Chapter 2

Problem domain

2.1 Introduction

When a patient with suspected bacterial infection admitted for the medical management, isolation of the microorganism is preferable for successful treatment of the causative organism. If the organism is isolated and identified, the most effective classes of antibiotics can be identified for the treatment [1]. This will improve the success of the treatment regime as well as minimize the emergence of antibiotic resistant to treatment agents. Blind treatment with antibiotics will leads to emergence of antibiotic resistant strains of bacteria [5].

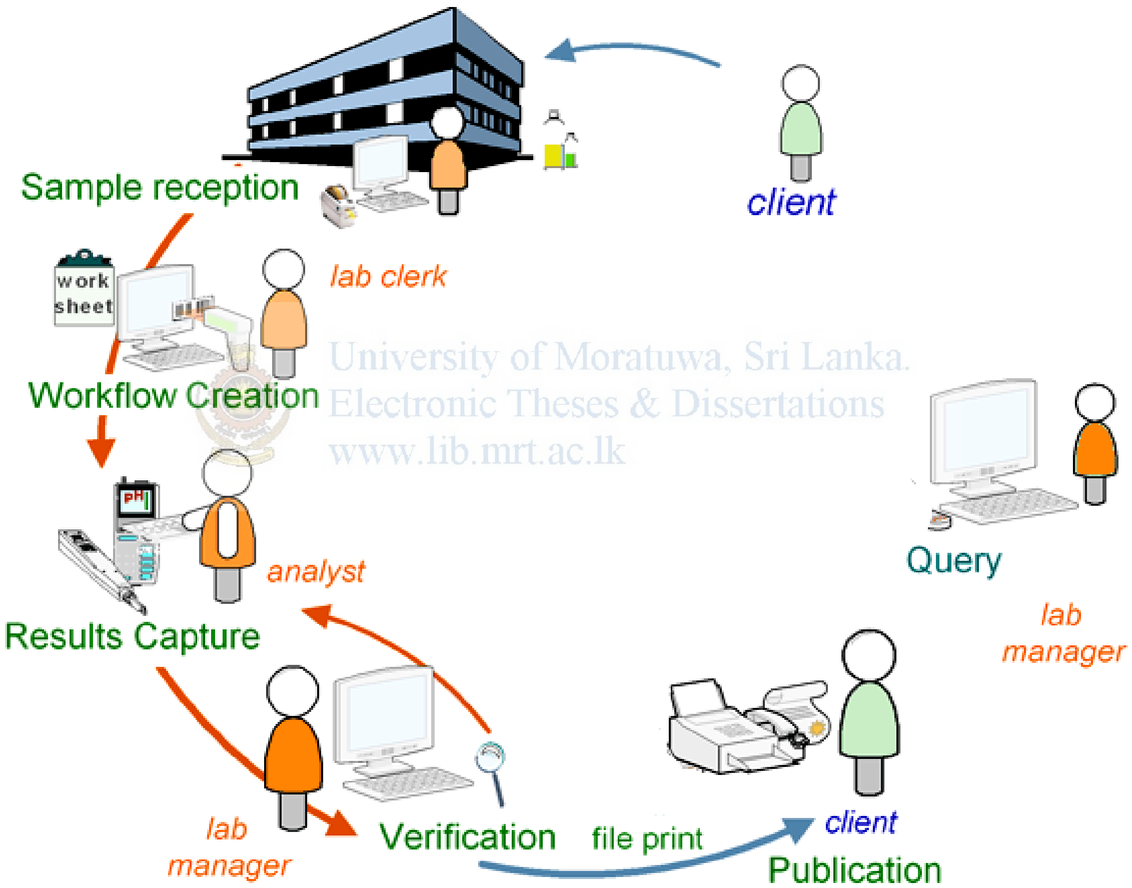

Figure 3: Overview of a laboratory information management system

Keeping proper records will make it possible to analyze the pattern of antibiotic resistance long before virulent pathogenic bacterial strains getting genetically mutated to produce drug resistant variants of the bacteria [2]. Carefully designed therapeutic guidelines will enable minimization of emergence of drug resistant bacterial strains [4].

To achieve this, hospital authority should have the timely and readily accessible data on antibiotic resistant pattern of the laboratory specimens. The proposed software will address the storage and analysis of drug resistant/sensitivity patterns of therapeutically important micro organisms to device therapeutic guidelines and treatment protocols.

Project is primarily aimed at developing a web technology enabled laboratory information management tool to store and manage antimicrobial drug information, antibiotic sensitivity test (ABST) data and therapeutically important microbial data. The software will allow feeding these information by various individuals along the line of processing antibiotic sensitivity tests in a laboratory environments. It facilitates secure and role based management of confidential information about patients and antibiotic sensitivity tests. It also has the ability to perform the analysis of stored information assisting microbiologists to come to conclusions on the drug resistant patterns of a particular laboratory within a specific time period. The project will use medical data exchange languages to design standard contents for the antibiotic sensitivity tests reporting forms used by the laboratories. Tool's design will be based on free and open source database and developer tools, allowing free distribution among interested parties.

BIKA LIMS [36, 37] is the only open source laboratory management system available right now. It is not specific to the microbiology field. Instead, it is more focused on Biochemistry laboratory procedures. BIKA LIMS will run as a module of the Plone Content Management system, which make it necessary to install Plone and to have expertise on the Plone CMS to use the LIMS system. Sub version of BIKA LIMS is available for Health Laboratory Information Management. This software is known as BIKA Health.

2.2 Problems and weaknesses of the manual laboratory information management

Manual laboratory document management is a time consuming task as well as it makes the data analysis procedure more cumbersome. In the present system, antimicrobial and ABST information are not properly stored for analytical purpose. Investigation results are kept in raw format for several months (3 – 6 months depending on the laboratory) for reissuing of the results if the original copy was lost.

If ABST information is necessary for any research or analytical purpose, it will not be available in a readily processed format.

Within the current system, there is no uniformity of laboratory data and standards in reporting formats. Request forms, Lab sheets and the Culture ABST reports vary form laboratory to laboratory. The types of antibiotics used in ABSTs are also varying depending on the laboratories which perform the tests. This makes the analysis of such data invalid even if analysis was performed.

Since there is no proper recording system, there is no way to monitor efficiency of the investigations performed through auditing the investigation process. Turn around time from acceptance of the specimen to the delivery of the report is a crucial factor for the successful management of the patient [18].

2.3 Comparison of BIKA LIMS with developed system

Table 1: Comparison of BIKA LMS and the proposed system

BIKA Health	Proposed System
General laboratory process and document management system	Microbiology laboratory specific document, process and information management system
Needs Plone Content Management System in addition to BIKA modules	Standalone system
Needs versatility in Plone before learning BIKA Health functions	Easy to learn the functionalities (steeper learning curve)
Based on the requirements of the South African continent.	Based on Sri Lankan health sector requirements and standards
Web enabled, multi user system	Web enabled, multi user system
User authentication based functionality	User authentication based functionality
Web browser based	Web browser based
Status tracking	Status tracking possible

Even though an open source system, BIKA fails to satisfy the requirement of local microbiology laboratories.

2.4 National Antimicrobial Resistance Monitoring System (NARMS)

NARMS [38] is collaboration among Centers for Disease Control and Prevention (CDC) of USA, U.S. Food and Drug Administration (Center for Veterinary Medicine) and U.S. Department of Agriculture (Food Safety and Inspection Service and Agricultural Research Services).

The National Antimicrobial Resistance Monitoring System (NARMS) for Enteric Bacteria was established in 1996, within the framework of the CDC's Emerging Infections Program's Epidemiology and Laboratory Capacity Program and the Food borne Diseases Active Surveillance Network (FoodNet). It is the only well established, national level drug resistance monitoring system. NARMS was studied extensively to get an idea of how to do antimicrobial resistance monitoring in national level and what are the possible benefits of such systems.

NARMS has a limited scope with limited set of bacteria and anti microbial agents. Participating health departments forward every twentieth non-Typhi Salmonella isolate, every

Salmonella Typhi, every twentieth Shigella isolate, and every twentieth E. coli O157 isolate received at their public health laboratories to CDC for susceptibility testing. Susceptibility testing involves the determination of the minimum inhibitory concentration (MIC) for 17 antimicrobial agents: amikacin, ampicillin, amoxicillin-clavulanic acid, apramycin, cefoxitin, ceftiofur, ceftriaxone, cephalothin, chloramphenicol, ciprofloxacin, gentamicin, imipenem, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline, and trimethoprim-sulfamethoxazole.

However, NARMS data have been collected continually since 1996, trend analysis is possible; this can provide useful information about patterns of emerging resistance, which in turn can guide mitigation efforts. NARMS data may also be an asset to outbreak investigations. Because antimicrobial use in food-producing animals may result in antimicrobial resistance which can be transmitted to humans through the food supply, antimicrobial resistance data from humans are important for the development of public health regulatory policy for the use of drugs in food-producing animals.

Summary

There is a need to store and analyze each and every record pertaining to antibiotic sensitivity and bacterial culture when a microbiological laboratory is operational. This stored data will allow analysis of the antibiotic resistant pattern and hence facilitate development of treatment protocols [31].

Next chapter will focus on the possible technological issues in developing a laboratory information management system to handle microbiological investigation procedures.