1.owl#Balcha_Hospital">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Balcha_Hospital</rdfs:label>
  <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Balcha_Hospital</sti:MedicalCenterName>
</sti:Hospital>
<sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Yahya">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Dr_Yahya</rdfs:label>
  <sti:works_in>
    <sti:Hospital rdf:about="http://www.owl-
ontologies.com/file1.owl#Tikur_Anbesa_Hospital">
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      >Tikur_Anbesa_Hospital</rdfs:label>
      <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >Tikur_Anbesa_Hospital</sti:MedicalCenterName>
    </sti:Hospital>
  </sti:works_in>
  <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Syphilis"/>
  <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Syphilis"/>
  <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Dr_Yahaya</sti:PersonName>
</sti:Doctor>
<sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Ibsa">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Ibsa</rdfs:label>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Avoid_non_sexual_physical_contact_with_infectious_so
res"/>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>

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    <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Syphilis"/>
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    >Ibsa</sti:PersonName>
  </sti:Patient>
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ontologies.com/file1.owl#Ejersa_Goro_Clinic">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Ejersa_Goro_Clinic</rdfs:label>
    <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Ejersa_Goro_Clinic</sti:MedicalCenterName>
  </sti:Clinic>
  <sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Dessie">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dessie</rdfs:label>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
    <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Chlamydia"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dessie</sti:PersonName>
  </sti:Patient>
  <sti:Health_Center rdf:about="http://www.owl-
ontologies.com/file1.owl#Arada_Health_Center">
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    >Arada_Health_Center</rdfs:label>
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rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Arada_Health_Center</sti:MedicalCenterName>
  </sti:Health_Center>
  <sti:Hospital rdf:about="http://www.owl-
ontologies.com/file1.owl#Alert_Hospital">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Alert_Hospital</rdfs:label>
    <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Alert_Hospital</sti:MedicalCenterName>
  </sti:Hospital>
  <sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Emabet">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Emabet</rdfs:label>
    <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Balcha_Hospital"/>
    <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
    <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Hepatitis_B"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Emabet</sti:PersonName>
  </sti:Doctor>
  <sti:Doctor rdf:about="http://www.owl-
ontologies.com/file1.owl#Dr_Yirgalem">

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    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Yirgalem</rdfs:label>
    <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Zewditu_Hospital"/>
    <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis"/>
    <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Yirgalem</sti:PersonName>
  </sti:Doctor>
  <sti:Prevention_and_control rdf:about="http://www.owl-
ontologies.com/file1.owl#Avoid_sharing_of_towells_and_wash_cloths">
    <sti:prevents_and_controls rdf:resource="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis"/>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Avoid_sharing_of_towells_and_wash_cloths</rdfs:label>
  </sti:Prevention_and_control>
  <sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Muna">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Muna</rdfs:label>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
    <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
    <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Gonorrhoea"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Muna</sti:PersonName>
  </sti:Patient>
  <sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Belay">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Belay</rdfs:label>
    <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Arada_Health_Center"/>
    <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Genital_Herpes"/>
    <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Genital_Herpes"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Belay</sti:PersonName>
  </sti:Doctor>
  <sti:Clinic rdf:about="http://www.owl-
ontologies.com/file1.owl#Addis_Zemen_Clinic">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Addis_Zemen_Clinic</rdfs:label>
    <sti:MedicalCenterName
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Addis_Zemen_Clinic</sti:MedicalCenterName>
  </sti:Clinic>
  <sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Caala">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Caala</rdfs:label>
    <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Alert_Hospital"/>

```

```

    <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Gonorrhoea"/>
    <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Gonorrhoea"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Dr_Caala</sti:PersonName>
</sti:Doctor>
<sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Kurat">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Kurat</rdfs:label>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
  <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis"/>
  <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Kurat</sti:PersonName>
</sti:Patient>
<sti:Patient rdf:about="http://www.owl-ontologies.com/file1.owl#Abdi">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Abdi</rdfs:label>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Avoid_sharing_of_towells_and_wash_cloths"/>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Use_latex_condoms"/>
  <sti:has_to_do rdf:resource="http://www.owl-
ontologies.com/file1.owl#Abstain_From_Sex"/>
  <sti:is_victim_of rdf:resource="http://www.owl-
ontologies.com/file1.owl#Trichomoniasis"/>
  <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Abdi</sti:PersonName>
</sti:Patient>
<sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Alemu">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Dr_Alemu</rdfs:label>
  <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Addis_Zemen_Clinic"/>
  <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis"/>
  <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Bacterial_Vaginosis"/>
  <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Dr_Alemu</sti:PersonName>
</sti:Doctor>
<sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Leyla">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Dr_Leyla</rdfs:label>
  <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#St_Paulos_Hospital"/>
  <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
  <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#HIVAIDS"/>
  <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"

```

```

    >Dr_Layla</sti:PersonName>
  </sti:Doctor>
  <sti:Doctor rdf:about="http://www.owl-ontologies.com/file1.owl#Dr_Amade">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Amade</rdfs:label>
    <sti:works_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Ejersa_Goro_Clinic"/>
    <sti:treats rdf:resource="http://www.owl-
ontologies.com/file1.owl#Chlamydia"/>
    <sti:specialized_in rdf:resource="http://www.owl-
ontologies.com/file1.owl#Chlamydia"/>
    <sti:PersonName rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Dr_Amade</sti:PersonName>
  </sti:Doctor>
</rdf:RDF>

```

```
<!-- Created with TopBraid Composer -->
```

STI Rule file

```

@prefix sti:<http://www.owl-ontologies.com/file1.owl#>
@prefix owl:<http://www.w3.org/2002/07/owl#>
@prefix rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs:<http://www.w3.org/2000/01/rdf-schema#>

```

```
#@include<OWL>
```

```
[rule 1: (?x sti:specialised_in ?y)
  (?z sti:is_victim_of ?y)
  -> (?x sti:treats ?z)]
```

```
[rule 2: (?z sti:is_victim_of ?x)
  (?z sti:is_treated_by ?y)
  -> (?y sti:specialised_in ?x)]
```

```
[rule 3: (?y sti:specialised_in ?x)
  (?z sti:is_treated_by ?y)
  -> (?z sti:is_victim_of ?x)]
```

```
[rule 4: (?z sti:is_victim_of ?y)
  (?x sti:specialised_in ?y)
  (?y sti:works_in ?w)
  -> (?z sti:has_to_go_to ?w)]
```

```
[rule 5: (?x sti:has_symptoms ?y)
  (?y sti:is_symptoms_of ?z)
  -> (?x sti:is_victim_of ?y)]
```

```
[rule 6: (?x sti:is_victim_of ?y)
  (?y sti:prevented_and_controlled_by ?y)
  -> (?x sti:has_to_do ?y)]
```

```
[rule 7: (?z sti:has_Symptoms ?s)
```

```
(?s sti:is_Symptoms_of ?y)
(?x sti:specialised_in ?y)
-> (?z sti:is_treated_by ?x)]
```