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Web-Based Surveillance System for Periodontal Disease for Nigeria

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Abstract: Periodontal disease is a common inflammatory condition which affects the supporting and surrounding soft tissues of the tooth; also the jawbone itself when in its most advanced stages, in its early stage called Gingivitis and later stage called Periodontitis. This paper developed an online population based periodontal disease surveillance system that allows for easy access to statistics of periodontal occurrence on real-time basis. The system was implemented using HTML, PHP and CSS while the database was implemented using MYSQL. The simple interface design proved to be user-friendly for all users that handled the system. The system will also go a long in solving the problem of poor health care system for periodontal patients as access to information and statistics of periodontal occurrence is made real-time.

Keywords: Disease Surveillance, Periodontal Disease, Web 2.0, Use-Case Modeling

1. Introduction

Oral health as a state of being free from mouth and facial pain, oral and throat periodontal, oral infection and sores, periodontal disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing [1]. Canada Dental Association (CDA), (2016) reported Oral diseases ranging from cavities to periodontal are all serious threats to the oral health with tobacco and alcohol as major causal factors. Across the world, 16-40% of children in the age range 6 to12 years old are affected by dental trauma due to unsafe playgrounds, unsafe schools, road accidents, or violence (Genco *et al*., 2013). Noma is a gangrenous lesion that affects young children living in extreme poverty primarily in Africa and Asia. Lesions are severe gingival disease followed by necrosis (premature death of cells in living tissue) of lips and chin [2, 3]. Many children affected by noma suffer from other infections such as measles and HIV. Without any treatment, about 90% of these children die [4, 5]. Cleft lip and palate, birth defects such as cleft lip and palate occur in about one per 500–700 of all births. This rate varies substantially across different ethnic groups and geographical areas [1]. Periodontitis is also known as pyorrhea, is a set of inflammatory diseases affecting the periodontium, i.e., the tissues that surround and support the teeth [6]. Periodontitis is caused when gingivitis is not treated advancing to periodontitis (which means inflammation around the tooth). In periodontitis, gums pull away from the teeth and form spaces (called "pockets") that become infected [7, 8].

Surveillance is the intelligence network that underpins the entire eradication initiative. It is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them [9]. Without this investigative network, it would be impossible to pinpoint where and how vaccine preventable diseases are still circulating or to verify when these diseases have been eradicated. It is critical to have in place a strong surveillance network to be able to detect new

cases (often where none had been before) and to develop the necessary response [10]. A health surveillance system is the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health (Thacker, 2000). Data disseminated by a public health surveillance system can be used for immediate public health action, program planning and evaluation, and formulating research hypotheses. Surveillance System (through the public health information system) forms the basis of disease control because it generates information for action reported by [10]. It serves several purposes by assessing the status and burden of a disease or epidemic, its trends, populations at risk, and the effects of changes in behavior, health practices, public health programs, and legislation. Disease surveillance is an epidemiological practice by which the spread of disease is monitored in order to establish patterns of progression [1]. The main role of disease surveillance is to predict, observe, and minimize the harm caused by out-break, epidemic, and pandemic situations, as well as increase knowledge about which factors contribute to such circumstances (CDC, 2016). A key part of modern disease surveillance is the practice of disease case reporting.

There are more specialized surveillance systems, including sentinel surveillance, zoonotic disease surveillance, adverse events surveillance, syndrome surveillance, disease registries, and laboratory surveillance. Some of them are more useful for certain diseases than others, but each fills a specific need. All these systems can be used to monitor disease trends and plan public health programs for a wide variety of conditions. Vital Statistics surveillance system consists on records of birth and death and it is a critical component for public health practice. Mortality data and infant mortality rate (the number of deaths among infants per 1,000 births) have long been used as indicators of overall population health. Birth data is also used to monitor the incidence of preterm birth, a risk factor for a variety of adverse health outcomes. Disease reporting involves the required reporting of certain diseases to public health authorities and is required internationally by the World Health Organization (WHO), through International Health Regulations (IHR) under who countries are required to report any public health emergency of international concern (World Health Organization, 2010). Sentinel surveillance is a population-based surveillance that involves collecting data from a sample of reporting sites (sometimes called sentinel sites); it also allows states to monitor trends using a relatively small amount of information. Zoonotic surveillance system (diseases found in animals that can be transmitted to humans) involves a system for detecting infected animals (Blackmore, 2003). Adverse event surveillance system is to gather information about negative effects experienced by people who have received approved drugs and other therapeutic agents; reports come from health care providers, including physicians, pharmacists, and nurses, as well as members of the general public, such as patients or lawyers, and manufacturers (FDA, 2002; Zhou, 2003). Syndrome surveillance system is a relatively new surveillance method that uses clinical information about disease signs and symptoms before a diagnosis is made; it is an active or passive system that uses case definitions that are based entirely on clinical features without any clinical or laboratory diagnosis. It uses electronic data from hospital emergency rooms, and provides the health department with early notification of the outbreak. Registries are a type of surveillance system used for particular conditions, such as periodontal and birth defects. They are often established at a state level to collect information about persons diagnosed with the conditions. This information can be used to improve prevention programs.

The timely transmission of surveillance data is critical for the development of surveillance or monitoring system, the widespread application of modern telecommunication network and technology make the rapid electronic data entry, reporting and analysis possible in resource-limited areas [11]. In remote areas without computers, mobile phones are commonly used among residents, which can be used for data reporting and transfer. Web based surveillance systems are used for monitoring the behavior, activities, or other changes in information on the Web. A Web-based application refers to any program that is accessed over a network connection using HTTP, rather than existing within a device's memory. Web-based applications often run inside a Web browser. However, Web-based applications also may be client-based, where a small part of the program is downloaded to a user's desktop, but processing is done over the Internet on an external server. Web-based applications are also known as Web apps. The Web can be used by public health Jurisdictions to disseminate data about an evolving threat as well as endemic diseases [12, 13].

Oral diseases are often hidden and invisible, or they are accepted as an unavoidable consequence of life and ageing [1]. However, there is clear evidence that oral diseases are not inevitable, but can be reduced or prevented through simple and effective measures at all stages of the life course, both at the individual and population levels. Untreated tooth decay is now known to be the most prevalent of the 291 conditions studied between 1990 and 2010 within the frame of the international Global Burden of Disease Study [14]. This is the most authoritative estimation of global disease burden and serves as a basis for health policy planning and resource allocation. Severe periodontitis, which is estimated to affect between 5 and 20 percent of populations around the world where male, was found to be the sixth most common condition. Oral periodontal is among the 10 most common periodontal in the world and even more prevalent in South Asia, with numbers expected to rise due to increasing tobacco and alcohol consumption [15]. Currently in Nigeria, there is no surveillance system that includes periodontal (gum) disease, requirement of resource intensive clinical measures for identifying cases of periodontal disease. in addition, no variations in measures of periodontal diseases from state to state, therefore this study addresses the problem by developing a system which will be able to help in tracking

and surveying periodontal (gum) disease such as gingivitis and periodontitis within south-western regions in Nigeria and hence this study. Primary responsibility is to support State and community based programs to prevent oral disease, promote oral health nationwide, and foster applied research to enhance periodontal disease prevention in community settings. The system combines monitoring and data presentation all in one package which enables users not only to present and evaluate the present situation, but also to undertake planning for a sustainable future.

2. Related Works

In literature, a number of disease surveillance systems have been developed for use; a number of which are been reviewed in the following paragraphs. [10] reported a health surveillance system for systematic collection, analysis, interpretation, and dissemination of data regarding health-related events for use in public health action to reduce morbidity and mortality and to improve health. A database for immunize-able diseases was used to develop a web based spatial immunize-able disease surveillance system for Nigeria. Due to the absence of spatial representation of health data in Nigeria, poor decisions are made on what preventive measures to employ. Researchers aimed at solving this problem by representing health data spatially on the web so that data disseminated by a public health surveillance system can be used for immediate public health action, program planning and evaluation, and formulating research hypotheses.

[16] reported that to overcome the limitations of the state-of-the-art influenza surveillance systems in Europe, an European-wide consortium aimed at introducing an innovative information and communication technology approach for a web-based surveillance system across different European countries, called Influenzanet was developed. The system, based on earlier efforts in The Netherlands and Portugal, works with the participation of the population in each country to collect real-time information on the distribution of influenza-like illness cases through web surveys administered to volunteers reporting their symptoms (or lack of symptoms) every week during the influenza season. Such a large European-wide web-based monitoring infrastructure is intended to rapidly identify public health emergencies, contribute to understanding global trends, inform data-driven forecast models to assess the impact on the population, optimize the allocation of resources, and help in devising mitigation and containment measures.

[17] developed a system named eDCS: e Dengue Control System based on the same principles of manual disease surveillance system while taking steps to provide timely, accurate information in a reliable and useable manner. The eDCS helps to manage outbreaks through early detection, rapid verification, and appropriate response to Dengue. It allows health care professionals and citizens to get early awareness about the dengue disease via Internet or mobile phone and bring them for performing Dengue prevention and controlling operation through the social media acceleration. The present notification of communicable disease system is manual, slow, inefficient, and repetitive all of these lead to handle the dengue related health problems ineffectively. Thus it is less effective in preventing a spreading epidemic, public health care professionals and others require an operational support system to help for managing day-to-day public health responsibilities as well as a method to effectively detect and manage health problems such as Dengue. The system was initially limited to dengue communicable disease but can be easily expanded to other communicable diseases, and non-communicable disease surveillance in future.

Velasco *et al*., (2014) used social media data and Internet-based data in global systems for public health surveillance. They reported that the exchange of health information on the Internet has been heralded as an opportunity to improve public health surveillance. In a field that has traditionally relied on an established system of mandatory and voluntary reporting of known infectious diseases by doctors and laboratories to governmental agencies, innovations in social media and so-called user-generated information could lead to faster recognition of cases of infectious disease. More direct access to such data could enable surveillance epidemiologists to detect potential public health threats such as rare, new diseases or early-level warnings for epidemics.

Having extensively carried out the review of a number of literatures on the area of development of periodontal surveillance, quite a number of information was gotten. Since the 1960s, different clinical, laboratory and radiological recording systems have been used to measure the prevalence, extent and severity of periodontal diseases at individual and population levels. Some of these recording systems are known as ‘indices’ (i.e. numeric scales with upper and lower limits), requiring validity, reliability, clarity, simplicity, objectivity, quantity, sensitivity and acceptability by both the examiner and the subject [18]. Russell *et al*., (1956) reported that the first attempts to measure periodontal diseases at the population level were made in the late 1950s, using Russell’s Periodontal Index, an innovative recording system that scored the presence and severity of both gingival bleeding and pocket depth, also known as ‘composite’ indices. Russell designed and tested the Periodontal Index as an epidemiological tool in which all teeth were examined and scored using five well-distinguished categories (0, 1, 2, 6 and 8) representing incremental degrees of disease severity. In the USA, Russell’s Periodontal Index was used in national surveys that reported mean periodontal index scores as population estimates, the effect of age on periodontal diseases, comparisons between racial /ethnic groups and epidemiological trends (Sanchez et al., 1974). Russell’s Periodontal Index was simple, had clear detection criteria for each score level, was developed and tested empirically and was able to detect differences between population groups. Furthermore, Russell recognized the need to train examiners to minimize between-examiner differences in scoring (Burt *et al*., 1992).

3. Materials and Methods

The researcher adopted the descriptive and exploratory designs that allowed the collection of data from a sub-set of Nigerian dentists and hospitals whose analysis was generalized for all dentists and hospitals in Nigeria. The adoption of these methods gave a multi-faceted articulation on the different aspects of the study. The data collected from this approach was used as a guide in order to develop the Web based surveillance system for periodontal disease.

3.1. Requirement Analysis

The research required the identification of all system users and the data needed for managing poultry farms and the necessary activities carried out by users were identified. Also, the factors affecting periodontal diseases and their corresponding influence were identified using interviews with dentists from hospitals. Following the identification of the information necessary for managing periodontal diseases and the problems associated with them, the system requirements were explicitly identified in order to formulate a solution for the web-based development system for periodontal disease management. The design of the user requirements of this system was done using the Unified Modeling Language tools (UML). The users of the system were identified by the dentists interviewed and were selected based on the type of information either accessed or benefitting to the users, they are:

a System administrator – is responsible for managing the use of the surveillance system and also register every authorized user of the system;
b Doctors (oncologists) – are primary users who provide information about incidence of periodontal diseases among patients;
c Health workers – are primary users who provide information about incidence of periodontal diseases in hospitals;
d Government and non-governmental agencies – view the state of periodontal diseases at the level of the different hospitals' report; and
e Health ministry staffs – can view and use the data ad graphs available in the system to determine the distribution of periodontal diseases around south-western Nigeria.

Following the user specification of the proposed web-based monitoring system for periodontal disease in Nigerian hospitals, the functional and non-functional requirements of the system was captured. This information was elicited as a result of ensuring that all necessary requirements of the system were captured during the requirements analysis. The functional requirements captured the intended behaviour of the system thus specifying the functions that the system components must be able to perform. The system was expected to allow users to conveniently access the system from any remote location using the Internet and able to allow users concurrently provide and access information without causing neither failure nor reduced response time. The non-functional requirements were intended in to order to judge the operation of the system. Thus, the must be able to control and restrict unauthorized access by unprivileged users of the system. This system must be able to ensure the security of information with the use of encryption and access using passwords.

3.2. System Design

The Unified Modeling Language (UML) is the primary modeling language used to analyze, specify, and design software systems. From the late 1980s and well into the 1990s, numerous methodologies arose and were subsequently modified and refined. Many of these were strong in certain areas, weaker in others. This gave rise to methodologists adopting useful facets from other methodologies into their own. UML allows software models to be constructed, viewed and manipulated during analysis and design. A use-case is a type of UML diagram that identifies the actors (users) involved in an interaction and the names and the types of the interactions involved.

Table 1. *Data insertion use case.*

Use-Case Names	Data Insertion
Description	Describes data entry for periodontal surveillance system.
Actors	Medical Personnel (Doctors and Nurses), individual and Administrator.
Pre-conditions	1. Medical staff must belong to an hospital already register to the monitoring system. 2. Medical staff must be registered to the system. 3. Individual must be resident in South-West in Nigeria.
Scenario	1. System prompts the users to login in to the system a If the user is already registered and approved/ activated, system permits the login and necessary and action performed by the user. b If the user is not valid or approved, the system denies the user access to login. 2. Administrator creates staff (s) of the monitoring system as user on the system and gives them required authorization a The staffs register/add hospitals in the south-West in Nigeria into the system. b The staff (s) activates other users of the system. 3. Users enter information of self and periodontal patient into the system.

The use case diagrams showed how data was entered and viewed from the proposed Poultry disease monitoring system. The first use-case describes data insertion Use-Case of the System for poultry disease monitoring system which involves the function of each actors of the system. The second use-case describes the data query section of the

system which describes the functionalities that allow the viewing, updating, and searching, editing and deleting old data from the system. Table 1 shows the data insertion use-case scenario for the proposed system for periodontal disease surveillance which identifies the actors (users) who are required to provide information to the system, namely: medical personnel (doctors, nurses and health workers) alongside the administrator.

The medical personnel who are to access the system must have been registered and can only access the system using the username and passwords that were provided by the administrator (super-user) at the point of registration. Following the registration, the user can provide additional information about the hospital from which other users of the system working in the same hospital can be activated. The users can then update the system with information relating to periodontal disease cases within their hospitals. The use-case diagram for the scenario is shown in Figure 1.

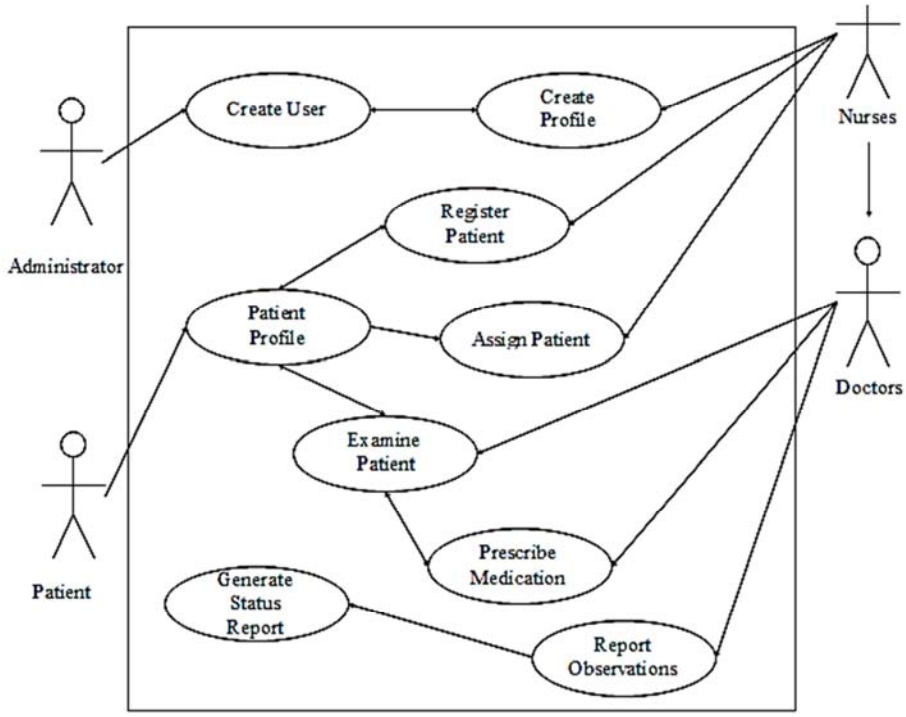

Figure 1. *Data Insertion Use Case.*

Table 2. *Data query use case.*

Use-Case Names	Data Insertion
Description	Describes data query for periodontal monitoring system.
Actors	Medical Personnel (Doctors and Nurses) and Administrator.
Pre-conditions	1. Medical staff must belong to an hospital already register to the monitoring system. 2. Medical staff must be registered to the system. 3. The NGO's must have been registered to the system. 4. Must be connected to the internet.
Scenario	1. System prompts the users to login in to the system a If the user is already registered and approved/ activated, system permits the login and necessary and actions are performed by the user. b If the user is not valid or approved, the system denies the user access to login. 2. Medical personnel can view periodontal statistics and view periodontal distribution 3. Government Agency and Non-government Agency can view the periodontal distribution on the graph as well as the statistics.

Table 2 shows the use case scenario for data query of the periodontal disease surveillance system. The table shows the different actors (users) that can query the database of the system for information stored. Such users are required to log into the system with the usernames and passwords provided to them by the administrator. The medical staffs and the stakeholders (government and non-government agencies alongside staffs of the ministry of health) can only view the distribution and statistics of periodontal diseases among the hospitals reporting the cases. Before any of these can take place, the user accessing the system must provide their usernames and passwords without which they are unable to access the system information and thus regarded by the system as unauthorized users.

Figure 2 shows the use case diagram for data query by the actors (users) who are authorized by the system via administrator to view information about periodontal disease statistics and distribution among the hospitals registered to the system. As a result, the proposed system is capable of monitoring diseases that are paramount in a particular area.

In the data query use-case, Policy makers are able to view the state of periodontal diseases at various hospitals in the study area (Figure 2).

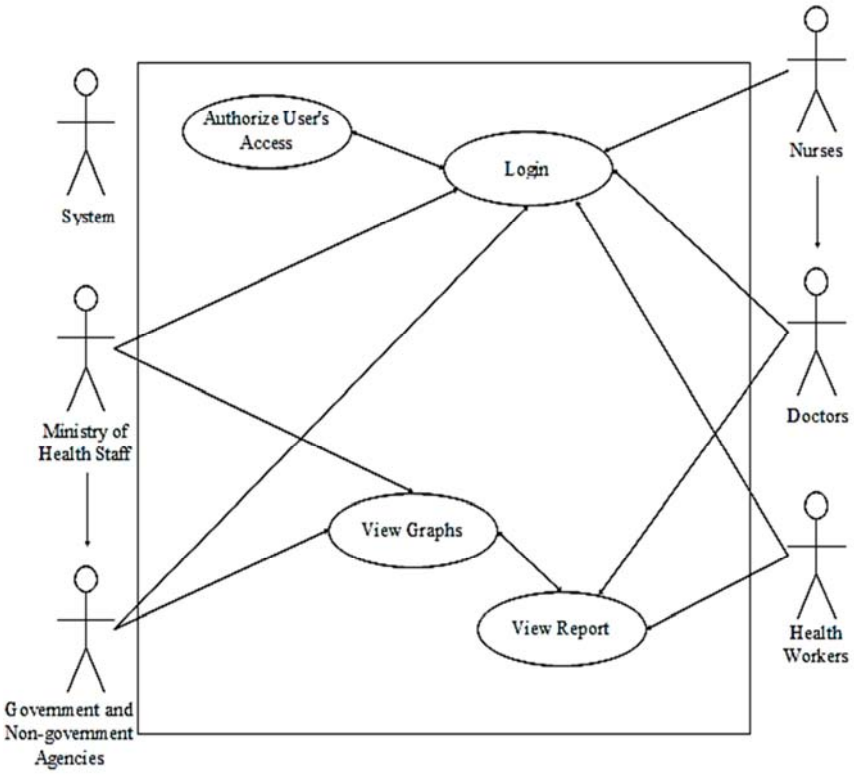

Figure 2. *Data Query Use Case.*

3.3. System Architecture

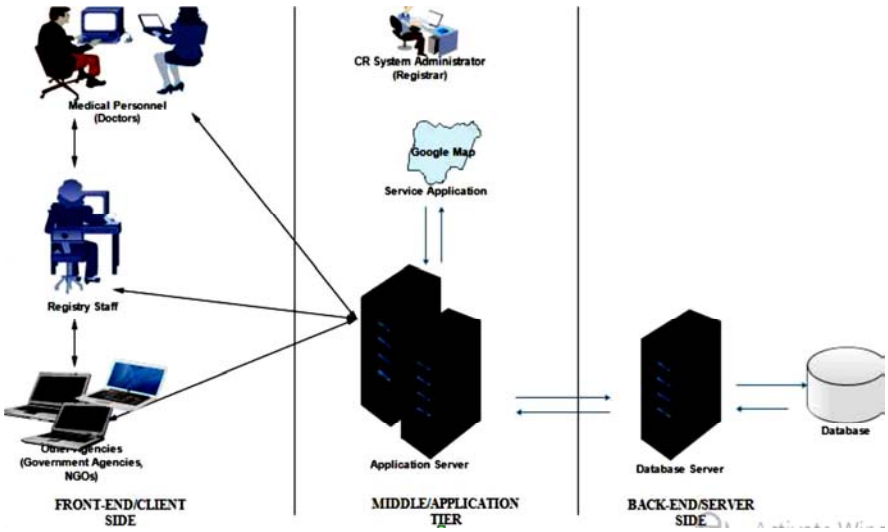

Figure 3. *System architecture for periodontal disease surveillance.*

In the design of any web based related system, the use of system architecture is highly important. In the periodontal disease monitoring system, there is a need to make the design of the system easily accessible, flexible and portable as much as possible. This was needful in order to allow users to easily make use of internet enabled mobile phones, tablets and other mobile devices, laptops, and desktop computers with web browsers to access the developed system. In this research, client-server system architecture was used and it is thin client-server. The Poultry disease monitoring system has two components namely: the server-side that runs on a server and a client-side that runs on the browser (Figure 3).

The system was modeled using the thin client-server architecture which makes use of the Web browser as the

client. This architecture makes it possible to use any internet-enabled device with a web browser installed to access the system; this is to ensure that the system is easily accessible, available and yet cheap to implement. In the client approach almost all the processing work was done on demand at the server-end while the task of the client-side was to display data and information to the user on the screen of the display monitor. This architecture was used due to its flexibility and easy accessibility. The users would not be required to install any software on their personal or mobile computers except a standard web browser, which is usually installed on the operating systems of personal and mobile computers provided by manufacturers.

The web based monitoring system for periodontal disease supports a database, application tier and user interface. The User Machine (computer, laptop or a mobile/smartphone) is used to access the pages and forms of the web application. The Web Server allows the application to run and behave as though it is hosted on the Internet, using the WAMP Apache server. The back-end which consists of the web server and the database management system (DBMS) holds and manages the data pool used by the application. The PHP Script controls the exchange of data between the front-end and the application back-end.

Clients do not require any powerful computer systems; users can use any computer with a web browser such as laptop/notebook, mobile phone, and desktop computer systems but servers require higher configuration (in terms of hardware) computer system since it is regularly subjected to heavy load; the servers are the HTTP and database server. Using the monitoring system, a doctor in a hospital upon examining and prescribing drugs to patients can provide regular updates to the system which alerts other stakeholders (non-government agencies) using the system who immediately will relay the information to the relevant disease control authorities (government agencies under the ministry of health) so that immediate action could be taken.

3.4. System Implementation

In order to develop the prototype system, the periodontal disease surveillance database was developed using MySQL. In the process of developing the periodontal disease database, different tables, files, records and fields were created. As a result, different aspects of the periodontal disease among patients diagnosed the date of diagnosis, description of results of examinations, drugs administered, doctor attending to patients, hospital location and were stored in the database.

The user interface which allows the user to navigate the system and also facilitate interaction with the database was also implemented using the Windows Interface Menu (WIMP) which makes the system simple and user-friendly. Therefore, the periodontal disease surveillance information system was implemented in design to accommodate users with varying skills and competence in the area of computer usage. The system's interface was implemented using Adobe Dreamweaver; while Apache was the web server used to provide the basic functionality of the monitoring system and PHP was used as a scripting language to program the server-side manipulation of the knowledge in the database. A well designed and simple user interface provides users with a better understanding of the system behaviour and overall functionality.

4. Results and Discussions

Following the implementation of the system, the results of the functionality of the proposed periodontal disease surveillance system are presented using the interfaces used to implement important parts of the system. The user interface allows the user to navigate the proposed system and communicate with the database. The system design is simple enough for use by anyone with little knowledge of computing and since the targeted end users are dentists and government agencies in the study area, the system is user friendly and made easy to use through the use of windows and interface menu. The interfaces built into the system include the:

a Home page;
b User registration Page;
c Login page;
d Patient registration page;
e Patient transfer page;
f The Administrators page; and
g Periodontal surveillance page.

The implemented system's index page is the home page that is used to navigate to different parts of the monitoring system by users accessing the system. This index page contains links to help users of the surveillance system to log in and new users to register (Figure 4). There is also news relating to periodontal disease on the homepage.

On the homepage, the new user can access a registration page and existing users can access the system proper after login. Users can easily access this interface by logging to the unified resource locator of the periodontal disease surveillance system but can only be able to perform other actions only if the person is authorized and has an account with the system.

Following access to the homepage by existing users (doctors and nurses) the patient registration page allows new patients to be added to the system as long as such a patient has been diagnosed as having periodontal disease. The doctor keys in the patient's details in order to determine if the patient is already registered and provides details regarding the results of the examination. On the patient registration page, if the patient has not yet been registered then details are provided, such as: the doctor key is the name, residential address, occupation, ethnic group, state of origin, residential town and state, marital status, sex, date of birth and year of disease diagnose. In addition, information about the disease with respect to the patient are also provided. All fields are required for successful registration and if one field is left empty, a prompt will come up (Figure 5).

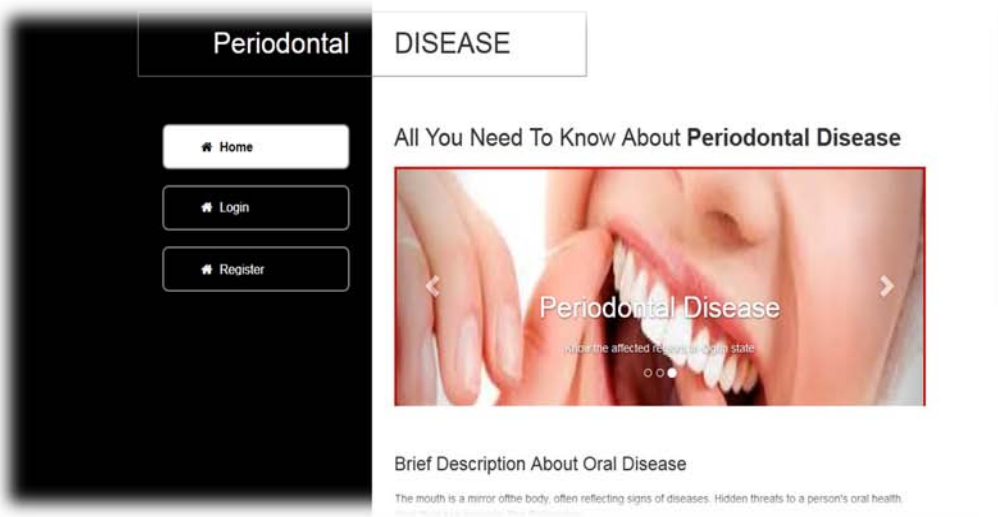

Figure 4. *Home page of monitoring system for poultry disease.*

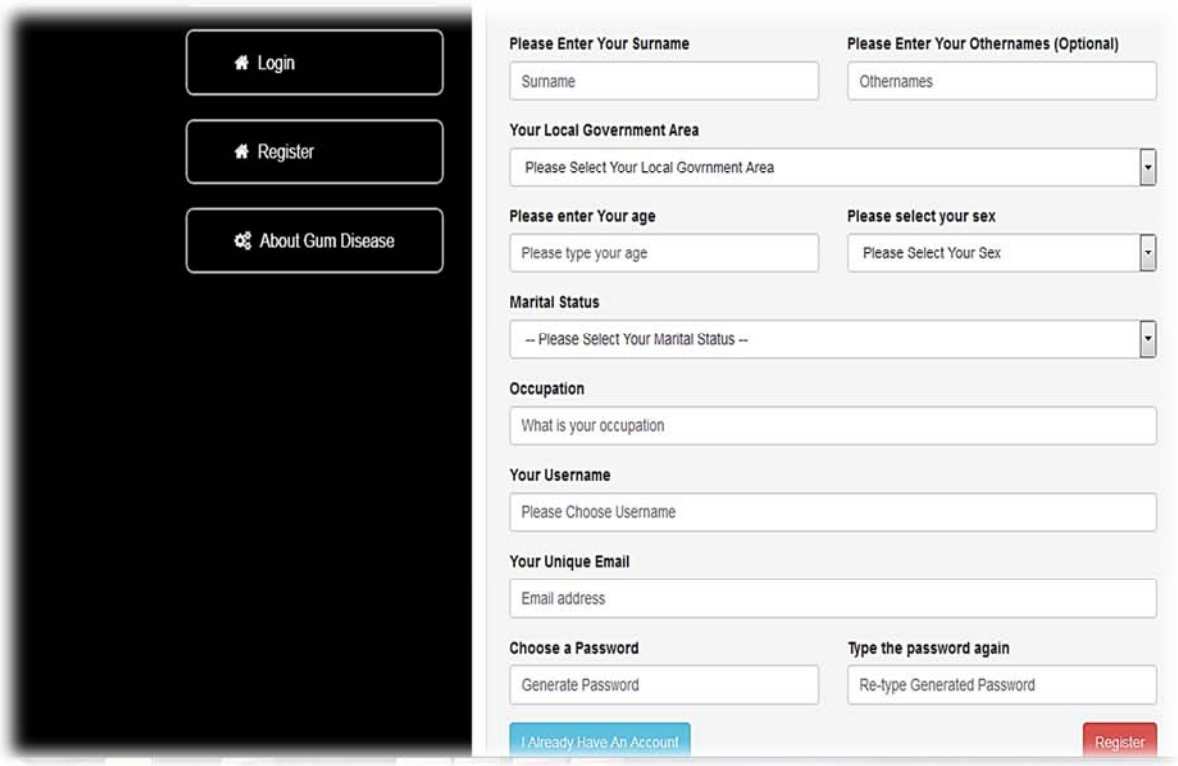

Figure 5. *Registration page for newly diagnosed periodontal patients.*

If users accessing the system from the home page are already registered to the system to by the system administrator, they can access the system by providing the username and password provided by the administrator at the point of verifying their registration to the system using the login interface (Figure 6). When the user of the system encounters the login page, he is required to enter his username and his password to be able to log into the system. For a login attempt to be successful, the username and password combination input by the user must correspond to values that are available in the database.

The disease report transfer page is used to produce information regarding the transfer of patients diagnosed of periodontal diseases to doctors stored in the system's database (Figure 7). Such diseases reports can then be forwarded (transferred) to the necessary and appropriate health department for the necessary actions to be taken regarding the disease. This is to ensure that the requirements necessary for prompt response by healthcare officials to any observed patients diagnosed by periodontal disease in real time. The page presents information regarding the name of the patient and the doctor to whom he/she has been referred to. The result of this page is then presented as a report to be viewed by interested stakeholders.

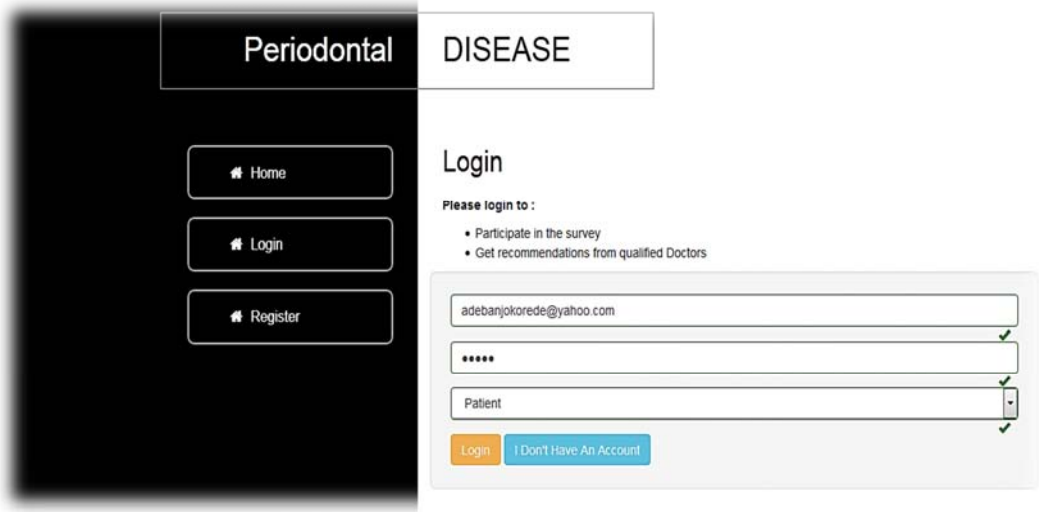

Figure 6. *Login dialog box.*

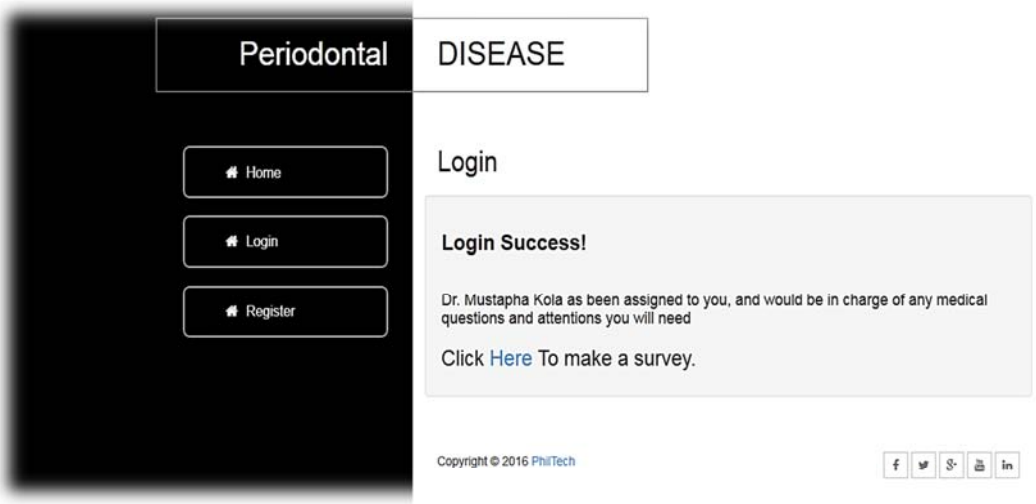

Figure 7. *Periodontal patient transfer notice.*

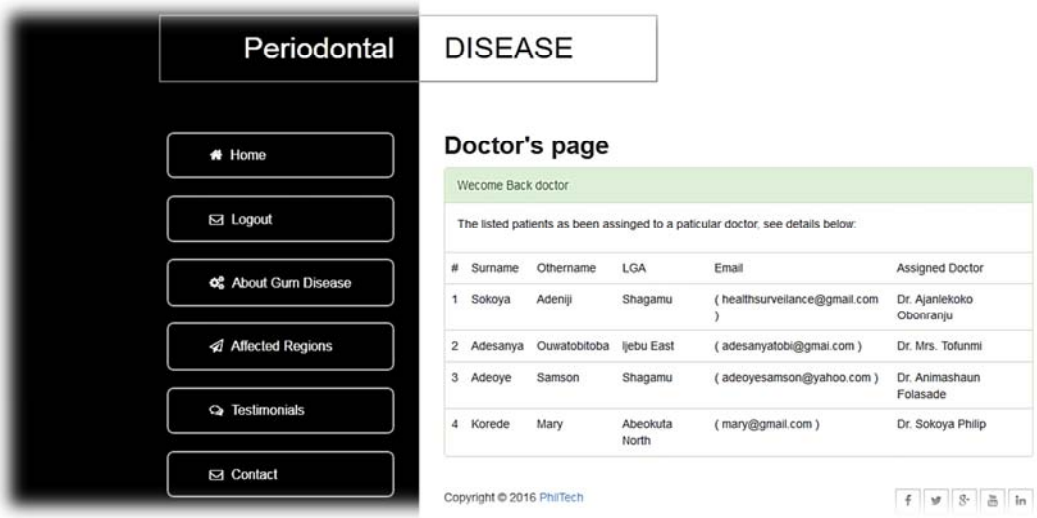

Figure 8. *Administrator's report page.*

The process of reporting periodontal patient's transfer using the periodontal disease surveillance system requires the disease transfer page. The page is used by the administrator to survey the actions taking place on the system between the patients and doctors. The page generates a report which is accessed by the administrator in order to understand the state of the distribution of periodontal patients in south-western Nigeria (Figure 8). The reports stores and provides information about the names of the patient, local government area belonged to, contact e-mail and the doctor assigned to. A report section is used to provide details on the distribution of patients diagnosed with periodontal disease; such information is then useful to the stakeholders in providing decision support to policy makers and other important government agencies.

There is also an administrator's dashboard that performs the administrative functions such as modifying site pages, adding events, and customizing the contact database. Administrator can log in and access the admin backend, an area reserved for site and account administration, and not seen by ordinary members or visitors to your site. The administrator have been granted the technical ability to perform certain special actions which include the ability to block and unblock user accounts from editing, edit fully protected pages, protect and unprotect pages from editing, delete and undelete pages, rename pages without restriction, and use certain other tools.

Whenever the system is being accessed by stakeholders (non-government agencies and ministry of health staffs) using their usernames and passwords to log into the system, they are directed to a surveillance page that allows them to view the graphical distribution of patients diagnosed of periodontal diseases based on their location, their age and their occupation (Figure 9).

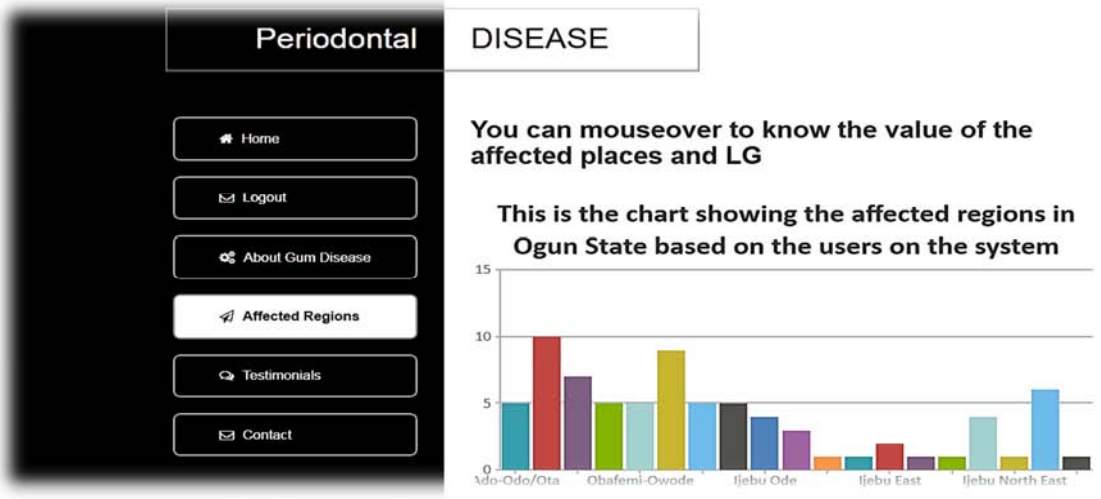

Figure 9. *Distribution of periodontal patients by location.*

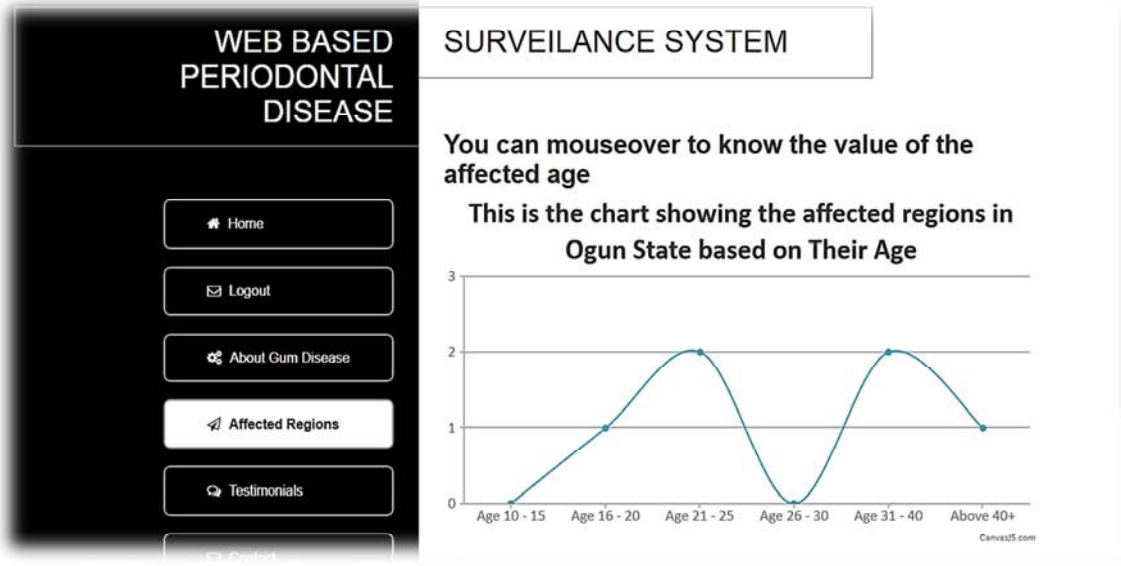

Figure 10. *Periodontal patients' distribution according to age group.*

This is the module that performs the surveillance functions for the periodontal disease surveillance system. It allows the government health workers as well as doctors to know the areas periodontal disease is more likely distributed. Figure 9 shows the graphical plot of the distribution of periodontal disease among local government areas in Ogun State, Nigeria based on the information stored on the prototype system. Figure 10 shows the distribution of the periodontal patients based on the age group using a line graph. Each point on the line corresponds to the number of patients affected within a particular age group. Figure 11 shows the distribution of periodontal patients according to their occupation using a bar chart within Ogun state.

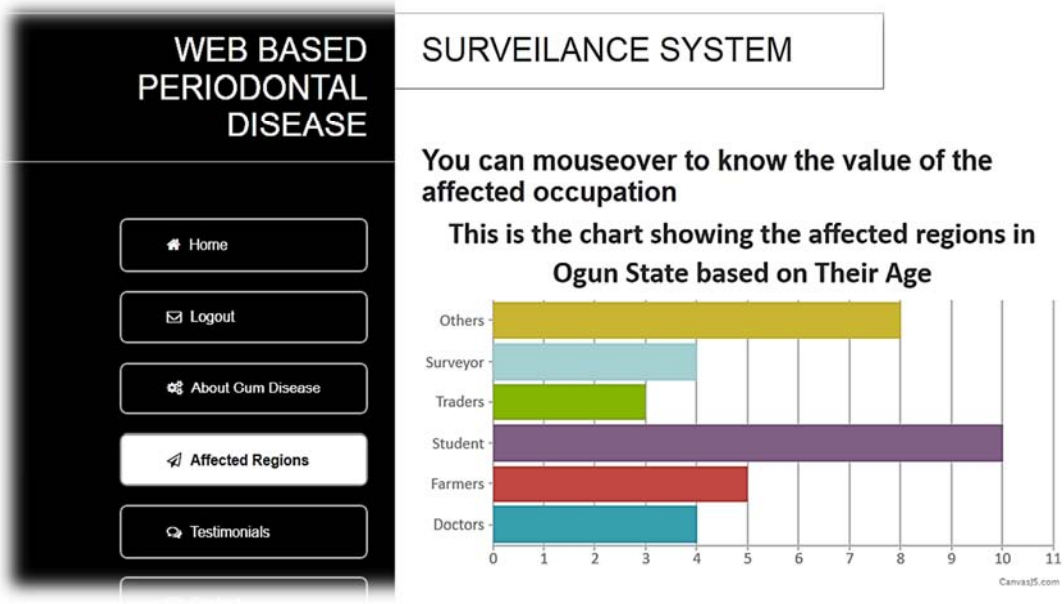

Figure 11. *Poultry disease distribution in Ijebu-Ode, Ogun State.*

The surveillance system for periodontal disease was developed to facilitate the easy storage and monitoring of disease related information which can be easily accessed by Admin, doctors/nurses and government and non-government agencies that are registered to the system as authorized users. This system would also act as a means of providing effective and timely information concerning the state of periodontal disease in south-western Nigeria, given the information found therein. The system also allows users to query information from different locations in South-western Nigeria. This system will be very useful to Nigeria as a result of the kind of information that is stored in the system.

The web-based surveillance system for periodontal disease was developed using the adopted data model to gather information comprehensively about periodontal diseases which help to monitor and assist in treatment of the disease and thus provide a database for storing the observations made about the diseases' occurrences in south-western Nigerian. The system will help determine the distribution rate of periodontal disease in south-western Nigeria and its prevalence rate in this region of the country. The system allows the users to register information about observation regarding periodontal disease, view disease statistics and disease distribution in different states within south-west Nigeria. Through the surveillance system for periodontal disease, the system administrators, doctors/nurses and health-care agencies/health ministry can be able to access the information available in the system as long as they are registered.

In overall, this system can become a central repository to all health across Nigeria with all information relating to different tooth-related diseases and surrounding health situations stored in one single system where analysis can be made to identify the kind of relationship that exist among the data stored. This system will hopefully aid effective and efficient decision-making and policy creation made at improving the management and prevention of such diseases in Nigerian.

5. Conclusion

Currently in Nigeria, there is no surveillance system that includes periodontal (gum) disease, requirement of resource intensive clinical measures for identifying cases of periodontal disease. In addition, no variations in measures of periodontal diseases from state to state, therefore this study addresses the problem by developing a system which will be able to help in tracking and surveying periodontal (gum) disease such as gingivitis and periodontitis within south-western regions in Nigeria.

The variables for the periodontal registry was critically investigated and identified in chapter two of the project work by extensively studying existing periodontal registries in Nigeria and the globe through related literatures. These were

used to design and implement a population-based periodontal registry data model using UML tools. The user requirements were modeled using use-case diagrams, the system requirements using system architecture and the data model using Entity Relationship Diagram (ERD). The system was implemented using Web 2.0 technologies, such as: HTML, PHP, CSS and SQL. The design and development of a web-based monitoring system that could help to monitor and assist in treatment of periodontal patients in south-western Nigeria is presented in this study. The system can assist doctors/nurses and stakeholders to monitor disease distribution in order to plan toward preventive measures.

With the web based surveillance system for periodontal disease, users can create new records for new patients diagnosed with the disease, edit existing records or search specific records based on the location. Any authorized user would be able to go online and view the distribution of patients diagnosed with periodontal disease at any desired location. This system demonstrates that web based system may enhance the surveillance of periodontal diseases by enhancing the tracking and monitoring of patient data management and this is achieved by editing and reporting. It can also enhance tracking information services, such as the provision of a query and the generation of reports to the necessary stakeholder of the system.

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