ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION STUDIES FOR AFRICA

A PROTOTYPE INFORMATION SUPPORT SYSTEM FOR ALL AFRICA LEPROSY AND REHABILITATION TRAINING CENTER

A Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Information Science.

by

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ADDIS ABABA UNIVERSITY

School of Graduate Studies

A Proptotype Information Support System For The All

Africa Leprosy And Rehabilitation Training Centre (ALERT)

by

Mohammed-Sied Salih Abdulkadir

School of Information Studies for Africa (SISA)

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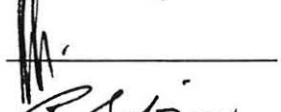
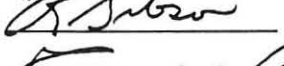
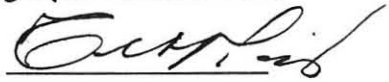
Dr. Taye Tadesse, Advisor	
Dr. R. Gibson, External Examiner	
Ato Tesfaye Birru, Internal Examiner	

DEDICATION

This thesis is dedicated to my father Abdullahi Abdulkadir

(Abashawl)

and

to my mother

Fatima Ismael

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ABSTRACT

This thesis discusses the development and implementation of a micro-computer based system designed for collecting and summarizing clinical information on leprosy patient visits to the hospital of the All Africa Leprosy & Rehabilitation Training center (ALERT). The medical records of leprosy patients are handled in the traditional hand written card called a Patient Card. However, many problems are associated with it. It is very difficult to find, for instance, a summary of diagnosis, treatments, sensation and muscle changes etc., for a patient over a number of visits. The manipulation of these data for statistical analysis and make available for administrative, educational and research purposes has become very difficult. Redundant handling of data in different sections of the hospital and problem of access to the data between the sections are some added problems.

The objective of this study is to demonstrate that data about leprosy patients can be stored in micro computer databases which would be readily accessible for a variety of administrative, clinical, educational and research related activities. A prototype of two types of patient information handling system are shown in the application program: the registration data, collected once and updated periodically; and the transaction data collected each time the patient has an encounter with a health professional. The registration data includes Patient Name, Patient ID, Address, and Date of Birth, Sex, Marital Status, Nationality etc. Encounter data, usually linked to registration data through the Patient ID, includes the date of encounter, provider's name, signs, symptoms, diagnosis, treatments, etc.

The data flows and the logical data structures required in the diagnosis and treatment of leprosy patients are designed using the data flow diagrams and logical data structures respectively. There are 29 databases designed using the procedures followed in the normalization process with the objective to avoid redundant handling of data and to avoid the three common anomalies namely insertion, deletion and modification anomalies. The major feature of these databases is that they are designed irrespective of a particular software in mind, with the objective to facilitate use of any software selected for the purpose.

The thesis describes the need for the implementation of a physician's workstation with an online medical record of leprosy patients and proposes a Local Area Network (LAN) with a distributed database management system where each section of the hospital will have their own data and share data to and from other sections but for dissemination and analysis purposes data can be aggregated at a central information unit.

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LIST OF ABBREVIATIONS

ALC = Alert Leprosy Control Division (Field area division)

NLCP = National Leprosy Control Program (an affiliated organization)

AHRI = Armaour Hansen Research Institute

MDT = Multi-Drug Therapy

MONO = Mono therapy (single drug therapy)

RFT = Released from treatment

GLRA = German Leprosy Relief Association

WHO = World Health Organization

AAU = Addis Ababa University

ILEP = International Leprosy Association

LIST OF INSTITUTIONS SURVEYED FOR CONSULTATION AND INTERVIEW

Ethio - Swedish Paediatric Clinic at the Black Lion Hospital

WHO - Regional Office in Addis Ababa (in the MOH)

AHRI - Armaour Hansen Research Institute

MOH - Ministry of Health Epidemiology Unit

Medical Faculty of the Addis Ababa University

NLCP - National Leprosy Control Program

CHAPTER 1

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

Efficiency and effectiveness of an organization in general and that of the health institutions in particular depend on better use of resources, better knowledge about operations and about the community served. This cannot be reached without information. On the Ninth Annual Symposium on Computer Applications in the Medical Care, Kerlin (1985, 3) stated that "survival ... will depend ... upon key people in the clinic who recognize the potential power of information and who harness it to the clinic's benefits. With limited funds and an expanding population to serve, the survivors will be those clinics that can more efficiently manage their own operations and can provide timely, substantive information to funding sources on a periodic and ad hoc basis".

To this end, Automation of medical information systems and services has gained a tremendous attention. Health care organizations increasingly make use of computer based information systems and services to support their health personnel provide better health services and for efficient management of their operations. Computers have become indispensable in the clinical, research and training activities of the health care institutions. They are often employed for their ability to acquire and display data from the real world in a form immediately suitable for analysis which may not be done by hand (Gardner David W. and David M. Klachko, 1985).

However, unlike other business organizations, information and use of computers in the field of health environment specially in countries like Ethiopia is very poor. We hardly find a complete, integrated and efficient system for handling and supplying patient information to physicians and other users in the profession. In order to provide an optimal care a physician needs to know as much as possible past history, present problems, medications, and laboratory tests etc. In most health provider institutions this information is stored in the traditional handwritten Patient Cards. At the time of the patient visit, however, it is very difficult to locate a specific type of information from this card when it is needed. The health care provider must either search the record and organize the information manually or rely on memory. The former is a time consuming and often incomplete while the latter results in serious errors. More over, it is difficult to manipulate the information for a variety of purposes such as for the correct measurement of the effectiveness of different treatment strategies, allocating resources, conducting researches etc.

The acronym ALERT stands for All Africa Leprosy and Rehabilitation Training Center. ALERT is established to provide formal leprosy training courses for international and national trainees as well as in-service training for doctors, with more emphasis to Africans. It also provides full hospital services for leprosy and other non-leprosy patients. The hospital serves as a demonstration center to support the training programs. It runs about 200 beds for in-patient services. The annual average patient visit of leprosy and other patients including new as well as repeat patients is about 79,000. Like any other hospitals in Ethiopia, the patient medical record system is based on the traditional handwritten patient cards. The problems attached with the traditional systems, as mentioned above, is also typical in the hospital division.

The purpose of this study is therefore, to demonstrate and lay down certain guidelines and design a computer based information support system in ALERT, to improve the existing patient data handling system so that the health providers would be supported in providing better medical services and the medical records would be readily available for a variety of administrative and research purposes.

1.2 JUSTIFICATION

Medicine like many scientific activities cannot be practised effectively without accurate and timely information about patients and their problems, about appropriate care giving procedures, and about the medical and institutional resources available to support care providers and their patients. Patients are becoming more routinely receiving treatment. In each episode bulk of information is collected. However, this information is not found online but in a traditional hard copy of one form or another. The information is contained in paper based patient records derived from provider-patient encounter, film based x-rays, scans from diagnostic procedures, outputs from laboratory equipments, voice recording of clinicians notes. These are the main sources of information and they constitute the major component of what we call the patient record.

To treat patients effectively, a busy doctor needs an accurate and organized information on who the patient is and what causes his illness. He needs all previous and current histories of individual patients readily put together and organized in some way.

The process of continuous evaluation of leprosy control activities require the use of a

method for collecting, processing, and analyzing information on clinical, epidemiological, and operational aspects of the leprosy control program. The need for information systems and services has become even more urgent under present circumstances when leprosy control has reached a turning point. Lechat (1985) attaches the following two main reasons for this need:

1) The leprosy control activities which, in general, have been carried out up to now through vertical programs, are to an increasing degree being integrated into the general health services, particularly within the primary health care approach, and it is accepted that this is the only way by which it will be possible to cope adequately with leprosy in countries which are also faced with many other health problems.

2) While the integration process calls for simplified methodologies, the increasing threat caused by resistance to drugs coupled with the problem of microbial persistence has made mandatory the use of combined chemotherapeutic regimens, which will result in greater operational complexity than the dapsone-based strategy.

In such a situation the health personnel including the management body need data to be collected and organized in an integrated manner so that the measurement of the effect of various operational treatment strategies could be supported with adequate and reliable information.

One of the major obstacles that the health providers and the management face is that lack of accurate, timely, appropriate and integrated data at all levels for clinical, managerial and research activities. Although bulk of information are available in the traditional paper based

records, it is very difficult to collect, manipulate and provide required data and effectively support in the delivery and administration of health care. As a result of manual operations each unit of the hospital maintains its own data irrespective of what is available in the other unit. This has lead to redundant handling and processing of information which in effect has led to wastage of resources, time and energy.

So, need arises to integrate the information produced at different units of the hospital. This has called for the development of an information support system which can collect, organize, and process patient data to provide health providers, researchers, health administrators, top management body and donors, a range of information dealing with the leprosy patients.

1.3 OBJECTIVES OF THE STUDY

1.3.1 General Objective

The general objective of this study is to support the clinical activities involved in the diagnosis and treatment of leprosy patients in the hospital division of ALERT. The study aims at development of a prototype leprosy patient case history databases, called LEPRO database, and coming up with plans to develop an overall information support system for ALERT. The prototype is intended to develop computer generated reports that provide physicians a summary of the medical data about a leprosy patient over a number of multiple visits of the patient. Physicians can select and view medical records on any file by entering any valid boolean expression on the possible data elements included in the system. The

report generator also allows the calculation of a descriptive statistics of individual data elements. This will improve the existing statistical data collection system in ALERT. The system can also help in minimizing the prevailing redundant efforts in data handling and preparing statistical reports which are now being carried out by both the statistics unit and other sections in the hospital division. Sub sets of the data included in the system can also be ready to researchers for further analysis.

1.3.2 Specific Objectives

The specific objectives consist of:

1. To carry out the systems analysis and design for ALERT using the tools and techniques applied in systems work.

2. To design leprosy patient case history database with different data entry, query and report formats necessary to enter and retrieve various patient information for use by the user community.
3. To show how the proposed system can be used to produce different statistical outputs such as type of diseases over a period of time grouped by age, sex and others including some epidemiological and operational indices from the database.

4. To design user interfaces through which the users can interact with the system during data entry, searching and retrieving any piece of information from the database.

1.4 METHODOLOGY

The fact finding techniques used consists of interviewing selected physicians, Director of the Hospital Services, Heads of the Hospital Sections and health assistants who are mostly involved in the clerical operations.

A great deal of the task in analyzing the system depends on collection and understanding of the requirements of the various sections and groups. The requirement identification is supported by distributing questionnaires to users within the sections of the Hospital Division, the Training Division, the ALERT Leprosy Control (ALC) Division and the Top Management which are considered to have a contribution in the design.

The design aspect largely depends on interviews and discussions mainly with the Hospital Director of ALERT, selected physicians and two health assistants as well as one senior laboratory technician. Analysis of the annual reports of ALERT has also been a major source of finding the requirements. The tools and techniques as well as the concepts applied in this work are based on a review of relevant literatures.

Much of the current problems, requirements and activities has been the result of observation for the very reason that the researcher of this study works in the organization under study.

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1.5 SCOPE AND LIMITATIONS OF THE STUDY

The current requirements of the users in ALERT are too many. The overall requirements is to establish organization wide information system. But, the study could not cover all. Given the time limitations, it would be difficult to come up with a complete design even only for the hospital division. Instead, the study preferred to be methodological in selecting the area of study. The method used in specifying the scope was to investigate the priority that the users would prefer to set depending on the urgency of need. Based on this the focus of this study is on aspects of leprosy patients that relates to:

-Current and proposed system study of clinical information flows and requirements, in the process of diagnosing and treating of leprosy patients only.

-Design of normalized logical databases in which case history of leprosy patients would be held.

-Prototype application program development on selected modules to demonstrate how the system should work and meet requirements.

- coming up with recommendations on the aspects required to develop an information support system for ALERT.

The sections through which a leprosy patient undergoes diagnosis and treatments and which are the focus of this study are the Registration, Diagnostic Clinic, Red Medical Clinic, New Case Clinic, Gate Clinic, Wards, Laboratory, Physiotherapy, Medico-Social Section and the Health Education sections of the Hospital.

1.6 ORGANIZATION OF THE THESIS

The thesis is organized into seven chapters. Chapter One provides an introduction, justification, objective, methodology, and scope and limitations of the thesis. Chapter Two deals with a background information on the organization under the target of this study. The main body of the thesis begins in Chapter Three, where, the analysis of the existing system, applying the tools and techniques used in systems work, are discussed. Chapter Three attempts to investigate the activities of the sub-systems, the problems arising in the existing system, the current information flow pattern and the information requirements in ALERT. Chapter Four discusses the design of proposed solutions to the information system. The proposed data flow diagrams and the logical database designs are discussed in this chapter. Chapter Five deals with the physical design aspect. The system requirements as regards to the hardware, network, change to the organizational structure, conversion and training are all discussed in Chapter Six. Chapter Seven is on the conclusions and recommendations on the over all aspects of the information support system.

Chapter 2

BACKGROUND INFORMATION.

2.1 WHAT IS LEPROSY?

Leprosy is a very chronic disease. Many of the mild forms an easily be restored to health. However, the more severe forms have a tendency to worsen with time, and the most severe and easily communicable forms last for life. The disease reduces life expectancy by a few years, and more so in the lepromatous forms (Koticha, 1988). In more than one third of untreated or advanced cases, leprosy results in disabilities which increase with time and are permanent. These disabilities affect mainly the limb extremities, and the face including the eyes, resulting in severe impairment of working capacity and seriously affecting the social life of the patient. The disabilities and disfiguration suffered by leprosy patients have in many cultural systems resulted in the belief that the disease is not curable. From this attitude originates such a high level of social exclusion that the patients themselves are convinced that their exclusion from the community is justified. A similar feeling of exclusion may also be shared by the patient's families.

So far, no preventive method are available, the control of the disease is based only on the appropriate treatment of patients, and is therefore, closely interrelated with individual patient care. The epidemiological impact of treatment measures depends at first on a high proportion of cases being diagnosed at early stage. The only diagnostic methods are clinical, and therefore, require specialized knowledge and experience. More over, so far

it is impossible to identify individuals at high risk of contracting the disease, and case detection procedures have to be applied to large sections of the population.

Leprosy is still calling for challenging tasks to researchers and professionals working in the areas of prevention and control mechanisms of the disease. So as to reduce the problems existing with the health, social and economic being of the patients, different strategies are being launched by different interested research, training and other medical institutions.

The success of the institutions, launching different strategies on knocking out the disease, largely depends on understanding the trend of patients manifesting the disease and on measurement of the effectiveness of their strategies. In this area of endeavour the need for timely, accurate, complete and integrated information becomes evident. All concerned professionals in the field need a continued information on the trend and other aspects of the disease.

2.2 STATUS OF HEALTH INFORMATION IN ETHIOPIA

The health condition of the Ethiopian people is one of the least developed in the world. In order to improve the health conditions of the population, the past government had taken the measure to restructure and decentralize the health services, with priority given to primary health care, which is believed to lead the goal of "health for all by the year 2000". However, along side this objective the need to develop and strengthen the information systems of each health service units and hospitals has not been taken as an integral part of the objective. Almost all hospitals in Ethiopia run their statistics and patient case recording

system manually. As a result, it has been common to face frequent failures to make good estimates of the overall prevalence of a certain disease. Hence, many difficulties arise in precise planning for the future at a center as well as national level. (Ministry of Health 1980). Health information systems and services do constitute an important input, and contribute for the improvement of the health condition of the population. Until now however, not much progress has been done towards improving patient case history recording system in the hospitals. Like any other hospitals in Ethiopia, the situation in ALERT hospital is not different. Hence, need arises for improving the information system of ALERT.

2.3 ESTABLISHMENT OF ALERT

The Addis Ababa Leprosy Hospital traces its origin back to 1930 and started providing specialized hospital care for leprosy patients. Two years later the foundation stone for Princes Zenbework Memorial Hospital was laid down.

ALERT was established in 1966 and took over the responsibility of running the Hospital on 1st, November 1967. ALERT is not a full autonomous organization but partially a government controlled.

The hospital, situated some 10 kms to the south of the center of the city of Addis Ababa, serves as the national referral hospital for leprosy and skin diseases. In addition to leprosy patients the Hospital serves non-leprosy patients in the fields of medicine, surgery and ophthalmology within the provision made by the Board of Directors to use up to 20% of the

resources to such patients. This provision has a positive impact, in that it helps to minimize the stigma against leprosy (ALERT Annual Report 1986).

ALERT is currently organized into four divisions. These are the Division of Hospital Services, the Division of ALERT Leprosy Control (ALC), the Training Division, and the Administration Division. Under the Division of Hospital Services, ALERT runs a two hundred bed referral hospital for leprosy, skin, medical, eye, dental and surgical diagnosis, treatment and rehabilitation, with an annual average of 79000 repeat and new patient visits out of which 400 are new leprosy cases. The hospital also functions as a demonstration center for the courses given in the Training Division. Within the Hospital Division there are sub-divisions such as, the Medical In-patients, Medical Out-patients (OPD), Surgical, Ophthalmology, and Rehabilitation departments. Other supportive Departments also include the Laboratory, X-ray, and the Pharmacy.

Under the Training Division, it conducts training activities on different aspects of leprosy in different course programs for medical professionals at different levels, extending from a social worker to a doctor. The trainees are coming from many African countries including Ethiopia, some European and Asian countries and the USA. On an average, about 415 trainees participate in the courses every year.

The Alert Leprosy Control (ALC) Division is also one of its major divisions assigned to field works to control the disease over a large area of the Shoa Administrative Region. This division also provides training on many aspects of leprosy control at a field level. Mainly it focuses on patients living in the 12 districts of the Shoa Region which covers an area of

about 85 thousand square kilometers. The total number of health centers, clinics and stations, where the leprosy treatment is carried out are about 291 (ALERT Annual Report 1985).

The organizational chart of ALERT is shown in Figure 1. Each of the sections shown in the chart has its own unique activities. The activities of some sections of the hospital in the case of diagnoses and treatment of leprosy patients is shown in Appendix II. The kind of information required by the different sections involved in the diagnoses and treatment of a leprosy patient is shown Appendix III.

ALERT is also affiliated with Armour Hansen Research Institute (AHRI) which is located in the same compound, to carry out a joint research activities on the possibility of preventing and ultimately eradicating leprosy by development of an effective vaccine. To this end, AHRI scientists and ALERT professionals are working in a cooperative effort towards this objective.

Current Status of Patient Data

Since its inception ALERT has a collection of more than 83000 leprosy case history records in both its hospital and ALC Divisions; about 53000 in the hospital division and more than 30000 in the ALC division. Many disease registers are also maintained in the different units of the hospital.

In the Hospital division, the existing recording and reporting systems have considerable

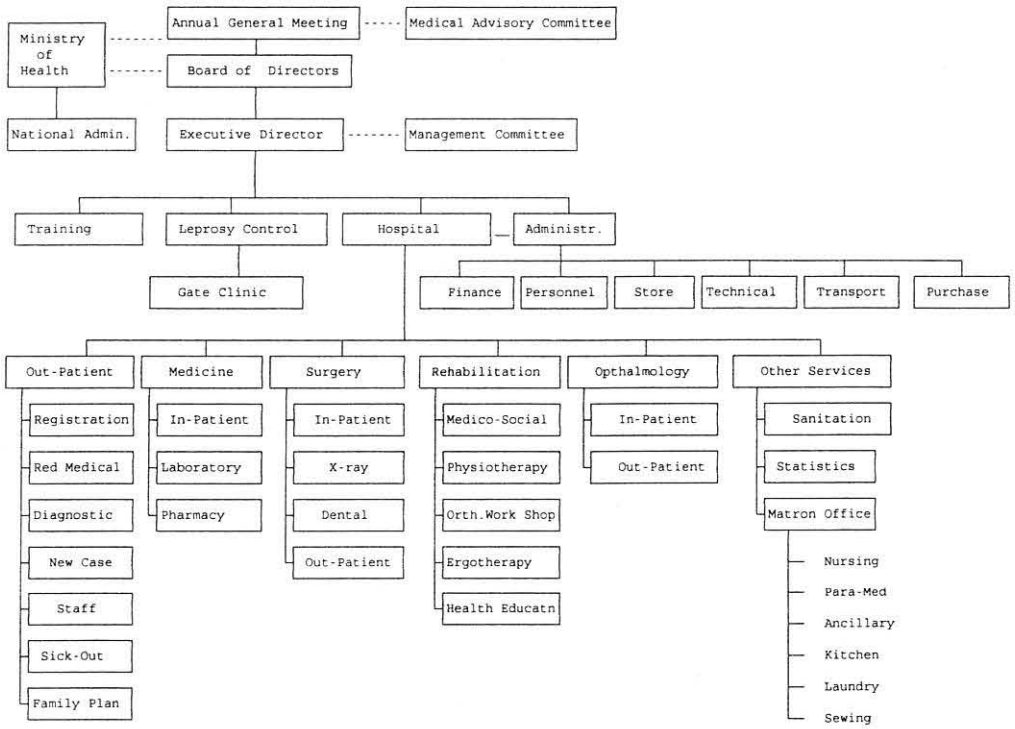

Figure 1: Organizational Structure ALERT.

defects. Valuable information and data are not recorded and reported or they are incomplete. The system for statistical data collection and reporting is manual. In the ALC Division, there is a relatively better data collection and reporting systems. Computer systems using dBASE IV Application program and a spread sheet application software is being utilized. However, the data entered into the computer system is based on the summary reports that are being submitted monthly from field supervisors. Data are not collected directly from the case history records with the exception of some 500 controlled leprosy patients who are under the target of a special research project. Very recently the Medical Advisory Committee has evaluated the information handling in the Hospital and highly commented on the poor information handling. The committee advised the need for change in the system. Some physicians and the management have felt that the computerization of the case history records at the hospital division is necessary. They recommended to develop a system permitting the collection of data that would enable the hospital to determine more precisely and accurately the evolution of the leprosy and thus would give all concerned users a more insight into the detail characteristics of the disease.

The existing patient clinical records and disease registers contain raw data essential for planning, controlling, and research. The statistics section is responsible to collect the data from the various sections and produce periodic statistical reports for use by the Hospital Director and the Ministry of Health (MOH). In addition, some sections like laboratory, X-ray, Gate clinic, Wards also produce their own periodic reports for use by the hospital director.

Chapter 3

SYSTEMS ANALYSIS

3.1 INTRODUCTION

This chapter focuses on the analysis of the tasks involved and the information required in the diagnosis and treatment of leprosy patients at ALERT. Leprosy patients are divided into new case, relapse and reactions cases or reactivations. A leprosy patient can go through in-patient and out-patient services. The sections involved in the treatment and diagnosis of a leprosy patient consist of the:

a) Registration b) Diagnostic Clinic

c) New Case d) Red Medical Clinic

e) Gate Clinic f) Ward

g) Laboratory h) Physiotherapy

i) Medico-Social Section j) Surgical Clinic and

k) Health Education.

The Histopathology Unit of the Armaour Hansen Research Institute (AHRI) is also involved in the biopsy examination of patients. The activities and information requirements of these sections as regards to leprosy patients is indicated in Appendix II. In this chapter the current information flow is described using Document Flows, Data Flow Diagrams, and Entity Relationship Diagrams. Moreover, the problems arising in the information flows and the requirements needed to solve the problems are described.

3.2 CURRENT INFORMATION FLOW

The current information system can be represented using a diagrammatic model: Data Flow Diagrams. Data Flow Diagrams are developed jointly by the analyst and users of the system through a continuous discussions and further refinement of the diagrams to ensure accuracy and completeness in the representation of the current system. (Ashworth 1990).

For initial development of the Data Flow Diagrams, it is very important to study the major documents and their sources and destinations. In the organization under study, the major information flows are the actual documents that move from section to section. The major documents on which the study focuses are indicated in the Appendix I.

3.2.1 **The Document Flows**

The documents listed in Appendix I are the main data stores that represent information about leprosy patients and that move from section to section within ALERT. Movements of these data stores are, therefore, shown in a document flow diagram. In the movement of these documents the section that receives them is designated as a recipient and the section from which the documents were collected is designated as a source. Each source or recipient is represented as an oval in the diagram. The relevant sources and destinations of the documents are listed as follows.

1 The Registration Section
2 The Red Medical Section
3 The Diagnostic Clinic
4 The New Case Clinic
5 The Gate Clinic
6 The Laboratory

7 The Physiotherapy
8 The Statistics Section
9 The Histopathology
10 The Medico-Social Section
11 The Health Education
12 The Wards
13 The Surgical Clinic

The documents will then be matched against the sources and destinations. The interaction of the documents with the sources and destinations are represented in Fig 2.

The Laboratory Request/result indicated in the diagram is a general name that embraces the different kinds of laboratory test requests such as blood, urine, stool, etc. The Physiotherapy Test also embraces sensation, muscle and disability grades.

The Patient Card that moves within the different sections gets updated with different data and instructions as it goes from one section to another. For instance, when it is transferred from the Registration Section to the Diagnostic Clinic, it contains personal details of the patient. When it is also transferred from the Diagnostic Clinic to the New Case Clinic, it is updated with diagnostic data about the patient. When it is further transferred from the New Case Clinic to the Gate Clinic, it is updated with treatment instructions or prescriptions etc. Any data collected about a patient is placed in the Patient Card by a physician/his assistant or a nurse.

The document flow diagram represents the major flow of documents when a leprosy patient undergoes diagnosis and treatments. In that diagram the Patient and the Histopathology is the only source and destination that is external to the boundary.

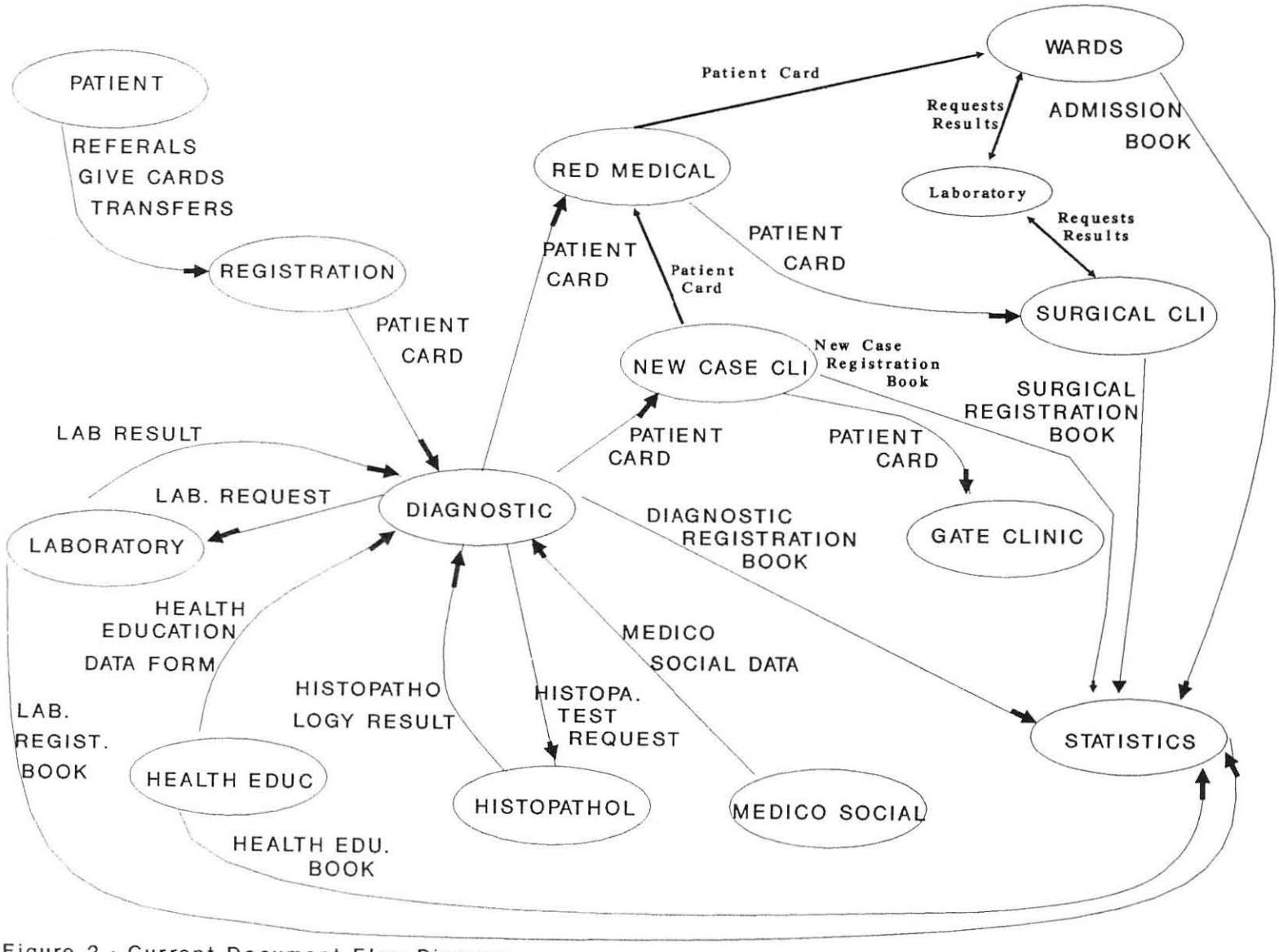

Figure 2 : Current Document Flow Diagram

3.2.2 Identifying Processes

When documents are received or sent, certain operations are performed by the sources and destinations in relation to the receipt or sending of these documents. These operations, carried out within the system boundary, are represented as processes in the Data Flow Diagram. Where these documents are held within files or other storage media, data stores are added to the diagram. The process made on the documents also lays down a basis for establishing a Data Flow Diagram. The main functions involved in the diagnosis and treatment of a leprosy patient, are represented as processes below.

1	Registration
Register Patient	

2	Diagnostic
Diagnose Patient	

3	New Case Clinic
Prescribe Treatment	

4	Gate Clinic
Follow up Treatment	

5	Red Medical
Admit a Patient	

6	Wards
Follow up Inpatient Treatment	

7	Laboratory
Process Lab. Test	

8	Physiothe.
Admit a Patient	

9	Medico-Social
Collect Medico-Social History	

10	Surgical Clinic
Process Surgical Treatment	

11	Health Ed.
Process Health Education	

12	Statistics
Produce Statistical Outputs	

Process 1 - Process Registration: This process consists of:

1) Providing appointments;

2) Accepting give cards, referrals, transfers;

3) Issuing new Patient Cards and registering patient's personal details in the card or retrieving an existing Patient Cards;

4) Recording new patients in the Patient Registration Book and assigning ID numbers to Patient Cards;

5) Issuing and providing patients a Registration Card;

6) Distributing Patient Cards to their respective clinics or physicians; and

7) Collecting all distributed Patient Cards when they should be returned.

Process 2 - Diagnose a Patient: This process consists of

1) Accepting Patient Cards;

2) Recording complaints, signs and symptoms;

3) Raising requests for laboratory tests, histopathology (biopsy) tests; sensation, muscle and disability tests, as well as requests for medico-social and health education data;

4) Accepting the results of all requests raised; storing all data collected in the Patient Card;

5) Identifying the disease and recording it in the Patient Card;

6) Registering diseases in the Diagnostic Registration Book; and

7) Transferring the Patient Card to subsequent processes or sections.

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2) Accepting give cards, referrals, transfers;

3) Issuing new Patient Cards and registering patient's personal details in the card or retrieving an existing Patient Cards;

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4) Accepting the results of all requests raised; storing all data collected in the Patient Card;

5) Identifying the disease and recording it in the Patient Card;

6) Registering diseases in the Diagnostic Registration Book; and

7) Transferring the Patient Card to subsequent processes or sections.

Process 3 - Prescribe Treatment: This process consists of:

1) Accepting Patient Cards from previous processes;

2) Prescribing the treatment procedures required and updating them in the Patient Card;

3) Writing transfer letters for patients living outside Addis Ababa; and

4) Transferring the Patient Card to subsequent processes.

Process 4 - Follow up Treatment: This process consists of:

1) Accepting Patient Cards from previous processes;

2) Providing drugs for patients under controlled supervision and taking attendances by preparing attendance sheets;

3) Follow up progresses by carrying out sensation and muscle tests to observe physical changes of the patient, as well as raising requests and accepting results for BI and MI tests to observe bacteriological changes of the patient; and

4) Updating all data collected in a separate progress follow up card.

Process 5 - Admit a Patient: This process consists of:

1) Accepting Patient Cards;

2) Checking available beds;

3) Requesting admission of a patient and updating Patient Cards with causes of admission and prescribing treatment procedures;

4) Raising requests and updating results for laboratory tests; updating health progresses of a patient in the Patient Card;

5) Instructing discharge of a patient; and

6) Transferring the Patient Card to subsequent processes.

Process 6 - Follow up In-patient Treatment: This process consists of:

1) Admitting and discharging a patient; providing drugs to patients according to the instructions and preparing drug consumption follow up cards for each patient;
2) Recording date of admissions, discharges, number of days stayed, and status at discharge, in the Ward Admission Books.

Process 7 - Process Laboratory Tests: This process consists of:

1) Accepting laboratory test requests;
2) Undertaking the tests and recording results in the result forms as well as in the Laboratory Register Books; and
3) Sending the result forms to the requesting sections.

Process 8 - Process Physiotherapy Tests: This process consists of:

1) Accepting requests for sensation, muscle and disability tests;
2) Undertaking the tests and recording results in the result forms; and
3) Sending the result forms to the requesting sections.

Process 9 - Process Medico-Social History: This process consists of:

1) Accepting requests for medico social data;
2) Interviewing a patient;
3) Collecting the data in the Medico-Social Form; and
4) Sending the form to the requesting section.

Process 10 - Process Surgical Treatment: This process consists of:

1) Accepting the Patient Card from preceding processes;

2) Prescribing surgical procedures required;

3) Raising request and accepting results for laboratory and/or X-ray examinations;

4) Making surgeries and updating the Patient Card with the detail of the surgeries carried out;

5) Providing appointments and updating the health progress details of a patient; and

6) Updating the Surgical Registration Book with the personal etails of a patient and kind of surgeries provided (for statistical purposes).

Process 11 - Process Health Education: This process consists of:

1) Accepting requests for data on health education;

2) Educating a patient;

3) Recording the kind of lessons taught in the Health Education Form and Health Education Register Book; and

4) Sending the form to the requesting section.

Process 12 - Produce Statistical Reports: This process consists of:

1) Collection of the registration books of the different sections;

2) Translating disease names into disease codes;

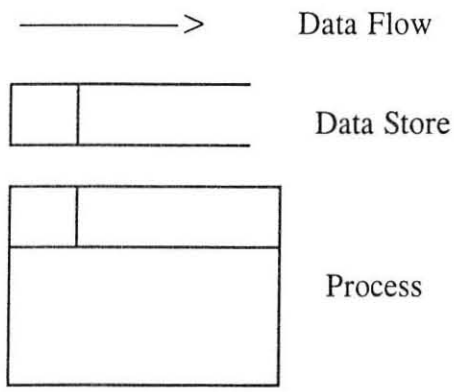
3) Counting and organizing the data into a required sequence;

4) Producing different reports; and

5) Returning the registration books back to their places.

3.2.3 The Data Flow Diagram (DFD)

In drawing the processes in a data flow diagram certain conventional symbols representing the source, destination and flows will be used.



The information flows between the processes and the data stores are determined and depicted in the Current Physical Data Flow Diagram shown in Figure 3.

The operations represented in the Data Flow Diagrams are predominantly update functions.

It may be noted that requests for Physiotherapy Test, Medico-social and Health Education data are made on a plain paper, because the kinds of tests to be done, the medico-social and health education data to be collected are pre determined and are the same for all leprosy patients. Thus, the requests are not represented as data stores but are considered just like any other enquiry. However, in the case of request for histopathology, the kind of each test required is specifically marked in a printed request form. So, the data about the histopathology requests is held in the forms and thus represented as data stores in the diagram.

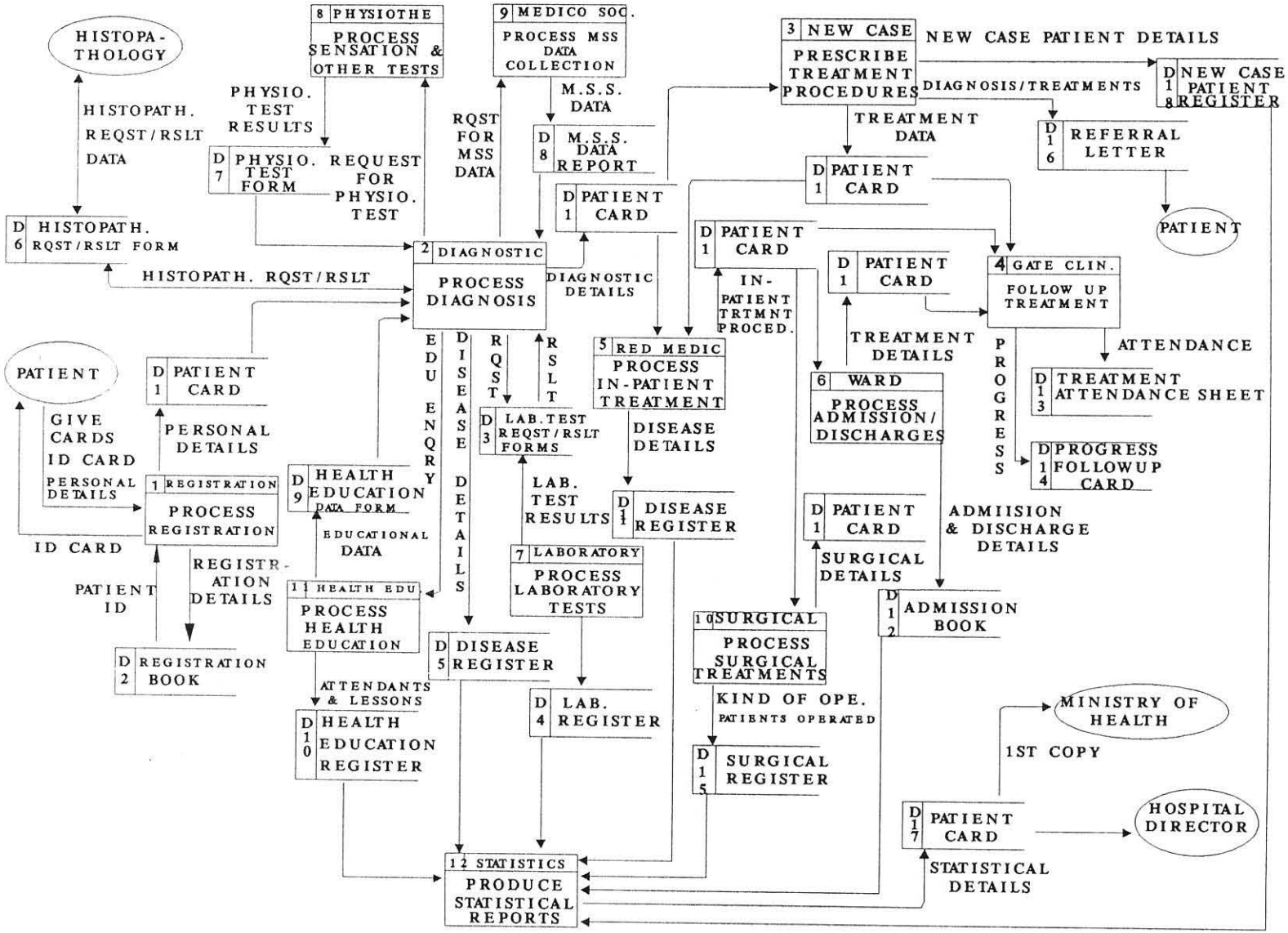


FIGURE 3: CURRENT SYSTEM PHYSICAL DATA FLOW DIAGRAM

The data flow diagram in Figure 3 indicates the top level data flows of the existing system. Each top level process can, however, be further decomposed into lower level processes. The lower level processes within each top level process is fully described in the description of processes given below. Each of the descriptions given about the lower level process can be represented in a bottom level data flow diagram. To demonstrate how it can be represented we take the Process Registration for example and is shown in Figure 4.

The frame indicates the higher level processes of those embraced lower level processes. The numbers assigned to each lower level process is a digit following the one given to the top level process. For instance, the top level process of the Process Registration is identified by number 1. So, all lower level processes are given numbers such as 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6.

The data stores indicated in the data flow diagram : Figure 3 correspond to those forms which are indicated in the existing forms summary sheet (Appendix I). Thus, the correspondence is indicated below.

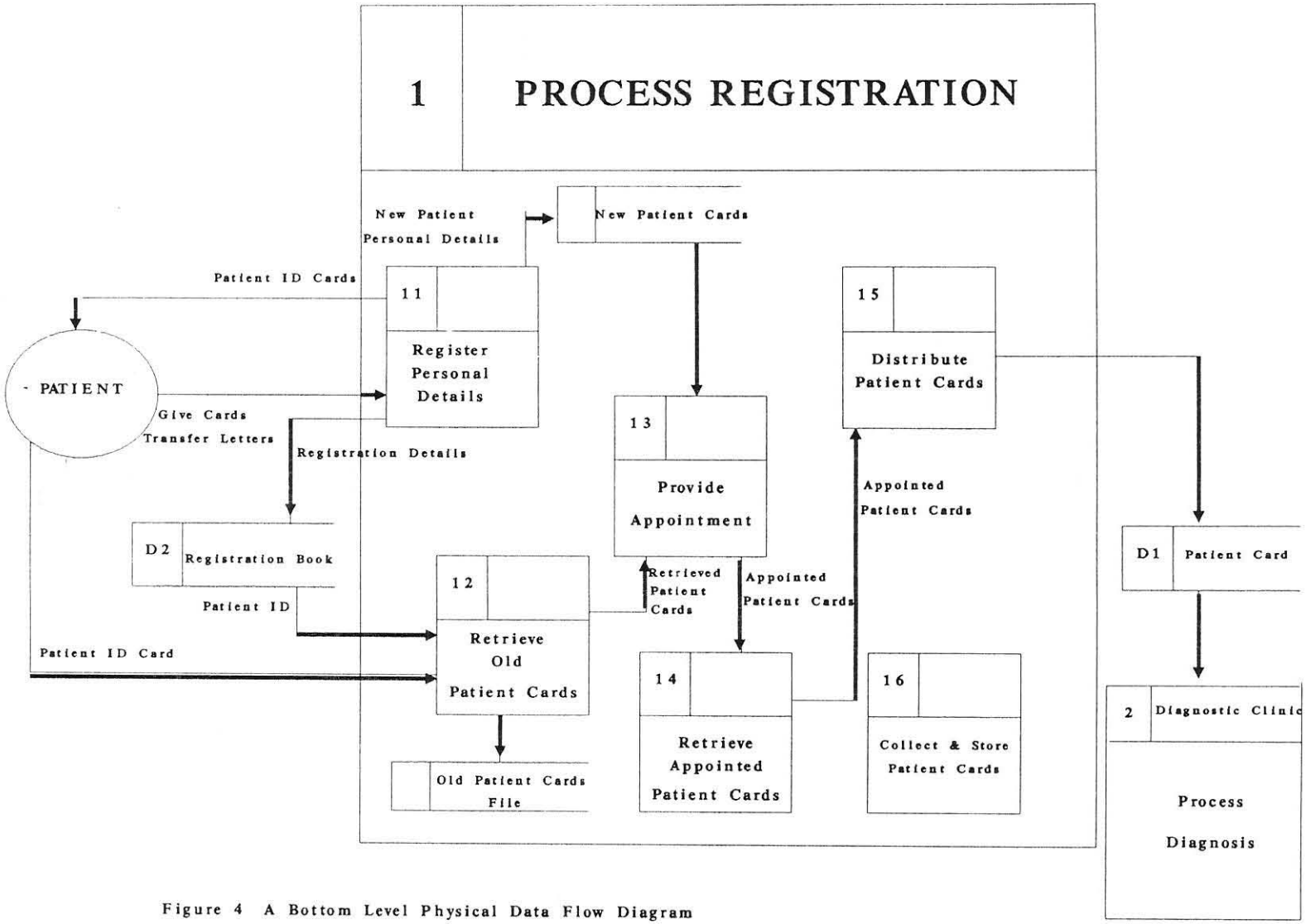


Figure 4 A Bottom Level Physical Data Flow Diagram
for Process 1 of the Top Level Diagram

Data Store Identifier in the DFD	Identifier given in the existing forms summary
D1	F18
D2	F40
D3	F9, F10, F11,F12,F13,F14,F15
D4	F3, F4, F5, F6, F7, F8
D5	F2
D6	F36
D7	F35
D8	F37
D9	F39
D10	F30
D11	F25
D12	F1
D13	F26
D14	F27
D15	F32
D16	F17
D17	F19, F20, F21, F22, F23, F24
D18	F38

Description of the Physical Data Flow Diagram

The data flow diagram depicted in Figure 3 indicates that a patient comes to the hospital with either of the following documents:

Appointment Cards

Give Cards

Transfer Letters or

Referral Letters.

Any one of these documents will be received by the Registration Section and the patient will get registered. The process involved in the registration function is to record personal details of the patient as well as some necessary notes contained in the transfer or referral letter in

a new Patient Card, if the patient is appearing for the first time. The Give Card is only to request for issue of a card and the Appointment Card is used as a certificate for appointment. The patient name and his ID will be recorded in a Registration Book. The Registration Book serves for retrieval purposes. Similarly a Registration Card that contains a patient ID number will be issued for every patient.

The above processes are indicated by the flow of the Registration Card from the Registration Section to the Patient; flow of registration details to the Registration Book and flow of personal details to the Patient Card. The contents of each of these data flows are the same; that is the Patient ID, Name, Age, Sex, Address etc. of the patient. If a patient is appearing for his second or more time, his card will be retrieved by his ID number which may be obtained from the Registration Card delivered by the patient or by searching his ID from the Registration Book. This flow is also indicated by the flow of Patient ID from the Registration Book and the Patient to the Process 1.

When the Process Registration is completed, the Patient Card flows to the Diagnostic Clinic. The Diagnostic Clinic is where patients with any skin manifestations appear for the first time before they are directed to any other clinic. Leprosy patients are detected in this clinic. This clinic, therefore, diagnoses patients. Any signs and symptoms observed are recorded in the Patient Card. Moreover, other physical examinations such as laboratory, physiotherapy and histopathology tests can be requested by an authorized physician and the results will be received and attached in the Patient Card. This is indicated by the flow of the data stores - Laboratory Request/Result form and Histopathology Request/Result forms from the Diagnostic Clinic to Laboratory and Histopathology units respectively. It may be noted

that the requests and results for laboratory tests are both stored in one and the same form. The forms are printed and designed to accommodate requests and results simultaneously.

The requests for physiotherapy tests, medico-social and health education data are made on plain papers. They are neither printed nor duplicated as that of the laboratory and histopathology. So, these requests are not represented as data stores but considered as flow of data. The results for these requests are, however, filled in and sent to the requesting clinics in duplicated forms. Hence, the results are represented as data stores. The flow of these data are, therefore, indicated by the flow of requests for physiotherapy tests, medico-social data, and health education data from the Diagnostic Clinic to Physiotherapy, Medico-Social Section, and Health Education respectively; and the flow of data stores from these sections to the Diagnostic Clinic.

All the forms about the result on laboratory, physiotherapy, histopathology, medico-social and health education are filed together or simply recorded in the Patient Card. The Patient Card with all the data from the Diagnostic Clinic will then flow to the New Case Clinic. The New Case Clinic adds the treatment details and updates them in the Patient Card. The Patient Card including the treatment details will flow to the Gate Clinic. The Gate Clinic is where patients are provided drugs under controlled supervision and followed up to observe health progresses until they finish their treatment. The follow up can also continue for months or years after a patient has completed his treatment. If a patient lives outside Addis Ababa, he would start taking the drug at the Gate Clinic and transferred to his nearby field leprosy control area. His transfer will be supported by a Transfer Letter.

The flow of the data described in the above paragraph is indicated in Figure 3 as a flow of the Patient Card from the Diagnostic Clinic to the New Case Clinic, from the New Case Clinic to the Gate Clinic, as well as the flow of a Transfer Letter from the New Case Clinic to the Patient, respectively.

The flow of a Patient Card from the Diagnostic to the Red Medical Clinic indicates that a patient with reactions or reactivations or relapses will be directed to this clinic. If the patient needs an in-patient service, the Red Medical Clinic facilitates his admission and the Patient Card will flow from the Red Medical to the Wards, where the patient is provided in-patient treatments. Upon completion of treatment for reactions or reactivations, the Patient Card will flow from the Wards to the Gate Clinic so that the patient gets prescription to continue treatment for leprosy in the New Case Clinic and follow up in the Gate Clinic. If the patient can be provided out-patient service, the Patient Card will directly flow from the Red Medical to the Gate Clinic, i.e., the Red Medical Clinic can also prescribe treatments and instruct the Gate Clinic to follow up the treatment of the patient. This is the case specially when the patient is not new.

3.2.4 The Logical Data Structures

When information for Data Flow Diagrams are collected, the information necessary for the development of logical data structure would also be sought in parallel. The first step in developing a logical data structure is to select entities. "An entity is some thing about which it is desirable to store data. An entity must be uniquely identified, but may vary from a physical object (such as a 'book') to a more abstract, such as 'sales area'" (Rowley 1990).

The entities identified for the information system under consideration consists of:

Patient	Laboratory
Disease	Physiotherapy
Ward	Histopathology
Treatment	Medico-Social Assessment
Surgery	Health Education
Treatment Attendance	

Information about all of these are held in the system. For example, information about patient is held in the Patient Card, in the disease registers and in the admission books. But, it may be noted that although the current system implements the patient data in different records, all are not the same entities. Sometimes it becomes difficult to decide whether a certain data store is an entity or not. Ashworth (1990) has given some guidelines on identifying entities. Applying those guidelines we can prove the entities identified above can qualify to be entities because:

1) Each entity has a unique identifier as indicated below.

Table 1: Entity Unique Identifiers

Entity	Identifier
Patient	Patient ID
Disease	Disease Code
Ward	Ward No.
Treatment	Drug Code
Surgery	Surgery Code
Treatment Attendance	Attendance Card No.
Laboratory Test	Test Code
Physiotherapy Test	Physio.Test Form No.
Histopathology	AHRI No.
Medico-Social Assessment	MSS Form No.
Health Education	H.Edu. Form No.

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Physiotherapy Test	Physio.Test Form No.
Histopathology	AHRI No.
Medico-Social Assessment	MSS Form No.
Health Education	H.Edu. Form No.

With the exception of the Patient ID, the existing system does not provide identifiers for all other entities identified above. The disease and treatment data collected about a patient is simply placed in the Patient Card. The laboratory results are printed forms but with no identifying numbers affixed. Physiotherapy, Medico-Social and Health Education data are recorded in a simple duplicated forms. It is found, therefore, essential that:

- International Classification of Disease (ICD) codes be used for identifying Disease entity.
- Drug Code be used as identifier to Drug entity. Lab Test codes be established for laboratory tests. The Hospital Director, the Head of Laboratory and the Head of Physiotherapy section of ALERT have been convinced to comply to all these changes.

2) There are several data items associated with each entity. This is indicated in the Data Item Description Tables 8A-8L in pages 100 to 110. This will be discussed more in detail in Chapter 4 Section 4.5.1.

3) The association of one entity to the other is shown in the Logical Data Structures to be discussed in Section 3.2.6.

After selecting the entities, the relationships among these entities are discussed below.

3.2.5 Identifying Relationships

The kind of relationships that can exist between the entities listed above have been examined. Only entities that have direct relationships are taken for analysis and design

purposes. One possible way of examining the relationships is through an entity grid approach. This is shown in Figure 5.

The shaded area is to avoid duplicate consideration of entity relationships. The 'X' mark signifies the existence of a direct relationship which is of interest to the system under consideration. How each of the relationships is identified and is important to the system under consideration is discussed below. Only direct relationship are discussed.

	Patient	Disease	Ward	Lab.	Physio.	Histopa. thology	HLTH Educ	Treat-ment	Medio Social	Surg ery	Physi cian	Treat. Atten d
Patient		X	X	X	X	X	X	X	X	X	X	X
Disease	////////										X	
Ward	////////	////////		X							X	
Laboratory	////////	////////	/////								X	
Physio.	////////	////////	/////	/////								
Histopa.	////////	////////	/////	/////	////////						X	
Health Edu	////////	////////	/////	/////	////////	////////						
Treatment	////////	////////	/////	/////	////////	////////	/////					X
Medico-soc.	//////// //////	//////// ////////	////////	///// /////	//////// ////////	//////// ////////	///// /////	////// //////				
Surgery	////////	////////	/////	/////	////////	////////	/////	//////	//////		X	
Physician	////////	////////	/////	/////	////////	////////	/////	//////	//////	/////		
Treatment Attend.	////////// ////	//////// //////	////////	////// //	////// //////	////////// //////	////////	////// /////	////// /////	////// ////	////// /////	

Figure 5: An Entity Relationship Grid

Patient - Disease : A particular diseases can be associated with a particular patient and a patient can be diagnosed to have been infected by one or more diseases. Moreover, we would want to find all the diseases by which a particular patient is affected and find how many patients are infected by a particular disease. Data about a patient, that is a patient ID,

is also held in the disease entity. So there is a direct relationship and it is of interest to the system.

Ward - Patient: A patient could be admitted to or located in a particular ward and a given ward admits many patients. So, there is a need to find in which ward a particular patient is admitted to and also to find all the patients admitted to a particular ward. The patient ID is also held in the Ward entity. That is an indication to the existence of a direct relationship. From this relation ship there emerges an entity called Admission. This is an entity used to record the admission history of a patient including the number of days he stayed through out his stay in in-patient treatment, his major causes of admission, his status at discharge, progress of health etc. So, there is also a relationship between the Patient and the Admission. The Ward - Patient relation is reflected when a patient is transferred from ward to ward during his stay as in-patient; while the relationship of Admission to Patient is reflected when holding the history of admission of the patient.

Laboratory - Patient: A particular laboratory test is done for a particular patient. So, the patient details are required to be presented along with each kind of test done. Each laboratory test is identified by the Test Code assigned . So, there is a direct relationship which of interest to the system. Likewise, there is a direct relationship, which of interest, between the following entities.

a) Patient - Physiotherapy Test,

b) Patient - Histopathology Test,

c) Patient - Medico-social Assessment, and

d) Patient - Health Education.

Treatment - Patient: Treatment is provided to a patient and a patient is treated when diagnosed. To find what treatments were provided, access to the Patient entity is required. So, the relationship is direct.

Surgery - Patient: Surgical treatment can be provided to a patient. Access to a patient entity is required in order to find the kind of surgical treatments provided. The relationship is, therefore, direct and important to the system.

Treatment Attendance - Patient: Treatment attendance is taken for each patient for whom drug treatment was prescribed. So, the relationship between both entities is direct and it is required by the system.

Ward - Laboratory Test: A particular laboratory test is requested by a particular physician working in a particular ward. So, access to the Ward entity is required to identify to which ward a lab test belongs and ward number is held in each Laboratory Request/Result Forms. The relationship is, therefore, direct and important to the system.

Another way to understand the relationship is understand the degree of relation ships between entities and model the relationships conceptually, using one or more diagramming techniques. The following relationships are common between entities. These are One-to-one (1:1), one-to-many (1:M), many-to-many (M:N).

In addition to the degree of relationships, the existence of the relationships should also be examined. Relationships can be either optional or mandatory (Ashworth 1990). In all the

entity relationship shown in Figure 5 of the system under study, the relationship is mandatory from the detail end and optional from the master end.

The following relationships are one to many relationships:

Physiotherapy Test - Patient
Histopathology Test - Patient
Health Education - Patient
Treatment Attendance - Patient

One occurrence of the master entity Patient is related to many occurrences of the detail entities - Histopathology Test, Physiotherapy Test, etc. These detail entities are located at the many end. Neither of the entities located at the detail end can exist without the corresponding Patient entity. Because no physiotherapy test or disease or treatment etc., can exist without the related occurrence of a patient. But, a patient might not have any of the tests, or diseases, or treatments etc. Likewise, the other master entities like the Physician and the Ward are master entities, the mandatory relationship being at the detail end.

Other relationships such as

Patient - Wards,
Patient - Disease,
Patient - Treatment
Patient _ Laboratory Test,

are many-to-many (M:N) relationships. This is because a particular occurrence of a Patient can be associated with many occurrences of a Disease, a Treatment, a Laboratory Test, a Ward and Surgery. For instance, a patient can have many diseases; many laboratory tests; many drugs being prescribed for him; more than one surgeries being done for him; and he

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Other relationships such as

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Patient - Disease,
Patient - Treatment
Patient _ Laboratory Test,

are many-to-many (M:N) relationships. This is because a particular occurrence of a Patient can be associated with many occurrences of a Disease, a Treatment, a Laboratory Test, a Ward and Surgery. For instance, a patient can have many diseases; many laboratory tests; many drugs being prescribed for him; more than one surgeries being done for him; and he

can be admitted to more than one ward through transfer. On the other hand, many patients can be admitted to a ward; the same disease can belong to many patients; the same kind of drug can be prescribed for many patients; and a particular surgery can be done for many patients.

There is also a many-to-many relationship between the wards themselves. A particular ward can accept patients which were admitted in some other wards and subsequently transferred to. That ward can also transfer patients to some other wards. This is a very common transaction between the wards in the study.

To avoid, therefore, the complex many-to-many relationships the following link entities are created among the entities having the M:N relationships.

Entities with M:N Relationships	Link Entities
Patient - Wards	Admission
Patient - disease	PatientDisease
Patient - Treatment	Prescription
Patient - Surgery	PatientSurgery
Patient - Laboratory Test	PatientLabTest

The relationship between the Patient and Medico-Social Assessment is one to one in that medico-social assessment is carried out only once for each patient. So, a particular patient is associated with only one Medico-Social Assessment and a particular Medico-Social Assessment belongs to one and only one patient. Normally, entities with one to one relationships can be amalgamated. So, the Medico-Social Assessment data is amalgamated with the Patient entity.

3.2.6 Validating the Logical Data Structures

Validation of the logical data structure is required to avoid redundant relationships. The validation procedure proceeds by checking for any redundant access paths from one entity to another. In selecting which path should be avoided, we have to opt for the shortest one and retain the path that keeps all the necessary relationships. Usually we choose to remove the shortest path because removing the longest path can lead us to miss some necessary paths that are essential for linking other entities. For instance a list of laboratory test occurrence for a particular ward in a particular date can be accessed in two ways. One through the path: Ward - PatientLabTest - Laboratory Test; and the other through the path: Ward - Admission - Patient - PatientLabTest - Laboratory Test. This can be done as:

1) In the first path, we find a particular occurrence of the Ward and find all occurrences of the PatientLabTests (lab test codes) by selecting a particular date and then linking to the Laboratory Test to translate the codes into full descriptions.

2) In the second path, we find a particular occurrence of the Ward and find all occurrences of patients in that particular ward. This is done through accessing the path: Ward - Admission and the path Admission - Patient. We can then find all associated occurrences of laboratory tests for each patient on the particular date using access path Patient - PatientLabTest - Laboratory Test. The first route is simpler and quicker than the second. However, in logical data structure, we are much concerned in keeping all the necessary interrelationships. So, the path Ward to PatientLabTest - Laboratory Test is redundant and will be removed. But we should retain the path Ward - Admission - Patient - PatientLabTest - Laboratory Test because it is required

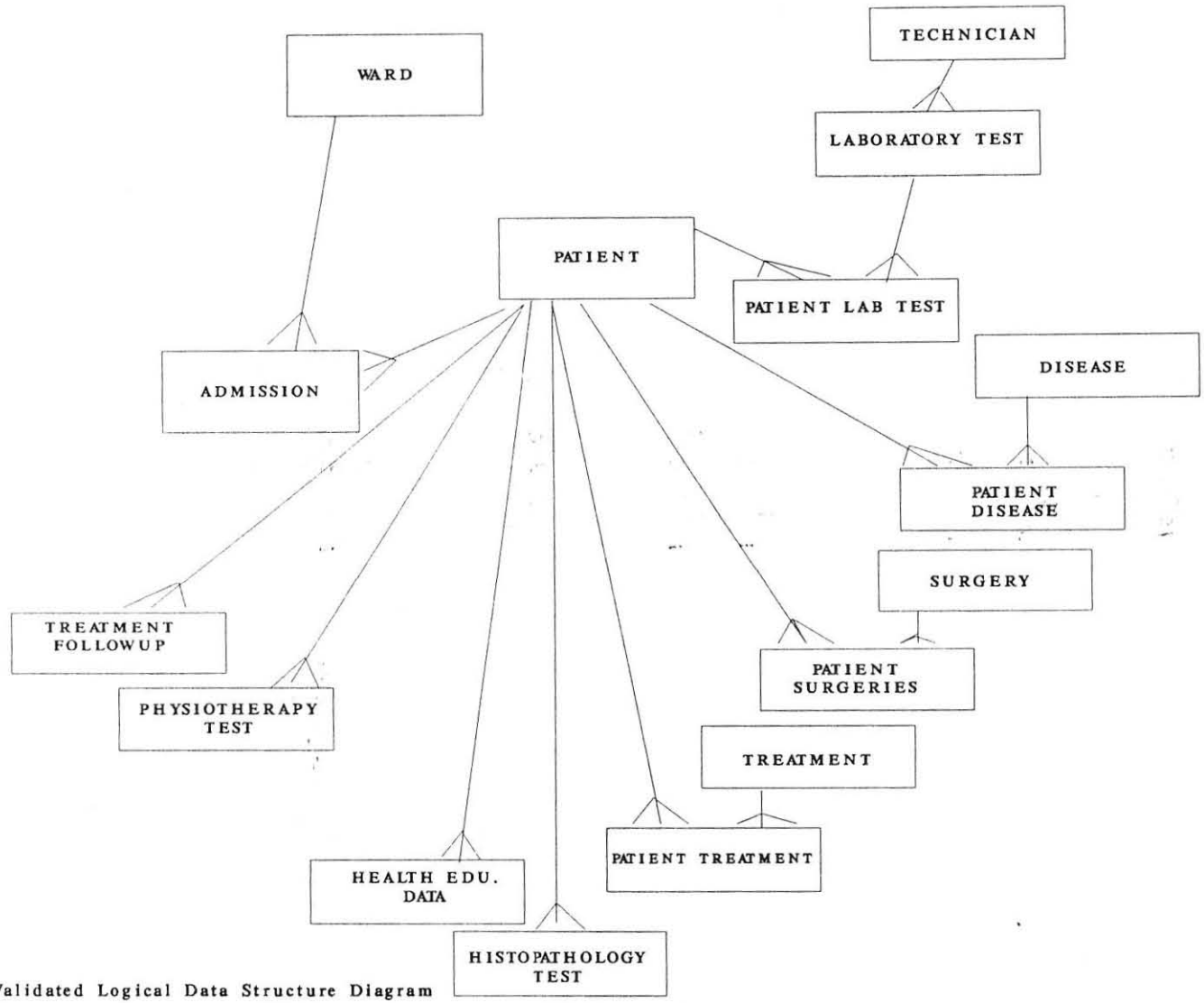

Figure 6: Validated Logical Data Structure Diagram

by other processing, for instance, for statistical processing on bed utilization of a patient. The validated entity relationship diagram is shown in Figure 6.

3.3 PROBLEMS OF THE EXISTING SYSTEM

Physicians in ALERT face difficulty in reading and summarizing the data available in the manually prepared patient card. Since each patient card contains to the extent of some 40 to 50 pages of raw historical data; and since they have to screen a number of patients in a day they cannot easily summarize and understand the pattern of a certain medical parameter. For example, when they want to examine the trend of a particular laboratory test of a particular patient over a period of time, they cannot readily find the summary of that data. Each occurrence of the test is distributed over different pages of the Patient Card and it becomes difficult to collect and summarize that piece of data from the card. More over, since a patient is usually treated by many physicians, the record is subject to various hand writings and this adds to the difficulty in reading the clinical history. So, for better medical services and understanding of a patient history, the physician needs a summarized information, an integrated and a good presentation of the clinical data. That will support his understanding of the patient and enables him to identify the right diagnosis.

ALERT invests a considerable amount of resource in collecting data for use in planning, programming and evaluating health activities. A significant amount of time is spent in filling up forms, patient cards, register books and reports by different sections. The statistical work is being done manually both by the statistical unit of the hospital and by the respective sections. The statistical data are collected by tallying the frequencies from the

register books maintained at each section of the hospital. Too many clerical jobs are involved. Counting the number of occurrences of diseases and examinations, and summarizing and sorting the frequencies is a laborious job in the statistical and other units as well. It is also observed that the reports produced in the statistics unit do not provide such information as the epidemiological and operational indices of leprosy.

The investigation of the problems has been supported by the questionnaire forwarded and the results of the questionnaire are presented in Table 2.

It is therefore, realized that many of the problems can be solved by designing a computer assisted system that enables easy sorting of information into a required sequence, easy retrieval of specific pieces of information, preparing essential statistical reports, better storage facilities, better response time for report production, and accuracy in the preparation of the statistical information.

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Physicians in ALERT face difficulty in reading and summarizing the data available in the manually prepared patient card. Since each patient card contains to the extent of some 40 to 50 pages of raw historical data; and since they have to screen a number of patients in a day they cannot easily summarize and understand the pattern of a certain medical parameter. For example, when they want to examine the trend of a particular laboratory test of a particular patient over a period of time, they cannot readily find the summary of that data. Each occurrence of the test is distributed over different pages of the Patient Card and it becomes difficult to collect and summarize that piece of data from the card. More over, since a patient is usually treated by many physicians, the record is subject to various hand writings and this adds to the difficulty in reading the clinical history. So, for better medical services and understanding of a patient history, the physician needs a summarized information, an integrated and a good presentation of the clinical data. That will support his understanding of the patient and enables him to identify the right diagnosis.

ALERT invests a considerable amount of resource in collecting data for use in planning, programming and evaluating health activities. A significant amount of time is spent in filling up forms, patient cards, register books and reports by different sections. The statistical work is being done manually both by the statistical unit of the hospital and by the respective sections. The statistical data are collected by tallying the frequencies from the

register books maintained at each section of the hospital. Too many clerical jobs are involved. Counting the number of occurrences of diseases and examinations, and summarizing and sorting the frequencies is a laborious job in the statistical and other units as well. It is also observed that the reports produced in the statistics unit do not provide such information as the epidemiological and operational indices of leprosy.

The investigation of the problems has been supported by the questionnaire forwarded and the results of the questionnaire are presented in Table 2.

It is therefore, realized that many of the problems can be solved by designing a computer assisted system that enables easy sorting of information into a required sequence, easy retrieval of specific pieces of information, preparing essential statistical reports, better storage facilities, better response time for report production, and accuracy in the preparation of the statistical information.

Table 2: Results of the Questionnaire about the Existing Problems

Problems areas	Interviewees Responded Postive	%
1. The raw data available is not readily summarized when needed	15	60%
2. Much important data are not collected	18	72%
3. Information is not collected as required and on time	15	60%
4. Relevant statistical reports are not produced at all	12	48%
5. It is very difficult to pick or search a particular document from a pile of documents	20	80%
6. Collected data get lost before they are compiled	5	20%
7. The statistical reports produced in the statistics unit is not known and not important for in-house use	20	80%
8. Problem of access to the data of other sections	3	12%
9. Overlapping and inappropriate planning schedules of meetings and training programs.	3	12%
Total Number of Interviewees	25	

3.4 INFORMATION REQUIREMENT DETERMINATION

3.4.1 Data Required to be Organized

A successful information system actually depends on the precise understanding of the information requirements and the requirements should be expressed in ways that are natural to and can easily be understood by users (Tsichritzis, 1989, 7). The overall Information requirement of the Hospital Division are presented in Appendix III.

The questionnaire on the study of the requirement analysis started by asking the users if a change is required in the current information handling systems and if that change should be supported by a computer system. With the exception of one respondent at the Gate Clinic, all other respondents (i.e., 24 respondents out of 25, or 96%) expressed the need for a computer based information system.

3.4.2 Access Requirements

Different user groups require different databases that are to be accessed depending on the specific requirements. Table 3 provides some of the most frequently required information in ALERT with their frequency of need for access.

CHAPTER 4

PROPOSED INFORMATION SYSTEM DESIGN

4.1 INTRODUCTION

A success in designing an information system depends on its ability to solve the problems and meet the requirements. This chapter begins the steps towards the solution by specifying the problems and requirements and putting the probable solutions and the constraints that may hinder the implementation. To solve the problems and meet the requirements some changes are required on the organizational structure, the data flow diagrams and some other methods of implementing the improved system.

4.2 PROBLEMS AND REQUIREMENT LIST

The first step taken in the design of the improved system is to insure that solutions are found to every problem or requirement identified during the investigation step. Table 6 provides the possible solutions to the problems and requirements. Most of the solutions pointed out in the table are proposals that should be taken care of during the actual implementation of the system.

Table 6: Problems and Requirement Lists

Problems/Requirments	Possible Solution
The raw data available is not readily summarized when needed	Logicalizing current data stores, maintaining different query files and summarizing required data. Creating application programs and using software utilities to manipulate data. However, the volume of available data are too much and cannot be exhuastivelly collected and summarized as required. Lack of computer storage space, man power as well as other resources would be the main constraints in transferring the available data to a computer system.
Much important data are not collected.	Detail information requirment analysis, creating appropritate data collection forms and online data capturing.
Information is not collected as required and on time Collected data get lost before they are compiled	Online updating of transactions. Online capturing of the data and taking frequent backup and recovery system
Relevant statistical reports are not produced at all	Requirment analysis and introducing statistical packages and/or developing in-house programs
It is very difficult to pick or search a particular information from a pile of documents	Creating different query and search formats
The statistical reports produced at the Statistics Unit is not known and not important for in-house use	Closing down the unit and shifting the staff to a computer unit after providing adequate computer training
Problem of access to the data available in other sections	Organizational policy and centralized information system that provides a controlled access to databases through a net work communication
Overlapping inappropriate planning of schedules on meeting and trainig programs	Input Validation
Backup and security of files for any possible techinical failurity	System backup taking method, taking weekly backup of files in magnetic tape, uninterrupted power supply devices

Table 6: Continued

Problems/Requirements	Possible Solutions
Control over access to the physical facilities and access to the file maintenance	Organizational policies on the use of physical facilities; allocating users passwords to update, delete, and retrieve specific records or fields or files. This would be done during the practical implementation of the system.
Input error protection	System error protection methods such as defining field formats, range of values, and other characterstics of each field (see Data Dictionary)

To solve the problems arising in access to databases on a timely basis, strengthen data security, capture data, etc., the study proposes a net work of computers that access files and resources from a central server. Each computer must have a processing capacity such as to load and run programs in its own memory so that the server would not be burdened by the need to provide processing to individual work stations; and it can be optimized to handle mainly file storage and retrieval, user management, security and network services. In addition, communication hardware and software as well as printers will be required. The issue on the need for network is further discussed in Chapter Six.

4.3 REQUIRED DATA FLOWS

In the previous chapter, we have seen:

a) How the current system operates,

b) The problems experienced by the users and

c) Some of the issues need to be improved. The current system is described using the

current Data Flow Diagram, current Logical Data Structures and lists of problems and requirements. This section focuses on the detail description of the required system, and attempts to come up with some possible solutions being represented in a revised data flow diagrams, logical data structures; and some other proposals required to improve the system.

The current information system is bound by duplication of functions within the different sections. Data is redundantly kept in different sections, both in the Patient Card and in the different Register Books maintained at each section. To avoid such redundancies, therefore, need arises to establish a logical system that enables to store data only once, indicates the flow of only necessary data for a process, and provides access to all concerned user sections. This fact, therefore, calls for the need to restructure the current data flow diagrams. The restructuring of the current data flow diagrams begins by the identification of duplicated data stores, processes and data flows. The current Physical Data Flow Diagram in Figure 3 is the basis for the discussions below.

Duplicated Data Stores

The purpose of keeping patient data in the Register Books in the current system is to facilitate statistical manipulations. Data collected direct from a patient or from transient data stores are recorded in the Patient Card. The same data is also copied directly from the Patient Card and the transient data store to the Register Books. This makes the Register Books redundant data stores. The Register Books identified as duplicate data stores are presented below with their data store identifier used in the Current Data Flow Diagram.

Data Store Identifier	Data Store Name
D2	Registration Book
D4	Lab. Registers
D5	Disease Register
D10	Health Education Register
D11	Disease Register
D12	Admission Book
D15	Surgical Register
D18	New Case Patient Register

These are the redundant data stores that should be eliminated in the required Data Flow Diagram. In the current system, when a transaction about a patient occurs, it is updated both in the Patient Card and the Register Book. However, these redundant updating processes can be removed by updating appropriate data store only once, and the same usual statistical and other information services can be provided.

Another major change to the current data flow diagram is that of the data store: Patient Card. Any information collected about a patient is accumulated in the Patient Card without any logical grouping and chronological order. Different data that can be logically separated out into different data stores are mixed up. The Patient Card, therefore, requires a complete change. Instead of having everything in one data store, different data stores which brings similar data items with the same unique identifiers together will be separated out. The Patient Card will, therefore be split into nine data stores.

These are:

1) Personal Details
2) Disease
3) Treatment
4) Laboratory Test
5) Histopathology Test
6) Surgery
7) Admission
8) Physiotherapy Test
9) Health Education

The data store - Medico-Social Data indicated in the current data flow diagram as D8, can be combined together with one of the splitted data stores: Personal Details, just mentioned above, because the data item contents are additions to the personal details of a patient and both can be identified with the same identifier, i.e., Patient ID.

The current data stores: Laboratory Test Request/Result and the Histopathology Request/Result contain the request details as well as the result details of the tests. The Laboratory Request/Result form serves as a transient data store (data held only for short time after entering into a process). When the test is over the details of the results of the tests are copied into the Patient Card and the forms can be thrown away. Since the Patient Card should be splitted into different data stores, the result of the Laboratory Tests is going to be stored in a permanent data store - Laboratory Test while the request continues to be considered as a transient data store. That requests will flow from the Diagnostic Clinic or other Clinics into the Laboratory Section and once fulfilled they can be disposed of. The request will no more be held after it is accepted by the Laboratory Section but the result will be stored in the Laboratory Test. Access could then be provided to each requesting section to this data store. This change would avoid the duplication of updating the test results in the Laboratory Request/Result Form, the Patient Card and the Lab Register Books.

The Histopathology Request/Result (D6) will, however, continue to serve as a permanent data because the test is done out side the system (at AHRI) and both the details of the request and the result are required for comparison purposes at any point in time. A particular form of leprosy which was diagnosed at the Diagnostic Clinic can be different when the histopathology test is carried out. So, such different conclusions arrived at by

both the Diagnostic clinic and the Histopathology unit is required to be permanently kept in the system.

Combining Processes

The processes involved in the Diagnostic and New Case Clinic are two processes performed serially. New leprosy case patients are detected in the Diagnostic Clinic before they arrive at the New Case Clinic. All the physical examinations of new leprosy patients are first done by this clinic and all the results of the examinations and diagnosis is then sent to the New Case Clinic. The New Case Clinic then adds treatment procedures needed for the patient after reviewing the data collected by the Diagnostic Clinic. When two or more processes are performed together or consecutively, they can be combined to form one process. So, there is a clear evidence that the process involved in the New Case Clinic can be combined together with the processes of the Diagnostic Clinic. This will, therefore, call for the combination of the Process no. 2 and 3 of the current physical data flow diagram and they are within the Process no.2 of the Proposed Data Flow Diagram (see Figure 7 in the next topic).

A similar reason can be attached to the functions of the Red Medical Clinic. We have said that the function of the Red Medical Clinic (Process no.5, Figure 3) is to facilitate the admission and discharge of leprosy in-patients and following up treatments in the Wards. This process includes prescribing the need for in-patient treatment, checking availability of empty beds and requesting for physical examinations such as laboratory and x-ray tests. Although the function is carried out in the Wards, the process is to diagnose and treat,

which is the same as the function involved in the Diagnostic and the New Case Clinic. However, this function includes one more process i.e., admission. So, the process involved in the Red Medical Clinic can be partly combined with Process no. 2 of the Proposed Data Flow Diagram (Figure 7) and partly separated into a new process: Process Admission. This is indicated by Process no 4 of the same figure (Figure 7).

Process no. 10 : Process Surgical Treatments of Figure 3 can be combined with process No.2 and No. 4 of Figure 7. The same reason given to the case of the Red Medical Clinic also applies to the functions of the Surgery. This is because, the surgery process involves both in-patient and out-patient services. The Process no. 4 of Figure 3 Follow up Treatment, however, remains as it is.

After accommodating these changes the top level data flow diagram for the required system can be depicted. This is shown in Figure 7.

Drawing the Proposed Top Level Data Flow Diagram

The proposed data flow diagram (PDFD)presented here is showing the logical flows of the data irrespective of the physical processes. By physical processes it means that the data flows are designed irrespective of where and who processes them. The diagram incorporates the major changes required to avoid redundancies and solve the existing problems. Some processes and data stores which need to be brought together are combined.

The diagram also takes into account some additional requirements of the users that should

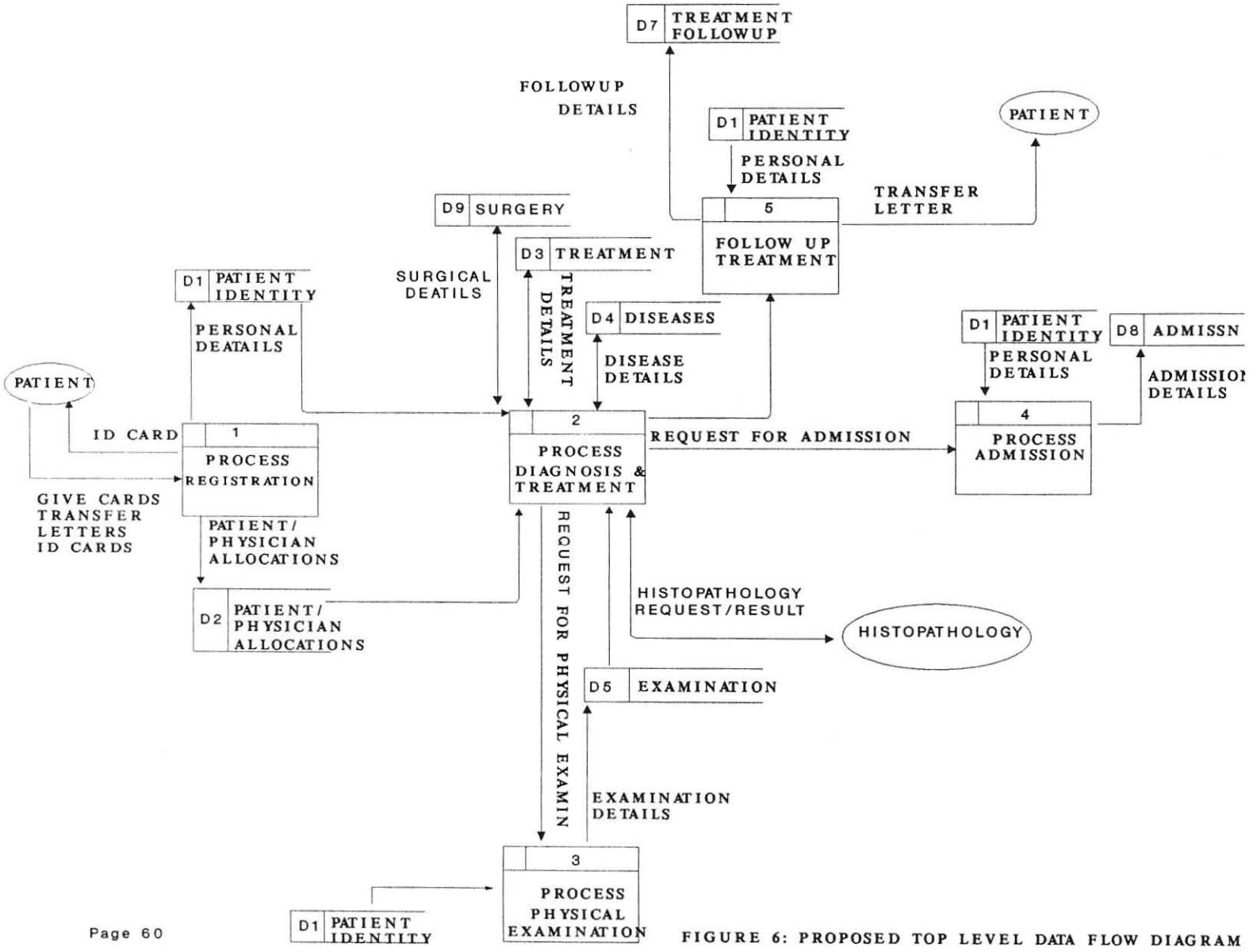


FIGURE 6: PROPOSED TOP LEVEL DATA FLOW DIAGRAM

be incorporated in the improved system. One of the major requirements included in the Required Data Flow Diagrams is that of the checking of any previous patient records available. When a patient does not deliver a Registration Card, which is usually issued to patients, it has been difficult to retrieve a particular patient record (Patient Card) from the pile of cards . The Required Data Flow Diagram, would therefore, include solutions to this problem. Other additions include checking of authorizations for laboratory test requests raised each day by a physician.

The bottom level diagrams are depicted following the top level ones and the description of each bottom level processes are presented in the Process Description Table. Some of the retrievals specially the statistical reports required for each process are not indicated in the logical data flow diagram. They are separately shown in the Output form design discussed in Chpater Five section 5.6.3.

Second Level Data Flow Diagram

The Process no. 3 - Process Physical Examination of Figure 7 represents five processes. These are the Processes for Laboratory Test, X-ray test, Physiotherapy Test, Medico-Social Assessment, and Health Education. They are shown as one process because the data that flows in and out of these processes are similar: Requests and Results. It becomes easier to see the flow in that way rather than complicating the diagram by surrounding each process around Process no. 2. So, Process no. 3 can further be decomposed into lower level diagram consisting of five processes and four data stores indicated in the table below. The graphical representations of these bottom level diagrams are indicated in Figures 7-16.

Each of the processes within Process no.3 have their own data stores. The data store: Examination (D5) indicated in Figure 7 is the combined name given to these five data stores. To indicate that the processes as well as the data stores are extensions of the top level diagram they are identified by an extension number to the top level data flow identifier. This will be as follows:

Process Name	Process Identifier
Process Laboratory Tests	3.1
Process X-ray Examination	3.2
Process Physiotherapy Exam.	3.3
Process Medico-Social Hist.	3.4
Process Health Education	3.5

Data Store Name	Data Store Identifier
Laboratory Examination	D5.1
X-ray Examination	D5.2
Physiotherapy Examination	D5.3
Health Education	D5.4

Each bottom level data flow diagrams including the associated process description table is indicated in the following pages.

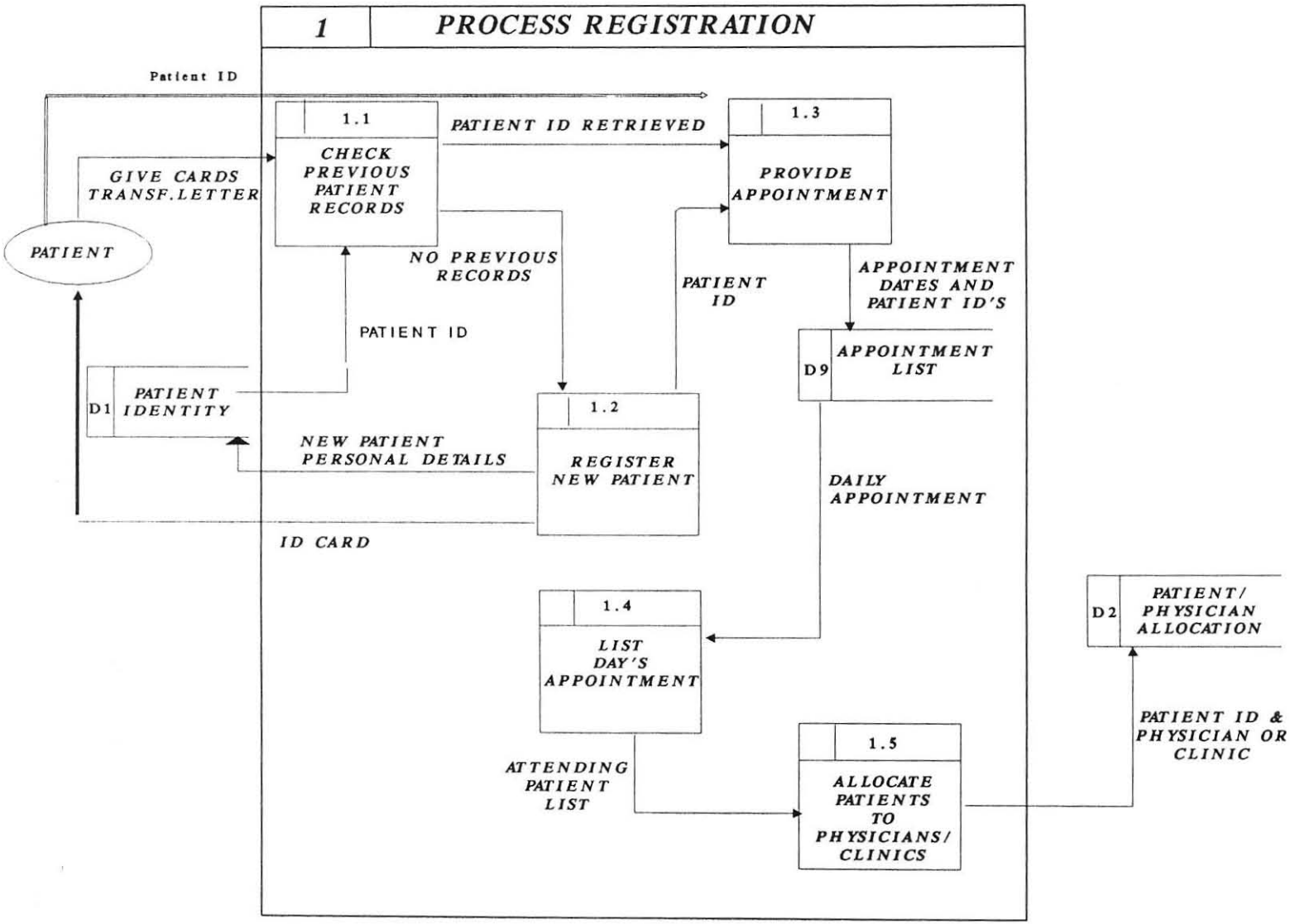


FIGURE 8: BOTTOM LEVEL DIAGRAM FOR PROCESS NO. 1

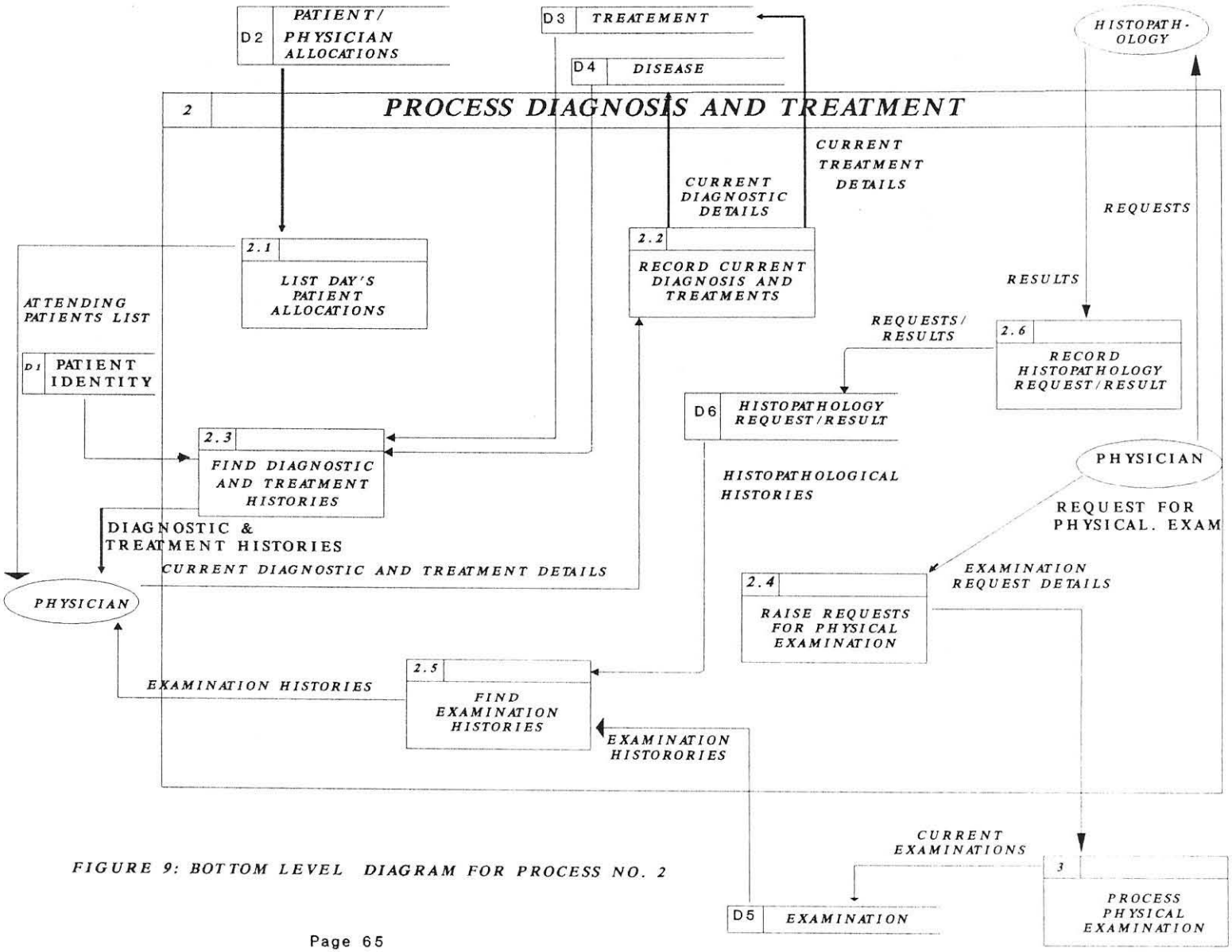


FIGURE 9: BOTTOM LEVEL DIAGRAM FOR PROCESS NO. 2

Table 7-B: Bottom Level Process Description Table for Process No. 2

Process ID	Process Name	Description
2.1	List Day's Patient Allocation	This process assumes Process no. 1.5. Listing of patients assigned for a physician or clinic in a particular day is carried out daily by this process.
2.2	Record Current Diagnosis and Treatment	This process is to record current diagnostic as well as treatment details of a patient.
2.3	Find Diagnostic and Treatment Histories	In many of the cases a review of past historical diagnostic and treatment details of a patient may be required to support the identification of the current diagnosis and prescription of alternative treatments. So, this process brings together and lists data about all past as well as current histories from the Disease and Treatment data stores.
2.4	Raise Requests for Physical Examination	For further diagnosis, requests can be raised for physical examination tests. The physical examination tests include the test for Laboratory, X-ray, Muscle and Sensation tests as well as Medico-Social and Health Education data.
2.5	Find Examination Results	This process assumes Process no. 2.6, and all bottom level processes under process no.3. and finds the results from the Examination files. Using these and other processes a physician diagnoses the problem of the patient, prescribes the correct treatment and updates the Disease and Treatment file in Process 2.2.
2.6	Record Histopathology Request and Results	This process records all details about the requests raised and results obtained about the histopathological examinations.

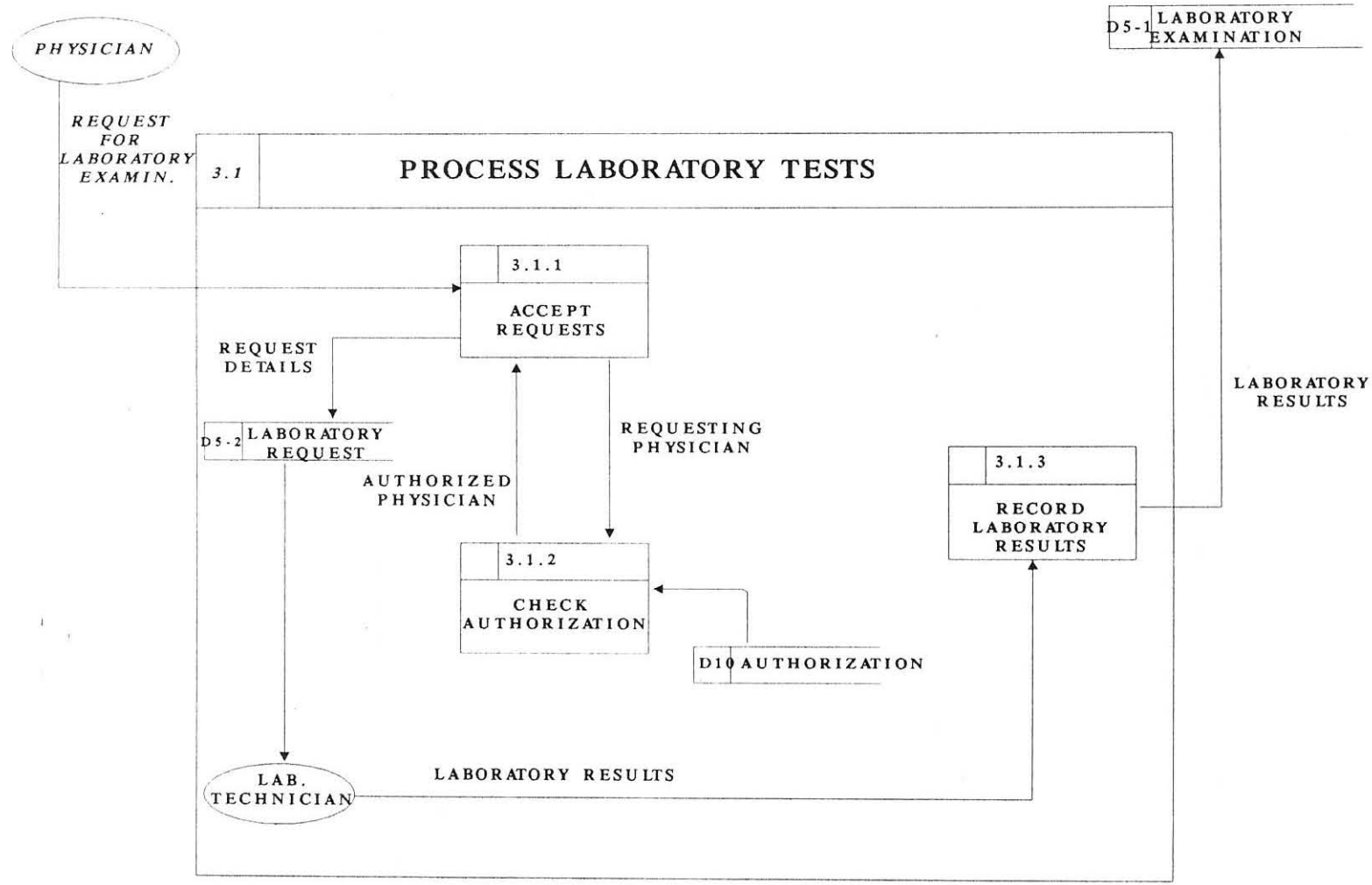


FIGURE 10: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.1

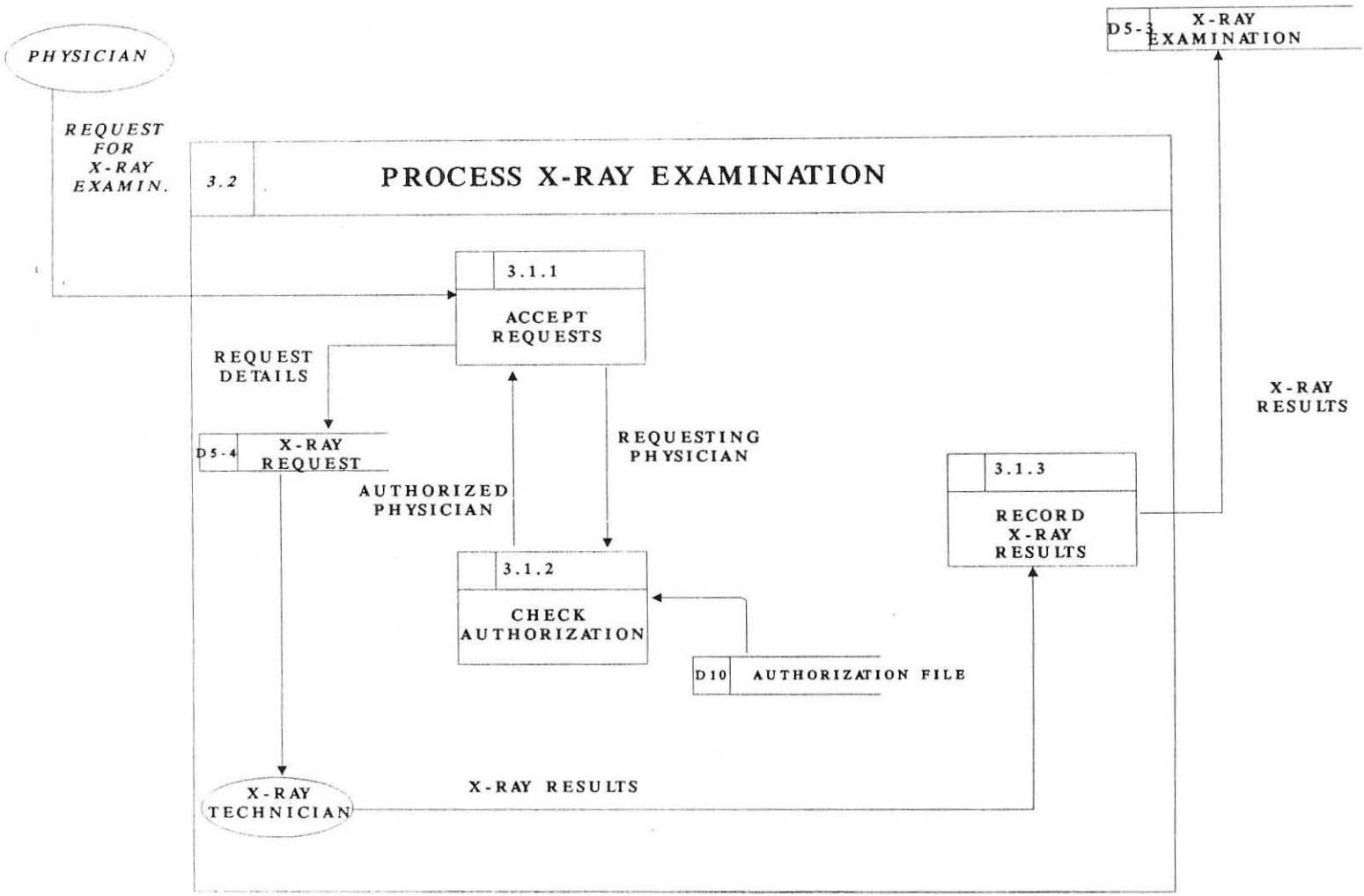


FIGURE 11: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.2

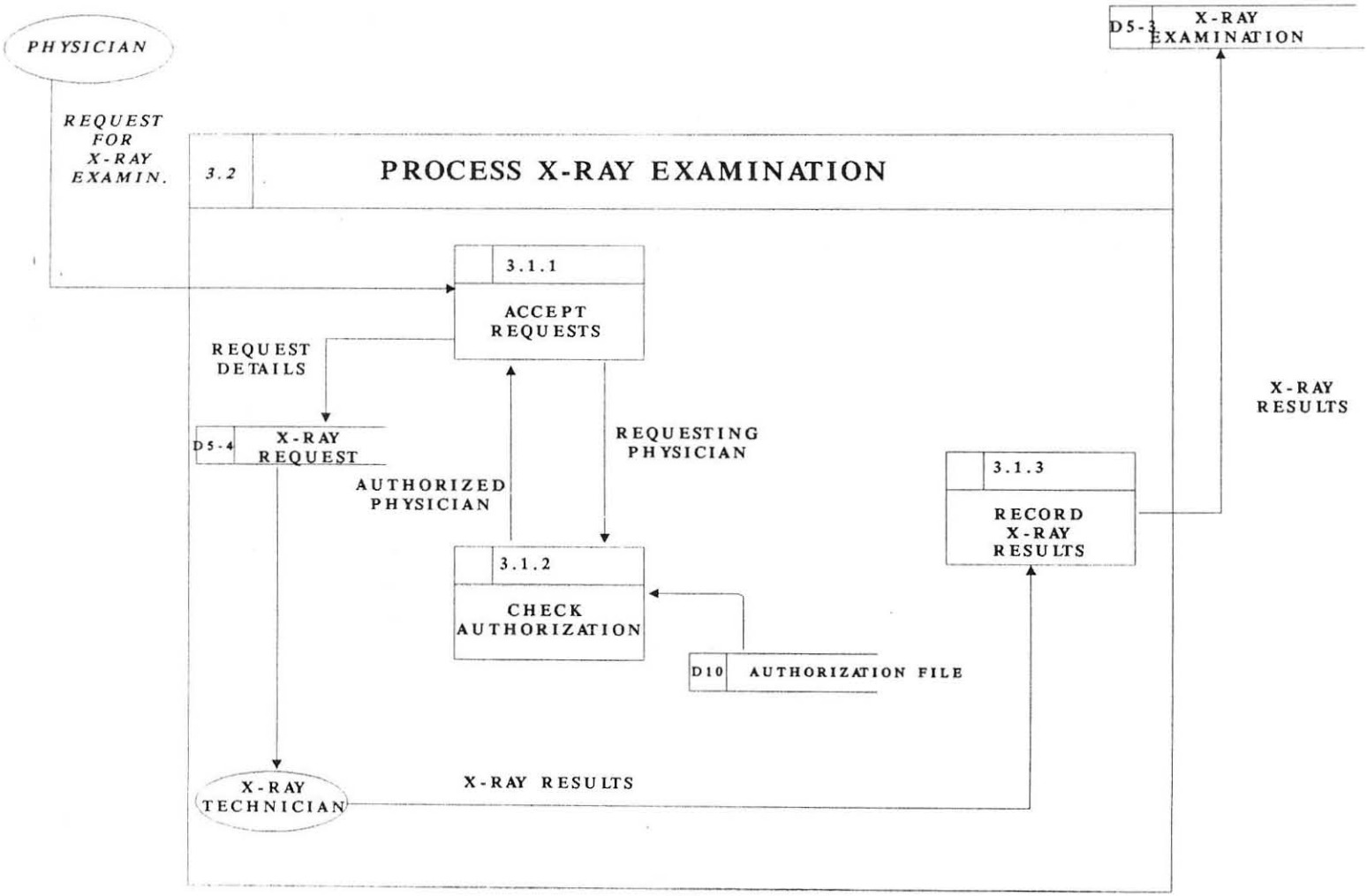


FIGURE 11: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.2

Table 7-C: Bottom Level Process Description Table for Process No. 3.1

Process ID no.	Process Name	Description
3.1.1	Accept Requests	This process accepts the details of the requests for Laboratory tests and assumes Process no. 2.4.
3.1.2	Check Authorization	This process checks requests to insure that they are raised from an authorized physician. Before any examination is tested it will be checked for its validity.
3.1.3	Record Results	The Results of an examination are recorded in a proper Lab Test file in this process.

Table 7-D: Bottom Level Process Description Table for Process no 3.2

Process ID no.	Process Name	Description
3.2.1	Accept Requests	This process accepts the details of the requests for x-ray tests and assumes Process no. 2.4.
3.2.2	Check Authorization	This process checks requests to insure that they are raised from an authorized physician. Before any examination is tested it will be checked for its validity.
3.2.3	Record Results	The Results of an examination are recorded in the X-ray Exam file in this process.

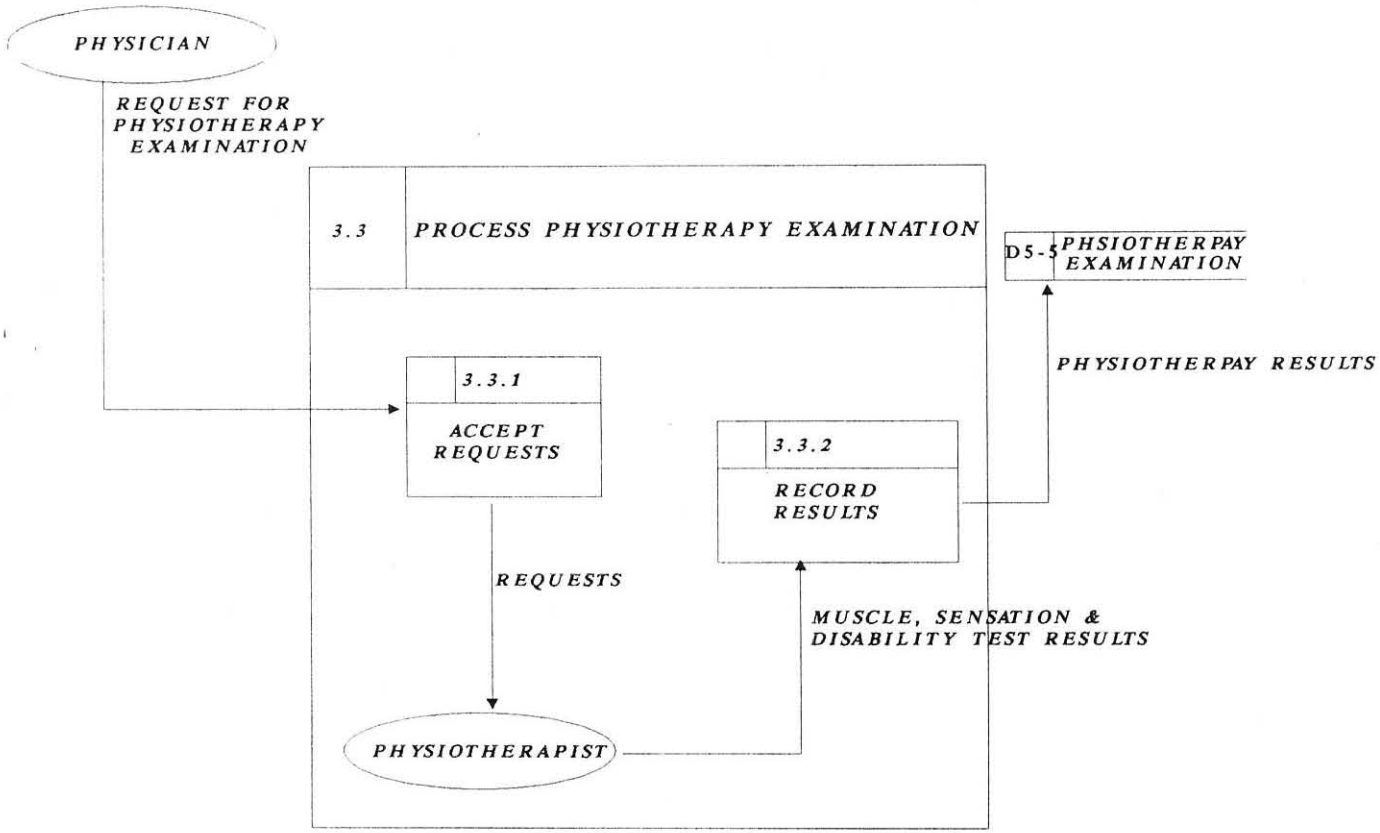


FIGURE 12: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.3

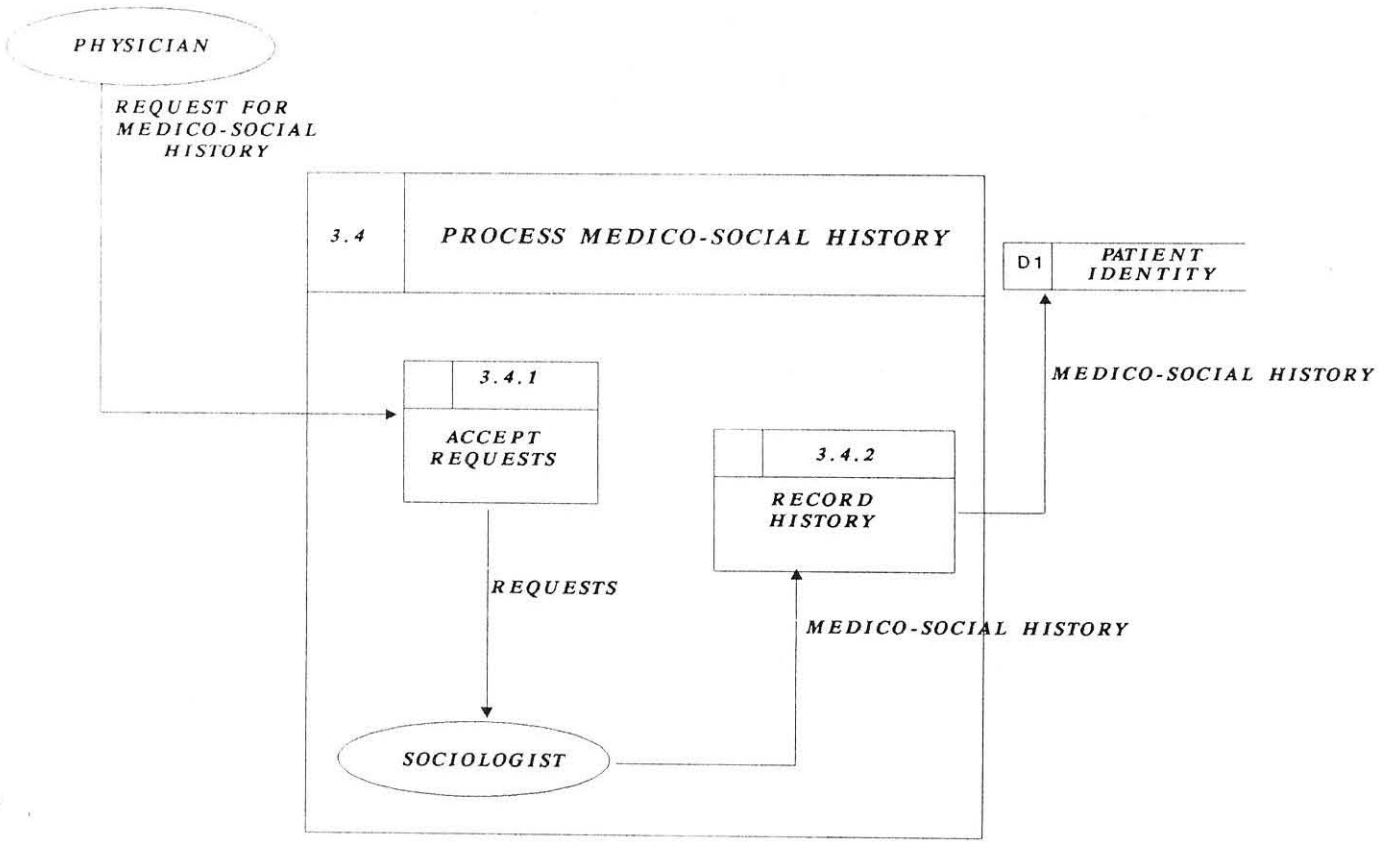


FIGURE 13: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.4

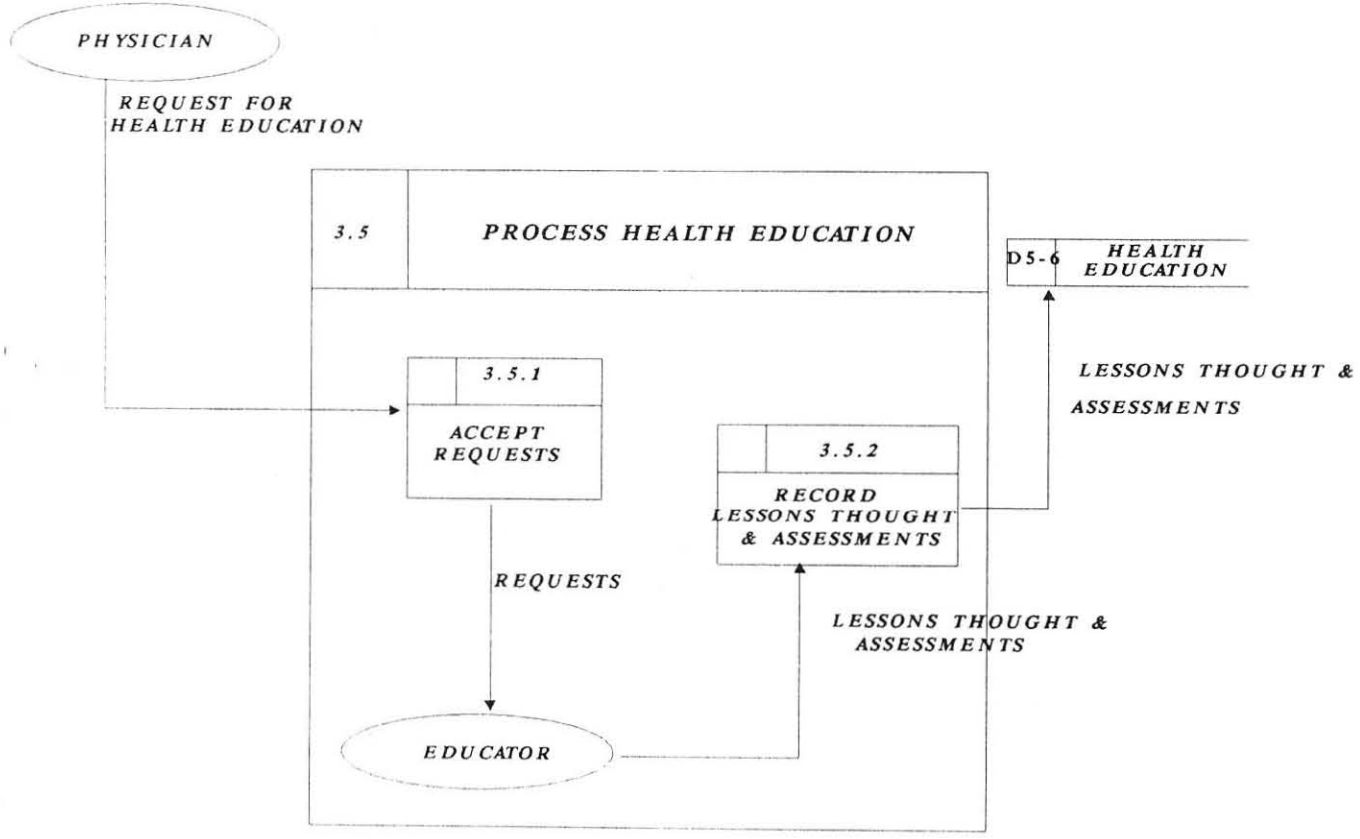


FIGURE 14: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO3.5

Table 7-E: Bottom Level Process Description Table for Process no. 3.3

Process ID no.	Process Name	Description
3.3.1	Accept Requests	This process accepts the requests and assumes Process no. 2.4.
3.3.2	Record Results	The Results of the muscle and sensation tests are recorded in the Physiotherapy Test file in this process.

Table 7-F: Bottom Level Process Description Table for Process no. 3.4

Process ID no.	Process Name	Description
3.4.1	Accept Requests	This process accepts the requests and assumes Process no. 2.4.
3.4.2	Record Results of Interview	The Results of interview are recorded in the Patient Identity file in this process.

Table 7-G: Bottom Level Process Description Table for Process no. 3.5

Process ID no.	Process Name	Description
3.5.1	Accept Requests	This process accepts the requests and assumes Process no. 2.4.
3.5.2	Record Results of Interview	The lessons thought as well as data about educational assessments are recorded in the Health Education Record by this process.

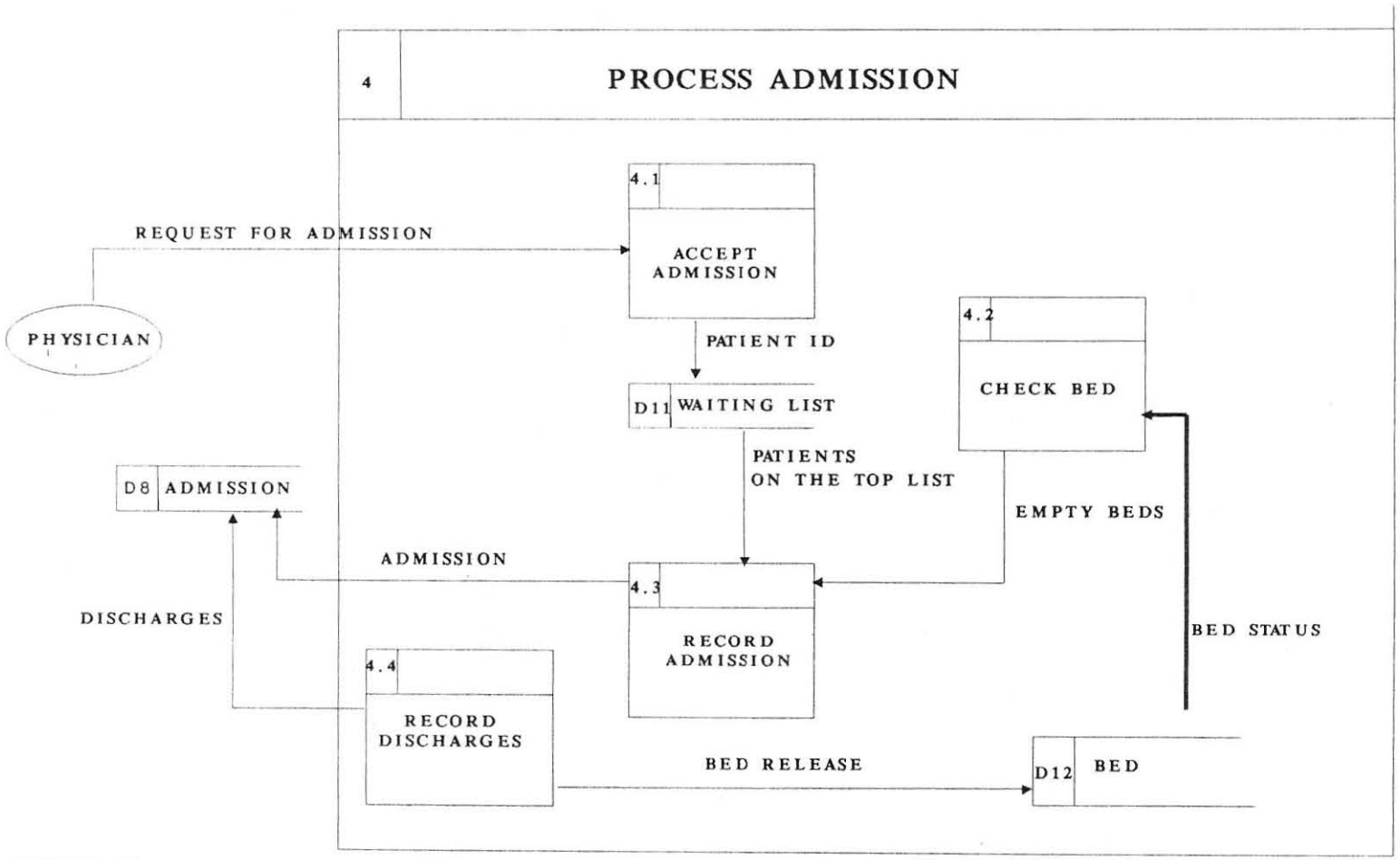


FIGURE 15: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO. 4

Table 7-H: Bottom Level Process Description Table for Process no. 4

Process ID	Process Name	Description
4.1	Accept In-patients	This process accepts in-patients and records every patients in a waiting list.
4.2	Check Bed Availability	This process checks for any empty beds to which the patient can be admitted. It lists the day's empty beds with their bed number, ward type etc. When there are no empty beds a patient will be provided an appointment.
4.3	Record Admissions	Beds are assigned to patients in this process; and at the same time the patient ID and bed no. assigned will be updated to the admission file.
4.4	Find In-patient Histories	In many of the cases a review of past historical diagnosis and treatment details of a patient are required to support the identification of the current diagnosis and prescription of alternative treatments. So, by this process the Disease, Treatment and other historical data will be listed when need be.
4.5	Record Current Treatment	By this process the details of the current in-patient treatment details including surgeries will be updated.
4.6	Record Discharges	Patients who completed in-patient treatment will be discharged and the discharge dates and other notes about the status of the discharge will be recorded in the Admission file. This process assumes Process no. 4.3.

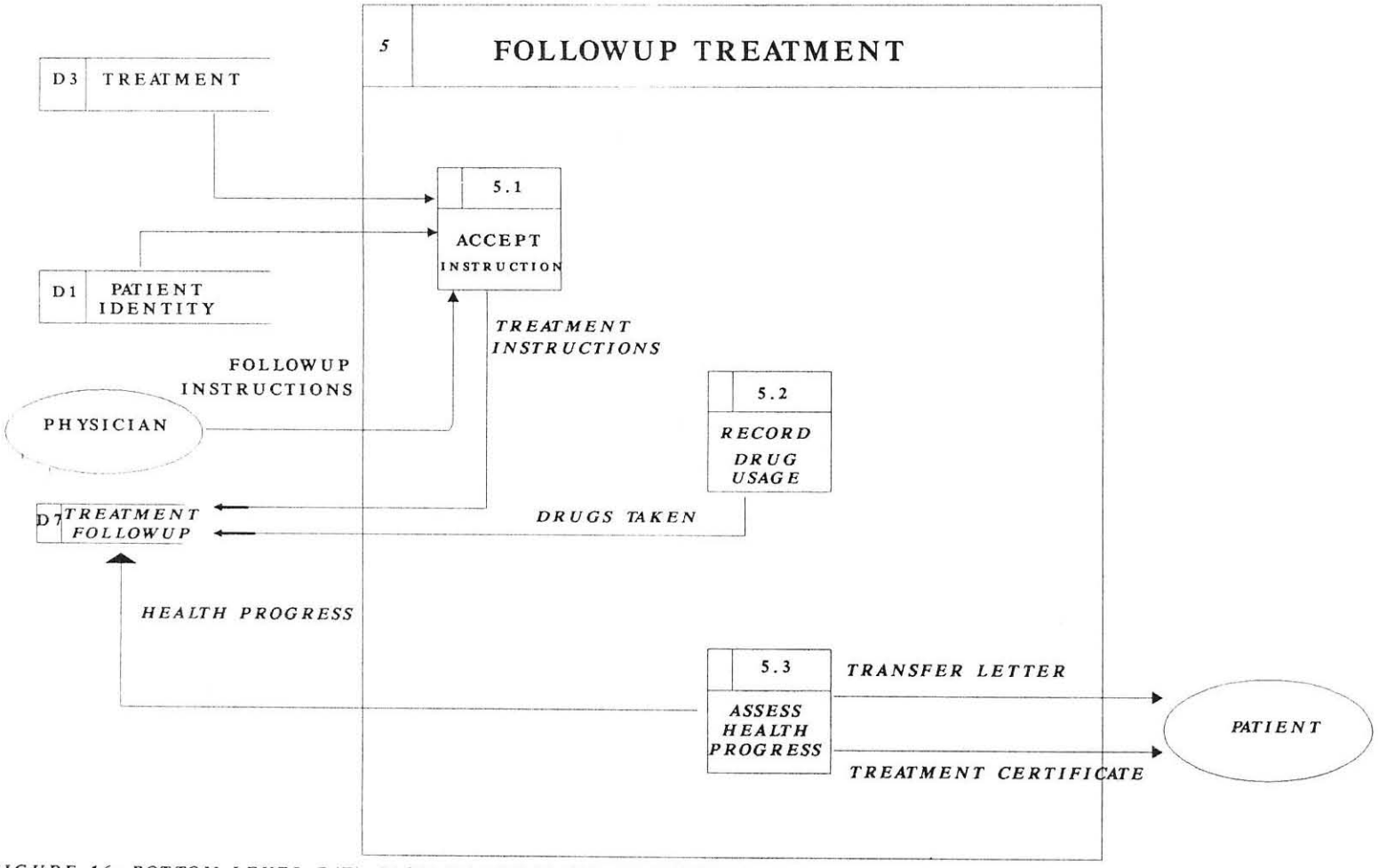


FIGURE 16: BOTTOM LEVEL DATA FLOW DIAGRAM FOR PROCESS NO. 5

Table 7-I: Bottom Level Process Description Table for Process no. 5

Process Id	Process Name	Description
5.1	Accept Instructions	This process accepts the instructions to carry out the controlled treatment follow up. The kind, dosage and administration of the drugs prescribed will be recorded in the Treatment Follow up file.
5.2	Record Drug Usage	The daily or weekly or monthly drugs taken by a patient will be recorded by this process.
5.3	Assess Health Progress	The health status of the patient may be evaluated at different times. It will thus, be recorded by this process.

4.4 DATABASE DESIGN

4.4.1 Introduction

In the above topics we have represented the functions of the proposed system using data flow diagrams. The data that results from the processes would be held in entities. Investigating the nature, content, and relationship of these entities is an important component in systems anlaysis and design. In section 3.2.4 a logical data structure had been developed as part of investigating entities and their relationships. For each entity the data items that describe the entity has to be identified. However, at the initial stage of identitifying the entities the data items that would be associated with each entity would not be exhausitve. Only the major data items are going to be visualized. The assignment of data items to each entity would be inflexible. Moreover, since formal techniques would not be used, there can be undiscovered relationships between data items which could be invalauble for some retrievals.

To overcome these limitations an additional approach for defining and analysing systems data, independently of the processing, is needed. Rigorouse analysis of data items and their relationships should be carried out. The rigorouse analysis of data makes possible for producing a complete and detailed logical database, which inturn, would be a base for physical database design. There are different kinds of data modeling techniques used to produce detailed logical databases. These are broadly categorized as hierarchial, network and relational data models. The hierarchial data model uses a parent-child or tree structure to represent the relationships among entities (Rowley, 1990). The basic principle of hierarchial data model is that for one or more subordinates (childs), there is only one superior (parent). The network data model is based on the assumption that a given entity can have as many number of superiors (parents) as well as many number of subordinates or childs (Davis and Olson, 1985). The relational data model is based on a set of tables known as relations where each table or relation consists of a row (tuples) representing a unique entity occurence and a column representing an attribute. All the data items organized in the tables are manipulated through the relationships (links) established between the different tables. In other words, many update and query are accomplished by manipulating tables in various ways.

Among these data modeling techniques, the relational data modeling is proposed for anaysis of the data in the study under consideration.

4.4.2 Relational Data Analysis

The objective of this chapter is to produce a logical database design based on the relational data analysis. It can be asserted that the development of the logical data structure discussed in Chapter Three is an analysis of a systems data based on a top-down approach that concentrates first on designing the entities and their relationships and then leads to the analysis of the data item content of each entity. The description of data item contents of each entity was delayed until this stage. The reason was that data items have got a special treatment in relational data analysis, where the nature of each and every data item will be widely identified and studied. The relational data analysis, on the other hand, is a bottom up approach of designing the systems data that concentrates on the data items of each entity and the relationships between each data items; and leads to the analysis of the entities and their relationships at large. The purpose of relational analysis is to organize all of the data items into a set of normalized relations where we can avoid:

1) Unnecessary duplication of data items in different relations, and

2) Problems related to modifying, updating and deleting data.

The normalization process commonly consists four stages. This involves presenting data items in their:

1) un normalized form

2) First Normal Form

3) Second Normal Form

4) Third Normal Form

Normally the data items necessary for relational data analysis is obtained from input and output forms of the existing system. However, almost all the sources taken by this study, for identifying the data items and proceed with the relational analysis, were the input forms. The data items in the output forms were not used much because they are mainly derived statistical items whose value can be obtained by manipulating the occurrences (values) of the data items contained in the input forms. The data items of the input forms are permanently held in the system. So, there is no need to keep spaces for derived data items. A derived data item can be removed from a relation without any loss of information so far as its value can be obtained from a permanently held data items. The nature of all the system data taken by this study is such that each and every transaction about the patient occurring in any one time has to be peramently saved and accumulated in a history file; and is required any time by physicians, researchers and administrative personnel. The derived data items can be manipulated each time a need arises. The data item contents of each entity are identified and presented in a Data Item Description Tables (Table 8A to 8L). The relational analysis in this topic is, therefore, supported by those tables. The table includes some volumetric information important for physical database design. These volumentric information include the data space required for each data group occurrence, the total number of occurrences for each data group, and the number of occurrences participating in each relationship. The data item contents are presented in a number of tabular forms.

The data items have been developed by analyzing and asking which data item should be associated with which entity in the logical data structure. The link entities which have been created as a result of M:N relationships between entities are also assigned a corresponding data items. This simplifies the normalization process which will be discussed in the next

sections. So, as a result of analysis of each entity, most of the data item description are informally normalized.

Table 8-A: Data Item Description Table
Entity Name : Patient
Description : Personal Details of the Patient
Volumetric Information : An Average of Two New Leprosy Patients Per Day

Date_Item Name	Description	Form at	Size	Aliases	Range of Values	mment
DATE_REG	Date Registered	D	8		Current Date	Mandat
PAT_ID	Patient ID No.	C	7		Immediate Number	Mandat
PAT_NAME	Patient Name	C	30			Mandat
DATE_BRT	Date of Birth	D	8	Age		Mandat
ADM_REG	Admin Region	C	10			Mandat
WOREDA	Woreda	C	15	Higher		
KEBELE	Kebele	C	2			
HOU_NO	House Number	C	4			
FAR_ASSN	Farmer Assocation	C	15			
STAFF	Staff patient Y/N	L	1			
STAF_FAM	Staff Family Y/N	L	1			
NNSTAFFLEP	Non-staff leprosy patient Y/N	L	1			
NNSTAF_FA	Non-staff leprosy patient family	L	1			
ETN_GROUP	Ethnic group of the patient	C	10			
RELIGION	Religion	C	10		Islam, Christian, Other	
BIR_PLACE	Place of birth	C	15			
MARI_STAT	Marital status	C	7		Married, Single,	
DIVO_REAS	Reason for divorse	C	15		Divorced	
NO_CHILDR	Number of children	N	2			
ELD_CH_AGE	Age of the eldest children	N	2			
YNG_CH_AGE	Age of the youngest children	N	2			
MOTHE_ALIV	Mother alive Y/N	L	1			
FATHE_ALIV	Father alive Y/N	L	1			
BROTHR_NO	Number of brothers	N	2			
SISTRS_NO	Number of sisters	N	2			
GUARDIAN	Name & address of the guardian	C	30			
REL_ADDIS	Name & address of relatives in Addis	C	30			
OCCUP_NOW	Occupation now	C	10			
OCCUP-BEF	Occupation before having leprosy	C	10			
EDUC_BKGD	Educational background	C	10			
REL_W_LEP	Name & Patient ID of relatives with leprosy	C	30			
DDS_T_DUR	Duration of DDS treatment taken	D	8			
DEFAULTER	Defaulter patient Y/N	L	1			
WHY_DEFLT	Why defaulter (if defaulter)	C	25			
NRST_CLIN	Nearest clinic to residence	C	10			
HM_CLI_DS	Distance from home to clinic	C	6			
RESTOCOME	Reason to come to ALERT	C	20			
INTERVWR	Name of the Interviewee	C	30			
COMMENTS	Additional case notes & recommendations	C	30			

Table 8-B: Data Item Description Table

Entity Name : Patient_Disease
Description : A link entity between a Patient and Disease used for recording the kind of diseases, signs and symptoms examined by physician during diagnosing a patient at any particular time.
Volumetric Information: An average three kind of leprosy forms and associated diseases per patient

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comment
DX_DATE	Diagnosis Date	C	8			Mandator
PAT_ID	Patient ID	C	6			Mandator
DIS_CODE	Disease Code	C	6			Mandator
NEW_CASE	Status of the disease (New)	L	1			
RELAPSE	Status of the disease (Relapse)	L	1			
REPEAT	Status of the disease (Repeat)	L	1			
TRANSFD	Status of transfer	L	1			
COMPLNT	Complaint of the patient	C	10		Voluntary, Contact Survey,	
DET_MODE	Detection Mode	C	10		GeneralSurvey	
ONSET	Onset of the disease	N	2			
PHYS_CODE	Diagnosing Physician	C	4			
CLINIC	Diagnosing Clinic	C	6			
PR_LESN	Predominant lesions	C	7		Macules,Plaques, Nodules	
NO_LESN	Number of lesions	C	6		Single, Few, Many	
DST_LESN	Distribution of lesions	C	9		Asym, Part sym, Sym	
HYPOPIGM	Hypopigmentation	C	8		Marked,Moderate,Slight	
DFN_LSN	Definition of lesions	C	8		Good,Moderate,Poor	
CEN-HEAL	Central Healing	C	8		Marked,Moderate,Nil	
SEN_LOSS	Loss of Sensation	C	8		Marked,Moderate,Slight	
EYES	Condition of the eye	C	9		Keratitis,Iritis,Leproma	
MADUROSS	Madurosis	C	8		None,Partly,Complete	
VOICE	Status of patient Voice	C	6		Normal, Hoarse	
GEN_COND	General health condition	C	8		Good,Moderate,Poor	
COMPLICA	Complications	C	30			

Table 8-C: Data Item Description Table

Entity Name : Patient - Treatment
Description : A link entity between Patient and Treatment used to record treatment details prescribed for a patient at any as well as follow up of the drug administration for a patient.
Volumetric Information: An average of three drugs are prescribed for a patient in a particular prescription and for each prescription one attendance sheet is prepared for controlling the drug administration. A leprosy patient is estimated to have received a prescription of two in a year for leprosy treatment only.

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
PAT_ID	Patient ID	C	6			
TRTMT_DATE	Date of treatment	D	8			
MONO	Monotherapy	L	1			
MDT	Multi-Drug Therapy	L	1			
DRG_CODE	Drug Code	C	6			
UNIT	Unit of measure	C	4			
DOSAGE	Dosage	C	8			
TRT_LENG	Length of treatment	C	8			
QUANTITY	Quantity of drugs	N	3			
PHYS_CODE	Treating physician code	C	4			Diagnosing physi & treating physic can be two differ physicians.
PRE_INFO	Precautionary information	C	30			
DATE_GIVEN	Date of drug given	D	8			
TIME	Time of drug given	N	5			
DOSAGE	Dosage given at a time	N	4			
COMMENT	Status of the administration of the drug i.e., whether finished or discontinued.	C	1			'F' for Finished 'D' for Discontin
HLTH_PRG	General Health Progress of the patient	C	10			
RELEASED	Released from treatment	L	1			
DATE_REL	Date released from treatment	D	8			

Table 8-D: Data Item Description Table

Entity Name : Disease
Description : A Table of Disease Codes
Volumetric Information:

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
Dis_Code	Disease Code	C	6			Mandatory
Dis_Name	Disease Name	C	25			Mandatory

Table 8-E: Data Item Description Table

Entity Name : Treatment
Description : A list of drugs
Volumetric Information:

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
DRG_CODE	Drug code	C	6			
DRG_NAME	Drug name	C	20			

Table 8-F: Continued

Entity Name : Pysiotherapy Test (Contd.)
Description :
Volumetric Information:

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
SENFTL1	Sensation/Foot/Left site 1	C	1		Stimulus felt,	
SENFTL2	Sensation/Foot/Left site 2	C	1		Stimulus not felt,	
SENFTL3	Sensation/Foot/Left site 3	C	1		absorbtion, clawing,	
SENFTL4	Sensation/Foot/Left site 4	C	1		cracks, ulcer	
SENFTL5	Sensation/Foot/Left site 5	C	1			
SENFTL6	Sensation/Foot/Left site 6	C	1		" " "	
SENFTL7	Sensation/Foot/Left site 7	C	1		" " "	
SENFTL8	Sensation/Foot/Left site 8	C	1		" " "	
SENFTL9	Sensation/Foot/Left site 9	C	1		" " "	
SENFTL10	Sensation/Foot/Left site 10	C	1		" " "	
SENHNDR1	Sensation/Hand/Right site 1	C	1		" " "	
SENHNDR2	Sensation/Hand/Right site 2	C	1		" " "	
SENHNDR3	Sensation/Hand/Right site 3	C	1		" " "	
SENHNDR4	Sensation/Hand/Right site 4	C	1		" " "	
SENHNDR5	Sensation/Hand/Right site 5	C	1		" " "	
SENHNDR6	Sensation/Hand/Right site 6	C	1		" " "	
SENHNDR7	Sensation/Hand/Right site 7	C	1		" " "	
SENHNDR8	Sensation/Hand/Right site 8	C	1		" " "	
SENHNDR9	Sensation/Hand/Right site 9	C	1		" " "	
SENHNDR10	Sensation/Hand/Right site 10	C	1		" " "	
SENHNDL1	Sensation/Hand/Left site 1	C	1		" " "	
SENHNDL2	Sensation/Hand/Left site 2	C	1		" " "	
SENHNDL3	Sensation/Hand/Left site 3	C	1		" " "	
SENHNDL4	Sensation/Hand/Left site 4	C	1		" " "	
SENHNDL5	Sensation/Hand/Left site 5	C	1		" " "	
SENHNDL6	Sensation/Hand/Left site 6	C	1		" " "	
SENHNDL7	Sensation/Hand/Left site 7	C	1		" " "	
SENHNDL8	Sensation/Hand/Left site 8	C	1		" " "	
SENHNDL9	Sensation/Hand/Left site 9	C	1		" " "	
SENHNDL10	Sensation/Hand/Left site 10	C	1			
SENASSER	Assessor of the sensation	C	30			

Table 8-G: Data Item Description Table

Entity Name : PatientLabTest
Description : A link entity between the Patient entity and the Laboratory entity which contains various laboratory tests done for each leprosy patient
Volumetric Information: On the average Skin Smear Tests are done eight times in a year for each patient while all other tests such as Haematology, Urine, etc is estimated to be Five tests (including repeating tests) in a year for each patient.

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
PAT_ID	Patient ID	C	6			
PAT_NAME	Patient Name	C	30			
BIR_DATE	Date of Birth	D	8			
SEX	Sex	2	1			
TST_KIND	Kind of Test	C	15		Haematology, Stool, Urine, Serology, Skin Smears, Blood-Chemistry, Onchocerciasis, Leishmaniasis, TB, Spotum,	
TST_CODE	Test Code	C	6			
RESULT	Test Result	C	8			
TECH_NAME	Technician Reporting	C	30			
TECHCODE	Technician Code	C	4			
REPRTDATE	Report Date	D	8			

Table 8-H : Data Item Description Table

Entity Name : Histopathology Test
Description : A table of data about the biopsy examinations for a leprosy patients.
Volumetric Information: On the average biopsy examination is carried out once for each patient.

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
AHRI_NO	Biopsy Number	C	7			A number assigned by AHRI
PAT_ID	Patient ID	C	6			
REQ_CLINC	Requesting Clinic	C	4			
CLIN_INFO	Clinical Information	C	50			
LAB_INFO	Laboratory Information	C	10			
CLIN_DIAG	Clinical Diagnosis	C	15			
DATE_REQ	Date Requested	D	8			
BIOP_SITE	Sites of the biopsies taken	C	15			
PRE_BIOPS	Previous Biopsies	C	10			
PHYS_CODE	Requesting physician Code	C	30			
DATE_REPO	Date biopsy result reported	D	8			
REPORT	Report of the findings	C	100			
CONCLUSION	Conclusion about the feature of the type of leprosy	C	20			
REPO_BY	Reporting Technician of the results	C	30			

Table 8-I: Data Item Description Table

Entity Name : Health Education Record
Description : Various prevention and care methods as well as general health lessons taught for each patient.
Volumetric Information: On the average the teaching is carried out eight times for each patient; with a one week gap in each teaching; throughout the date of diagnosis to date of release from treatment.

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
PAT_ID	Patient ID	C	6			
PAT_NAME	Patient Name	C	30			
BIR_DATE	Date of Birth	D	8			
SEX	Sex	C	1		'M' or 'F'	
TEACH-MT	Teaching Method	C	2		'IT' for Individual Teaching 'GT' for Group Teaching 'SS' for Slide Show 'CC' for Cooking Class 'PS' for Puppert Class	
LESS_CODE	Leeson Code	C	4			
LESSON_TYP	Lessons Taught	C	9		"LEPCAUSE" for Leprosy Cause "LEPTRT" for Leprosy Treatment "REACT" for Reactions "SKINCARE" for Daily Skin Care "EXER" for Daily Exercise "SHOECARE" for Daily Shoes Care "EYEINSPR" for Eye Care on Insp. Prot. Cleaning "EYEBLNK" for Eye Care on Blinking "CRABURCUT" for Inujury cause & prevenstion of Cracks, Burns and Cuts "ULCER" for Inujury cause & prevenstion of Ulcer	

Table 8-J: Data Item Description Table

Entity Name : Surgery
Description : A table of codes for surgical operations for correction of deformities.
Volumetric Information:

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
SURG_COD E	Surgery Code	C	6			
SURG_DES CR	Surgery Description	C	30			

Table 8-K: Data Item Description Table

Entity Name : Patient Surgery
Description : A table of surgical operations for correction of deformities made for a patient.
Volumetric Information: On the average two surgical operations can be done for a patient in a year.

Data_Item Name	Description	Format	Size	Aliases	Range of Values	Comments
PAT_ID	Patient ID	C	6			
SURG_COD	Surgery Code	C	6			
SUR_DATE	Surgery Date	D	8			
SURGEON	Name of Surgeon	C	30			
SURGDETAIL	Other Detail Medical comments of the surgeon	C	50			

Table 8-L: Data Item Description table

Entity Name : Admission
Description : A table of admissions
Volumetric Information: On the average a patient can have two admissions in a year.

Data_Item Name	Description	For mat	Size	Range of Values	Com nts
WARD_NO	Ward Number	C	3		
WARD_TYP	Ward Type	C	10	Medical, Surgical, Paediatric, Opthalmology.	
PAT_ID	Patient ID	C	6		
DX_DATE	Diagnosis Date/if the disease has been first diagnosed and recorded in any Out-patient section, this date should be the same date with that section.				
DIS_CODE	Code of the Disease causing admission	C	6		
ADM_EXPLAN	Explannation for reason of admission	C	30		
DATE_ADM	Date of admission	D	8		
DATE_DSC	Date of discharge	D	8		
DAY_STYD1	Number of days stayed in this ward	N	3		
STATUS_DIS	Status of the patient at discharge	C	10		
BEDNO	Bed Number	C	2		

4.4.3 Process of Normalization

The first step in relational data analysis is to represent all of the data in a table. Each of the data items listed in the Data Item Description Table should be analyzed by inserting the actual data occurrences and the heading information at the top of each table. However, as there are many data item groups, analyzing each table by giving examples of actual data occurrences makes the paper too extended. To avoid that the normalization will be demonstrated by giving hypothetical values of data occurrences for only one representative table: PatientLabTest. For all other tables we shall only describe the data items without putting them in tables and giving actual data item values. But, a list of the data items arranged in their unnormalized form, first, second, and third normal forms will be presented in a columnar form followed by explanations whenever necessary.

To represent a table in unnormalized form we have to select first a data item(s) that can uniquely identify a table. The data item(s) that uniquely identify the particular table is known as a Primary Key. Whenever a data item is identified to be a primary key, it will be underlined in all tables that follows. The primary key selected for the data source PatientLabTest is the Patient ID.

The unnormalized form of the table for the PatientLabTest is presented in Table 9.

Table 9: Unnormalized PatientLaboratoryTest Table

Patient ID	Patient Name	Birth Date	Sex	Report Date	Technician Code	Technician Name	Kind of Test	Test Code	Test Description	Result
DL3294	Alemu Desie	01/01/43	M	01/01/94	TK001	Teka	BI & MI	B001	BI site 1	0
							Stool	AMBO	Amoebiasis	+
								HIST	Histolytica Cy	+
								TRCH	Trichuris	+
				01/02/94	TK001	Teka	Stool	AMBO	Amoebiasis	+
								HIST	Histolytica Cy	+
								TRCH	Trichuris	+
DL3295	Abebe Alem	01/01/43	M	01/01/94	TK001	Teka	BI & MI	B001	BI site 1	0

In this table only the data about the laboratory results are held because it is already said that the request aspect is a transient data store that will not be held permanently.

First Normal Form

A table is in its first normal form when there are no repeating groups of a data item occurrences for one occurrence of the primary key. The Patient ID is the primary key of the Unnormalized Relation (Table 9) because two patients can have the same Kind of Test associated with the same Test Code and Result. So, two logical rows representing an occurrence of two patients will be identified by Patient ID. In this table there are many repeating groups. Each repeating group is separated to a new relation. For a given value of Patient ID, the Report Date, Technician Code, Technician Name, and Kind of Test is repeating and this is separated to a new relation shown in Table 9-2. With the repeating

group separated to a different relation, the remaining data items indicated in Table 9-1 do not repeat for a single value of the Patient ID and each row can uniquely be identified.

Table 9-1: Patient Identity Relation

Patient ID	Patient Name	Birth Date	Sex
DL3294	Alemu Desie	01/01/43	M
DL3295	Abebe Alem	01/10/43	M

The Primary key for the new relation in Table 9-2 is the Report Date and Kind of Test. For a given patient, the same kind of laboratory test can be done on different occasions. In a particular occasion also more than one Kind of Tests can be done for the same patient. In both of these conditions, the unique identifiers will be a combination of the Report Date, and the Kind of Test. The Patient ID will be included to serve as a link with Table 9-1.

Table 9-2: Laboratory Test Kinds Relation

Patient ID	Report Date	Kind of Test	Technician Code	Technician Name
DL3294	01/01/94	BI&MI	TK001	Teka
DL3294	01/01/94	Stool	TK001	Teka
DL3294	01/02/94	Stool	TK001	Teka
DL3295	01/10/94	BI&MI	TK001	Teka

Still, for a particular Kind of Test, the data items Test Code, Test Description and Result are repeating. So, Table 9 demonstrates a nested repeating group. By 'nested', it means a repeating data item within a repeating group.

Table 9-3 occurred as a result of repeating Test Codes, Test Description, and Result for a single value of Kind of Test. Thus, these data items are removed to a separate relation.

In the new separated relation, the Test Code will identify a particular row. The three compound keys identified earlier will then be added to serve as a link with the Table 9-2. Each row in Table 9-3 is distinguished by the Test Code. So, the unique keys in Table 9-3 would be the combination of the four data items underlined.

Table 9-3 : Laboratory Results Relation

Patient ID	Report Date	Kind of Test	Test Code	Test Descr.	Result
DL3294	01/01/94	BI & MI	B001	BI 1	0
DL3294	01/01/94	STOOL	AMBO	Amoebias.	+
DL3294	01/01/94	STOOL	HIST	Histolyt.	+
DL3294	01/01/94	STOOL	TRCH	Trichur.	+
DL3294	01/01/94	STOOL	AMBO	Amoebias.	+
DL3294	01/10/94	STOOL	HIST	Histolyt.	+
DL3294	01/02/94	STOOL	TRCH	Trichur.	+
DL3295	01/01/94	BI & MI	B001	BI 1	0

Table 9 is, therefore, separated into three different relations with the column headings indicated from Table 9-1 to Table 9-3. For each separated relation we have determined the primary key that uniquely identifies each row in the tables and only one value is associated with each column/row intersection.

Second Normal Form

A relation is in second normal form when any data item wholly depends on the compound key. In this case when there are data items that depend only on part of the compound key, the data items will be separated into a different relation. This is known as functional dependency. Functional dependency exists when for a given value of a particular data item, there is one and only one value of another data item associated with it. In Table 9-3 the data item Test Description does not directly depend on the four data items but it directly depends only on the Test Code because for a single value of a Test Description, there is one

Table 9-6 : Laboratory Results Relation

Patient ID	Report Date	Kind of Test	Test Code
DL3294	01/01/94	BI & MI	B001
DL3294	01/01/94	Stool	AMBO
DL3294	01/01/94	Stool	HIST
DL3294	01/01/94	Stool	TRCH
DL3294	01/01/94	Stool	AMBO
DL3294	01/10/94	Stool	HIST
DL3294	01/02/94	Stool	TRCH
DL3295	01/01/94	BI & MI	B001

Third Normal Form

A table can be represented in its third normal form by removing any data items that do not directly depend on the compound key but depend on any other non-key data item within the same relation or on another relation within the same data source.

Looking at Table 9-2 we find that the data item Technician Name does not depend directly on the compound key but it is directly dependent on the Technician Code. It will, thus be separated to another relation with the Technician Code as it's primary key. This is indicated in Table 9-7.

Table 9-7 : A List of Technician Codes

Technician Code	Technician Name
TK001	Teka Alemayehu

The Technician Code will be left in Table 9-2 as it's value is determined by the compound keys. Technician Code serves as foreign key in Table 9-2. A foreign key is a data item that

do not belong to the table in which it is in, but included to indicate the relationship to master entities.

The relation in Table 9-2 will thus, be refined as shown in Table 9-8.

Table 9-8: Reporting Technician Relation

Patient ID	Report Date	Kind of Test	Technician Code
DL3294	01/01/94	BI&MI	TK001
DL3294	01/01/94	Stool	TK001
DL3294	01/02/94	Stool	TK001
DL3295	01/10/94	BI&MI	TK001

Third normal form also calls for examining the dependency of the elements in the compound key each other. This is an inter-key dependency, where any part of the compound key depends on any other part of that key. The dependent key should then be removed to a separate relation with the determining item(s) being a primary key. In Table 9-6, there exists an inter-key dependency between the key items Test Code and Kind of Test. The codes associated within a particular Kind of Test, say Haematology or Urine or Stool etc., will not be used in any other Kind of Test. But the reverse is not true: For a given value of Kind of Test say, Stool, there are many Test Codes contained with it. However, for a given value of Test Code, associated with it, there is always one value for Kind of Test. This means that given a particular Test Code, the Kind of Test to which it belongs can be uniquely identified. Kind of Test is, therefore, dependent on Test Code. The relation between the two data items becomes as shown in the following two tables.

Test Code	Kind of Test
B001	Skin Smears
AMBO	Stool
HIST	Stool
TRCH	Stool

Patient ID	Report Date	Test Code
DL3294	01/01/94	B001
DL3294	01/01/94	AMBO
DL3294	01/01/94	HIST
DL3294	01/01/94	TRCH
DL3294	01/02/94	TRCH
DL3295	01/01/94	B001

The former relation will be combined with Table 9-4 because they have the same primary key. The result of the combination is shown in Table 9-9. The latter relation can be combined with Table 9-5 because that table has also the same identifier with this relation. Table 9-6 will then lose its existence as independent relation.

The process of normalization for the PatientLabTest is now complete. The remaining data items of other entities described in the Data Item Description Table can be analyzed in the same process using only the column headings. All the normalized relations of the PatientLabTest, when arranged into columnar form would look like as below.

Table 9-1: Patient Identity Relation

Patient ID	Patient Name	Birth Date	Sex
DL3294	Alemu Dessie	01/01/43	M
DL3295	Abebe Alem	01/10/43	M

Table 9-4: A List of Laboratory Test Codes

Test Code	Test Description
BI001	Bacteriological Index at site 1
AMOEB	Amoebiasis
HISTL	Histolytica Cyst
TRCHU	Trichuris

Table 9-5 : Laboratory Results Relation

Patient ID	Report Date	Test Code	Result
DL3294	01/01/94	B001	0
DL3294	01/01/94	AMBO	+
DL3294	01/01/94	HIST	+
DL3294	01/01/94	TRCH	+
DL3294	01/01/94	AMBO	+
DL3294	01/10/94	HIST	+
DL3294	01/02/94	TRCH	+
DL3295	01/01/94	B001	0

Table 9-7 : A List of Technician Codes

Technician Code	Technician Name
TK001	Teka Alemayehu

Table 9-8: Reporting Technician Relation

Patient ID	Report Date	Kind of Test	Technician Code
DL3294	01/01/94	BI&MI	TK001
DL3294	01/01/94	Stool	TK001
DL3294	01/02/94	Stool	TK001
DL3295	01/10/94	BI&MI	TK001

Table 9-9: Kinds of Laboratory Tests Available

Test Code	Test Description	Kind of Test
B001	BI at Site 1	Skin Smears
AMBO	Amoebiasis	Stool
HIST	Histolytica Cyst.	Stool
TRCH	Trichuris	Stool

It can be proved that the tables are well normalized because:

1) Given a value for the key(s) of each relation, there is just one possible value for all other data item in that relation.

2) Each data item in each relation is wholly and directly dependent on the primary key(s) of that relation.

3) No two rows are identical. Each row (record) can be uniquely identified.

Normalization of the Remaining Data Sources

The PatientTreatment Relation (Table 11)

The Patient ID, and Date of Treatment is the unique key across the whole data source. The data items MONO, MDT, Precautionary Information, Other Procedures and Physician are directly dependent on both the Patient ID and Date of Treatment. Given a Patient ID and a particular Date of treatment, the kind of treatment procedure (MONO or MDT or Other Procedures) prescribed, the Precautionary Information provided and the Physician who had prescribed the treatment for the patient on that date, can be uniquely identified. It is likely that more than one physician can examine a particular patient on a particular date. However, all of them do not prescribe treatment for the patient simultaneously. Only one of them is responsible to prescribe a treatment procedure.

Table 10: PatientTreatment Normalized Tables

Data Source Name: PatientTreatment and Treatment Attendance

UNF	1NF	3NF
Patient ID	Patient ID	Patient ID
Date of Treatment	Date of Treatment	Date of Treatment
MONO	MONO	MONO
MDT	MDT	MDT
Other Procedures	Precuationary info	Precuationary info
Physician Code	Other Procedures	Other Procedures
Pre-cautionary info.	Physician Code	Physician Code
For each treatment		
procedure, the following	Patient ID	Patient ID
data items repeat.	Date of Treatment	Date of Treatment
Drug Code	Drug Code	Drug Code
Unit of Measure	Unit of Measure	Unit of Measure
Dosage	Dosage	Dosage
Treatment Length	Treatment Length	Treatment Length
Quantity Prescribed	Quantity Prescribed	Quantity Prescribed
For each Drug Code		
also the following data		Patient ID
items repeat.	Patient ID	Date of Treatment
Date Drug Given	Date of Treatment	Drug Code
Time Drug Given	Drug Code	Date Drug Given
Dosage Given	Date Drug Given	Time Drug Given
Cum. Usage Total	Time Drug Given	Dosage Given
Cum.Usage Percent	Dosage Given	
	Cum. Usage Total	
	Cum. Usage Percent	

The repeating groups are removed to a separate relation with the key items: Patient ID, Date of Treatment and Drug Code. This is because a patient can be treated at different dates with the same drug or many drugs can be prescribed for a patient on a particular date. In this case, the three key data items uniquely identify a particular row. Moreover, for a single value of a Drug Code: the Date Drug Given, Time Drug Given, Dosage Given, Cum. Usage Total, and Cum. Usage Percent are repeating. These are nested repeating data items and are separated into a different relation with two additional Key items: Date Drug Given and Time Drug Given. The Five keys uniquely identify a particular row. They are shown in the 1NF.

There is no part key dependency between the data items and the keys in the table because all are wholly dependent on the key items. So, the analysis goes directly to the third normal form.

The Cum.Usage Total is a derived data item that can be calculated by the cumulative summation of the Dosage Given over a period of dates and times for a given patient. So, it is dependent on the data items Patient ID, Date of Treatment, Drug Code, Date Drug Given, Time Drug Given, and Dosage Given. It can thus, be separated to a different relation. Likewise Cum.Usage Percent depends on the data items: Quantity Prescribed, and Cum.Usage Total. So, this data item can also be separated to a different relation. However, the Cum.Usage Total and Cum.Usage Percent are derived data items whose value can be obtained by calculating other data items. Derived data items can be removed from the normalized relations so far as the data items participating in the calculated field are permanently saved in the system. The need to avoid derived data items has been discussed in Section 4.2.2. As a result the two derived data items are removed from the relation.

The Health Progress Evaluation Relation (Table 11)

In this relation Attendance is obtained from the Cum. Drug Usage Percent. If a patient has used Cum.Drug Usage more than 75% of the drugs prescribed, his attendance will be 'Regular'. If it is less than 75% it will be 'Irregular'. So, Cum.Drug Usage Percent determines the Attendance. However, it is excluded from the 2nd and 3NF analysis for it is a derived data item.

Table 11: Health Progress Evaluation Normalized Tables

Data Source: Health Progress Evaluation

UNF	1NF	2NF	3NF
Patient ID Date of Evaluation Cum.Drug Usage Percent Attendance Health Progress Released Y/N Date Released Appointmnt Date Evaluated By	Patient ID Date of Evaluation Cum.Drug Usage Percent Attendance Health Progress Released Y/N Date Released Appointment Date Evaluated By	Patient ID Date of Evaluation Health Progress Released Y/N Date Released Appointmnt Date Evaluated By	Patient ID Date of Evaluation Health Progress Released Y/N Date Released Appointment Date Evaluated By

The PatientDisease Relation (Table 12)

The Patient ID is a unique identifier across the whole relation. For a single value of the Patient ID, and Date of Diagnosis, the data items:

Disease Code,
New Case,
Relapse,
Repeat,
Onset of the Disease,
Predominat Lesions,
Number of Lesions,
Distribution,
Central Healing,
Hypopigmentation,
Definition of Lesions,
Madurosis,
Sensation Loss,
Eyes,
Madurosis,
Voice,
Signs & Symptoms,
Other Diagnoses notes, and Complaints are repeating; because a patient can have more than one value of the data items listed above in a particular visit. So, these data items are removed into a separate relation as shown in the second relation of the 1NF column in Table

13. The primary key of the separated relation would be the Disease Code, Complaints, and Signs & Symptoms; because a single row can be uniquely identified by the combination of these three data items. The two data items: Patient ID and Date of Diagnosis are added to the compound keys to serve as link with the first relation in the 1NF column. So, five of the data items are underlined to indicate that they are key items. The first relation in the 1NF column of Table 13 is the one that remained after the separation of the repeatable data items. Its unique identifier are both the Patient ID and the Date of Diagnosis; because the non-repeating data items can be uniquely identified by the combination of these two key items. The result of these analysis is shown in the 1NF of Table 12.

Testing for Second Normal Form

In the analysis of the 1NF table, the data items :

New Case,
Relapse Case,
Repeat Case,
On Set of the Disease,
Predominant Lesions,
Number of Lesions,
Distribution of Lesions,
Hypopigmentation,
Definition of Lesions,
Central Healing,
Loss of Sensation,
Condition of the Eye,
Madurosis, and
Status of Patient Voice do not wholly depend on the five keys but on the Patient ID, Date of Diagnosis, and Disease Code; because by three of these keys each occurrence of those data items can uniquely be identified. So, they are removed to a separate relation to insure that the relation is in its second normal form. This is indicated in the fourth relation of the 2NF column of Table 12.

Like wise, the data items:

Clinic,
Physician Code,
General Health Condition,
Complications, and
Other Diagnosis Notes are functionally dependent on the

Patient ID and Date of Diagnosis only. So, these data items are also removed to a separate relation as indicated in the first relation of the 2NF column of Table 12.

An occurrence of the data items: Transfer and Detection Mode can uniquely be identified by Patient ID only. These data items take values only once when the patient appears to the hospital for his first time. Thus, they are removed to a separate relation as indicated in the second relation of the 2NF column.

After separating the data items that partly depend on the keys of the 1NF, the table remains with key only relation as shown in the third relation of the 2NF column.

Table 12: PatientDisease Normalized Tables

Data Source Name: Patient Disease

UNF	1NF	2NF	3NF/4NF
Patient ID_ Date of Diagnosis For a single value of the Patient ID and Date of Diagnosis the following data items repeat. New Case Relapse Case Repeat Case Transfer Detection Mode On Set of the Disease Clinic Physician Code Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice General Health Condition Complications Other Diagnosis Notes Disease Code Signs & Symptoms Complaints	Patient ID Date of Diagnosis Transfer Detection Mode Clinic Physician Code General Health Condition Complications Other Diagnostic Notes Patient ID Date of Diagnosis Disease Code Complaints Signs & Symptoms New Case Relapse Case Repeat Case On Set of the Disease Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice Complications	Patient ID Date of Diagnosis Clinic Physician Code General Health Condition Complications Other Diagnosis Notes Patient ID Transfer Detection Mode Patient ID Date of Diagnosis Disease Code Complaints Signs & Symptoms Patient ID Date of Diagnosis Disease Code New Case Relapse Case Repeat Case On Set of the Disease Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice	Patient ID Date of Diagnosis Clinic Physician Code General Health Condition Complications Other Diagnosis Notes Patient ID Transfer Detection Mode Patient ID Date of Diagnosis Disease Code New Case Relapse Case Repeat Case On Set of the Disease Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice Complications Patient ID Date of Diagnosis Complaints Patient ID Date of Diagnosis Signs & Symptoms

Testing for Third and Fourth Normal Form

There is no functional or inter-key dependencies between the data items. So, the relations in the 2NF are also in their 3NF. However, looking at the key only relation i.e., the relation that contains only primary keys, there are independent multi-valued data items. These are the Disease Code, Signs & Symptoms and Complaints. Three of them are independent of each other. So, they are decomposed into three relations indicated at the bottom of the fourth column of Table 12. This kind of dependency is usually discovered

when testing data items for fourth normal form. Davis and Olson, 1985 described a fourth normal form as that which eliminates cases in which the compasite key of a record type contains two or more data items that are independent, multi-valued facts about an entity. They extend their assertions by giving illustration where relations has a compasite key of Employee, Skill and Language. The Skill and Language are multi-valued (many different languages and many skills for an employee) but there is no logical dependency between the skill and the language. So, to put into a fourth normal form the data must be represented by two records (Employee, Skill) and (Employee, Language). The main purpose of decomposing a relation to be in a 4th normal form is because the multi-valued data items contained in the relation do not have logical dependency with each other (Shepherd, 1990). This means that given a particular occurrence of say a Skill, we cannot determine the value of the occurrence of a Language. In the same case, neither Disease Code determines Complaints/Signs & Symptoms nor Complaints/Signs & Symptoms determine Disease Codes.

Table 13: The Patient Ward Location Relation

This is a relation to record the location of wards to which patients are admitted. It has emerged as a result of the many to many relationship between the Patient and the Ward. In this relation, the WardNumber is the unique key across the whole system data. All associated data items are repeating for a single value of a WardNumber because in particular ward many patients can be admitted simultaneously. The primary key for the repeating data items consists of the Patient ID and the Date Admitted. Each patient in a ward is identified by the Patient ID; and as patient can be admitted in different occasions, each occasion will be identified by the Date Admitted. The key items for this relation would, therefore, be a

compound of three keys namely the WardNumber, Patient ID and Date Admitted. This is shown in Table 13.

In testing for 2NF, it is evident that the Ward Type is a fact about only WardNumber. For a given value of WardNumber, there is exactly one Ward Type associated with it. This is a functional dependency and is removed to a separate relation shown in 2NF. The Number of Days Stayed is a derived data item and can be removed from the relation. The relation in the 2NF is also in 3NF because there is no inter-key dependency.

Table 13: Admission Normalized Relations

Data Source Name: Admission

UNF	1NF	2NF/3NF
Ward No	Ward No	Ward No
Patient ID	Patient ID	Patient ID
Admission Date	Admission Date	Admission Date
Discharge Date	Discharge Date	Discharge Date
Ward Type	Ward Type	Bed no.
Bed Number	Bed Number	Transferred From
No.of Days Stayed	Transferred From	Transferred To
Transferred From	Transferred To	
Transferred To		Ward No
		Ward Type

Table 14: The Admission History Relation

This table is used for recording the admission history of a patient apart from the history of the Wards to which he had been admitted. The major cause of his admission, the number of days he stayed through out the time he had been treated as in-patient is contained in this relation.

Table 14: Data Source Name: Admission History

UNF	1NF/2NF/3NF
Patient ID Admission Date Discharge Date Ambulatory Comments for Admission No.of Days Stayed Status at Discharge Major Causes of Admission(Disease Codes) Date of Diagnosis Physician Code	Patient ID Admission Date Discharge Date Ambulatory Comments for Admission Status at Discharge Physician Code Patient ID Admission Date Disease Codes Date of Diagnosis

Patient ID and Admission Date is the unique identifier for the unnormalized form of the relation. The major cause of admission refers to the diseases that caused a patient to be admitted. The diseases can be many. So, the Disease Code and Date of Diagnosis are repeating data items and are removed to a separate relation in the 1NF. The unique identifiers in the separated relation would be the Patient ID, Date Admitted and Disease Code. Discharge Date cannot serve as a key because the Major Causes of Admissions (i.e., Diseases Codes) are recorded on the date of admission of the patient or at any time during his stay. However, since the occurrence of the Discharge Date takes place at some later date, it cannot be associated with the disease code and cannot serve as a primary key.

The data item Number of Days Stayed can be removed from the relation because its value can be obtained by calculating the differences between the Date Admitted and Date Discharged. It is a derived data item; and earlier it is mentioned that a derived data item can be removed from the relation. The relations in the 2NF are also in 3NF. There is

neither dependency between key data items nor between non-key data items.

The Histopathology Relation (Table 15)

The unique identifier for this table is the AHRI Number which is commonly used as a biopsy number assigned to each patient by the Histopathology Unit. More than one biopsy tests can be done for a patient over a period. In this situation the Date Requested also serves as a key. Each record of the histopathology would then be identified by the compound key. The Patient ID becomes a foreign key that links the Histopathology with the Patient Entity.

Most of the data items in the histopathology database holds textual information. There are no repeating groups of data items. The data items in the UNF are also in their 1NF, 2NF, and 3NF.

Table 15: Histopathology Normalized Table

Data Source Name: Histopathology Results

UNF	1NF/ 2NF/ 3NF
AHRI NO	AHRI NO
Date Requested	Date Requested
Patient ID	Patient ID
Requesting Clinic	Requesting Clinic
Clinical Information	Clinical Information
Laboratory Information	Laboratory Information
Clinical Diagnosis	Clinical Diagnosis
Sites of Biopsies	Sites of Biopsies
Previous Biopsies	Previous Biopsies
Requesting Physician	Requesting Physician
Date Result Reported	Date Result Reported
Report of the Findings	Report of the Findings
Conclusion	Conclusion
Reported By	Reported By

The Health Education (Table 16)

This table has a compound key consisting of Patient ID and Date Lesson Provided. A patient can be provided an education on different dates. Each record would then be uniquely identified by both keys.

The repeating groups are indicated in the table and they are separated into another relation with the key data items underlined. This is indicated in the 1NF column.

There is part key dependencies in the relations. Patient Name, Birth Date and Sex are determined by the Patient ID. In addition, the Lesson Type depend on the Lesson Code. These two dependent data items are, therefore, separated. The tables in the 2NF are also in 3NF.

Table 16: Health Education Normalized Tables

Data Source Name: Health Education

UNF	1NF	2NF/ 3NF
Patient ID Date Lesson Provided Patient Name Birth Date Sex Teaching Method For a single value of the compound keys Patient ID and Date Lesson Provided the following data items repeat Lesson Code Lessons Types	Patient ID Date Lesson Provided Patient Name Birth Date Sex Teaching Method Patient ID Date Lesson Provided Lesson Code Lesson Type	Patient ID Patient Name Birth Date Sex Patient ID Date Lesson Provided Teaching Method Lesson Code Lesson Type Patient ID Date Lesson Provided Lesson Code

The Physiotherapy Relation (Table 17)

In this table the Patient ID and the Date of Test are the unique identifiers. Patients are assessed their muscle and sensation test as well as their level of disability at different time intervals. So, each record or row is identified by the Patient ID and the Date of Test. There is no repeating group in the table but the Patient Name, Date of Birth and Sex directly depend on the Patient ID. They are removed to separate relation in the 2NF. The tables in the 2NF are also in their 3NF.

Table 17: Physiotherapy Test Normalized Table

Data Source Name: Physiotherapy Test

UNF	2NF/ 3NF
Patient ID	Patient ID
Date of Test	Patient Name
Date of Birth	Sex
Patient Name	
Sex	Patient ID
Facial/Eye Closure/Right	Date of Test
Facial/Eye Closure/Left	Facial/Eye Closure/Right
Ulnar/Abd.5th Fing/Right	Facial/Eye Closure/Left
Ulnar/Abd.5th Fing/Left	Ulnar/Abd.5th Fing/Right
Ulnar median/Adb.index Fing./Right	Ulnar/Abd.5th Fing/Left
Ulnar median/Abd.Index Fing./Left	Ulnar median/Adb.index Fing./Right
Median/Abduction thumb/Right	Ulnar median/Abd.Index Fing./Left
Median/Abduction thumb/Left	Median/Abduction thumb/Right
Median/Opposition thumb/Right	Median/Abduction thumb/Left
Median/Opposition thumb/Left	Median/Opposition thumb/Right
Radial/Wristextention/Right	Median/Opposition thumb/Left
Radial/Wristextention/Left	Radial/Wristextention/Right
Comm.Peroneal/Dorsiflex/Right	Radial/Wristextention/Left
Comm.Peroneal/Dorsiflex/Left	Comm.Peroneal/Dorsiflex/Right
Comm.Peroneal/Eversion foot/Right	Comm.Peroneal/Dorsiflex/Left
Comm.Peroneal/Eversion foot/Left	Comm.Peroneal/Eversion foot/Right
First assessment weakness/paralysis	Comm.Peroneal/Eversion foot/Left
Followup assessment,deterioration etc	First assessment weakness/paralysis
Comments + nerve damage	Followup assessment,deterioration etc
Disability grade/Eye/Right	Comments + nerve damage
Disability grade/Eye/Left	Disability grade/Eye/Right
Disability grade/Hands Right	Disability grade/Eye/Left
Disability grade/Hands Left	Disability grade/Hands Right
Disability grade/Feet Right	Disability grade/Hands Left
Disability grade/Feet Left	Disability grade/Feet Right
	Disability grade/Feet Left

Table 18 Column 2 Continued

2NF/3NF
Sensation/Blink
Sensation/Lagophthalmos
Sensation/Foot/Right site 1
Sensation/Foot/Right site 2
Sensation/Foot/Right site 3
Sensation/Foot/Right site 4
Sensation/Foot/Right site 5
Sensation/Foot/Right site 6
Sensation/Foot/Right site 7
Sensation/Foot/Right site 8
Sensation/Foot/Right site 9
Sensation/Foot/Right site 10
Sensation/Foot/Left site 1
Sensation/Foot/Left site 2
Sensation/Foot/Left site 3
Sensation/Foot/Left site 4
Sensation/Foot/Left site 5
Sensation/Foot/Left site 6
Sensation/Foot/Left site 7
Sensation/Foot/Left site 8
Sensation/Foot/Left site 9
Sensation/Foot/Left site 10
Sensation/Hand/Right site 1
Sensation/Hand/Right site 2
Sensation/Hand/Right site 3
Sensation/Hand/Right site 4
Sensation/Hand/Right site 5
Sensation/Hand/Right site 6
Sensation/Hand/Right site 7
Sensation/Hand/Right site 8
Sensation/Hand/Right site 9
Sensation/Hand/Right site 10
Sensation/Hand/Left site 1
Sensation/Hand/Left site 2
Sensation/Hand/Left site 3
Sensation/Hand/Left site 4
Sensation/Hand/Left site 5
Sensation/Hand/Left site 6
Sensation/Hand/Left site 7
Sensation/Hand/Left site 8
Sensation/Hand/Left site 9
Sensation/Hand/Left site 10
Physiotherapist

The Patient Relation (Table 18)

The data items listed in this table are filled on the first day when a leprosy patient appears at the hospital. They contain data about the personal and socio-medical histories of the patient.

The unique identifier for this table is the Patient ID. Each and every data item depends on the Patient ID and there are no repeating data items. The table, thus, requires no further

normalization.

Table 18: Patient Identity Normalized Table

Data Source Name: Patient

Patient ID No.
Date Registered
Patient Name
Father's Name
Grand Father's Name
Date of Birth
Admin Region
Woreda
Kebele
House Number
Farmer Assocation
Staff patient Y/N
Staff Family Y/N
Non-staff leprosy patient Y/N
Non-staff leprosy patient family
Ethnic group of the patient
Religion
Place of birth
Marital status
Reason for divorce
Number of children
Age of the eldest children
Age of the youngest children
Mother alive Y/N
Father alive Y/N
Number of brothers
Number of sisters
Name & address of the guardian
Name & address of relatives in Addis
Occupation now
Occupation before having leprosy
Educational background
Name & Patient ID of relatives with leprosy
Duration of DDS treatment taken
Defaulter patient Y/N
Why defaulter (if defaulter)
Nearest clinic to residence
Distance from home to clinic
Reason to come to ALERT
Name of the Interviewee
Additional case notes & recommendations

The PatientSurgery Relation (Table 19)

In Table 19 the unique identifier is the Patient ID because there is one possible value for that data source. The Patient ID can be used to make each row unique across the whole of the data source. Since the Surgery Code and Surgeon are repeating data items they are removed to separate relations.

With the repeating group removed to a separate relation, we have a new relation with key data items underlined in the 1NF column because:

1) A patient can have different surgeries on different occasions, and more than one surgeries can be done for a patient on the same date; and
2) More than one surgeons are involved in a particular surgery.

So, the Patient ID, Date of Surgery, Surgery Code, and Surgeons make a particular row or record unique.

The tables in the 1NF are already in 2NF since there is no part key dependencies of data items. However, the data item Surgery Details do not directly depend on Patient ID only, but it also depends on the combination of the Patient ID and Date of Surgery. The Surgery Details are facts about the histories of a patient associated with his surgeries on a particular date. Hence, this data item is removed to a separate relation with the compound keys Patient ID and Date of Surgery.

Table 19: PatientSurgery Normalized Relations

Data Source Name: PatientSurgery

UNF	1NF	2NF	3NF/4NF
Patient ID Patient Name Birth Date Sex Surgery Details For each Patient ID the following data items repeat Surgery Date Surgery Code Surgeon Code	Patient ID Patient Name Birth Date Sex Surgery Details Patient ID Surgery Date Surgery Code Surgeon	Patient ID Patient Name Birth Date Sex Surgery Details Patient ID Surgery Date Surgery Code Surgeon	Patient ID Patient Name Birth Date Sex Patient ID Surgery Date Surgery Details Patient ID Surgery Date Surgery Code Patient ID Surgery Date Surgeon

Another point relates to the Fourth Normal Form. Fourth Normal Form is where a key of a record type does not contain two or more independent multi-valued facts about an entity (Davis, 1985). In the relation identified by the four key data items in the third column of Table 19, the compound key contains two data items that are independent but contain multi-valued facts. These are the Surgery Code and Surgeon because there are many different Codes and many Surgeons. However, there is no logical dependency between Surgery Code and Surgeon. It means that neither a particular Surgeon is associated with only one Surgery Code nor a particular Surgery Code is associated with only one Surgeon. So, the data must be represented into two relations. This is indicated in the 3NF/4NF column of the same table: Table 11.

4.4.4 Optimization of the Normalized Tables

In the previous sections we have seen the relational analysis done on a number of data sources and produced from each source a number of normalized relations. The relations that have the same unique identifier will now be combined together and each new relation created as a result of the normalization will be given a name. The process of merging data items having the same unique identifiers together is known as Optimization (Ashworth, 1990). The process of optimization proceeds by examining the third or fourth normal forms of the relations of each data source. The optimization of the relations under consideration is straightforward and is shown in Table 20. It can be noted that the relations that contain derived data items are taken out from the optimization.

Table 20: Optimized Relation of All the Data Sources

Surgical History Patient ID Surgery Date Surgery Details Patient Surgery Patient ID Surgery Date Surgery Code Patient Surgeons Patient ID Surgery Date Surgeon Surgery Surgery Code Surgery Description Health Progress Patient ID Date of Evaluation Health Progress Released Y/N Date Released Appointment Date Evaluated By	Patient Patient ID Transfer Detection Mode Treatment Procedures Patient ID Date of Treatment MONO MDT Precautionary info Other Procedures Physician Code Drug Prescription Patient ID Date of Treatment Drug Code Unit of Measure Dosage Treatment Length Quantity Prescribed Drug Administration Patient ID Date of Treatment Drug Code Date Drug Given Time Drug Given Dosage Given Drug Drug Code Drug Name Disease Disease Code Disease Name	Diagnostic Notes Patient ID Date of Diagnosis Clinic Physician Code General Health Condition Complications Other Diagnosis Notes Patient Diseases Patient ID Date of Diagnosis Disease Code New Case Relapse Case Repeat Case On Set of the Disease Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice Complications Complaints Patient ID Date of Diagnosis Complaints Signs & Symptoms Patient ID Date of Diagnosis Signs & Symptoms	List of Laboratory Test Codes Laboratory Test Code Laboratory Test Description Kind of Test Laboratory Result Patient ID Report Date Test Code Result List of Technician Codes Technicia Code Technician Name Reporting Technician Patient ID Report Date Kind of Test Technician Code Physician Physician Code Physician Name

Table 20: Optimized Relation of All the Data Sources

Surgical History Patient ID Surgery Date Surgery Details Patient Surgery Patient ID Surgery Date Surgery Code Patient Surgeons Patient ID Surgery Date Surgeon Surgery Surgery Code Surgery Description Health Progress Patient ID Date of Evaluation Health Progress Released Y/N Date Released Appointment Date Evaluated By	Patient Patient ID Transfer Detection Mode Treatment Procedures Patient ID Date of Treatment MONO MDT Precautionary info Other Procedures Physician Code Drug Prescription Patient ID Date of Treatment Drug Code Unit of Measure Dosage Treatment Length Quantity Prescribed Drug Administration Patient ID Date of Treatment Drug Code Date Drug Given Time Drug Given Dosage Given Drug Drug Code Drug Name Disease Disease Code Disease Name	Diagnostic Notes Patient ID Date of Diagnosis Clinic Physician Code General Health Condition Complications Other Diagnosis Notes Patient Diseases Patient ID Date of Diagnosis Disease Code New Case Relapse Case Repeat Case On Set of the Disease Predominant Lesions Number of Lesions Distribution of Lesions Hypopigmentation Definition of Lesions Central Healing Loss of Sensation Condition of the Eye Madurosis Status of Patient Voice Complications Complaints Patient ID Date of Diagnosis Complaints Signs & Symptoms Patient ID Date of Diagnosis Signs & Symptoms	List of Laboratory Test Codes Laboratory Test Code Laboratory Test Description Kind of Test Laboratory Result Patient ID Report Date Test Code Result List of Technician Codes Technicia Code Technician Name Reporting Technician Patient ID Report Date Kind of Test Technician Code Physician Physician Code Physician Name

Table 20: Continued

Patient Ward Location	Histopathology Result	Teaching Method	Physiotherapy Test
Ward No	AHRI NO	Patient ID	Patient ID
Patient ID	Date Requested	Date Lesson	Date of Test
Admission Date	Patient ID	Provided	Facial/Eye Closure/Right
Discharge Date	Requesting Clinic	Teaching Method	Facial/Eye Closure/Left
Bed no.	Clinical Information		Ulnar/Abd.5th Fing/Right
Transferred From	Laboratory Information		Ulnar/Abd.5th Fing/Left
Transferred To	Clinical Diagnosis	List of Lesson	Ulnar median/Adb.index Fing./Right
	Sites of Biopsies	Codes	Ulnar median/Abd.Index Fing./Left
	Previous Biopsies		Median/Abduction thumb/Right
Admission History	Requesting Physician	Lesson Code	Median/Abduction thumb/Left
	Date Result Reported	Lesson Type	Median/Opposition thumb/Right
Patient ID	Report of the Findings		Median/Opposition thumb/Left
Admission Date	Conclusion		Radial/Wristextention/Right
Discharge Date	Reported By	Patient Education	Radial/Wristextention/Left
Ambulatory			Comm.Peroneal/Dorsiflex/Right
Comments for		Patient ID	Comm.Peroneal/Dorsiflex/Left
Admission		Date Lesson	Comm.Peroneal/Eversion foot/Right
Status at Discharge		Provided	Comm.Peroneal/Eversion foot/Left
Physician Code		Lesson Code	First assessment weakness/paralysis
			Followup assessment,deterioration etc
			Comments + nerve damage
Cause of Admissions			Disability grade/Eye/Right
			Disability grade/Eye/Left
Patient ID			Disability grade/Hands Right
Admission Date			Disability grade/Hands Left
Disease Codes			Disability grade/Feet Right
Date Diagnosed			Disability grade/Feet Left
			(Include others from Table 18)
Ward			
Ward No			
Ward Type			

Table 20: Continued

Patient	Contined...	Continued...
	Religion	
Patient ID No.	Place of birth	Name & Patient ID of relatives
Date Registered	Marital status	with leprosy
Patient Name	Reason for divorce	Duration of DDS treatment
Date of Birth	Number of children	taken
Admin Region	Age of the eldest children	Defaulter patient Y/N
Woreda	Age of the youngest children	Why defaulter (if defaulter)
Kebele	Mother alive Y/N	Nearest clinic to residence
House Number	Father alive Y/N	Distance from home to clinic
Farmer Assocation	Number of brothers	Reason to come to ALERT
Staff patient Y/N	Number of sisters Name & address of the	Name of the Interviewee
Staff Family Y/N	guardian	Additional case notes &
Non-staff leprosy patient Y/N	Name & address of relatives in Addis	recommendations
Non-staff leprosy patient family	Occupation now	Detection Mode
Ethnic group of the patient	Occupation before having leprosy	Transferred
	Educational background	

4.4.5 Required Logical Data Structures

The normalized relations are groups of data items with primary and foreign keys. They can be represented by a logical data structure diagram. In order to do so, each optimized relation is represented as an entity. One relation is related to the other if its primary key appears as part key or foreign key in the other relation. The part key or foreign key then serves as a linking of one relation to the other. Linking (relationship) of each relation is shown by an arrow where the head of the arrow indicates the many end while the tail of the arrow indicates the one end. The one end of the relationship signifies that an item appears as a sole primary key in the relation, while the 'many' end points out that an item which is a primary key in other relation appears as part of a compound key or a foreign key in the relation in hand. In other words an entity, say entity A, whose primary key appeared as a compound or foreign key in another entity, say in entity B, occurs many times in entity B. This is the many-to-one relationship.

When part of the compound key does not appear as a primary key in another relation, this becomes an operational master. An operational master is an alternative data item that serves as a direct method of accessing a particular requirement other than the primary key. For instance, we may want to find the type of diseases in a particular year from the PatientDisease relation, which has the data items: Patient ID, Disease Code and Date of Diagnosis. One way to find the occurrences of diseases is to read through all the diseases in the database. Another direct way to meet the requirement is to read through serially until the data value matches the required year (Diagnosis Date). The Diagnosis Date then becomes an operational master and one can directly access and quickly find the diseases in a particular moment by specifying the Diagnosis Date.

In many of the normalized relations one can note that there are many data elements representing dates. The dates are serving as part of a compound key but they do not appear as a sole primary key in any of the relations. So, dates are operational masters in the entities on hand.

All the normalized tables indicated in Table 20 are represented in a logical data structure diagram; this is shown in Figure 17. That will be the required data structure diagram for the system under consideration. A logical data structure is required to support the processing to be performed in the new system. The required system processing was shown in the proposed data flow diagram in Figure 7. The revised required logical data structure diagram includes some changes to the current logical data structure. New entities have been added and some changes in naming the entities have also been made.

In many of the normalized relations one can note that there are many data elements representing dates. The dates are serving as part of a compound key but they do not appear as a sole primary key in any of the relations. So, dates are operational masters in the entities on hand.

All the normalized tables indicated in Table 20 are represented in a logical data structure diagram; this is shown in Figure 17. That will be the required data structure diagram for the system under consideration. A logical data structure is required to support the processing to be performed in the new system. The required system processing was shown in the proposed data flow diagram in Figure 7. The revised required logical data structure diagram includes some changes to the current logical data structure. New entities have been added and some changes in naming the entities have also been made.

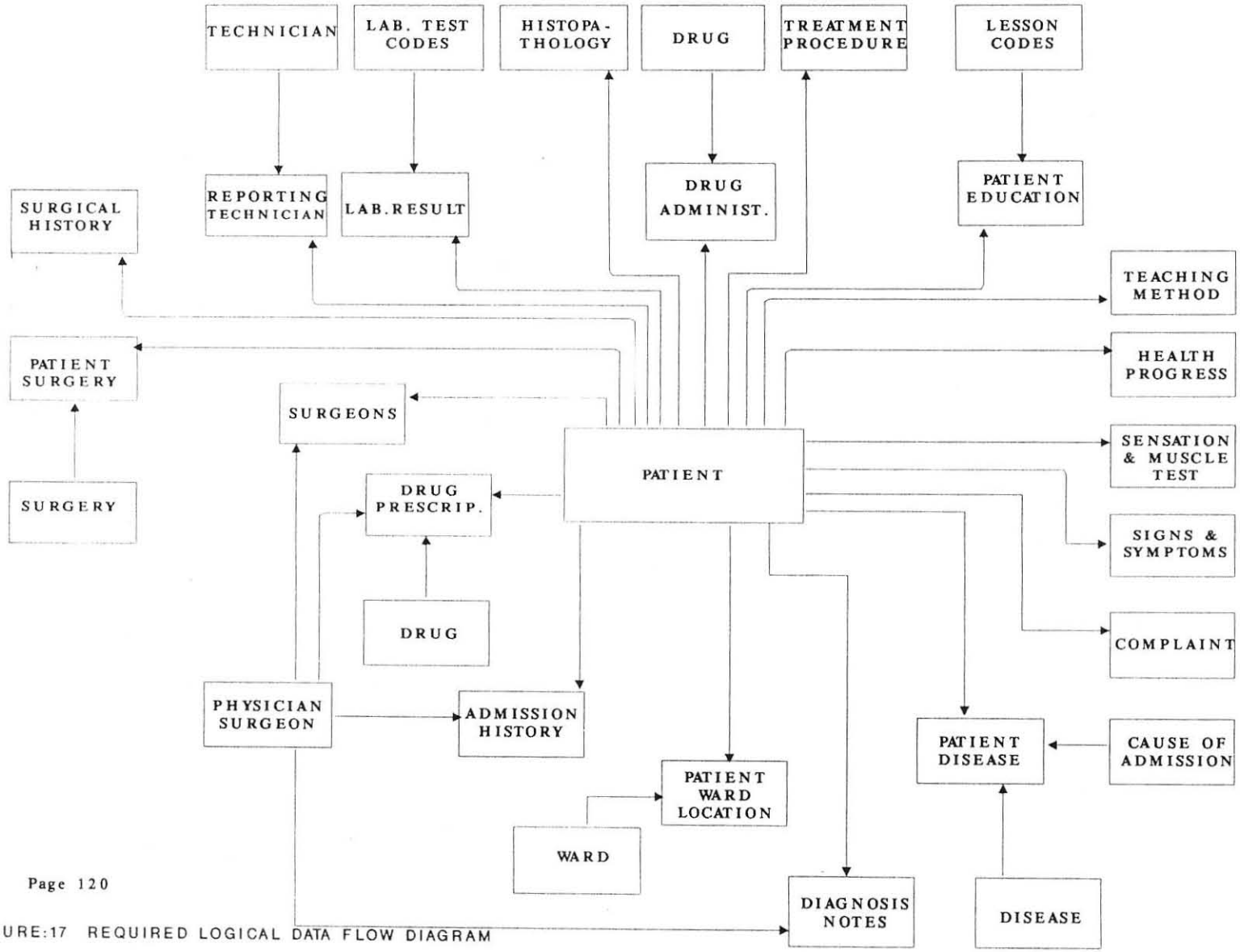


FIGURE:17 REQUIRED LOGICAL DATA FLOW DIAGRAM

CHAPTER 5

PHYSICAL DATABASE DESIGN

5.1 DATABASE IMPLEMENTATION

In Chapter Four the detailed logical design of the information processing has been shown. The logical design has been developed independently of its physical implementation. The database were developed in such a way that they could be implemented in any hardware and software. In this chapter attempts will be made to show how those processes and the data will be implemented with emphasis on a particular software selected for the purpose. Emphasis will be given to physical development of a model (prototype) system on two modules: the registration and Diagnosis and Treatment.

In order to develop the physical design, we need to fit the logical design into a particular relational database management package. There is a wide variety of different software packages which support the creation of databases on microcomputers. Different software each with varying features are widely available in the market. But it is difficult to find a particular software having all necessary features required by a system. The question would, therefore, be comparison of potential candidate software and the selection of the one that best fits to the system under consideration. Selection of an appropriate software requires knowledge and experience about the peculiar characteristics and facilities of the software. The minimum criteria that the software should satisfy should be set beforehand.

To develop a system proposed by this study it is advisable to opt for a relational database management software that should meet the following criteria in some way or another. Rowley, (1990) gives us some basic notes that should be taken into consideration while selecting a software. The software has to be evaluated in terms of:

1) Having a multi-user options;
2) Working with different operating systems;
3) Allowing for the maximum number of characters in a record;
4) Having no limit to the number of records in a database;
5) Having variable length records and fields (if possible);
6) Allowing the possibility of the inclusion of new fields added to an existing database;
7) Providing for all possible input validation facilities;
8) Making possible for importing from and exporting to data with other database packages;
9) Able to integrate with word-processor, spreadsheet, graphics packages and their data;
10) Providing maximum control for privacy and integrity of data;
11) Providing option for user-defined screens, reports, menus, which can optionally be designed without programming, through a menu interface;
12) Having a programming language interface for development of customized applications with built-in compiler;
13) Making programming possible with standard programming languages such as Pascal to take some added advantages of facilities that cannot obtained from the of-the-shelf software application languages;
14) Providing query facilities of high level; and retrieval based on indexed files of text words on any field in a record;
15) Making possible to get technical assistance, consultancy, and training from the

vendors;

16) The possibility of being continually revised by its vendor and new releases of the software must taken into account.

In addition, the system requires a software that provides all the possibilities for keeping the integration of data and provides security over access and manipulation of the data. The integrity and security requirements are described as follows.

5.2 DATA INTEGRITY

Before any data is stored on a disk, it is essential to establish an edit check on the fields to care for the integrity of data. In relational databases, there are three techniques available to keep the integrity of data (Shepherd, 1990). These are:

1) The Domain Constraints;

2) The Referenial Integrity Constraints; and

3) Entity Integrity.

1. The Domain Constraint enables to reject any attempt to enter data value outside the domains set for each data item (field). The domains that should be imposed for each field is indicated in the Data Item Description Table. See Tables 8A to 8L of the previous chapter under the range of values column.

2. Referenial Integrity enables to keep the integrity of data through enforcement of foreign keys. There are three kinds of referenial integrity: insertion, deletion and update.

2.1 The Insertion Integrity takes care of inserting a foreign key value that does not appear in the file in which the foreign key appears as a primary key. For instance, the Physician Code is a foreign key in the Drug Prescription file and is a primary key in the Physician file. The insertion integrity technique, thus, protects the entry of a Physician Code in the Drug Prescription file if that code did not appear in the Physician file. The foreign keys to which insertion integrity should be imposed are shown below, their file names being underlined.

Surgical History (SURG_HST)
PAT_ID (Patient ID)
WARD NO.

Patient-Surgeon (Pat_Surg)
PAT_ID
SURGEON

Patient Surgery (PAT_SURG)
PAT_ID
SURG_COD

Health Progress (HLTH_PRG)
PAT_ID

Treatment Kind (Trt_Kind)
PAT_ID
PHYS_COD (Physician Code)

Prescription (Prescrip)
PAT_ID
DRG_CODE (Drug Code)

Drug Admin. (Drg_Admin)
PAT_ID
DRG_CODE

Admission History (ADM_HIST)
PAT_ID

Admission Cause (ADM_CAUS)
WARD_NO
PAT_ID
DIS_CODE

Histopathology (HISTOPA)
PAT_ID

Patient Disease (PAT_DIS)
PAT_ID
DIS_CODE (Disease Code)
PHYS_COD

Complaint (CMPLNT)
PAT_ID

Laboratory Result (LAB_RSLT)
PAT_ID
TST_CODE (Lab. Test Code)

Reporting Technician (RPT_TECH)
PAT_ID
TECH_COD (Technician Code)

Admission (ADMSSN)
WARD_NO
PAT_ID

Teaching Method (TEACH_MTD)
PAT_ID

Patient Education (PAT_EDU)
PAT_ID
LESS_COD (Lesson Code)

Physiotherapy (PHYSIO)
PAT_ID

The file whose primary key appears as foreign key in other file is called a **Parent** file while that which holds a foreign key is called a dependent file.

2.2 Deletion Integrity is essential in case of need for deletion of a record whose primary key appeared as foreign key in many other records. There are three possible ways in keeping the integrity of the data. The Cascade, Set-to-Null, and Restrict. When a field is set to be cascade, any attempt to delete a record in the parent file would subsequently result in the deletion of all associated records in the dependent file.

2.2.1 The Set-to-Null protects the deletion of related records in a dependent file when a record from the parent file is deleted. If we set a foreign key to NULL, we can retain the record in the dependent file but we make the value of the foreign key unknown. By this we can break the relationship between the dependent and the parent file. Normally, this happens when there is an optional relationship between entities.

2.2.2 The Restrict Rule prevents the deletion of the parent row when some rows in the dependent file are deleted. In some situations errors may take place when recording a particular transaction that is associated with a particular parent file. To correct the error, it may call for the deletion of the transaction including the parent file. If the restrict rule is not applied, it is likely that the parent file can at the same time be deleted. To protect the deletion of the parent row with which the transaction files are associated, the restrict rule should be applied to the above mentioned foreign data items.

2.3 Update Integrity - this technique provides the option to change the foreign key value of all related records in the dependent file when there is a change in the primary key of the parent file. This rule applies to all the primary keys in Table 24.

Through these techniques we can maintain the consistency of the fields that relate one file to the other.

3. Entity Integrity this is also another way to ensure data integrity. It is done by setting all primary key values to 'NOT NULL'. If the primary key is set to 'NOT NULL' any attempt to insert or add a record without assigning the primary key value would be rejected. Thus, each primary key in Table 24 should be set to 'NOT NULL'.

5.3. USE OF THE COMMIT COMMAND

This technique provides the possibility to keep transactions in memory or in temporary files before they are immediately posted to the files. Transactions held in memory or temporary files are updated when the **COMMIT** command is evoked. This command has a wider application in the system taken by this study. Earlier it is mentioned that physicians and other health personnel are responsible for any transaction occurring about any patient. For each physician there are assistants to whom the physician orally dictates in writing the medical histories being examined during patient-physician encounter. The histories recorded should be signed by the physician. Before signing, the physician checks the data to make sure that they are recorded properly. To represent this process in a computer system, the commitment command has an important role.

The commitment command provides the option to store data temporarily by the health assistants and later updated by the physician at any time of the day he wants. This can be done by providing the authority to run the commit command only to the responsible physician. In addition, the commit command is used more often for protection of the destruction of data due to concurrent updating of records by different users or any technical failures. Since every transaction is temporarily held, the likelihood of incomplete updating or processing will not occur. Transactions can be updated at the time when the file is free.

5.4 DATA SECURITY

Data can be secured through assigning passwords to fields and files and through using views to keep unauthorized personnel from seeing complete records.

Since maximum control over data access is required in the system; the DBMS must allow passwords to the system, the files and the fields in the event of viewing, updating, deleting, adding, etc.

The software should, therefore, be evaluated in terms of satisfying the sixteen criteria set above and in terms of the possibility to enforce rules to keep the consistency, accuracy and integrity of the data. Selection of the software requires a special attention and calls for a combined effort of a study group.

5.5 MAPPING DATABASES TO A RELATIONAL RDBMS

There are many relational database management systems (RDBMS) developed using the IBM's relational database language called SQL (Structured Query Language). SQL is a representative language of relational database management system and most of the popular RDBMS including dBASE IV, DB2, ORACLE, INGRESS, etc., are SQL based packages (Shepherd 1990, 274). SQL based database management systems provide all the data integrity and security requirements mentioned above. In addition to ease of use by end users, they also provide a limit on user access to the database through the view facilities which prevent users from accessing attributes (fields) to which they are not permitted. So, SQL based RDBMS packages can be taken as a candidate packages in selection of the software for the system under consideration.

For demonstration purposes, one of the relational databases: dBASE IV has been selected for physical design. The reasons are:

1) dBASE IV is already owned and familiar in the organization taken by this study. In the earlier chapter it was mentioned that in the Division of ALERT Leprosy Control (ALC), a computer system is installed for processing research data on five hundred leprosy patients. That system runs on dBASE IV customized programs. dBASE IV is also used in the Finance section for processing payroll.

2) Although dBASE IV is not recommended as the best software package for the implementation of the Leprosy Patient Recording System, it is a relational DBMS that fulfils many of the criteria set above. For these reasons, the operation of the prototype

computer based leprosy patient record is shown using dBASE IV.

In physical design the first step that should be followed is transforming the logical data files into the data definition constructs of dBASE IV. Each data item in the logical data structure will be converted into a field and each entity name will be converted into a database file name. The data structure definition are commonly held in the data dictionary. The Data Item Description Table shown in Table 8A to 8L was developed to serve two purposes: to identify the data items associated with each entity and serve as a data dictionary. As the progress in the data analysis proceed on, new data items have been included and the Data Item Description has been refined to form a data dictionary. The complete data dictionary, after transforming the logical data files into the data definition constructs of dBASE IV is presented in Appendix V.

5.5.1. Catalogues

One tool for grouping database files is a catalog. A catalog is used to group together lists of related files. It is important, where there are a number of database files, to keep track of the names of the files when working with dBASE IV. The main advantage of catalog files is that it enables to limit to the number of files displayed in the option box to those files stored in the catalog.

The total number of database files created are 29. Each database file is organized into a particular catalogue with the possibility of being repeated in another catalog. There are seven catalog files created. The name and description of each data base file and the catalogue to which the file belongs is given in the table 21. Every record in each database

file is assigned a primary and a foreign key. These keys index the database to allow quick and efficient access to any record and to link the various databases together. Moreover, these keys serve to keep the integrity of the data. The primary and foreign keys were identified during the normalization process discussed in the previous chapter. Each of the 29 databases are defined as either Parent or Transaction. The records in the Parent database do not repeat once they have occurred. While the records in the Transaction can repeat and can contain information which is referred to by records in the Parent database. Thus, the storage required in the Parent database can be reduced without decreasing the amount of information stored. It can be noted that the identification of the parent and transaction files has been possible through the process of normalization discussed in Chapter 4. This is the added advantage of normalization in addition to avoiding anomalies.

Table 21: Catalog Files.

CATALOG FILE NAME	FILES IN CATALOG	DESCRIPTION OF FILES	
TREATMEN.CAT	COMPLNT.DBF	Database for patient complaints	Transaction
	DIAGNOTE.DBF	Database for diagnosis notes and attending physicians	"
	DISEASE.DBF	Database for disease codes	Parent
	DRUG_ADM.DBF	Database for drug administration	Transaction
	HLTHPROG.DBF	Database for health progress of patients	Transaction
	PATIENT.DBF	Database for patient personal & socio-medical histories	Parent
	PATNTDIS.DBF	Database for patient diseases	Transaction
	PHYSICIAN.DBF	Database for physicians and their codes	Parent
	PRESCRIP.DBF	Database for drug prescriptions	Transaction
	SIGNSYMP.DBF	Database for signs and symptoms of patient diseases	"
	TREATMEN.DBF	Database for drugs and their codes	Parent
	TRT_KIND.DBF	Database for treatment procedures used for treating a patient	Transaction
ADMISSIO.CAT	ADMISSN.DBF	Database for admitting wards	Transaction
	ADM_CAUS.DBF	Database for major causes of admission	"
	ADM_HIST.DBF	Database for admission history of patients	"
	DISEASE.DBF	*	
	PATIENT.DBF	*	
	PHYSICIAN.DBF	*	
	WARD.DBF	Database for type of wards	Parent
LABORATO.CAT	LAB_CODE.DBF	Database for laboratory test codes	Parent
	LAB_RESL.DBF	Database for laboratory test results	Transaction
	PATIENT.DBF	*	
	REPO_TEC.DBF	Database for lab result reporting technicians (kind of tests)	Transaction
	TECHNCAN.DBF	Database for technicians and their codes	Parent
HISTOPAT.CAT	HISTOPAT.DBF	A database for histopathology results	Transaction
	PATIENT.DBF	*	
	PHYSICIAN.DBF	*	
PHYSIOTH.CAT	PHYSIOTH.DBF	A database for physiotherapy results	Transaction
	PATIENT.DBF	*	

SURGERY.CAT	PATIENT.DBF	*	
	PATNTSUR	Database for surgeries done for patients	Transaction
	PHYSICAN.DBF	*	
	SURGEON.DBF	Database for attending surgeons during surgery of a patient	Transaction
	SURGERY.DBF	Database for surgery types and their codes	Parent
	SURGHIST.DBF	Database for surgical notes of surgeries done for patients	Transaction
HEALTHED.CAT	LESS_COD	Database for lesson types and their codes	Parents
	PATIENT	*	
	PAT_EDUC	Database for kind of lessons provided to patients	Transaction
	TEACHMET	Database for teaching methods employed to educate patients	"

* = indicates the file is being repeated in the corresponding catalogue file name.

5.5.2. Linking the Databases

To effectively track a patient over the course of multiple visits, there must be a 'glue data' (Wallace, 1994) that allows to link a patient's visit to the hospital over the course of multiple visits. For instance Mr. X's visit today must be linked with his visit a month or a year(s) ago. This means, need arises for having a common identifier, which would relate one record with the other. For this be possible a coding that represents common definitions of diagnosis, and definitions of medicine should be introduced. Thus, a number of different data coding standards are needed and these standards must be enforced. The issue to introduce medical code standards is discussed in the Coding Topic in this chapter.

Throughout the relational analysis discussed in the previous chapters, the concept of primary, and foreign keys have been emphasized. A primary key is the one which uniquely identifies one record occurrence from the other. For instance, the Patient ID is a primary key since no two patients can have the same Patient ID. By searching a value that matches the primary key, it is possible to link the multiple visits of a patient. More over, the fragmented databases which are generated as a result of normalization, have to be linked so as to provide a complete information from a number of files. One way of linking a number

of different files is through the foreign keys. A foreign key relates a record in a file with another record in another file.

The linking of the databases created using the dBASE IV linking facility in this study is shown Table 22.

Table 22: Linked Files

Link File Name	Description	File	Linked With	Linking Field	Link Num
PRESCRIP.QBE	Related files of drug prescription	PRESCRIP.DBF	PATIENT.DBF PHYSICAN.DBF TREATMEN.DBF	PAT_ID PHYS_CODE DRG_CODE	LINK1 LINK2 LINK3
COMPLNT.QBE	Related files of complaints	DIAGNOTE.DBF	PHYSICAN.DBF PATIENT.DBF	PHYS_CODE PAT_ID	LINK3 LINK1
		COMPLNT.DBF	DIAGNOTE.DBF	PAT_ID DATE_DX	LINK1 LINK2
SIGNSYMP.QBE	Related files of signs & symptoms	DIAGNOTE.DBF	PHYSICAN.DBF PATIENT.DBF	PHYS_CODE PAT_ID	LINK3 LINK1
		SIGNSYMP.DBF	DIAGNOTE.DBF	PAT_ID DATE_DX	LINK1 LINK2
PATDISEA.QBE	Related files of patient diseases	DIAGNOTE.DBF	PHYSICAN.DBF PATIENT.DBF	PHYS_CODE PAT_ID	LINK3 LINK1
		PATNTDIS.DBF	DIAGNOTE.DBF DISEASE.DBF	PAT_ID DATE_DX DIS_CODE	LINK1 LINK2 LINK4
ADMHIST.QBE	Related files of admission history	ADM_HIST.DBF	PATIENT.DBF PHYSICAN.DBF ADM_CAUS.DBF	PAT_ID PHYS_CODE DATE_ADMTD	LINK3 LINK1 LINK4
		ADM_CAUS.DBF	PATIENT.DBF DISEASE.DBF	PAT_ID DIS_CODE	LINK3 LINK2
ADMISSIO.QBE	Related files of patient ward location (admitting wards)	ADMISSN.DBF	WARD.DBF PATIENT.DBF	WARD_NO PAT_ID	LINK1 LINK2
LAB.QBE	Related files of lab test results	LAB_RESL.DBF	LAB_CODE.DBF PATIENT.DBF	TST_CODE PAT_ID	LINK1 LINK4
		REPO_TEC.DBF	LAB_RES.DBF	PAT_ID REPRTDATE	LINK4 LINK5
			LAB_CODE.DBF TECHNCAN.DBF	TST_KIND TECH_CODE	LINK2 LINK3
HISTOPAT.QBE	Histopathology related files	HISTOPAT.DBF	PATIENT.DBF PHYSICAN.DBF	PAT_ID PHYS_CODE	LINK1 LINK2

SURGERY.QBE	Related files of surgeries	PATNTSUR.DBF	PATIENT.DBF SURGERY.DBF	PAT_ID SURG_CODE	LINK1 LINK2
		SURGHIST.DBF	PATNTSUR.DBF	PAT_ID SUR_DATE	LINK1 LINK3
		SURGEON.DBF	PATNTSUR.DBF	PAT_ID SUR_DATE	LINK1 LINK3
			PHYSICAN.DBF	PHYS_CODE	LINK4
PHYSIOTH.QBE	Related files of physiotherapy	PHYSIOTH.DBF	PATIENT.DBF	PAT_ID	LINK1
EDUCATION.QBE	Related files of health education	TEACHMET.DBF	PATIENT.DBF	PAT_ID	LINK1
		PAT_EDUC.DBF	TEACHMET.DBF	PAT_ID DATE_LESSN	LINK1 LINK2
			LESS_COD.DBF	LESS_CODE	LINK3

5.6 USER INTERFACE

The user interface is extremely important to the goals of use and capturing of clinical information of leprosy patients. The system must be able to display a collection of integrated clinical information in a way that is easy to use and understand. The problem of capturing clinical information must be addressed. The clinician-computer interface is the problem to be faced in the system under consideration. Problems related to the physician such as dislike of key board data entry, difficulties in finding time to learn to use the system, reliance on dictation and hand writing notes are going to affect the implementation of the system. These problems can be alleviated, among other things, by building a usable human interfaces for information capture and retrieval. There must be models for the interface which are based on the way clinicians think and work. The following points should be considered.

1) Displays must be dynamic. The information presented must change immediately in response to types and values that are input.

2) There must be an easy way to "point" to the object of interest, to move it, and to act upon it with some tools. This requires a pointing device which is suitable for regular human use and which is integrated with the displays to make it obvious how to use with minimal training. The mouse/screen icon is one of the effective pointing devices which minimizes the need for typing and possibly mis-typing.

3) Very high resolution is needed to support a number of colors which makes it possible to differentiate and present multiple active windows of text, tabular and form-based information.

An important consideration in designing a user interface relates to how the application program appears on the screen and how one interacts with the system. There are three display components.

1) Windows: Information should be displayed through windows and sub-windows. Multiple sub-window types within a window should be supported.

2) Pop-up menus: Pop-up menus are used to access tool commands or display options. The advantage of using pop-up menu is that they standardize the way in which all commands are accessed while remaining invisible until needed.

3) Forms: A form provides a mechanism for data capture. Form items include fill-in blanks, choice lists (displayed through pop-up menus), and command keys which cause command execution when they are pointed at.

Based on these considerations a prototype application program is developed. The logic for designing a prototype is discussed in the following section while the necessary input and output forms are indicated in the subsequent sections.

5.6.1 Prototype System Development

In many parts of this thesis, the aim of this study has been stated to be development of a prototype information system for ALERT with emphasis on leprosy patients' record system. The hospital director had conceived a problem and was seeking assistance from an information professional. In attempting to understand and solve the problem, it has been found that the real requirements are too extensive and it was difficult to specify in advance all the requirements. Through discussions with the researcher about the difficulty in going for extensive systems, the director has been able to initiate a prototyping methodology with emphasis on leprosy. He has been able to articulate the basic needs about leprosy patients in terms of output from the system. The researcher of this study has taken the initiative to solve the problem and has planned to proceed by capturing an initial set of requirements and then look a means to demonstrate the actual implementation of the system to provide those requirements.

The researcher believes that the development of the information system should be an evolutionary process for it requires an extensive participation by all health personnel. Since prototype calls for a high user involvement, it would be possible to observe and understand the medical environment while working with the professionals. The strategy followed is that by examining the activities first, a simple and sketchy initial model, that contains only a few simple functions, should be built. By implementing a workable system, the complete

design process can, therefore, proceed step by step.

The prototype system is important in estimating the cost of developing a working prototype. It is also suitable for ease of change. As users are more involved in the design they raise additional requests. In such a situation, the changes required can be accommodated without much difficulty. The prototype is also important for speed of building a system that meets the requirement. But it is understood that it is incomplete. However, it is going to be modified later in line with the users's requirements.

The prototype application development taken by this study consists of two modules: the Registration and the Diagnosis & Treatment. With in the Registration module only the sub-process that is involved in registering a new patients is developed. Within the Diagnosis & Treatment also the sub-process Diagnosis is taken.

The source code for the application prorgram is provided in two floppy disks and is enclosed with the thesis. The one contans the program file while the other contains data files.

5.6.2. Description of the Application Program

The application program can be invoked at the dos prompt. Upon typing the executable file LEPRO, the program can be invoked and the wel-come menu appears in the screen. The user would be asked to enter his password that provides him access to the program. Upon entering a valid password and pressing <ENTER> the main menu would then appear in a second screen.

The application consists of fourteen main menus where users are required to press the first letter of the option or highlight and press <ENTER> key at the option they want to invoke. Each main menu can have a possible sub-menu(s) which requests users to narrow down their choice. Each sub-menu can also contain a further detailed sub-menu in which case the final operation is reached by going through a hierarchy of menus. Two menus are developed to demonstrate how the system operates. Due to the time constraint that the researcher had, however, the application designed does not demonstrate all the features described in the database design phase discussed in the previous chapter. Only sample features are taken for demonstration purposes. The complete application development will be done during the implementation phase, in which the researcher expects to act a vital role. The features of the two menus are described in the following sections.

5.6.2.1. The Patient Registration Main Menu

As a patient appears to the registration section, the registrar chooses this menu to register the patient's identification or check if there is any existing patient identification. After selecting the Registration menu, a sub menu is displayed to allow selection either to register a patient and/or to provide an appointment and allocation. Allocation refers to allocating a patient to a particular physician or clinic. At this second level detail, selecting the Register Patient option automatically opens the registration screen to handle the actual processing of data input.

Along side the registration screen, all possible options for adding, editing, listing, toggling between the specific record etc., are provided. The Find and Listing options have a sub-menu to allow the operator to narrow down his selection for specific record and range of

records respectively.

If a patient is a returning patient, he can be identified in one of three possible ways.

1) When registering the patient as new the system automatically detects and informs the registrar that a match is found.
2) Either the Patient ID is entered on the Find screen and a search is made for a match, or
3) The patient's name, father's name, and grand father's name is entered on the same screen .

Once information is entered in one of the three possible ways, the patient's complete identifying information will appear on the screen. The patient identification can, thus, be verified and updated by the registrar. To check if more than one match is found, a message will appear asking the registrar to search for more matches, at the bottom of the screen. If the patient is new, his identification is entered into the system.

However, when an entry of a patient name that is already in the file, but is misspelt, is attempted it cannot be detected. At this stage the system is designed to detect any name that exactly matches with the existing records. Since there is no standard way of recording a patient's name such kind of problem is to be faced. To avoid such problem a programme that detects names that have similar spellings should be introduced. The system should be programmed to estimate through pattern matching, and detect names with similar spellings and should ask which name was meant. Developing such kind of a program, would however, require a lot of efforts and could not be covered by this study. In alleviating this kind of problems some proposals are drawn to standardize data entry of names and minimize

errors by Hadera Abera (1995) (Unpublished Thesis). The same procedure can be followed when registering patients in ALERT.

The system produces an error message if an attempt is made to give any duplicate Patient ID number. It also produces individual help messages for each field telling the registrar what is to be entered in that field. The help message appears at the bottom of the screen. There is also some other error checking performed on most of the fields on the screen to reduce the amount of errors input to the databases.

The Count option counts the number of patients available in the database or on a specific date ranges. To know the number of patients registered on a specific date, the user would be prompted to specify the beginning and ending date required. If the date range entered is valid, the count would be displayed; for invalid dates the "NOT FOUND" message would appear.

5.6.2.2. The Diagnosis and Treatment Menu

This main menu consists of three sub-menus: The Diagnosis, Treatment, and the Exit to main menu options. During the patient-physician encounter, the physician or his assistant chooses the Diagnosis screen to see if there is any existing information on this patient and to add current diagnosis. If the patient is a repeat patient (i.e., returning for the same disease as before) the system automatically detects and informs the physician that the patient is returning for the same disease as before. It then asks for view of the date(s) visited for the same disease. In order to protect a duplicate entry of a disease in the same date, the system refuses to accept and produces an error message for duplicate data entry.

In general, when case records are being recorded, they are automatically verified. Each primary and associated records are examined for consistency and reasonableness and error messages are displayed.

Other important feature of this screen is that it contains a memo field which allows for free text entry of data when the physician feels unsatisfied in describing the patient's diagnosis using the standard fields.

To facilitate coding of diseases the system provides a quick online reference to the code file. An indexed disease code file is easily accessed by pressing F9 when opening the disease file. When invoked the disease code file appears in the screen and prompts to enter up to the first three characters of a disease name to see the code assigned to that disease.

The detail description and features of the two menus are indicated in the screen flow diagram to be shown in Section 5.6.4.

5.6.2.3. Sample Output of the Application

The system generates a summary of patient visits and diagnoses histories including complaints, signs and symptoms, and diagnoses notes. This report allows the physician to trace the patient's progress. For each date of visit the system generates information that does not other wise present; for example, the patient's age. The patient's age at diagnoses is calculated using the diagnosis date from the diagnosis file and the birth date from the patients identification file. The report can be produced in the screen or in printed form. An example of diagnoses history is Figure 18. All other sample outputs are shown in

Appendix IV.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
(ALERT)

Patient Identification		Patient Address	
Patient ID	:DL3294	Admin. Region	:Wollo
Name	:Abera	Farmer's Assn.	:Zuria Milash
Father's Name	:Alemu	Town	:Desie
Grand F.Name	:Desta	Woreda	:Desie Zuria
Date of Birth	:10/12/43	Kebele	:Argucho
Sex	:M	House No.	:-
Leprosy Patient	:Y		

Date Diagnosed	Age at Diagnosis	Attending Physician	Clinic	Disease Name
01/01/90	47	Dr. Solomon	New Case	BB Leprosy
15/09/92	49	Dr. Elsabeth	Red. Med	ENL Reaction
20/12/93	40	Dr. Tibebe	Diag.	ENL Reaction

Date Diagnosed	Diagnosis Notes
01/01/90	Appears unkempt, flat affect, little interest in surroundings, has rebuffed attempts to resocialize with Gac. May need to consider medication
15/09/92	Drug reaction. Reports rash after sulfla for UTI 2 years ago. Pencillin allerty reported ten years ago. Alchohol Abuse Can't seem to get through the day without a little 'Tella'. Reacts apathetically to suggestion.

Figure 18: Sample Clinical Summary Output

A major use of database is the generation of statistical reports that summarizes the information stored in the database. The system can produce, for instance, list of patients with various diseases over a specified period of time. Sample report is shown in Figure 19.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER FORM OF LEPROSY REPORT YEAR OF REPORT 1994			
FORM OF LEPROSY	MALE	FEMALE	TOTAL
I	2	1	3
TT	-	2	2
BT	1	1	2
LL	5	-	5
BL	2	2	4
TOTAL	10	6	16

Figure 19: A Sample Clinical Statistics

5.6.3. Forms Design

To interface a system with the external environment, input and output forms are an essential consideration in systems analysis. Forms are a means of communication and a means of structuring information. Forms can be made in printed forms or viewed on the screen. The type of forms established for the leprosy patient recording system include:

1) online data entry forms (OLDIF);

2) Online data output forms (OLDOF);

3) Printed data entry forms (PDEF) and

4) Printed data output forms (PDOF).

Actually, there is no need to prepare printed forms for online data input and output because they are available online in the computer system. But, they are designed and depicted together with the printed forms as part of documentation. Each form is assigned a form

number and a form type using the abbreviations indicated above. It is likely that the same form can serve as input and output. Whenever, a form serves both purposes, it is labelled with more than one form type.

The system is expected to operate online, capturing data direct from the patient-provider interactions and disseminating information back to users. Much of the system's data processing will involve displaying a form on the screen where a physician or his assistant are required to fill in the blank forms with transaction details. The forms are designed to allow entry of both structured and unstructured medical elements. The structured element refers to the coded data and standard field values while the unstructured one refers to the data elements (fields) designed to allow the entry of free texts. The purpose of including free text fields is that in case of explaining a patient's disease or treatment, the physician may not be satisfied with the content options that the coded as well as the other data elements provide. So, he may extend his explanation by adding notes in the free text fields. It is mandatory, however, to enter data in its coded format as well. Coding of the medical data elements is discussed in the next few topics.

The online format of each panel's field is specified in terms of alpha/numeric (where 'X' is used to indicate any character, '9' for numeric, 'DD/MM/YY' for date, 'MEMO' for blank windows to allow writing free text notes, 'L' for logical and 'A' for only alphabet) type character and length, together with allowable range of limits; input validation facilities (this is shown in the Data Item Description Table, Data Dictionary, and the validation facilities are to be contained within the internal system of the specific software); data entry facilitating options (shown in the screen design) such as the option to jump from one record to another; and many other message pairs including editing and deleting options. The input

validation facilities are to be checked by the processor. The input/output forms required are shown in Appendix IV.

5.6.4. Screen Design

Following is given the screen grid chart and screen flow diagram of the prototype system. The screen grid chart provide a complete description of the screen name and give reference **DFD DIAGRAM NUMBERS** to indicate the application of the screens in the identified processing events. The screen flow diagram indicates the logical relationship and physical flow of the screens.

validation facilities are to be checked by the processor. The input/output forms required are shown in Appendix IV.

5.6.4. Screen Design

Following is given the screen grid chart and screen flow diagram of the prototype system. The screen grid chart provide a complete description of the screen name and give reference **DFD DIAGRAM NUMBERS** to indicate the application of the screens in the identified processing events. The screen flow diagram indicates the logical relationship and physical flow of the screens.

Table 23: Screen Description Chart

SCREEN NO.	NAME	DESCRIPTION	DFD REF.
SCREEN 1	WL_COME	Wel-come display message	
SCREEN 2	PASSWORD1	Password Entry	
SCREEN 3	PASSWORDENIED	Invalid password display for level one password	
SCREEN 4	MAINMENU	The main menu screen with 12 options	
SCREEN 5	REGISTRATION	Registration main menu with three sub menus	Process 1
SCREEN 5.1	REGISTER_MN	Registration data entry form and option menus	Process 1
SCR. 5.1.1	R_ADDMENU	Registering new patient	Process 1.2
SCR. 5.1.1.1	R_DUPLICATE	Checking duplicate ID's	Process 1.1
SCR. 5.1.1.2	R_FORGOTTEN_ID	Checking ID empty record	"
SCR. 5.1.1.3	R_NAMESAKES	Checking duplicate registation	"
SCR. 5.1.1.4	R_NAMESAKE_DESP	First name sake display	"
SCR. 5.1.1.5	R_MORENAMESAKE	More name sake checking	"
SCR. 5.1.2	R_EDITMENU	Editing an existing patient details	"
SCR. 5.1.3	R_DELETE	Delete an existing patient details	"
SCR. 5.1.3.1	R_INVALID_ID	Invalid ID selected for deleting a patient record	"
SCR. 5.1.3.2	R_DELETESURE	Confirmation to delete the patient record just selected	"
SCR. 5.1.3.3	R_DELSTAT	Status of deletion. A request for patient	"
SCR. 5.1.4	R_FINDRECORD	An option to search a registered patient	"
SCR. 5.1.4.1	R_INVALIDSRCH	Message for invalid Patient ID selected for search	"
SCR. 5.1.4.2	R_VLDSEARCH	Display of patient detail for successfully searched Patient ID	"
SCR. 5.1.4.3	R_SEARCHOTHER	Message to search if other patient with identical name exists	"
SCR. 5.1.5	R_LSTRCRDS	Message to specify time ranges required to list patients registered	"

SCREEN No.	NAME	Description	DFD REF.
SCR. 5.1.5.1	R_LISTING	Listing option for patients registered during the date range specified	Process 1.1
SCR. 5.1.6	R_CNTRCRDS	An option to count the number of patients registered during a specified period of time.	"
SCR. 5.1.6.1	R_SHOWCNT	Display of number of patients registered during a spedified period	"
SCREEN 6	DIAGTRT	Diagnosis & treatment menu with three sub-menus	Process 2
SCREEN 6.0	DIAGMN	Diagnosis data entry form with option menus	"
SCREEN 6.1	D_ADD	Recording current diagnosis in Form N0.7	Process 2.2
SCREEN 6.1.1	D_CODLIST	List of disease codes invoked by pressing F9	"
SCREEN 6.1.2	D_DUPLICATE	Message indicating that a duplicate Patient ID & Date of Diagnosis being attempted	"
SCREEN 6.1.3	D_UNREGID	Message indicating that the Patient ID being attempted is not registered before.	"
SCREEN 6.1.4	D_FORGOTTEN_ID	Message indicating that the Patient ID is being over looked.	"
SCREEN 6.2	D_EDIT	Editing option for existing diagnosis record.	"
SCREEN 6.3	D_DELETE	Deleting option to erase an existing diagnosis record, asking to specify parameters required to search and delete the record.	"
SCREEN 6.3.1	D_INVALID	A message indicating for invalid parameters used in the attempt to delete a diagnosis record.	"
SCREEN 6.3.2	D_DELSURE	A message asking for confirmation to delete the specified record.	"
SCREEN 6.3.3	D_DELSTAT	Status of deletion. A requuest for patience.	"

SCREEN NO.	NAME	DESCRIPTION	DFD REF.
SCREEN 6.0	D_FIND	An option asking for parameters to search for a specific existing diagnosis records.	Process 2.5
Screen 6.4.1	D_INVLDSRCH	A message indicating the parameters used to search the record do not exist in the file.	"
SCREEN 6.4.2	D_RCRDFOUND	Display of the specific diagnosis records found.	"

Figure 20: SCREEN FLOW DSIGN

ALL AFRICA LEPROSY & REHABILITATION
TRAINING CENTER (ALERT)

WELCOME

TO

THE COMPUTERIZED

LEPROSY PATIENT DATA MANAGEMENT SYSTEM

< PRESS CR >

SCREEN 2: PASSWORD1

LEPROSY PATIENT RECORDING SYSTEM

YOUR PASSWORD PLEASE....

F1: HELP ESC:EXIT

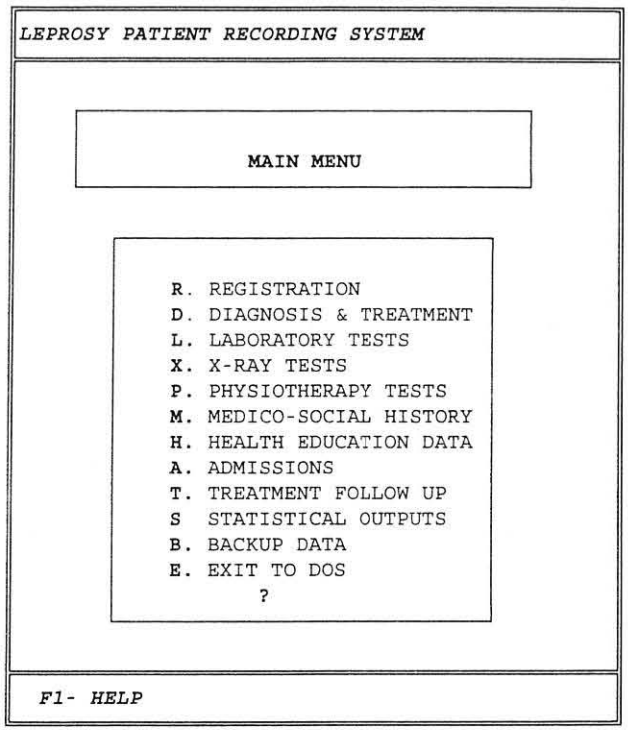
SCREEN 3: PASSWORDENIED

USER <P-WORD>

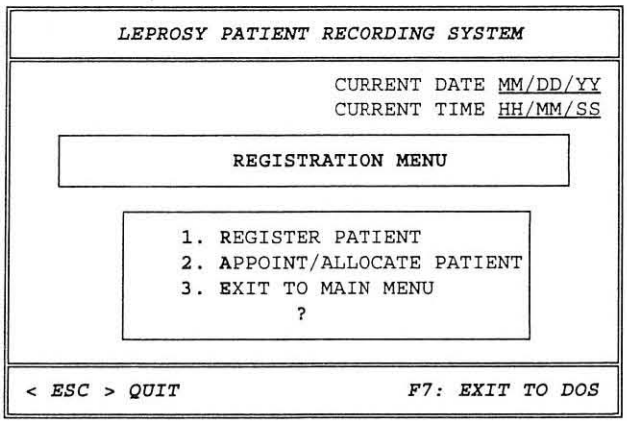
ACCESS DENIED

<DOS PROMPT>

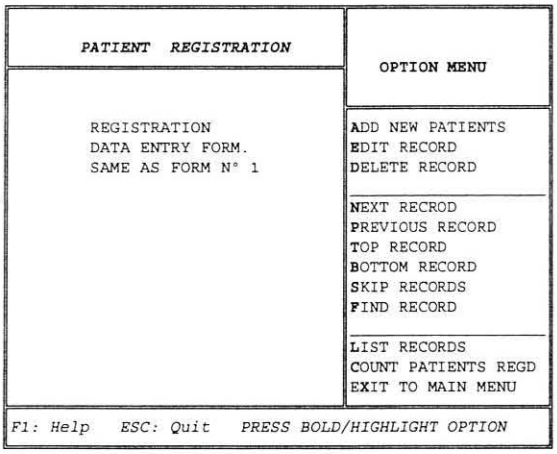
SCREEN 4: MAINMENU



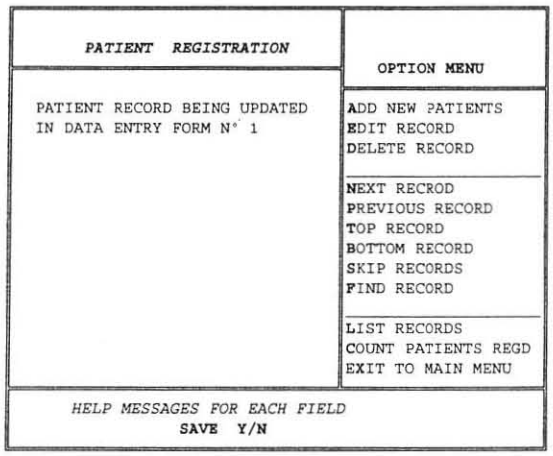
SCREEN 5: REGISTRATION MENU (REGST_MN)



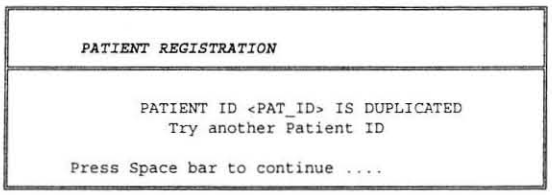
SCREEN 5.1: REGISTER PATIENT (REG-MN)



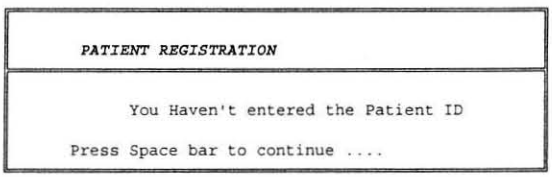
SCREEN 5.1.1: ADD OPTION MENU (R_ADDMENU)



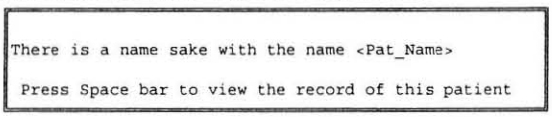
SCREEN 5.1.1.1: DUPLICATE ID FOUND (R_DUPLICATE)



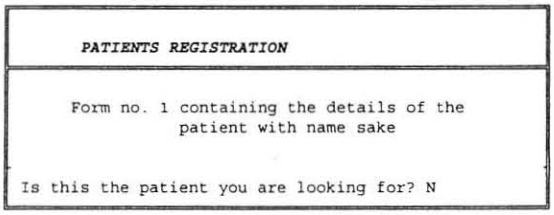
SCREEN 5.1.1.2: PATIENT ID OVER LOOKED (R_FORGOTTEN_ID)



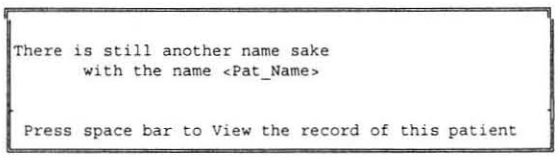
SCREEN 5.1.1.3: NAMESAKE FOUND (R_NAMESAKES)



SCREEN 5.1.1.4: NAMESAKE DISPLAY (R_NAMESAKE_DISP)

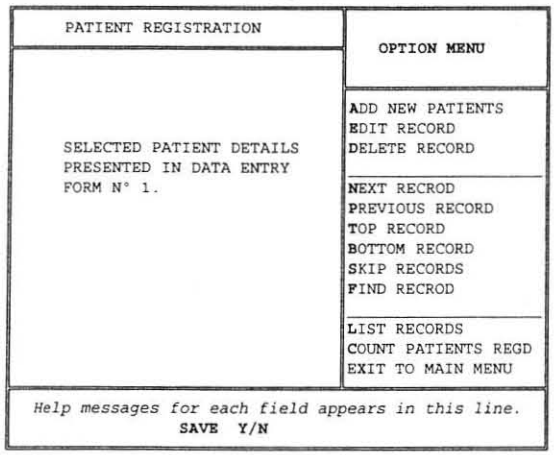


SCREEN 5.1.1.5: SEARCH FOR MORE NAME SAKES (R_MORENAMESAKE)



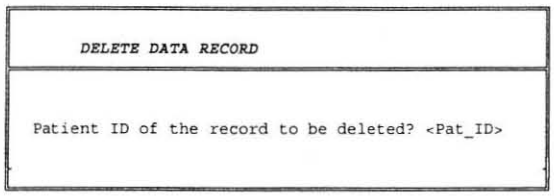
Then Screen 5.1.1.4 repeats. If the answer to the prompt is 'Y', the system will return to the option menu.

SCREEN 5.1.2: EDIT OPTION MENU (R_EDITMENU)

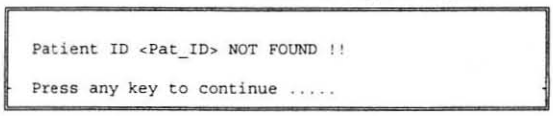


When editing, if errors found, the input validation messages indicated in the screen numbers 5.1.1.1 to 5.1.1.5 appear.

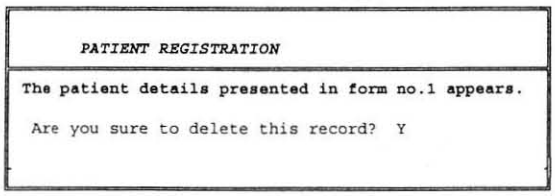
SCREEN 5.1.3: DELETE OPTION MENU (R_DELETE)



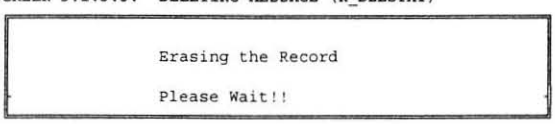
SCREEN 5.1.3.1: INVALID PATIENT ID (R_INVALID_ID)



SCREEN 5.1.3.2: DELETE REASSURING (R_DELSURE)



SCREEN 5.1.3.3: DELETING MESSAGE (R_DELSTAT)



The option menus NEXT RECORD, PREVIOUS RECORD, TOP RECORD, AND BOTTOM RECORD takes straight to the record indicated. In addition, the **SKIP RECORDS** prompts for the number of records required to be skipped. It gives an example as: **(Example: 15 or -5)?** It will then skip to the record located after skipping the number of records entered at the prompt.

SCREEN 5.1.4: FIND OPTION MENU (R_FINDRECORD)

```
                FIND DATA RECROD

                                    Patient ID:
        Patient Name:
       Father's Name:
 Grand Father's Name:
```

SCREEN 5.1.4.1: INVALID PATIENT ID (R_INVLDSRCH)

```
Record with target data was NOT found.
Press space bar to continue....
```

SCREEN 5.1.4.2: VALID PATIENT ID FOUND (R_VLDSRCH)

```
PATIENT REGISTRATION                    OPTION MENU

                                        ADD NEW PATIENTS
                                        EDIT RECORD
Successfully searched record            DELETE RECORD
detail appears in data entry            ____________________
form N° 1.                              NEXT RECROD
                                        PREVIOUS RECORD
                                        TOP RECORD
                                        BOTTOM RECORD
                                        SKIP RECORDS
                                        FIND RECORD
                                        ____________________
                                        LIST RECORDS
                                        COUNT PATIENTS REGD
                                        EXIT TO MAIN MENU
Edit this record?   N
```

SCREEN 5.1.4.3: SEARCH FOR ANOTHER NAMESAKE (R_SRCHOTHER)

```
PATIENT REGISTRATION                    OPTION MENU

                                        ADD NEW PATIENTS
                                        EDIT RECORD
Successfully searched record            DELETE RECORD
detail appears in data entry            ____________________
form N° 1.                              NEXT RECROD
                                        PREVIOUS RECORD
                                        TOP RECORD
                                        BOTTOM RECORD
                                        SKIP RECORDS
                                        FIND RECORD
                                        ____________________
                                        LIST RECORDS
                                        COUNT PATIENTS REGD
                                        EXIT TO MAIN MENU
Search a Namesake ?     Y
```

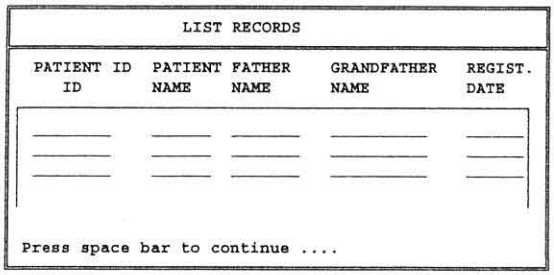
If the answer to the prompt in the status line is 'Y' Screen 5.1.4.2 appears. If 'N', search will not proceed any further and prompt returns to the option menu. Screen 5.1.4.2 and 5.1.4.3 repeat until all namesake searches are finished.

SCREEN 5.1.5: LIST OPTION (R_LSTRCRDS)

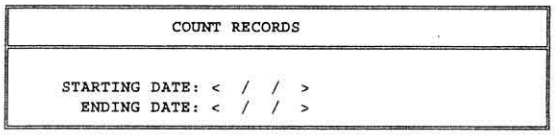
```
              LIST RECORDS
     PATIENTS DATABASE

  STARTING DATE: <  /  /  >
    ENDING DATE: <  /  /  >
```

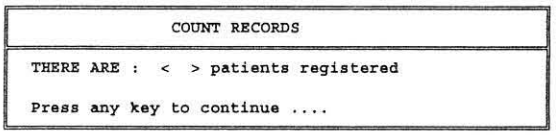
SCREEN 5.1.5.1: LISTING RECORDS (R_LISTING)



SCREEN 5.1.6: COUNT OPTION MENU (R_CNTRCRDS)

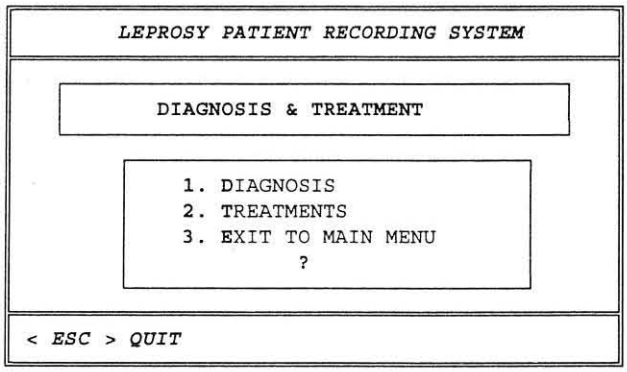


SCREEN 5.1.6.1: COUNT DISPLAY (R_SHOWCNT)

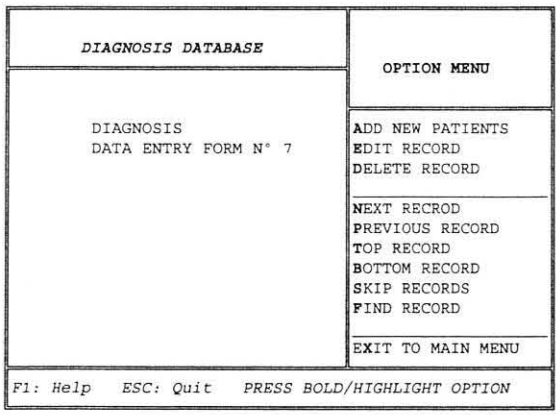


The last option menu 'Quit to MAIN MENU' exits to the main menu.

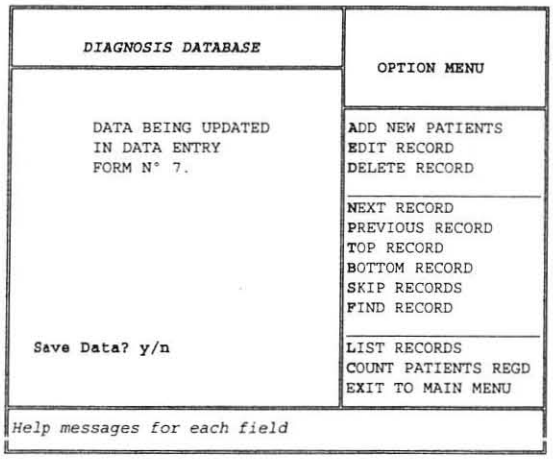
SCREEN 6: DIAGNOSIS & TREATMENT MENU (DIAGTRT)



SCREEN 6.0: DIAGNOSIS MENU (DIAGMN)



SCREEN 6.1: DIAGNOSIS ADD MENU (D_ADD)

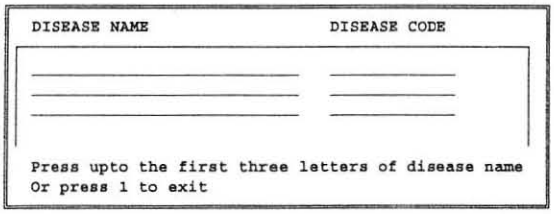


This menu automatically opens four empty database files to which data will be appended simultaneously. These files include, the DIAGNOTE.DBF (diagnosis notes file), the COMPLNT.DBF (complaints file), the SIGNSYMP.DBF (signs and symptoms file) and the PATNTDIS.DBF (patient diseases file) respectively. These files will be ready to append data in this order. For each record appended in each file, the 'Save data? y/n' option is prompted. Entering option 'Y' saves the data to disk and the system proceeds to the next database file in the order. While entering 'N' it immediately proceeds to the next database file with out saving.

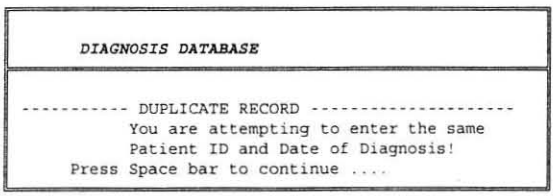
When the system is at the PATNTDIS.DBF a message 'press F9 to look up disease codes' blinks. Pressing F9 opens the Diseases file; the data: disease and their codes being indexed by disease name. By entering up to the first three characters of the disease name the system searches and lists all the disease names that begin with the three letters and the associated codes that is assigned to each disease name. This is to facilitate the searching of codes during data entry. That screen is shown below. The system jumps the two fields of the DIAGNOTE.DBF file when entering data in this file. These fields are the Complications

and the Diagnosis Notes. The reason is that both are not repeating fields. But the sequence of entering these data is after updating the complaints, signs and symptoms and diseases. However, the other fields of the DIAGNOTE.DBF file, i.e., the Patient ID, the Diagnosis Date, the Physician Code and Clinic are the first data items required to be appended before any data is entered in the other files.

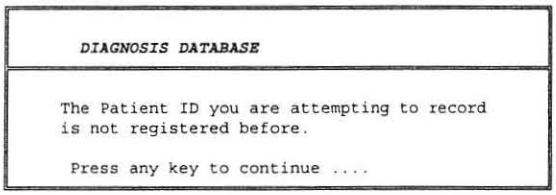
SCREEN 6.1.1: LISTING DISEASE CODES (D_CODLIST)



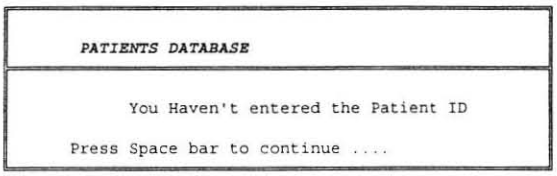
SCREEN 6.1.2: DUPLICATE CHECKING (D_DUPLICATE)



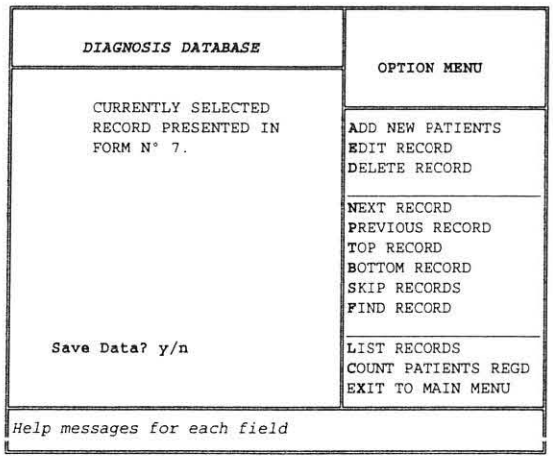
SCREEN 6.1.3 UNREGISTERD ID (D_UNREGID)



SCREEN 6.1.4: PATIENT ID OVERLOOKED (D_FORGOTTEN_ID)



SCREEN 6.2: EDIT OPTION (D_EDIT)

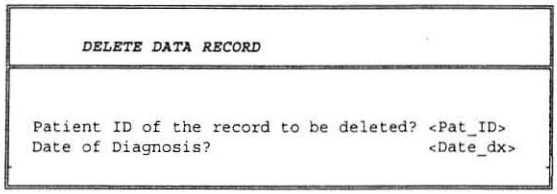


The moment this option is invoked, the message 'Press F5 to return to the option menu' appears so that if the editing is required to be aborted, pressing F5 jumps the system to the option menu.

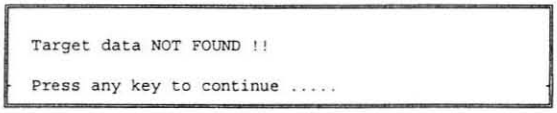
Like the Add Option, the Edit Option simultaneously opens four database files: the DIAGNOTE.DBF, the COMPLNT.DBF, the SIGNSYMP.DBF and the PATNTDIS.DBF respectively. The record selected using the Patient ID and Date of Diangosis will then be opened. At the end of editing the record, a prompt 'Save Data? Y/N' appears. Answering 'Y' permanently saves the data to disk and the system proceeds to the COMPLNT.DBF file; while answering 'N' instructs the system simply to proceed to the COMPLNT.DBF without saving. Records in the COMPLNT.DBF that have been selected using the Patient ID and Date of Diagnosis will be scanned according to the order they were entered during transaction updating. When the data for each record is updated the system will ask for saving. Entering 'Y' saves the edited record to disk; while 'N' leaves the record unedited and proceeds to the next record in the same file. The process of saving then repeats sequentially until the records under the same Patient ID and Date of Diagnosis are finished. When all records in the sequence are edited the system prompts indicating that 'There are

no more complaints' and asks 'Enter new complaints? y/n'. Replying 'Y' opens empty COMPLNT.DBF file for entry of more complaints; and replying 'N' instructs the system to proceed to the next database file, i.e., SINGSYMP.DBF. For each additional complaints entered the option 'Save data? Y/N' is prompted. When the business with the COMPLNT.DBF is over the system proceeds to the SIGNSYMP.DBF and the PATNTDIS.DBF files respectively to update the records contained in these files with the same process. When the system is at the PATNTDIS.DBF the message 'Press F9 to lookup disease codes' appears. This has already been discussed in Screen 6.1.

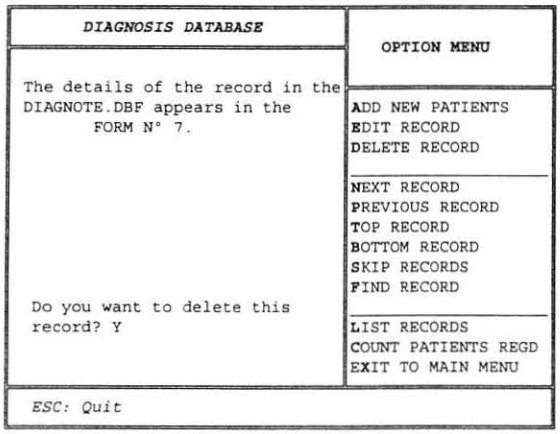
SCREEN 6.3 DELETE RECORD OPTION (D_DELETE)



SCREEN 6.3.1: INVALID REQUEST (D_INVALID)

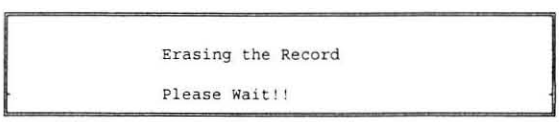


SCREEN 6.3.2: DELETE REASSURING (D_DELSURE)



When 'Y' is chosen the currently opened record will be deleted.

SCREEN 6.3.3: DELETING MESSAGE (D_DELSTAT)



After deleting the record in the DIAGNOTE.DBF, the system sequentially proceeds to the other files i.e., to the COMPLNT.DBF, the SIGNSYMP.DBF and the PATNTDIS. For each record in these files Screen 6.3.2 repeats and for each reply of 'Y' to the delete prompt, screen 6.3.3 repeats. If the reply to the delete prompt is 'N', it simply jumps to the next immediate record without deleting.

The option menus NEXT RECORD, PREVIOUS RECORD, TOP RECORD, AND BOTTOM RECORD takes straight to the record indicated by the choice. In addition, the **SKIP RECORDS** prompts for the number of records required to be skipped. It gives an example as: **(Example: 15 or -5)?** It will then skip to the record located after skipping the number of records entered at the prompt.

SCREEN 6.4: FIND RECORD OPTION (D_FIND)

```
FIND DATA RECORD

                                Patient ID: <Pat_ID>
Date of Diagnosis: <Date_Dx>
```

SCREEN 6.4.1: INVALID DATA (D_INVLDSRCH)

```
Record with target data was NOT found.
Press space bar to continue....
```

SCREEN 6.4.2 TARGET DATA FOUND (D_RCRDFOUND)

```
DIAGNOSIS DATABASE                    OPTION MENU

The details of the record in the      ADD NEW PATIENTS
DIAGNOTE.DBF appears.                 EDIT RECORD
                                      DELETE RECORD
                                      ---------------
                                      NEXT RECORD
                                      PREVIOUS RECORD
                                      TOP RECORD
                                      BOTTOM RECORD
                                      SKIP RECORDS
                                      FIND RECORD
                                      ---------------
   Press RETURN to continue...        EXIT TO MAIN MENU

F2: Diseases   F3: Signs & symp.   F4: Complanits
```

The details of diseases, signs & symptoms, and complaints can be displayed by pressing the

keys indicated in the status line.

5.6.5. Disk Storage Space Requirements

The type and number of databases required to establish a leprosy patient recording system has been indicated in the previous sections. In this section a rough estimation of the size and volume of transactions in respect of each of the databases are provided for the purpose of hardware and software environment. It facilitates the determination of the disk space requirements of data, memory requirements, and estimate the processor requirements to handle the processing of the transactions.

This account does not attempt to replace a detailed study to work out specifications in respect of disk space, memory and processing requirements; rather it attempts to provide the basis upon which such considerations will depend.

Attempts has been made to measure the volume and storage space requirements of the files over the last ten years as well as the growth over the coming five years are considered. Such duration has been selected for the reason that the management requires the conversion of the past ten years retrospective data on leprosy patients; and at the same time requires the proposed system to operate, without major change, in the coming five years planning period (1995-1999) of the organization. The long term planning period of ALERT is every five years period.

No significant growth rate are expected to take place in the coming five years. The analysis has taken the growth rate of the past ten years. The same average figure is expected to take

Database Name: COMPLNT.DBF Description : A file used to record patient complaints (contains a repeating data) Total number of leprosy patients in a year (ref DIAGNOTE.DBF) 18870 Average record per patient in a particular visit ..... X 3 Total number of records in this file ..... . 56,610 size per one record .... X 25 Total number of record sizes in this file.....—>	1,415,250	21,228,750
Database Name: PATNTDIS.DBF Description : A file to record the diseases of a patient (contains a repeating data) Total number of leprosy patients in a year (ref DIAGNOTE. DBF)..... 18870 Average number of diseases per patient per visit..... X 2 Total number of records in this file in a year..... 37740 Size per one record ..... X 108 Number of record sizes in this file.....—>	3,887,220	58,308,300
Database Name: Diseases Description : A list of Diseases and disease codes Number of records in this file. 1000 (estimation provided by the Hospital Director). The codes are sought to include general diseases other than leprosy. It will be used when diagnosing leprosy patients for other general diseases. Size per one record ..... X 25 Total Size of records in this file .....—>	25,000	25,000
Database Name: SIGNSYMP.DBF Description : A file to record the signs and symptoms observed on a patient.(contains a repeating data) Number of patients in a year (Ref. DIAGNOTE.DBF) ..... 18870 Average number of signs and symptoms per patient per visit..... X 4 Total number of records in this file in a year..... 75480 Size per one record..... X 25 Total number of record sizes .....—>	1,887,000	28,305,000
Database name: PRESCRIP.DBF Description : A file to record prescribed drugs for a patient (contains a repeating data) Number of patients in a year (Ref. DIAGNOTE.DBF) ..... 18870 Average drug prescription per patient per visit (including for general diseases) X 3 Total records in a year..... 56610 Size per record ..... X 45 Total size of records.....—> The average drug prescription is a rough estimation provided by physicians based on their experiences. Since most of the data important for this analysis are kept manually, it has been difficult to sort out and exactly determine the number of possible drugs prescribed for a patient.	2,547,450	38,211,750
Database Name: DRUG_ADM.DBF Description : A database for recording a controlled administration of drugs Number of leprosy patients under controlled drug administration, in a year, including new & repeat patients (1984-94 average) 400 Number of records, per follow up. (On the average a patient is provided two drugs twice a day for ninety days in a particular follow up (2 X 2 X 90) X 360 Number of records in a year..... 144000 Size per record ..... X 45 Total size of records ..... —>	6,480,000	97,200,000
Database Name: DRUGS Description : A list of drugs and their codes Number of kind of drugs in the Pharmacy (based on 1984 year end inventory) ..... 900 Average number of new type of drugs added every year (an estimation provided by the pharmacist)..... 27 Total number of records ..... 927 Size per record ..... X 27 Total size of records.....—>	25,029	36,864

Database Name: TRT_PROC.DBF Description : A file to record the treatment procedure prescribed for a patient Number of repeat and new patients who undergo a particular treatment procedures 400 Size per record..... X 47 Total size of records .....——>	18,800	282,000
Database Name: PHYSICIAN Description : A list of Physicians and Codes (only those with the responsibility to diagnose and prescribe treatment) Number of health providers who have been employed in the 1984..... 35 Number of incoming health providers every year (average of 1984-94)..... 4 Number of health providers in each year..... 39 Size per record..... . X 25 Total size of records .....——>	975	2,475
Database Name: HLTHPROG.DBF Description : A file to record the periodic evaluation of the health progress of a patient Average number of leprosy patients that have been evaluated each year (1984-94)' (only progress of the status of leprosy is evaluated)..... 400 Average number of evaluations per patient ..... 3 Total records in this file in a year ..... .1200 Size per record ..... .X 34 Total size of records .....——>	40,800	612,000
Database Name: LAB_CODE.DBF Description : A list of laboratory tests and their codes Number of Laboratory codes to be introduced ..... 215 Size per record ..... X 42 Total size of records.....——>	9030	9,030
Database Name: LAB_RESL.DBF Description : A file to record laboratory results of patients. Average number of kind of laboratory examinations done each year (1984-94) for leprosy patients only,..... 25000 Average number of specific tests (test codes) in each kind of laboratory examination ..... X 5 Total number of records for each year..... 125000 Size per record..... X 29 Total size of records.....——>	3,625,000	54,375,000
Database Name: REPO_TECH.DBF Description : A file to record kind of laboratory examinations vis-a-vis reporting technician Average number of kind of laboratory examinations (Ref. LAB_RESL.DBF)..... 25000 Size per record..... X 34 Total size of records .....——>	850,000	12,750,000
Database Name: TECHNCAN.DBF Description : A list of Technicians and their codes Number of Technician who have been employed in the 1984..... 25 Number of incoming Technician every year (average of 1984-94)..... . 5 Number of Technicians each year..... 30 Size per record..... X 35 Total size of records .....——>	1,050	3,675
Database Name: HISTOPAT.DBF Description : A file to record biopsy results of patients Average number of biopsy examinations done each year (1984 - 1994)..... 250 Size per record ..... X 288 Total size of records.....——>	72,000	1,080,000

Database Name: PHYSIOTH.DBF Description : A file to record sensation and muscle tests of patients. Average number of leprosy patients who had muscle and sensation tests done in a year (1984-94) (Ref. DIAGNOTE.DBF)..... 18870 Size per record ..... X 179 Total size of records ..... ——>	3,377,730	50,665,950
Database Name: ADM_HIST.DBF Description : A file to record the admission of history of a patient Average number of leprosy in-patients in a year (1984-94) ..... 1170 Size per record ..... X 68 Total size of records ..... ——>	79,560	1,193,400
Database Name: ADMISSN.DBF Description : A database to record the location and transfer of patients from a ward to another. Average number of leprosy in-patients in a year (1984-94)..... 1170 Average number of transfer of a patient from a ward to another in a particular admission ..... X 2 Total number of records in a year in this file ..... 2340 Size per record ..... X 34 Total size of records ..... ——>	79,560	1,193,400
Database Name: ADM_CAUS.DBF Description : A file to record the major diseases causing admission Total number of in-patients in a year (1984-94)..... 1170 Average number of diseases causing admission per patient ..... X 2 Total number of records in this file ..... 2340 Size per record ..... X 29 Total size of records ..... ——>	67,860	1,017,900
Database name: WARD.DBF Description : A list of Wards Number of wards..... 6 Size per record ..... X 14 Total size of records..... ——>	84	84
Database Name: PATNTSUR.DBF Description : A file to record surgical treatments for patients Average number of leprosy patients operated (1984-94) ..... 700 Size per record ..... X 21 Total size of records ..... ——>	14,700	220,500
Database Name: SURGHIST.DBF Description : A file to record a free text detail surgical history of a patient Average Number of leprosy patients operated (1984-94) ..... 700 Size per record ..... X115 Total size of records ..... ——>	80,500	1,207,500
Database Name: SURGERY.DBF Description : A list of surgeries and surgery codes Number of kind of surgeries ..... 50 Size per record ..... X 37 Total size of records ..... ——>	1850	1,850
Database Name: PAT_EDUC.DBF Description : A file to record the kind of lessons provided to a patient. Average number of new and repeat patients educated each year (1984-94)..... 700 Average number of sessions and lessons per patient (5 sessions, each with 5 lessons X 25 Total number of records in a year..... 17500 Size per record ..... X 19 Total size of records..... ——>	332,500	4,987,500

Database Name: LESS_COD.DBF Description : A list of lessons and their codes Number of kind of lessons routinely provided..... 50 Size per record ..... .X 14 Total size of records .....———>	700	700
Database Name: TEACHMET.DBF Description : A file to record the teaching methods used in educating patients Average Number of patients educated in a year (1984-94)..... 700 Average number of teaching methods used per patient..... X 3 Total number of records in a year..... 2100 Size per record ..... X 17 Total size of records .....—>	35700	535,500
		396,784,778

The size of records refers to the number of characters.

5.6.6. Coding

A code has a significant role in structuring clinical information recording. It makes easier to retrieve and summarize coded clinical data since related clinical entities can be readily linked and brought into broader groups.

A development of coding schema for symptoms, diagnosis, procedures and medications, however, requires a great deal of investigation. An encounter form with a checklist of the codes in sufficient detail to be useful would be too lengthy to fill out (Steinwachs, 1978). One alternative is to have a clerk code the data. This, however, has following problems.

1) It requires additional personnel; and
2) When the coded information is translated back into text and printed out on the form used at a patient's next visit, it may no longer be in a form useful to the physician.

Another alternative may be to have the computer translate what the physician has written, into coded form. However, the code translation table alone may require significant amount of disk storage and processor's time.

The third alternative is to introduce codes only for major and common medical elements which have statistical significance and storing them in a file. When need arises to enter a particular medical element during a patient visit, the physician or his assistant should refer to the code file and only the codes would be entered into the system. The system would, therefore, manage the linking of the codes with the codes files. The major limitation of this alternative is that it takes the time of the physician. However, as compared to the other two alternatives, this can have many advantages giving solution to the issue of coding. With a little time of experience and introducing some data entry facilitating techniques, the codding would become very familiar and easily manageable.

In any way possible this study emphasize the need to introduce coding to the major diseases, medications, lab tests, surgeries, etc. The coding will have a significant value when introduced in line with some internationally adopted standards. However, while a variety of coding schema for clinical information are available, such as ICD version 10, SNOMED, ICHHPC, etc., each is intended for a different purpose serving the specific needs of the developer institutions; and it may be too general or too detailed.

This study suggests the need for selecting and coding only the very common and major medical elements which have statistical significance; and introducing a combinations of the internationally accepted codes (such as ICD) and an in-house developed codes. Those medical elements which are represented in the International Classification of Diseases (ICD) should be coded accordingly; while those which are not, should be coded using in-house developed ones. The codes should then be distributed to all the medical people to keep uniformity in recording data; and they should be reviewed regularly by all concerned in order to add new ones and correct spelling errors or abbreviations. An example of coding

can be taken from the experiences of Ventura County (California) Medical Center. This is indicated in Table 25. That coding has been designed for structuring data entry for general medicine. A similar trend can be followed in coding the medical elements involved in leprosy diagnosis and treatment. But, the example given does not totally apply to the system under consideration.

In the computer implementation, codes established for each medical element can be stored in various files and accessed by pressing a key that invokes the required code file. Each code would be alphabetically indexed. The description of the code would then appear in the first column and its code in a second column. Upon pressing the first three letters of the required description, all possible range of descriptions whose first three letters are the same would be displayed. The appropriate option can, therefore, be selected by pressing an 'ENTER' key. In a situation where it is found difficult to introduce codes, data can be entered in their un coded format.

Upon establishing the coding system, a 'Code Library' or Directory that contains the full description and mnemonics of each and every data element including any other pertinent facts about the mnemonics should be prepared. This directory could serve as a printed reference manual. Of course, it should also be available in the computer system to facilitate data entry.

Table 25: General Medicine Codding Example

DIAGNOSIS AND MASTER PROBLEM LIST			
CODE	HEALTH PROBLEM	CODE	HEALTH PROBLEM
PREVENTIVE MEDICINE		SKIN	
BHTM3	IMMUNIZATION	DKLSHS	WARTS
BHZZI	HEALTH	GJCE1	BOIL/CELLULITIS
BHCN4	SURV.ADULT	GJBV7	IMPETIGO
BHNV1	WELL CHILD CK.	GHAW5	ECZEMA
BHPY4	PRENATAL VISIT	GHAQ1-B	CONTACT DERM.
BHCW5	POSTPARTIM CK.	GHAQ1-S	SEBORRHEIC DERM.
BHRL1	ORAL CONTRACEP. COUNSELING	GKNM1	PSORIASIS
		GLKG2	ACNE
		GHHD1	SEBACEOUS CYST
		GLBJ8	BRUISE/CONTUSION
ENDOCRINE/METAB		MUSCULOSKELETAL	
EHAT2	DIABETES	VJHW6	RHEUM. ARTHRITIS
EHCH9	HYPOTHYROIDISM	VJGC1	OSTEOARTHRITIS
EHCK6	HYPERTHYROIDISM	VLGJ1	SPRAIN/STRAIN
QLCD1	OBESITY	VRAR8	LOW BACK PAIN
CIRCULATORY SYSTEM		NON SPECIFIC DISORDER	
MLQMI	MI	JGBM3	DIZZINESS
MLPE4	ANGINA/CHR.IHD	MGAY1	CHEST PAIN
MLSN3	CHF	WLWG1	SYNCOPE
MHEN3	ATRIAL FIB/FLUTTER	QGCY2	NAUSEA/VOMITING
MHAB1	HYPERTENSTION	QGAE1	ABDOMINAL PAIN
MLGB2	MURMURS	GHZA3	RASH
NLPR2	CVA	CGDC2	WEIGHT LOSS
MLPG1	ASCVD	BLAC6-A	MALAISE/FATIGUE
NHDV1	PHLEBITIS/THROMB.		
NERVOUS SYSTEM		MENTAL DISORDER	
WGAQ1-B	TENSION H/A	YJXK1	ANEXIETY SYNDROME
WHAZ5	MIGRAINE	YJSN1	DEPRESSION
WHCE1	EPILEPSY	YHCJ1	ALCOHOL ABUSE

PROCEDURE AND LABORATORY TESTS

CODE	PROCEDURES	CODE	RADIOLOGY & OTHER TESTS	CODE	LAB ORDERED
RYNT4	AMINOCENTESIS	SNAD1	CHEST X-RAY	MNFK3	CHEM.PANEL
VYBF6	ARTHROCENTESIS	TNAW3	UPPER GI	CNAY1	ELECTROLYTES
CXKL6	CHEMOTHERAPY	TNBG7	GALL BADDER (OCG)	CNVJ6	GLUCOSE
SYBL4	CIRCUMCISION	TNAJ8	BARIUM ENEMA	MNAW8	CBC/DIFF.
RBAGQ	CONDYLOMATA Tx	TNXC6	IVP	MNKG3	SED. RATE
RXAC1	DIAPHRAGM INSERT			JNAL1	UA
MXAB2	EKG			CPEB8	LIPID PROFILE
RYGL4	CERV.CRYO/MEN.REG			CQWW6	THYROID PANEL
GYAR5	I&D ABCESS OF			CRTQ3	LIVER PANEL
RXAS3	IUD INSERTION			CNLA4	CREATININE
WYKJ7	LUMBAR PUNCTURE			CPVG2	BUN
QQAB7	PAP			DARQ4	DIG LEVEL
MYZJQ	PFT'S			CPSW2	THEOPHYLLINE LEVEL
RZABQ	SIGMOIDOSCOPY			MPEA2	PT
GYCE2	SKIN Bx			FPFK1	SERUM HCG
HXBF3	TONOMETRY			MMFZ2	SEROLOGY
SYHW1	VASECTOMY			TXRD3	STOOL FOR O & P

MEDICATIONS

CODE	MEDICATIONS	CODE	MEDICATIONS	CODE	MEDICATIONS
LSRS2	ACTIFED	TTKL3	DYAZIDE	TSNJ1	KCL 10%
MTJC1	ALDOMENT	YSJD2	ELAVIL	DVHHI	KWELL
LVAKI	AMINOPHYLLIN	DSBTI	ERYTHROMYCIN	TTGE1	LASIX
DSHBI	AMPICILLIN	FSBL6	FERROUS SULFATE	QSAK4	MAALOX
MTHX1	APRESOLINE	DVPY2	FLAGYL	DVTK4	MONISTAT CREAM
WSAY1	ASPIRIN	DSNTS	GANTANO	WSKX1	MOTRIN
LSGL1	BENADRYL	TTAK6	HYDROCHLOROTHIA	QSFX2	MYLANTA
DSTT6	CORTISPORIN OTIC	WSBS1	ZIDE	WSKK6	NAPROSYSN
YSFH8	DALMANE	WSLH5	INDERAL	NSFK1	NITROGLYCERINE
ESFH3	DIABINESE	ESAQ1	INDOCIN	DVMKS	NYSTATIN
MSCR1	DIGOXIN	ESCB1	INSULIN - REG	DSGW1	PENCILLIN
LSTB5	DIMETAPP	NSHW1	INSULIN - NPH ISORDIL	WSCJ1	PHEN VCACOD

SOURCE: IEEE 1985 COMPUTER APPLICATIONS IN MEDICAL CARE. PP9.

CHAPTER 6

IMPLEMENTATION OF THE PROPOSED SYSTEM

6.1 INTRODUCTION

Implementation of the proposed system actually depends on the final decision of the management body. This chapter gives some recommendations to implement the proposed system when the management of ALERT approves the actual realization of the system. Sections 6.1 through 6.5 recommends the possible technical pre-requisite conditions for implementing the system. In Section 6.7 a recommendation on the phases required for the actual implementation of the system is provided. Finally Section 6.8 discusses the changes to the existing organizational structure and the need to establish a new information unit with the responsibility to manage the information flow within ALERT. Some additional administrative requirements regarding to the training, conversion and administrative control are discussed in sections 6.9 to 6.11 respectively.

6.2. NETWORK DESIGN CONSIDERATIONS

One major component requiring a considerable attention lies in providing a complete and timely information to a health personnel is to establish a network to inter-connect the different databases produced and retrieved at different sections of the hospital; and buying and managing the hardware systems required to keep thousands of patient's clinical information for decades. Online data entry and dissemination has a significant role to have

a solution to many of the problems investigated by this stdy. In the previous chapters one major problem of the current system was indicated to be the redundancy in handling and manipulation of data. Such redundancy can be avoided by maintaining a common database that can be shared by all the sections of the hospital. Some of the elements of the database to be shared are the patient's personal and medico-social history. This database the one required by almost all the sections of the hospital. Likewise the lab test database is required by the Wards, Diagnostic Clinic, New Case Clinic, Red Medical Clinic, and Gate Clinic. Physicians require, at the laboratory section, a system that accepts requests from their point of duty station. They want that system to hold requests until specimens are collected, to inform the status of requests (drawn, accepted, or results completed). They want to access the laboratory database in real time. The laboratory section, on the other hand, requires the system to produce a print out of lists of test requests to keep track of a set of specimens and the day's work load as well. The clinical sections also require the sensation and muscle test databases. During the physician-patient encounter, almost all medical databases of a leprosy patient available at various sections are required to have been transferred automatically.

All these requirements can be efficiently fulfilled provided that there are computers, at the different location of the hospital, which are connected to each other by a communication network.

A network is a group of interconnected nodes, or workstations (Shepherd, 1990). Through a network it is possible to share computer resources such as printers, storage devices, programs etc. The workstation can be a micro-computer, or a mini-computer, or one of

several other computer devices. When the nodes are in close proximity, we call the network a Local Area Network (LAN). When the nodes are geographically diverse, it is a Wide Area Network (WAN). There are different possible physical arrangement of the nodes, called a topology. The possible topologies are ring, bus and star topologies. The technical specifications involved, and the relative advantages of different architectural alternatives of the network have to be considered. Involvement of technical consultants is an absolute necessity for efficient and better architectural and technical design of a network.

This study suggests a micro-computer based Local Area Network to implement the information system under study. The detailed technical specifications involved in networking is beyond the scope of this study. The LAN has a considerable advantage in sharing data and it is economically cost effective. The integrated system that the LAN supports is less expensive than the mainframe. Moreover, as systems become obsolete or other new systems are installed, the old system can be replaced or upgraded at a less expense. It is to be remembered that the long term requirement of the management of ALERT is to establish an overall hospital information system that would also include data about non-leprosy patients, pharmacy, and some other systems in other sections. In this situation the LAN is more flexible to allow to be expanded or rearranged easily when adding systems according to the hospital needs.

6.3. DISTRIBUTION OF DATA WITHIN THE NETWORK

The need for networking of the multiple databases designed has been discussed. One important issue worth considering about the multiple databases relates to the control of data processing and data management. There are two alternatives of this issue.

1) Establishing a central databases where all the data will reside only at a central information unit.

2) Development of distributed databases where the different sections of the hospital will have their own data and sharing to other sections whenever necessary. For dissemination and analysis purposes, however, data can be aggregated at the central information unit. This requires a package that can handle the processes involved in distributed databases.

Of these two alternatives, the distributed database design represents a significant challenge in the information system under consideration. Maintaining organization's database in a number of processing locations and inter-connecting each processing systems for the sake of sharing data makes the task complex, but of course, yielding a much better benefit.

The question of storing data in a distributed database is normally viewed from minimizing communication requirements and maintaining adequate control and security within the network. (Brooks, et al,1982). In a distributed database management system (DDBMS) there would be a collection of data stored in different inter-connected computers which would be located at different sections. Where each section needs to examine or share data of other sections, it can access it through the communication network.

In a distributed database environment, different sections can use heterogenous database management systems which can use different processors, different hardware configurations and different topologies of a network. The distributed database management can handle and manage the operation of heterogenous systems through the system of partitioning and replicating data to different sections. These are the two methods of distributing a database. Partitioning is where selected portions of a single database reside at different sections while replication is where data would be knowingly duplicated to different sections in an effort to get it as close to the end user as possible, and retaining additional copies at the central unit, when necessary. (Shepherd, 1990).

In an effort to reduce the complexities in a heterogeneous environment, most vendors of distributed database management system (DDBMS) advocate the use of SQL based products so that different sections can communicate with each other using a common language (Shepherd, 1990).

The consideration of a distributed database system has a significant importance on the system taken by this study. It is likely that for the laboratory section, a specially designed software for laboratories can be selected. The same can be true for the Pharmacy. For all other clinical sections of the hospital, a different software and hardware configuration can be suited. The study group on the hardware and software can come up with the need for a heterogeneous systems. In such a situation, therefore, the need for a distributed database becomes evident. The heterogenous systems, when introduced, would then require a common language which makes possible managing the distributed databases.

6.4. ADVANTAGES OF DISTRIBUTED DATABASE

With a DDBMS, data will be located as close as to the end user. The costs and response times associated with data communications, when compared with the centralized DBMS, is too minimal. The delays in waiting for response from a central node is quite less with DDBMS because the requested data is to be placed at the local node. Data can thus, be efficiently processed.

Since operations do not depend on any one particular system, if one node fails to operate, the remaining ones can proceed. More over, when each section is responsible to maintain its own data worries about security are reduced and users can retain a sense of ownership. However, the distributed database requires more sophisticated concurrency control, replication control, and recovery procedures. These disadvantages can be offset by the benefit derived out by having data closer to its users, more efficient processing and increased reliability.

In contrast, the advantages of the centralized system are:

1) Lower cost of operation
2) Economies of scale in hardware purchases
3) Compatibility of hardware and software
4) Relatively easy intra-file communication since all data are held under the control of one system.

In light of the trend in the fall of prices of computer facilities, however, the cost related

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4) Relatively easy intra-file communication since all data are held under the control of one system.

In light of the trend in the fall of prices of computer facilities, however, the cost related

advantages may not have a significant consideration in the evaluation of the two alternatives. The main point of evaluation should, therefore, be the system's performance. In the medical environment, where every day there are a number of suffering patients are seeking for immediate help, any kind of delay in the provision of the health care cannot be tolerated. Specially any delay due to inefficient arrangement of computer based systems has every possibility to be rejected. Like any other environments, a computer based system is affected by user resistance in the medical environment. The same can also be true for ALERT. The daily volume of patient transactions of the different sections is too high. All the health providers would like to provide the required medical services as soon as possible. To do so, they require the patient information to be available as soon as possible. So, the response time in accessing a database is critical in the environment in which the system is to operate.

So, in light of:

1) The volume of daily transactions,

2) the advantages that a distributed system has in reducing communication requirements, and

3) Keeping the system operational in the medical environment, the distributed database structure is proposed for the system under study.

6.5. HARDWARE REQUIREMENTS

The hardware specification required for the system is beyond the scope of the study. However, some general issues that should be considered in the hardware selection would be elaborated in this section. The availability of numerous hardware in the market calls for technical people who can evaluate between different alternative hardware components

and vendors. Hardware selection should be carried out as a project, to be undertaken by a group of technical people, information unit personnel, and management body who have the upper hand in the commitment and release of funds for the investment. The project should involve the evaluation of alternative hardware components and the different vendors who can provide the hardware. Computer hardware must be compared in terms of capability, capacity, reliability, cost and compatibility. Capability refers to the performance of the computer for the intended purpose. Capacity is measured in terms of the number of transactions that can be processed for a given period of time. Reliability refers to the frequency of technical failures, including damage from heat, water, fire and other physical damages. In this consideration every possibility to guarantee a continued operation of the system must be addressed. A technical failure that stops operation even for a single day cannot be tolerated. Because of technical failures, the daily treatment schedules of patients cannot be postponed. So, in the hardware selection the possibility that, in case of one computer fails, other computers remain operational providing the usual data should be assured. Cost pertains to the original cost, operating cost, maintenance cost and cost of utilities such as electric power, stationeries etc. Other important aspect refers to compatibility. The status of the hardware being compatible one with the other, as use expands and additional hardware are included, should be considered. To avoid the incompatibility problems a policy on use of limited hardware, software and vendor options should be set. In general, the hardware to be selected should provide the possibility to add capacity to main memory, to change disk storage units, to change communication network hardware, and to replace any of the low speed parts with high speed one, when the need dictates.

6.6 DATA ENTRY

One problem that can be perceived in the implementation task is with regard to how data should be entered into the system just proposed. There are two alternatives. In One alternative a physician, himself or by dictating his assistant, would enter data in its structured and possibly in its unstructured form (when necessary). The second alternative is to let a physician or his assistant enter the medical data in its usual free form (the manual system) containing narrative statements and a copy be sent to a data entry operator who abstracts and codifies only the pertinent and desired information, such as chief complaints, diagnosis, procedures, medications, etc., and finally enters it into the system.

The first alternative has the advantage to store and retrieve complete medical history in a computer based system; because all structured and unstructured data would be entered into the system; and taking the advantage of the benefits of computerized information, it would be possible to manipulate and summarize even the unstructured data in different forms required by users. This alternative, however, may consume the physician's time in searching the codes. Physicians may also feel dealing with duplicate jobs when some of the data entered in the structured data elements need to be re-written when entering a free text medical notes that may be extended to describe more about a medical history.

There are many disadvantages with the second alternative. These are:

1) The alternative allows the manual system to go along with the computer based system: a task entailing a duplicate effort. In such a situation it is not wise to keep the same data in two different systems. That would be wastage of resources.

2) It requires additional data entry operators.

3) Since only abstracts of the physician's clinical notes are to be entered into the system, it would be difficult to manipulate and provide a complete information from that system when need arises.

4) As we have discussed in Section 5.4.6, the data could not be codified to a significant degree as required by a physician.

It is recommended, therefore, that the first alternative be selected to implement the system under consideration. The disadvantage that, it consumes time when searching a code would, only be a short run problem. With some period of experience, the physician and his assistant can learn the most common codes and the data entry time may not be a worrying factor. Besides, some data entry facilitating techniques to the structured data elements can be introduced to the system. For instance, by assigning possible values to some of the structured data elements, the system can be programmed to give choices which are to be selected and entered by pressing a single key.

Until the system is well developed and proved to be successful, however, a parallel run of both the manual and computer based system is essential. Some ideas mentioned in alternative two can be helpful for starting the system. To begin the system it is essential first to enter data by abstracting only the pertinent and necessary information from the existing patient cards. With regard to the data operating personnel, it is recommended that the health assistants, ward clerks, laboratory clerks, registration clerks and other section's clerks in ALERT be adequately trained on the operation of the system. The entry of the abstracts of the narrative medical data can be done every afternoons because the health

assistants are less busy and sometimes free. After running the system becomes successful, alternative number one should be fully implemented.

6.7 RECOMMENDATIONS FOR IMPLEMENTATION OF THE SYSTEM

The development plan for the actual implementation of the proposed system is recommended to proceed in the following phases.

Phase 1

1) The application program for which a prototype of two modules are demonstrated should be upgraded using the same or other appropriate software and should be extended to include other remaining modules. It has to be noted that the prototype application program developed using the dBASE IV by this study is just to demonstrate how the system should operate and what it should include in meeting the requirements in facilitating data entry, in retrieving a summarized patient data and manipulating statistical information. However, It be taken as a possible candidate to all other alternatives that the technical group might come up with.

2) After enhancing the prototype, sample data should be entered into the system following the proposals mentioned in Section 6.5. A seminar should then be held to introduce the general and detailed benefit of the computer based system; what the system can do; and how it can meet the requirements; to physicians, the management body and other health personnel. The seminar should be supported with an introductory demonstration.

3) Identification and specification of the hardware and software as well as net work capabilities should be carried out.

4) Vendor relationships for information and support should be established.

5) The required software and hardware should be Acquired and installed.

6) Development of a demonstration to provide concrete example of what the system is trying to accomplish so that user involvement could progress is also necessary. The demonstration should be carried out through actual use of the facilities. Vendor relationship would have a significant role in supporting the demonstration.

7) Development of a "pilot" system. For the purpose of evaluation and validation of requirements an actual use should preferably be demonstrated in the Gate Clinic, because it would be a representative unit.

8) Based on the evaluation, an enhanced and modified "pilot" system should be proliferated to other units for a wider feedback. Requirements for additional functionality could be determined and the target system could then be developed.

9) Development and full proliferation of target system.

Phase 2

To come up with a complete hospital information system for ALERT a similar procedure of systems analysis and design should be carried out for the pharmacy, hospital administrative systems such as scheduling the daily health personnel on duty as well as a

system for recording of patient data other than leprosy. This refers to skin patients, ophthalmic patients, other general medical diseases, and TB patients.

Phase 3

In phase three the information system design should be extended to include divisions other than the hospital. These divisions include the Training, the ALC and the Administration preferably with the priority of the ALC, Training and Administration respectively. All the systems should then be integrated to form a computer based information support system for ALERT.

6.8. ORGANIZATIONAL SETTING REQUIREMENTS

6.8.1. Changes to Out-Patient Section

The proposed system requires some changes to be made in the organizational structure of some unit of the Hospital Division of ALERT. One of the major changes relates to the arrangement of the clinical sections involved in the diagnosis and treatment of leprosy out-patients. In the current system when a leprosy patient is detected at the Diagnostic Clinic, this section will direct the patient to the New Case Clinic. The New Case Clinic, after prescribing a necessary treatment procedures, will direct the patient to the Gate Clinic for out-patient follow up or to the Red Medical Clinic for in-patient follow up. When the patient is a relapse case, he should sometimes appear to the OPD (Sick Out Clinic) and some times also to the Red Medical Clinic to continue out-patient treatment. Previously,

relapse cases were taken care of by the Gate Clinic. From 1990 to the middle of 1991, the Gate Clinic was assigned to care for both new cases as well as relapse cases and sometimes reactions cases as well. Beginning the middle of 1991 to the end of 1992, the Red Medical Clinic was assigned to care for out-patient relapse and reaction cases in addition to the routine care for in-patients. Currently, i.e., since July 1994, the OPD (Sick Out Clinic) is assigned to care for the relapse cases.

The researcher of this study has observed that there is no clear and a stable structure of these sections. As a result of many similar clinical sections involved in the diagnosis and treatment of the same group of patients (leprosy out-patients), the information about these patients is scattered and redundantly kept in these sections. So, the proposed system requires the different units involved in caring for new, relapse and reaction out-patient cases be brought together to close proximity so that the same information could be captured and held at one central site. Like the Ophthalmology section which is recently structured to be self contained in the diagnosis and treatment of all kinds of ophthalmic patients, it is proposed that the diagnosis and treatment of all kinds of leprosy out-patients (new case, relapse, and reactions cases), which is now being distributed to the Diagnostic, New Case, Red Medical and the Gate Clinic, should be the responsibility of one section.

The researcher of this study suggests:

1) the structure and functions of the Gate Clinic be upgraded to care for leprosy out-patients of all kind (new case, relapse and reaction. It has been selected for the fact that it is the section under which the final result of prolonged treatments and the health progress of leprosy out-patients could be followed up. Information about the effectiveness of

treatment measures, the complications, and adverse reactions is held in this unit. The infrastructural set up of this section is also suitable to accommodate the proposed integration.

So, when leprosy patients are detected at the Diagnostic Clinic, they have to be immediately sent to this Clinic and all information from the day they have been detected to the date of release from treatment should be kept in this section.

2) the Red Medical should be located to one of the Wards and should care for only in-patients.
3) the Diagnostic Clinic should continue to care for skin diseases but when it suspects a patient to be a leprosy patient it has to send him to the Gate Clinic immediately.
4) The New Case Clinic should be merged with the Gate Clinic
5) the OPD should continue to care for other general diseases only.

This proposal in structural change does not affect the human aspect. In only requires bringing up the health providers into a close relationship.

This set up reduces the costs involved in communication networks; for all the data required about a leprosy out-patients could now be available in one central unit;

6.8.2 Changes to the Statistics Section

Some changes are also required in the Statistics Section. It has been indicated that the services provided by this unit are quite unsatisfactory. Almost all users, who need statistical reports, indicated that even they do not know the kind of reports produced in this section. As a result, each section or individual is producing its or his own statistical reports. The main services that this section provides are directed to the Ministry of Health (MOH). However, the data that this section provides are not quite reliable. Therefore, the improved system stipulates that this unit be closed down and the two staff working in this section be shifted to the new proposed information unit after providing adequate computer training. A proposal for new information unit is discussed in the following sub section.

6.8.3. An Information Unit

The third change relates to the creation of a new information unit. Each of the activities involved in the flow of information has to be organized and coordinated. An information unit that manages data in the organization's databases in such a way as to make it widely available through out the organization and assists end users acquire and develop their own computing systems, has to be established. More over, in order to apply information resources for their ad-hoc problems, end users require appropriate hardware, software, training and consultation. Some of the typical software that would be required by users include query software to answer non-routine information requests; graphics software to display data in graphic formats; report generator software in order to produce customized reports easily; word processor in order to store, retrieve and print text documents etc.

Users need a technical assistance and training in using these software and in writing computer instructions in a 4GL language so that they can retrieve information to satisfy their ad-hoc queries. They also need assistance on how to access databases and other administrative supports with various computing procedures. An information unit has a significant role in the provision of these supports. It also plays an important role in the acquisition of computers, software, access to communication networks, and in identifying the need for development of application systems and in requirement studies. Therefore, an information unit with the responsibilities to provide the services mentioned above should be established in ALERT.

6.8.4. Organization of the Information Unit

There are many alternatives in the organizational set up of an information unit. These are functional, product and matrix (Davis, 1988). The product form is applied in product oriented organizations such as big super markets with the divisions like food products, clothing and cosmetics. Each division can have its own information center which is responsible to the product division manager. The matrix is the same as product form i.e., the information unit is distributed among different organizational units and reports to the divisional manager, but reports to a central information unit in the matter of technical direction, coordinations and standardization etc. The most common organizational structure of information units is a functional organization where personnel of the unit are grouped by the functions they perform such as programmers, systems analysts, communication network specialists and possibly maintenance personnel. A functional organization has the advantage in developing specialization. Specialization is important for training and maintaining

technical competence. Based on this, a functional organizational structure is proposed. The proposal is based on the need for establishing organization wide hospital information system that includes not only leprosy patients but also other non-leprosy patients. In the previous sections it has been discussed that this study has focused on leprosy patients based on the priority set by the hospital director. But the overall requirement of the management is to establish organization wide information system. So, in light of this requirement and the economic considerations, the following set up of the information unit is proposed.

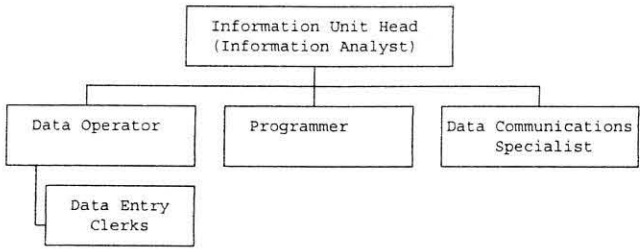

Figure 22: Proposed Organizational Setting of the Information Unit

Information Unit Head: This is the post for a professional who, in addition to managerial activities of planning, coordinating, and controlling, can work with users to define information requirements, and design computer based processing system such as database design, program specifications etc. This post requires ability to work with people and understanding of organization, management and decision making functions; and to have more analytical knowledge than technical skills. The head should also be responsible to provide guidance and training to users in solving user defined problems, particularly using personal computers and 4GL.

Programmer: This post requires a professional who designs, codes, and tests programs based on specifications from the information analyst; and works on the maintenance such as repairs and enhancements.

Data Communications Specialist: This post requires a expertise in the design of data communications hardware and software and distributed database processing.

Data Operator: This post requires a computer equipment operator who coordinates and controls data entry clerks, checks controls on processing and distributes output to authorized users. An important task to this post relates to establishing system security and backup procedures and investigating security violations.

Data Entry Clerks: In section 6.5 the possibility of data being entered by the physician or by the health assistants has been noted. The idea now is that these health assistants can serve as a data entry clerks. In the current system, the health assistants play the role of data entry operators. They record the patient data in the patient card based on the dictation of the physician. This study, thus, recommend that there would be no need for new data entry operators. Not withstanding that their aim is to serve the physicians, some selected health assistants can be assigned as data entry operators reporting to the information unit. But, they should be properly trained on entering data online at their workstation. These clerks can be selected from the existing health assistants, ward clerks, laboratory clerks and other clerks found in the different units of the hospital.

The information unit should be functionally organized reporting to the Executive Director.

The executive director wants the unit to be expanded in the long run to include an information support to the Training and ALC divisions.

Taking into account the necessary changes and requirements discussed, the overall organizational structure need to have the following shape. Ref. Figure 21.

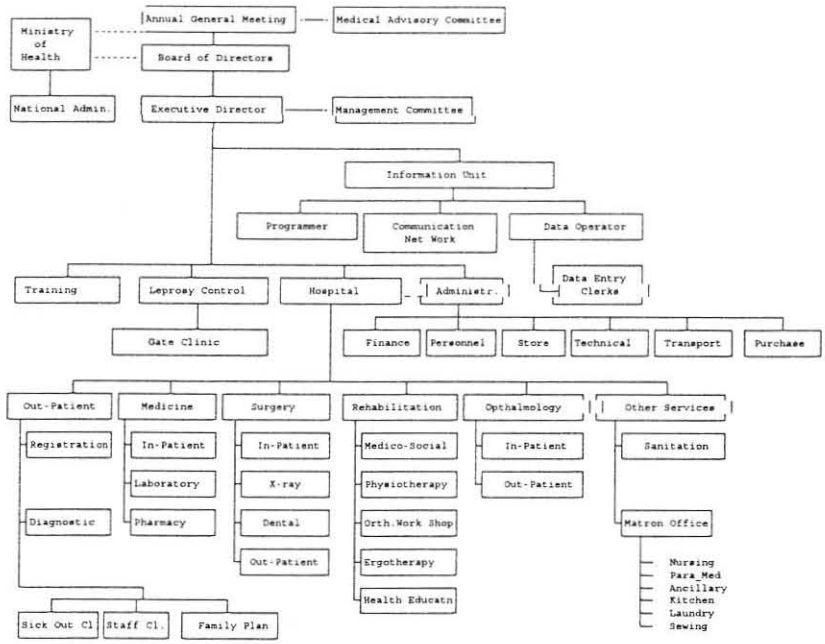

Figure : Proposed Organization chart of ALERT

6.9. TRAINING

The training of the medical staff to be involved in the operation of the computer based system has to be carefully planned. The health assistants, the clerks in the Ward, Laboratory, and Registration including the physicians have to be taught how to enter medical histories such as complaints, signs and symptoms, diseases, prescriptions, laboratory requests, admissions, discharges etc. In addition physicians and other authorized personnel who can access a database have to be taught how to access a database, how to

view a required information, and how to create ah-hoc query formats using high level languages. One important point worth considering is that as soon as the required personnel are trained they have to start the operation immediately. The training should be carried out towards the end of the implementation phase. A gap between the training and actual implementation of the system usually leads to forgetting the training provided. This would entail additional costs and energy in conducting a refreshing training sessions and above all users may be reluctant and unwilling for re-training. Specially, in the medical environment this issue is very sensitive. Medical personnel are the most busy persons who always give more attention to the treatment of patients than to any other administrative activities. Any request for re-training has every possibility of being rejected. So, care should be taken in the scheduling of the training programme and the implementation of the actual system.

6.10 CONVERSION

Conversion is the process of changing the manual system into the computer based system. In section 5.4.5 the need for ten years data conversion was discussed. The conversion requires a plan and description of all the activities that must be performed to convert the system. The staff to be involved in each activity, the number and cost of additional task force required for conversion and the time table of each activity has to be predetermined. After proper planning the conversion of the retrospective data should be assigned to a task force in a separate session.

Along side the conversion of the retrospective data, the adoption of the proposed system for the automable part of the current operations should be carried out altogether. However, the

manual system should also be run in parallel for a reasonable period of time. These would enable to get greatest security when errors are found in the proposed computer based system. The period of time that the manual system should operate with the proposed system in parallel should be kept as short as possible since double operating costs are occurring while running two similar systems at the same time.

6.11 ADMINISTRATIVE CONTROL

Administrative control refers to the control required in the day-to-day running of the computer based system. Among other things, it consists of back-up facilities, file storage control, control over access to the database.

To protect the disaster of files and programs caused by any event, backup facilities should be provided on specific dates, preferably every day. The system must also allow to take an automatic timed back-up so that any loss of data during transaction processing can be protected. The back-up objectives can be achieved by keeping copies of data files and programs in a safe place and in such a way that they can be reconstructed when necessary.

File storage control refers to the storage of infrequently used files in a library and limits the access to these files. Entry to this library should be controlled so that unauthorized personnel cannot access the files.

The control over access to the databases has been discussed in the Section 5.2.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION

The focus of this study was on introducing computer based systems that would support in the delivery and administration of health care. Attempts have been made to introduce a more flexible system that would allow to design different databases with various reporting formats tailored to specific needs of the health professionals; and to organize and manipulate statistical data useful for administrative, training and research purposes.

The study has begun by conducting a survey to investigate the activities involved, in the clinical operations of the different sections of the hospital division, as related to leprosy patients. It has been investigated that problems with regard to redundant handling of data, difficulty in finding a summary of patient data over a number of visits, difficulty in finding statistical data for the purpose of clinical, administrative, training and research as well as reporting purposes were among the major problems encountered. Problems of easy access to patient card, the possibility of losing cards and redundant issuing of cards for a patient have also been noticed.

The survey proceeded by further investigating the organizational structure of ALERT and the information flow among the different clinics so as to discover the areas in which the problems exist. In this step the processes involved, the input/output movements, the data

stores/entities in which data is held, and the relationships that could exist between the different entities has been identified and represented in dataflow and logical data structure diagrams. As a result the duplicate data stores and the need for combining processes and the need for logical groupings of data have been investigated.

From the analysis of the information flows, the detailed problems were further studied. The study has, therefore, realized that many of the problems can be solved by designing a computer assisted system. In order to accomplish that the study continued by investigating and listing the problems/requirements to be solved, the kind and frequency of data required, the methods of processing data required to have maximum information service, and the need for secured information.

The step in solving the problem proceeded first by avoiding the duplicate data stores and combining disintegrated processes and restructuring the data flow diagrams and the logical data structures. The data stores in which data will be held or from which data will be retrieved are represented in entities. The entities and the kind of relationship between these entities have been modelled using a logical data structure diagram. The data elements that can be represented in each entity have been distinguished and represented in the data item description table. The data items have been analyzed using the relational approach to data modelling. The relational approach was found easier, flexible and more suitable from the view point of end users, as compared to other models.

The shift in emphasis changed from the entities and their relationships to the data items held within each entity and the relationships between the data items. The kind of relationship

that can exist between the data items has been analyzed through the process of normalization. This relationship serves as a cross check against the relationships between entities. The normalization process makes it possible to avoid the duplicate data handling and avoid the common anomalies. It also makes possible to identify primary keys that serve as a link between tables (files). A number of normalized tables in which the system's data should be held wisely have been designed. These files are created irrespective of a particular software in mind with the objective that they can be fitted to any software.

In the subsequent steps the normalized tables have been physically designed using one of the relational database management systems: dBASE IV. Each entity (logical data file) was transformed into the data definition constructs of dBASE IV. Each entity name was converted into a database file name and each data item into a field. Relationships between the database files have been shown using the dBASE IV linking facility.

An interface through which users can interact with system and the database files during data entry and retrieval has been designed based on a prototype of two modules, namely the registration and diagnosis. The screen flows, the input/out put forms and the sample outputs of the prototype application program have been developed.

An important concern in the data entry relates to coding. Coding has a significant role in structuring clinical information. It makes easier to retrieve, summarize and group clinical data. It also has an important role in linking related clinical entities. Three alternative considerations have been forwarded in coding the medical elements. One is to have a clerk code the clinical data which the physician has recorded in a free-form. The second is to

have a computer translate the free-form text in to coded format. The third one was to have the physician or his assistant enter only the medical codes by referring to a code file held within the computer system. The computer system would then manage linking the codes to the code files to associate them with the medical description they represent. The limitation of each alternative has be elaborate. The third alternative has been found to be the best solution. The disadvantage that the alternative consumes the physician's time will only be a short run problem; with a short period of experience and required facilities, code entry would be familiar and be managed very shortly.

In order to implement the system there would certainly be pre-requisites. Among them are the hardware and software selection to keep thousands of patient clinical information, the network design considerations, processing control and management alternatives of data in a network, additions and changes to the existing organizational structure, and finally proposals for a phase by phase implementation plan of the system.

The use of local area networks has been emphasized to have the advantage of shared databases. Besides, a network system avoids the workload in transporting patient cards, lab test forms, and other medical results and at the same time eliminates the problem of lost patient cards, lab results duplicate handling of data etc.

A centralized and distributed control of data processing and management has been focused for evaluation. A distributed database management system (DDBMS) was proposed to implement the system under consideration. In light of the possibility to introduce a heterogeneous database management systems, for different sections of the hospital, the need

to have databases as close as to the end users, the need to access data as quick as possible, the volume of daily patient transactions, the distributed approach to database management and control would gave the greatest advantage over the the centralized one.

General considerations required in the selection of hardware and the need to set up a technical group for the technical specification, evaluation, installation of the system have been forwarded. Major consideration has been on the need to consider the capability, capacity, reliability, cost and compatibility of the hardware.

The study has recommended and put forward the phase-by-phase development plans required to implement the system. In this aspect the need to upgrade the prototype application program and entering sample data to the system, conducting a seminar with potential users to demonstrate and convince the benefits of the computer based system, and other subsequent activities required to be completed in phase one, have been indicated. Phase two and three discusses the need to develop other systems in other sections and divisions following similar systems analysis and design procedures used in this study. The study then underlines the need for establishing an integrated information system that brings together the organization wide information.

The third pre-requisite focuses on the major changes required to the existing organizational structure of the hospital division and emphasizes the need for and setting up of a new information unit that would be responsible for the management of the computer based information system. Associated to this was the training of all potential users who would be involved either in data entry or retrieval. The conversion of an existing data and the

administration controls required to protect the system from any possible losses and damages has been indicated.

The methods and systems employed in the design of the leprosy patient record system is not only applicable to leprosy but also to the establishment and maintenance of other systems within the ALERT.

7.2 RECOMMENDATIONS

This study has demonstrated development of an information system using a structured method of systems analysis and design. The results of the study provides the basis upon which the remaining tasks to extend similar approach to other systems and to come up with the overall information support system for ALERT can further be developed. Since the prevailing requirement is to develop organization-wide information system, it is hereby recommended that a high level technical group should be formed as the first step to carry out the further development task of the proposed system. The composition of that group is recommended to comprise representatives of the management body, who has the upper hand in committing funds for the possible investment, a system analyst, selected physicians and the programmer. An external technical consultant is also required to obtain technical expertise and advice in the installation of the system.

One important point worth considering relates to the prototype application program. The aim of that prototype was to demonstrate how the system should operate and the things that should be included within it. It was not the intension of this study to recommend that the

prototype should directly be implemented. As other better and suitable medical software might be selected by the technical group, this prototype serves as one alternative against which the features of other candidate software would be compared.

Another important recommendation is that the system must include links to administrative, bibliographic and research databases with the objective:

- To improve the support of patient care and quality of care
- To enhance productivity of health care professionals and reduce administrative cost of health care delivery and financing.
- To support clinical and health service research.
- Insure patient data confidentiality.

GLOSSARY

Anomaly: A state of dificulty in adding, deleting and modifying a record due to improper database design.

Attribute: A data element that describes a characterstics of an entity.

Candidate Key: A key or keys that alternatively serve as a primary key.

Column: The vertical dimention of a table when representing entities in a table.

Commit: A command in a SQL based RDBMS used to make a transaction or temprory files permanently saved into a physical storage.

Compasite Key: Similar to a compound key but one or more of the data items in the combination have no unique significance.

Compound Key: Where more than one key is required to uniquely identify a record in a relation.

Conceptual Database: The user view of the entities and their relationships expressed graphically using the logical data structures.

Concurency: The state of a file or a record being updated or used by more than one users simultaneously. It is used to indicate that an attempt for a simultaneous update to a record may result to be over written one by the other. So, a data may be lost.

Data Group: Ref. entity

Data Item: An attribute that represent the smallest unit of information in a system's data.

Data Structure Diagram: A graphical representation of entities and their relationships.

Data Dictionary: A repository of data used for looking up the items of data held in the database. It describes the identifier, description, type, length, range of values for each data element in the database.

Data Flow Diagram: A graphical representation of the data or information flows of a system.

Database Managment System: (DBMS). A collection of programmes that takes care the mechanics involved in handling the physical storage of data and accessing mechanisms, defining fields, records and their relationships.

Database: A well normalized collection of related records.

Derived Data Item: A data item whose value can be obtained by calculating the values in

another data items.

Detail Entity: Ref. master entity.

Determinant: An attribute whose value uniquely identifies a particular occurence of another attribute.

Distributed Database Management System (DDBMS): A DBMS that can manage a distributed databases stored in a multiple computers located at different sites.

Distributed Database: A common phenomenon in a networking enivironment where a portion or a copy of a database is distributed throughout the organizational units.

Entity Integrity: A SQL based RDBMS command which states no key in the compound or compasite key can contain a null value.

Entity: Something of a significance in the system about which data will be held.

Entity Occurence: A value or an instance of an entity. For instance, the entity Patient may contain the occurences Mr. X, Mr. Y, etc.

Epidemiological Indices: Statistical indices used to verify the effectiveness of the strategies employed and the relevance of screening and treatment procedures in order to adapt or modify them as required. These include rates like the incidence rate, bacteriological status rate, relapses etc.

Foreign Key: A key attribute in an entity that appears in another entity for the sake of relating entities one with the other.

Functional Dependency: When any non-key data item is dependent on only part of the compound key but not on the whole that is a functional dependency.

Health Care Provider: All medical personnel involved in the diagnosis and treatment

key: Fields which are used to uniquely access records in a file. It is used to describe the primary, candidate, foreign.

Local Area Network: A collection of connected computers and other devices over a small area, usually personal computers.

Logical Data Structue: A method to describe represent the information to be held in a system.

Mandatory Relatioships: Is a relationship where if an occurence of one entity exists, it must always be associated with one occurence of another entity.

Master Entity: If a situation where there is one to many relationship, the one end is called a Master entity. While the many end is called Detail entity.

Multivalued Dependency: When a value of an attribute in an entity multidetermines a set of values of attributes in another entity. In other words, if the same value in attribute A is associated with the same set of values in attribute B we call there is a multivalued dependency exists between A and B. If A also multidetermines C but there is no relationship between B and C, we call there is an independent multivalued dependency, and anomalies will occur.

Node: A site in a local area network

Normal Form: The results of applying a set of rules to eliminate anomalies. These normal forms constitute first, second, third and fourth normal forms.

Normalization: The process of residing all the data for an entity in tables and applying a set of rules to eliminate anomalies.

Occurence: Ref. Entity occurence.

Operational Masters: A secondary key that can serve to access an entity occurence from another entity occurence through the relationship other than the primary key.

Operational Indices: Statistical indices used to calculate and assess the efficiency of treatement. This include rates like the treatment attendance rate, rate of release from treatment, prevalence etc.

Optional Relationships: This is a situation where an occurence of the entity can exist without its corresponding entity.

Panel: A computer screen used for displaying and putting data.

Partitioning: A term common in distributed databases. It means separation of a file along its vertical or horizontal dimention for the sake of distributing a file to different locations.

Patient Card: A form used to record personal details of a patient, statements on diagnosis and therapeutic actions. The card is not entirely standardized and frequently fall short of the ideal.

Physical Database: The database as it is designed in referece to a particular hardware and software configuration.

Primary Key: A data element that can uniquely identify a particular occurence of an entity.

Relation: A data stucture that contains rows and columns, with no repeating values in a

Multivalued Dependency: When a value of an attribute in an entity multidetermines a set of values of attributes in another entity. In other words, if the same value in attribute A is associated with the same set of values in attribute B we call there is a multivalued dependency exists between A and B. If A also multidetermines C but there is no relationship between B and C, we call there is an independent multivalued dependency, and anomalies will occur.

Node: A site in a local area network

Normal Form: The results of applying a set of rules to eliminate anomalies. These normal forms constitute first, second, third and fourth normal forms.

Normalization: The process of residing all the data for an entity in tables and applying a set of rules to eliminate anomalies.

Occurence: Ref. Entity occurence.

Operational Masters: A secondary key that can serve to access an entity occurence from another entity occurence through the relationship other than the primary key.

Operational Indices: Statistical indices used to calculate and assess the efficiency of treatement. This include rates like the treatment attendance rate, rate of release from treatment, prevalence etc.

Optional Relationships: This is a situation where an occurence of the entity can exist without its corresponding entity.

Panel: A computer screen used for displaying and putting data.

Partitioning: A term common in distributed databases. It means separation of a file along its vertical or horizontal dimention for the sake of distributing a file to different locations.

Patient Card: A form used to record personal details of a patient, statements on diagnosis and therapeutic actions. The card is not entirely standardized and frequently fall short of the ideal.

Physical Database: The database as it is designed in referece to a particular hardware and software configuration.

Primary Key: A data element that can uniquely identify a particular occurence of an entity.

Relation: A data stucture that contains rows and columns, with no repeating values in a

particular column. Some times it is called a table.

Relationship: An association of one entity to another entity.

Row: The horizontal dimention of a table when representing entities in a table.

Subkey: One of the component parts of a compound key.

System: is a set of interrelated elements brought together to achieve a purpose in the environment in which the system operates.

APPENDIX I

Existing Forms Summary

Title	Description	Source	Destination	Freq.	No.of Copies	Comments	
F1	Admission Book	Ward 1-6	Statistics	M	1	Reversible	
F2	Disease Register	Diagnostic	Statistics	M	1	Reversible	
F3	Haematology Book	Laboratory	Statistics	M	1	Reversible	
F4	Urine Exam. Book	Laboratory	Statistics	M	1	Reversible	
F5	Bio.chem & Serology Lab. Book	Laboratory	Statistics	M	1	Reversible	
F6	Smears for Leishmania,Onhocerca	Laboratory	Statistics	M	1	Reversible	
F7	BI & MI Reg.Book	Laboratory	Statistics	M	1	Reversible	
F8	TB Lab.Register	Laboratory	Statistics	M	1	Reversible	
F9	Feaces Parasitology	Laboratory	Statistics	M	1	Reversible	Request/Result
F10	Blood Chemistry Request/Result Form	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F11	Haematology test Request/Resul	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F12	Stool test Request/Result	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F13	Urine test Request/Result	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F14	Serology test Request/Result	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F15	Spotum + Fungus test Request/Result	Diagnostic, Sick Opd, Red Medical, Staff Clinic, Wards.	Laboratory	D	1	Reversible	
F17	Referral Letter	New Case Clinic		*	1		

Title	Description	Source	Destination	Freq.	No.of Copies	Comments
F18	Patient Card	Registration	Diagnostic, New Case, Red Medical, Wards, Eye Cl., Red Medical, Gate Clinic, Surgical Cli., Staff Clinic, Dental Clinic, Sick OPD.	D	1	Reversible
F19	Morbidity Stat.	Statistics	MOH, Hospital Director	M	3	
F20	Communicable Diseases Report	Statistics	MOH, Hospital Director	M	3	
F21	Dischagre Report	Statistics	MOH, Hospital Director	M	3	
F22	Lab. Tests Report	Statistics	MOH, Hospital Director	M	3	
F24	Surgical Operations Report	Statistics	MOH, Hospital Director	M	3	
F25	Red Medical Disease Register	Red Medical	Statistics	M	1	
F26	Treatment Attendance sheet	Gate Clinic		D	1	
F27	Progress Follow up Card	Gate Clinic		D	1	
F39	Health Education Record	Health Educ.	Statistics	M	1	
F29	Eye Reg. Book	Eye Clinic	Statistics	M	1	reversible
F30	Health Edu.Book	H.Education	Statistics	M	1	reversible
F31	Sick OPD data Collection form	Sick OPD	Statistics	M	1	
F32	Surgical Book	Surgical Cl.	Statistics	M	1	reversible
F33	Staff patient data collection form	Staff Clinic	Statistics	M	1	
F34	Dental Reg.Book	Dental Clinic	Statistics	M	1	reversible
F35	Physiotherapy Test Result	Physiotherapy	Diagnostic,	*	1	
F36	Histopathology Request/Result	Diagnostic,	AHRI	*	1	reversible

Title	Description	Source	Destination	Freq.	No.of Copies	Comments
F37	Medico-Social Form	Medico Social Section	Diagnostic, New Case	*	1	
F38	New Case Patients Register	New Case Clinic	Statistics	D	1	Reversible
F40	Registration Book	Registration	Registration	D	1	

Reversible = Returnable to place of origin, M = Monthly, D = Daily, * = As required

APPENDIX II

TASK ANALYSIS OF THE DIVISIONS

The Hospital Division

The Hospital Division, headed by the Director of Hospital Services, is organized into six divisions:

Division of Surgery
Division of Rehabilitation
Division of Medicine
Division of Out-Patient Services
Division of Ophthalmology and
Other supportive sections like the Sanitation, Statistics, and Matron Office

The Division of Medicine: In-patient Section

The activities of this section are:

Recording of day-to-day admissions, discharges, clinical progresses and transfers and documenting the results of the weekly meeting of the clinical staff,

The day-to-day scheduling of the assignments of physicians, nurses, and health assistants,

Periodic evaluation of histopathological results of patients, detection of patients with special complications and deciding the tendency of a certain complication and its treatment,

Analyzing the length of stay (use of beds) of patients and turn over of admissions and discharges by classifying into leprosy, non-leprosy, age,and by classification of diseases,

Evaluation of the effectiveness of various treatment measures,
Evaluation of lepromatous patients showing a reaction and other complications. This provides an estimate of the resources needed such as specialized medical care, medicines, hospitalization etc, to treat such cases.

The Pharmacy

The responsibility of the Pharmacy is to carry out inventory management of drugs, i.e, ordering, purchasing, receiving, storing, issuing, and controlling inventory levels;

Identifying essential drugs; keeping safety levels of special drugs; and periodic preparation of essential and new drug lists to physicians.

The activities this section is involed are:

The day-to-day filling of purchase orders, goods receiving notes, issue vouchers, prescriptions, posting the transactions to stock cards.

Reporting backlog purchases, out of stock items, over stocked drugs, expired drugs etc.

Evaluation of drug issuance by type of patient (leprosy patient and family, staff patient, etc.).

Comparison between authorized and actual drug purchases.

Analysis of foreign medical suppliers, possible donors, policy revisions on the provision of free drugs. The main source of supply of drugs and other related supplies is the government owned Central Medical Store (EPHARM). But as the supply from this store is not reliable, some essential drugs are imported to secure continuity of supply. Donations in kind also constitute as major source of supply.

The Laboratory

The responsibility of this section is to carry out various tests that would be requested by authorized health personnel of both the hospital sections and the Leprosy Control field areas. The kinds of test done in the laboratory are the skin smears, bacteriology, haematology, urine, stool, Bio-chemistry, serology, TB, Faeces Parasitology, smears on onchocerca, malaria, and body fluids. It also carries out a quality control task specially on the skin smear tests, made by the laboratory technicians, by sending them abroad.

The activities of this section are:
Accepting various test requests, recording results for statistical purposes and sending them to the appropriate sections after due examination.

Control over specimens and over results being responded in due time.

Analysis of the progress of number of tests over a period of time and determining the number of technicians required.

Preparing plans for replacement of old or acquisition of new laboratory machines and equipments based on the need and the level of activities.

The Red Medical Clinic

The activities of this section are:
To care for leprosy patients with problems which cannot be managed in the Gate Clinic;

To care for discharged leprosy patients belonging to Gate Clinic who are still under steroid treatment;

To care for patients with problems coming with transfer letters from ALC or National

Leprosy Control Program (NLCP) areas, most of whom will be admitted;

To keep a special registration of all leprosy patients suffering from reaction and/or relapses and/or reactivations during treatment or after treatment (RFT) from MDT (Multi-Drug Therapy) regimen; and

To register reactivations or relapses under or after DDS Monotherapy.

The New Case Clinic

This is a clinic where newly diagnosed leprosy patients come with all the result of investigations from the Diagnostic Clinic and it prescribes to them all necessary treatment procedures. For out-patients the treatments will be prescribed to be continually provided in the Gate Clinic or at the ALC field areas. But, for those patients who should be treated in their nearby field areas, treatment will be started in the Gate Clinic. If the patient need an in-patient service, he will be sent to the Red Medical Clinic, a section that facilitates admissions. This section prepares statistics on the number of new leprosy patients categorized by type of leprosy.

The Diagnostic Clinic

This is a daily clinic where all patients with any skin manifestations come on an appointment basis. All consultations are free of charge for the first visit so as not to discourage new leprosy patients who cannot afford to pay. Once diagnosed, all skin disease patients, except leprosy patients, will be charged for subsequent visits. The main activities of this section are:
Case detection;
Diagnosis;
Treatment of non-leprosy patients.

The Registration Section

This is the section where patients get registered. It is responsible to store and retrieve patient cards each time a patient visits the hospital.

The Surgical In-patient Section

The activities of In-patient Surgical section are:
Admission of reconstructive, septic, and non-leprosy patients for correction of deformities;
Diagnosis;
Treatment; and
Discharging.

The Surgical Out-patient Section

Surgical patients can be provided out-patient services for correction of deformities in this unit.

The X-ray Section

This section is engaged in the undertaking various x-ray tests based on the requests made from the Surgical, Sick-out, Staff, Diagnostic and In-patient clinics.

The Physiotherapy

Activities of this section consists of disability prevention and correction through physical and mechanical means, for instance, prevention and overcoming contractures and pre- and post-operative therapy. All hospitalized patients as well as newly diagnosed patients and patients attending the different leprosy out-patient clinics are regularly examined by this section.

Nerve function assessment is another important function. Patients are instructed how to care for their eyes, hands, and feet which often have loss of protective sensation.

Many patients are assessed for surgery and following reconstructive surgery. Patients for leprosy reconstructive surgery need the utmost care, post-operatively, to guarantee successful outcome of surgery. Patients are given appointments for follow up visits.

This section also provides services for patients with congenital club foot deformity where, in most cases, hundreds of children are successfully treated.

The Medico-Social Section

This section is engaged in the investigation of socio-medical background of the newly detected leprosy patients and in providing financial and other assistance when they are admitted or transferred. It also deals with the support and encouragement of cooperative association of the patients such as agricultural projects, sewing and dress making projects, kindergarten, youth and children welfare service, and other similar associations. It facilitates in mobilizing resources from any potential donors for assisting the projects financially, materially and administratively.

The Health Education

The aim of this section is to evoke in the public at large and the patients and their relatives, a reasoned attitude towards leprosy which neither exaggerates the dangers of leprosy nor minimizes them. It provides individual as well as group health education for leprosy in-patients and out-patients daily through individual teaching, group teaching, radio programmes in the compound and puppet shows. Patients are also educated to protect their insensitive eyes, hands, feet while preparing coffee, cooking and baking 'injera'.

APPENDIX III

INFORMATION REQUIRMENTS

The Department of Medicine - In-patient Section

Information is required on:

- Name, Age, sex, address of patients
- Disease causing admission
- Leprosy classification (for Leprosy patients)
- Previous histories
- Date of admission
- Date of discharge
- No of days stayed on bed
- Status at discharge i.e., released, died, transferred etc.
- Periodical bed utilizations summaries (average length of stay)by age, by disease group, by classification of patients (i.e, Leprosy and non-Leprosy)
- Clinical follow ups
- Periodic bacteriological status (for leprosy patients)
  - Clinical status
- Histopathological diagnosis
- Laboratory, X-ray and other tests, by date ordered, type of test, and result
- Treatments given, length of treatment given, dosage, type of treatment (Mono or MDT), precautionary information.
- Progress of health of the patient
- Daily bed occupancy status (occupied, empty, reserved etc).
- List of physicians, nurses, and health assistants on duty.

The Laboratory

Information Requirements:

- Patient name, Id, age, sex, status (bed patient, ambulatory, outpatient)
- Ordering/requesting physician and clinic
- Date and time or request
- Type of tests required
- Date result reported
- Reporting Technician
- Results reported
- Statistics on tests carried out over a period of time
  - Type of tests
  - Number of each test
- Smear results sent abroad for checking quality control, Slide no., the technician being checked for quality control, the responses of quality control, date the responses received.

The Red Medical Section

This section requires information on:

- Name, Id, age, sex and address of leprosy patients
- Classification of leprosy
- Previous treatment given
- Duration of the previous treatment given
- Type of reaction/relapse/reactivations
- Date when the MDT or MONO treatment was given
- Status of referral (referred while MDT, after RFT)
- Date reaction treatment started
- Treatment given for reaction (drugs prescribed, dosage, quantity)
- Periodic progress information
- Status when RFT (release from treatment)
- Statistics

The New Case Clinic

To facilitate activities, the New Case Clinic requires information on:

- All results of investigation from the Diagnostic Clinic (See Diagnostic Clinic information requirement on leprosy patients)
- Mode of Detection (i.e, voluntary, survey, contact, or referred)

The Diagnostic Clinic

Information is required on:

- Diagnosis of leprosy patients
  - Name, Id, age, sex, address of patients
  - Status of visit (1st visit, repeat etc)
  - Laboratory examinations
  - Physiotherapy tests
  - Medico-Social Histories
  - Health educations
  - Diagnosis
- Diagnosis and treatment of non-leprosy patients
  - Name, Id, age, sex, address of patients
  - Status of visit (1st visit, repeat etc)
  - Past medical histories if any
  - Laboratory examinations
  - Diagnosis
  - Treatments and precautions given (drugs prescribed, dosage, length of treatment, quantity)
- Statistical reports on:
  - Number of new cases by age, by type of patients (leprosy or non-leprosy)
  - Number of repeat cases by age, by type of patient (leprosy or non-leprosy)
  - The progress of number of visits over the years
  - Common causes of morbidity

The Reconstructive Surgery - In-patient and Out-patient Sections

The information requirement of this section include:

- Name, id, age, sex, address of patients
- Disease causing admission
- Type of the patient; leprosy or non-leprosy, in-patient/outpatient
- Previous patient histories
- Date of admission
- Date of discharge
- No of days stayed on bed
- Status at discharge i.e., released, died, etc.
- Periodical bed utilizations summaries (average length of stay) by age, by disease group, by classification of patients (i.e, non-Leprosy, septic, reconstructive)
- Laboratory tests, by date ordered, type of test, and result.
- Treatments given, length of treatment given, dosage, precautionary information.
- Progress of health of the patient
- Daily bed occupancy status (occupied, empty, reserved etc).
- List of physicians, nurses, and health assistants on duty.
- List of patients on waiting lists
- Common causes of morbidity over a year and years.

The Physiotherapy

The Physiotherapy section requires information on:

- Name, id, age, sex, address of the patients
- Discharge Assessments
- Surgical procedures done for th
- Type and number of pre- and post- operative assessments, discharge assessment

APPENDIX IV

INPUT/OUTPUT FORM DESIGN

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT REGISTRATION FORM

FORM NO. 1
FORM TYPE OLDEF

REGISTRATION DATE DD/MM/YY PATIENT ID AA9999

PATIENT NAME FATHER'S NAME GRAND FATHER'S NAME
XXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXXXXXXXXXXX

DATE OF BIRTH DD/MM/YY SEX L

ADRESS
ADM.REGION XXXXXXXXXXWOREDA XXXXXXXXX KEBELE 99 H.NO. 9999
FARMERS'S ASSOCIATION XXXXXXXXXXXXX

STAFF PATIENT Y/N L STAFF FAMILY Y/N L LEPROSY PATIENT L

Figure A: Patient Registration Form

NOTE:

One of the problems mostly encountered in filling this form relates to the date of birth. It is of common observation that patients do not exactly know or tell their date of birth. While most patients can tell their age, some do not. What is being done in the registration section is that if a patient cannot tell his exact date of birth but knows his age, the registrar recalculates back his year of birth by deducting his age from the current year and assigns the first day of the middle of the year he was born. For instace, if a patient tells in 1995 that he is 30 years old, 30 will be deducted from 95 and his year of birth would be 1965. So, July 1, 1965 would be assumed and recorded as his date of birth. If the patient cannot tell his age at all, the registrar will estimate the age and will calculate the date of birth in the same way. Once the date of birth is obtained as such, there will be no need of asking a patient each time he appears at the hospital. Date of birth has a singnificant implication on the medical statistics. To know which age group a particular disease affects, analysis is to be based on the age groups. The system would, thus, automatically assign ages along side the diseases and other data of the patient each time the patient appears at the hospital. It calculates the age by deducting the date of birth from the current date the patient appears to the hospital.

APPENDIX IV

INPUT/OUTPUT FORM DESIGN

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT REGISTRATION FORM

FORM NO. 1
FORM TYPE OLDEF

REGISTRATION DATE DD/MM/YY PATIENT ID AA9999

PATIENT NAME FATHER'S NAME GRAND FATHER'S NAME
XXXXXXXXXXXX XXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX

DATE OF BIRTH DD/MM/YY SEX L

ADRESS
ADM.REGION XXXXXXXXXXWOREDA XXXXXXXXX KEBELE 99 H.NO. 9999
FARMERS'S ASSOCIATION XXXXXXXXXXXXXX

STAFF PATIENT Y/N L STAFF FAMILY Y/N L LEPROSY PATIENT L

Figure A: Patient Registration Form

NOTE:

One of the problems mostly encountered in filling this form relates to the date of birth. It is of common observation that patients do not exactly know or tell their date of birth. While most patients can tell their age, some do not. What is being done in the registration section is that if a patient cannot tell his exact date of birth but knows his age, the registrar recalculates back his year of birth by deducting his age from the current year and assigns the first day of the middle of the year he was born. For instace, if a patient tells in 1995 that he is 30 years old, 30 will be deducted from 95 and his year of birth would be 1965. So, July 1, 1965 would be assumed and recorded as his date of birth. If the patient cannot tell his age at all, the registrar will estimate the age and will calculate the date of birth in the same way. Once the date of birth is obtained as such, there will be no need of asking a patient each time he appears at the hospital. Date of birth has a singnificant implication on the medical statistics. To know which age group a particular disease affects, analysis is to be based on the age groups. The system would, thus, automatically assign ages along side the diseases and other data of the patient each time the patient appears at the hospital. It calculates the age by deducting the date of birth from the current date the patient appears to the hospital.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT APPOINTMENT/ALLOCATION FORM

FORM NO. 2
FORM TYPE OLDEF

PATIENT ID DD/MM/YY
DATE APPOINTED DD/MM/YY
PRESENT/ABSENT (**P**/**A**) A
CLINIC ASSINGED XXXXX
PHYSICIAN ASSINED XXXXX

Figure B: Appointment/Allocation Data Entry Form

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
DAILY PATIENT APPOINTMENT/ALLOCATION LIST

FORM NO. 3
FORM TYPE OLDOF

CLINIC XXXX
PHYSICIAN XXXX

APPOINTMENT DATE __/__/__

PATIENT ID	PATIENT NAME
AA9999	XXXXXXXXXXXXXXXXXXXXXXXXXX
AA9999	XXXXXXXXXXXXXXXXXXXXXXXXXX
...	...

Figure C: Appointment/Allocation Data Entry Form

NOTE:

The above two forms are used to enter appointment and the clinic or physician to which the patient is assinged. Both forms are filled online on the date of appointment.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
DISEASE CODE DATA COLLECTION FORMAT

FORM NO. 4
FORM TYPE PDEF

DISEASE CODES	DESCRIPTION	SOURCE OF CODE
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXX
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXX
...	...	.....

Figure D: Disease Code Data Collection Format

NOTE:

This form is used to collect possible classification of diseases and their codes. The classification can be found as an internationally established coding standard such as ICD or in-house developed standards and abbreviations.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
DRUG CODE DATA COLLECTION FORMAT

FORM NO. 5
FORM TYPE PDEF

DRUG CODES	DESCRIPTION	SOURCE OF CODE
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXX
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXX
...	...	

FIGURE E: Drug Codes Data Collection Format

NOTE
This form is used for collecting pharmacological classifications and codes of drugs assigned for each kind of drug. The codes can be internationally known or locally developed.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
SURGICAL CODE DATA COLLECTION FORMAT

FORM NO. 6
FORM TYPE PDEF

SURGERY CODE	DESCRIPTION	SOURCE OF CODE
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXX
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXX
...	...	....

FIGURE F: Surgery Codes Data Collection Format

NOTE:
Like the disease and drug code data collection formats, this form is also used to collect surgical classifications and codes.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT DISEASE DATA ENTRY FORM

FORM NO. 7
FORM TYPE OLDEF

PATIENT ID AA9999 DATE OF DIAGNOSIS DD/MM/YY

PHYSICIAN CODE XXXX CLINIC XXXXXXXX

DISEASE CODE(S) XXXXXXX
NEW CASE L RELAPSE L REPEAT L TRANSFERRED L ON SET XXXXXXX
CLINIC XXXXX DIAG.PHYSICIAN XXXXX
PREDO.LESIONS XXXXXXXXXX CENTRAL HEALING XXXXXXXXX
NUMBER OF LESIONS XXXXXXX LOSS OF SENSATION XXXXXXX
DISTR.OF LESIONS XXXXXXXXX CONDITION OF EYES XXXXXXX
HYPOPIGMENTATION XXXXXXXXX MADUROSIS XXXXXXX
DEFINITION OF LESIONS XXXXXXXX STATUS OF VOICE XXXXXXX
GENERAL HEALTH CONDITION XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

MAJOR COMPLAINT-XXXXXXXXXXXXXXXXXXXXXXXXX

COMPLICATIONS -XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
OTHER DIAGNOSIS NOTES MEMO

Figure G: Patient Diseases Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT DRUG PRESCRIPTION DATA COLLECTION FORMAT

FORM NO. 8
FORM TYPE OLDEF

PATIENT ID AA9999
DATE OF TREATMENT DD/MM/YY
PHYSICIAN CODE XXXXXX
CLINIC XXXX
MONOTHERPAY Y/N X
MDT Y/N X

OTHER PROCEDURE NOTES XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DRUG CODE	UNIT	DOSAGE	TREATMENT LENGTH	QUANTITY
XXXXXX	XXX	XXXXXXX	XXXXXXXX	XXXXXXX
XXXXXX	XXX	XXXXXXX	XXXXXXXX	XXXXXXX
XXXXXX	XXX	XXXXXXX	XXXXXXXX	XXXXXXX

Figue H: Drug Prescription Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
PATIENT DRUG ADMINISTRATION DATA COLLECTION FORMAT

FORM NO. 9
FORM TYPE OLDEF

PATIENT ID AA9999

DATE OF TREATMENT DD/MM/YY
DATE DRUG GIVEN DD/MM/YY
TIME DRUG GIVEN 99:99

DRUG CODE	UNIT	DOSAGE
XXXXXX	XXX	XXXXX
XXXXXX	XXX	XXXXX
XXXXXX	XXX	XXXXX

Figure I: Drug Administration Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
HEALTH PROGRESS DATA COLLECTION FORMAT

FORM NO. 10
FORM TYPE OLDIF, OLDOF

PATIENT ID AA9999

DATE OF EVALUATION	DRUG CODE	CUMULATIVE USAGE PERCENT	HEALTH PROGRESS
DD/MM/YY	XXXXXXXXXX	XXXXXXXXXXXXX	XXXXXXXXXXXXXX
DD/MM/YY	XXXXXXXXXX	XXXXXXXXXXXXX	XXXXXXXXXXXXXX
...		...	...

OTHER PROGRESS NOTES XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

RELEASED FROM TREATMENT Y/N L
DATE RELEASED FROM TREATMENT DD/MM/YY

Figure J: Health Progress Data Input/Output Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
IN-PATIENT DATA COLLECTION FORMAT

FORM NO. 11
FORM TYPE OLDEF

PATIENT ID AA9999
DATE ADMITTED DD/MM/YY
AMBULATORY Y/N L
DATE DISCHARGED DD/MM/YY
NO. OF DAYS STAYED 999

CUASE OF ADMISSION
(DISEASE CODES)
XXXXXX
XXXXXX
XXXXXX

ADDITIONAL NOTES FOR ADMISSION OF THE PATIENT XXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

STATUS AT DISCHARGE XXXXXXXXXXX

ADMITTING WARDS (WARD LOCATION OF PATIENT ADMISSIONS)

WARD NO	ADMISSION DATE	DISCHARGE DATE	DAYS STAYD	TRANS.FROM	TRANS.TO
XX	DD/MM/YY	DD/MM/YY	99	XXX	XXX
XX	DD/MM/YY	DD/MM/YY	99	XXX	XXX
..	....	.....		...	...

Figure K: Admission History Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
LABORATORY CODE DATA COLLECTION FORMAT

FORM NO. 12
FORM TYPE PDEF

LAB.CODE	DESCRIPTION	CATEGORY	SOURCE OF CODE
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXXXXXXX
XXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXXXXXXX
...	...		.....

Figure L: Laboratory Codes Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
LABORATORY RESULT DATA COLLECTION FORMAT

FORM NO. 13
FORM TYPE OLDEF

PATIENT ID AA9999
DATE OF REPORT DD/MM/YY
REPORTING TECHNICIAN
CODE XXXXXXXXXXXXXXXXXXXXX

TEST CODE	TEST RESULT
XXXXXX	XXXXXXXXXXX
XXXXXX	XXXXXXXXXXX
...	.....

Figure M: Laboratory Codes Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
HISTOPATHOLOGY DATA COLLECTION FORMAT

FORM NO. 14
FORM TYPE PDEF

AHRI NO. AA9999
DATE OF REQUESTDD/MM/YY
PATIENT ID AA9999
REQUESTING CLINIC XXXX
CLINICAL INFORMATION XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
LABORATORY INFORMATION XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
SITES OF BIOPSIES XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
PREVIOUS BIOPSIES XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
REQUESTING PHYSICIAN CODE XXXX
DATE RESULT REPORTED DD/MM/YY
REPORT OF THE FINDINGS XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CONCLUSION XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
REPORTED BY XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure N: Histopathology Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
MEDICO-SOCIAL DATA COLLECTION FORMAT

FORM NO. 15
FORM TYPE PDEF

PATIENT ID AA9999
ETHNIC GROUP XXXX
RELIGION XXXXXXXXXX
PLACE OF BIRTH XXXXXXXXX
MARITAL STATUS XXXXXXXXX
REASON FOR DIVORCE XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NUMBER OF CHILDREN 99
AGE OF THE ELDEST CHILDREN 99
AGE OF THE YOUNGEST CHILD. 99
MOTHER ALIVE Y/N L
FATHER ALIVE Y/N L
NUMBER OF BROTHERS 99
NUMBER OF SISTERS 99
NAME & ADDRESS OF THE GUARDIAN XXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NAME & ADDRESS OF RELATIVES IN ADDIS ABABA XXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
OCCUPATION NOW XXXXXXXXXXXXXXXXXXXXXXXXX
OCCUPATION BEFORE HAVING LEPROSY XXXXXXXXXXXXXXXXXXXXXXXXX
EDUCATIONAL BACK GROUND XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NAME & PATIENT ID OF RELATIVES WITH LEPROSY AA9999
DURATION OF DDS TREATMENT TAKEN XXXXXXXXXXXXXXX
DEFAULTER PATIENT Y/N L
REASON FOR DEFAULTING XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NEAREST CLINIC TO RESIDENCE XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
DISTANCE FROM HOME TO CLINIC XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
REASON TO COME TO ALERT XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
ADDITIONAL CASE NOTES & RECOMMENDATIONS XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
NAME OF THE INTERVIEWER XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure O: Histopathology Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
MUSCLE AND TEST SENSATION DATA COLLECTION FORMAT

PATIENT ID AA9999 FORM NO. 16

DATE OF TEST DD/MM/YY FORM TYPE OLDEF

LEFT SIDE		RIGHT SIDE	
FACIAL		FACIAL	
EYE CLOSURE	9	EYE CLOSURE	9
ULNAR		ULNAR	
5TH ABDUCTION FINGER	9	5TH ABDUCTION FINGER	9
MEDIAN		MEDIAN	
ADBDUCTION THUMB	9	ABDUCTION THUMB	9
OPPOSITION THUMB	9	OPPOSITION THUMB	9
WRIST EXTENSTION	9	WRIST EXTENSTION	9
COMMON PERONEAL		COMMON PERONEAL	
DORSIFLEX	9	DORSIFLEX	9
EVERSION FOOT	9	EVERSION FOOT	9

FIRST ASSESSMENT: WEAKNESS/PARLYSIS XXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
FOLLOWUP ASSESSMENT, DETERIORATION XXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DISABILITY GRADES

	LEFT	RIGHT
EYE	9	9
HAND	9	9
FEET	9	9

SENSATION TESTS

EYE BLINKING X LAGOPHTHALMOS X

FEET	RIGHT	LEFT
SITE 1	X	X
SITE 2	X	X
SITE 3	X	X
SITE 4	X	X
SITE 5	X	X
SITE 6	X	X
SITE 7	X	X
SITE 8	X	X
SITE 9	X	X
SITE 10	X	X

HAND	RIGHT	LEFT
SITE 1	X	X
SITE 2	X	X
SITE 3	X	X
SITE 4	X	X
SITE 5	X	X
SITE 6	X	X
SITE 7	X	X
SITE 8	X	X
SITE 9	X	X
SITE 10	X	X

NAME OF THE ASSESSOR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure P: Physiotherapy Data Entry Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
HEALTH EDUCATION DATA COLLECTION FORMAT

FORM NO. 17
FORM TYPE OLDEF

PATIENT ID AA9999
DATE LESSON PROVIDED DD/MM/YY
TEACHING METHOD XXXXXXXXXXXXXXXXXXXXX

LESSON CODES
XXXXXX XXXXXXX
XXXXXX XXXXXXX
XXXXXX XXXXXXX

Figure (/Q) : Health Education Data Collection Format

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
DISABILITY REPORT
FROM DATE DD/MM/YY TO DD/MM/YY

FORM NO. 18
FORM TYPE OLDOF

	AGE GROUP						
DISABILITY GRADE	0 - 5	5-15	15-30	30-45	45-60	>60	TOTAL
1	999	999	999	999	999	999	999
2	999	999	999	999	999	999	999
3	999	999	999	999	999	999	999
TOTAL	9999	9999	9999	9999	9999	9999	9999

Figure R: Disability Report

NOTE:

This format provides information about new patients with disabilities and supports to assess the delay in case detection and the attention towards the age group. The report can be repeated for sex groups as well.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
REACTION REPORT
FROM DATE DD/MM/YY TO DD/MM/YY

FORM NO. 19
FORM TYPE OLDOF

	LEPROMATOUS PATIENTS						
TYPE OF REACTION	1987	1988	1989	1990	1991	1992	1993
LEPRA REACTION	999	999	999	999	999	999	999
ENL REACTION	999	999	999	999	999	999	999
	999	999	999	999	999	999	999
TOTAL	9999	9999	9999	9999	9999	9999	9999

Figure S: Reaction Report

NOTE:

This report provides information on the number of patients showing a reaction. It helps to estimate the resources needed to treat such cases (specialized medical care, medicines, hopitalization etc.)

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER ALERT REACTION REPORT YEAR OF REPORT YYYY		
	FORM NO. 20 FORM TYPE OLDOF PDOF	
KIND OF LEPROSY	BACTERIOLOGICALLY + AT BIGNING OF YEAR	PATIENT BECOMING BACTERILOGICALLY -
LL	999	999
BB	999	999
BT	999	999
TT	999	999
BL	999	999
NC	999	999
TOTAL	9999	9999

Figure T: Bacteriological status report

NOTE:

This report provides information for assessement of the effectiveness of treatment. Number of patients whose bacteriological index becomes negative is one of the good measurement technique for effectiveness of treatment procedures.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
TREATMENT ATTENDANCE REPORT
YEAR OF REPORT YYYY

FORM NO. - 21
FORM TYPE - OLDOF
PDOF

YEAR	NO.OF PATIENTS ATTE-NDING TRT FOR 1 YEAR	PATIENT TREATED REGULARLYFOR 1 YR
1990	999	999
1991	999	999
1992	999	999
1993	999	999
1994	999	999
1995	999	999
TOTAL	9999	9999

Figure U: Treatment Attendance Report

NOTE:
This form provides information about the variation of attendance vis-a-vis the duration of treatment. This information is important in knowing the extent required to take measures in inducing patients to continue treatment. This report can easily be modified to include the number of attendants classified by age, sex and type of leprosy.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
FORM OF LEPROSY REPORT
YEAR OF REPORT YYYY

FORM NO. 22
FORM TYPE OLDOF
PDOF

FORM OF LEPROSY	MALE	FEMALE	TOTAL
I	999	999	9999
TT	999	999	9999
BT	999	999	9999
LL	999	999	9999
BL	999	999	9999
NC	999	999	9999
TOTAL	9999	99999	99999

Figure V: Form of Leprosy Report

NOTE:

This report can easily be modified to include the forms of leprosy classified by age group.

ALL AFRICA LEPROSY & REHABILITATION TRAINING CENTER
ALERT
TREATMENT PROCEDURES REPORT
YEAR OF REPORT YYYY

FORM NO. 23
FORM TYPE OLDOF
PDOF

FORM OF LEPROSY	PATIENTS UNDER MONO	PATIENTS URDER MDT	TOTAL
I	999	999	9999
TT	999	999	9999
BT	999	999	9999
LL	999	999	9999
BL	999	999	9999
NC	999	999	9999
TOTAL	9999	99999	99999

Figure W: Treatment Procedures Report

APPENDIX V

DATABASE STRUCTURES

File # 1
Structure for database: G:\HOME\MOHAMMED\ADM_CAUS.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_ADMTD	Date	8		Y
3	DIS_CODE	Character	6		Y
4	DATE_DX	Date	8		Y
	** Total **		29		

File # 2
Structure for database: G:\HOME\MOHAMMED\ADMISSN.DBF

Field	Field Name	Type	Width	Dec	Index
1	WARD_NO	Character	3		Y
2	PAT_ID	Character	6		Y
3	DATE_ADMIT	Date	8		Y
4	DATE_DSC	Date	8		Y
5	BED_NO	Numeric	2		N
6	TRANS_FROM	Character	3		N
7	TRANS_TO	Character	3		N
	** Total **		34		

File # 3
Structure for database: G:\HOME\MOHAMMED\DIAGNOTE.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_DX	Date	8		Y
3	CLINIC	Character	6		N
4	PHYS_CODE	Character	4		N
5	GEN_COND	Character	8		N
6	COMPLICA	Character	30		N
7	OTHERNOTES	Memo	10		N
	** Total **		73		

File # 4
Structure for database: G:\HOME\MOHAMMED\DRUG.DBF

Field	Field Name	Type	Width	Dec	Index
1	DRG_CODE	Character	6		N
2	DRG_NAME	Character	20		N
	** Total **		27		

File # 5
Structure for database: G:\HOME\MOHAMMED\LAB_CODE.DBF

Field	Field Name	Type	Width	Dec	Index
1	TST_CODE	Character	6		Y
2	TST_DESCRP	Character	20		N
3	TST_KIND	Character	15		Y
	** Total **		42		

File # 6
Structure for database: G:\HOME\MOHAMMED\LESS_COD.DBF

Field	Field Name	Type	Width	Dec	Index
1	LESS_CODE	Character	4		Y
2	LESSON_TYP	Character	9		N
** Total **			14		

File # 7
Structure for database: G:\HOME\MOHAMMED\PATIENT.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_REG	Date	8		N
3	PAT_NAME	Character	15		Y
4	FATHERNAME	Character	15		Y
5	GRANDFATHR	Character	15		Y
6	SEX	Character	1		N
7	DATE_BRT	Date	8		Y
8	ADM_REG	Character	10		N
9	TOWN	Character	10		N
10	WOREDA	Character	15		N
11	KEBELE	Character	2		N
12	HOU_NO	Character	4		N
13	FAR_ASSN	Character	15		N
14	STAFF	Logical	1		N
15	STAF_FAM	Logical	1		N
16	NNSTAFFLEP	Logical	1		N
17	NNSTAFF_FA	Logical	1		N
18	ETN_GROUP	Character	10		N
19	RELIGION	Character	10		N
20	BIR_PLACE	Character	15		N
21	MARI_STAT	Character	7		N
22	DIVO_REAS	Character	15		N
23	NO_CHILDR	Numeric	2		N
24	ELD_CH_AGE	Character	2		N
25	YNG_CH_AGE	Character	2		N
26	MOTHE_ALIV	Logical	1		N
27	FATHE_ALIV	Logical	1		N
28	BROTHER_NO	Character	2		N
29	SISTRS_NO	Character	2		N
30	GUARDIAN	Character	30		N
31	REL_ADDIS	Character	30		N
32	OCCUP_NOW	Character	10		N
33	OCCUP_BEFO	Character	10		N
34	EDUC_BKGD	Character	10		N
35	REL_W_LEP	Character	30		N
36	DDS_T_DUR	Date	8		N
37	DEFAULTER	Logical	1		N
38	WHY_DEFLT	Character	25		N
39	NRST_CLIN	Character	10		N
40	HM_CLI_DS	Character	6		N
41	RESTOCOME	Character	20		N
42	INTERVWR	Character	30		N
43	COMMENTS	Character	30		N
** Total **			448		

File # 8
Structure for database: G:\HOME\MOHAMMED\PATNTSUR.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	SUR_DATE	Date	8		Y
3	SURG_COD	Character	6		Y
	** Total **		21		

File # 9
Structure for database: G:\HOME\MOHAMMED\PHYSIOTH.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_TEST	Date	8		Y
3	EYECLORI	Character	1		N
4	EYECLOLE	Character	1		N
5	ABD5FINR	Character	1		N
6	ABD5FINL	Character	1		N
7	ABDIFINR	Character	1		N
8	ABDIFINL	Character	1		N
9	ABDTHMBR	Character	1		N
10	ABDTHMBL	Character	1		N
11	OPPTHMBR	Character	1		N
12	OPPTHMBL	Character	1		N
13	WRSTEXTR	Character	1		N
14	WRSTEXTL	Character	1		N
15	DRSFLXFR	Character	1		N
16	DRSFLXFL	Character	1		N
17	EVERSFTR	Character	1		N
18	EVERSFTL	Character	1		N
19	FRSTASST	Character	10		N
20	FFASSMNT	Character	10		N
21	COMMENTS	Character	20		N
22	DISAEYER	Character	1		N
23	DISAEYEL	Character	1		N
24	DISAHANR	Character	1		N
25	DISAHANL	Character	1		N
26	DISAFEER	Character	1		N
27	DISAFEEL	Character	1		N
28	ASSESSOR	Character	30		N
29	SENEYEBL	Character	1		N
30	SENLAGO	Character	1		N
31	SENFTRT1	Character	1		N
32	SENFTRT2	Character	1		N
33	SENFTRT3	Character	1		N
34	SENFTRT4	Character	1		N
35	SENFTRT5	Character	1		N
36	SENFTRT6	Character	1		N
37	SENFTRT7	Character	1		N
38	SENFTRT8	Character	1		N
39	SENFTRT9	Character	1		N
40	SENFTR10	Character	1		N
41	SENFTL1	Character	1		N
42	SENFTL2	Character	1		N
43	SENFTL3	Character	1		N
44	SENFTL4	Character	1		N
45	SENFTL5	Character	1		N
46	SENFTL6	Character	1		N

47	SENFTL7	Character	1	N
48	SENFTL8	Character	1	N
49	SENFTL9	Character	1	N
50	SENFTL10	Character	1	N
51	SENHNDR1	Character	1	N
52	SENHNDR2	Character	1	N
53	SENHNDR3	Character	1	N
54	SENHNDR4	Character	1	N
55	SENHNDR5	Character	1	N
56	SENHNDR6	Character	1	N
57	SENHNDR7	Character	1	N
58	SENHNDR8	Character	1	N
59	SENHNDR9	Character	1	N
60	SENHNDR10	Character	1	N
61	SENHNDL1	Character	1	N
62	SENHNDL2	Character	1	N
63	SENHNDL3	Character	1	N
64	SENHNDL4	Character	1	N
65	SENHNDL5	Character	1	N
66	SENHNDL6	Character	1	N
67	SENHNDL7	Character	1	N
68	SENHNDL8	Character	1	N
69	SENHNDL9	Character	1	N
70	SENHNDL10	Character	1	N
71	SENASSER	Character	30	N
	** Total **		179	

File # 10
Structure for database: G:\HOME\MOHAMMED\SIGNSYMP.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_DX	Date	8		Y
3	SIGNS_SYMP	Character	10		Y
	** Total **		25		

File # 11
Structure for database: G:\HOME\MOHAMMED\SURGERY.DBF

Field	Field Name	Type	Width	Dec	Index
1	SURG_CODE	Character	6		Y
2	SURG_DESCR	Character	30		N
	** Total **		37		

File # 12
Structure for database: G:\HOME\MOHAMMED\TEACHMET.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_LESSN	Date	8		Y
3	TEACH_MT	Character	2		N
** Total **			17		

File # 13
Structure for database: G:\HOME\MOHAMMED\TRT_KIND.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	TRTMT_DATE	Date	8		Y
3	MONO	Logical	1		N
4	MDT	Logical	1		N
5	PRE_INFO	Character	30		N
	** Total **		47		

File # 14
Structure for database: G:\HOME\MOHAMMED\ADM_HIST.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_ADMTD	Date	8		Y
3	DATE_DSC	Date	8		Y
4	AMBULATORY	Logical	1		N
5	ADM_EXPLAN	Character	30		N
6	STATUS_DIS	Character	10		N
7	PHYS_CODE	Character	4		Y
	** Total **		68		

File # 15
Structure for database: G:\HOME\MOHAMMED\COMPLNT.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_DX	Date	8		Y
3	COMPLNT	Character	10		Y
	* Total **		25		

File # 16
Structure for database: G:\HOME\MOHAMMED\DISEASE.DBF

Field	Field Name	Type	Width	Dec	Index
1	DIS_CODE	Character	6		Y
2	DIS_NAME	Character	25		N
3	CODE_SOURS	Character	2		N
	** Total **		34		

File # 17
Structure for database: G:\HOME\MOHAMMED\DRUG_ADM.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	TRTMT_DATE	Date	8		Y
3	DRG_CODE	Character	6		Y
4	DATE_GIVEN	Date	8		Y
5	TIME	Character	5		Y
6	DOSAGE	Numeric	3		N
7	CUMULATIVE	Numeric	4		N
8	UNIT	Character	4		N
	** Total **		45		

File # 18
Structure for database: G:\HOME\MOHAMMED\HLTHPROG.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATEOFEVAL	Date	8		Y
3	DRUGUSE_PE	Numeric	3		N
4	HLTH_PRG	Character	10		N
5	RELEASED	Logical	1		N
6	DATE_REL	Date	8		N
	** Total **		37		

File # 19
Structure for database: G:\HOME\MOHAMMED\LAB_RESL.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		N
2	REPRTDATE	Date	8		Y
3	TST_CODE	Character	6		Y
4	RESULT	Character	8		N
	** Total **		29		

File # 20
Structure for database: G:\HOME\MOHAMMED\PAT_EDUC.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_LESSN	Date	8		Y
3	LESS_CODE	Character	4		Y
	** Total **		19		

File # 21
Structure for database: G:\HOME\MOHAMMED\PATNTDIS.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_DX	Date	8		Y
3	DIS_CODE	Character	6		Y
4	NEW_CASE	Logical	1		N
5	RELAPSE	Logical	1		N
6	REPEAT	Logical	1		N
7	ONSET	Numeric	2		N
8	PR_LESN	Character	7		N
9	NO_LESN	Character	6		N
10	DST_LSN	Character	9		N
11	HYPOPIGM	Character	8		N
12	DFN_LSN	Character	8		N
13	CEN_HEAL	Character	8		N
14	SEN_LOSS	Character	8		N
15	EYES	Character	9		N
16	MADUROSIS	Character	8		N
17	VOICE	Character	6		N
18	GEN_COND	Character	8		N
	** Total **		111		

File # 22
Structure for database: G:\HOME\MOHAMMED\PHYSICAN.DBF

Field	Field Name	Type	Width	Dec	Index
1	PHYS_CODE	Character	4		Y
2	PHYS_NAME	Character	30		N
	** Total **		35		

File # 23
Structure for database: G:\HOME\MOHAMMED\PRESCRIP.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	DATE_TRTED	Date	8		N
3	DRG_CODE	Character	6		Y
4	UNIT	Character	4		N
5	DOSAGE	Character	8		N
6	TRT_LENG	Character	8		N
7	QUANTITY	Numeric	4		N
	** Total **		45		

File # 24
Structure for database: G:\HOME\MOHAMMED\REPO_TEC.SRT

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	REPRTDATE	Date	8		Y
3	TST_KIND	Character	15		Y
4	TECHCODE	Character	4		Y
	** Total **		34		

File # 25
Structure for database: G:\HOME\MOHAMMED\SURGEON.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	SUR_DATE	Date	8		Y
3	SURGEON	Character	30		Y
	** Total **		45		

File # 26
Structure for database: G:\HOME\MOHAMMED\SURGHIST.DBF

Field	Field Name	Type	Width	Dec	Index
1	PAT_ID	Character	6		Y
2	SUR_DATE	Date	8		Y
3	SURGDETAIL	Character	100		N
	** Total **		115		

File # 27
Structure for database: G:\HOME\MOHAMMED\TECHNCAN.DBF

Field	Field Name	Type	Width	Dec	Index
1	TECHCODE	Character	4		Y
2	TECH_NAME	Character	30		N
	** Total **		35		

File # 28
Structure for database: G:\HOME\MOHAMMED\WARD.DBF

Field	Field Name	Type	Width	Dec	Index
1	WARD_NO	Character	3		Y
2	WARD_TYP	Character	10		N
** Total **			14		

File # 29
Structure for database: G:\HOME\MOHAMMED\HISTOPAT.DBF

Field	Field Name	Type	Width	Dec	Index
1	AHRI_NO	Character	7		Y
2	DATE_REQ	Date	8		Y
3	PAT_ID	Character	6		Y
4	REQ_CLINIC	Character	4		N
5	CLIN_INFO	Character	50		N
6	LAB_INFO	Character	10		N
7	CLIN_DIAG	Character	15		N
8	BIOP_SITE	Character	15		N
9	PRE_BIOPS	Character	10		N
10	PHYS_CODE	Character	4		Y
11	DATE_REPO	Date	8		N
12	REPORT	Character	100		N
13	CONCLUSION	Character	20		N
14	REPO_BY	Character	30		N
	** Total **		288		

APPENDIX VI

QUESTIONNAIRE DISTRIBUTED TO POTENTIAL USERS IN ALERT

A QUESTIONNAIRE SURVEY ON INFORMATION NEEDS OF USERS IN ALERT

Dear respondent

The aim of this questionnaire is to propose an improved information system development plan for ALERT and develop a prototype computer system that facilitates data collection, manipulation, and access to information in the way and the time you need the information. The system is expected to help put together all the required information needed for your daily activity, planning and general awareness about your field and reduce the clerical work that you are involved in, so that you & your staff will have much time to be concerned on the analytical rather than clerical aspect of your activity. The task of development is to be done as part of a thesis work for the masters course in Information Science.

INFORMATION ON HOW TO FILL THE QUESTIONAIRE

If the space provided is not sufficient for your answers, please use the attached blank papers and indicate the question number to which you are providing an answer. In some of the choice questions, if you find more answers than one choice, please circle each choice. More over, if the choice given does not suit to your answer use the blanks provided at the end of the choice question and put your own answer.

If you also want to recommend further about the need of computerized information system, you are welcome and you can attach your comments in the blank sheets.

Your earliest reply is well appreciated specially if submitted not later than February 20, 1994.

QUESTIONS

1) Do you want a change in the way your current information system is organized?
Yes ____ No ____
2) If your answer to question 1 is yes, do you want such a change to be supported by a computer system?
Yes ____ No ____

3) What are the data you require for your daily activity? For your planning activity? For your general awareness in your field?

Data for Daily Activity

_____
_____
_____
_____

Data for Planning Purposes

_____
_____
_____
_____

Data For General Awareness

_____
_____
_____
_____

4) What are your major problems with the current information handling system?
   a) The raw data is not readily summarized when needed
   b) Much of the data are not necessary
   c) Much important data are not collected by the existing system
   d) Information are not obtained as required and on time.
   e) Statistical reports important for our analysis are not produced at all.
   f) It is very difficult to pick or search a particular document from a pile of documents.
   g) Others (please list them below)

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

5) Are most of the information you need from the existing system bounded by strict dead lines?
   Yes _____ No _____
   If Yes, would you please list the kind and frequency of information that you need to be ready on those dead lines.

Type of information	Frequency of need
a)_____	_____
b)_____	_____
c)_____	_____

d)_____ _____
e)_____ _____
f)_____ _____

6) For what purpose do you need information? Circle the choice.
   a) For planning
   b) For Problem Solving
   c) For keeping updated about development in research
   d) Others (please specify)

_____
_____
_____

7) Would you please put in priority the activities (information needs) you want to be computerized.

First Priority

i) _____
ii) _____
iii) _____
iv) _____
v) _____
vi) _____

Second Priority

i) _____
ii) _____
iii) _____
iv) _____
v) _____
vi) _____

Third Priority

i) _____
ii) _____
iii) _____
iv) _____
v) _____
vi) _____

8) How important are the statistical reports produced in the statistics unit for your decision making or problem solving?

   a) Very important for us b) Not important for us
   c) we don't know the kind of statistical reports produced
   d) Any other comment (please specify)

_____

9) By whom do you feel data should be collected & compiled?

a) Collected by health assistants & compiled by statistician
b) Collected by chief of nurses & compiled by statistician
c) By statistician
d) By other data processing section
e) By other means (please specify)

_____

10) How willing are you to be involved in the development of an improved information system with the designer?

a) I am Willing to be fully involved as the designer requires
b) Only occasionally
c) I am so busy
d) Other comment (please specify)

_____

Dear Respondent

Would you mind filling the following information (OPTIONAL)

Your Name _____
Your Current Title _____
Your Division (section)_____
Date the questionnaire responded _____

Thank you for your responses.

APPENDIX VII

LIST OF PERSONS INTERVIEWED

Name	Title
Mr. Neil Alldred	Executive Director of ALERT
Dr. Tesfaye Bulto	Hospital Director of ALERT & Vice Ex. Director
Dr. Solomon Desta	Dermatologist
Dr. Said Abdulkadir	Surgeon
Mrs. Gunilla Ganlov	Head of the Laboratory
Ato Tsegaye Tadese	Senior Lab. Technician
Dr. S.A. R Kirishnan	D/Training Director
Ato Asfaw Tsegaye	Health Assistant
Ato Alemayehu Sendek	Health Assistant
Dr. H/Selassie H/mariam	Physician
Ato Sahlu Zewge	Physiotherapist

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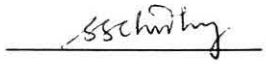
DECLARATION

The thesis is my original work and has not been presented for a degree in any other university.

MOHAMMED-SIED SALIH

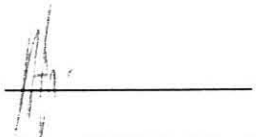
May 24, 1995

The thesis has been submitted for examination with our approval as university advisors.



Dr. G.G. Chowdhury

May 24, 1995



DR. TAYE TADESSE

May 24, 1995