University of the Philippines Manila
College of Arts and Sciences
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DentISt: Dental Information System 2.0

A special problem in partial fulfillment
of the requirements for the degree of
Bachelor of Science in Computer Science

Submitted by:

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ACCEPTANCE SHEET

The Special Problem entitled "DentISt: Dental Information System 2.0" prepared and submitted by Maria Cristina B. Balsita in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science has been examined and is recommended for acceptance.

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Abstract

One of the first attempts in the conversion of patient dental records of UPCD to electronic records is Open DentIS. However, the system lacks some functionalities and problems were encountered when it comes to patient records access. Dental Information System 2.0 (DentISt), the second version of Open DentIS, gives UPCD clinicians free access and storage of electronic patient dental records. The system stores patient dental records containing different forms derived from the UPCD admitting section form. DentISt also provides a graphical representation of the teeth in which observations are easily added with just a few clicks. Moreover, the second version is able to address the problem with the running time of a patient dental chart.

New and improved functionalities such as querying for patients and statistics are available in DentISt. The system allows clinicians to easily search for patients according to specified criteria. Generating yearly reports is made easier too by Statistics feature of the system. The appointment scheduling feature allows clinicians to keep track of their upcoming appointments with patients. Addition of faculty clinician role also gives faculty clincians of UPCD access to patient records and added privileges such as printing of patient record and approval of updates on patient dental chart.

Keywords: Dental Information System, Dental OpenMRS Module, OpenMRS, Dental Informatics, Medical Informatics

Contents

List of Figures

List of Tables

I. Introduction

A. Background of the Study

For the past years, technology has been building an important role in medical field. The development of information systems designed specifically for the field of medicine has offered great innovation and drastic improvement on the practice. These systems make data gathering and accessing more efficient and faster.

Dentistry, a field of medicine, is in line with these advancements. Dental informatics provides a way of integrating patient data and dental records giving practitioners a better way of storing and accessing information. However, less advancements are made in this field compared to the field of medical informatics. At present, only a number of commercial dental information softwares are available. These include EagleSoft[1], DentalPro[2], Dentrix[3], and TabDental[4]. These softwares are very expensive thereby limiting the number of clinics that can use them. The first open-source software developed especially for dental management and patient record is Open Dental[5] but like other systems, it is not free. As of 2011, the cost fot the software plus the support is USD 149 per month with no upfront cost[2].

University of the Philippines College of Dentistry(UPCD) trains dentistry students academically and clinically. The college realized the importance of having dental systems to help students and professors alike, to record and access patients' data easily. The first system they used was created by a group of Computer Science students for their Software Engineering course. It was reported to have bugs. When the staff tried to reformat the computer in an attempt to fix the bugs, all the system data, along with the software's data, were erased. They were not able to recover it again [3].

In 2011, Aurielle Lee, a BS Computer Science student, created another dental information system (Open DentIS) for UPCD. Open DentIS was developed as an OpenMRS module and appears as a separate gutter in the OpenMRS system. OpenMRS is a free and open-source electronic health records system. Open DentIS can be installed on a server and access by UPCD clinicians via the web. Open DentIS makes use of Open-

[1] http://patterson.eaglesoft.net/
[2] http://www.dentalpro.org/
[3] http://www.dentrix.com/
[4] http://sfd.co/news-tabdental-windingup.html
[5] http://www.opendental.com/

MRS' concept feature by creating a dental lexicon which is based on UPCD terminlogies to standardized dental terms. Moreover, it uses the standard graphical representation of the teeth which is used to store information about a tooth of a patient [3].

B. Statement of the Problem

The creation of a Open DentIS by Aurielle Lee is a crucial advancement for UPCD. However, there are problems that still need to be addressed.

Deployment of the system is not easy. The installation of different softwares and application that will support it is a long and complicated process. After the installation, the administrator needs to manually create the clinician role. Since no SQL file was created for privileges, all privileges of a clinician role is also manually configured at the start of installation. Those without knowledge on how these work will get confused.

The Open DentIS served as a prototype to UPCD. After using it, Dean Vicente Medina of UPCD realized new features that need to be added. Needed modifications in Open DentIS include addition of options such as "normal all" and "no all" in different exam forms so as to immediately check all other options in the group. Moreover, they want the dental chart to be included as a tab of the patient information. Additional features requested include the addition of faculty clinician roles to manage the clinicians and patient records. The dental system should allow for viewing of appointments between clinicians and patients. The system should also generate printable patient records and statistics.

Another problem of Open DentIS is the accessing of a patient's dental chart. When a clinician wants to edit a particular dental chart, he will need to edit and submit patient information first, before having to do the task. This sequence of tasks will be very incovenient since it is not in accordance with the normal worflow of clinicians.

The loading of a patient's dental chart is also a problem of Open DentIS. Most of the time it takes long for it to load, especially if a lot of data is already stored in that dental chart. One possible reason for this is the dental chart is coded in Javascript which puts a burden on the client browser. Also, errors are present in the JavaScript console whenever the dental chart is accessed. This may have affected the performance of the system.

C. Objectives of the Study

To create Dental Information System (DentISt) which is the second version of Open DentIS with the following roles and their respective functionalities:

1. to allow users having clinician role to perform the following
    (a) to search and view patient records
    (b) add and edit dental chart of a patient
    (c) add and edit services rendered to a patient
    (d) add and edit consultations/referrals of a patient
    (e) schedule appointments with patients
    (f) view personal appointment schedules
    (g) query for patients having the following criteria
        i. male patients
        ii. female patients
        iii. patients within an age group
        iv. patients having a certain job
        v. patients living in an area
        vi. patients needing a specific treatment
        vii. patients with specific dental condition
2. to allow users having clinician in Oral Diagnosis role to
    (a) perform clinician role functionalities
    (b) add patient records
    (c) edit patient record's Oral Diagnosis forms
3. to allow users having faculty clinician role to
    (a) perform clinician role functionalities
    (b) print patient records
    (c) approve updates on patient dental chart
    (d) view list of appointment schedules of clinicians

(e) search and view clinicians

(f) view statistics of the section within a specified time period

i. number of patients with specific dental condition

ii. number of patients who underwent a particular treatment

iii. number of patients needing a specific treatment

iv. number of male patients

v. number of female patients

vi. number of patients within an age group

vii. number of patients living in a particular location

4. to allow system adminstrator to

(a) manage user accounts

i. add/edit/delete/search/view user accounts

ii. add/remove clinician role to/from user accounts

iii. add/remove system administrator role to/from user accounts

iv. grant/revoke faculty clinician role to/from clinicians belonging to a section

(b) view statistics within a specified time period

i. number of patients with specific dental condition

ii. number of patients who underwent a particular treatment

iii. number of patients needing a specific treatment

iv. number of male patients

v. number of female patients

vi. number of patients within an age group

vii. number of patients living in a particular location

viii. number of patients treated/registered over the time period

D. Significance of the Project

The DentISt is an important information system for UPCD to help them collect, organize and store data efficiently. Patients do not need to write down information manually

thereby avoiding readability issues. Also, there is no need for a safe, large repository of papers since data is in electronic form which is more secured. The search for patient information is made easier since data is be stored orderly and in one place. More importantly, data can be easily accessed via the web.

Setting appointments with patients is made easier using DentISt. Viewing own list of upcoming appointments helps clinicians prepare. Patients are to be informed or reminded earlier to avoid missed appointments.

Addition of faculty clinician roles gives faculty clinicians of UPCD access to patient dental records. The need for approval of updates on patient dental chart by a faculty clinician ensures that any observation entered on the dental chart is final and correct.

Statistics can help UPCD in decision-making. Knowing which cases are more frequent lets them know which section needs more clinicians in a particular time. It also helps them summarize the number of patients and cases treated and the services needed by patients, at a given time. Generating yearly reports is made easier through this.

Moreover, in comparison with Open DentIS, DentISt is much faster in terms of loading of the dental chart. Application crashes are prevented. It also follows the normal clinician workflow which means in doing simple tasks, unnecessary steps are avoided.

UPCD do not have to spend much on the system since the platform, OpenMRS, is a free open-source software. Using OpenMRS also increases and contributes to the possibility of creating future dental information systems through different open-source platforms, thereby giving a chance for clinics to use these systems without paying a lot.

E. Scope and Limitations

1. DentISt is created as an OpenMRS module.

2. The following forms can only be added and edited by clinicians in Oral Diagnosis (OD forms)

    - Patient Information Form
    - Physical Assessment Form
    - Vital Signs Form
    - Dental History Form

- Medical History Form
- Social History Form
- Soft Tissue Exami Form
- Radiographic Exam Form
- Treatment Plan Form

3. The system is designed based on University of the Philippines Manila - College of Dentistry clinical processes (from patient information gathering to setting appointments).

4. The system uses UPCD lexicon curated by Aurielle Lee in Open DentIS.

F. Assumptions

1. If a patient is admitted and needs a treatment, the faculty decides which clinician will treat the patient.

2. User accounts are manually created by the system administrator or can be requested by the clinicians themselves.

3. All students are given clinician access in DentISt.

II. Review of Related Literature

Dental informatics applies computer and information science to improve dental practice, research, education, and management [4]. It has developed significantly since the 1960s, when the first uses of informatics approaches to address dental issues were documented. It provides a way of integrating dental records with patient information using computer technology. The dental informatics discipline aims to support and improve diagnosis, treatment and prevention of disease and injury and preserve and improve oral health [5]. While biomedical informatics is an established discipline, dental informatics is a small but growing discipline [1]. It has gone through a number of developments since computers were first exploited to address problems in dental practice, research and education. There are signs proving that dental informatics is establishing itself as a discipline. However, there are still dangers that continue to hinder its growth and development. These include the need for standards such as controlled vocabularies or knowledge-based ontology of dental concepts and information representation and architecture [6].

Nowadays, an increasing number of dental offices are using electronic information technologies. As technology advances and become more effective, the use of electronic patient records (EPRs) is becoming a common practice. They offer not only great quality, but also patient-safety benefits [7]. Electronic patient records are computer-based tools designed to provide clinicians with access to complete, comprehensive, and accurate data about patients [8]. Also known as computer-based patient records (CPRs) [9], electronic patient records are said to be the next step for the dental information technology industry in the quest to digitize almost every aspect of dental practice. EPRs' benefits particularly for large clinical institutions are obvious. With the use of EPRs, document storage and access should be easier and control of records should improve. It should also offer value information for better clinic management and excellent data for evaluation for overall patient care [10]. Ultimately, EPR should improve health care quality [11].

As of 2002, general dentists who used computers in the clinical environment (i.e, in the dental operatory) in the United States reached 25%. However, only 1.8% maintain completely CPRs. The confusion as to what clinical information fields the dental records

must or should contain is a major reason for this. Most clinicians still prefer paper-based records than computer-based records simply because not all types of patient information can be covered by an automated dental system [12].

Usability problems have also been a great factor in retarding information system adoption [13]. These usability problems of dental information systems are of great importance since they can cause new types of errors that are less prevalent or absent when traditional approaches are used [14]. Errors may include wrong input of tooth condition since symbols for these conditions are confusing especially when using different commercial dental systems.

In learning what these usability problems are and how they affect user adoption to a system, four dental softwares namely Dentrix, Eaglesoft, SoftDent and PracticeWorks (PW) were tested in a study conducted by Monaco et al in [14].

Dentrix, developed by Henry Schein Practice Solutions has been the leading software program in practice management with almost 30,000 installations and 20 years of experience. Basic tasks like sending appointment reminders, submitting patient insurance claims, processing patient payments and accessing patient data can be done faster or automatically with Dentrix. However, in the year of 2004, the cost of the software alone ranges from USD 8,000 to USD 13,000 [15].

Patterson Eaglesoft also offers features such as digital charting, patient appointment scheduling and billing but unlike any other softwares, they allow for personalized settings. Eaglesoft packs flexible customization capabilities so one can organize information according to his preference [16].

Softdent[6] is a practice management software for dentists and clinicians alike. It includes complete hard tissue and soft tissue charting. Patient medical history can be accessed in the comprehensive electronic medical form. With its simplified scheduling, one do not need to arrange schedules by himself, the software does it for him [17].

With PracticeWorks [7] software, innovative features allows users to be more flexible about information. With its integrated management feature, users can easily manage and track referrals. Sending appointment reminders and scheduling treatments are also made easier. Above all, PracticeWorks offers reliable security to protect all patients'

[6] http://www.carestreamdental.com/practice-management-systems/softdent.aspx
[7] http://www.carestreamdental.com/practice-management-systems/practiceworks.aspx

data and financial information [18].

These dental softwares have a wide range of features and are not free. Results showed that there are lots of design problems that affected the usability of the systems. These problems include confusion of users due to the use of semantically related labels and objects by the systems. For instance, users who cannot find a way on how to label a tooth as missing recorded it as having been extracted instead. Unnecessary separation of clinically related information also contributed to the difficulty of adopting to the system. In all systems except PW, the users have had a hard time navigating from one screen to another. Also, poorly organized controls for entering findings and treatment procedures contributed to task failures of users [14].

These usability problems are due to users having different workflows which affected their adoption to the softwares. The poor match between the users and the software applications task model in three of four softwares led to the failure to complete a specific task [14].

The Open Source Software (OSS) phenomenon has become an important area of interest in information systems due to the large and fast-growing number of OSS users. Adoption and use of OSS in health care organizations is encouraged due to OSS's potential to both enhance health care delivery and lower software costs [19]. Because its source code can be inspected and reviewed, OSS offers potentially more reliability and security than proprietary softwares [20].

A lot of open-source electronic health record (EHR) systems are available nowadays. These platforms are created to aid developers in managing heath care records. Two of the most widely used open-source EHR systems in the United States and overseas are OpenVistA[8] and OpenEMR[9] [21]. Other platforms also include GNU Health[10] and FreeMed[11] and OpenMRS[12].

The first open source medical record keeping system is Veterans Health Information Systems and Technology Architecture (VistA) which is originally developed and maintained by the U.S. Department of Veterans Affairs [22]. VistA is believed to be the largest integrated Healthcare Information System in the world. It is designed to pro-

[8] http://worldvista.sourceforge.net/openvista/index.html
[9] http://www.open-emr.org/
[10] http://health.gnu.org/
[11] http://freemedsoftware.org/
[12] http://openmrs.org

vide a high-quality medical care environment for a country's military veterans. VistA has a proven track record of supporting a large variety of clinical settings and medical delivery systems. However, a major problem with VistA is that it uses Massachussetts General Hospital Utility Multi-Programming System (MUMPS) as its language. Other languages are preferred than MUMPS, which make modifications and enhancements to VistA extremely difficult [23].

OpenEMR is an ONC-ATB Ambulatory EHR 2011-2012 certified electronic health records and medical practice management application. It features fully integrated electronic health, records, practice management, scheduling, electronic billing[24]. OpenEMR is configurable to suit users' needs. OEMR, a non-profit organization supporting OpenEMR project, creates modules pre-configured to users' specialties. Users can also have complete control over the program and data. OpenEMR is free, open source and has a multilanguage support[25].

One of the most recent and promising open source EMRs is the OpenMRS. The concept of OpenMRS started on February 2004 from Paul Biondich and Burke Mamlin. OpenMRS is an open source medical record system framework for developing countries. Its free nature makes it one of the few real options in creating information systems. Because of its commitment in creating reliable medical records databases, it has attracted different programmers [26].

OpenMRS allows users to view patient data stored in OpenMRS database, thereby centralizing the patient data in a server that can be easier to access for the users, particularly medical doctors and health workers [27]. OpenMRS, being a client-server platform, can be distributed across a network of connected computers or the Internet. It is intended to provide a framework for developers to avoid the need to create a medical system from scratch.

The system is based on a conceptual table structure which is independent of the types of medical information to be collected or the forms to be used. This is very beneficial because it can be customized to different user needs. It also makes use of a concept dictionary that allows minimal use of free text and maximum use of coded information. Moreover, OpenMRS is free. All of its components and resources are available for download. The only component that is not free is a currently used plug-in, which utilizes Microsofts InfoPath program for data entry. Nonetheless, this is a small

barrier to overcome. Because of its low cost, being essentially free, most developing countries prefer to use OpenMRS [28].

It is possible to extend the use of OpenMRS to other fields of medicine by creating modules specifically designed for them. In 2011, [27] created a statistical module to allow medical doctors and researchers perform statistics and data mining with OpenMRS. The module provides data visualization through graphs and was tested in the field of pediatric epidemiology.

In the field of dentistry, [3] created the dental module of Open DentIS for University of Philippines College of Dentistry (UPCD). The module offers a standard graphical representation of the teeth (dental chart), allows for access of patient information and provides secure storage of electronic dental records.

III. Theoretical Framework

A. Dental Informatics

Dental informatics is the application of computer and information science to improve dental practice, research, education and management [5]. Improvement of patient outcomes is its main goal. Thus, the field of dental informatics must be dedicated on supporting and improving diagnosis, treatment and prevention of disease and traumatic injury, relieving pain and preserving and improving oral health. Subgoals include the efficient delivery of dental care and firm support of research and education relating to the discipline [5].

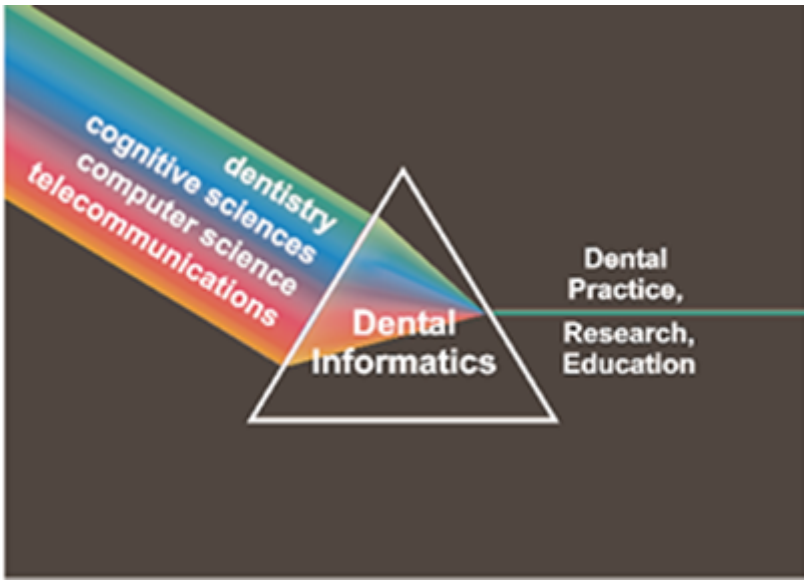

Figure 1: Dental informatics combines its methodological foundations to address problems in practice, research, and education [1]

Figure 1 shows how dental informatics combines primarily with four more component sciences of informatics to develop solutions in dental practice, research and education [1]. Dental informatics derives methods, theories, and techniques from sciences such as dentistry, computer science, cognitive science, and telecommunications.

Dentistry is defined by the World Health Organization(WHO) as the science and art of preventing, diagnosing and treating diseases, injuries and malformations of the teeth, jaws, and mouth [29].

Computer science is a discipline that involves the understanding and design of computers and computational processes. It focuses and develops data representations, algorithms, programming languages, operating systems, and computational approaches

(such as symbolic reasoning). The emphasis here is not on information, but how it is represented, processed, manipulated, and managed in computing systems.

On the other hand, cognitive science is an area which draws on several fields such as psychology, artificial intelligence, linguistics, and philosophy, to develop theories of perception, thinking, and learning. Since the central idea in cognitive science is that thinking can best be understood in terms of representational structures in the mind and computational procedures that operate on those structures, it highly relates to information science and computer science.

Finally, the science that deals with communication at a distance is known as telecommunications. Major research issues in this field include the process of communication between computers, management of traffic and usage of bandwidth efficiently. It also concerns on security of communication.

B. OpenMRS

OpenMRS is a software platform which enables design of a customized medical records system. There is a need for medical and systems analysis knowledge to fully control and benefit from the platform though programming knowledge is not necessarily required. Customization to other fields is possible since the system is based on a conceptual data which is not dependent on actual medical information that is needed to be collected [30].

There are three main layers to the system namely data model, API and web application. OpenMRS data model is HL7 compliant in terms of standard representations of observations, encounters, etc. It focuses mainly on patients, includes a room for internalization and is dedicated to guard against invalid data. It makes use of a concept dictionary with flexible semantic relationships and significant context-dependent metadata which is used in various ways throughout the application [31]. The API (application programming interface), on the other hand, wraps the data layer and hides its complexity from developers by presenting a list of methods one can use to access and store data. The user interface and modules that extend the core system functions are included in the web application layer [30].

The latest version of OpenMRS, which is OpenMRS 1.8.3, was released in December 2011. It is the maintenance release to OpenMRS 1.8 which fixed high-priority bugs introduced in version 1.8.2. Nonetheless, there were no database changes between OpenMRS

1.8.2 and OpenMRS 1.8.3. It is also forward and backward compatible [32].

OpenMRS organization also released its first OpenMRS Standalone platform which provides simplified, all-inclusive installation option with both embedded database and web server in December 2011. With the new OpenMRS Standalone, installation will be easily done by expanding the downloaded archive and running the extracted .jar file. The platform will be useful in small-scale production environments; however being new, it is still not stable and is undergoing modifications [33].

C. OpenMRS Module

A module is a packaged Java code that can be installed into a running OpenMRS instance and is able to modify almost all aspects of OpenMRS. It can provide new functionalities such as report and printing options. It can also create web pages, add tables, run applications, etc. Modules allow developers to write and integrate codes into OpenMRS without having to modify the core code base [34]. The structure of OpenMRS module and the steps in creating one can be seen in Appendix A.

D. UP College of Dentistry

1. UPCD Structure

UP College of Dentistry accepts patients in Oral Diagnosis. Basic patient information are gathered in this section. Different examinations are also performed here so as to serve as a basis on to what treatment does a patient need. These include soft tissue, dental and radiographic exams.

The UP College of Dentistry consists of different sections where clinicians work and perform treatments on patients. The three main sections are the following:

- Oral Medicine - Periodontics, Oral Surgery, Endodontics
- Prosthodontics - Removable Prosthodontics, Fixed Partial Prosthodontics
- Operative Dentistry - Orthodontics, Pedodontics, Restorative Dentistry

Oral Medicine is a specialty of dentistry concerned with the oral health care of patients with chronic, recurrent and medically related disorders of the oral and maxillofacial region, and with their diagnosis and non-surgical management. The Prosthodontics

section specializes with the diagnosis, treatment planning, rehabilitation and maintenance of the oral function, comfort, appearance and health of patients with clinical conditions associated with missing or deficient teeth and/or oral and maxillofacial tissues using biocompatible substitutes [35]. While Operative Dentistry focuses primarily on the diagnosis, prevention, treatment and prognosis of diseases or trauma to teeth. Treatments conducted should restore proper tooth morphology, function, esthetics and harmonious relationship with the surrounding tissues.

Patients may also be endorsed to outside sections or clinics that can perform specific exams or treatments not covered by UPCD.

2. UPCD Patients Workflow

The standard workflow of patients of UPCD consists of steps starting from the collection of basic information to scheduling of appointments with assigned clinicians. A treatment is performed to a patient only by the clinician he/she was assigned. When a treatment cannot be completed in one day, a patient is allowed to come back for more appointments until the treatment is finished. If all the needed treatments are carried out, the patient is checked out. If not, the patient is assigned to either a new clinician or his/her previous clinician and then proceeds to another treatment. The processes going on inside sections of UPCD are no longer in scope with the proposed dental information system. Figure 2 and 3 summarizes the workflow of patients.

The Oral Diagnosis (OD) section of UPCD is responsible for the management of patient records. When a patient is admitted in UPCD, a patient record is created. The clinician in OD then collects patient data starting from basic information such as the name, age, adrress, occupation, birthday and contact number. Then the patient undergoes physical assessment. Medical, social and dental history are asked and any history of illness is recorded. If the patient record already exists, the clinician in OD verifies if there is a clinician assigned to the patient. If none, this patient is a returning patient with new complaints so examinations are performed again. If there is a clinician assigned to the patient, either a treatment is not finished yet or another treatment is to be performed. The patient is examined by the clinician assigned to him/her.

Next, the soft tissue examination is performed. If needed, the patient is requested to take dental radiographic or X-ray examinations to be studied by the clinician. Analysis

of the radiographs are then written down on a patient data sheet. The patient's mouth and teeth are examined and observations are also examined and recorded in the dental status chart.

By then, all of the services needed by the patients, problems to be addressed and the proposed treatment are listed in the patient record. The patient is then referred to the sections in UPCD (Operative Dentistry, Oral Medicine, Prosthodontics) which will cover the treatments. A clinician belonging to that section is assigned to the patient to start the first treatment.

The clinician assigned to the patient then examines and double checks the information and exam results of the patient. The treatment is then carried out. If the treatment is not finished along the day, the clinician may schedule more appointments with patient until it is finished. If the treatment is finished, the clinician checks if all the treatments needed by the patient are carried out. If all treatments are carried out already, the patient is checked out. If not, the patient is either assigned to a new clinician or the current clinician who then performs the next treatment. To keep track of services rendered by clinicians to the patient, they are listed in the patient record.

The UPCD Admitting Section Patient Form can be seen in Appendix C.

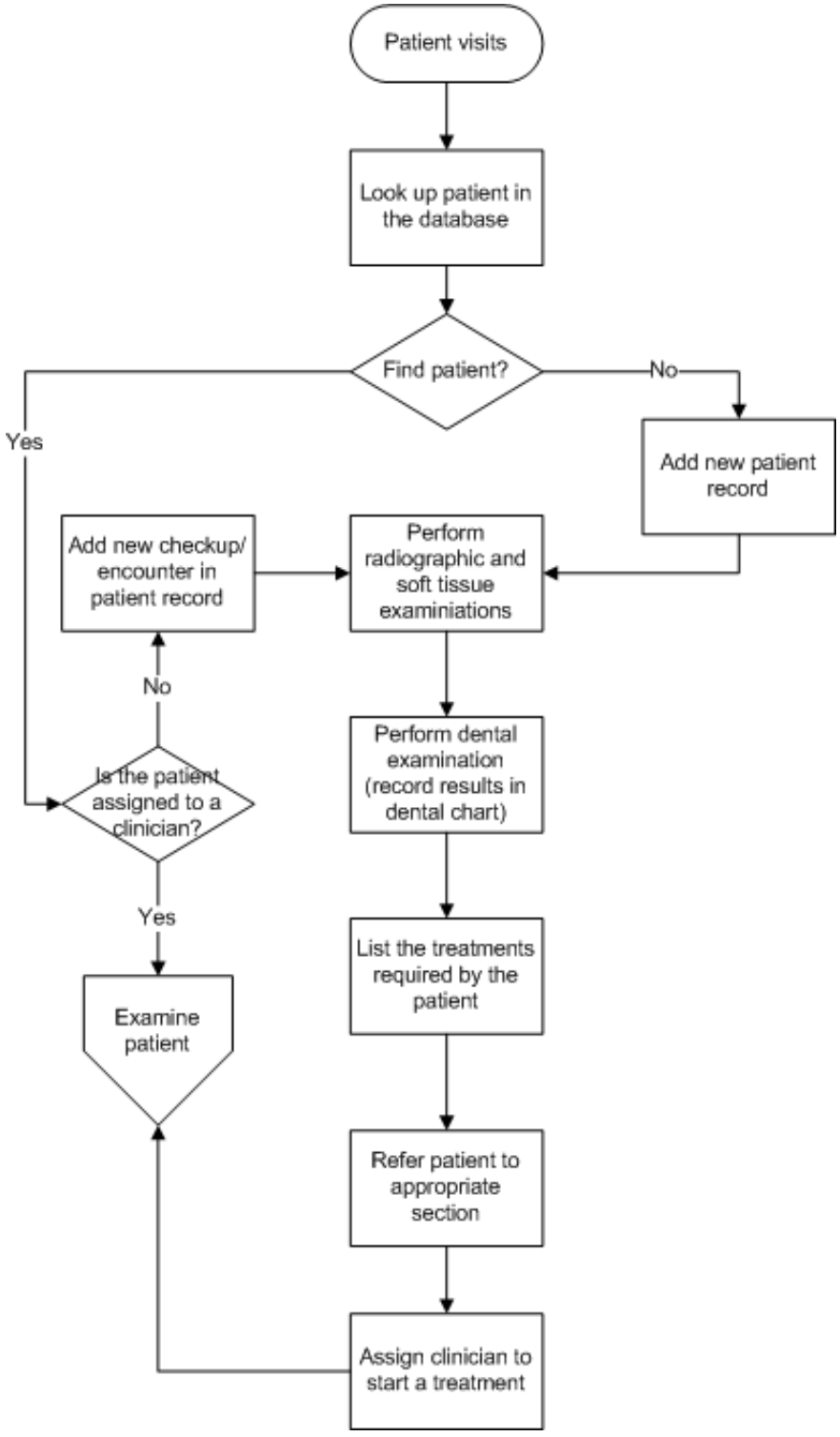

Figure 2: Workflow of Patients of UPCD

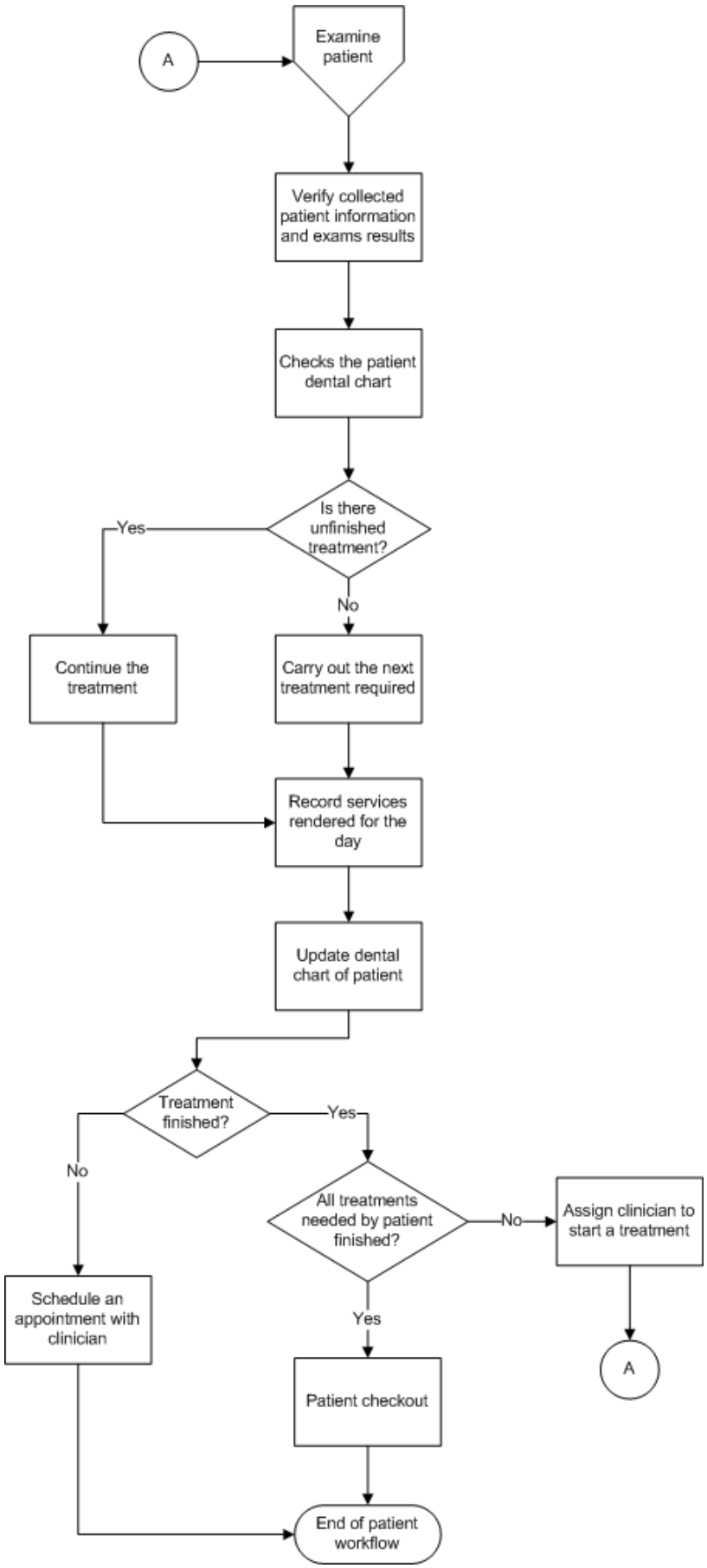

Figure 3: Workflow of Patients of UPCD

IV. Design and Implementation

A. Context Diagram

The DentISt will have two main types of roles - the System Administrator, and the Clinicians. The clinicians can be further categorized into three types - normal clinicians, clinicians in Oral Diagnosis and faculty clinicians. The context diagram is shown in Figure 4.

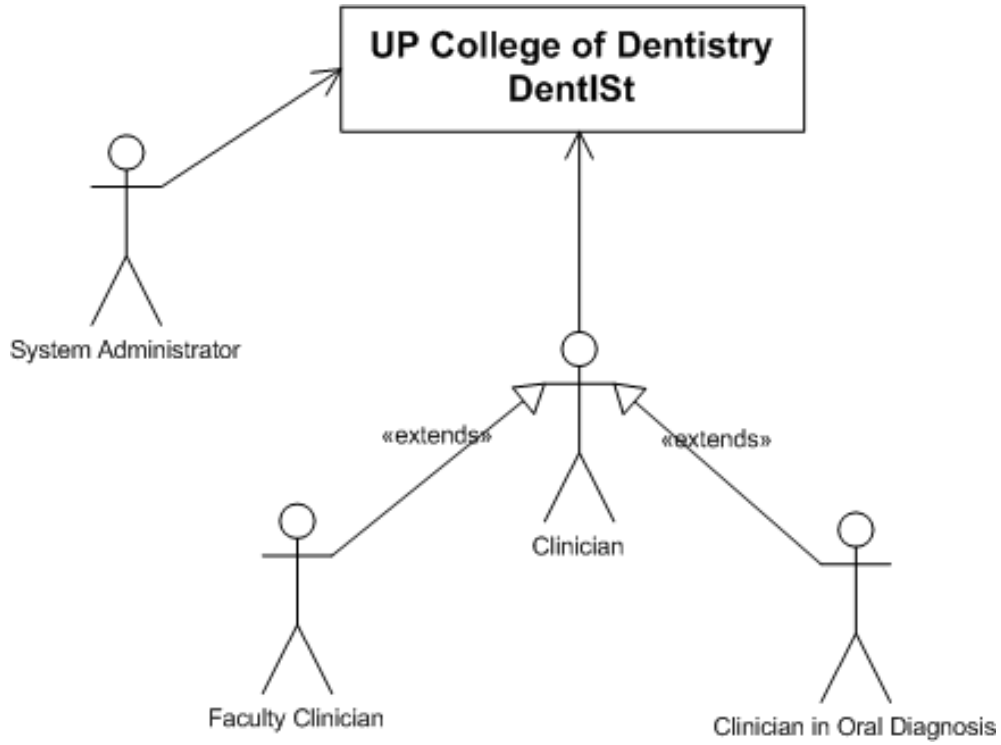

Figure 4: Context Diagram of DentISt

B. Use Case Diagrams

Clinicians can search and view patient records. They can also manage appointments and query for patients meeting certain conditions. Clinicians in Oral Diagnosis (OD) are the ones able to add patient records. Faculty clinicians, on the other hand, can manage patient records and clinician accounts. Both system administrator and faculty clinician can view statistics generated by the system. Only the system administrator has the privilege to manage user accounts. Figure 5 shows the top level use case diagram of DentISt.

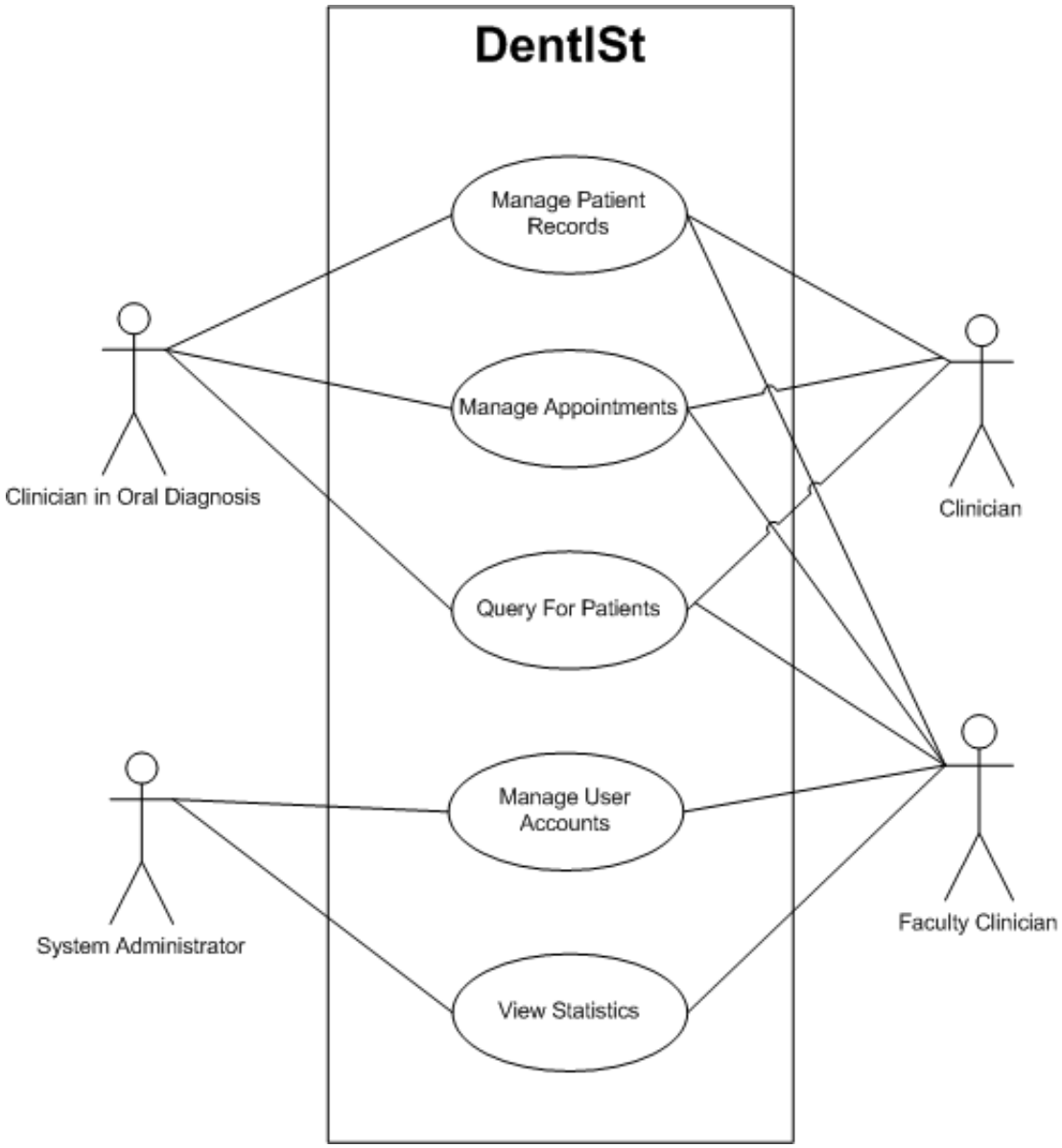

Figure 5: Top Level Use Case Diagram of DentISt

1. Manage Patient Records

The Manage Patient Records Use Case involves user accounts with clinician roles. Clinicians can search and view patient records. They can edit the consultations/referrals, services rendered form and the dental chart of a patient. Scheduling of appointments are also done by clinicians. Only clinicians in Oral Diagnosis (OD) are allowed to add patient records. They can also edit OD forms. OD forms include the basic information form, physical assessment form, vital signs form, history forms (present illness, social, medical and dental), soft tissue and radiographic exam findings and treatment plan. They can also add and edit the patient's dental chart, services rendered form and consultations/referrals. Clinicians in OD can also set appointments with patients assigned to them. Figure 6 shows the use case diagram.

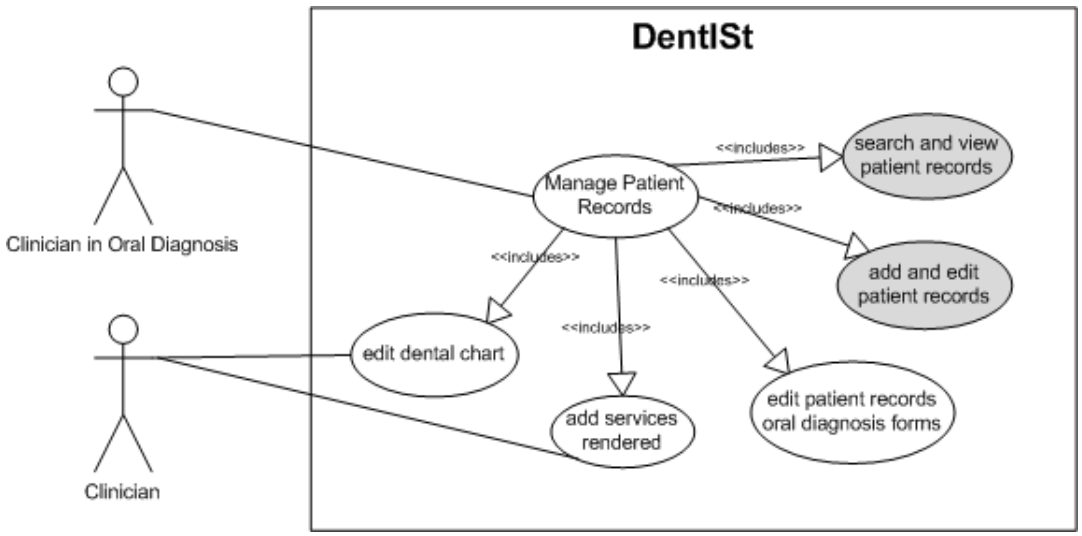

Figure 6: Manage Patient Records Use Case Diagram of Clinicians and Clinicians in Oral Diagnosis

Faculty clinicians can also manage patient records by searching and viewing them. Printing of patient records is also a task of faculty clinicians. Figure 7 shows the Manage Patient Records Use Case Diagram of Faculty Clinician. Use cases in gray are built-in OpenMRS functions.

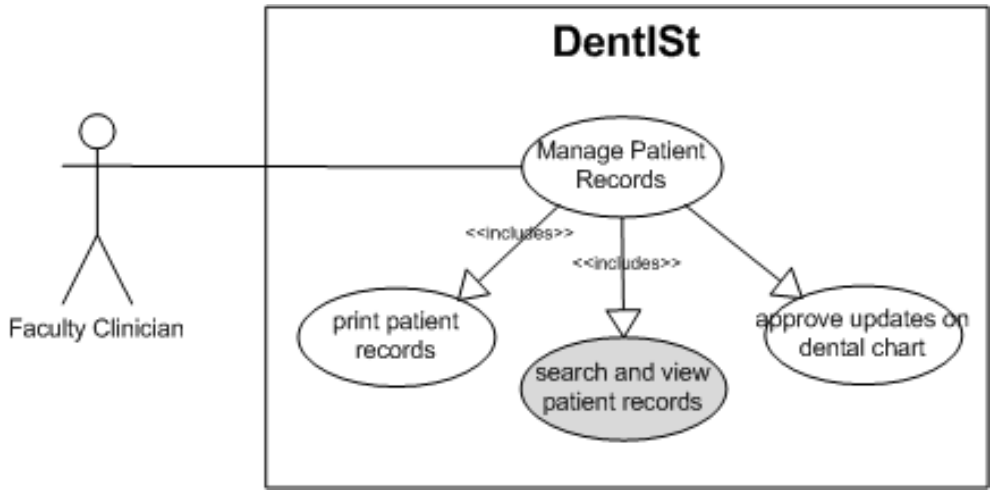

Figure 7: Manage Patient Records Use Case Diagram of Faculty Clinician

Activity Diagrams of Manage Patient Records are shown in Figures 8, 9, 10, 11, 12, 13 and 14.

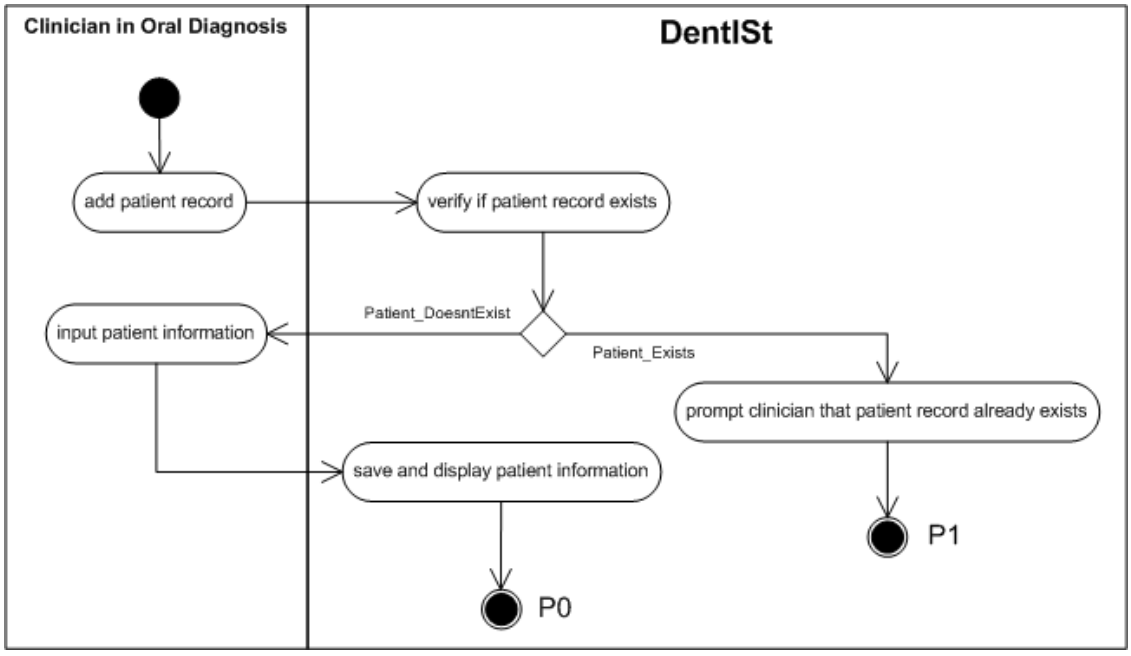

Figure 8: Add Patient Record Activity Diagram of DentISt

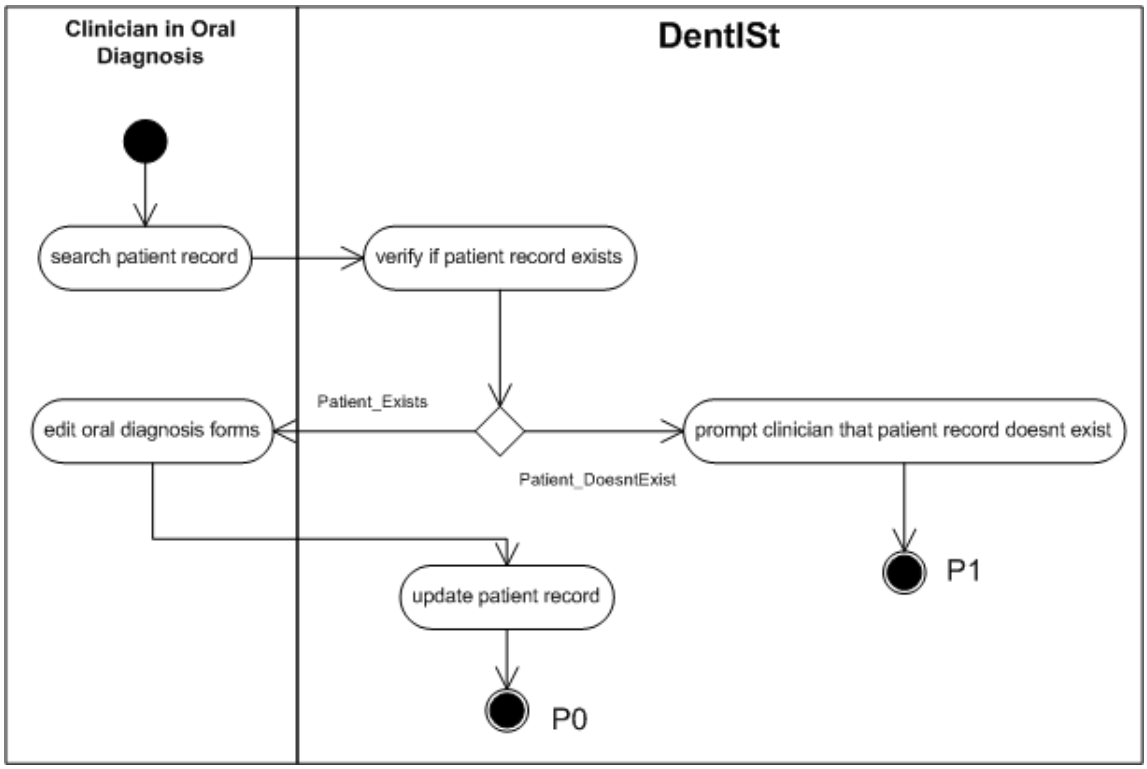

Figure 9: Edit Oral Diagnosis Forms Activity Diagram of DentISt

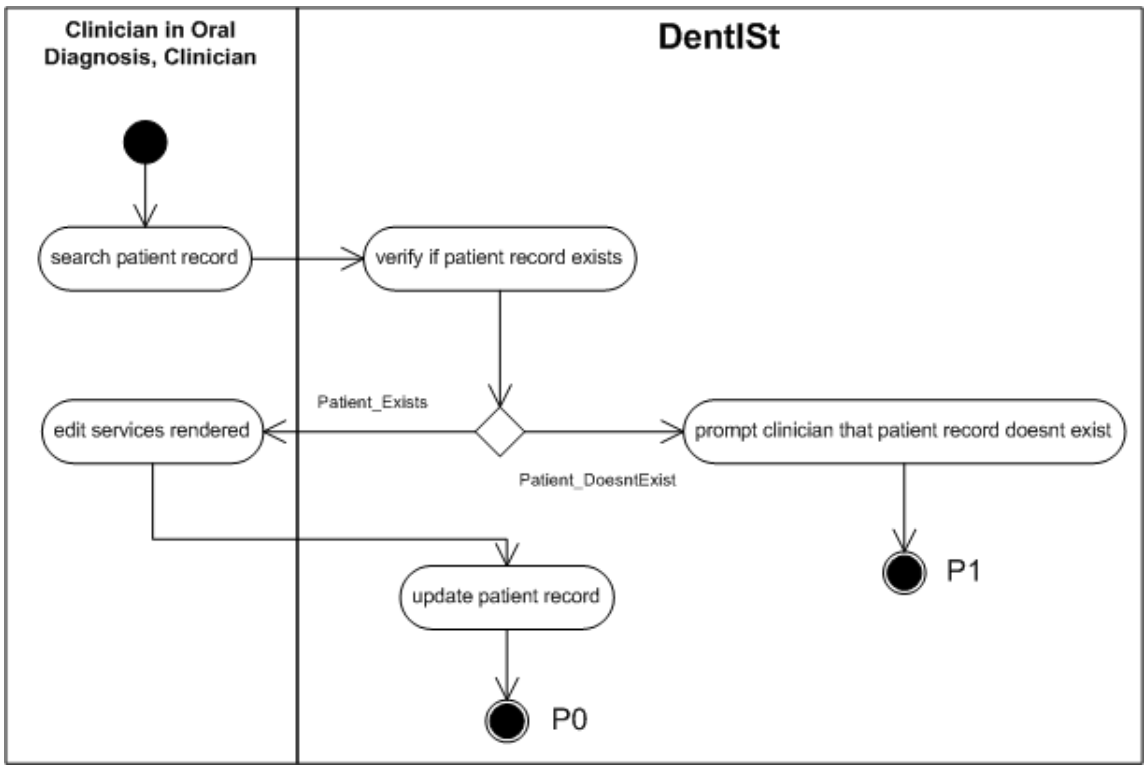

Figure 10: Edit Services Rendered Form Record Activity Diagram of DentISt

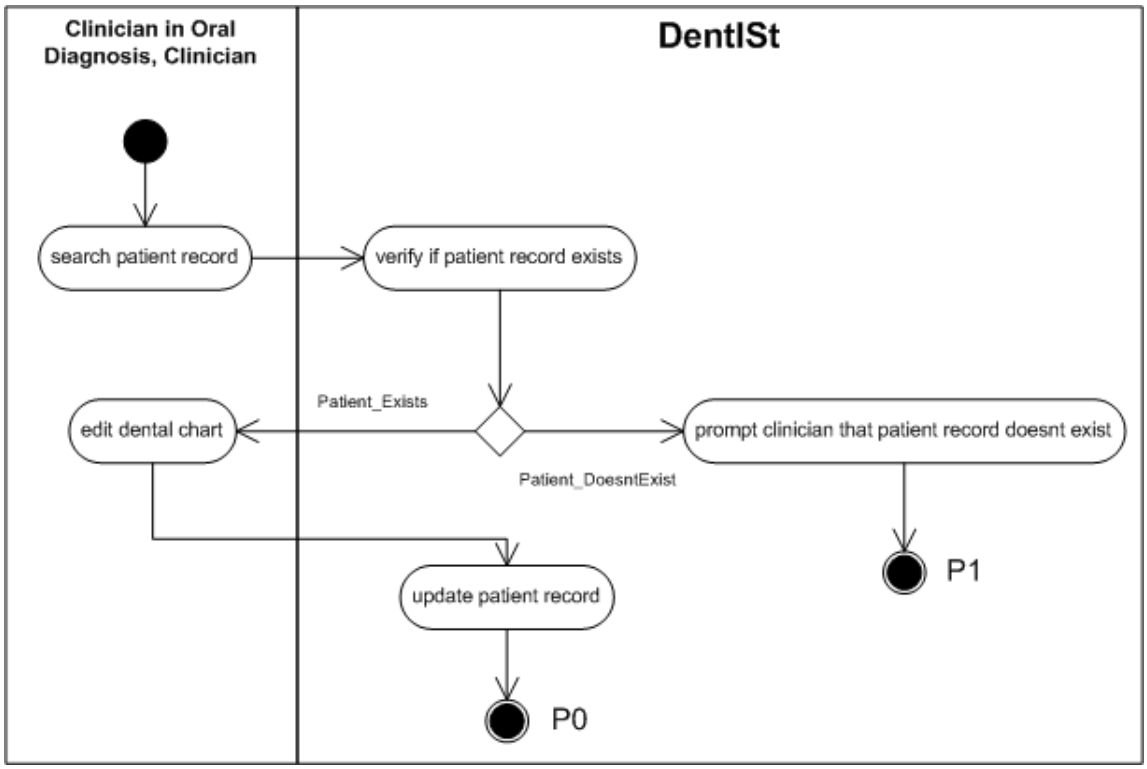

Figure 11: Edit Dental Chart Activity Diagram of DentISt

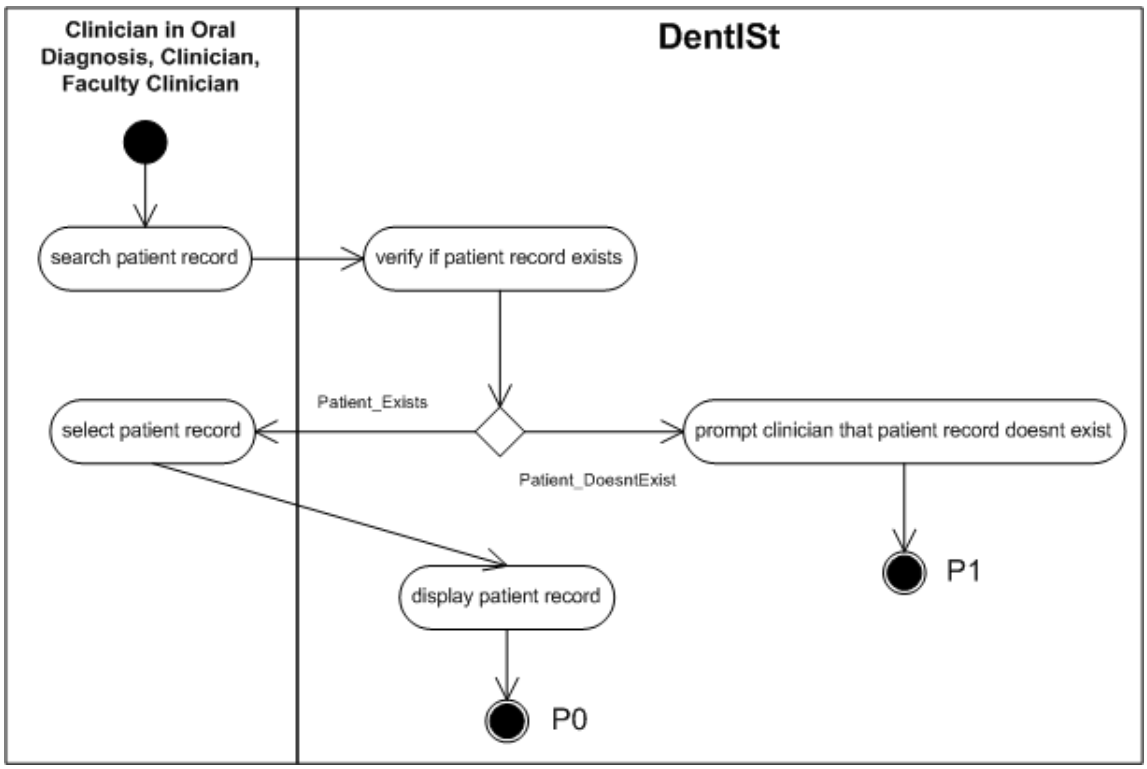

Figure 12: Search and View Patient Record Activity Diagram of DentISt

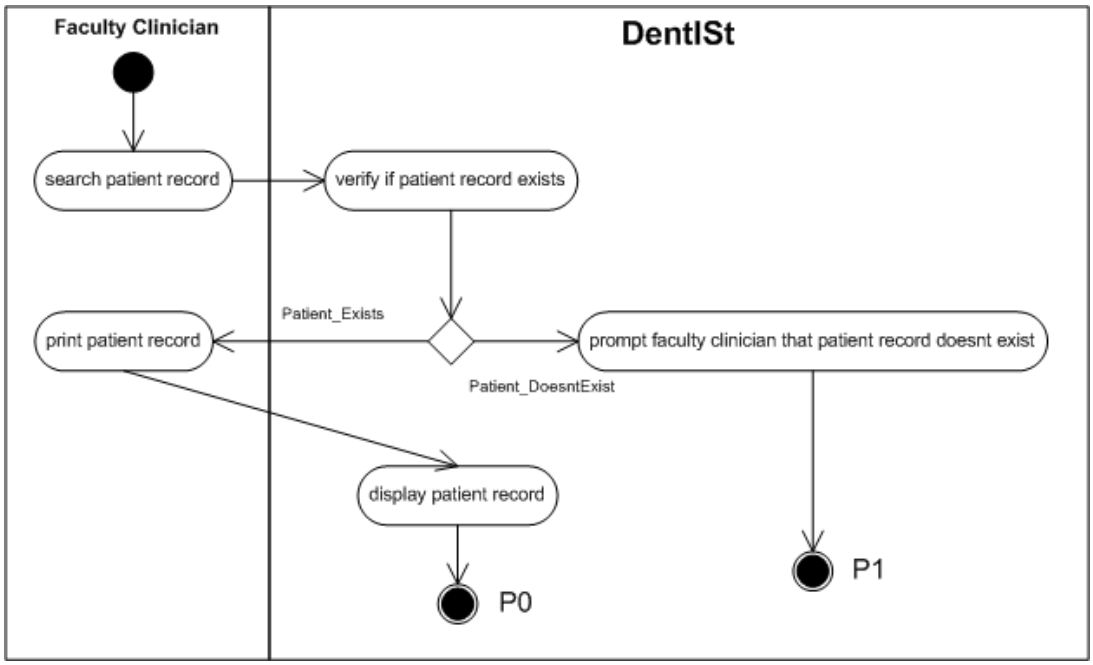

Figure 13: Printing a Patient Record Activity Diagram of DentISt

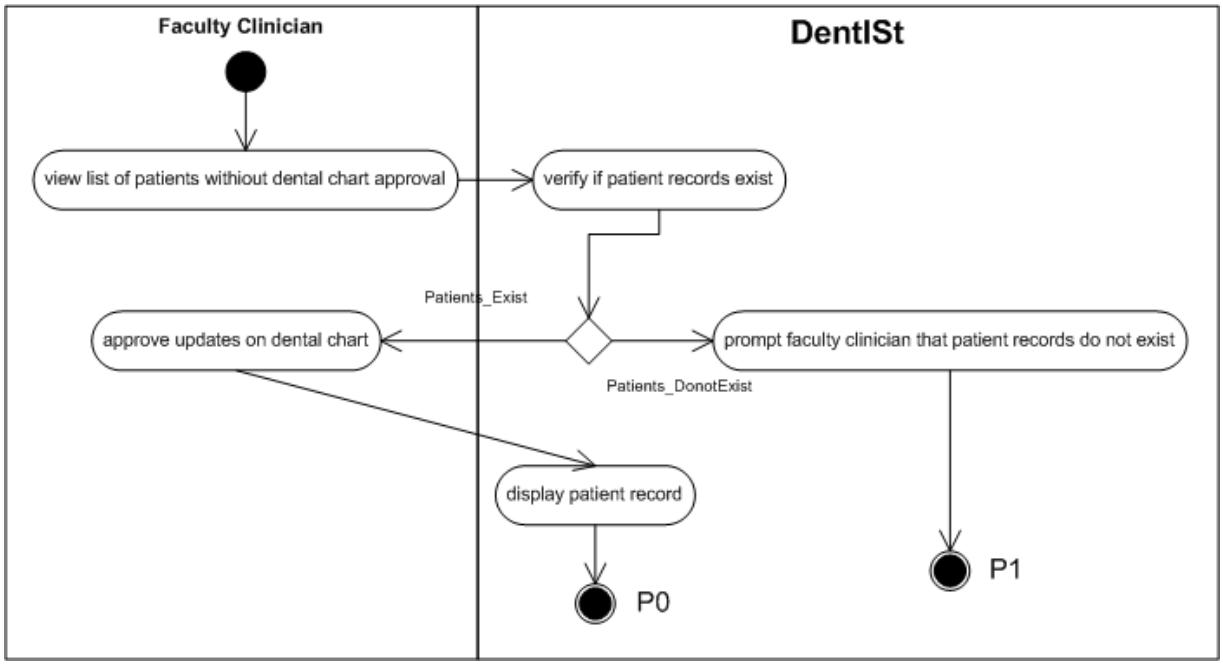

Figure 14: Approve Updates on a Patient Dental Chart Activity Diagram of DentISt

2. Manage Appointments

All clinicians, even those in Oral Diagnosis, can set appointments with patients assigned to them. The Manage Appointments Use Case Diagram is shown in Figure 15.

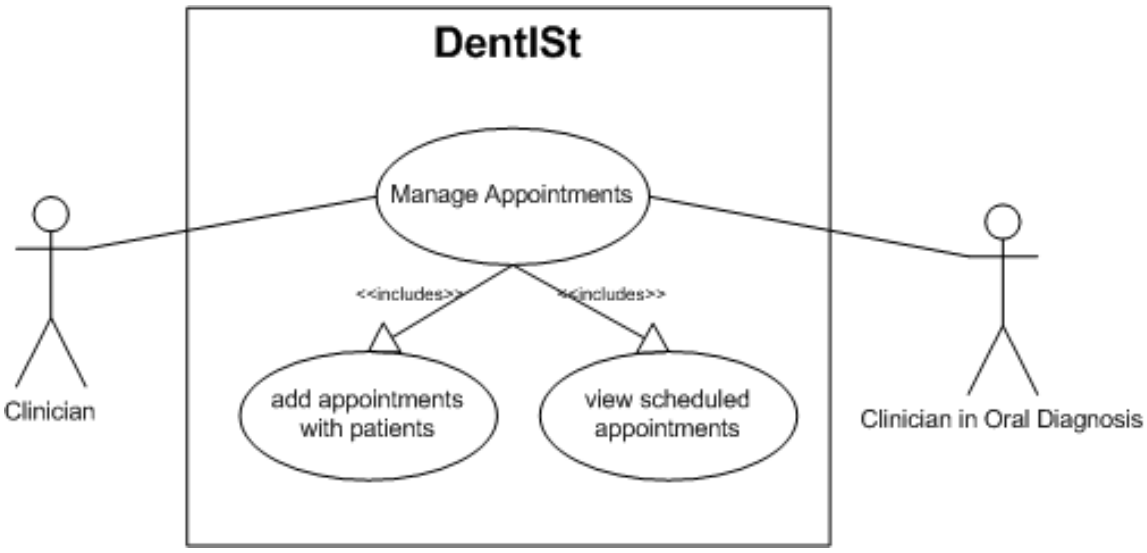

Figure 15: Manage Appointments Use Case Diagram of Clinicians Belonging to a Section

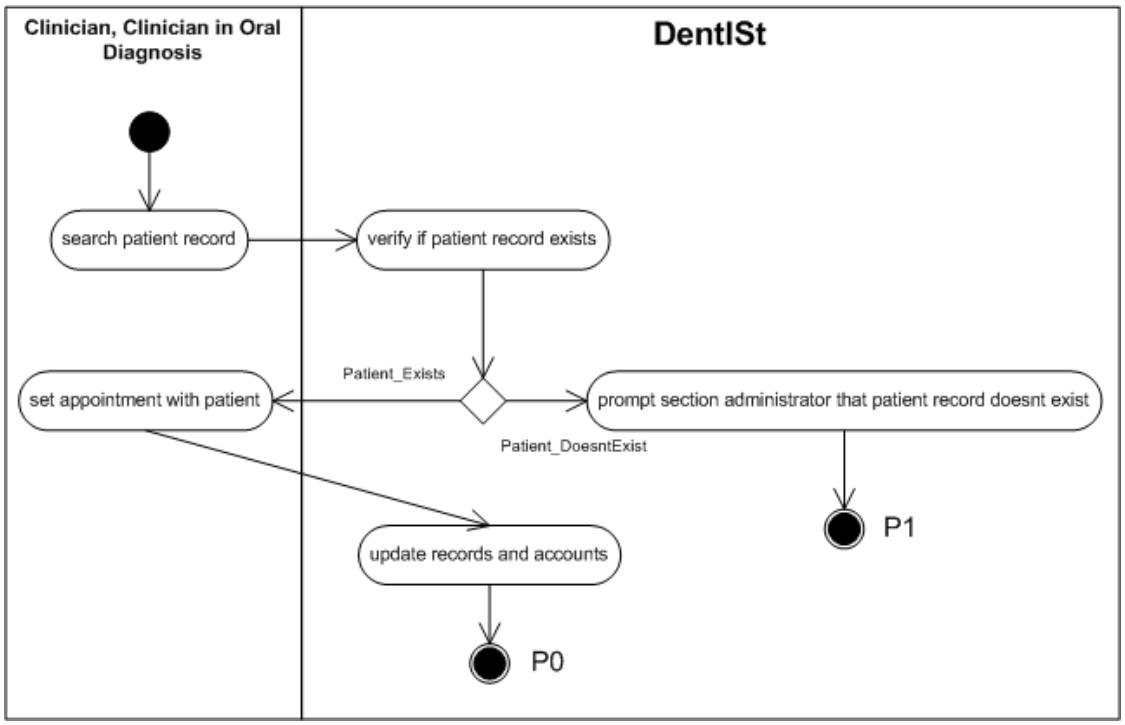

Figure 16: Set an Appointment with Patient Activity Diagram of DentISt

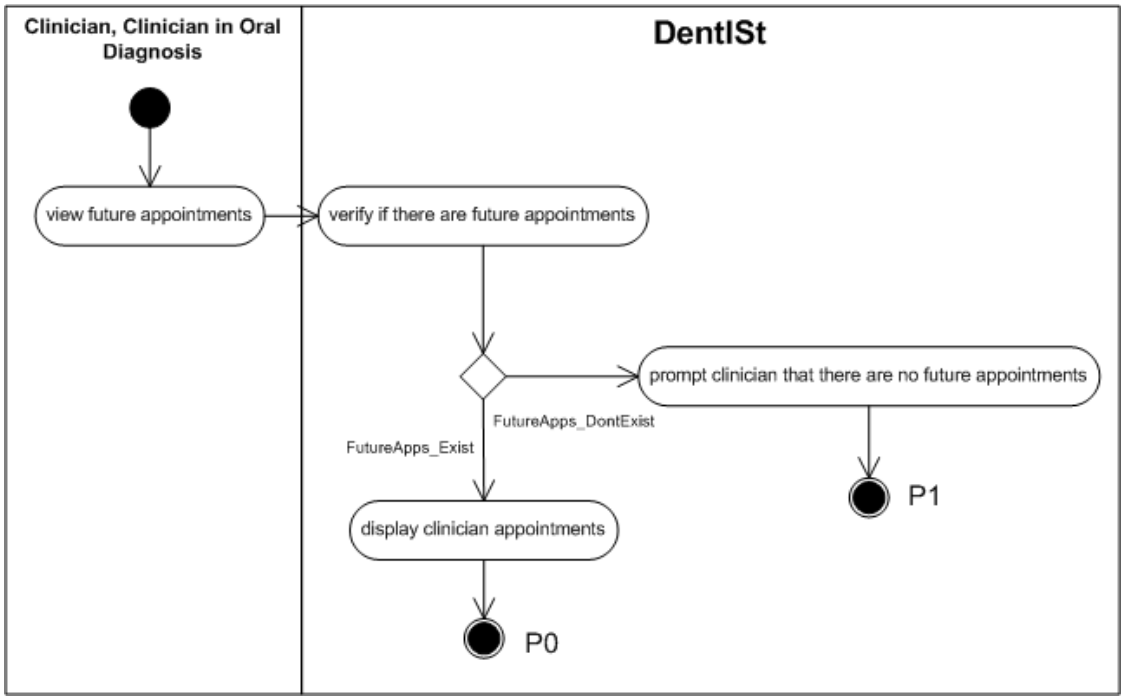

Figure 17: View Clinician Appointments Activity Diagram of DentISt

Faculty clinicians, on the other hand, can view the list of scheduled appointments of clinicians with patients.

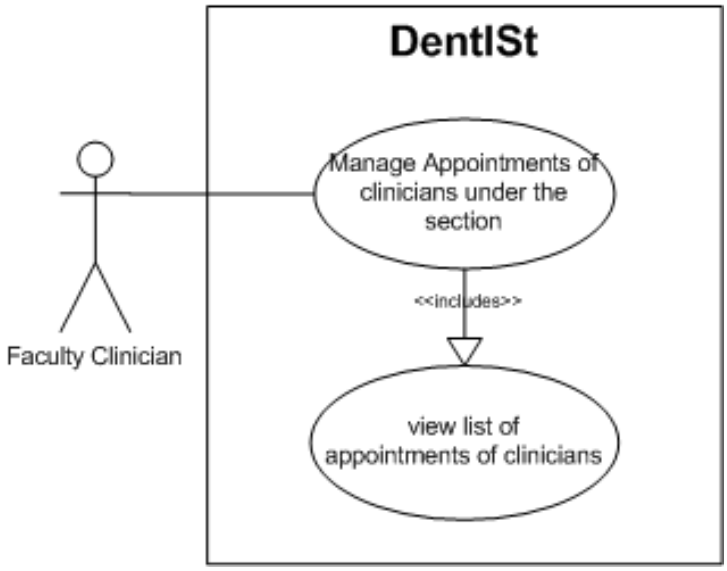

Figure 18: Manage Appointments Use Case Diagram of Faculty Clinicians

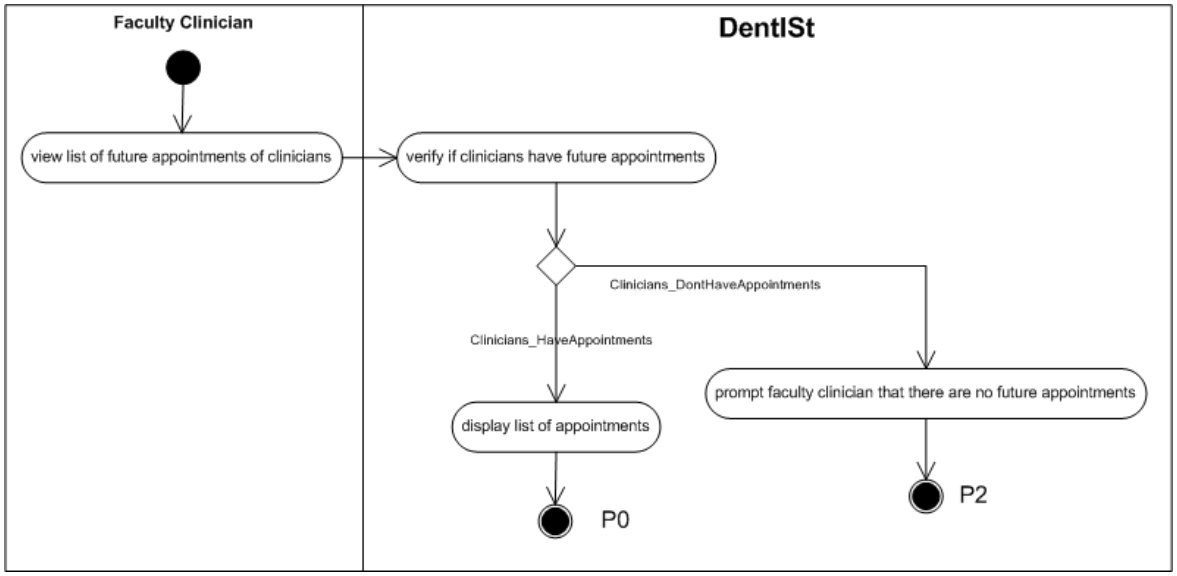

Figure 19: View List of Clinician Appointments Activity Diagram of DentISt

3. Query For Patients

All clinicians (faculty clinicians and those in Oral Diagnosis) can query for patients meeting different criterion. Criterion includes the sex, age, occupation, address, chief complaints, dental status chart and needed services of patients.

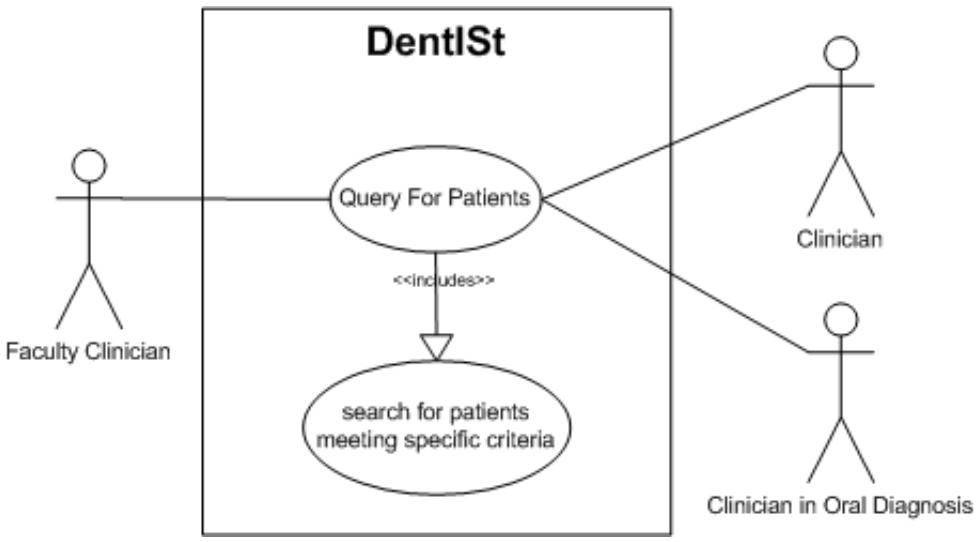

Figure 20: Query For Patients Use Case Diagram of Clinicians

The activity diagrams are shown in Figure 21.

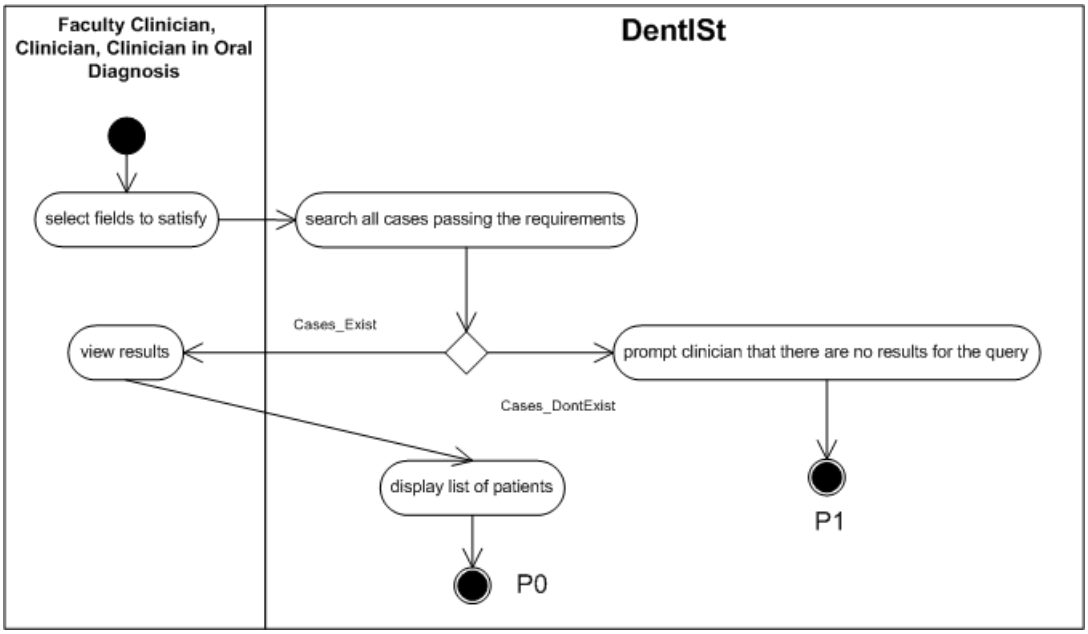

Figure 21: Search For Patients according to Specified Parameters Activity Diagram of DentISt

4. View Statistics

Statistics can be viewed by both system administrator and faculty clinicians. However, they are based on the fields set by the system administrator and faculty clinicians on their query.

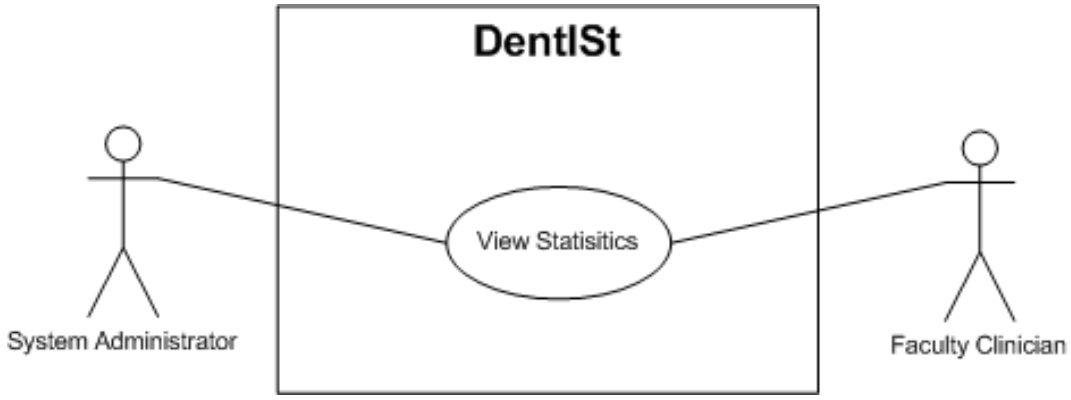

Figure 22: View Statistics Use Case Diagram of System and Faculty Clinician

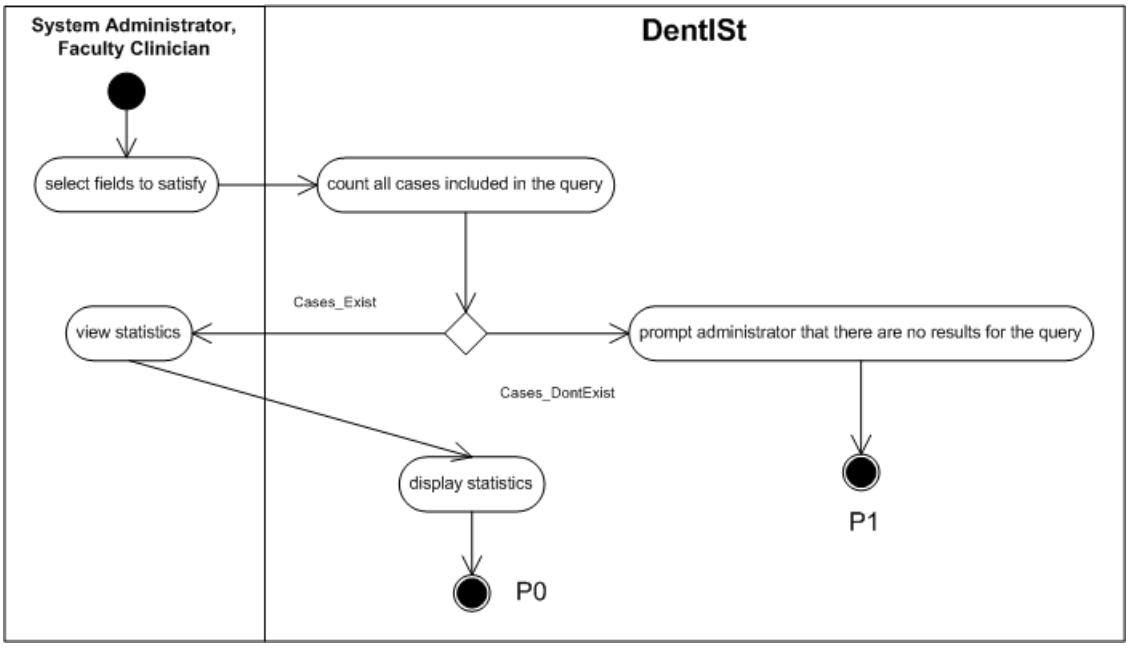

Figure 23: View Statistics Activity Diagram of DentISt

5. Manage Accounts

The Manage Accounts Use Case Diagram involves the system administrator and faculty clinician. In DentISt, system administrator can manage user accounts with clinician and faculty clinician roles. He can add, edit and delete user accounts and assign clinician roles or system administrator roles to them. The faculty clinician also manages user accounts. He can search and view accounts with clinician role.

The Manage Accounts Use Case Diagram of System Administrator and Faculty Clinician is shown in Figure 24.

Figures 25, 26, 27, 28, 29 and 30 show the Activity Diagrams for the Manage User Accounts.

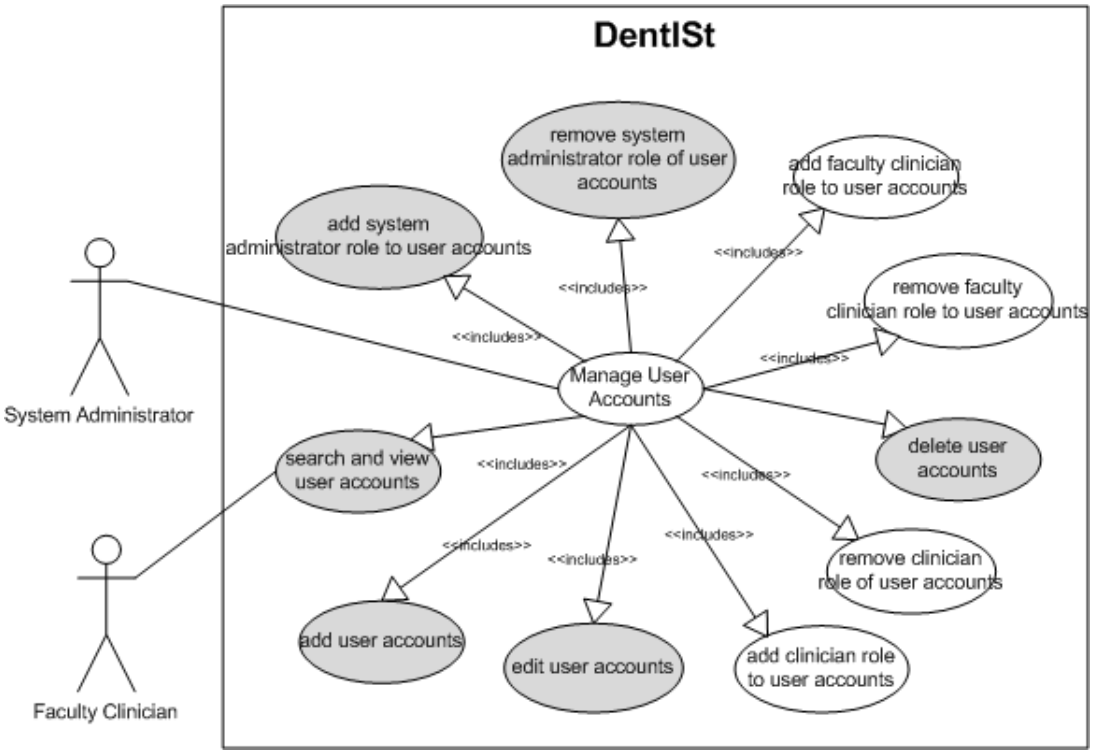

Figure 24: Manage Accounts Use Case Diagram of System and Faculty Clinician

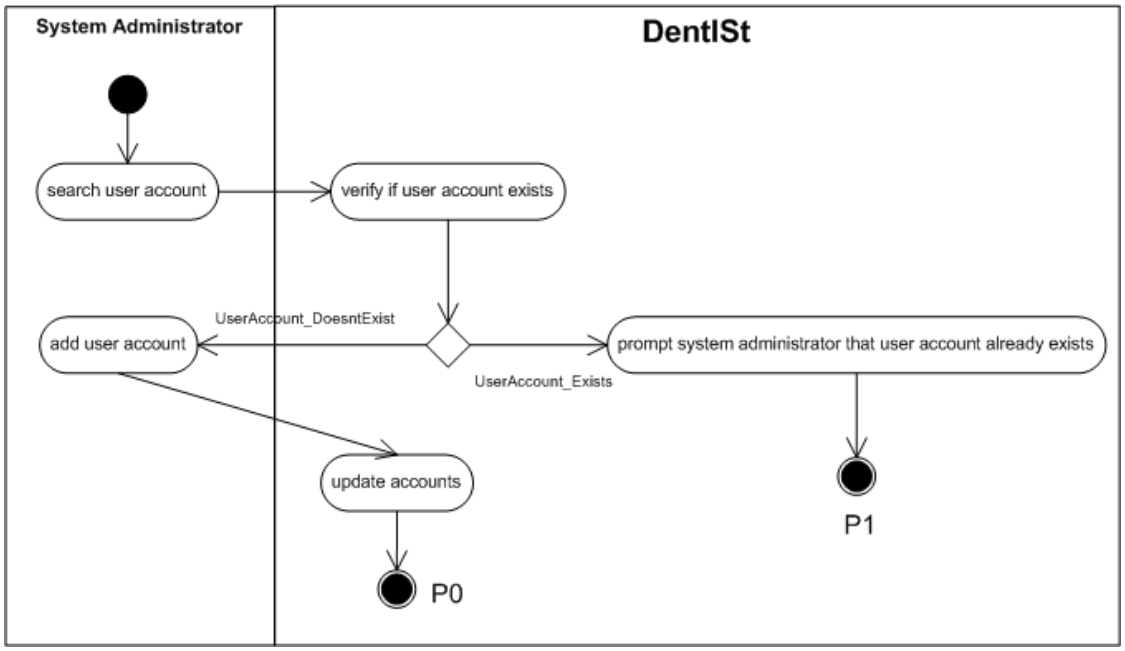

Figure 25: Add User Account Activity Diagram of DentISt

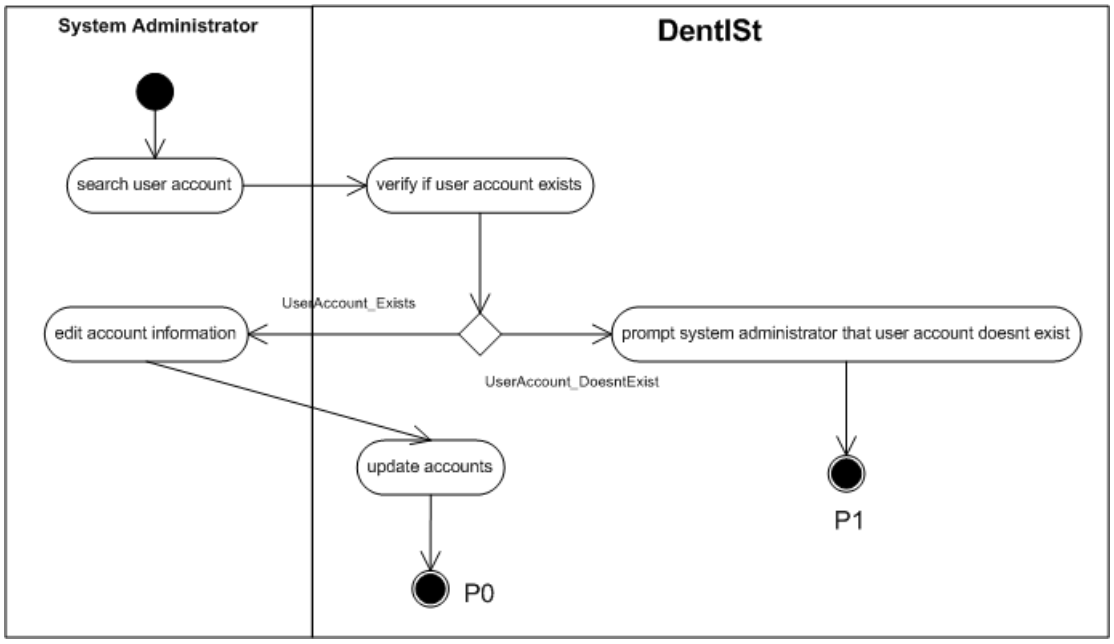

Figure 26: Edit User Account Activity Diagram of DentISt

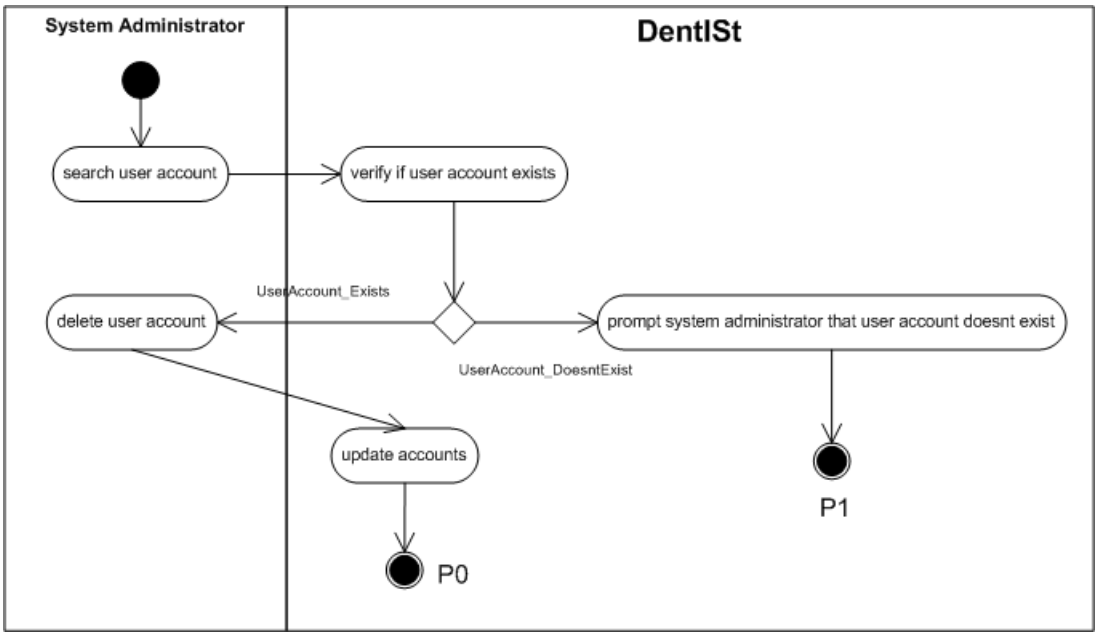

Figure 27: Delete User Account Activity Diagram of DentISt

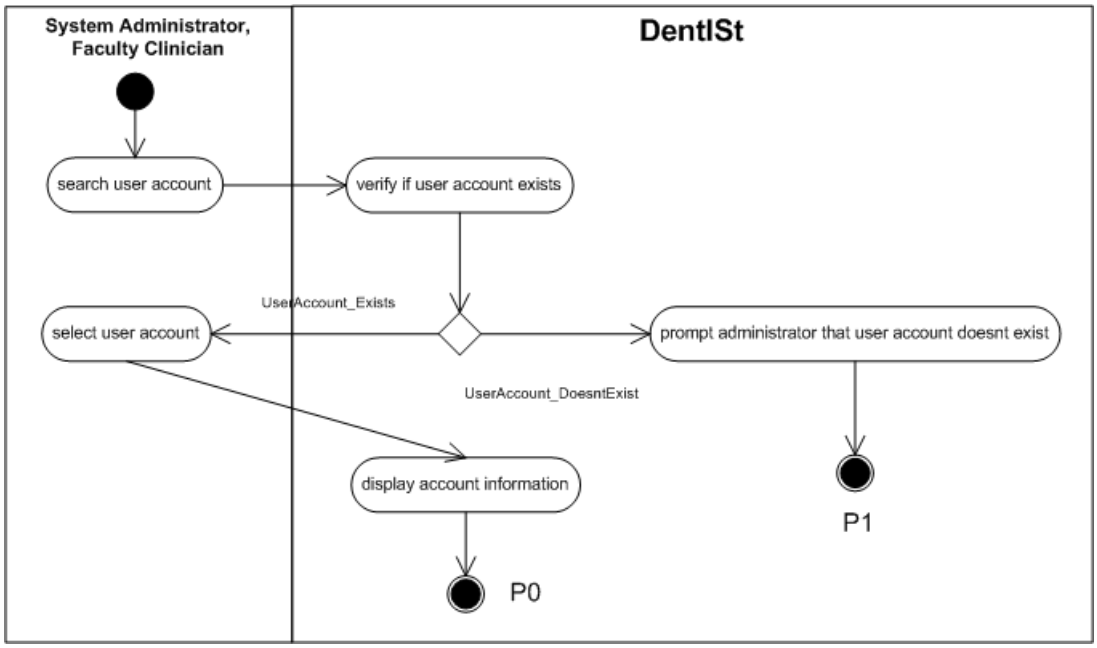

Figure 28: Search and View User Account Activity Diagram of DentISt

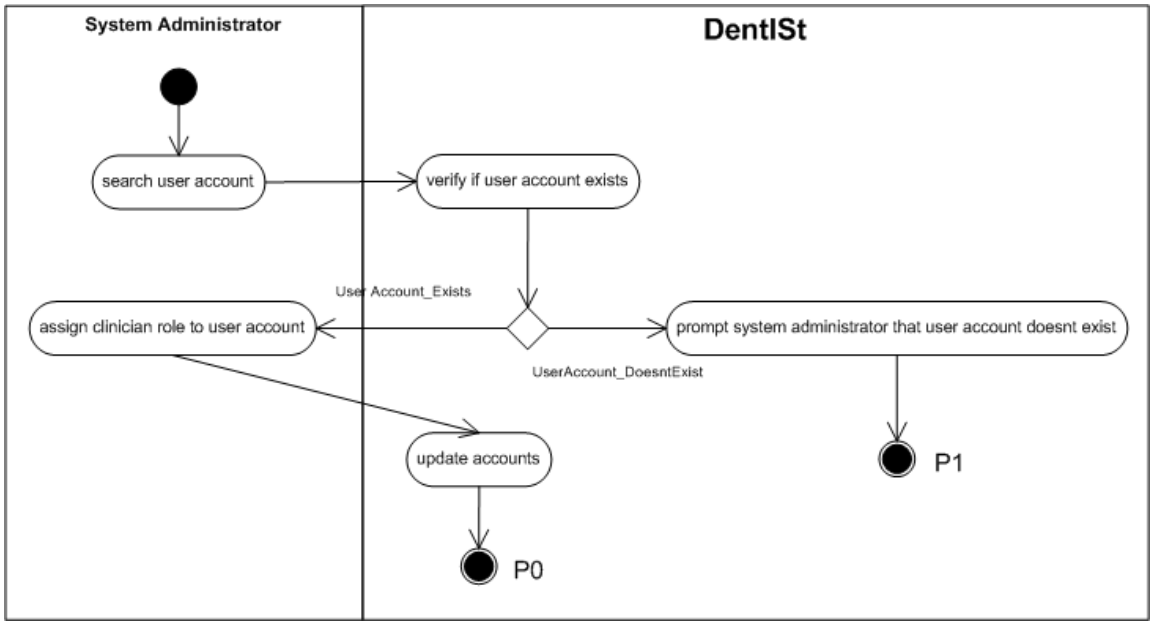

Figure 29: Assign Clinician Role to User Account Activity Diagram of DentISt

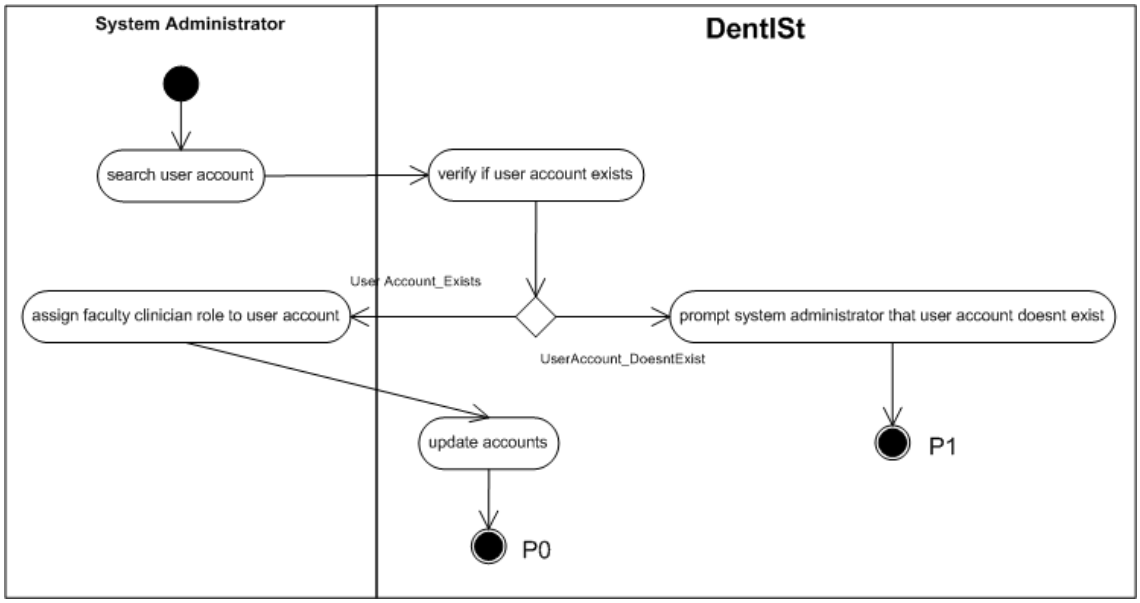

Figure 30: Assign Faculty Clinician Role to User Account Activity Diagram of DentISt

C. Entity Relationship Diagram (ERD)

Figure 31 illustrates the DentISt entity relationship diagram with the dental status surfaces table - caries_status, recurrent_status, amalgam_status, composite_status, glassionomer_status and tempfilling_status. Tables colored in gray are built-in OpenMRS tables.

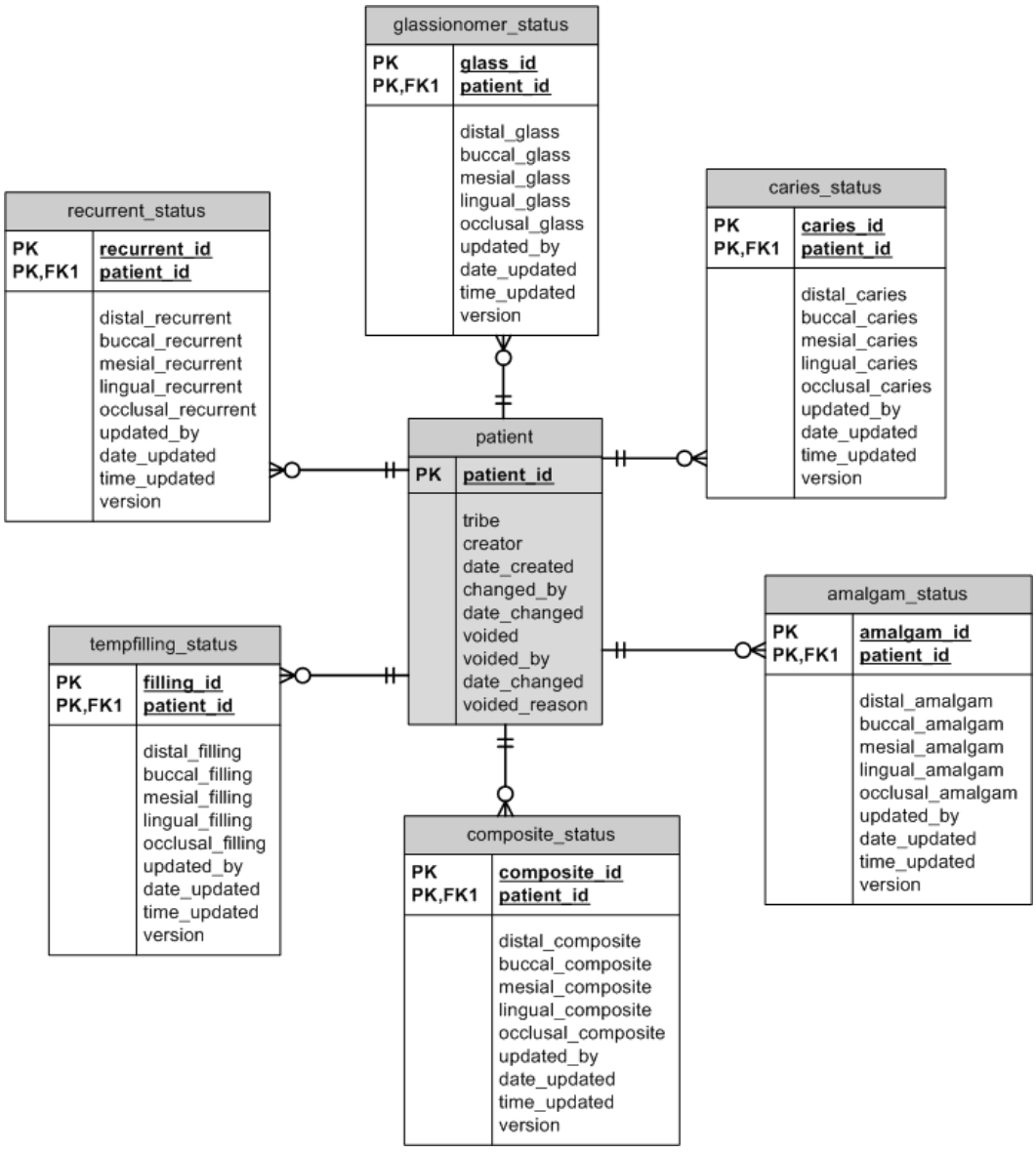

Figure 31: ERD of Patient

Tables such as the patient_check_list, services_needed and the dental_chart are shown in Figure 32.

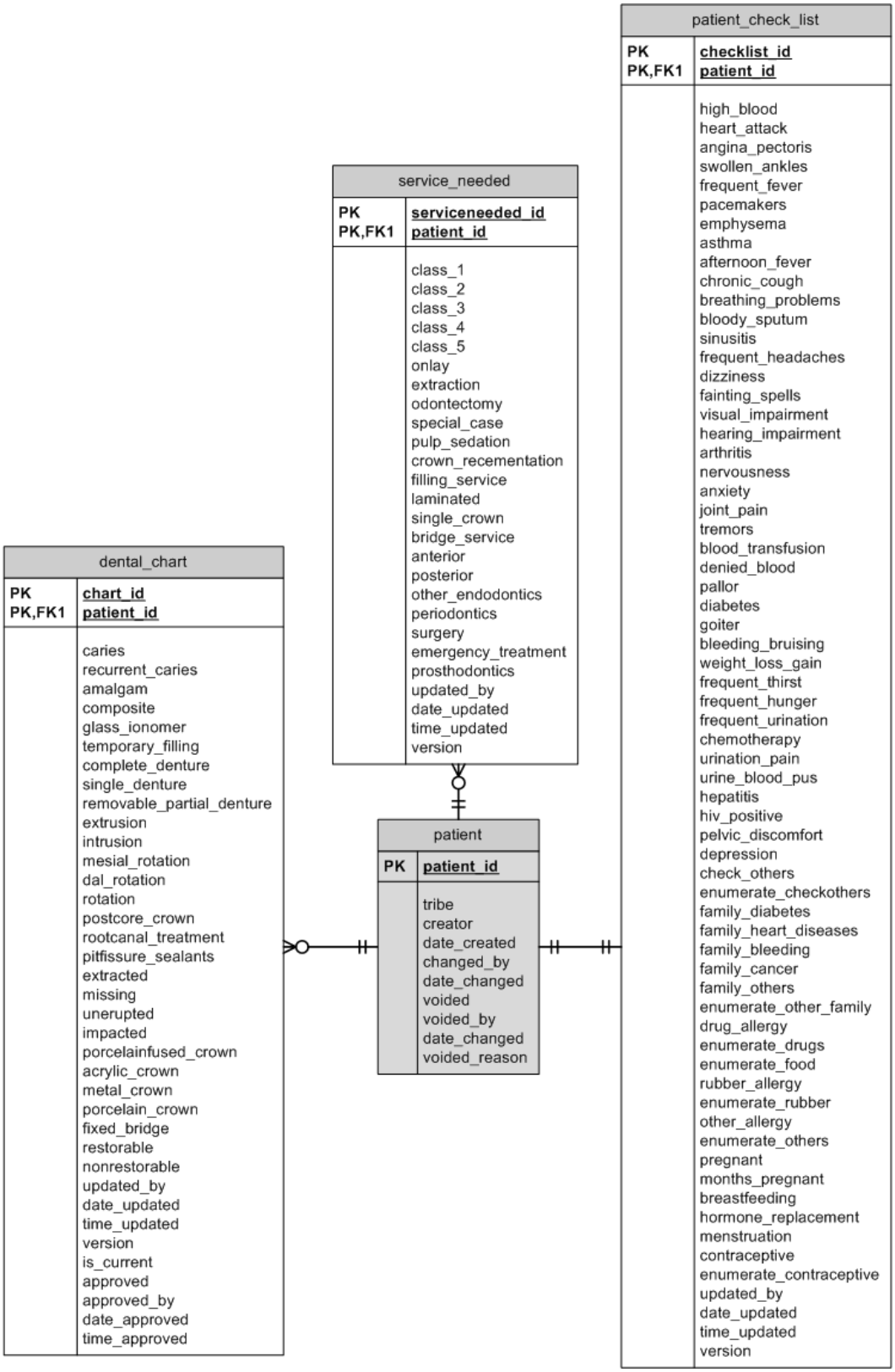

Figure 32: ERD of Patient

The Entity Relationship Diagram of patient and all other related patient information, those gathered in Oral Diagnosis, are shown in Figure 33. The tables connected to patient table are the following - patient_additional_info, patient_vital_signs, patient_physical_assessment, patient_social_history, patient_appointment, treatment_plan, patient_medical_history and patient_dental_history.

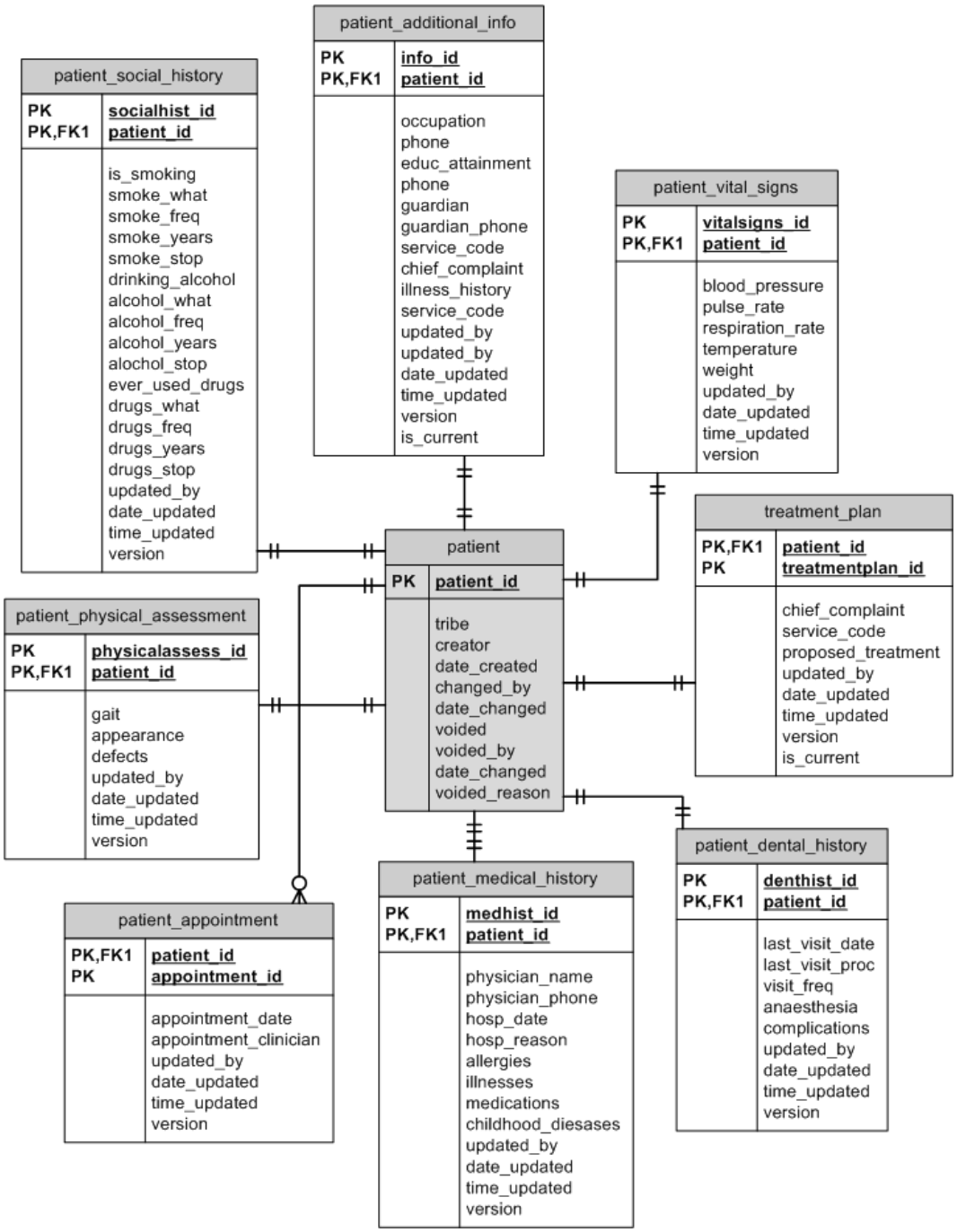

Figure 33: ERD of Patient

D. Data Dictionary

Tables with headers in gray are OpenMRS built-in tables.

Attribute	Data Type
patient_id	integer(11)
tribe	integer(11)
creator	integer(11)
date_created	datetime
changed_by	integer(11)
date_changed	datetime
voided	smallint(6)
voided_by	integer(11)
date_changed	datetime
voided_reason	varchar(255)

Table 1: Patient Table

Attribute	Data Type	Description
info_id	integer(11)	Patient information identifier
patient_id	integer(11)	Patient identifier
occupation	varchar(20)	Occupation of patient
phone	varchar(100)	Contact number of patient
educ_attainment	varchar(30)	Highest educational attainment of patient
guardian	varchar(100)	Guardian of patient
guardian_phone	varchar(100)	Contact number of guardian
service_code	varchar(20)	Service code of treatment type
chief_complaint	varchar(100)	Chief complaint of patient
illness_history	varchar(100)	Pressent illness of Patient
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version
is_current	varchar(50)	Is it the current record

Table 2: Patient_Additional_Info Table

Attribute	Data Type	Description
checklist_id	integer(11)	Checklist identifier
patient_id	integer(11)	Patient identifier
clinician_id	integer(11)	Clinician identifier
high_blood	enum('Y', 'N')	Experienced highblood?
heart_attack	enum('Y', 'N')	Experienced heart attack?
angina_pectoris	enum('Y', 'N')	Experienced Angina Pectoris?
swollen_ankles	enum('Y', 'N')	Experienced swollen ankles?
frequent_fever	enum('Y', 'N')	Experienced frequent high fever?
pacemakers	enum('Y', 'N')	Has pacemakers?
emphysema	enum('Y', 'N')	Has emphysema?
afternoon_fever	enum('Y', 'N')	Experienced afternoon fever?
chronic_cough	enum('Y', 'N')	Has chronic cough?
breathing_problems	enum('Y', 'N')	Has breathing problems?
bloody_sputum	enum('Y', 'N')	Has bloody sputum?
sinusitis	enum('Y', 'N')	Has sinusitis?
frequent_headaches	enum('Y', 'N')	Has frequent headaches?
dizziness	enum('Y', 'N')	Experienced dizziness?
visual_impairment	enum('Y', 'N')	Experienced visual impairments?
hearing_impairment	enum('Y', 'N')	Experienced hearing impairments?
arthritis	enum('Y', 'N')	Has arthritis?
nervousness	enum('Y', 'N')	Experienced nervousness?
anxiety	enum('Y', 'N')	Experienced anxiety?
joint_pain	enum('Y', 'N')	Experienced joint pain?
tremors	enum('Y', 'N')	Experienced tremors?
blood_transfusion	enum('Y', 'N')	Undergone blood transfusion?
denied_blood	enum('Y', 'N')	Denied of blood donation
pallor	enum('Y', 'N')	Experienced pallor
diabetes	enum('Y', 'N')	Has diabetes
goiter	enum('Y', 'N')	Has goiter
bleeding_bruising	enum('Y', 'N')	Experienced bleeding or bruising
weight_loss_gain	enum('Y', 'N')	Experienced sudden weight loss or gain?
frequent_thirst	enum('Y', 'N')	Frequently thirsty?
frequent_hunger	enum('Y', 'N')	Frequently hungry?
frequent_urination	enum('Y', 'N')	Frequently urinating?
chemotherapy	enum('Y', 'N')	Has undergone chemotherapy?
urination_pain	enum('Y', 'N')	Experienced urination pain?
urine_blood_pus	enum('Y', 'N')	Has blood or pus in urine?
hepatitis	enum('Y', 'N')	Has hepatitis?
hiv_positive	enum('Y', 'N')	Is HIV positive?
pelvic_discomfort	enum('Y', 'N')	Experienced pelvic discomfort?
depression	enum('Y', 'N')	Experienced depression?

Attribute	Data Type	Description
check_others	enum('Y', 'N')	Others?
enumerate_checkothers	varchar(50)	Specify others
family_diabetes	enum('Y', 'N')	Family history has diabetes?
family_heart_diseases	enum('Y', 'N')	Family history has heart diseases?
family_bleeding	enum('Y', 'N')	Family history has cancer?
family_cancer	enum('Y', 'N')	Family history has cancer?
family_others	enum('Y', 'N')	Other family history diseases?
enumerate_other_family	varchar(50)	Specify others
drug_allergy	enum('Y', 'N')	Allergic to drugs?
enumerate_drugs	varchar(50)	Specify drugs
food_allergy	enum('Y', 'N')	Allergic to food?
enumerate_food	varchar(50)	What food?
rubber_allergy	enum('Y', 'N')	Allergic to rubber?
enumerate_rubber	varchar(50)	What rubber?
other_allergy	enum('Y', 'N')	Other allergies?
enumerate_others	varchar(50)	Specify others
pregnant	enum('Y', 'N')	Is pregnant?
months_pregnant	integer(10)	Number of motnhs pregnant
breastfeeding	enum('Y', 'N')	Is breastfeeding?
hormone_replacement	enum('Y', 'N')	Is undergoing hormone replacement?
menstruation	enum('Y', 'N')	Has menstruation?
contraceptive	enum('Y', 'N')	Using contraceptive?
enumerate_contraceptive	varchar(50)	What contraceptive?
updated_by	varchar(100)	User who updated the record
date_updated	varchar(100)	Date updated
time_updated	varchar(100)	Time updated
version	integer(11)	Version

Table 3: Patient_Checklist Table

Attribute	Data Type	Description
denthist_id	integer(11)	Dental history identifier
patient_id	integer(11)	Patient identifier
last_visit_date	datetime	Date of Last Visit
last_visit_proc	varchar(100)	Last Visit Procedure
visit_freq	varchar(25)	Frequency of Dental Visit
anaesthesia	varchar(25)	Exposure and Response to Local Anaesthesia
complications	varchar(25)	Complications during and or after Dental Procedure
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 4: Patient_Dental_History Table

Attribute	Data Type	Description
physicalassess_id	integer(11)	Physical assessment identifier
patient_id	integer(11)	Patient identifier
gait	varchar(50)	Gate
appearance	varchar(50)	Appearnce
defects	varchar(50)	Defects
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 5: Patient_Physical_Assessment Table

Attribute	Data Type	Description
vitalsigns_id	integer(11)	Vital signs identifier
patient_id	integer(11)	Patient identifier
blood_pressure	varchar(7)	Blood pressure
pulse_rate	integer(3)	Pulse rate
respiration_rate	integer(3)	Respiratory rate
temperature	float(3,1)	Temparature
weight	float(5,2)	Weight
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 6: Vital_Signs Table

Attribute	Data Type	Description
medhist_id	integer(11)	Medical history identifier
patient_id	integer(11)	Name of patient
physician_name	varchar(50)	Name of physician
physician_num	integer(11)	Contact number of physician
hosp_date	datetime	Latest hospitalization date
hosp_reason	varchar(100)	Latest hospitalization reason
allergies	varchar(100)	Allergies
illnesses	varchar(100)	Illnesses
medication	varchar(100)	Medication
childhood_disease	varchar(100)	Childhood diseases history
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 7: Patient_Medical_History Table

Attribute	Data Type	Description
socialhist_id	integer(11)	Social history identifier
patient_id	integer(11)	Patient identifier
is_smoking	enum('Y', 'N')	Is the patient using or have used tobacco, cigarette?
smoke_what	varchar(25)	What kind does the patient smoke?
smoke_freq	varchar(25)	How Often does the patient smoke?
smoke_years	integer(2))	How many years has the patient been smoking?
smoke_stop	varchar(25)	If patient already stopped, how long since last used?
drinking_alcohol	enum('Y', 'N')	Does the patient drink alcoholic beverage?
alcohol_what	varchar(25)	What kind does the patient drink?
alcohol_freq	varchar(25)	How often does the patient drink?
alcohol_years	integer(2)	How many years has the patient been drinking?
alcohol_stop	varchar(25)	If patient already stopped, how long since last used?
ever_used _drugs	enum('Y', 'N')	Has the patient used drugs for recreation purposes?
drugs_what	varchar(25)	What kind of drug?
drugs_freq	varchar(25)	How often does the patient use drugs?
drugs_years	integer(2)	How many years has the patient been using?
drugs_stop	varchar(25)	If patient already stopped, how long since last used?
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 8: Patient_Social_History Table

Attribute	Data Type	Description
caries_id	integer(7)	Caries identifier
patient_id	integer(7)	Patient identifier
distal_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with caries
buccal_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with caries
mesial_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with caries
lingual_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with caries
occlusal_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with caries
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 9: Caries_Status Table

Attribute	Data Type	Description
recurrent_id	integer(7)	Recurrent Caries identifier
patient_id	integer(7)	Patient identifier
distal_recurrent	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with recurrent caries
buccal_recurrent	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with recurrent caries
mesial_recurrent	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with recurrent caries
lingual_recurrent	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with recurrent caries
occlusal_recurrent	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with recurrent caries
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 10: Recurrent_Status Table

Attribute	Data Type	Description
composite_id	integer(7)	Composite identifier
patient_id	integer(7)	Patient identifier
distal_composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with composite
buccal_composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with composite
mesial_composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with composite caries
lingual_composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with composite
occlusal_composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with composite
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 11: Composite_Status Table

Attribute	Data Type	Description
amalgam_id	integer(7)	Amalgam identifier
patient_id	integer(7)	Patient identifier
distal_amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with amalgam
buccal_amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with amalgam
mesial_amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with amalgam
lingual_amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with amalgam
occlusal_amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with amalgam
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 12: Amalgam_Status Table

Attribute	Data Type	Description
glassionomer_id	integer(7)	Glass Ionomer identifier
patient_id	integer(7)	Patient identifier
distal_glassionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with glass ionomer
buccal_glassionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with glass ionomer
mesial_glassionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with glass ionomer
lingual_glassionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with glass ionomer
occlusal_glassionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with glass ionomer
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 13: Glassionomer_Status Table

Attribute	Data Type	Description
tempfilling_id	integer(7)	Temporary Filling identifier
patient_id	integer(7)	Patient identifier
distal_tempfilling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Distal surface with temporary filling
buccal_tempfilling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Buccal surface with temporary filling
mesial_tempfilling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Mesial surface with temporary filling
lingual_tempfilling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Lingual surface with temporary filling
occlusal_tempfilling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Occlusal surface with temporary filling
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 14: Tempfilling_Status Table

Attribute	Data Type	Description
chart_id	integer(11)	Dental chart identifier
patient_id	integer(11)	Patient identifier
clinician_id	integer(11)	Clinician identifier
caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with caries
recurrent_caries	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with recurrent caries
amalgam	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with amalgam
composite	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with composite
glass_ionomer	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with glass ionomer
temporary_filling	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with temporary filling
complete_denture	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with complete denture
single_denture	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with single denture
removable_partial_denture	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with removable partial denture
extrusion	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with extrusion

Attribute	Data Type	Description
intrusion	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with intrusion
mesial_rotation	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with mesial rotation
desial_rotation	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with desial rotation
rotation	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with rotation
postcore_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with post core crown
rootcanal_treatment	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with root canal treatment
pitfissure_sealants	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with pit fissure sealants
extracted	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Extracted teeth
missing	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Missing teeth
unerupted	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Unerupted teeth
impacted	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Impacted teeth

Attribute	Data Type	Description
porcelainfused_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with porcelain fused to metal crown
acrylic_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with acrylic crown
metal_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with metal crown
porcelain_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Teeth with porcelain crown
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version
is_current	varchar(50)	Is it the current record
approved	enum(‘yes’, ‘no’)	Is the dental chart approved by a faculty clinician?
approved_by	varchar(50)	User who approved the dental chart
date_approved	varchar(50)	Date approved
time_approved	varchar(50)	Time approved

Table 15: Dental_Chart Table

Attribute	Data Type	Description
patient_id	integer(11)	Patient identifier
treatmentplan_id	integer(11)	Treatment plan identifier
chief_complaint	varchar(100)	Chief complaint of patient
service_code	varchar(20)	Service code of treatment type
proposed_treatment	varchar(200)	Proposed treatment plan
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version
is_current	varchar(50)	Is it the current record

Table 16: Patient_Treatment_Plan

Attribute	Data Type	Description
softtissue_id	integer(7)	Soft tissue identifier
patient_id	integer(7)	Patient identifier
head_neck_tmj	varchar(100)	Lesion description in the head, neck, and TMJ
mucosa	varchar(100)	Lesion description in the mucosa
pharynx	varchar(100)	Lesion description in the pharynx
tounge	varchar(100)	Lesion description in the tongue
salivary_gland	varchar(100)	Lesion description in the salivary gland
gingiva	varchar(100)	Lesion description in the gingiva
lips_frenum	varchar(100)	Lesion description in the lips/frenum
palate	varchar(100)	Lesion description in the palate
mouth_floor	varchar(100)	Lesion description in the floor of the mouth
lymph_nodes	varchar(100)	Lesion description in the lymph nodes
thyroid	varchar(100)	Lesion description in the thryoid
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 17: Soft_Tissue_Exam Table

Attribute	Data Type	Description
radiographic_id	integer(11)	Radiographic exam identifier
patient_id	integer(11)	Patient identifier
radiographic_date	datetime	Date of radiographic exam
tooth_no	set('11','12','13','14','15','16','17','18', '21','22','23','24','25','26','27','28', '31','32','33','34','35','36','37','38', '41','42','43','44','45','46','47','48')	Tooth number in radiographic exam
findings	varchar(100)	Radiographic exam findings
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 18: Radiographic_Exam Table

Attribute	Data Type	Description
serviceneeded_id	integer(11)	Service needed identifier
patient_id	integer(11)	Patient identifier
class_1	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Class 1 type tooth
class_2	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Class 2 type tooth
class_3	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Class 3 type tooth
class_4	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Class 4 type tooth
class_5	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Class 5 type tooth
onlay	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Onlay type tooth
extraction	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs extraction
odontectomy	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs odontectomy
special_case	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Special case tooth

Attribute	Data Type	Description
pulp_sedation	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs pulp sedation
crown_recementation	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs crown recementation
filling_service	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs filling service
laminated	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs to be laminated
single_crown	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs single crown
bridge_service	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Tooth that needs fixed bridge
anterior	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Anterior tooth
posterior	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Posterior tooth
ortho_endo	set(‘11’,‘12’,‘13’,‘14’,‘15’,‘16’,‘17’,‘18’, ‘21’,‘22’,‘23’,‘24’,‘25’,‘26’,‘27’,‘28’, ‘31’,‘32’,‘33’,‘34’,‘35’,‘36’,‘37’,‘38’, ‘41’,‘42’,‘43’,‘44’,‘45’,‘46’,‘47’,‘48’)	Other endodontics services
periodontics	enum(‘Y’, ‘N’)	Management of periodontal disease
surgery	set(‘pedodontics’, ‘orthodontics’)	Pedodontics or orthodontics services

Attribute	Data Type	Description
emergency_treatment	set('acute infections', 'traumatic injuries')	Acute infections or traumatic injuries
prosthodontics	set('complete denture', 'single denture', 'removable partial', 'others')	Prosthodontics services
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 19: Service_Needed Table

Attribute	Data Type	Description
consultation_id	integer(7)	Consultation/referral identifier
patient_id	integer(7)	Patient identifier
date	datetime	Date of Consultation
consultation_reason	varchar (100)	Reason for consultation
consultation_from	varchar(20)	Section where patient previously belong
consultation_to	varchar(20)	Section where patient is endorsed
consultation_findings	varchar(100)	Consultation findings
consultation_clinician	varchar(100)	Clinician name
consultation_clinician_nature	varchar(100)	Clinician nature
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 20: Patient_Consultation_Referral Table

Attribute	Data Type	Description
servicerendered_id	integer(11)	Service identifier
patient_id	integer(11)	Patient identifier
date	datetime	Date of rendered service(s)
service_r	integer(11)	Service(s) rendered
clinician	integer(11)	Clinician name
faculty	varchar(100)	Faculty name
fees	Float(7,5)	Cost of service(s)
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 21: Service_Rendered Table

Attribute	Data Type	Description
appointment_id	integer(11)	Appointment identifier
patient_id	integer(11)	Patient identifier
appointment_clinician	varchar(100)	Clinician name
appointment_date	datetime	Schedule of appointment
updated_by	varchar(50)	User who updated the record
date_updated	varchar(50)	Date updated
time_updated	varchar(50)	Time updated
version	integer(11)	Version

Table 22: Patient_Appointment Table

E. DentISt Roles Privileges

The DentISt Clinicians must have the following privileges:

- Add Appointments
- Add Concept Proposals
- Add Consultations
- Add Observations
- Add Services
- Edit Concept Proposals
- Edit Dental Chart
- Edit Observations
- Edit Patients
- Manage Concepts
- Manage Dental Records
- Manage Forms
- Manage Locations
- Manage Programs
- Manage Reports
- Patient Dashboard - View Appointments Section
- Patient Dashboard - View Consultations Section
- Patient Dashboard - View Dental Chart Section
- Patient Dashboard - View Dental Section
- Patient Dashboard - View Information Section
- Patient Dashboard - View MedicalSocial Section
- Patient Dashboard - View Services Rendered Section
- Patient Dashboard - View Treatment Plan Section
- Query Patients
- View Clinician
- View Concept Classes
- View Concept Datatypes
- View Concept Proposals
- View Concept Sources
- View Concepts
- View Database Changes
- View Dental Link
- View Encounter Types
- View Encounters
- View Field Types
- View Forms
- View Identifier Types
- View Locations
- View Navigation Menu

- View Observations
- View Orders
- View Patient Cohorts
- View Patient Identifiers
- View Patient Programs
- View Patients
- View People
- View Problems
- View Programs
- View Relationships
- View Users

DentISt remaining roles - Clinician in Oral Diagnosis and Faculty Clinician - inherit from Clinician Role and with the following privileges added:

Clinician in Oral Diagnosis

- Add Patients
- Add People
- Edit Dental History
- Edit Medical History
- Edit Patient Checklist
- Edit Patient Information
- Edit People
- Edit Physical Assessment
- Edit Radiographic Exam
- Edit Social History
- Edit Soft Tissue Exam
- Edit Treatment Plan
- Edit Vital Signs

Faculty Clinician

- Approve Updates
- Edit Users
- Print Dental Records
- View All Clinicians
- View Roles
- View Statistics

F. Dental Module Development

Java is the language used in creating an OpenMRS module. Eclipse IDE for Java EE Developers, specifically Eclipse 3.7.x (Indigo), is the Java development environment in creating a dental OpenMRS module[36]. In creating a dental module using Eclipse, the following plug-ins were installed:

- Subclipse[13]
- m2e Maven plugin[14]
- m2e connector for maven-scm-plugin[15]
- m2e-subclipse (Maven SCM handler for Subclipse plugin)[16]

Maven Eclipse plug-in allows a user to import the template of a basic module from the OpenMRS modules repository. This automatically creates the necessary packages, imports the dependencies, and sets up the build path of the module. A guide for developing a simple module, on the other hand, is provided by the OpenMRS website[37]. With these, a module that can be uploaded to OpenMRS is created. The back end processes, such as processing of inputs and generating data, are handled by controllers located in omod/src/main/java while front end development or the user interface is located in omod/src/main/webapp.

Web pages created for the dental module are JSP files written under omod/src/-main/webapp. These are responsible for the user interface of the system. The JSP file includes the use of various technologies including HTML for the interface development, Javascript for additional functionalities, JSTL for communicating with controllers and CSS for design. Various patient dental forms and the patient dental chart are designed under this package.

The files needed for back end development, such as controllers and Java files responsible for processing the inputs of the user, are found inside the omod/src/main/java package. For every pages requiring submission of data from patient dental forms, corre-

[13] `http://www.arakhne.org/eclipse/subclipse/index.html`
[14] `http://maven.apache.org/download.html`
[15] `http://objectledge.org/confluence/display/TOOLS/M2E+Connectors`
[16] `http://market.eclipsesource.com/yoxos/node/org.maven.ide.eclipse.subclipse.feature.feature.group`

sponding controllers are needed to manipulate the inputs. These controllers are also in charge with database accesses (either viewing, adding or editing observation).

The front and back end of the module is integrated and configured together in the moduleApplicationContext.cml that is found under omod/src/main/resources.

V. Architecture

A. System Architecture

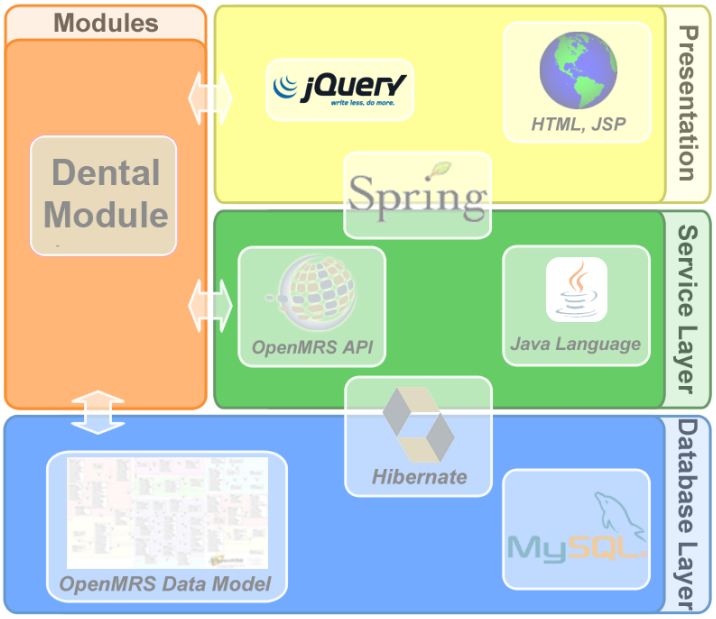

Figure 34: System Architecture of DentISt

Figure 34 shows how the dental module (DentISt) connects with the three OpenMRS domains - Presentation, Service and Database. The dental module web interface is coded in HTML and JSP while using jQuery as its Javascript framework. It is linked to the Service layer using Spring framework. DentISt uses the Java language to connect to the OpenMRS database and perform different services. The Database layer uses Hibernate, which is an Object Relational Mapper, to link database tables to the Service layer [38].

B. Technical Architecture

Dental Information System 2.0 (DentISt) will use the following softwares:

- Apache Tomcat 6.0
- MySQL5
- OpenMRS 1.8.3

The Java Heap Memory minimum must be set to 512MB and maximum 1024MB. Compatible server operating systems include:

- Windows Server
- Ubuntu Linux or Redhat Linux

The required hardware depends on the implementation size[39]. For small implementations, OpenMRS can be run on just about any desktop or laptop.

- For hundreds of patients, the minimum system requirements are 1 GHz processor or better, 256 MB of memory or more, 40 GB hard drive or larger.
- For 10,000 patients, the minimum system requirements are 1.5+ GHz, 2 GB of memory, and 150+ GB of disk space with RAID and appropriate backup facilities.
- For over 250,000 patients, minimum requirements are two 2.26 GHz quad processors, 16 GB of memory, 500 GB of disk space with RAID and appropriate backup facilities.

The client side must have any of the following compatible web browsers:

- Mozilla Firefox 11.0
- Google Chrome 18.0.1025.142
- Safari 5.1.5
- Opera 11.62

VI. Results

When you open the site, the homepage of DentISt(shown in Figure 35) which is also its login page is displayed.

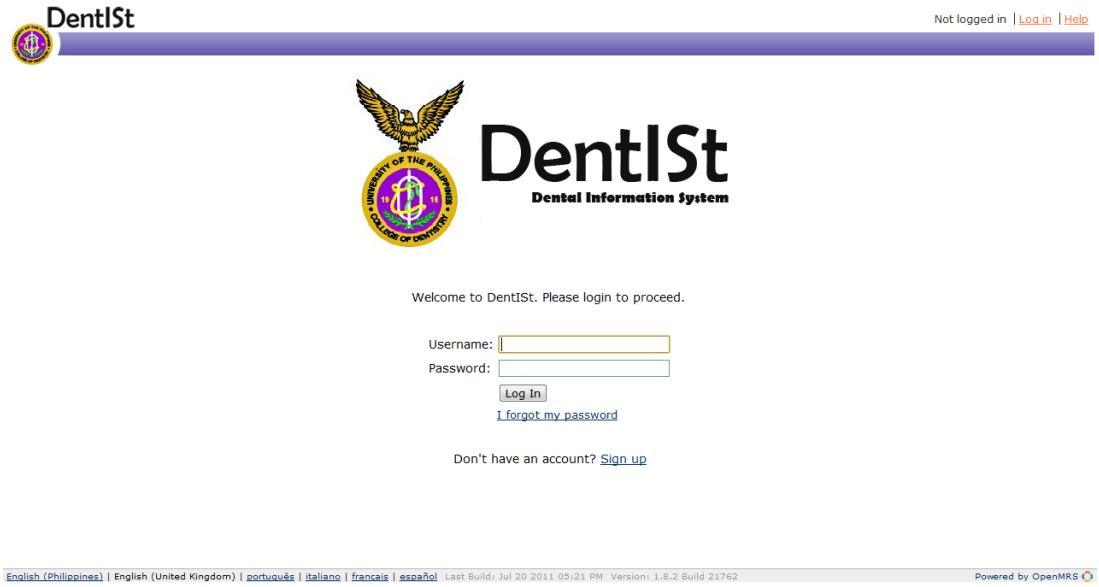

Figure 35: Login Page of OpenMRS

After logging in, registered users will be able to view the navigation menu of DentISt shown in Figure 36. This consists of different tabs namely Home, Find/Create Patient, Dictionary, and UPCD Functions. Note that the UPCD Functions gutter can only be seen if the dental module is loaded in the OpenMRS instance.

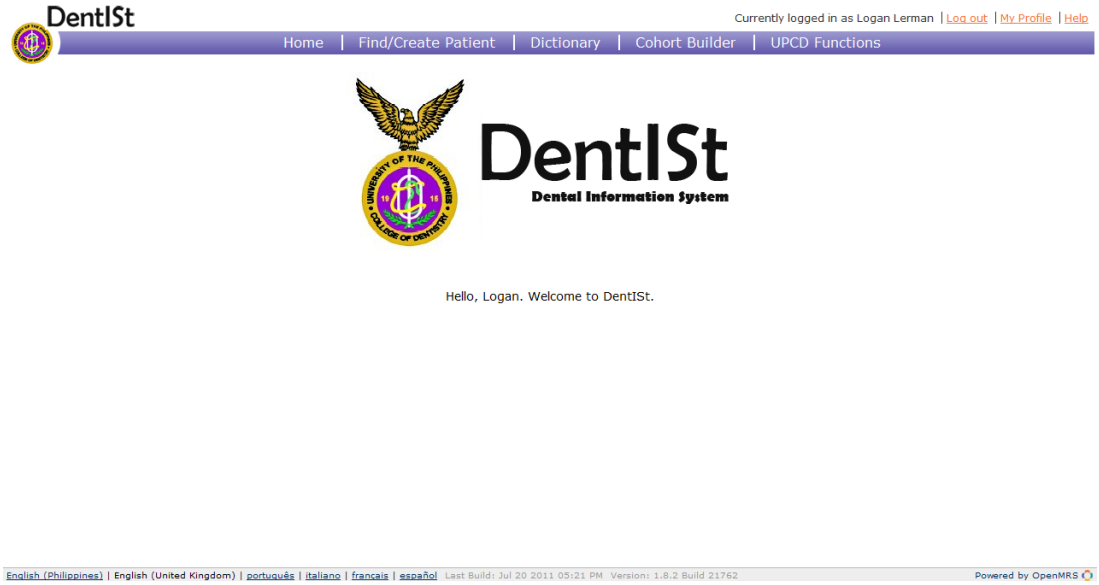

Figure 36: Home Page of OpenMRS

To find or create a patient, users must click the Find/Create Patient tab. Only clinicians in Oral Diagnosis can create a patient while all other clinicians and faculty clinicians can search a patient by name. The Find/Create Patient functionality is a built-in with OpenMRS. Figure 37 shows how to search for a patient while Figures 38 and 39 show how to add a patient and edit patient basic information.

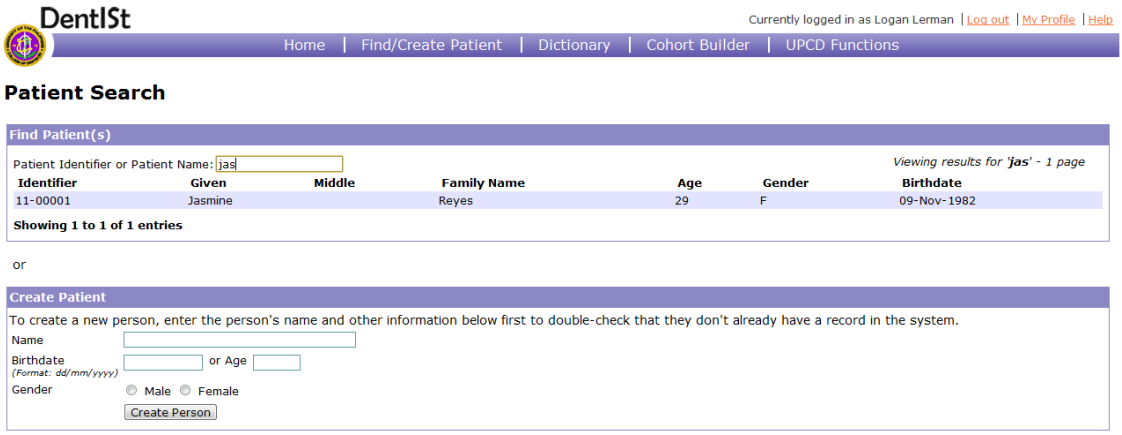

Figure 37: Find Patient of OpenMRS

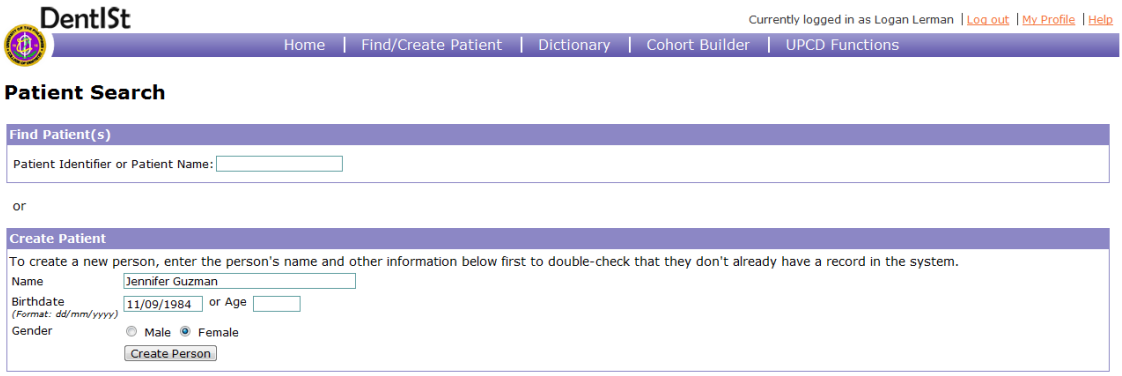

Figure 38: Create a New Patient

In creating a new patient, the identifier to use is UPCD Identification Number with the format NN-NNNNN, the first two numbers being the year the patient is registered, while the last five numbers are any random numbers.

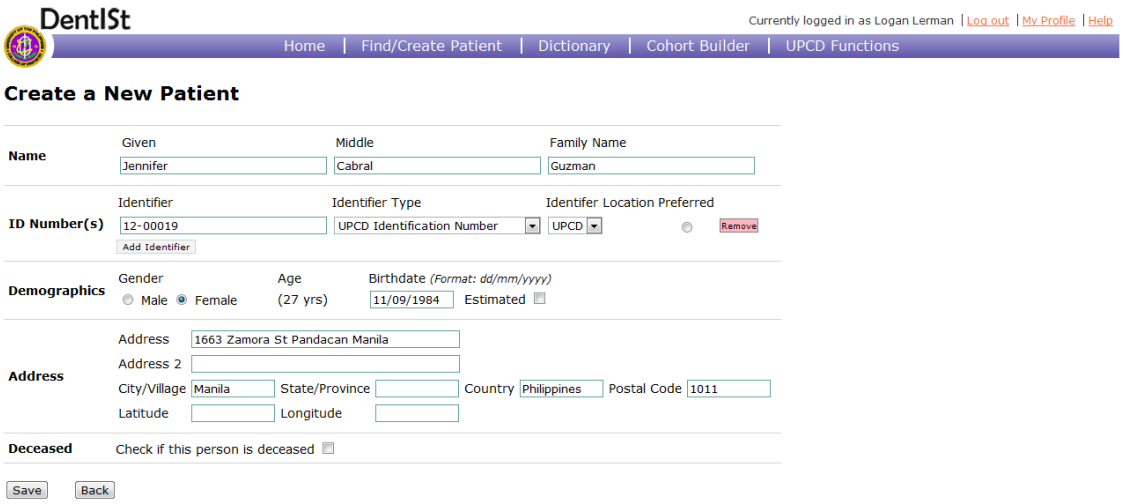

Figure 39: Create a New Patient

After creating a patient, the clinician is directed to the patient dashboard shown in Figure 40. The patient dashboard consists of eight tabs listing different information - Patient Information, Medical Data, Dental Data, Treatment Plan, Dental Chart, Services Rendered, Consultations/Referrals, Appointments.

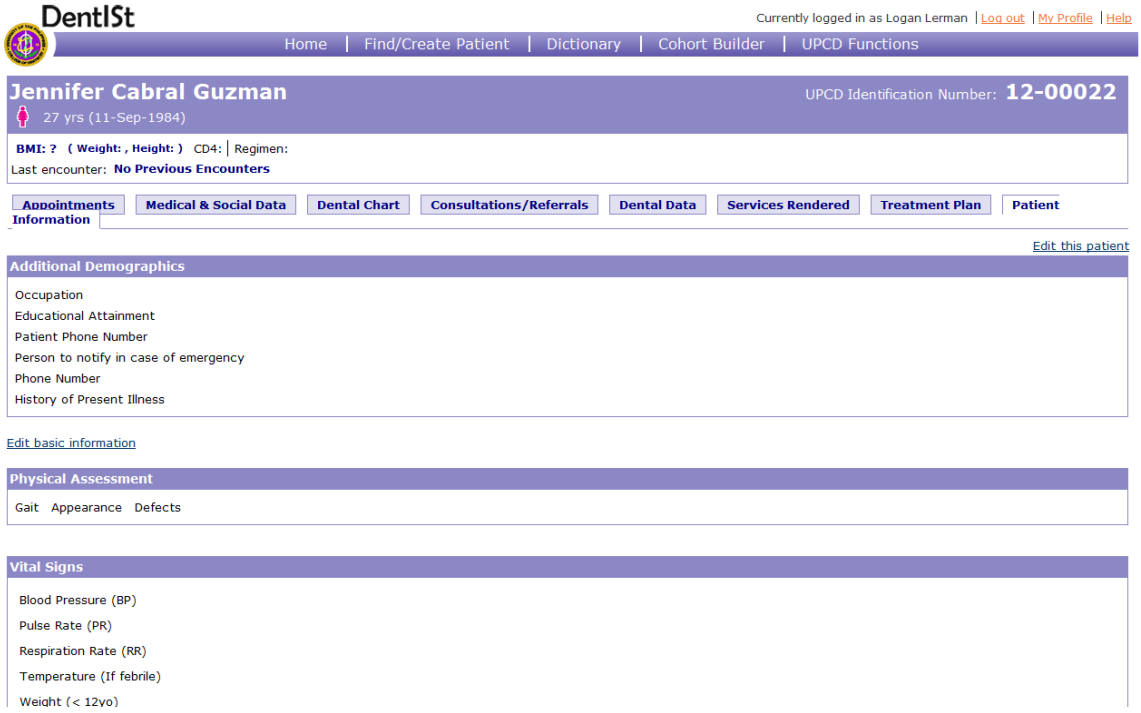

Figure 40: Patient Dashboard

In the Patient Information tab, clinicians in Oral Diagnosis can edit basic information, physical assessment and vital signs. The forms are shown in Figures 41 and 42. In the basic information form, required fields include the patient contact number and the guardian's name and contact number. To avoid wrong data to be recorded, before submitting form data, clinicians are asked to if they are sure of what they'll submit.

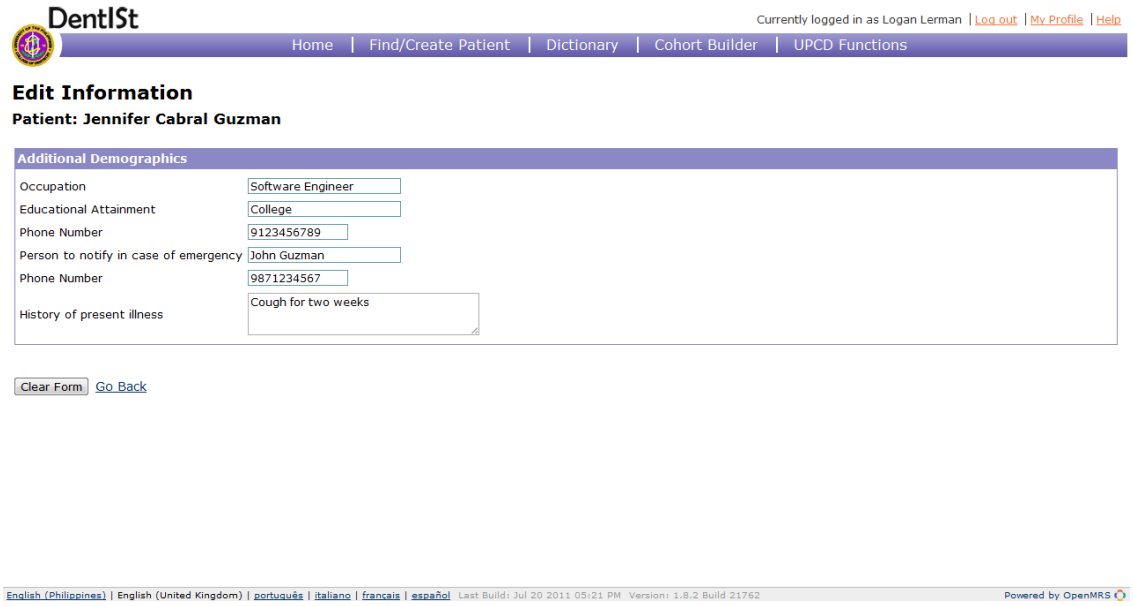

Figure 41: Update Basic Information

Figure 42: Update Physical Assessment and Vital Signs

In the Medical and Social Data tab, medical history, social history and the patient checklist are found. To update these data, clinicians in Oral Diagnosis need to fill out the forms shown in Figures 43, 44 and 45.

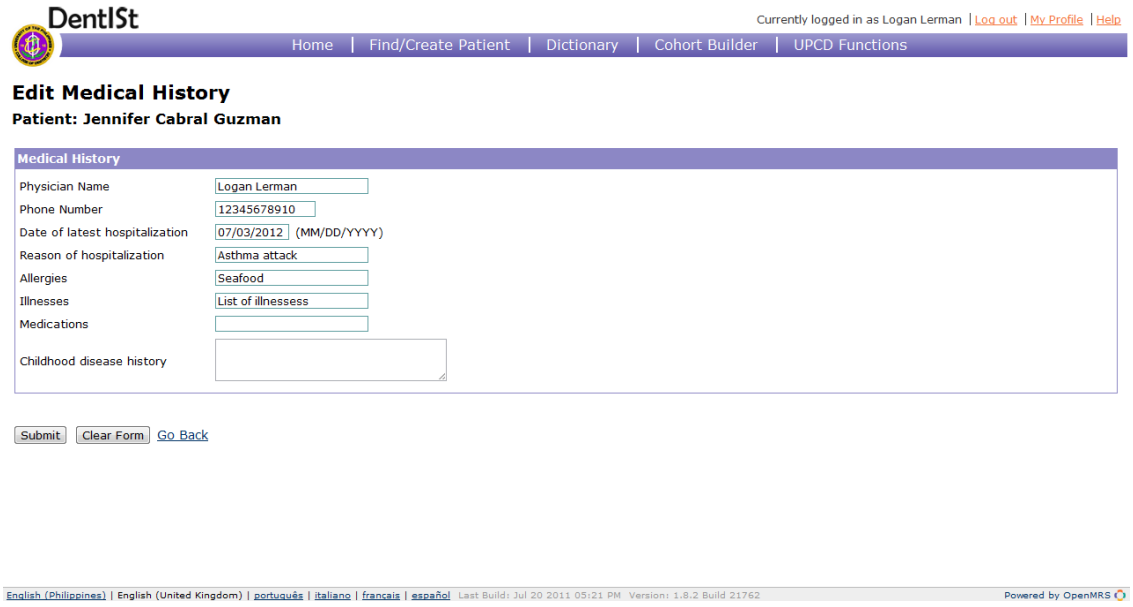

Figure 43: Update Medical History

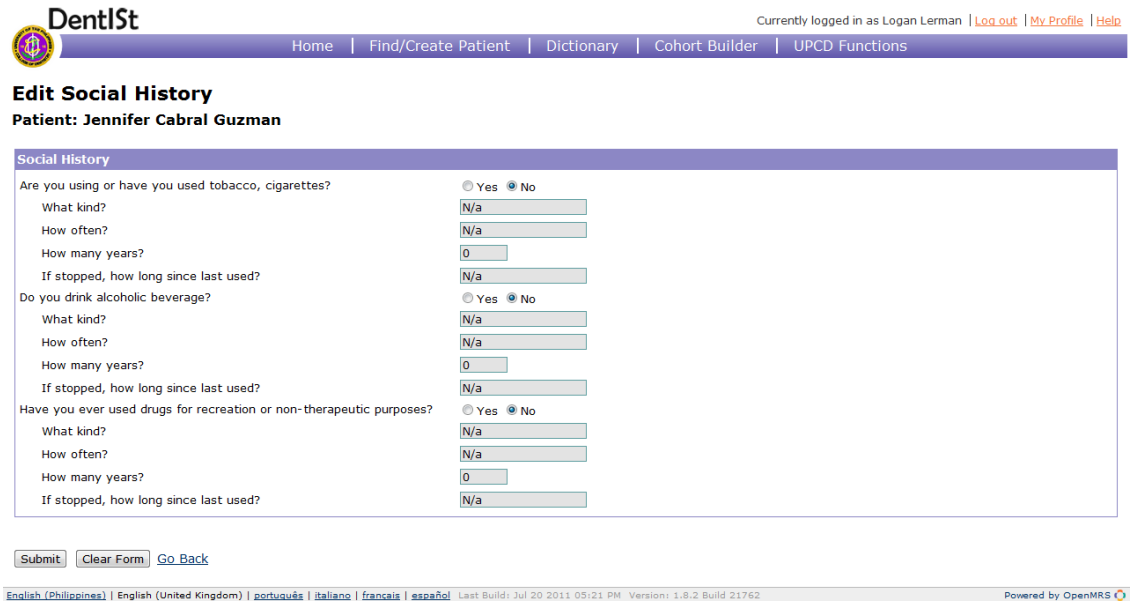

Figure 44: Update Social History

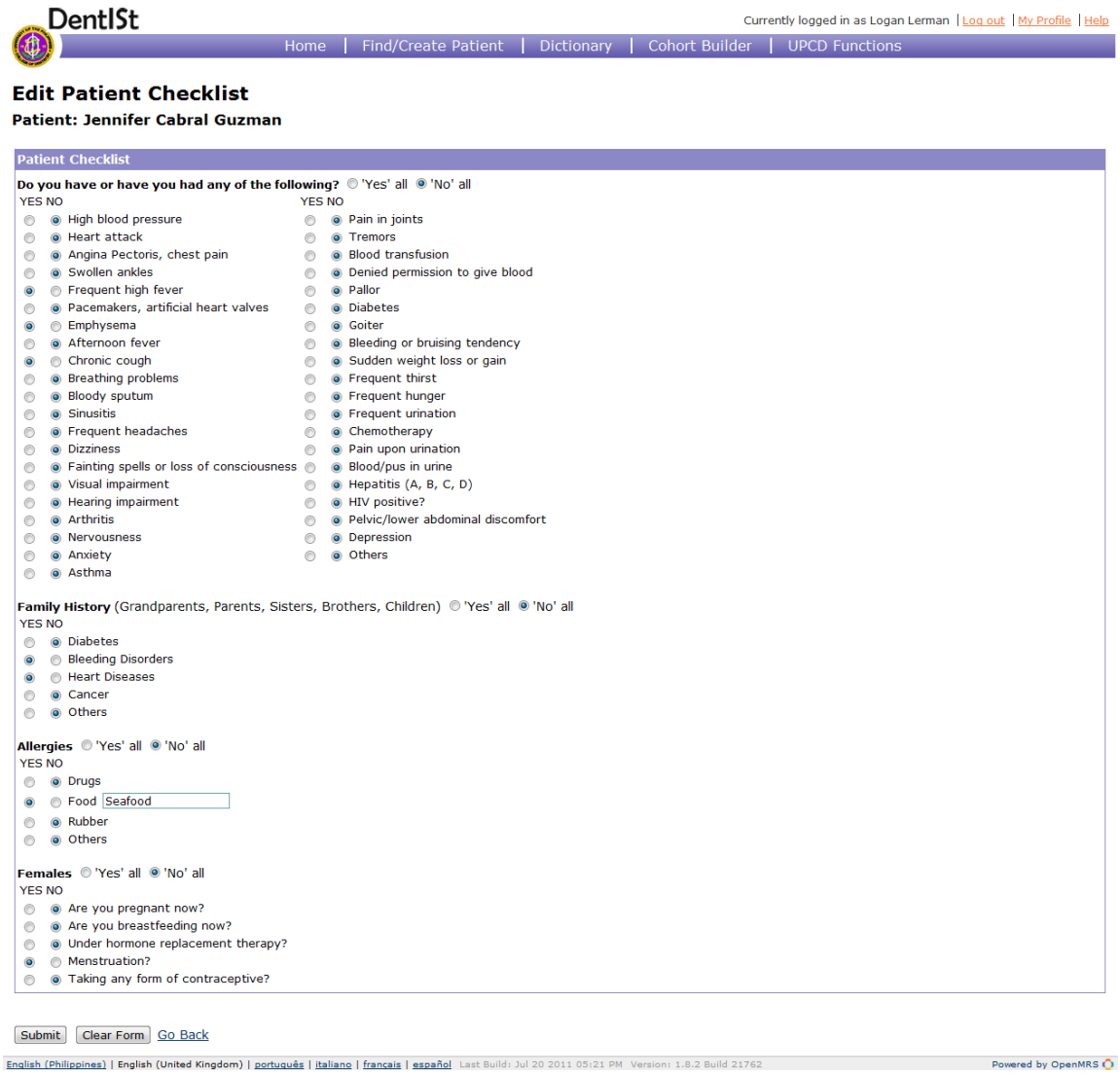

Figure 45: Update Patient Checklist

The Dental Tab lists the dental history and results on soft tissue and radiographic examinations. Forms are shown in Figures 46, 47 and 48.

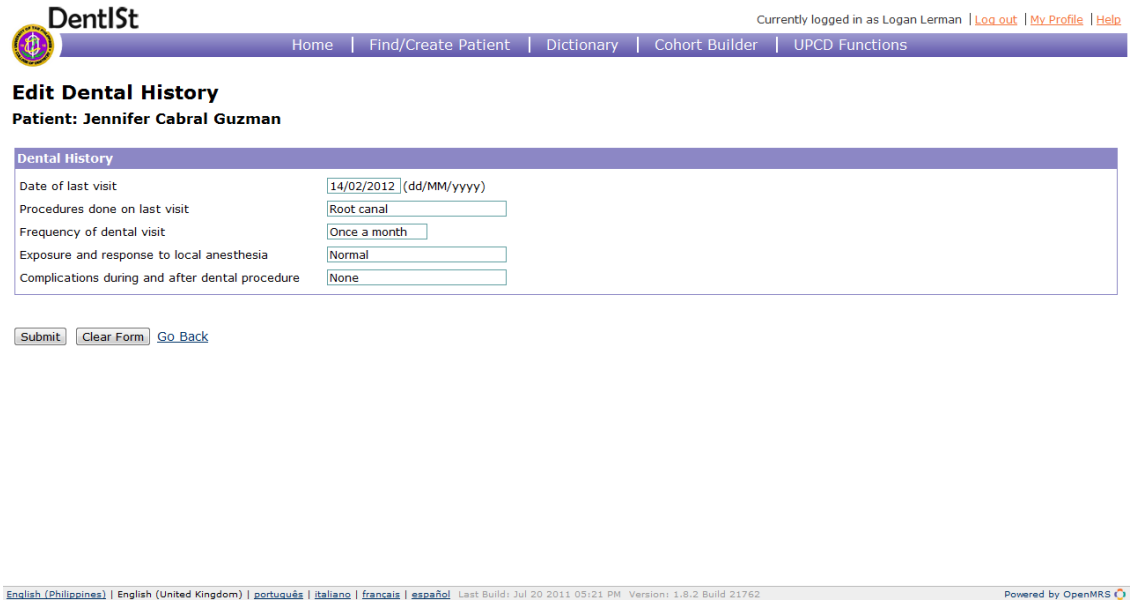

Figure 46: Update Dental History

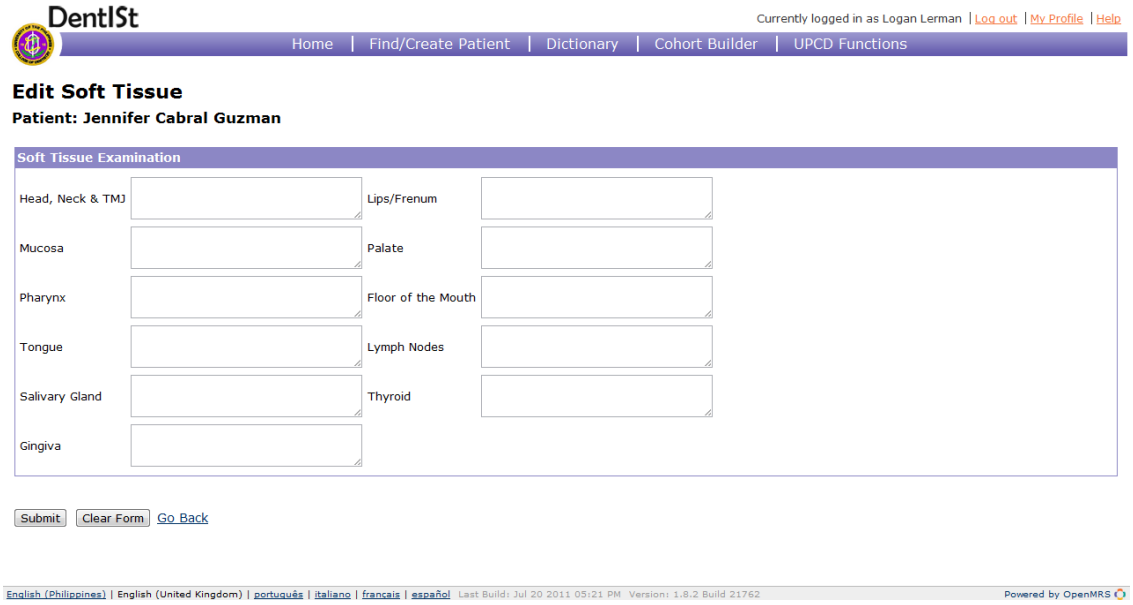

Figure 47: Update Soft Tissue Exam

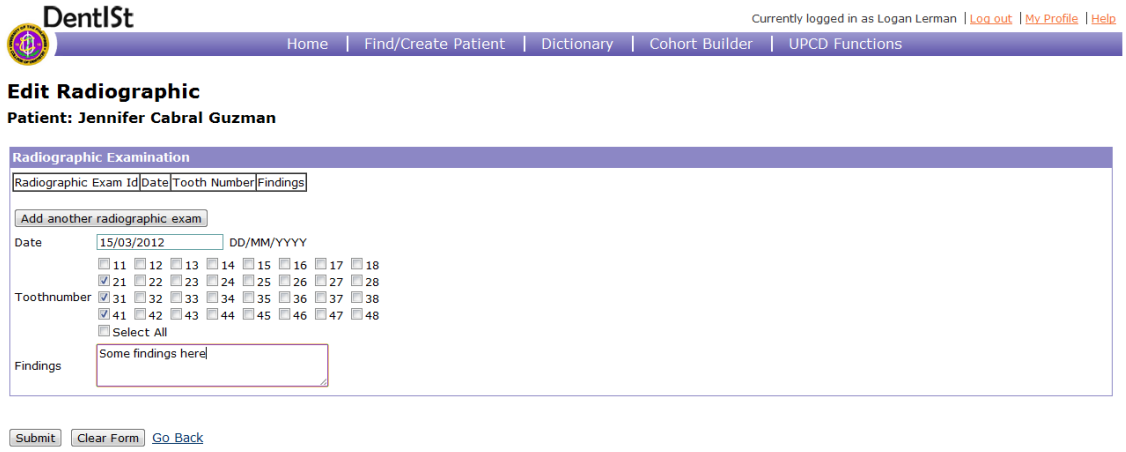

Figure 48: Update Radiographic Exam

The treatment tab lists the chief complaint, service code and proposed treatment for the patient. It also shows the problem list which is filled out using the dental chart. Figure 49 shows the treatment plan form.

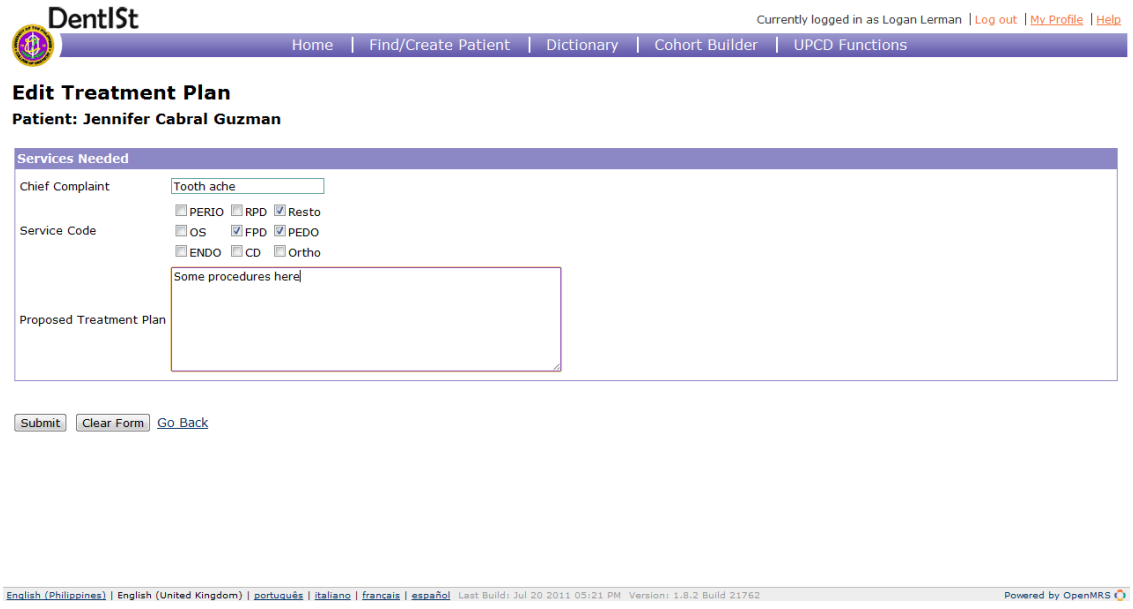

Figure 49: Update Treatment Plan

Patient's dental status chart (Figure 50) is found in the Dental Chart tab.

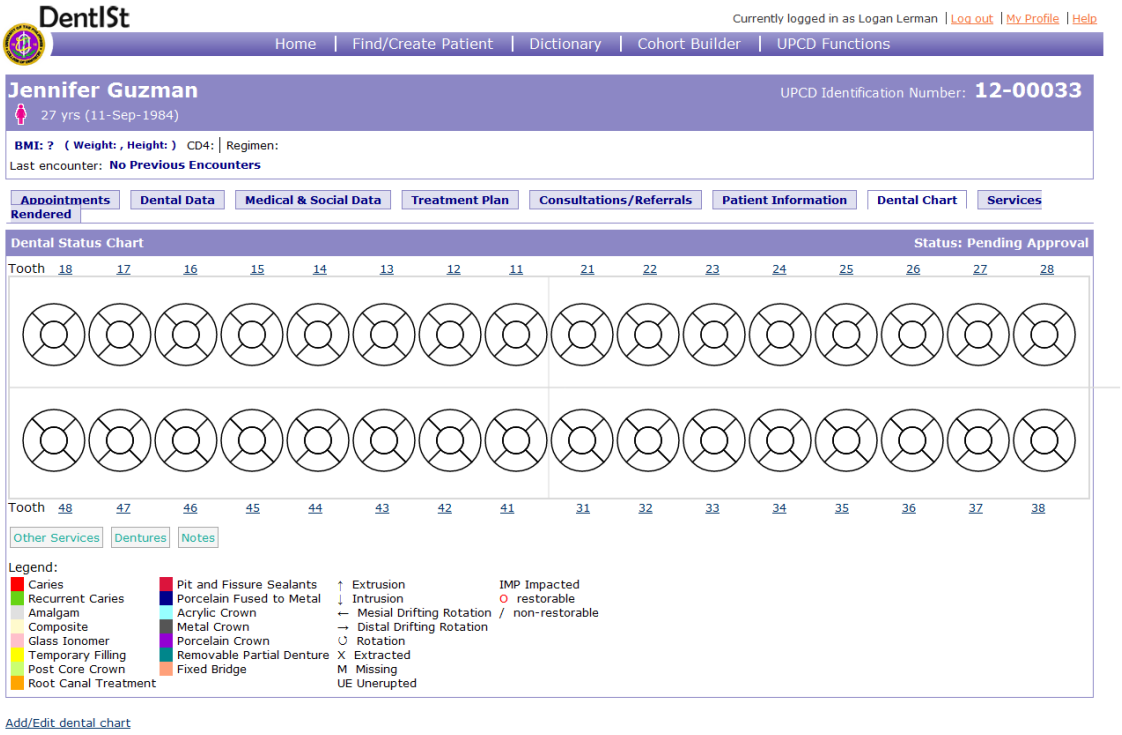

Figure 50: Patient Dashboard - Dental Chart

The legend per graphical representation as shown in Figure 51 is always present below the dental chart for easier viewing. Red represent caries, green represents recurrent caries, upward arrow represents extrusion, the sign IMP represents impacted and so on.

Figure 51: Legend - Dental Chart

Any clinicians can edit the patient's dental chart by clicking the *Add/Edit Dental Chart* link. The site is then directed to a page where clinicians can edit the dental chart by clicking on different tooth numbers and adding necessary conditions. Services needed are also filled out using the dental chart. These are shown in Figures 52, 53, 54, 55 and 56.

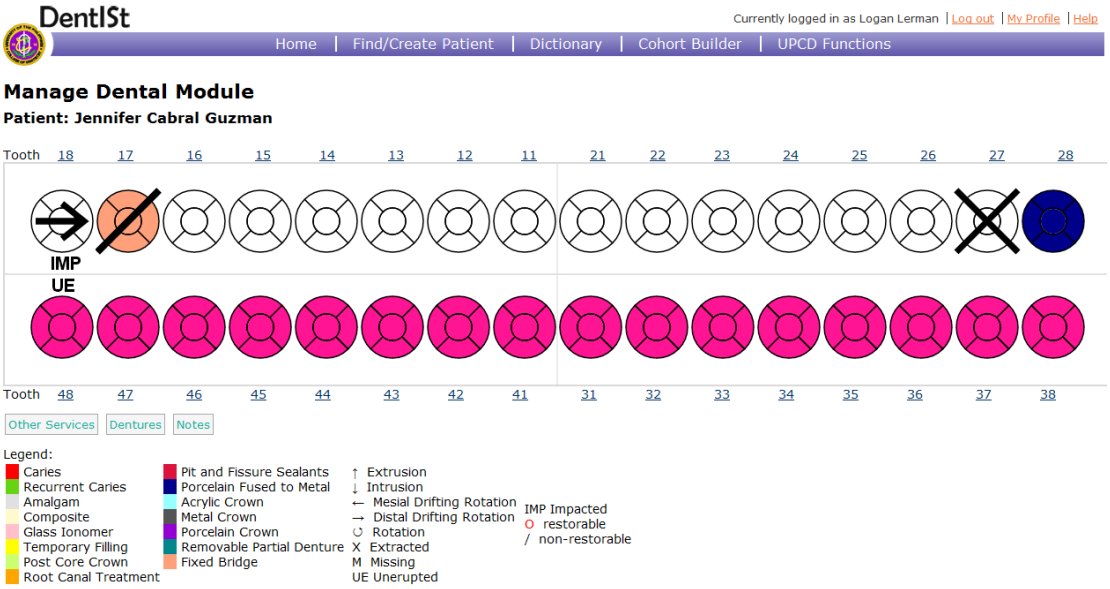

Figure 52: Update Dental Chart

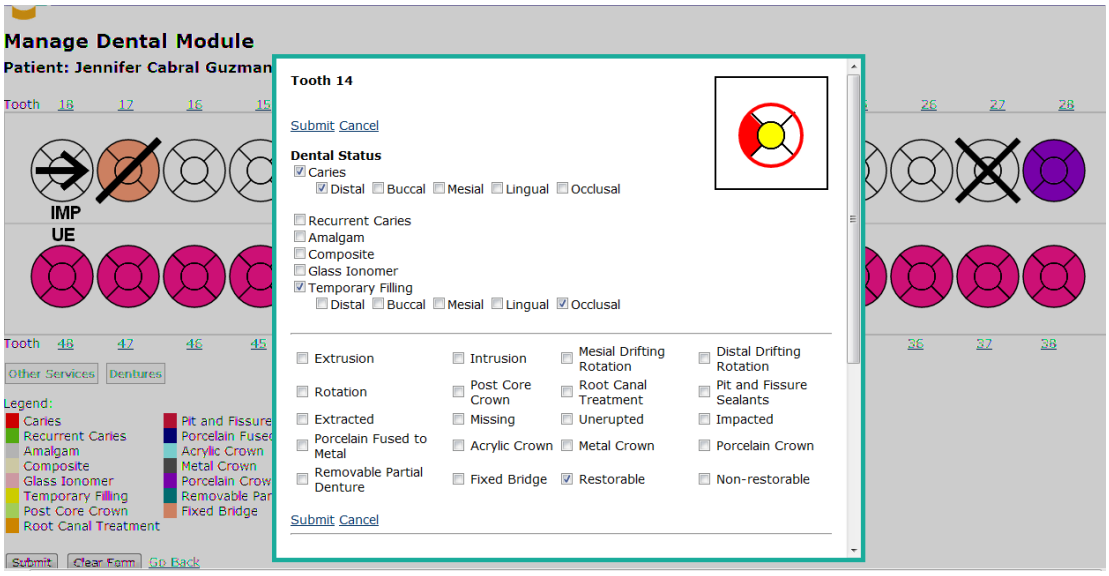

Figure 53: Update Dental Chart

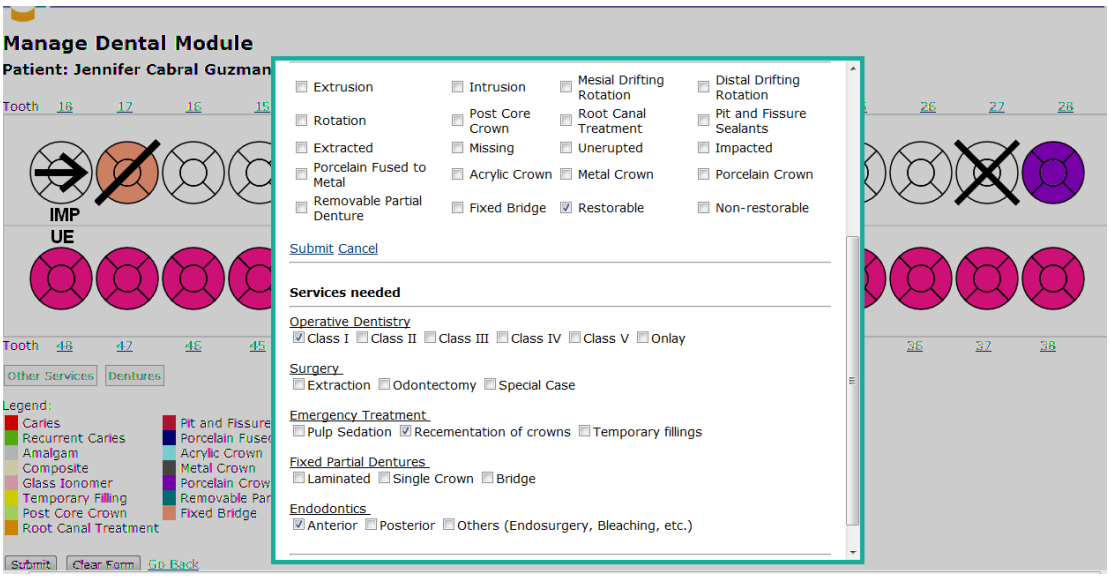

Figure 54: Update Dental Chart - Services Needed

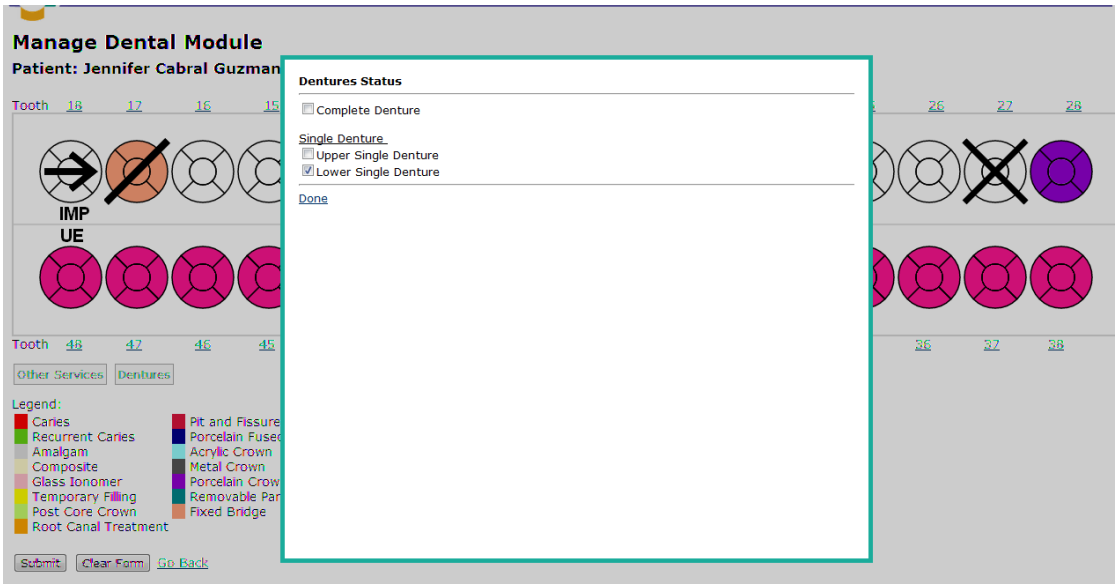

Figure 55: Update Dental Chart - Dentures

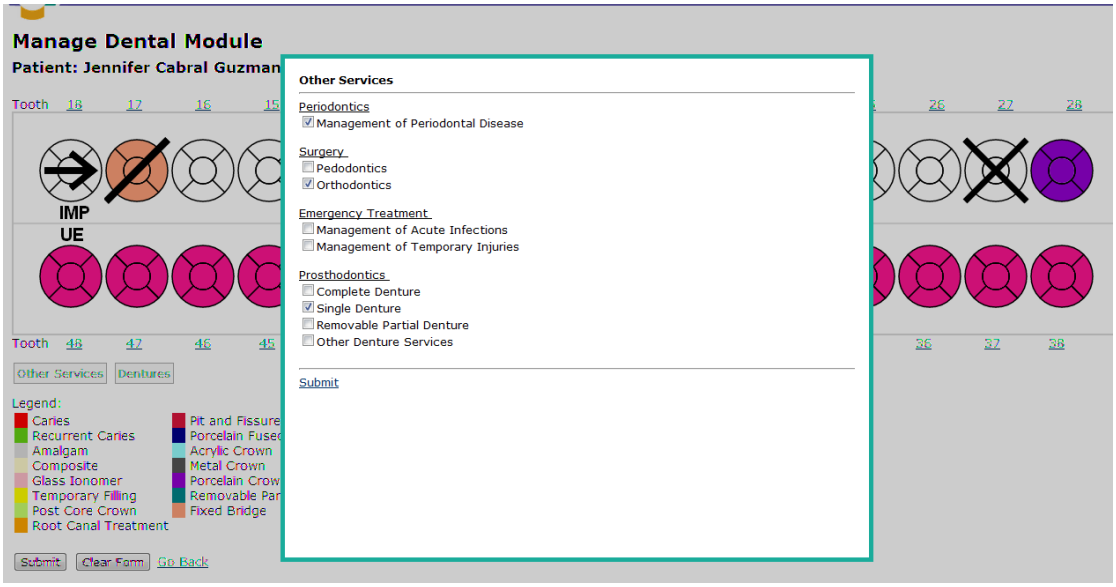

Figure 56: Update Dental Chart - Other Services

Clinicians can also fill out the notes section for additional comments and observations on the patient teeth, as shown in Figure 57.

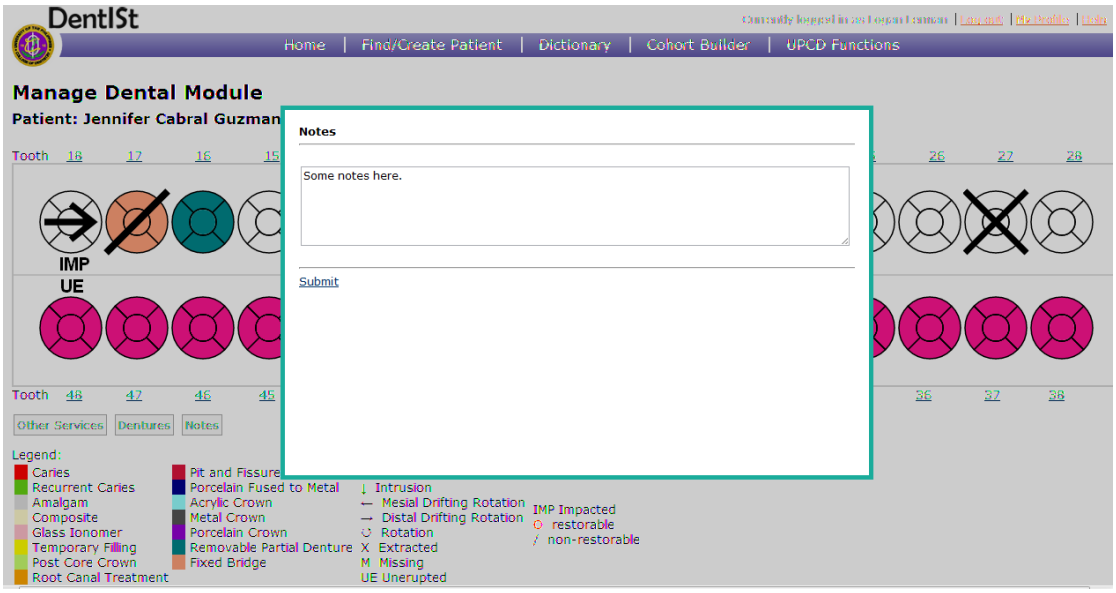

Figure 57: Update Dental Chart - Notes

Clinicians are also able to view dental chart versions along with the date, time and user who last updated the record (shown in Figure 58.

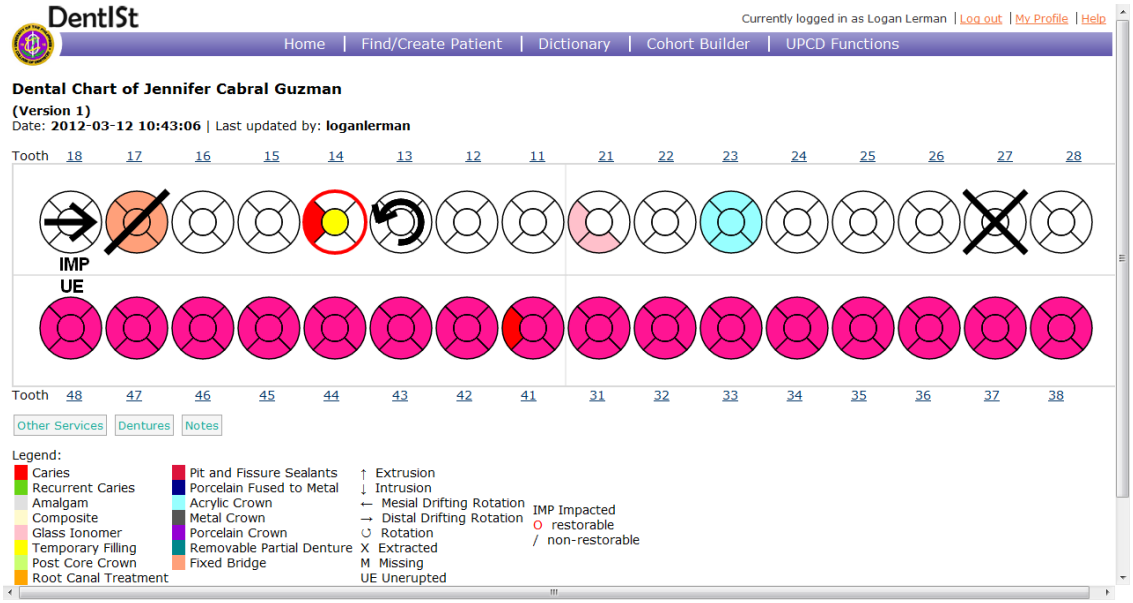

Figure 58: View Dental Chart Versions

Faculty clinicians can print patient records and approve changes on patient dental charts as shown in Figures 59, 60, 61 and 62.

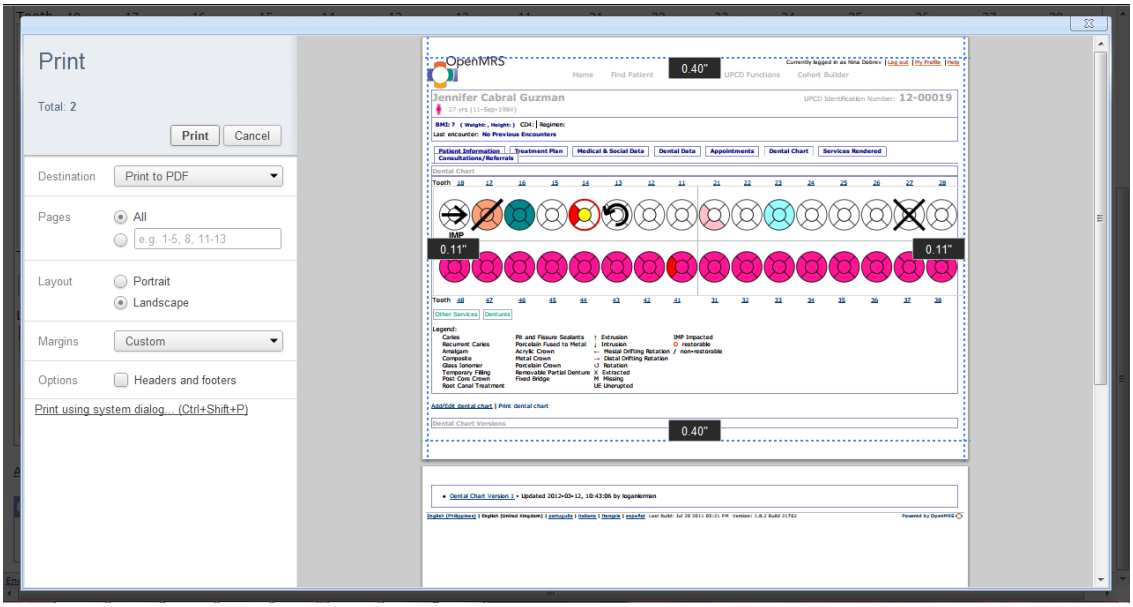

Figure 59: Print Patient Record

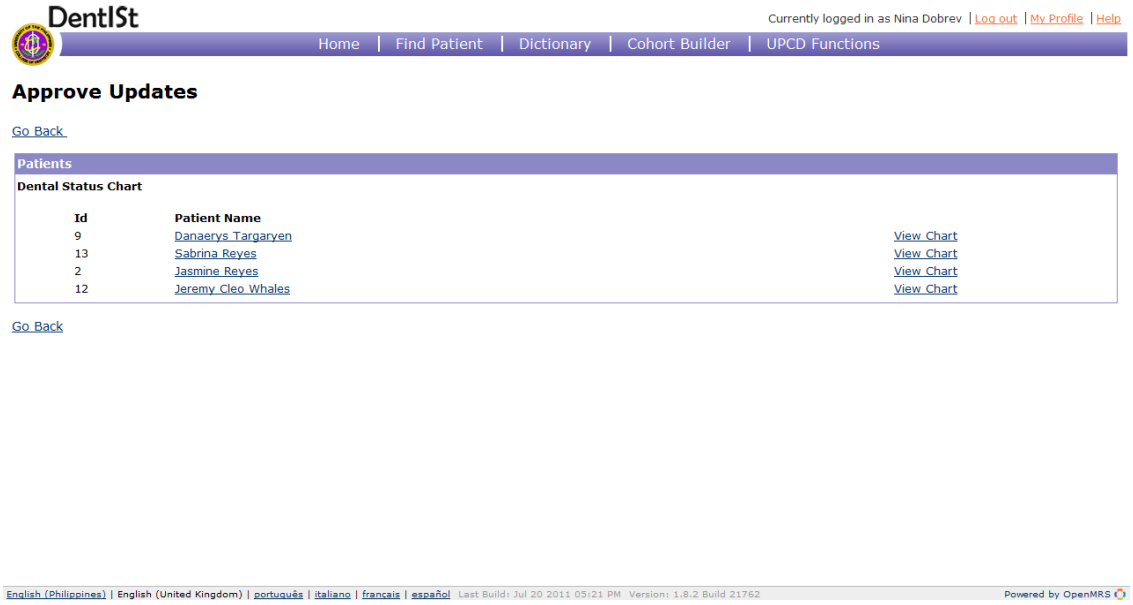

Figure 60: Approve Updates on Patient Dental Status Chart

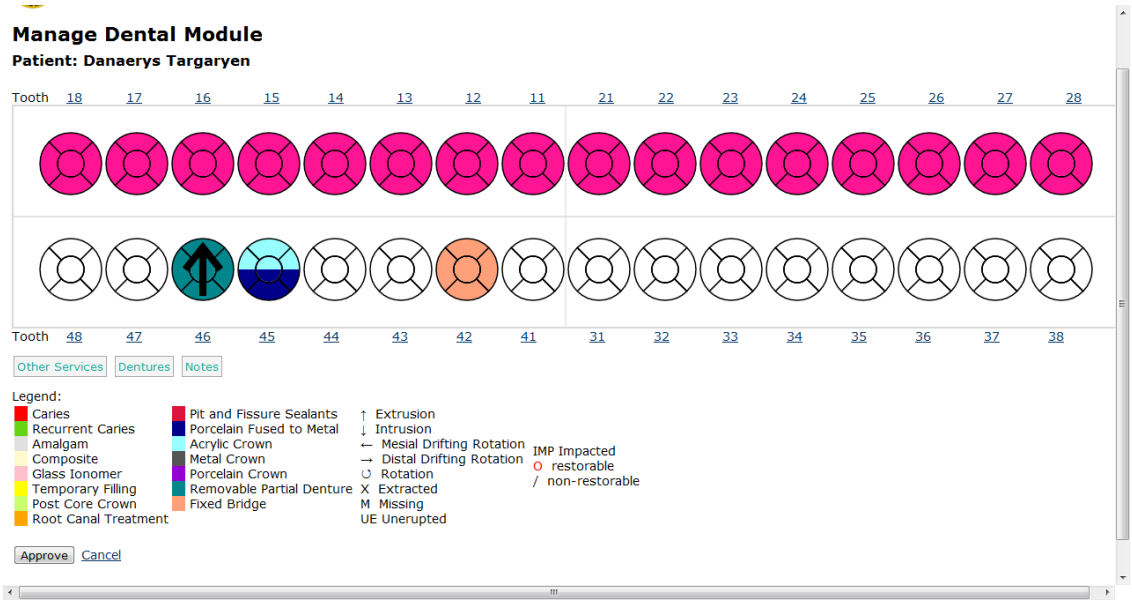

Figure 61: Approve Updates on Patient Dental Status Chart

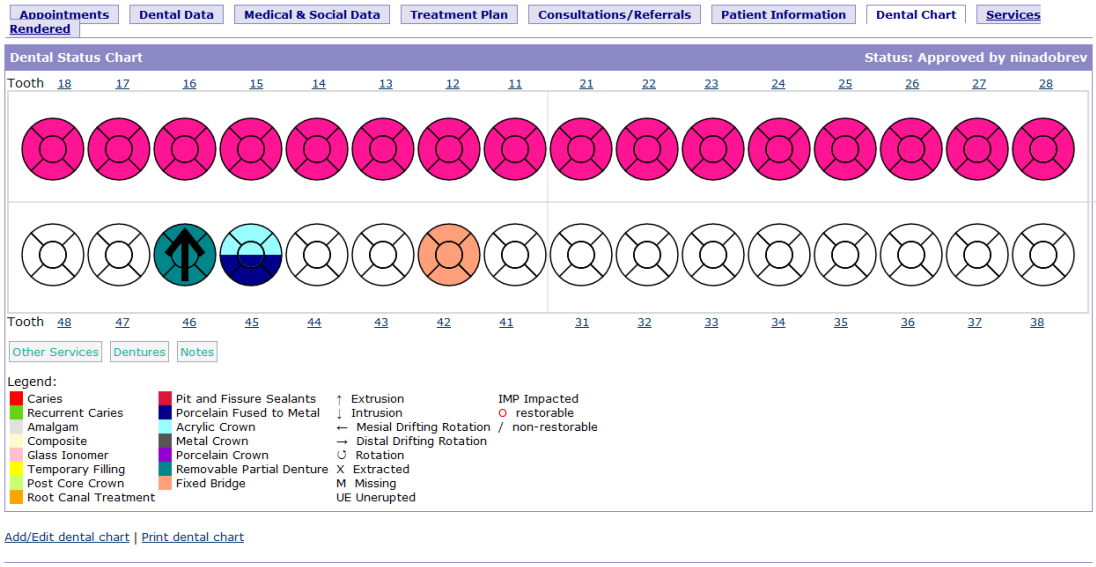

Figure 62: Approve Updates on Patient Dental Status Chart

In the navigation menu, the *UPCD Functions* link lists the additional functionalities of DentISt. If logged in as a clinician, Figure 63 shows the different features - *View Upcoming Appointments* and *Query For Patients*.

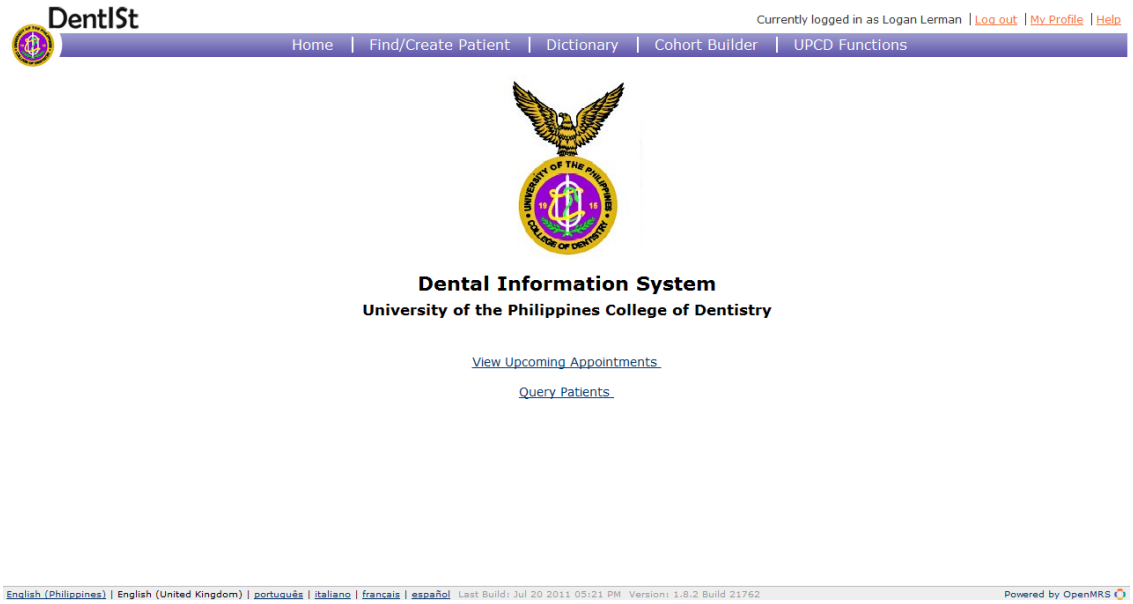

Figure 63: UPCD Gutter for Student Clinicians

On the other hand, if logged in as faculty clinician, other functions such as *View All Upcoming Appointments*, *View Statistics* and *View Users* are also present.

All clinicians can view their own upcoming appointments. Faculty clinicians are also able to view all upcoming appointments of all clinicians. Figures 65, 66, and 67 shows the said functionalities.

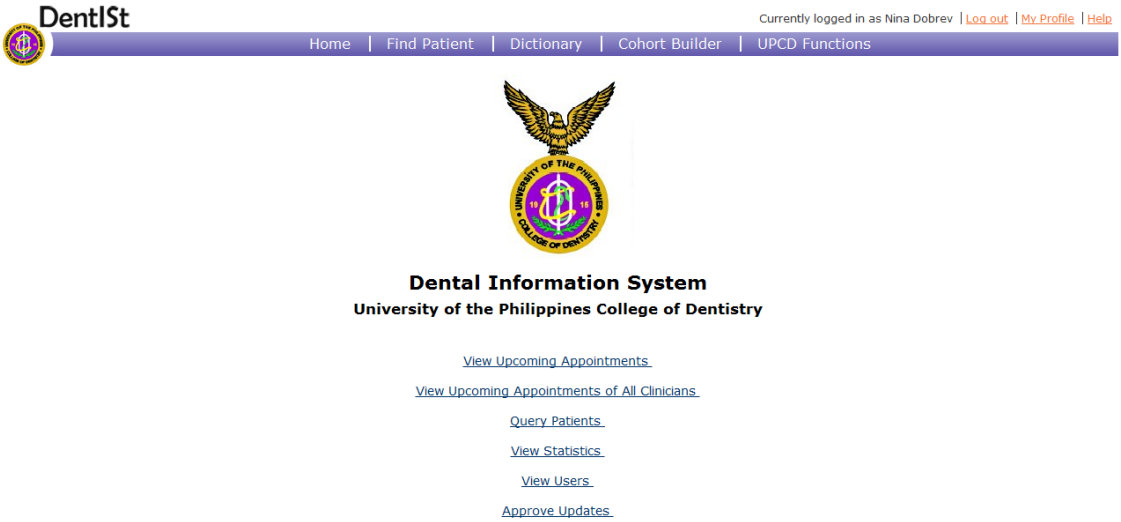

Figure 64: UPCD Gutter for Faculty Clinicians

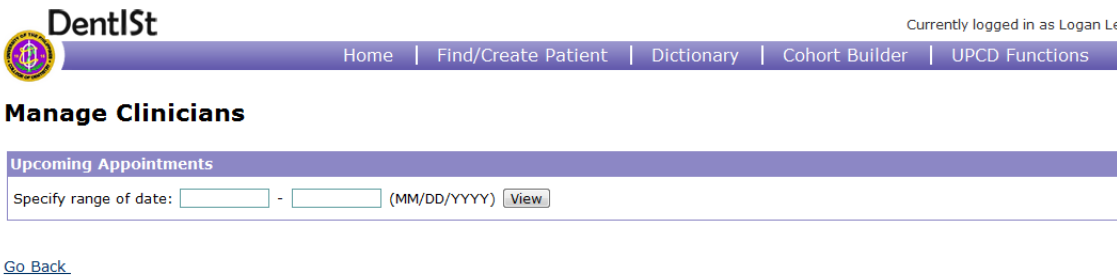

Figure 65: View Own Upcoming Appointments

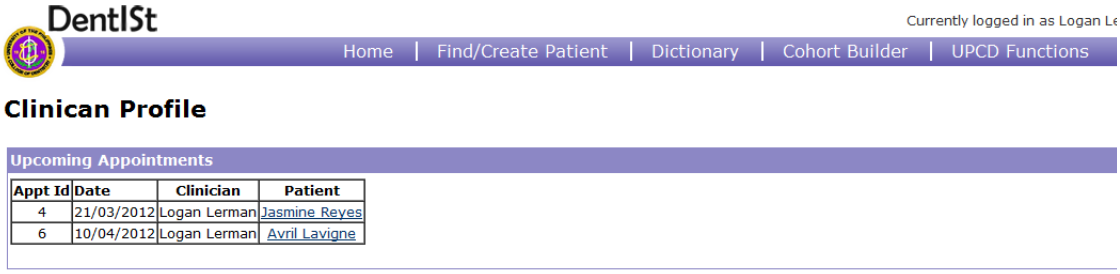

Figure 66: View Own Upcoming Appointments

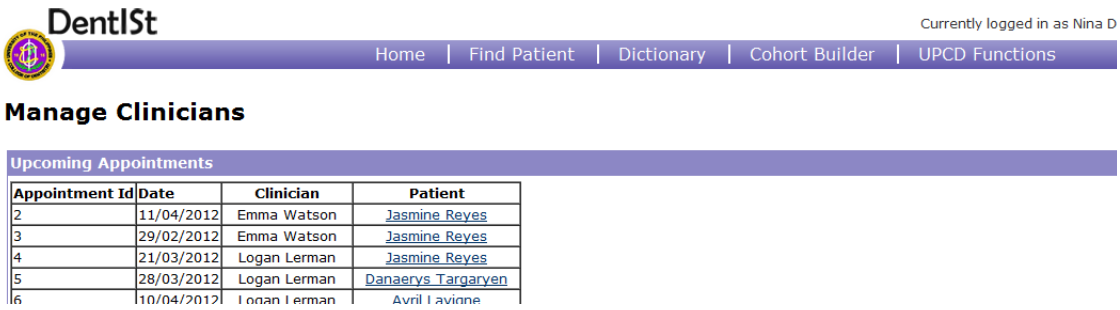

Figure 67: View All Clinicians Upcoming Appointments - Faculty Clinician

Figure 68 shows the Query for Patient page. All clinicians can search for patients according to age, gender, occupation and complaints. They can also search patients having specific dental condition(s) or those needing specific service(s). After which the results are displayed as shown in Figure 69.

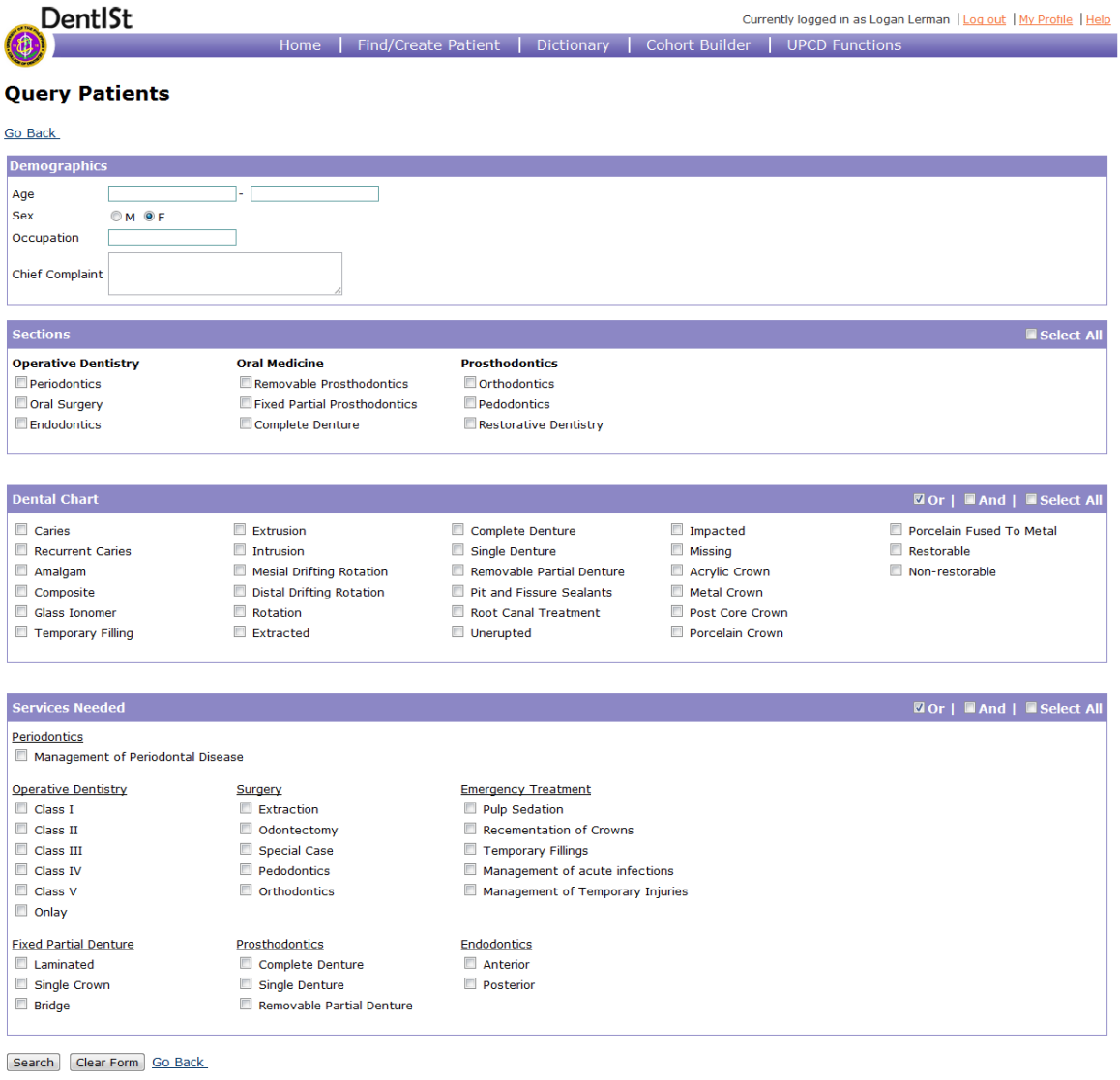

Figure 68: Query for Patients

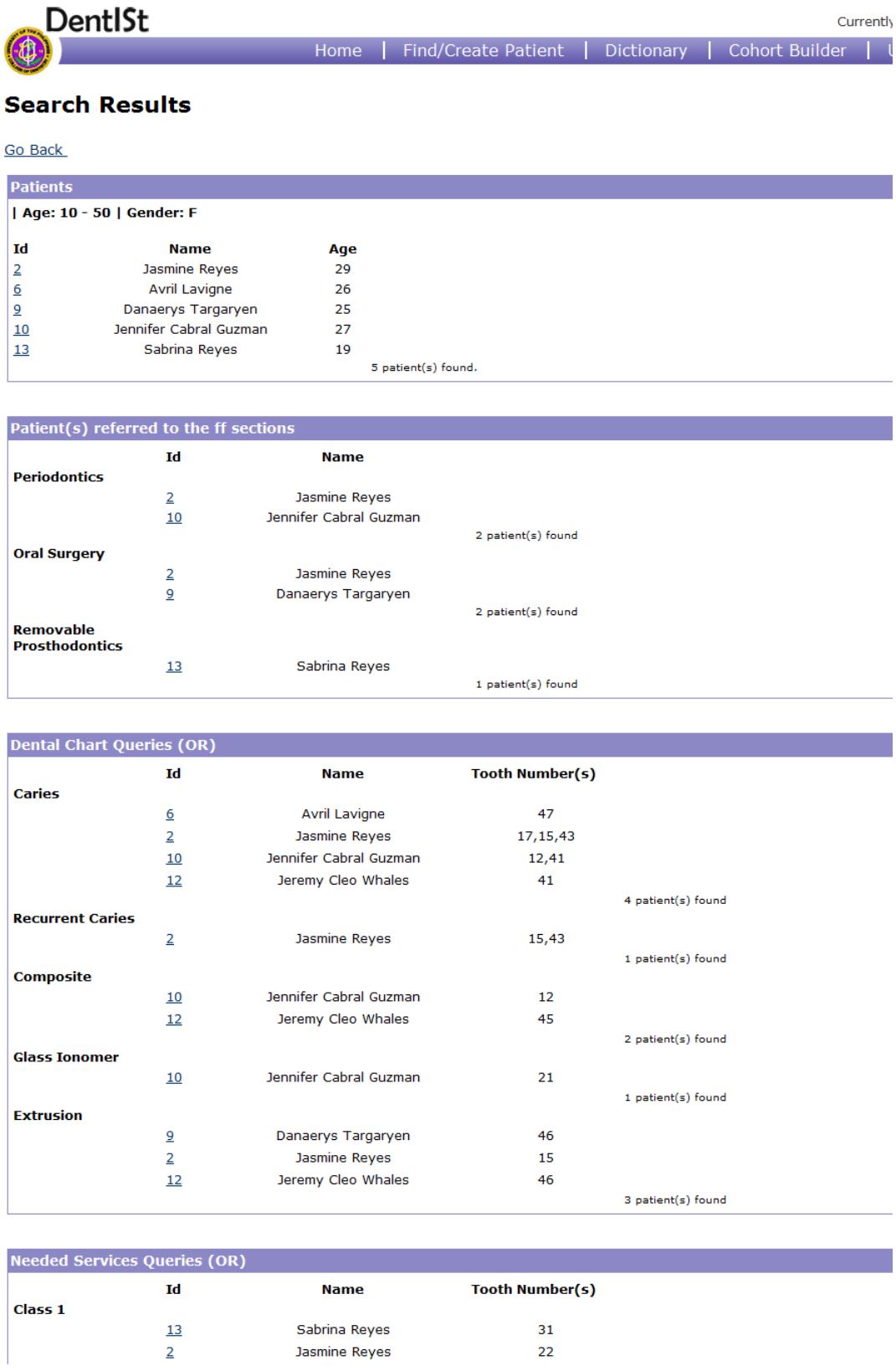

Figure 69: Query for Patients - Results

Faculty clinicians, on the other hand, can generate statistics as shown in Figures 70 and 71. Statistics are also based on what fields are selected. DentISt can generate the number of patients having particular condition, needing particular services having age and date as bounds.

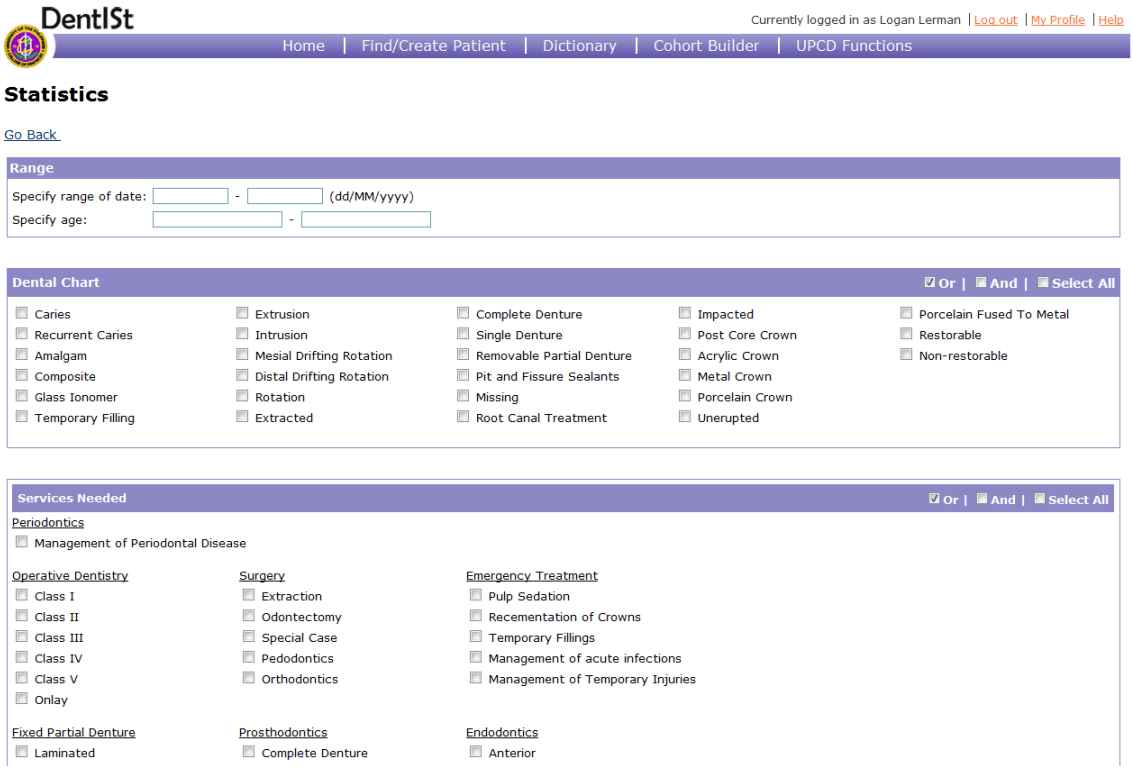

Figure 70: View Statistics

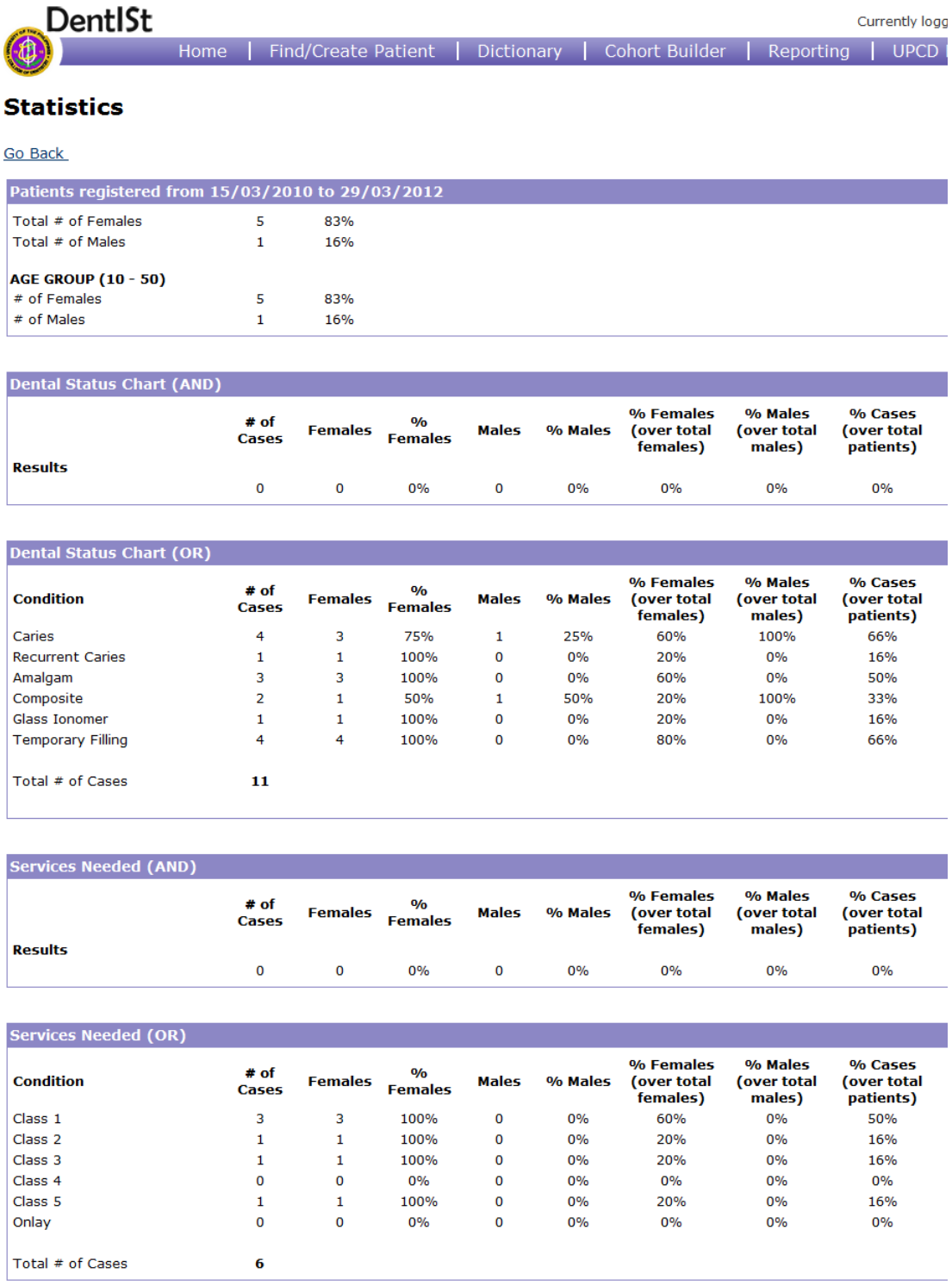

Figure 71: View Statistics - Results

Faculty clinicians can also view clinician accounts. They can edit clinician information and their roles as shown in Figures 72 and 73.

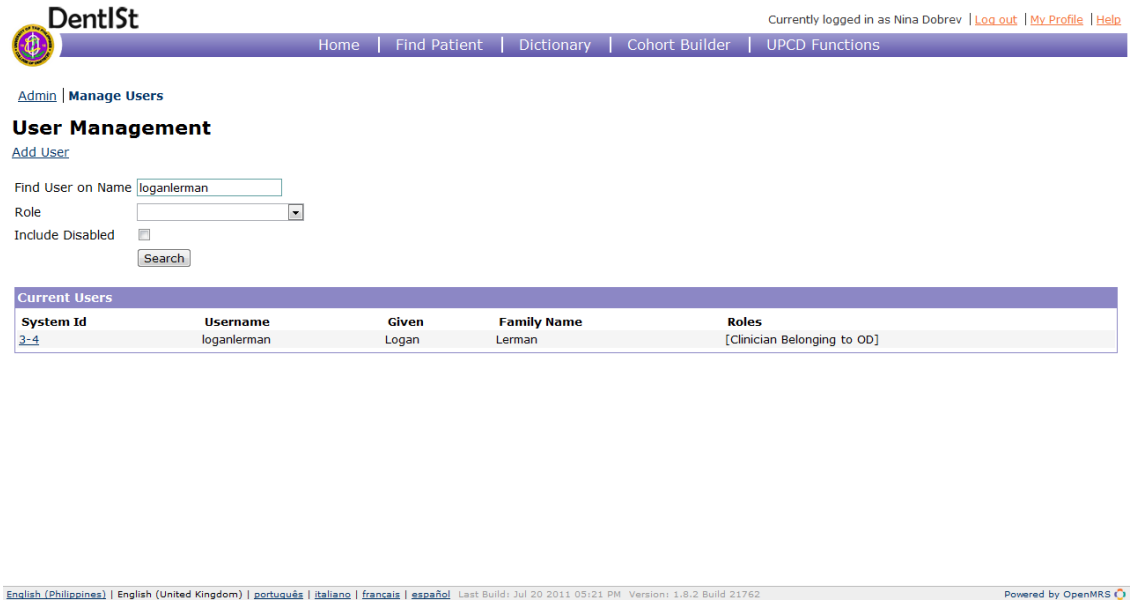

Figure 72: View Users

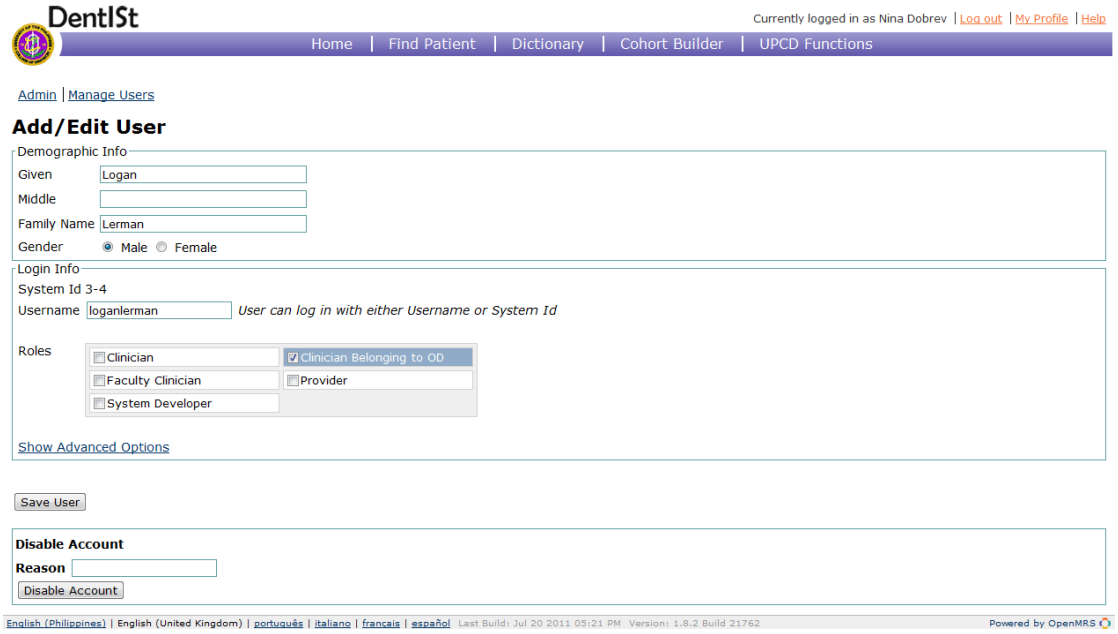

Figure 73: Edit User

VII. Discussion

DentISt or Dental Information System 2.0 is the second version of Open DentIS which is a free, electronic dental records system using OpenMRS platform. It is specifically created for University of the Philippines, College of Dentistry to help them store patient records electronically. The system has three main roles - clinician, clinician in Oral Diagnosis and faculty clinicians. The system stores patient dental records consisting of basic information, medical, social and dental history, physical assessment, vital signs, patient checklist, soft tissue examination results, radiographic examination results, dental status chart, treatment plan, and problem list. Services needed by patients and consultations/referrals are also included in the dental record. Clinicians can also set appointments with patients.

UPCD DentISt presents a significant improvement over its first version. Privileges are now added automatically after the deployment of module to OpenMRS. Clinicians can set appointments with patient and be reminded of their upcoming appointments by viewing the UPCD Functions tab. Addition of faculty clinician role also gives faculty clinicians in UPCD access to patient records. Faculty clinicians are also able to use new and improved functions - printing of dental records, query for patients and statistics. Clinicians can search for patients according to their occupation, complaints and the section they are currently endorsed or referred. Statistics will help clinicians and administrative staff of UPCD generate yearly reports on the number of patients and cases treated and services needed by patients. Faculty clinicians are also the ones to approve updates on dental chart. An update on a dental chart by any clinician is given a status 'pending approval'. Whenever a faculty clinician logged in, he will be the one to approve the said update. This will help in ensuring that updates on patient dental chart are correct and definite. Viewing of upcoming appointments of all clinicians can also be done by faculty clinicians. Furthermore, they can also view and edit clinician accounts.

Also patient dental record is included as tab in the patient dashboard rather than in the navigation menu. DentISt follows standard clinicians workflow since dental records of patients can be accessed immediately after finding or creating a patient record.

The patient's dental chart loading is also improved. Input of tooth conditions is

much faster since data is first colored on a widget before being applied on the dental chart. Also, versions of the dental chart is available for viewing of registered clinicians. Tracking of changes on patient status chart along with when and who updated the chart will be much easier because of this.

The use of OpenMRS, an electronic medical record (EMR) system, helped in minimizing coding since common tasks of an EMR, such as adding and finding patient records, are already available. However, being a new, free and open-source EMR, there is a lack of resources and documentations available online. Also, there is not much OpenMRS implementations available especially in the Philippines. Due to this, developing a module for OpenMRS takes great effort and intensive cooperation with other implementers.

DentISt is created as an OpenMRS module which only focuses on dental-related data of patients specified by the UP College of Dentistry. Since OpenMRS architecture is divided into the three layers - Presentation, Service and Database - the connection from the presentation layer down to the database layer is very complicated. Simple operations on the database such as adding data to tables, adding tables, and so on require codes for each of the three layers. This way of programming is very time-consuming especially for an information system involving a lot of database access. Since developing a module involves a lot of files cluttered in different packages, logging operation success and failures, along with errors, is very important. Also, compilation and upload of module to the OpenMRS system consume a lot of time especially if the module created is already large in size. Furthermore, changes on a single file must be reflected to other configuration files or else the module will not work. Coding a module for OpenMRS is a tedious task nevertheless it's efficient when it comes to organization of codes.

VIII. Conclusion

Dental Information System 2.0 (DentISt) is an improved version of Open DentIS offering management of patient dental records electronically stored. The use of DentISt will be the first step of UP College of Dentistry in shifting from using paper records to electronic records.

Additions and changes on patient forms requested by Dean Vicente Medina of UPCD are also implemented on the dental module. The loading of patient dental chart is also improved. Changes on tooth conditions are first viewed on a widget (a picture of a single tooth) before being submitted and reflected in the patient dental status chart. Also, viewing of dental chart versions is possible. This will help clinicians track changes on patient's status chart and view the date, time and username of the clinician who last updated the dental chart.

The system follows standard clinician workflow since dental records are accessed immediately after finding or creating a patient record. Also, clinicians can set appointments with patients and view their upcoming appointments. This DentISt functionality will help clinicians keep track of their schedules.

Addition of faculty clinician roles will give faculty clinicians of UPCD access to patient dental records. They are also able to print the patient records. Approval of updates on patient dental status charts is also a task of faculty clinicians. New and improved functionalities such as the query for patients and statistics will help clinicians generate reports on number of patients and cases treated and services needed by patients. Querying for patients will be based on a criteria set by clinicians, therefore narrowing the results to be displayed by the system. Statistics are also based on the fields set by users. This gives faculty clinicians a summary on the number of patients and cases that have already been treated and the services needed by them in a specified time span.

Furthermore, the use of a free, open-source electronic medical record system (OpenMRS) helped in creating a specialized system for UPCD without much resources at expense.

IX. Recommendation

UPCD DentISt is a very useful tool in storing electronic patient dental records. However, the system can still be extended to other sections' dental forms not just admitting section forms (those included in the system already). Sections of UPCD have their own separate forms (i.e. Prosthodontics forms) which contain section-specific concepts. Including other UPCD sections' forms will help the college shift completely from paper records to electronic records.

With DentISt, different forms are presented in tabs on the patient dashboard. However, the order of the arrangement of the tabs is not handled and can not be controlled by the dental module. It is good to find a way to control the arrangement of these tabs for better viewing.

Integration of UPCD concept dictionary with dental forms will help in error-checking and in managing observations or data collected more easily.

Also, statistics and query for patients functionalities can have more determining factors such as patient addresses, etc. Other features present in commercial dental softwares could also be added such as billing and insurance management.

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XI. Appendix

A. OpenMRS Module

The structure of an OpenMRS module if viewed as a single mavenmodule is listed below:

1. .settings - Eclipse specific folder containing preferences for your environment
2. api - non web specific "maven module' project
   (a) src
      i. main - Java files in the module that are not web-specific. These will be compiled into a distributable mymodule.jar
      ii. test - contains the unit test Java files for the generic Java classes
   (b) target - folder built at runtime that will contain the distributable jar file for the module
3. omod
   (a) main
      i. java - web specific Java files like controllers, servlets, and filters
      ii. resources
         A. config.xml
         B. *.hbm.xml files
         C. liquibase.xml (or the old sqldiff.xml)
         D. messages_*.properties files
         E. modulesApplicationContext.xml
         F. log4j.xml - optional file to control logging in your module
      iii. webapp - jsp and html files included in the omod
         A. portlets -
         B. resources - image, js, and css files that your jsp files reference
         C. tags -
         D. taglibs -
   (b) test - contains Java unit test classes that test the controllers in omod/src/-main/java

4. .classpath - Eclipse specific file that points to the files necessary for building the omod and jar files on the fly

5. .project - Eclipse specific file containing the name and properties of your eclipse project

6. pom.xml - Maven build file. Delegates to pom.xml files in the omod and api project [34]

To create a module, the easiest way is to use the module Maven archetype. This will create the project skeleton and a pom.xml file with all the dependencies for OpenMRS API's and repositories. Note that in following the instructions below, Maven should be installed in the user's system.

1. Go to .m2 folder of the system.
   (a) For Linux users: ~/m2
   (b) For Windows XP users: C:\Documents and Settings\USER\.m2
   (c) For Vista/Windows7 users: C:\Users\USER\.m2

2. If settings.xml does not exist in the folder, create one and copy the settings code located in Appendix (B.)

3. In the command line, go to the folder where the project will be created (like your workspace folder)

4. Run Maven plugin command - "mvn module-wizard:generate"

5. Follow the wizard prompts
   (a) To create a basic module, set all module wizard questions to 'n'
   (b) To create a module with admin link, set module wizard question "Do you want admin page link" value to 'y'. An additional parameter is prompted asking for the text of link which should appear in admin page (parameter: Link Name). Answer it with the preferred text.
   (c) To create a module with spring driven page, set module wizard question "Do you want Spring driven Mvc page" value to 'y'

(d) To create a module with service/dao files, set module wizard question "Do you want service/serviceimpl/dao/hibernatedaomapping" value to 'y'. Additional prompts for service name and object name is then asked from the user [34].

B. Maven Settings

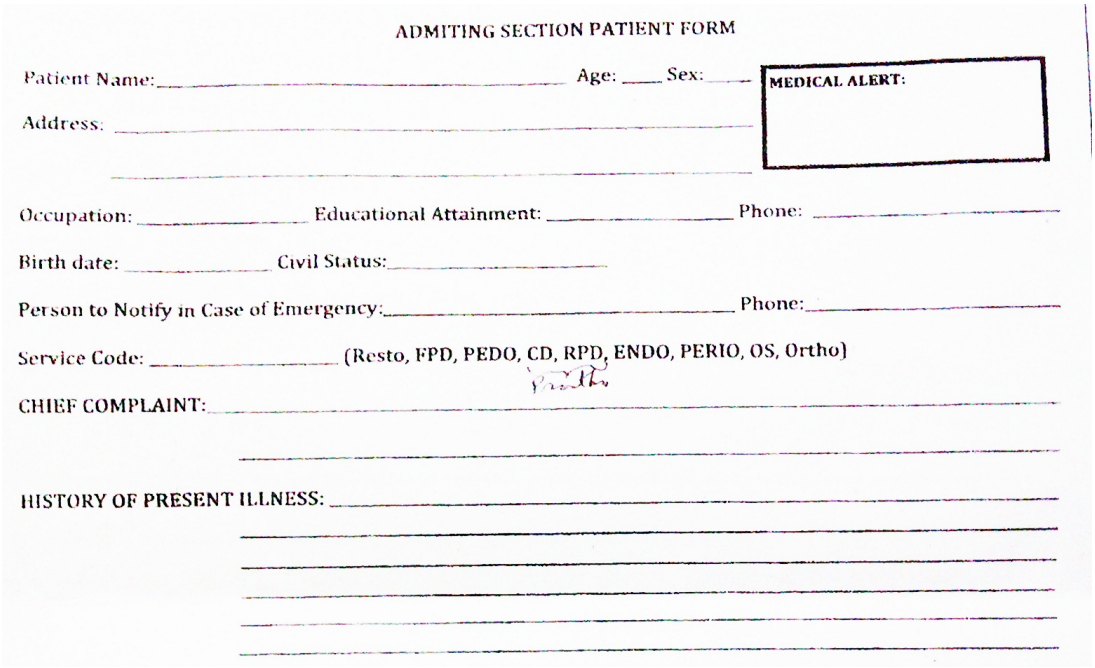
```
// settings.xml
<settings xmlns=``http://maven.apache.org/SETTINGS/1.0.0"
  xmlns:xsi=``http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation=``http://maven.apache.org/SETTINGS/1.0.0
                    http://maven.apache.org/xsd/settings-1.0.0.xsd">

  <pluginGroups>
    <pluginGroup>org.openmrs.maven.plugins</pluginGroup>
  </pluginGroups>
  <profiles>
    <profile>
      <id>OpenMRS</id>
      <activation>
        <activeByDefault>true</activeByDefault>
      </activation>
      <properties>
        <archetypeCatalog>
        http://mavenrepo.openmrs.org/nexus/service/local/repositories/releases/
        content/archetype-catalog.xml
        </archetypeCatalog>
      </properties>
      <repositories>
        <repository>
          <id>openmrs-repo</id>
          <name>OpenMRS Nexus Repository</name>
          <url> http://mavenrepo.openmrs.org/nexus/content/repositories/public
          </url>
        </repository>
      </repositories>
```

```
    <pluginRepositories>
      <pluginRepository>
        <id>openmrs-repo</id>
        <name>OpenMRS Nexus Repository</name>
        <url> http://mavenrepo.openmrs.org/nexus/content/repositories/public
        </url>
        <snapshots>
          <enabled>false</enabled>
        </snapshots>
      </pluginRepository>
    </pluginRepositories>
  </profile>
</profiles>

</settings>
```

C. UPCD Patient Form



ADMITING SECTION PATIENT FORM

Patient Name:_____ Age: ____ Sex: ____ MEDICAL ALERT:

Address: _____

_____

Occupation: _____ Educational Attainment: _____ Phone: _____

Birth date: _____ Civil Status: _____

Person to Notify in Case of Emergency: _____ Phone: _____

Service Code: _____ (Resto, FPD, PEDO, CD, RPD, ENDO, PERIO, OS, Ortho)

CHIEF COMPLAINT: _____

_____

HISTORY OF PRESENT ILLNESS: _____

_____

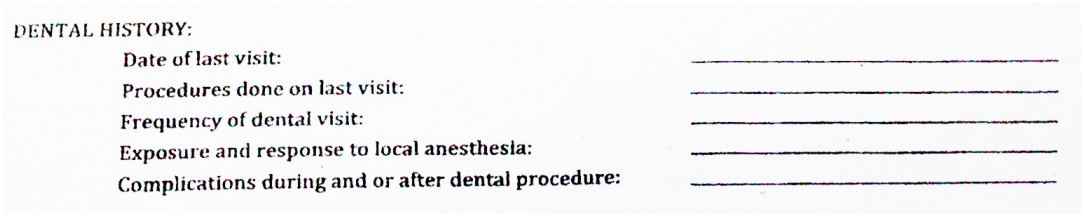
_____

_____

_____

_____

Figure 74: UPCD Admitting Section Patient Form with Patient Demographics, Chief Complaint, History of Present Illness


DENTAL HISTORY:

Date of last visit: _____

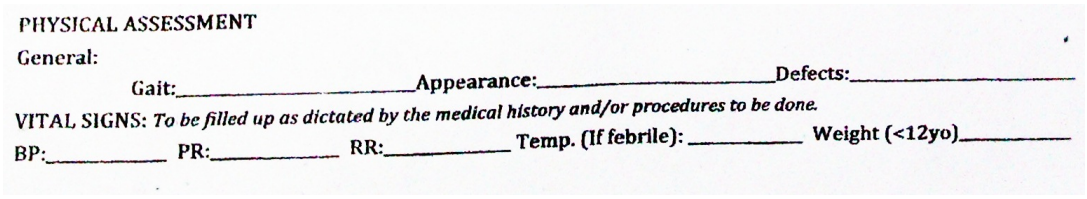
Procedures done on last visit: _____

Frequency of dental visit: _____

Exposure and response to local anesthesia: _____

Complications during and or after dental procedure: _____

Figure 75: UPCD Admitting Section Patient Form with Dental History


PHYSICAL ASSESSMENT

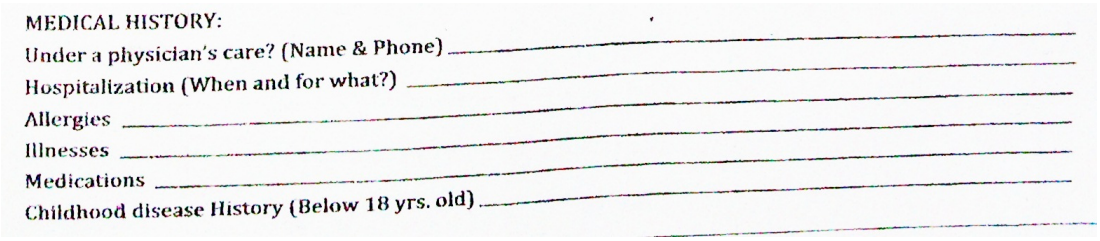
General:

Gait:_____ Appearance:_____ Defects:_____

VITAL SIGNS: *To be filled up as dictated by the medical history and/or procedures to be done.*

BP:_____ PR:_____ RR:_____ Temp. (If febrile): _____ Weight (<12yo)_____

Figure 76: UPCD Admitting Section Patient Form with Physical Assessment and Vital Signs


MEDICAL HISTORY:

Under a physician's care? (Name & Phone) _____

Hospitalization (When and for what?) _____

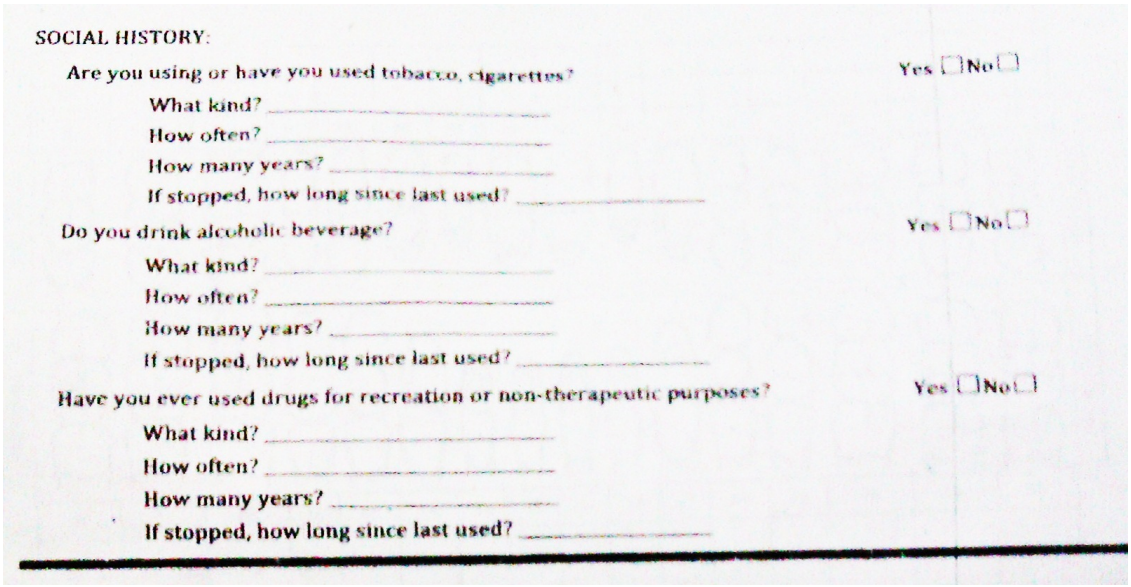
Allergies _____

Illnesses _____

Medications _____

Childhood disease History (Below 18 yrs. old) _____

Figure 77: UPCD Admitting Section Patient Form with Medical History


SOCIAL HISTORY:

Are you using or have you used tobacco, cigarettes? Yes ☐ No ☐

What kind? _____

How often? _____

How many years? _____

If stopped, how long since last used? _____

Do you drink alcoholic beverage? Yes ☐ No ☐

What kind? _____

How often? _____

How many years? _____

If stopped, how long since last used? _____

Have you ever used drugs for recreation or non-therapeutic purposes? Yes ☐ No ☐

What kind? _____

How often? _____

How many years? _____

If stopped, how long since last used? _____

Figure 78: UPCD Admitting Section Patient Form with Social History

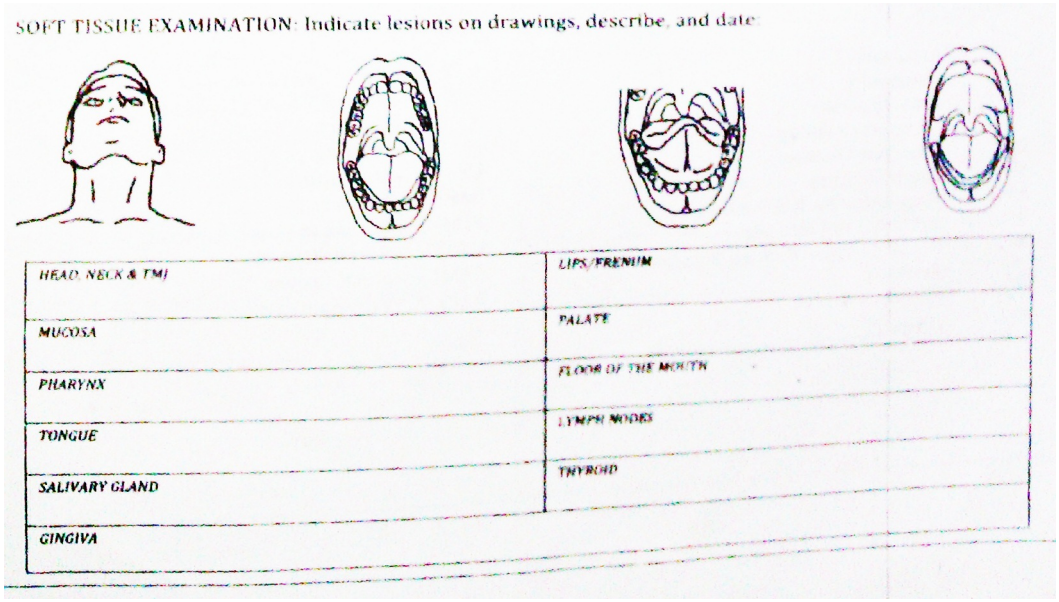


Figure 79: UPCD Soft Tissue Examination

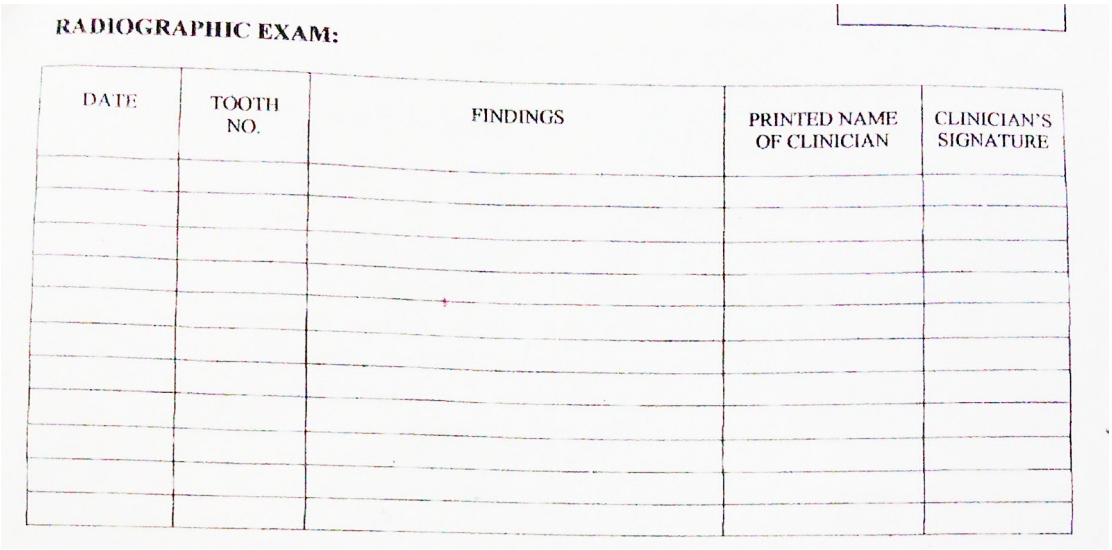
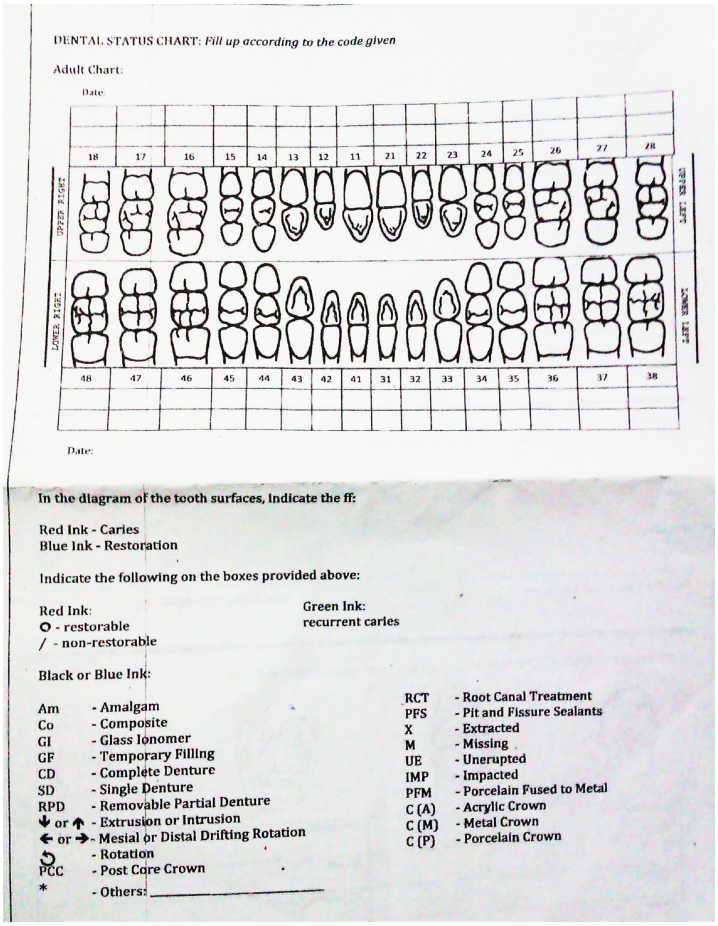


Figure 80: UPCD Radiographic Examination



DENTAL STATUS CHART: *Fill up according to the code given*

Adult Chart:

Date:

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

UPPER RIGHT — UPPER LEFT

LOWER RIGHT — LOWER LEFT

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

Date:

In the diagram of the tooth surfaces, indicate the ff:

Red Ink - Caries
Blue Ink - Restoration

Indicate the following on the boxes provided above:

Red Ink:
O - restorable
/ - non-restorable

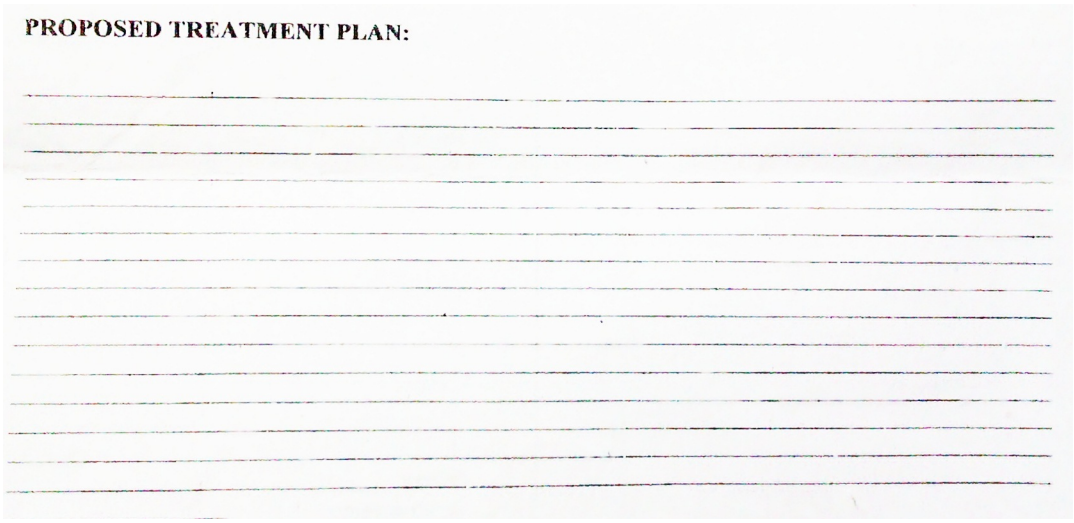
Green Ink:
recurrent caries

Black or Blue Ink:

Am	- Amalgam
Co	- Composite
GI	- Glass Ionomer
GF	- Temporary Filling
CD	- Complete Denture
SD	- Single Denture
RPD	- Removable Partial Denture
↓ or ↑	- Extrusion or Intrusion
← or →	- Mesial or Distal Drifting Rotation
↻	- Rotation
PCC	- Post Core Crown
*	- Others: _____

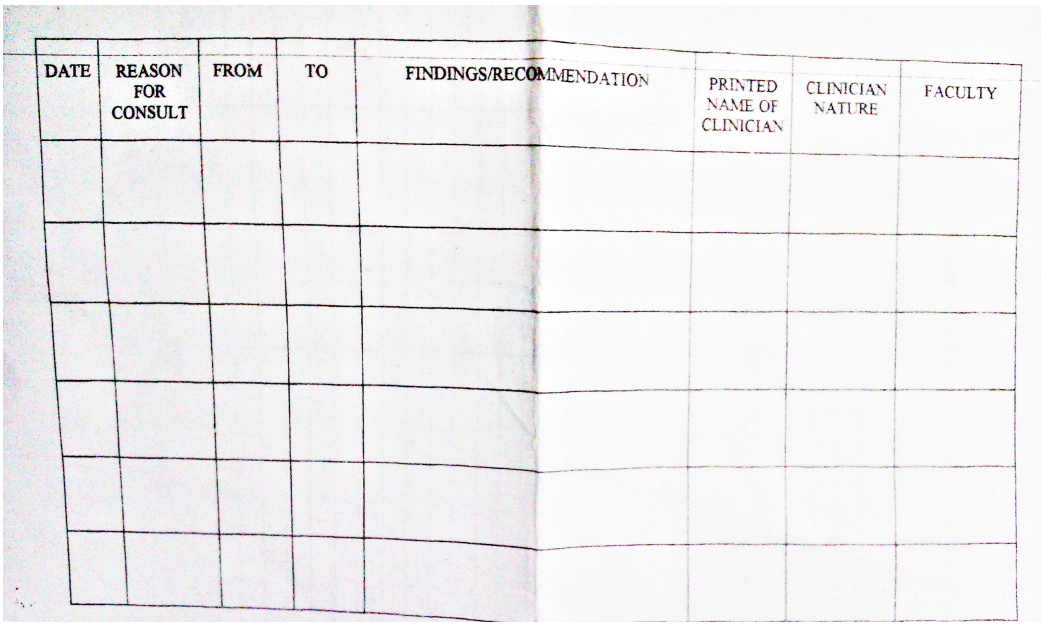
RCT	- Root Canal Treatment
PFS	- Pit and Fissure Sealants
X	- Extracted
M	- Missing
UE	- Unerupted
IMP	- Impacted
PFM	- Porcelain Fused to Metal
C (A)	- Acrylic Crown
C (M)	- Metal Crown
C (P)	- Porcelain Crown

Figure 81: UPCD Dental Status Chart



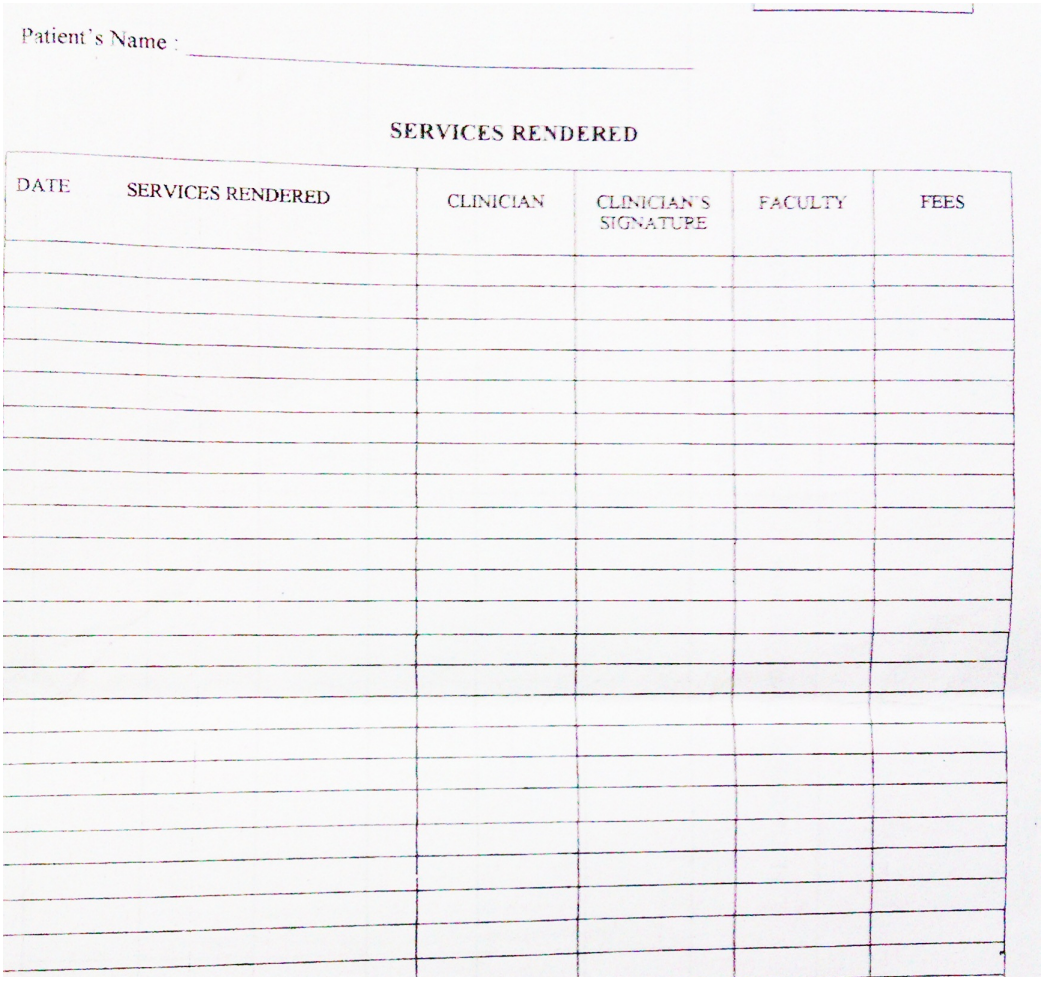
PROPOSED TREATMENT PLAN:

Figure 82: UPCD Proposed Treatment Plan



DATE	REASON FOR CONSULT	FROM	TO	FINDINGS/RECOMMENDATION	PRINTED NAME OF CLINICIAN	CLINICIAN NATURE	FACULTY

Figure 83: UPCD Consulatations/Referral

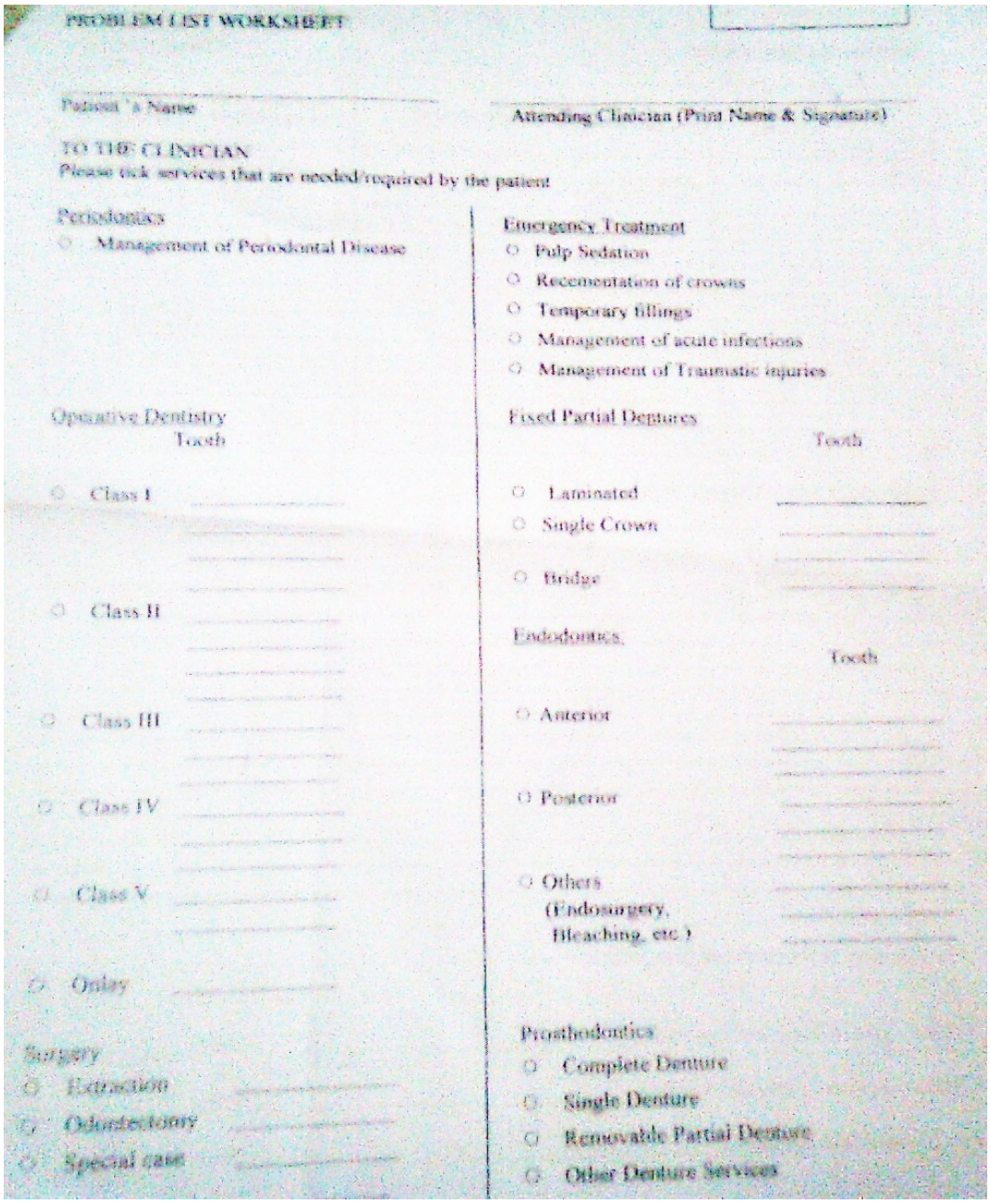


Patient's Name : _____

SERVICES RENDERED

DATE	SERVICES RENDERED	CLINICIAN	CLINICIAN'S SIGNATURE	FACULTY	FEES

Figure 84: UPCD Services Rendered



PROBLEM LIST WORKSHEET

Patient 's Name

Attending Clinician (Print Name & Signature)

TO THE CLINICIAN
Please tick services that are needed/required by the patient

Periodontics
- Management of Periodontal Disease

Operative Dentistry
Teeth
- Class I
- Class II
- Class III
- Class IV
- Class V
- Onlay

Surgery
- Extraction
- Odontectomy
- Special case

Emergency Treatment
- Pulp Sedation
- Recementation of crowns
- Temporary fillings
- Management of acute infections
- Management of Traumatic injuries

Fixed Partial Dentures
Teeth
- Laminated
- Single Crown
- Bridge

Endodontics
Teeth
- Anterior
- Posterior
- Others (Endosurgery, Bleaching, etc.)

Prosthodontics
- Complete Denture
- Single Denture
- Removable Partial Denture
- Other Denture Services

Figure 85: UPCD Problem Worksheet

D. Source Code

XII. Acknowledgement

March 20, 2012. My SP defense day. I just can't tell you how happy I am after the defense :') This will not be possible, of course, without the people whom I'll forever keep in my heart. :)

First af all, I want to thank the **Lord Almighty**, for giving me the strength to stay up all night every single day. Haha. With this, I learned the importance of naps. I also want to thank Him for encouraging me through His words, for giving me wisdom and determination to finish this project. All is impossible without Him :) You'll always be my One and Only.

To my dear family who has always been there for me ever since. **Mama, Papa, Robelle, Gester, Lolo and Bebe**. Kahit ang gulo-gulo kong tao at ilang away na ang nangyari sa atin, salamat dahil nariyan pa rin kayo. I love you all. :) At siyempre hindi ko makakalimutan imention si **Baby MM** (my brother's daughter)! I love you baby :) :) Dahil everytime na nakikita kita, I feel happy and motivated. Cuteness overload! I know you'll grow pretty and intelligent rin, kanino pa ba magmamana? Haha joke. Just know na kahit baby ka pa lang ngayon, you make people around you soooooo happy :) And I'm one of them! Hihi. Basta makikinig lagi sa amin ha? God bless :)

At dahil sila ang the best, uulitin ko sila! XD Sa aking **Mama at Papa** na madalas kong iniistress, I'm really really sorry. Sorry po dahil 'di ako nakikinig 'pag pinapatulog niyo na ako every night... Kasi naman may SP 'di ba? Hehehe. Ayun ito na po ang outcome ng aking pagpupuyat, I promise matutulog na ako palagi ng umaga (Weh). Mahal na mahal na mahal na mahal ko kayo! :D :D :D . . Para sa inyo po ang lahat ng ito :)

Sa aking ate Lilybeth, uwi na kayo! Miss ko na kayo - Kuya Joseph, Janjan, Lorraine at siyempre si Jude!! Kailangan niya ko makilala bago siya lumaki. Haha. Salamat po sa walang sawang pagsuporta, alam niyo na yun :)

Dean Vicente Medina of UPCD! Thank you for my SP topic. Hihi. Thanks for the company and all the things na natutunan ko dahil sa inyo! Salamat rin po kanila Mam Vicky, Mam Merl, Kuya Jun at kay Ate Yolly na nakabonding ko noong nag-SA ako sa Dent! Hihi the best kayo!! Bawi me after all these :)

To my SP adviser, sir Richard Bryann Chua, thank you!! Indeed, best adviser ever.

:) Even though there are times na nakakapressure talaga, well, ngayon ko narerealize na para samin din naman lahat ng iyon. Thank you for everything sir. Lablablab. :) Cheers to other Chua babies - Regina, Bev, Jj, Twiks, V, Kuya Ish!! XD

DPSM Professors! Salamat po sa inyong lahat, marami po akong natutunan sa apat na taong pagsasama! Tunay ngang magagaling lahat ng taga-DPSM! Best department po tayo. Hihihi. To all my other professors and all the teachers since nursery! Thank you rin po. Wala ako sa kinatatayuan ko ngayon kung wala kayong lahat :)

Ate Aurielle! Salamat po sa motivation at sa pagtuturo kahit ang kulit kulit kulit ko na. Salamat sa time mo ate ha? Kung wala ka wala rin ako dito. Hihi. Ang ganda mo po at talino! Idol na kita. Hihihi. Lablab ate!

To my best friends, thank you so much :) you all are my inspiration. Jan, Patricia, Joy. Thank you for listening to all my never-ending rants. Thank you for the happy moments shared together. Hindi ko pinagsisihang sumama everytime na gagala tayo kahit na sobrang busy. Sobrang hindi ko maafford na imiss ang mga moments na 'yon with all of you dahil lang sa SP na ito (loljk hindi lang ito nila-'lang' hehe). More gala soon? Haha.

To my ever cheerful friend, Rovina, salamat sa pagiging ate ko. Hehe. I know you're not here to cheer me when I'm down, but knowing that you're safe and happy wherever you are makes me feel happy too. I miss you. And I'm really praying to see you soon.

Mami JJ, this one's for you too. :') You are the friend to talk to when it comes to these things. Haha well not really these things lang. Ikaw lagi ang masarap kausapin, masarap kwentuhan, masarap kaasaran (haha!) lalo 'pag nagstay tayo all night. 'Yun bang bigla akong magkakaproblema tapos bigla na lang ako magtatanong ng random personal questions sayo. :)) Alam mo na 'yon. You never let me down. I wish I can do the same to you :) Congratulations :)

A big thank you also to my highschool friends - Paola, Erick, Mark, Eddie, Gamba, Tonton, Trisha, Marj B, Marj D, Geraldine, Von, Carl. I miss all of you!! At special mention si Ronniel dahil sa walang sawang pagkumusta niya sa akin at pagka-excite sa graduation ko. Hahaha. Eto na po 'yon, punta ka sa grad ko ha. :)

To my elem buddies! Reunion na ulit? Hehe. I miss you - Nadem, Crizza, Erin, Bon, Martin, Kevin B, Edrine, Jacques, Cherry Anne, Jaylon, Khyle, Kevin G, etc :) Ang dami niyo kasi. Haha. Really, I'm so grateful to have all of you.

BLOCK 12 '08! Best ever block. Sana hindi ito ang ending ng lahat a? Reunions please. Thank you for everything - for happy moments, kulitan, bonding, jamming sessions, asaran, gala, swimming, parties!! SALAMAT SA LAHAT! The best kayo pagdating sa pagsuporta. Sobra. Stat people - Faye, Mami JJ, Mami Aura, Twiks, Enzi, Chester, Dan, Renz, Nard, Mik, Ana, Jen, Migi - the best tayo! Hihi. At siyempre hindi papatalo HI people - Jan, Joy, Arvin, Ian, Chessel, JM, Bev, Lalay, Eulah, Vienna, Fiona, Migo, Patrick, Axel, Melvin, Louie, Tine. At siyempre sila Ef, Rex, Neil, Azie, Xmae! Pati na rin Ate Isay, Ate Naji, Kuya Cheng, Kuya Ish, Angela, Jamie! Pambihira sinabi ko na lahat. Hahaha. Sorry kung may 'di pa nabanggit diyan basta walang angat satin! Pantay pantay lang lahat tayo at sobrang hindi ko kayo makakalimutan ever. Hindi mabubuo ang BLOCK 12 kung may isa mang mawala sa inyo. Lablablab :)

Dahil palagi mo ko niyayabangan, inaaway at kinukulit, dito ka nararapat. Rex uwi na!! Hahaha. I miss you. Pasalubong ko!

At sa lahat ng iba pa! Napakarami niyong tumutulong at nagpapasaya sa akin. Hihi alam niyo na yon kung sino man kayo. Salamat! May God bless you! :)

At siyempre, save the best for last. To the person who has always been there all along, **Arvin Jasper S. Linog** (naks buong pangalan), Im really happy to have you again. Thank you for believing in me, for cheering me up, for understanding my moodswings. Hehe. Sensya na kung paminsan mainit ulo, SP kasi e! Hahahaha. Salamat dahil nandiyan ka lalo kapag nahihirapan na ko, lalo kapag feel kong wala namang may pake sakin at walang nagcacare kung matapos ko ba ito o hindi. 'Di ko na masabi kung gaano karami na ang nagawa mo para sakin. Thanks for everything. Basta babawi ako sayo. I'm praying that you'll do best in all that you do. Haha. Salamat sa lahat. You never fail to make me feel special and I'm really super duper lucky to have you. I love you with all my heart. :')

I know these words will never be enough to tell you how important all of you to me. Still, kahit nakakairita na basahin, thank you for everything. College experience is the best, alam niyo yan :) Sana 'di rito magtatapos ang lahat ha! To infinity and beyond! Again, I'm so lucky to have met all of you. And frankly, I'd have it no other way :) Lablablab!