OBSERVATORY SYSTEM FOR MONITORING HEPATITIS C DEVELOPMENT IN NIGERIA

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ABSTRACT

Hepatitis C development is a public health concern globally; hence eliminating it has become a major public health goal by various countries. In Nigeria, monitoring Hepatitis C development with the view to eliminate it has faced several challenges such as lack of central national database on the virus, inadequate health intelligence and surveillance systems to monitor and control the incidences and prevalence of disease, manual system of health records collection, storage and access by majority of health care providers, and lack of synchronized records of existing and newly diagnosed patients. The aim of this project is to design and develop an observatory system for monitoring Hepatitis C development in Nigeria. The system will serve as a decision making tool for health care professionals for decisions regarding individual patient management, as well as public health professionals and the general public to enhance the development of public health policies and strategies.

Key words: Hepatitis C; Observatory; Health Information Systems; Public Health Observatory; Medical Observatory System; Decision Support System

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CHAPTER ONE: INTRODUCTION

1.0. Introduction

Hepatitis C Virus (HCV) has been recognized worldwide as a public health challenge due to its effect on morbidity and mortality rates. HCV is a virus infection which is now the leading cause of liver-related diseases such as Liver cancer, cirrhosis, liver failure/transplants and death in the general population as well as death among HIV infected persons (Kumar et al, 2010).

In fighting any infectious disease such as HCV, there are three possible routes that can be taken: eradication (worldwide permanent and complete reduction of incidence to zero), elimination (localized reduction or incidence to zero due to concerted efforts), and control (localized reduction in prevalence, incidence, mortality and morbidity to an acceptable level). In the case of Hepatitis C, the goal is to eliminate the disease to various levels at different geographical locals worldwide.

Since an antiviral treatment already exists for Hepatitis C, Wiktor & Huttin (2016) stresses the need for more accurate and reliable data on HCV to enable formulation of policies to help eliminate HCV as a public health concern. To this end, the 69th World Health Assembly in its Global Health Sector Strategy on Viral Hepatitis 2016–2021 (WHO, 2016), plans to eliminate the public health concern of viral Hepatitis through various strategy directions, first of which is ‘Information for Focused Action’. The strategy direction emphasizes the need for “a robust strategic information system that analyses and translates up to date data on viral hepatitis into usable information …” to enable unified data for better understanding of the disease and ensure informed national, regional and global hepatitis surveillance, monitoring, evaluation and policy making to halting the spread and effects of the disease (Pg. 25 – 28).

According to the WHO (2016) report, few countries have national hepatitis strategies, plans and budgets, and a health information system to monitor the disease. In Nigeria, there is no national program hence no unified country-wide data on Hepatitis C prevalence (Maisanda et al, 2018). This is mostly due to isolated and mostly manual data collection and storage by health care institutions and professionals, lack of up-to-date health records of new and existing patients, as well as the large size of the Nigerian population compared to available health care providers.

The project aims at developing an observatory system for online collection and processing of health data, and access functionalities with information visualization to aid and influence the formulation of policies in the healthcare system in Nigeria.

1.1. Problem Statement

About 130 – 15 million people have Hepatitis C virus worldwide, with West Africa, Central and East Asia, as well as North Africa having the highest casualty figures (WHO Global Health Sector Strategy on Viral Hepatitis 2016–2021, 2016). This prevalence figure is on the increase despite the availability of Hepatitis C cure. Nigeria being a West African nation has a prevalence rate of 0.5% to 15% based on the geographical region (Maisanda, 2018).

Monitoring Hepatitis C development in Nigeria faces challenges such as:

- Lack of central National database on the virus

- Inadequate health intelligence and surveillance systems to monitor and control the incidences and prevalence of disease (Welcome, 2011)
- Manual system of health records collection, storage and access by majority of health care providers
- Lack of synchronized records of existing and newly diagnosed patients

1.2. Project Goal

The goal of the project is to develop an observatory information system for online collection and processing of health data, and access functionalities with information visualization to aid and influence clinical decision making, monitoring of trends as well as the formulation of policies in the healthcare system in Nigeria with special emphasis on HCV.

1.3. Project Objectives

- Study current Information system on HCV monitoring in Nigeria
- Data collection
- Determine system requirements
- Design and Implement the Information system
    - Web portal
    - Data querying and visualization (using charts and/or maps)
- Develop a comprehensive system manual

1.4. Project Motivation

Hepatitis C has become a global public health burden due to its impact on the wellbeing (the mortality and morbidity) of people, its high prevalence rate as well as the increase in the epidemic despite an existing medical solution. In addition, many countries Nigeria included do not have a national strategy and an information system for monitor the spread, advocacy for healthier living as well as response to treatment options.

It has therefore become imperative to develop a medical observatory system to enable proper data collection and monitoring of HCV in Nigeria.

1.5. Expected Outcome

An information system for online collection and processing of health data, and access functionalities with information visualization.

Drupal Content Management System is expected to be used with a dedicated website that will be provided.

Security control to the system is of high importance, hence there will be various levels of access including the administrator who has full access to the system, and who can create users. User groups with various access levels will be determined based on the system requirements gathered.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

A lot of work has been done by several researchers on various aspects of the subject matter. As such, this chapter gives a detailed literature review on the subject of Observatory Systems for monitoring Hepatitis C Development in Nigeria. The chapter is broken down into conceptual framework and Empirical review.

Conceptual Framework

In this section, various concepts related to the subject matter are discussed making references to published literature. These concepts are hepatitis, hepatitis C, Hepatitis C in Nigeria, Information Systems, Decision Support Systems, Health Systems (Public Health versus Medical Systems), Health Information Systems, Observatory, Public Health Observatory, Medical Observatory systems, Health Indicators, Data Visualization and Content Management System.

2.1 Hepatitis

Hepatitis is a liver disease resulting from infection of the liver cells by the hepatitis virus. There are 5 hepatitis viruses: hepatitis A, B, C, D and E (HAV, HBV, HCV, HDV and HEV) varying in morphology, replication strategy and genomic organization. The viruses manifest in similar manners in infected persons during the stage of acute infection, however, they have different abilities to cause chronic disease (Kumar et al, 2010). This thesis focuses on the HCV virus.

2.2 Hepatitis C

Discovered in 1989, the HCV is estimated to affect 170 million people worldwide, with 4 million new cases every year (Ya'aba et al, 2015). HCV is a major public health concern because majority of the infected persons are not aware of their infection, neither have they been tested hence may live with it for many years leading to chronic infection of the liver.

Although HCV can be cleared naturally, persistent infection of an individual with the virus can cause chronic infections leading to cirrhosis and liver cancer - Hepatocellular carcinoma (HCC). According to Axley et al (2018), about 20% of people with chronic HCV infections progress to cirrhosis within 20 – 30 years, and 1% to 4% of these individuals develop HCC if they have the viral genotype, obesity, diabetes and concurrent liver disease among other factors such as lifestyle.

HCV is transmitted through the exposure to the blood of an infected person, and its prevalence varies by geographical location, ethnicity and age group. A treatment has been developed for HCV but it is very expensive.

2.3 Hepatitis C in Nigeria

In Nigeria, majority of HCV patients discover their status when required to be tested for the disease during blood donation, pregnancy, before surgery or when receiving treatment for HIV. As such, Ya'aba et al (2015) states that the prevalence rate of HCV in Nigerian populace based on mode of discovery indicates that 2.1% in the general population, 3.6 – 8.0% among blood donors, 8.2% among HIV infected persons, and 5.1% among the high risk population.

It was reported in Chan et al (2017), that in 2013, experts agreed that about 10% of HCV patients in Nigeria were infected through blood transfusion while 1% were active injection drug users.

Accurate comprehensive national data on the prevalence of Hepatitis C in Nigeria does not exist. However, several attempts have been made to study prevalence in select geographical locations by various researchers. After review of 85 publications (grey literature and peer reviewed), Maisanda & Manfred (2018) reports that the prevalence of hepatitis C in Nigeria which is very high at 7% to 15% is dependent on many factors prominent of which are tradition and cultural practices. Due to such practices as circumcision, tribal marks and drinking from the same cup, the North-central Nigeria (Benue, Nasarawa, Plateau, Kogi, Abuja) has the highest prevalence rate of between 0.7% to 15% in the country. The South-South zone has a prevalence rate similar to the North-central, except for states of Imo, Rivers and Bayelsa with 0.7%, 0.5% and 0.5% respectively which have the lowest prevalence rate nationwide.

2.4 Information System

An information system (IS) is a set of processes that is applied to organizational data which enables data capturing, storage, processing and distribution of information relevant for organization’s operations, control and management activities (Alcamí & Carañana, 2012). The purpose of an IS is to ensure that information is delivered to stakeholders to support decision making; strategic control, evaluation and monitoring, as well as implementation of adopted decisions in an efficient and effective manner to meet organization’s goals and objectives.

An information system is composed of software and hardware, human resources (people), procedures, databases and telecommunications (García, 2000).

Alcamí & Carañana (2012) gives four categories of an IS: Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS) and Executive Information Systems (EIS). This categorization is based on the information needs of the organization. The category of interest in this study is the MIS with DSS Capabilities.

2.5 Decision Support Systems (DSS)

A DSS enhances efficient and accurate decision making process by providing interactive access to relevant data and decision support tools such as ad hoc queries, reporting tools, simulation models, data visualization and data mining, as well as Online Analytical Processing (OLAP).

2.6 Health Systems

Health systems encompass people, institutions/organizations, infrastructure/resources and actions (i.e. efforts in both public health services , personal/medical health care or both aimed at promoting good health) which exist to promote, restore and ensure/maintain the health of a population.

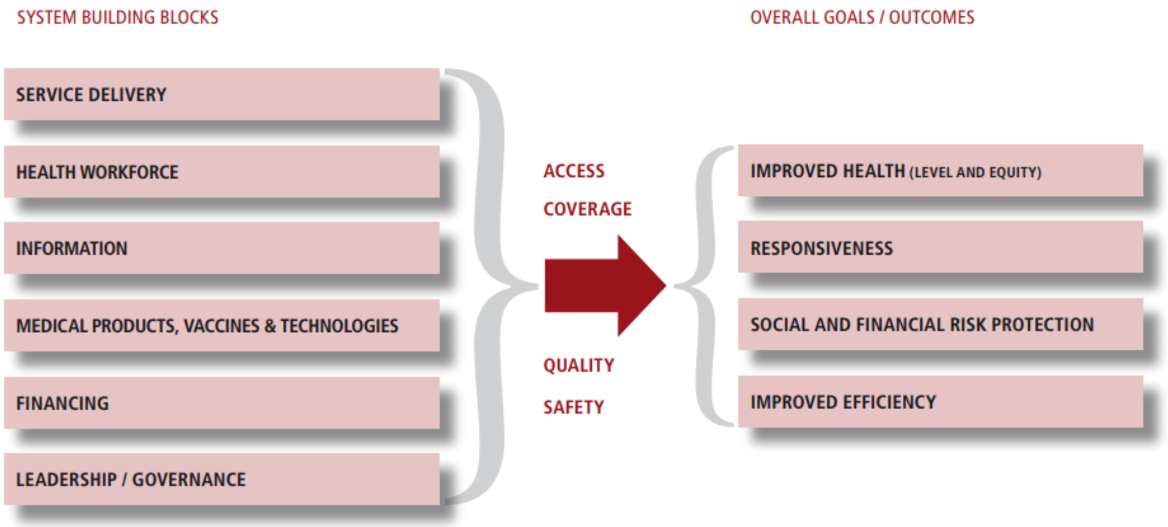
The WHO Framework (2007) identifies six building blocks of a health system as shown in figure 1 below.

It is important to differentiate between public health systems and medical or personal health care systems. Public health systems are population based while medical systems are individual based (Lurie & Fremont, 2009).

2.6.1 Public Health Systems Versus Medical Systems

According to Fineberg (2011), Public health systems refer to health systems focused on preventing and controlling as well as promoting health at the community and population level; while, Medical systems refer to health systems geared towards individual health care with regards to attending to patients with known diseases by averting complications among them to optimize the outcomes.

Figure 1: The WHO Health System Building Blocks



Source: WHO (2007)

Public Health system deals with health from the perspective of population.

Medical systems include health facilities such as hospitals, clinics and tertiary health centres at the national and sub-national levels, and they focus on collecting, storing and processing electronic data about patients—including personal information, medical histories (including hospital visits, patient complaints, diagnosis, prescriptions, etc), health status, test results, medical images, prescriptions, DNA sequences, referrals and many other individual patient data generated at health centers.

2.7 Health Information Systems

HIS is an IS that produces, analyses, disseminates and uses information on health system performance, health determinants (such as genetics, where we live, education, and income), and health status effectively and efficiently to foster individual health as well as expected health outcomes of the health system WHO Framework (2007).

2.8 Observatory

Observatories were originally installations, buildings or institutions used in astronomy for observing celestial objects. However, the concept of observatories has expanded to other areas of human endeavor such as health, security, crime, violence, etc. An observatory can either be an institution or a platform such as a web portal, and it varies in the focus area, geographical coverage, as well as organizational and functional structures.

Observatory refers to any specialized or thematic databank, information repository and knowledge-building hub which collects data from a variety of primary sources of socio-demographic information for advanced analysis using core indicators to support decision-making and research processes (Jabar, 2017). An observatory which is an Information system is not a replica or replacement of the subject-matter information system, but integrates the functions and content of these systems to develop more comprehensive, accurate, and coherent overview applying decision support concepts to the data for effective data analytics using data visualization tools. Observatories help to identify gaps in subject-matter information, and improvements in information systems.

The Observatory comprises of a web portal, a data/statistics platform, access to subject area publications, collection of analytical profiles and networking (Gattini, 2009).

The basic functions of an observatory are: i) gathering subject-matter (e.g health, crime, violence, etc) related population and/or institution-based data; ii) processing the collected data as indicators; iii) interpreting the results in the context needed and; iv) disseminating the results through data visualization in the form of digital and printed media (e.g bulletins and infographics), open access datasets and informative documents to relevant stakeholders at both regional, national, institutional and individual levels.

Examples of observatories for various specific areas are: i) Violence and Security: Juarez municipal violence and injury observatory in Mexico (Jabar, 2017); ii) Health: Eastern Mediterranean Regional Health System Observatory (Pourmalek, 2012), The African Health Observatory – AHO (WHO, 2016).

With focus on Health observatory (HO), HO's can be discussed from two aspects: public health observatories; and medical observatory system.

2.9 Public Health Observatory

The general understanding of health observatory is with regards to public health, hence 'Public Health Observatory'. Gattini (2009) defines Public health observatory (PHO) as a virtual-based policy-oriented location-based center designed to carry out ongoing and systematic observation on important aspects of health systems and public health so as to support effective and efficient evidence-based decision-making, policy, planning and implementation of decisions in public health as well as health systems. The primary goal of the public health observatory is to ensure the well-being of the population of the society of interest by providing intelligent information base through relevant reporting tools for policy makers and other key stakeholders. It assists in monitoring and evaluation; alert and early warning functionalities; patient and health institution administration; public health development planning; stimulating and supporting research; public health trends analysis; user-centered / friendly reporting; and communication information to multiple users including health-care data producers, consumers and decision makers (i.e. planners, policy-makers, health-care providers, managers, individuals and communities) in formats each user understands (Hemmings, 2003).

Current PHO's tend to be specific and focus on some key public health areas, such as: inequalities in health, gender inequalities in health, public health, health systems, public health surveillance, health determinants, natural disasters, health sector reforms and human resources (Gattini, 2009).

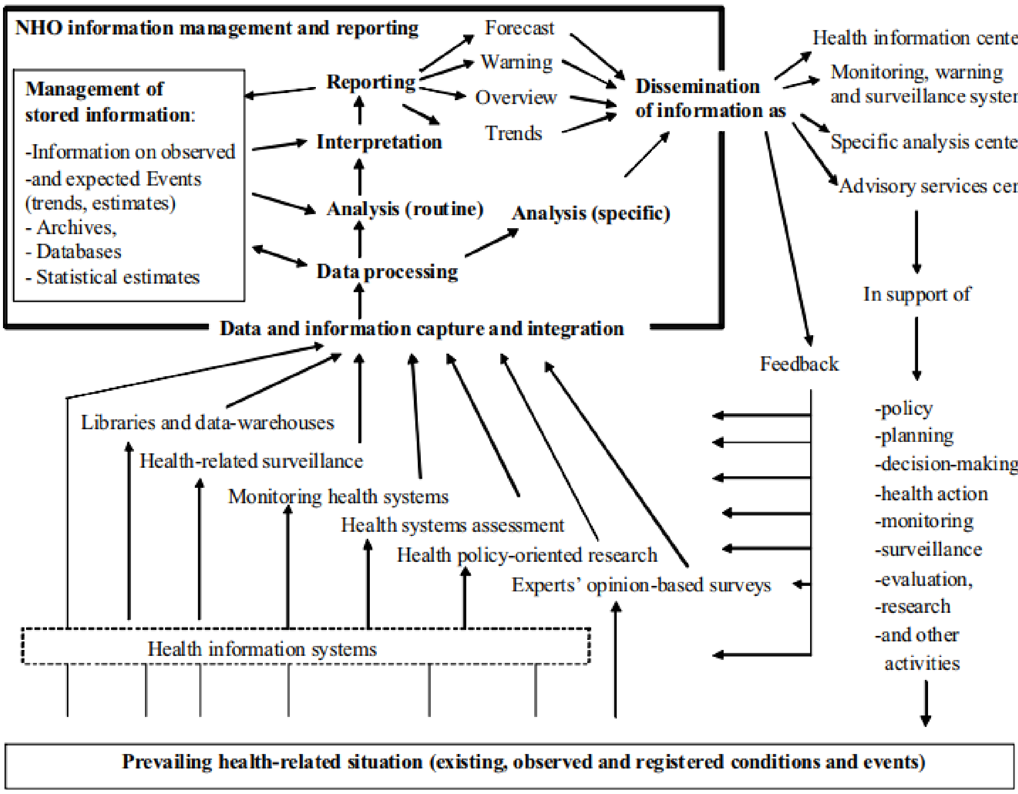
2.9.1 National Public Health Observatory (NPHO)

An NPHO as the name implies has a country-wide coverage on general range of public health issues or specific thematic area of health such as hepatitis. Based on the function and capacity, any properly implemented National Public Health observatory can simultaneously serve as a platform for monitoring health systems; public health surveillance; specialized analysis of related health-policy matters; public health warning system; production and management of health information; as well as policy-oriented recommendations (Gattini, 2009).

An overview of the National Public Health Observatory in relation to information management and its functions is shown in Fig 2 below.

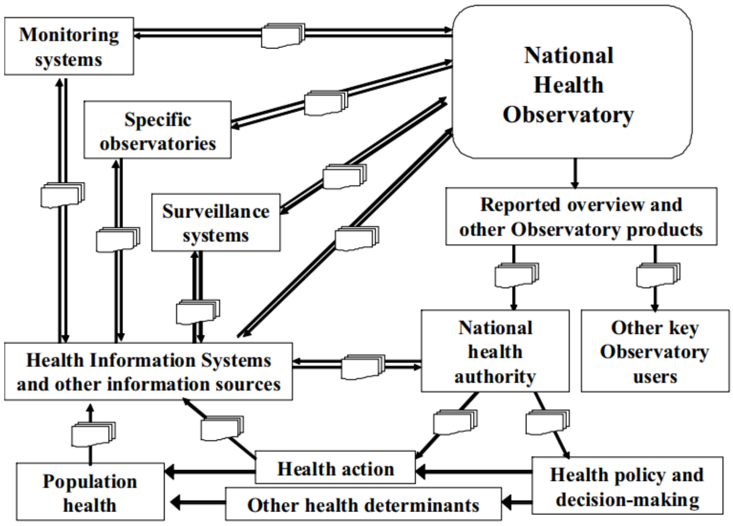
An implementation of a NPHO with regards to its data interaction with various users is shown in figure 3 below.

Figure 2: Information sources and management and Observatory functions



`Source: Gattini (2009)

Figure 3: Implementation of a National Public Health Observatory



Source: Gattini (2009)

2.9.2 Examples of Public Health Observatories

Public Health Observatories vary in different aspects such as geographic coverage, organizational and functional structure with each focusing on specific or generic thematic areas such as Hepatitis C, Malaria,Urban Health, Health research, etc.

Example of PHO's on thematic areas are:

i) Urban Health observatories like the London Health Observatory (LHO), in London, England (Caiaffa et al, 2014);
ii) National Human Resources for Health Observatory in Sudan (Pourmalek, 2012); and
iii) The Brazilian Observatory on Health Inequities – BOHI (Gattini, 2009).

Example of PHO's based on geographical coverage (global, regional, national and sub-national) are:

i) Global HO's e.g. Global Health Observatory (WHO, 2016) and Polaris Observatory (Polaris Observatory HCV Collaborators, 2017).

ii) Regional HO's e.g.: the African Health Observatory – AHO (WHO, 2016) and the Eastern Mediterranean Regional Health System Observatory (Pourmalek, 2012);

iii) National HO's e.g. National Health Research Observatory (NHRO) in South Africa (Jeenah et al, 2016), and HO's in France and Switzerland (Pourmalek, 2012).

Example of PHO's based on function is the Brazilian Observatory on Health Inequities - BOHI. BOHI serves as an open space of data, dialog, reference and communication on Health Inequalities for users from government and civil society organizations that work to define and implement social policies that address health inequalities and social determinants of health in Brazil (Guerra et al, 2016).

2.10 Medical Observatory System

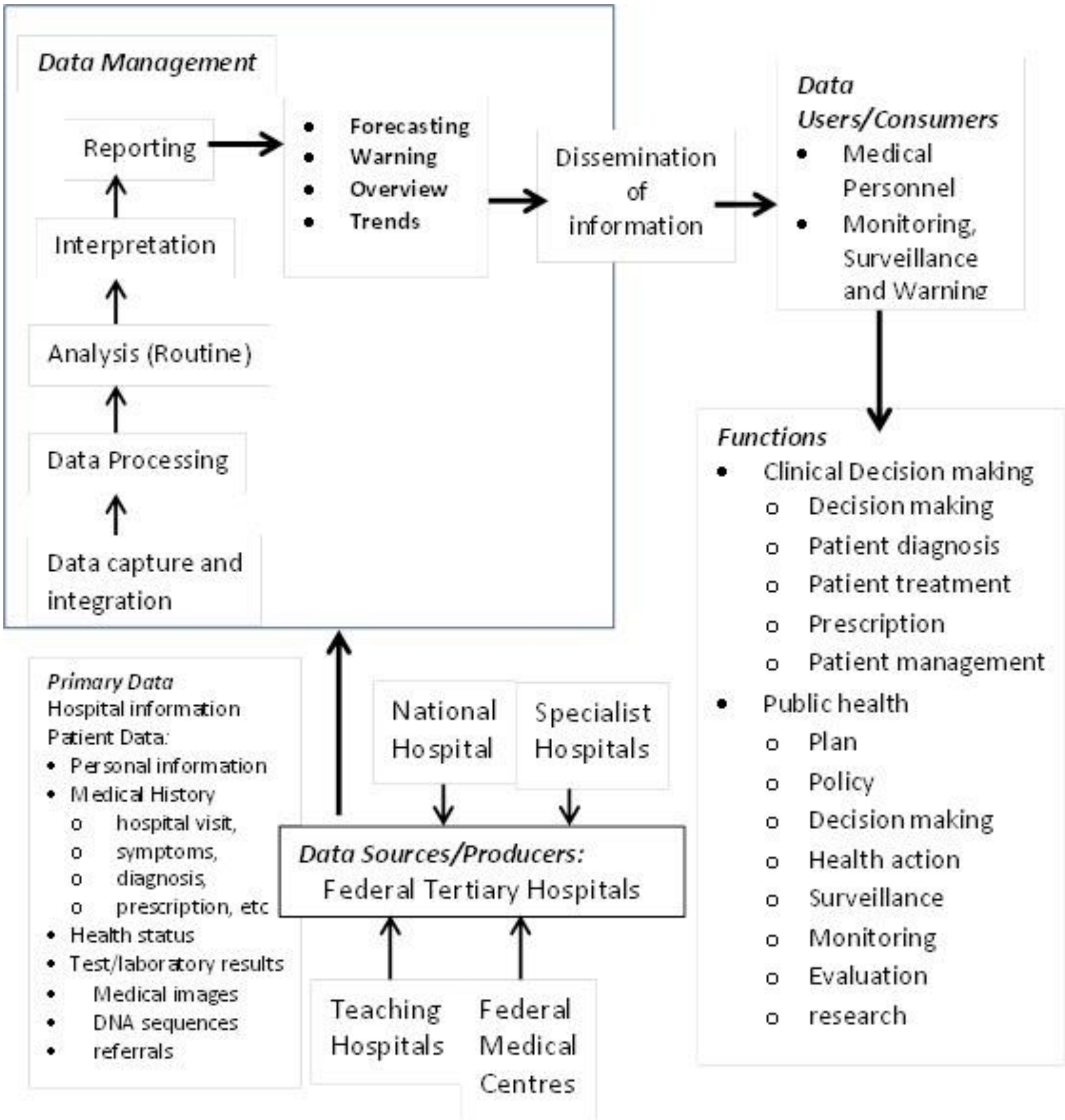
MOS's aim to provide medical personnel (i.e. doctors, physicians, counsellors, therapists, etc) with timely patient data to aid in clinical-decision making during patient diagnosis, prescriptions, treatments and management as well as avoiding errors in treatments.

The data collected and used in MOS's is basically individual level data on patient's personal details, health care needs as well as treatment.

MOS's help to prevent health professionals from being over-burdened with too much data and reporting demands from various poorly coordinated systems.

The Data management and observatory functions of MOS are shown in Figure 4 below.

Figure 4: MOS Data Management and observatory functions



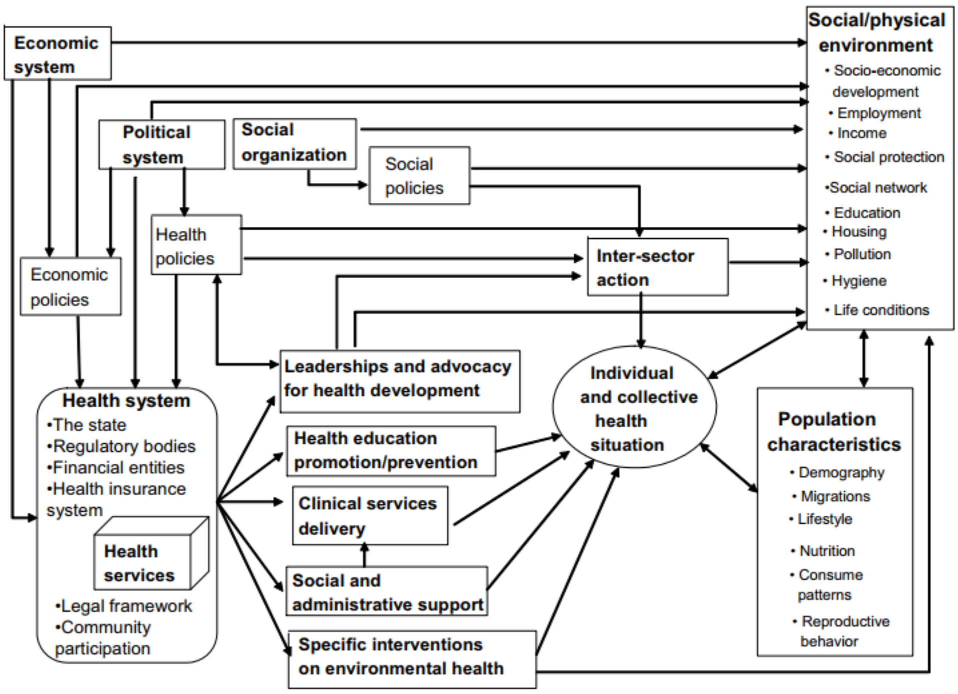
2.11 Health Indicators

A health indicator is any measure of the health status and welfare of a population group based on available socio-economic, demographic, living condition, life style and health data/information of the society of interest (Guerra, 2016). For an indicator to be useful in any Health Observatory, it should reflect the social conditions and health status of the population group. Some factors that may be used to select indicators for any HO are:

- Validity – ability to be an accurate means of measuring phenomenon;
- Sensitivity: to be able to detect the phenomenon;
- Specificity: ability to detect only the intended phenomenon;
- Measurability: obtainable with the data available by assigning ratio or percentage value to it; and
- Relevant: ability to meet health priorities in the region.

An understanding of the health determinants as seen in figure 4 below and their inter-relationship to each other in the target population is important in deciding the health indicators to use.

Figure 5: Integrated view of health related factors influencing individual and collective health



Source: Gattini (2009)

Examples of Health indicators are: mortality, fertility or morbidity rates (ratio of umber of incidences compared to the population of interest); probability of incidence in a location or at a particular age range; number of cases (number of births, deaths, incidence or infection, etc. over a period of time such as yearly, monthly, weekly, daily), etc.

2.12 Data Visualization

Data visualization is the graphic or visual representation of quantitative data or information. It uses variables for the units of data as well as attributes to present data in a systematic form in order to gain insight and extract knowledge.

Data visualization leads to improved decision making, better collaboration or information sharing, improved ad-hoc data analysis, Time savings, high return on investment, self-service capabilities to users, etc (Wang et al, 2015). It makes data easier to understand.

Many data visualization techniques exist, and their use depends on the type of data, nature of expected insight to be gleaned as well as the available resources to develop the visualization. Some of these techniques are: table, pie chart, bar chart, histogram, line chart, scatter plot, area chart, bubble chart, flow chart, Venn diagram, multiple data series or combination of charts, time line, data flow diagram, and entity relationship diagram, Parallel coordinates, cone tree, tree map, semantic network etc.

2.13 Content Management System (CMS)

A CMS is a software application, computer system or computing platform such as a web site that allows publishing, modification or editing of content, and web site maintenance from a centralized administrative page. It allows non-technical persons to build and maintain web sites.

CMS is categorized into Enterprise CMS and Web CMS.

- Enterprise CMS is used by co-operations for more efficient and effective content management. They are used by large e-commerce organizations such as Jumia and Konga. Example of the Enterprise CMS are Magneto, OSCommerce, etc.
- Web CMS is used for website administration and management. It is an application used to store, process, control, deploy and access content on the world wide web. There are different examples of CMS such as Drupal, Joomla, Wordpress, etc but they are all based on common features such as:
    - Enabling many people to contributed and share the data in the web site;
    - Access control to data using passwords, usernames, user permissions, etc.;
    - Simplify report writing; defining data as anything (i.e. texts, multimedia, documents, phone numbers, articles, etc);
    - Facilitating storage and retrieval of data; installation of modules and extensions for specialized tasks such as creating forms.

  Web CMS are platforms based on PHP programming language, and they have 3 basic structures: a hosting service that stores the website content; files of the website; and a linked database such as MySQL. Comparison of popular Web CMS's based on these structures is shown in the Table 1 below:

Table 1: Comparison of Different Web Content Management Systems

Product	Programming Language	Database	Web Server
Joomla	PHP	MySQL	Apache
Drupal	PHP	MySQL, PostgreSQL	Apache, IIS
WordPress	PHP	MySQL	Apache, mod rewrite
Plone	Python	Zope	Apache, IIS, Zope
TYPO3	PHP	MySQL, PostgreSQL, Oracle, MSSQL	Apache, IIS
Open CMS	Java 1.4	MySQL, PostgreSQL, Oracle, MSSQL	Tomcat, Apache

Source: Shah (2012).

Empirical Review

Despite the popularity of research work and literature on health observatories, it has been observed that these works consider observatories from the public health perspective. An extensive research revealed one work on the subject of 'Observatory system for Hepatitis C in Nigeria' by Umar R. (2017) which focuses on medical observatory.

Umar R. (2017) reported on the development of an information system for online entry and processing of health data with access and data visualization functionalities using clinical data from the Lagos State University Teaching Hospital (LUTH). The Observatory system implemented using Drupal CMS with a database backend in MySQL, aimed to have a grip on healthcare initiatives, its impacts and challenges such as unavailability of relevant Hepatitis C data nationwide.

CHAPTER THREE: METHODOLOGY/SYSTEMS ANALYSIS AND DESIGN

3.1. Introduction

This section gives an overview of the outputs of the Analysis and Design phases of the software development methodology applied in developing the MOS. Such outputs include system architecture, use cases, feature list, database modelling (Entity Relationship Diagram), Database design (data dictionary) as well as the technology used in the implementation phase and method of data collection.

3.2. Software Development Lifecycle (SDLC)

The SDLC which is the oldest formalized methodology for developing information systems such as the MOS (Nwakanma et al, 2018) was utilized in this project. The four common phases are: planning, analysis, design and implementation.

- Planning: at this stage, the detailed plan for working on the project was developed. Here, Decision on technology to use was also made.
- System Analysis: here, decision on the purpose of the MOS, its users, data to be stored, as well as where and when it will be used were made. The output of this phase includes contents of Chapter one of this document, system architecture, use case and attributes/features list.
- Design: In this phase, the system design and database design were done. Outputs of this phase are system architecture, database models (e.g. Entity Relationship Diagram (ERD)) and data dictionary.
- Implementation: Here, the actual MOS was developed using Drupal and PHP/MySQL. Outputs of this phase are the actual database

(shown using the SQL scripts), and the actual MOS (shown using screenshots).

3.3. System Architecture

The MOS system will work in an N-Tier architecture environment as shown in the figure 6 below. The N-Tier architecture is a commonly used software architecture model in Information systems. The MOS when fully deployed will run this architecture.

In addition, the general system architecture is shown in figure 7 below.

Figure 6: N-Tier Architecture

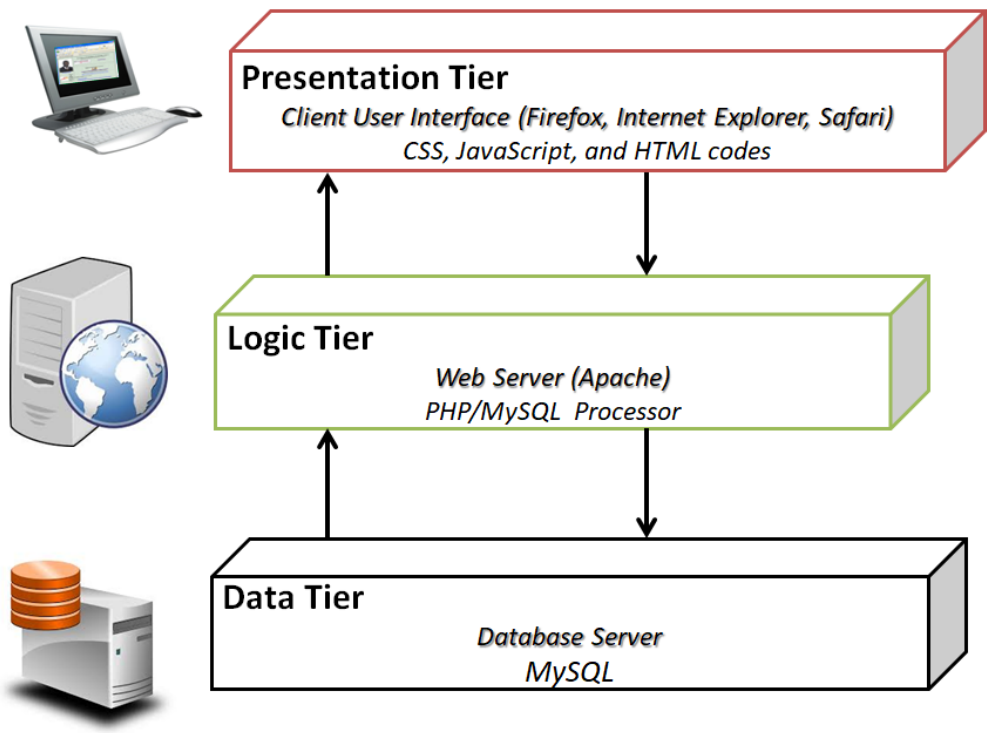
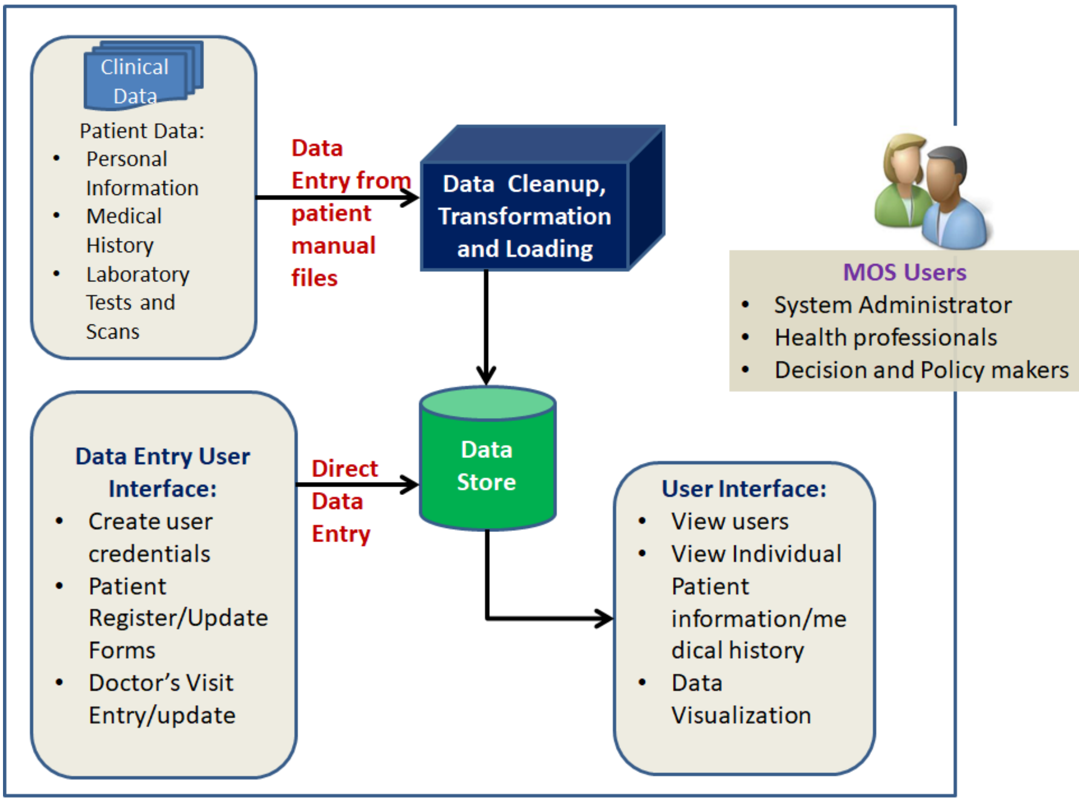


Figure 7: MOS System Architecture



3.4. Use Case

The information gathered from requirement phase and face-to-face interviews the interaction of the users with the proposed MOS is captured in the use case diagram in Figure 8 below.

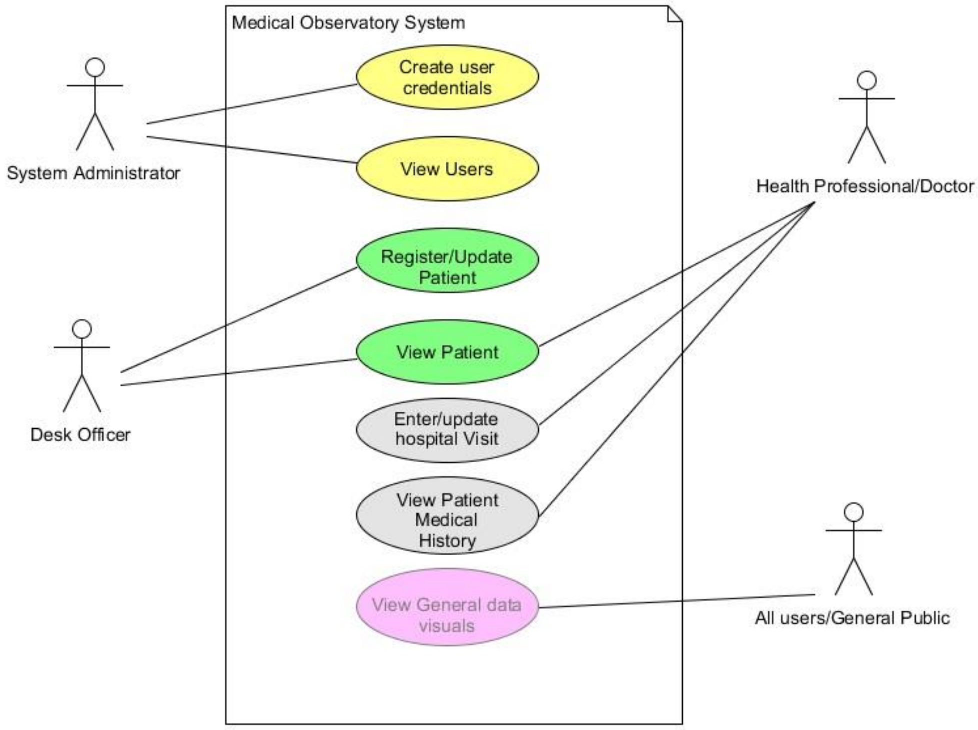
3.5. Attributes/Feature List

The attributes/features identified for data storage of the MOS are:

- Personal Patient details such as: Hospital card no., NHIS no. age, gender, occupation, marital status, state of residence, Local Government Area (LGA) of residence, town of residence, and height
- Disease related details such as mode of discovery, social activities, risk factors, treatment stage, asymptomatic and symptomatic.

- Hospital visit details such as: body vitals(weight, and blood pressure), symptoms, diagnosis, prescription and lab details (requests, specimen, result)

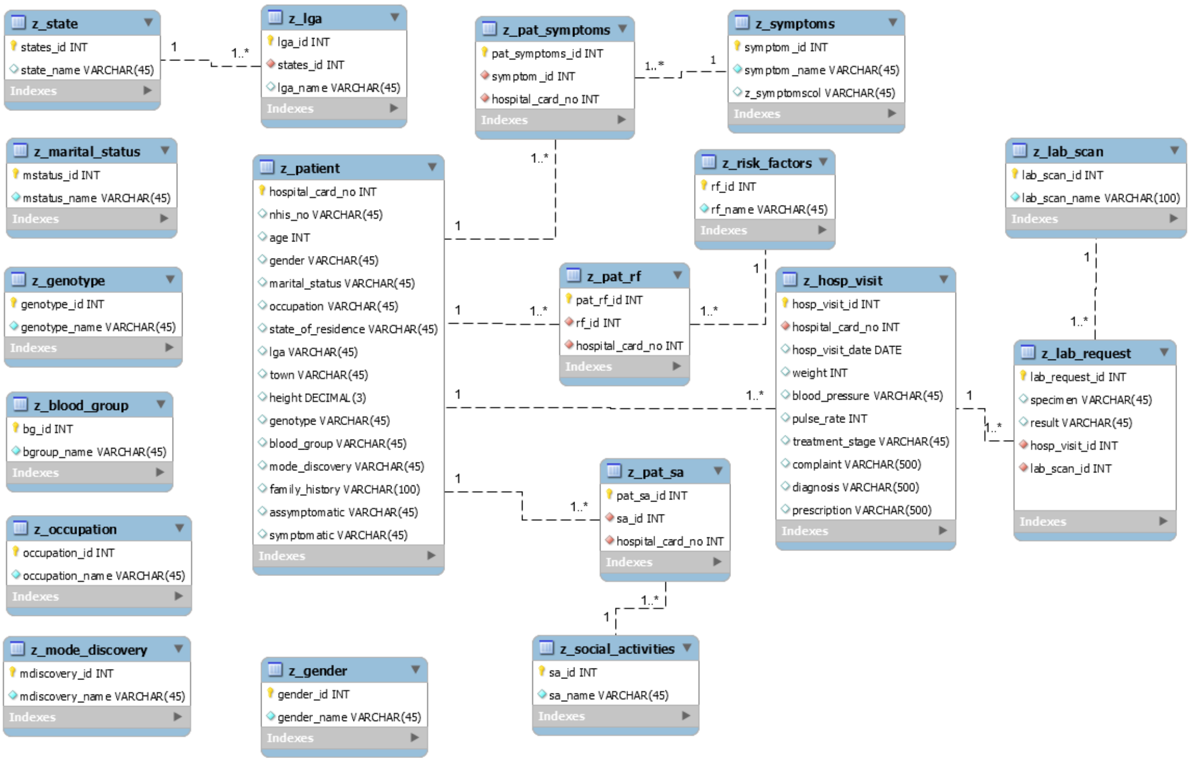
Figure 8: MOS Use Case Diagram



3.6. Database Modelling

A database is modelled using a collection of entities and their inter-relationships depicted in an Entity Relationship Diagram (ERD) (Chen, 1976). The attributes identified in the previous section are grouped into entities (tables in the database). The entities will hold the data that make up the database. The ERD for the MOS is shown in figure 9 below:

Figure 9: Entity Relationship Diagram



3.7. Technology Used

The technologies used in developing the MOS are: Drupal Content Management System, UMLet, MySql Workbench, PHP Programing Language/MySQL Database Management System, and XAMPP and Apache (Web server).

3.7.1. Drupal

Drupal is an open-source content management system licensed under the GPL. It is an open source platform and CMS for developing dynamic web projects/sites (such as personal blogs, e-commerce sites, corporate websites, etc) with diverse features such as user administration, discussion capabilities, publishing workflow, news aggregation as well as metadata functionalities that uses XML publishing to share contents. It is developed in PHP programming language and supports MySQL database for the backend. This project uses Drupal 7.59.

3.7.2. UMLet

This is an open source Unified Modelling Language (UML) tool which is Java based. It allows users to draw UML diagrams such as use cases. It does not require an install, but an instance of the program is run as an Eclipse plug-in or stand alone.

3.7.3. PHP (Hypertext Preprocessor) Programming Language

PHP is a server-side programming language that is used by many developers globally to build dynamic web pages. It allows connection to MySQL database. It is embedded in to HTML codes for execution. PHP needs a processor and web server such as XAMPP or WAMP to run on a desktop.

3.7.4. MySQL Database Management System

MySQL is an open source relational DBMS that uses SQL scripting language data processing in the database. MySQL Is mostly used in web applications, and it provides API's for diverse programming languages such as PHP, Python, C++, Java and C.

3.7.5. MySQL Workbench

MySQL Workbench is a database modelling and design visual tool. It is an integrated development environment that allows database design, development, administration and migration among other things.

3.8. Data Collection

The primary data needed by the MOS is clinical data obtained at the point of care during each patient visit to the hospital. However, this data could not be obtained due to time constraint.

The comprehensive feature/attribute list in section 3.5 as well as values for some hepatitis C related data such as symptoms, risk factors and laboratory/scan request were obtained by face-to-face interviews with doctors at the University of Abuja Teaching Hospital.

CHAPTER FOUR: IMPLEMENTATION

4.1. Introduction

This chapter gives details of the MOS as implemented with reference to the system functionalities, data dictionary and the graphical user interface.

4.2. System Functionalities

The functionalities of the MOS are:

- Data entry using the web forms in Figures 10, 11 and 12 below.
- Data update and viewing by users based on permissions
- Data storage in the MySQL Database
- Adding, deleting and updating of users and permissions by the system Administrator
- Information visualization through charts, tables and views.
- Dashboard with set of indicators

Figure 10: Register New Patient

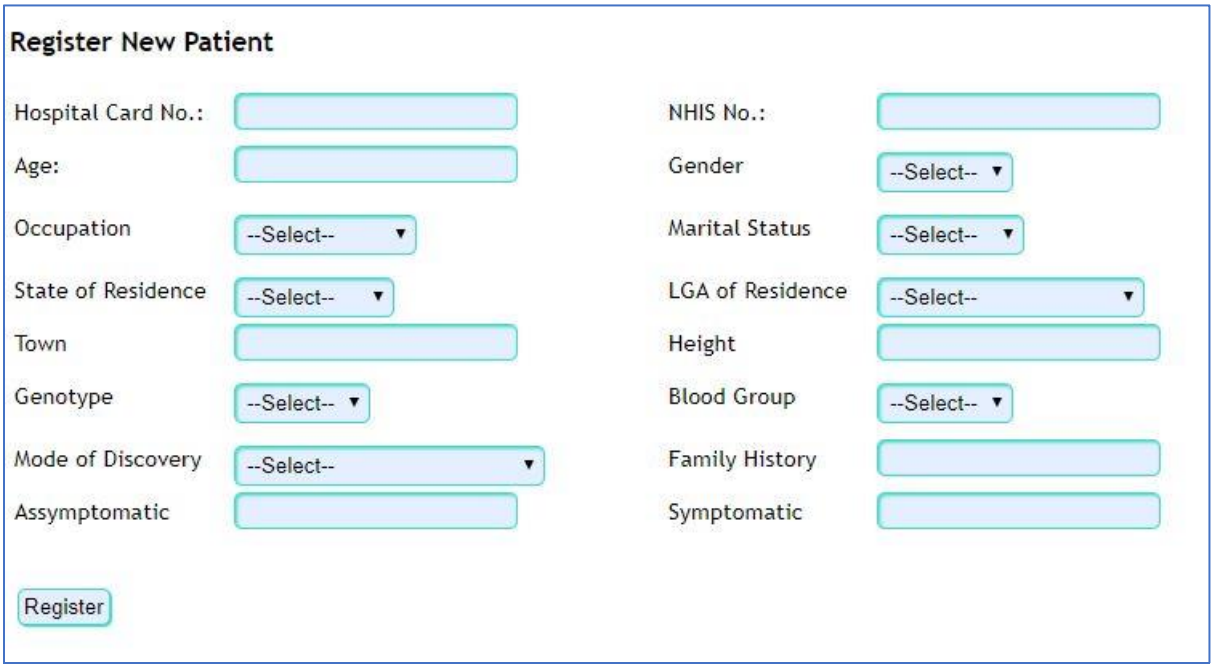
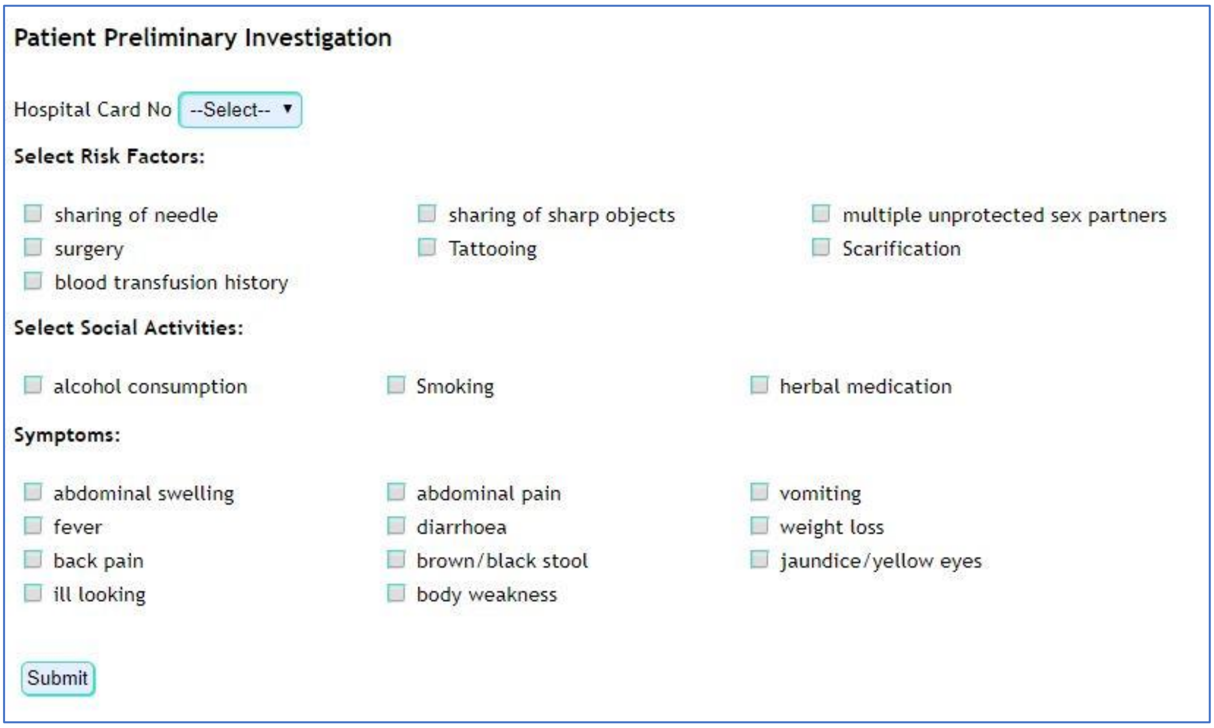


Figure 11: Patient Preliminary Investigation



Patient Preliminary Investigation

Hospital Card No --Select--

Select Risk Factors:

- sharing of needle
- sharing of sharp objects
- multiple unprotected sex partners
- surgery
- Tattooing
- Scarification
- blood transfusion history

Select Social Activities:

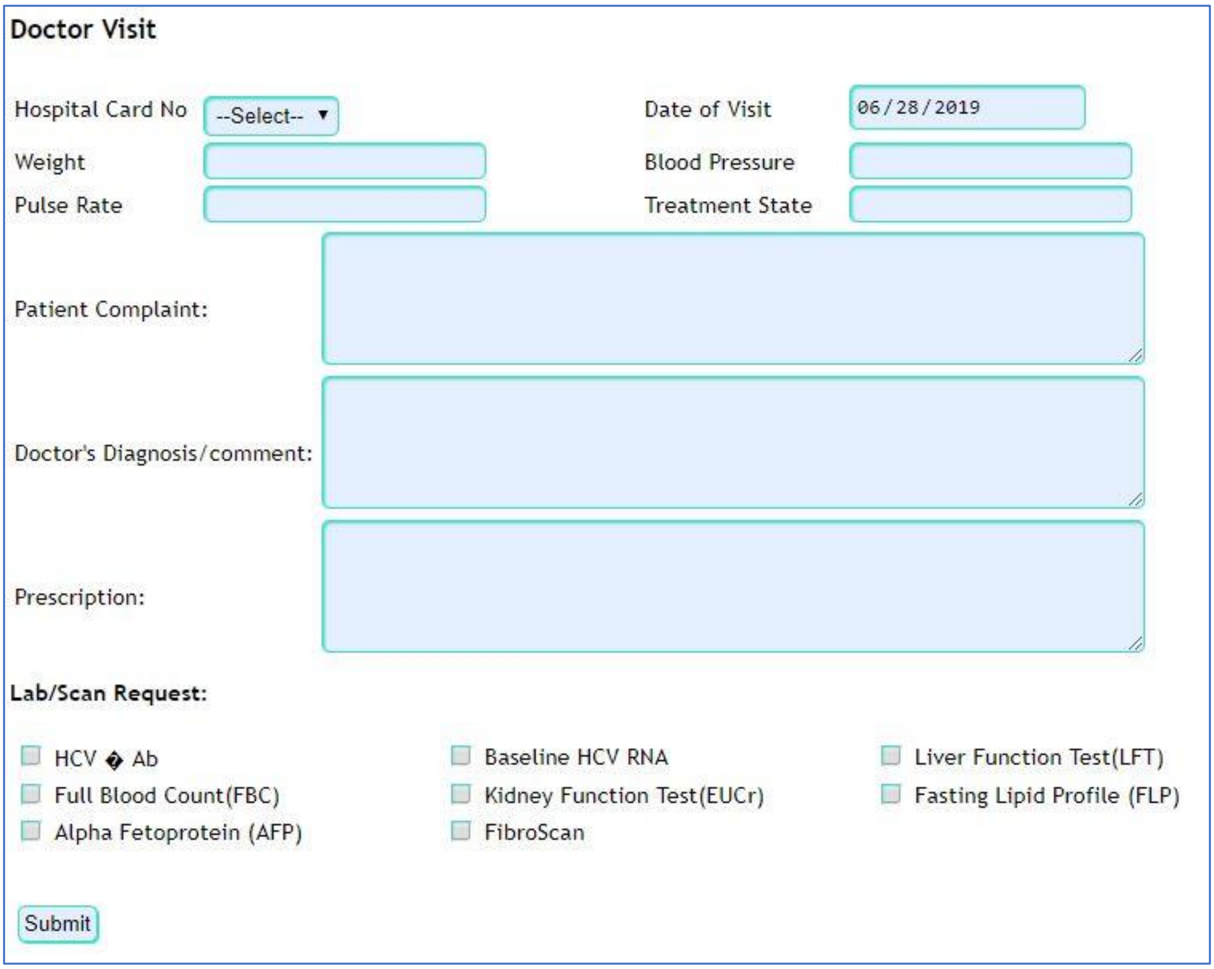
- alcohol consumption
- Smoking
- herbal medication

Symptoms:

- abdominal swelling
- abdominal pain
- vomiting
- fever
- diarrhoea
- weight loss
- back pain
- brown/black stool
- jaundice/yellow eyes
- ill looking
- body weakness

Submit

Figure 12: Patient visit to Doctor form



4.3. Database

The database is made up of tables in which actual data is stored. The entities and attributes in the ERD in figure 8 are converted to tables and fields in the database.

4.3.1. Table list

The database comprises two sets of tables. The first set are Drupal tables for the MOS, while the second set are the custom tables from our database analysis and design.

The custom MOS related tables in the database are: `z_patient`, `z_gender`, `z_marital_status`, `z_lga`, `z_state`, `z_genotype`, `z_blood_group`, `z_occupation`, `z_mode_discovery`, `z_pat_symptoms`, `z_symptoms`, `z_pat_rf`, `z_risk_factors`, `z_social_activities`, `z_pat_sa`, `z_hosp_visit`, `z_lab_request`, and `z_lab_scan`. These are differentiated from the Drupal tables by the use of the ‘z’ prefix.

The SQL Script for creating the database and tables for the MOS is provided in Appendix 1.

4.3.2. Database Population

Some of the data are entered into the respective tables in the database by the admin to form look-up values for the drop boxes and check boxes in the data entry web forms. These are:

z_gender: `male, female`

z_marital_status: `Divorced, Married, Single, Separated, Widowed.`

z_states: the 36 states of the Federation

z_lga: the 774 LGAs in NigerIA

z_occupation: `Civil Servant, ,Business, Private Sector, Pastor, Imam, Student, House wife, Politician, NGO Worker, Unemployed`

z_genotype: `AA, AS, SS, AC, SC`

z_blood_group: `A, B, AB, 0`

z_mode_discovery: `routine screening/test, during illness, during ante-natal, public servants screening, blood transfusion screening, pre-op screening, medical screening, and during febrile illness.`

z_risk_factors: sharing of needle, sharing of sharp objects, multiple unprotected sex partners, surgery, Tattooing, Scarification, blood transfusion history

z_symptoms: abdominal swelling, abdominal pain, vomiting, fever, diarrhoea, weight loss, back pain, brown/black stool, jaundice/yellow eyes, ill looking, body weakness

z_social_activities: alcohol consumption, Smoking, herbal medication

z_lab_scans: HCV – Ab, Baseline HCV RNA, Liver Function Test(LFT), Full Blood Count(FBC), Kidney Function Test(EUCr), Fasting Lipid Profile (FLP), Alpha Fetoprotein (AFP), FibroScan.

The rest of the tables in the database to be populated with patient data are empty due to the unavailability of data. The tables are: z_patients, z_pat_rf, z_pat_symptoms and z_pat_sa.

CHAPTER FIVE: CONCLUSION

5.1. Summary

HCV is a disease of great concern in the public health sphere as it is regarded as a silent killer due to the ability of the disease to stay undetected in individuals for years, low level of awareness, poor disease management strategies in many countries (Nigeria included), and most importantly, the inability of many health care institutions to use information systems store health/clinical patient data so as to enable easy and fast access to patient data for decision making by health care and public health professionals. Hence, the MOS was developed to help tackle the challenges of data storage and access for decision making and policy/strategy development on HCV in Nigeria.

5.2. Conclusion

The MOS is a web-based application/system for use by health care professionals in tertiary hospitals across the country. Its primary purpose is to enable them in the decision making process on individual HCV patient management. The MOS has features such as multiple user login, data entry, data manipulation (view and update data) and data visualization.

APPENDIX 1: SQL CREATE SCRIPT

```
CREATE SCHEMA IF NOT EXISTS `mydb` DEFAULT CHARACTER SET utf8 ;
-- -----------------------------------------------------
USE `mydb` ;

-- -----------------------------------------------------
-- Table `mydb`.`z_patient`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_patient` (
  `hospital_card_no` INT NOT NULL,
  `nhis_no` VARCHAR(45) NULL,
  `age` INT NULL,
  `gender` VARCHAR(45) NULL,
  `marital_status` VARCHAR(45) NULL,
  `occupation` VARCHAR(45) NULL,
  `state_of_residence` VARCHAR(45) NULL,
  `lga` VARCHAR(45) NULL,
  `town` VARCHAR(45) NULL,
  `height` DECIMAL(3) NULL,
  `genotype` VARCHAR(45) NULL,
  `blood_group` VARCHAR(45) NULL,
  `mode_discovery` VARCHAR(45) NULL,
  `family_history` VARCHAR(100) NULL,
  `assymptomatic` VARCHAR(45) NULL,
  `symptomatic` VARCHAR(45) NULL,
  PRIMARY KEY (`hospital_card_no`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_gender`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_gender` (
  `gender_id` INT NOT NULL AUTO_INCREMENT,
  `gender_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`gender_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_marital_status`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_marital_status` (
  `mstatus_id` INT NOT NULL AUTO_INCREMENT,
  `mstatus_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`mstatus_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_state`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_state` (
  `states_id` INT NOT NULL AUTO_INCREMENT,
```

```
  `state_name` VARCHAR(45) NULL,
  PRIMARY KEY (`states_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_lga`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_lga` (
  `lga_id` INT NOT NULL AUTO_INCREMENT,
  `states_id` INT NOT NULL,
  `lga_name` VARCHAR(45) NULL,
  PRIMARY KEY (`lga_id`),
  INDEX `fk_z_state1_idx` (`states_id` ASC),
  CONSTRAINT `fk_z_state1`
    FOREIGN KEY (`states_id`)
    REFERENCES `mydb`.`z_state` (`states_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_genotype`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_genotype` (
  `genotype_id` INT NOT NULL AUTO_INCREMENT,
  `genotype_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`genotype_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_blood_group`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_blood_group` (
  `bg_id` INT NOT NULL AUTO_INCREMENT,
  `bgroup_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`bg_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_occupation`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_occupation` (
  `occupation_id` INT NOT NULL AUTO_INCREMENT,
  `occupation_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`occupation_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_mode_discovery`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_mode_discovery` (
```

```
  `mdiscovery_id` INT NOT NULL AUTO_INCREMENT,
  `mdiscovery_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`mdiscovery_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_symptoms`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_symptoms` (
  `symptom_id` INT NOT NULL AUTO_INCREMENT,
  `symptom_name` VARCHAR(45) NOT NULL,
  `z_symptomscol` VARCHAR(45) NULL,
  PRIMARY KEY (`symptom_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_pat_symptoms`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_pat_symptoms` (
  `pat_symptoms_id` INT NOT NULL AUTO_INCREMENT,
  `symptom_id` INT NOT NULL,
  `hospital_card_no` INT NOT NULL,
  PRIMARY KEY (`pat_symptoms_id`),
  INDEX `fk_z_symptoms1_idx` (`symptom_id` ASC),
  INDEX `fk_z_patient2_idx` (`hospital_card_no` ASC),
  CONSTRAINT `fk_z_symptoms1`
    FOREIGN KEY (`symptom_id`)
    REFERENCES `mydb`.`z_symptoms` (`symptom_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE,
  CONSTRAINT `fk_z_patient2`
    FOREIGN KEY (`hospital_card_no`)
    REFERENCES `mydb`.`z_patient` (`hospital_card_no`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_risk_factors`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_risk_factors` (
  `rf_id` INT NOT NULL AUTO_INCREMENT,
  `rf_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`rf_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_pat_rf`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_pat_rf` (
  `pat_rf_id` INT NOT NULL AUTO_INCREMENT,
  `rf_id` INT NOT NULL,
```

```
  `hospital_card_no` INT NOT NULL,
  PRIMARY KEY (`pat_rf_id`),
  INDEX `fk_z_risk_factors1_idx` (`rf_id` ASC),
  INDEX `fk_z_patient4_idx` (`hospital_card_no` ASC),
  CONSTRAINT `fk_z_risk_factors1`
    FOREIGN KEY (`rf_id`)
    REFERENCES `mydb`.`z_risk_factors` (`rf_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE,
  CONSTRAINT `fk_z_patient4`
    FOREIGN KEY (`hospital_card_no`)
    REFERENCES `mydb`.`z_patient` (`hospital_card_no`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_social_activities`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_social_activities` (
  `sa_id` INT NOT NULL AUTO_INCREMENT,
  `sa_name` VARCHAR(45) NOT NULL,
  PRIMARY KEY (`sa_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_pat_sa`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_pat_sa` (
  `pat_sa_id` INT NOT NULL AUTO_INCREMENT,
  `sa_id` INT NOT NULL,
  `hospital_card_no` INT NOT NULL,
  PRIMARY KEY (`pat_sa_id`),
  INDEX `fk_social_attributes1_idx` (`sa_id` ASC),
  INDEX `fk_z_patient3_idx` (`hospital_card_no` ASC),
  CONSTRAINT `fk_social_attributes1`
    FOREIGN KEY (`sa_id`)
    REFERENCES `mydb`.`z_social_activities` (`sa_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE,
  CONSTRAINT `fk_z_patient3`
    FOREIGN KEY (`hospital_card_no`)
    REFERENCES `mydb`.`z_patient` (`hospital_card_no`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_hosp_visit`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_hosp_visit` (
  `hosp_visit_id` INT NOT NULL AUTO_INCREMENT,
  `hospital_card_no` INT NOT NULL,
```

```
  `hosp_visit_date` DATE NULL,
  `weight` INT NULL,
  `blood_pressure` VARCHAR(45) NULL,
  `pulse_rate` INT NULL,
  `treatment_stage` VARCHAR(45) NULL,
  `complaint` VARCHAR(500) NULL,
  `diagnosis` VARCHAR(500) NULL,
  `prescription` VARCHAR(500) NULL,
  PRIMARY KEY (`hosp_visit_id`),
  INDEX `fk_z_patient1_idx` (`hospital_card_no` ASC),
  CONSTRAINT `fk_z_patient1`
    FOREIGN KEY (`hospital_card_no`)
    REFERENCES `mydb`.`z_patient` (`hospital_card_no`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_lab_scan`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_lab_scan` (
  `lab_scan_id` INT NOT NULL,
  `lab_scan_name` VARCHAR(100) NOT NULL,
  PRIMARY KEY (`lab_scan_id`))
ENGINE = InnoDB;


-- -----------------------------------------------------
-- Table `mydb`.`z_lab_request`
-- -----------------------------------------------------
CREATE TABLE IF NOT EXISTS `mydb`.`z_lab_request` (
  `lab_request_id` INT NOT NULL AUTO_INCREMENT,
  `specimen` VARCHAR(45) NULL,
  `result` VARCHAR(45) NULL,
  `hosp_visit_id` INT NOT NULL,
  `lab_scan_id` INT NOT NULL,
  PRIMARY KEY (`lab_request_id`),
  INDEX `fk_z_hosp_visit1_idx` (`hosp_visit_id` ASC),
  INDEX `fk_z_lab_scan1_idx` (`lab_scan_id` ASC),
  CONSTRAINT `fk_z_hosp_visit1`
    FOREIGN KEY (`hosp_visit_id`)
    REFERENCES `mydb`.`z_hosp_visit` (`hosp_visit_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE,
  CONSTRAINT `fk_z_lab_scan1`
    FOREIGN KEY (`lab_scan_id`)
    REFERENCES `mydb`.`z_lab_scan` (`lab_scan_id`)
    ON DELETE CASCADE
    ON UPDATE CASCADE)
ENGINE = InnoDB;
```

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