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THE PATH TO IMPROVING THE QUALITY OF LABORATORY DOCUMENTATION

(A CASE STUDY FROM CAMEROON)

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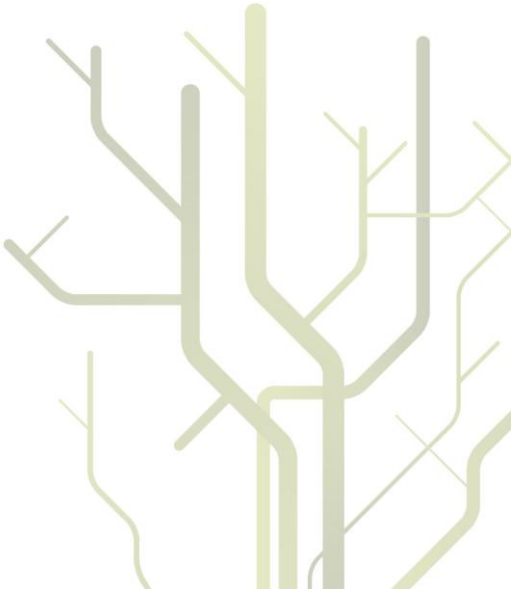

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ABSTRACT

Health care systems nowadays are affected by quality problems, most of which occur in developing countries due to the lack of adequate infrastructural, human, and financial resources. This has also caused the data quality generated in developing countries to be often poor. As a result, most governments in developing countries are in the process of improving quality in their health care systems through the introduction of Information Technology (IT) support systems.

This thesis explored the challenges and opportunities involved in the path to improving the quality of laboratory documentation in a Cameroonian hospital. The study employed the qualitative research approach whereby interpretive research methods were used during data collection. These consisted of participant observations, interviews, and document analysis. A total of 24 respondents were interviewed comprising of 19 hospital staff and 5 patients. The data was collected at the medical laboratory department of the Regional Hospital Bamenda over a period of two months. The theories of Information Infrastructures and Actor Network guided the study, that is, they were used to discuss the laboratory documentation, and the implementation of the IT support system in the everyday work practice.

The study findings primarily revealed certain quality-related lapses in the laboratory documentation. For example, illegible laboratory test orders, common errors in laboratory test ordering and result reporting, just to name a few. It further revealed that IT support systems have great potential to improve upon the quality of the laboratory documentation. Thus, it suggested that a tailored IT support system could be implemented to address this issue. However, the greatest challenge discovered was the lack of resources to make this happen. Based on these findings, it was suggested that if resources are made available to implement this system, the socio-technical approach should be employed in order to ensure success. This is because this approach has proven to be effective since it does not only take into consideration the new technology implemented, but also the interaction between the technology and its users.

Keywords: Actor Network Theory, Cameroon, Health care, Information Infrastructures, Information Technology, Laboratory documentation, Quality, Regional Hospital Bamenda

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LIST OF ABBREVIATIONS

1. ANT: Actor Network Theory
2. BLIS: Basic Laboratory Information System
3. CDC: Centers for Disease Control and Prevention
4. COS: Central Operating System
5. II: Information Infrastructures
6. IS: Information Systems
7. IT: Information Technology
8. Lab IDN: Laboratory Identification Number
9. MD: Medical Doctor
10. MoPH: Ministry of Public Health
11. QIC: Quality Improvement Collaborative
12. RHB: Regional Hospital Bamenda
13. WHO: World Health Organization

CHAPTER 1: INTRODUCTION

1.1: Background

The health care system has proven to frequently fall short in its ability to translate knowledge into practice, and to apply new technology safely and appropriately. This has resulted in the quality problems affecting the system (Institute of Medicine, 2001, p. 3). The Cameroonian health care system is no exception to the above phenomenon as evidenced by the ongoing pilot projects to improve quality of laboratory information (CDC, 2010).

This thesis explores the challenges and opportunities entailed in the path to improving the quality of laboratory documentation in a Cameroonian hospital, precisely the Regional Hospital Bamenda. The study is based on fieldwork from the laboratory department of the hospital, performed from the period of September to October 2010. It focuses primarily on the use of an Information Technology (IT) support system in a bid to improve on the quality of the documentation.

Over the past decade, the methodology for improving quality in health care has evolved (Massoud et al., 2001), to involve IT which plays a large and fundamental role in management, distribution, and storage of health information. Consequently, interdisciplinary access to health information is expected to increase the quality and continuity of care (Hellesø & Ruland, 2001). Given that the use of IT in healthcare reduces the manual and redundant entry of data, laboratory test and patient record systems can seamlessly transfer information without waiting for manual handoffs (Intel, 2003).

Similarly, it is believed that the quality of laboratory documentation at the Regional Hospital Bamenda (RHB) laboratory would greatly improve as a result of the implementation of an IT support system. This is because laboratory data will be better generated, managed, stored, and analyzed; waiting time for patients reduced, amongst others. This will boost the confidence level of the laboratory staff, and in turn eliminate competition from quack laboratories. However, the realization of the above successes will face a handful of challenges, some of which are centered on the fact that Cameroon is a developing country. Implying that the cost of purchasing IT may be high, human resources will need to be hired, and infrastructure to accommodate the system has to be set up. In addition, because quality improvement entails both humans and the technology, it may be challenging blending the two. The reasons being that the technology has to be collaboratively accepted by its

users; its implementation may generate some disorder in the work setting, and it may jeopardize privacy in health care if accessibility is not properly defined.

1.2: Purpose of the Study and Research Questions

The overall purpose of the study is to unravel the challenges and opportunities involved in improving the quality of laboratory documentation. Generally, it has been observed that the laboratory documentation has several lapses which go a long way to decrease its quality. This is because most of the documentation is paper-based and handwritten. In this respect, it is believed that introducing an IT support system will combat these lapses because it will increase accuracy, and smoothen the flow of information within and without the laboratory. With this in mind, the overall research question in this study is:

What factors shape the implementation of an IT support system to improve the quality of laboratory documentation?

The above research question translates into the following questions addressed in the research:

- What is the role of laboratory documentation in everyday clinical practice?
- How can laboratory documentation support interdisciplinary work?
- What are the quality-related lapses affecting the laboratory documentation?
- What kind of implementation strategy should be pursued to improve the quality of laboratory documentation?

1.3: Study Context and Methodology

This study was carried out at the medical laboratory department of the Regional Hospital Bamenda, Cameroon. Cameroon is a developing country located in the Central African region of the world.

In order to address the above mentioned research questions, the study employed the qualitative research design and in particular the interpretive case study research approach. Data for the study was collected through document (literature) analysis, participant observation, and interviews within a two-month period.

1.4: Motivation

My motivation to undertake this study is stemmed from my educational background and work experience as an intern and secretary, in the medical laboratory department of RHB, Cameroon. During this time, I observed that the laboratory documentation faced several quality-related challenges. Some of which include: illegible and ambiguous test orders, unnecessary repetition of analyses, long waiting time for patients, cumbersome statistical analyses procedures, just to name a few. So, coupled with the exposure I gained from the Master's course in Telemedicine and E-health at the University of Tromsø, and the great encouragement from my supervisor, I was able to proceed with this study.

1.5: Expected Contribution

This study gives insight into the different roles of laboratory documentation in everyday clinical practice, as well as the quality-related lapses affecting this documentation. It also explicitly elaborates on the challenges and opportunities of using IT systems to support information flow and boost up the quality level of laboratory documentation. As a result, the study contributes to expanding literature and discussions on quality improvement in health care systems in developing countries in particular. It is also hoped that this study will serve as a fundamental tool to advocate for the implementation of IT support systems in the Cameroonian health care system.

1.6: Outline of the Thesis

The thesis is organized into six chapters.

This *first chapter* being the introduction gives a foretaste of the study.

Chapter two, the theory, reviews findings from prior researches conducted in relation to the study, especially those related to quality in health care systems. It also describes the use of IT and its potential benefits for improving the quality of health care. Finally, this chapter elaborates on the theory of Information Infrastructures (II) to analyze the flow of information, and the Actor Network Theory (ANT) to depict the various actors, their roles, and interactions. These two theories guide the study given that they both dwell on the socio-technical approach, which involves the connection and interrelation between humans and technological components.

Chapter three, the research setting, illuminates entirely the context in which the research was carried out. This is done by providing a detailed description of the country (Republic of Cameroon) where the research was conducted, the hospital (Regional Hospital Bamenda) considered for the study, and the particular research site (the laboratory department).

Chapter four, the method, elaborates on the research approach and provides insight into how the study was conducted. It explains the purpose of the research and mentions the research questions. It also describes the quantitative, and the qualitative research designs with particular exposition on the interpretive research approach because it is the approach used during the research. Next, this chapter describes the different methods employed in collecting the study's data. This is followed by some reflections on the research method, pertaining to my role in the data collection process, and certain principles guiding interpretive fieldwork.

Chapter five describes in detail the case study, that is, the laboratory department, documentation, and ongoing processes in the laboratory. It begins with a detailed description of the routine workflow in the laboratory. This is followed by a description of the information infrastructures at the hospital in general and the laboratory in particular. Finally, this chapter elaborates on laboratory documentation: its different roles, the quality-related setbacks it encounters, and the IT system project aimed at improving it.

Chapter six provides an analysis and discussion of the key findings of the study, grounded on the theories of Information Infrastructures and Actor Network, with an overall focus on ensuring quality.

Chapter seven highlights major conclusions drawn from the findings of the study, and provides suggestions of the way forward. It also suggests possible areas suitable for further research.

CHAPTER 2: THEORY

This chapter aims at giving a broader understanding of the problems in this study, by relating them to relevant literature. It expounds on quality in health care systems and mentions the use of Information Technology systems as a potential means of solving particular underlying quality problems. Furthermore, two theories are employed namely: the theory of Information Infrastructures to analyze the flow of information, and the Actor Network Theory to depict the various actors, their roles, and interactions. A key relationship between these theories is the fact that they both highlight the feature of heterogeneity, that is, the socio-technical approach which involves both humans and technological components being connected and interrelated.

2.1: Quality in Health Care Systems

Certain studies relating to quality of care have revealed that many patients, doctors, nurses, and health care leaders are concerned about the fact that the care delivered is not necessarily the care we should receive (Donelan et al., 1999; Reed & St. Peter, 1997; Shindul-Rothschild et al., 1996; Taylor, 2001), as explained in the proceeding sections. As a result, it is thought that the health care delivery system is in need of fundamental change.

Today, quality problems in health care systems still exist and can account for the frustration levels of both patients and clinicians, as well as the routine failure of the health care system to deliver its potential benefits. As such, there exists not just a gap, but a chasm between the health care we have and the care we could have. For this reason, a Committee on the Quality of Health Care in America was formed in June 1998, and charged to develop a strategy that would result in a threshold improvement in the quality of health care over the next ten years. This committee is of the opinion that the quality problems in today's health care delivery are due to the following reasons: the growing complexity of science and technology, the increase in chronic conditions, a poorly organized delivery system, and the constraints on exploiting the revolution in information technology. However, they believe that Americans can have a health care system of the quality they need, want and deserve. But the current systems of care will have to be changed in order to achieve this higher level of quality. In order words, some areas of health care will have to cross the large chasms between today's system and tomorrow's possibilities (Institute of Medicine, 2001, p. 1, 4, 25).

The year 1998 was a watershed in the quest for improvement in the quality of healthcare (Kizer, 2000), whereby three major reports addressing serious quality-of-care concerns were issued. A report by the Institute of Medicine National Roundtable on Health Care Quality addressed three types of quality problems namely: overuse, underuse, and misuse (Chassin et al., 1998). Another report by the Advisory Commission on Consumer Protection and Quality concluded that the health care industry is plagued with overutilization of services, underutilization of services, and errors in health care practice (Advisory Commission on Consumer Protection and Quality in the Health Care Industry, 1998). The last report consists of the results of an extensive literature review of studies categorized under the rubric of quality of care (Schuster et al., 1998), and it substantiates the serious and pervasive nature of quality of care problems.

As of now, the Committee on the Quality of Health Care in America has already addressed one urgent issue: patient safety, which is a subset of overall quality-related concerns. But the Committee believes that a major force for improving patient safety is the intrinsic motivation of health care providers, shaped by professional ethics, norms, and expectations. Notwithstanding, this address mentions that health care is not as safe as it ought to be, as evidenced from medical errors being a leading cause of death and injury (Institute of Medicine, 2000).

An error is defined as the failure of a planned action to be completed as intended (i.e., error of execution) or the use of a wrong plan to achieve an aim (i.e., error of planning) (Reason, 1990).

According to the World Health Organization (WHO) guide on data quality, good quality data is described as being accurate, complete, readable, accessible when it is required, and useful for the intended users (WHO, 2003). Based on this description, it has been observed that the data quality in several developing countries is poor. This is because the data is often incomplete, inaccurate, untimely, obsolete, and unrelated to the task and function of local health personnel. Hence, the data is usually not helpful in the management of decision making (Sauerborn & Lippeveld, 2000). This poor data quality in turn greatly accounts for the fact that program planning and implementation in most developing countries are often based on estimation, tradition, and guess work. Consequently, scarce resources are inappropriately allocated giving rise to health services that cannot respond adequately to needs (Azubuike & Ehiri, 1999; Sandiford, Annet, & Cibulskis, 1992; Sauerborn & Lippeveld, 2000).

As revealed by a study on health information systems in developing countries (Azubuike & Ehiri, 1999), the following factors are said to account for the poor data quality:

- Inadequate health data collection systems: Many developing countries lack an organized and structured data collection system that incorporates village, community, district, regional, and state levels. As a result, the data collected is inaccurate and incomplete.

- Resource constraints: Most developing countries lack resources like skilled personnel, computer technology to deal with huge amounts of data, and software to enhance storage, retrieval, and transmission of data.

- Incentives to collect health information: In most developing countries, many health workers earn low wages, have a low morale, and work under poor conditions. They also have a limited understanding as to the objective of collecting data. Thus, they are neither interested nor motivated to collect data, or worst still, the data they collect is usually inaccurate and incomplete.

- Inadequately trained personnel: Most developing countries suffer from a shortage of adequately skilled health workers. For example, statisticians, data analysts, amongst others.

Lippeveld (2001) mentions that the poor data quality in most developing countries is due to constraints like: power shortages, lack of essential health information system supplies (for example, printed forms or registers), lack of essential communication technologies (for example, telephone lines between health units and district headquarters), and lack of technical staff (to ensure software and hardware maintenance).

Similarly, Anja et al. (2000) mention that impediments like: the lack of modern and adequate information and communication technology, lack of skilled personnel, low income and morale, and cultural differences, account for the poor data quality in most developing countries.

In recent years, most developing countries have acknowledged the need to improve on the quality of health care. Thus, they are making reforms in the general health system and particularly restructuring health information systems (Sauerborn & Lippeveld, 2000). Cameroon, as one of the developing countries has introduced public service reforms which have had great and positive impacts on the health sector. Some of which include: improving human resource policies, improving the general organization of the health sector, setting up a quality control laboratory for the study of the quality of drugs, improving on the quality of health workforce (for example, work environments and staff

remuneration), amongst others (Ngufor, 1999). Hence, the potential benefits from this initiative are discussed below.

2.2: The use of IT and its Potential Benefits for Improving Quality

According to WHO, the need for quality health information is more acute in developing countries where resources are limited, and unwise allocation of funds could imply a great difference between survival and death (WHO, 2006b). However, information and communication technologies are expected to play a key developmental role in poor countries. Many see potentials in these technologies to provide unprecedented opportunities for information-intensive social services, such as health and education (Avgerou, 2000).

For instance as illustrated in a case from Norway, certain investigations completed in 2002 (Haaheim et al., 2002), revealed that there were some problems associated with logistics, resources, quality, and existing infrastructures at the university hospital. At the laboratory in particular, a major cause of the problem was because the incoming requisitions were paper-based. Thus, the hospital planned for several years to improve quality and efficiency of its pre-analytic laboratory services. It later resorted to establishing electronic laboratory requisitions from General Practitioners' offices, and this greatly improved the quality problem, especially as the number of errors made in filling in requisition forms dramatically decreased (Ellingsen & Røed, 2010).

In addition, other studies evaluating the electronic laboratory requisitions from General Practitioners have proven to improve the quality of health care. This is because it ensures that only appropriate testing is done, and re-enforces the clinical guidelines for the performance of some preventive testing and follow-up (Shalev, Chodick, & Heymann, 2009).

In the light of developing countries, a study conducted in Malawi revealed that problems related to their health information system (for example, poor reporting and poor data management) were amended and stayed sustainable for four years, with the implementation of information and communication technologies (Braa, et al., 2004).

Similarly, the Committee on the Quality of Health Care in America is of the opinion that for a substantial improvement in quality to be achieved over the coming decade, IT must play a central role in the redesign of the health care system. This will in turn prevent errors, enhance consumer confidence, and improve efficiency in the health system (Institute of Medicine, 2001, p. 16).

Generally, the IT revolution which has been transforming nearly every other aspect of society has relatively not touched health care delivery. Although a majority of patient-clinician encounters occur for purposes of exchanging clinical information, only a small fraction of physicians offer e-mail interaction (a simple and convenient tool for efficient communication) to their patients (Hoffman, 1997).

One of the most important inputs to the provision of proper care is the meticulous collection of a patient's personal health information throughout life. But unfortunately, many health care settings lack basic computer systems to provide clinical information or support clinical decision making. Consequently, many forms of chronic illnesses have become nearly impossible to manage because for most individuals, their health information is dispersed in a collection of poorly organized and often illegible paper records, which cannot be retrieved in a timely fashion (Institute of Medicine, 2001, p. 15).

The safety and quality problems which exist in today's health care system are because the latter relies on outmoded systems of work. So, regardless of how hard the health care workforce tries, it fails due to poor designs. Redesigning systems of care to include the use of IT to support clinical and administrative processes is very vital because, it will ensure safer and higher-quality care, as well as improve efficiency (Institute of Medicine, 2001, p. 4).

The Internet has enormous potential to transform health care through IT applications in areas like consumer health, clinical care, administrative and financial transactions, public health, professional education, and biomedical health services research (National Research Council, 2000). Though some of these applications are more experimental (for example, the simulation of surgical procedures), many are currently within reach (for example, videoconferencing during emergency situations, remote medical consultations with patients in their homes, just to name a few) (Institute of Medicine, 2001, p. 15). The Internet also supports the rising interest among consumers in information and convenience in all areas of commerce, including health care. It has been estimated that about seventy million Americans use the Internet to retrieve health-related information (Cain et al., 2000).

According to the Committee on the Quality of Health Care in America, six specific aims for improving the quality of health care include the fact that health care should be:

- *Safe*: avoiding injuries to patients from the care that is intended to help them.

- *Effective*: providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and overuse).

- *Patient-centered:* providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions.

- *Timely:* reducing waits and sometimes harmful delays for both those who receive and those who give care.

- *Efficient:* avoiding waste, in particular waste of equipment, supplies, ideas, and energy.

- *Equitable:* providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socio-economic status

(Institute of Medicine, 2001, p. 39-40).

Based on the above listed six aims, IT has potential to improve the quality of health care as discussed respectively below.

- *Safety:* There exists growing evidence that automated order entry systems can reduce errors in drug prescribing and dosing (Bates et al., 1997, 1998a, 1999).

- *Effectiveness:* Considerable evidence exists that automated reminder systems improve compliance with clinical practical guidelines (Balas et al., 2000; Shea et al., 1996), and few promising studies indicate that computer-assisted diagnosis and management can improve quality (Durieux et al., 2000; Scott et al., 1998).

- *Patient-centeredness:* IT can facilitate access to clinical knowledge via understandable and reliable Web sites and online support groups (Cain et al., 2000); customized health education and disease management messages (Goldsmith, 2000). By using clinical decision support systems, IT can enable tailoring of information according to individual patient's characteristics, genetic makeup, and specific conditions (Garibaldi, 1998).

- *Timeliness:* Both patients and clinicians can benefit from Internet-based communication, immediate access to automated clinical information, diagnostic tests, and treatment results (Institute of Medicine, 2001, p. 164).

- *Efficiency:* It can be improved by using clinical decision support systems which reduce redundant laboratory tests (Bates et al., 1998b).

- *Equity:* If all people have access to technology infrastructure, they can get a broader array of options for interacting with clinicians through Internet-based health communication (Science Panel on Interactive Communication and Health, 1999).

Overall, IT is increasingly being used to ease communication of information across healthcare teams and groups with the aim of making the delivery of care safer and more efficient (Catwell & Sheikh, 2009; Mort & Smith, 2009). Studies also show that the exchange of patients' health information across organizational boundaries through automated systems holds the promise of quality improvements and cost savings for health care service organizations (General Accounting Office, 1991). In health care since time impacts both the quality and cost of patient care, when accurate and up-to-the-minute patient information is accessible at the point of care, doctors and nurses save valuable time otherwise devoted to waiting for laboratory results, locating charts, or researching treatment outcomes (Intel, 2003). Thus, several countries worldwide are now committed to the increasing use of IT in healthcare settings (Singleton, Pagliary, & Detmer, 2009). Cameroon is not left out of this. There are plans underway to deploy IT to the health sector. However, in order to achieve this deployment, the notion of information infrastructures is needed as a guide. In this light, this notion is discussed below.

2.3: Information Infrastructures (II)

In order for the use of IT systems in health care to improve quality, the concept of Information Infrastructures needs to be employed. This is because health systems are socio-technical systems where outcomes emerge from the interaction of people and technologies (Coiera, 2004). So, this concept is used as a guide to understand the connection between health care systems, technologies, and their users.

In complex organizations like hospitals, in order for anything to work, the web of interactions always entails humans (social systems) solving problems with limited resources (technical systems) and working around imperfect processes (Coiera, 2004). This implies that systems comprise of people, tools, and conversations joined together (Coiera, 2003), and organizational or technical systems cannot be designed independently of each other (Coiera, 2004). In this light, a hospital information

system could be seen as a huge socio-technical system, containing an information infrastructure linking health professionals to routine work practices.

According to Webster's dictionary infrastructure is defined as:

"a substructure or underlying foundation; especially, the basic installations and facilities on which the continuance and growth of a community, state, etc. depends as roads, schools, power plants, transportation and communication systems, etc" (Guralnik, 1976).

Hanseth & Monteiro (1998) define an infrastructure as:

"an evolving shared, open, and heterogeneous installed base."

The term 'infrastructure' has been presented as a substrate upon which something else runs or operates, and this substrate is initially built and maintained, but remains invisible. By implication an infrastructure becomes transparent when a large-scale technology brings solutions for the local and global variations in practice, which can then be used in a natural and easier way (Star & Ruhleder, 1996).

In relation to IT, the term 'infrastructure' has been used to denote basic support systems. For example, operating systems, file servers, communication protocols, and printers. This term was introduced due to a rise in the complexity of computing in organizations, in an effort to separate between such underlying support systems and the applications using them. Therefore, the examples of support systems mentioned above can be seen as an evolution of computer networks, inter-organizational systems, and distributed information systems. Information infrastructures although similar to information systems, are larger, more complex, and more diversified. Other aspects in which they differ are illustrated in the table below (Hanseth & Monteiro, 1998).

Information Systems (IS)	Information Infrastructures (II)
Made up of one individual component	Made up of large integrated systems
Have a limited and clear purpose	Have a broad purpose
Assume closed systems within organizational boundaries	Assume opened systems, that is, they have no start-date and no termination-date
Are developed within a hierarchical structure (that is, top-down project)	Development is evolutionary
Are centrally controlled	Lack complete control

Table 1: Differences between Information Systems and Information Infrastructures

The concept of information infrastructures is visualized as a combination of information and infrastructure technologies. This implies that II constitute a step in the development of information technologies as well as a step in the development of infrastructure technologies. In this respect, II are thought to share certain aspects with other kinds of information technologies, while having some unique aspects which make them different (Hanseth & Monteiro, 1998).

Information infrastructures are never transparent for everyone, and as they scale up, their work-ability becomes increasingly complex (Bowker & Star, 1999). In addition, the integration of II grows as the number of systems grow (Hanseth, 2002). Analyzing II is a tricky thing to do (Bowker & Star, 1999). However, in order to understand II, Hanseth & Monteiro (1998) conducted a study on the primary characteristics of other technologies in general, and analyzed how these characteristics appear in II. As a result, they identified key aspects of IIs, and in particular what makes them different from IS.

2.3.1: Key Aspects of Information Infrastructures

According to Hanseth & Monteiro (1998) primarily, the following characteristics give a deep insight into information infrastructures:

i. *Enabling*: II are designed to support not just one activity but a wide range of activities. In this sense, an infrastructure aims at opening up a field of new activities, not just improving or automating

already-existing ones. This is quite contrary to being especially designed to support one way of working within a specific application field (Hanseth & Monteiro, 1998). Thus, II reach beyond a single event or one-site practice. By virtue of this enabling property, II embody a set of standards which ensure their success by permitting and facilitating interconnection and interoperation between networks (Bowker & Star, 1999).

ii. Shared: Although II may appear differently, they are shared by the members of a community, or user groups, or a collection of users. This is because the information infrastructure is the one and same object used by all of them. For this reason, II are seen as irreducible, that is, they cannot be split into separate parts being used by different groups independently. A good example of a shared information infrastructure is e-mail communication, which is used by any set of users in any context consistent with its overall goals (Hanseth & Monteiro, 1998).

iii. Open: This implies that in II there are no limits as per the number of users, stakeholders, vendors involved, nodes in the network, and other technological components, application areas or network operators. Thus, II are constantly evolving as proven by several activities with varying relations over time, varying constellations and alliances, changing and unstable conditions for development, and changing requirements. Due to this constant evolution, II have no beginning or ending, their development time is open and ongoing. In addition, the open nature of II implies that they lack borders. This implies that one cannot draw strict borders between infrastructures because of the relevant connections or overlaps between them (Hanseth & Monteiro, 1998).

iv. Socio-technical networks: II are sunk into, inside of, other structures, social arrangements, and technologies (Bowker & Star, 1999). They are not just 'pure' technology but they embody technological components, humans, organizations, and institutions. In order to tap the potential of II, people have to create information, develop applications and services, construct facilities, and train others. So in effect, without support from people, II cannot work (Hanseth & Monteiro, 1998).

v. Heterogeneity: II consist of unlimited number of users, developers, stakeholders, components, and use areas. They are also considered to encompass components such as: a wide range and ever-expanding range of equipment, the information itself, applications and software, network standards and transmission codes, as well as people. Being heterogeneous also means that II can implement the same logical function in several different ways. For instance heterogeneity can be caused by these forms of infrastructure development: a standardized part (protocol) of an infrastructure being replaced over time by a new one, or larger infrastructures being developed by interconnecting two existing

different ones, or larger components or infrastructure being built based on existing smaller, independent components. Although II are heterogeneous, they are connected and interrelated, constituting ecologies of networks (Hanseth & Monteiro, 1998). For these reasons changes in II take time and involve negotiation, adjustment and other aspects of the systems concerned (Bowker & Star, 1999).

vi. Installed base: II do not grow de novo, but are considered always already existing. New infrastructures are developed by extending and improving the installed base (that is, the old infrastructure). The new infrastructure wrestles with the inertia of the installed base and inherits strengths and limitations from that base. By implication the new and old infrastructures are connected, with the old one heavily influencing the design pattern of the new one. The new version must be designed so as to ensure interoperability between the old and new versions. This property makes II transparent because they do not have to be reinvented each time or assembled for each task, but they invisibly support those tasks (Bowker & Star, 1999; Hanseth & Monteiro, 1998).

The theory of Information infrastructure is related to laboratory documentation below.

2.3.2: Laboratory Documentation Infrastructure

Generally, the traditional flow of information within and without the laboratory is via paper documents, which altogether make up the laboratory documentation. In the documentation of laboratory data, standards (a set of agreed-upon rules for the production of objects) are being employed. These standards ensure that the data is uniformly read and interpreted by any other laboratory staff.

The laboratory documentation infrastructure has several overlapping components (fragmented domains) which are linked together by human resources (see figure below).

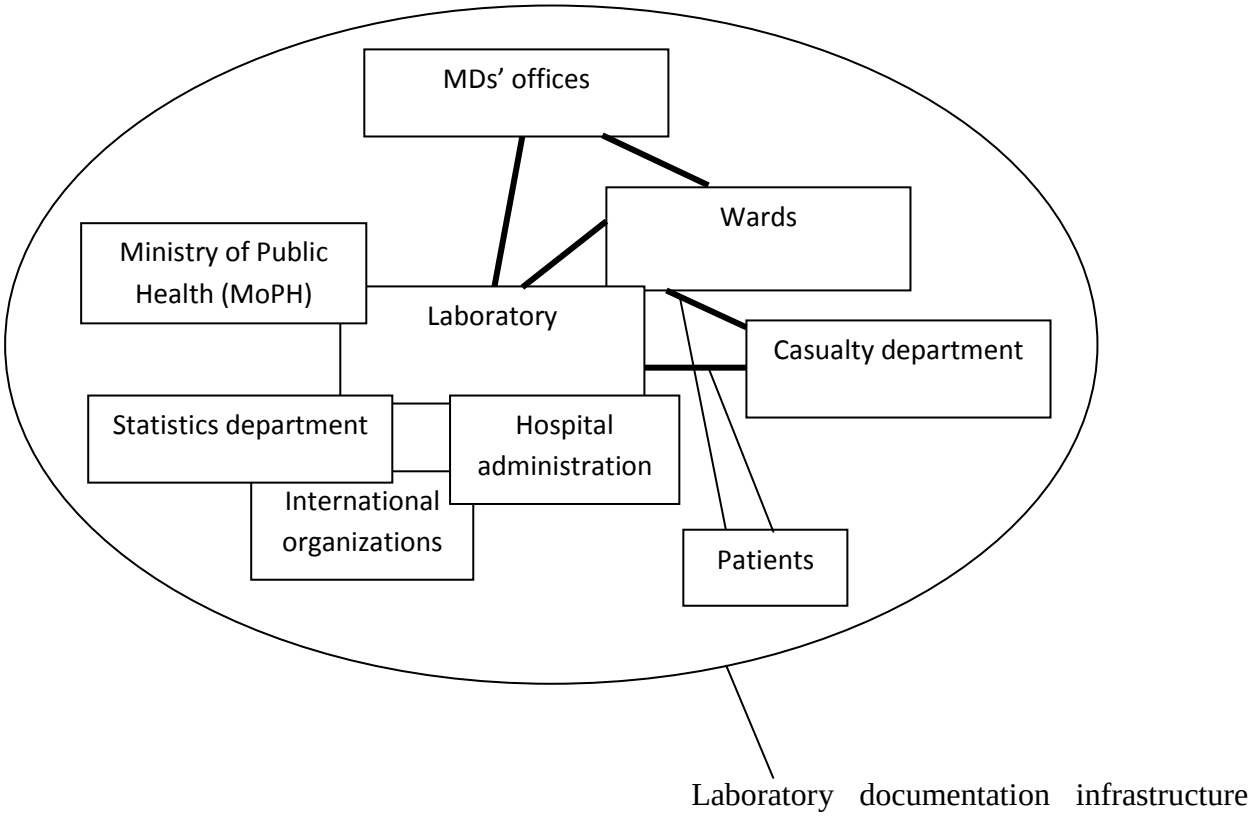


Figure 1: The Structure of the Laboratory Documentation Infrastructure

The above components linked together by patients make up the routine workflow. The patients link up most of these domains because they are responsible for delivering their laboratory test orders to the laboratory and the corresponding results back to the MDs, or nurses in the wards or Casualty department. This implies that the laboratory documentation is embedded into other structures, social arrangements and technologies. Therefore, without support from people (social components/humans) the laboratory documentation (technological component) cannot work.

Overall the routine workflow prominently uses the laboratory documentation in diagnosing diseases and determining disease prevalence (done through MoPH). More so, from this documentation, statistical analyses and individual country health profiles are compiled which guide hospital administrations during the purchase of laboratory reagents, and enable international organizations to fund health projects in the countries concerned, respectively.

In the routine workflow, paper documentation has been in existence from time immemorial. As such, designing an IT support system in the future will be influenced by, and must be linked and interoperable with the paper documentation. Although this documentation has great potential for constant evolution, the evolution process will entail a lot of time, negotiations, and adjustments.

On the whole, in order for health services to be of better quality, they should entail new technologies and innovation in clinical roles, work processes, and culture change (Coiera, 2004). For example, if the goal of designing an electronic medical record is to ensure that highest quality data are entered into the information system, it may be even more important to support collaborative discussion between clinicians than transcribing records into the system (Coiera, 2003).

Nowadays, it is becoming clear that the work environment may impose unacceptable loads on human cognitive abilities and potentially lead to memory overload and error (Parker & Coiera, 2000). Thus, if health care should evolve at a pace that will meet the needs of society, it will need to embrace the socio-technical design. Perhaps this journey begins by designing a sustainable and flexible culture that does not fear innovation and sees the redesign of roles, processes, organizations, and careers as the first amongst all of its duties (Coiera, 1999). Consequently, the Actor Network Theory is discussed below.

2.4: Actor Network Theory (ANT)

Based on the underlying assumption that introducing IT in health care will improve the flow of information and the quality of care, it can be argued that health services research especially evaluations of complex IT systems in health care organizations may benefit from being informed by ANT (Cresswell, Worth, & Sheikh, 2010). This is because an ANT-informed approach in health care settings can be beneficial both conceptually and practically (Cresswell, Worth, & Sheikh, 2010), that is, ANT can be useful in exploring changing power relationships in relation to work practices, health care reforms, and IT introduction (McLean & Hassard, 2004).

One of the reasons why the Actor Network Theory (ANT) emerged is because new methodology and theoretical devices are needed to enable us to think about hybrids of people and information technology. This theory argues that people and artefacts should be analyzed with the same conceptual apparatus because the social and technical are inseperable (Walsham, 1997). Consequently, because health systems are socio-technical systems (Coiera, 2004) and by implication hospital information

systems too, the latter could be analyzed in the light of ANT to enable a better understanding of the different actors and their respective roles.

Actor Network Theory (ANT), also known as the sociology of translation or enrolment theory, emerged in the mid-1980s primarily pioneered by Bruno Latour, Michel Callon, and John Law (Actor network theory, 2010). ANT is concerned with investigating social and technical elements put together, while creating and maintaining coextensive networks of human and nonhuman elements (Walsham, 1997). In other words, it is a conceptual frame for exploring collective sociotechnical processes with particular attention to science and technology activity (Actor network theory, 2010).

ANT traces its roots from the interdisciplinary field of Science and Technologies Studies (Actor network theory, 2010; Monteiro, 2000). Thus, it suggests that the work of science is not fundamentally different from other social activities. ANT considers science as a network of heterogeneous elements realized within a set of diverse practices. This is because ANT advances a *relational materiality*, the material extension of semiotics which presupposes that all entities achieve significance in relation to others (Actor network theory, 2010).

Generally, all activities are performed under the influence of a wide range of surrounding factors. Thus, the term actor-network refers to the act linked together with all of its influencing factors (which again are linked), producing a network. This implies that actor-network consists of and links together both technical and non-technical elements (Monteiro, 2000). In addition, it can be described as a heterogeneous network of aligned interests, including people, organizations and standards (Walsham, 1997). The theory of actor-network consists of certain key concepts as described below.

2.4.1: Some Key Concepts of ANT

a) Actor (or actant)

An actor is one who is counted on in the network; cannot be ignored but relates to other actors, because of the actor's role or influence (Law, 1987). Actors include both human beings and nonhuman actors such as technological artefacts (Walsham, 1997). The human or volitional actor for ANT is usually referred to as the actant. Actants generally derive their nature via the networks in which they associate (Actor network theory, 2010). Worth noting is the fact that in ANT, actors usually have different interests which as a matter of importance must be identified (Ellingsen, 2009).

b) Inscription

According to Akrich (1992) and Akrich & Latour (1992), the concept of inscription is particularly relevant in ANT. Inscription refers to the way technical artefacts embody patterns of use. Thus, an inscription can be used to describe how concrete anticipations and restrictions of future patterns of use are involved in the development and use of a technology (Monteiro, 2000). According to this concept, an actor should behave in a certain way, but making presumptions about the other actors in the network. In ANT language this is a kind of script, scenario or "program of action" (Latour, 1991) because the actor stands in and speaks for particular viewpoints which have been inscribed in him/her, that is, the actor's interests (Walsham, 1997). Inscriptions are given concrete content because they represent interests inscribed into a material (Law, 1992). However, the strength of inscriptions vary in that, some structure the pattern of use strongly while others structure it weakly. But the irreversibility of the actor-network into which interests are inscribed determine whether an inscription must be followed or can be avoided (Monteiro, 2000).

c) Translation

This concept entails collaboration, compromise, and negotiation between different users with different goals depending on the available possibilities. It is such that by the end, the different users reach their own respective goals. In the translation process, users' and others' interests may be translated into specific needs which are further translated into more general and unified needs (Monteiro, 2000).

Worth mentioning is the fact that a body of human and nonhuman allies is created by translating actors' interests to be aligned with the actor-network (Walsham, 1997). This means that the occurrence of a successfully aligned network depends on how successful actors translate each other's interests. The latter is very vital because amongst several possibilities, actors would only select that which in their own eyes would help them arrive at their goals (Latour, 1987).

Given that actors have a diverse set of interests from the onset, stability lies crucially on the ability to translate, that is, to re-interpret, re-present or appropriate, others' interests to one's own. However, when actors interests aligned in the actor-network attain that stability and social order, the alignment becomes irreversible or difficult to return to a point where alternative possibilities exist (Monteiro, 2000; Walsham, 1997). ANT employs terms like 'black box' and 'immutable mobile' to describe network elements with strong properties of irreversibility (Walsham, 1997).

As suggested by Callon (1986), the process of translation entails four moments namely:

1. *Problematisation:* It entails identifying the problem that needs to be solved, the relevant actors, and the delegates to represent the groups of actors. Then a primary actor is defined who acts as an obligatory passage point between the other actors and the network.

2. *Interessement:* It involves negotiating the terms of involvement of the interested actors. At this stage the primary actor convinces the other actors to accept the roles assigned them.

3. *Enrollment:* It refers to actors accepting the roles that have been defined for them during interessement.

4. *Mobilization of allies:* At this stage, assessment is made to see if the delegated actors in the network adequately represent the masses. If so, enrollment then becomes active support.

In summary, ANT examines the motivations and actions of group of actors that form elements linked by associations of heterogeneous networks of aligned interests (Walsham, 1997). It provides a language to describe how, where, and to which extent technology influences human behavior. Thus, ANT gives more insight on what it takes to get a technology functional and not on the functioning of the technology (Monteiro, 2000).

Analytically, ANT is interested in investigating and theorizing how networks come into being, tracing what associations exist, how they move, how actors are enrolled into a network, how parts of a network form a whole network, and how networks achieve temporary stability (or conversely why some new connections may form networks that are unstable) (Doolin & Lowe, 2002; Callon, 1986; McLean & Hassard, 2004).

2.4.2: ANT in Relation to Quality Health Care

Currently, one of the major challenges healthcare organizations globally face is to judiciously apply new technologies and intelligently redesign antiquated processes and structures, so that the application of these new technologies will be optimal. In so doing, it is believed that healthcare organizations will be better positioned to offer cost effective, quality health care delivery (Wickramasinghe et al., 2007).

Ever since the Institute of Medicine (2001) described the so-called “quality chasm” in health care, quality improvement has become an important policy issue. But a proposed solution for bridging this quality chasm is setting quality improvement collaboratives (QICs) to work. Generally, QICs are

often labelled as black boxes because their effects usually do not describe exactly how the results were obtained. However, ANT can be applied as a methodology for opening these black boxes of QICs (Broer, Nieboer, & Bal, 2010).

Although ANT could greatly benefit IT oriented health services (Cresswell, Worth, & Sheikh, 2010), information transmission via IT is not straightforward as inputs are often transformed into unpredictable outputs (Mort, Finch, & May, 2009). The reason being that the health care environment is multifaceted, implying that different groups use various technologies in complex ways (Cresswell, Worth, & Sheikh, 2010). In addition, the ANT approach is less concerned with the "why" or the intentionality question (Greenhalgh & Stones, 2010). Rather, it considers the roles of both human and non-human actors, and focuses on the performance of a project and the consequences of this performance on the actors involved (Broer, Nieboer, & Bal, 2010).

Therefore ANT warrants that the various actors and their interests be identified, the manners in which they convey their interests to each other examined, as well as the compromises they arrive at in order to maintain stability in their work settings. In addition, researchers must follow up the actors and analyze how these actors themselves define what is going on (Latour 1987; 2005).

CHAPTER 3: THE RESEARCH SETTING

This chapter aims at illuminating the context in which the research was carried out. It begins by describing Cameroon's profile, and the structure of the Regional Hospital Bamenda (the country and hospital respectively, where the research was conducted). Finally, it narrows down to describe the particular research site in the study, which is the laboratory department of this hospital.

3.1: Cameroon's Profile

The Republic of Cameroon is a sub-Saharan country located in the central region of the African continent. The surface area of this triangular nation is about 475,440 km^2 and the population is estimated at about 19,294,149 inhabitants, as of July 2010. Its current weather varies with terrain, from tropical along the coast, to semiarid and hot in the north. Administratively, Cameroon is divided into 10 semi-autonomous regions, each of which is headed by a presidentially appointed governor. These regions include: Extreme North, North, Adamawa, Center, East, South, Littoral, South West, North West, and West (World Factbook, 2010), as seen in the figure below.

Figure 2: Map of the Republic of Cameroon showing Administrative Divisions

(Source: The Fomunyoh Foundation, 2011)

Cameroon gained its independence from France and the United Kingdom on January 1st 1960 and October 1st 1961, respectively. Consequently the official languages in this nation are French and English (World Factbook, 2010).

According to WHO (2010b), certain highlights of Cameroon's health statistics are described below (see table 2).

Health Statistics	Value
Gross national income per capita (PPP international $)	2,060
Life expectancy at birth m/f (years)	50/52
Healthy life expectancy at birth m/f (years, 2003)	41/42
Probability of dying under five (per 1000 live births)	149
Probability of dying between 15 and 60 years m/f (per 1000 population)	451/422
Total expenditure on health per capita (International $, 2006)	80
Total expenditure on health as % of GDP (2006)	5.2

Table 2: Highlights of Cameroon's Health Statistics (Source: WHO, 2010b)

Cameroon has a Ministry of Public Health which caters for the development, implementation, and evaluation of public health policies, as well as the maintenance of all public health services in the country (AfDevInfo, 2009). In collaboration with the World Health Organization (WHO) and other

partners, Cameroon aims at promoting the attainment of the highest sustainable level of health by all its inhabitants (WHO, 2009).

3.2: The Structure of the Regional Hospital Bamenda, Cameroon

The Regional Hospital Bamenda, Cameroon is located in the capital city of the North West Region of Cameroon, called Bamenda. The hospital consists of 400 beds and has a turn-over rate of 65%. The total number of employees including temporary workers is 402, among which 355 are trained health personnel and the remaining 47 are ward servants. Temporary workers are contract workers who are employed by the hospital administration and given a stipend at the end of each month. They consist mainly of trained health personnel who are pending government recruitment, but also some ward servants who are employed as more infrastructures are constructed. RHB is headed by a director who has several subordinates (see Appendix A).

RHB consists of 10 wards (for example, maternity, female surgical, reanimation, amongst others) and 21 departments (for example, statistics, medical laboratory, pharmacy, just to name a few). Given that Cameroon was initially colonized by the Germans, most of the hospital buildings reflect the German style. In the hospital as well, the departments are located in one area while the wards occupy another area. Overall, all the buildings are connected to each other which makes access easy. Some of the hospital buildings are shown in the figures below.

Figure 3: Regional Hospital Bamenda, Cameroon (Ward Buildings)

Figure 4: Regional Hospital Bamenda, Cameroon (Department Buildings)

RHB acts as a national and referral hospital. It serves the Bamenda town population of about 500,000 inhabitants and the entire North West Region of about 2,500,000 inhabitants. Economically, it runs on functional credits (revenue/income) given by the state through the Ministry of Public Health. This revenue is given on a trimester basis i.e. every 4 months. In Cameroon there exist 11 of such hospitals, 3 of which are called annex regional hospitals.

This hospital also runs on locally generated income divided into Revenue Set Aside, Cost Recovery Budget, and Mortuary services. The Revenue Set Aside consists of 70% of bills paid by patients for consultations, medical and surgical acts, deliveries, and hospitalizations. The Cost Recovery Budget consists of bills paid by patients for laboratory analyses and x-ray examinations. The Mortuary services consist of bills paid by families of deceased persons, for proper preservation of corpses before burial dates.

3.3: The Medical Laboratory Department

The research was conducted at the Medical Laboratory Department of RHB, Cameroon (see figure 5).

Figure 5: Medical Laboratory Department of the Regional Hospital Bamenda, Cameroon

Alongside the RHB, the medical laboratory was created in 1966. This department consists of units like the Blood Bank, Registration, and Sample Collection, as well as other units where analyses are performed. These units include: Parasitology, Haematology, Microbiology, Bacteriology, Biochemistry, and Serology (see figure 6).

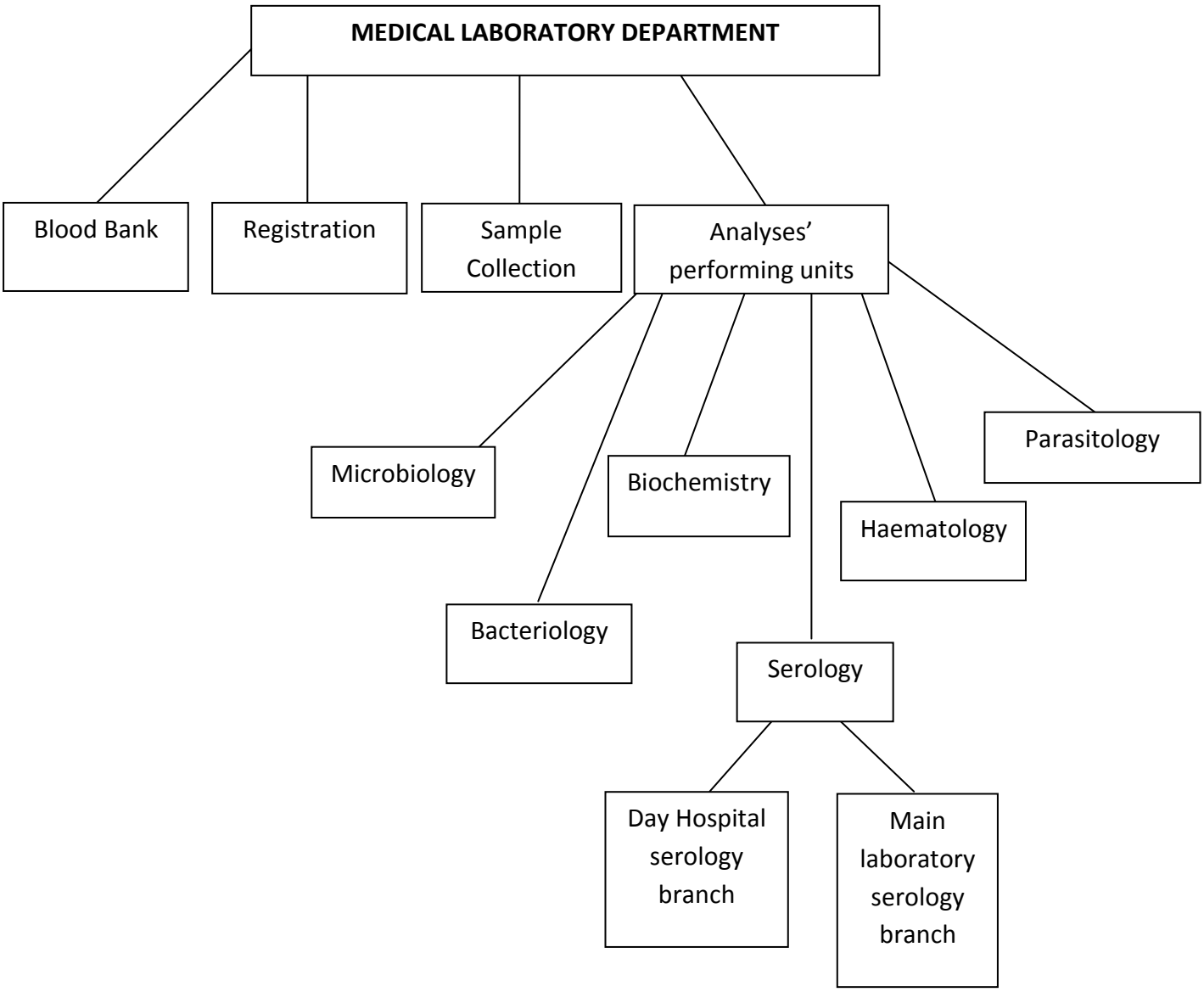


Figure 6: Organizational Structure of the Medical Laboratory Department

Due to serious infrastructural challenges, the above listed units of the laboratory occupy a single building, commonly referred to as the main laboratory building (excluding the Day Hospital[1] serology branch), which is usually crowded as a result. Worth mentioning is the fact that the Serology unit is

[1] Agreed Treatment Centre for HIV/AIDS cases

divided into two branches: one is located in the Day Hospital and the other is located in the main laboratory building. However, these two are neighbouring buildings connected by a corridor. The Day Hospital serology branch is reserved for HIV[2] screening-particularly involving people who are doing the screening for their very first time. On the other hand, the main laboratory serology unit is reserved for all other serological analyses including HIV screening for people doing it for a second time or more. The reason behind this Serology unit divide is to ensure division of labour. In addition, the Day Hospital offers special counseling (pre- and post-) facilities to persons coming for HIV screening for their very first time.

There is a lot of interaction within these units given the infrastructural nature, and due to the fact that most individual test orders require analyses to be performed at each of these units. On the whole however, the medical laboratory department performs quality biological analyses to the benefit of the population and public health.

The laboratory is furnished with modern technology equipments. It has a total staff of forty-four persons, 43 of whom are qualified[3] and capable of working in all the units of the laboratory, and 1 secretary. These qualified staff comprise of ten laboratory scientists, twenty-four laboratory technicians, seven assistant laboratory technicians, and two laboratory aids (in descending order of hierarchy). Unfortunately the laboratory has no clinical laboratory doctors, thus it is headed by a laboratory superintendent and his assistant. They both ensure the performance of standardized quality procedures at the individual units, via the unit heads who are directly answerable to them. This therefore makes the role of the laboratory superintendent very special and independent.

The laboratory is capable of performing 98 different analyses in total, divided between the various units (see Appendix B). On the average, the laboratory receives around 112 patients per day and performs about 306 analyses per day (because some of the 98 different analyses are performed multiple times). Of all its analyses, the most frequently performed are Haemoparasite and HIV screening.

[2] Human Immunodeficiency Virus

[3] Persons who have a qualification in Medical Laboratory Sciences

CHAPTER 4: METHOD

This chapter provides insight into how the study of laboratory documentation was conducted. It explains the purpose of the research and gives an overview of quantitative and qualitative research designs. This is followed by a presentation of the interpretive research approach, which is the approach used during the research. Furthermore, this chapter illuminates the research setting, describes the methods of data collection of the study's empirical material, and reflects on these methods.

4.1: Research Approach

4.1.1: Research Objectives

As health institutions become more complex, they tend to serve a greater population than initially expected. But unfortunately, the number of health workers is very much under proportion, and most of the documentation in the hospital is paper-based and handwritten; all of which can have serious impacts on the service quality rendered. However, the smooth flow of accurate information within various hospital departments can decrease the burden of the few health workers and therefore increase the quality of service they deliver. Thus, this study is aimed at unraveling the challenges and opportunities involved in improving the quality of laboratory documentation. In this light, the overall research question is:

What factors shape the implementation of an IT support system to improve the quality of laboratory documentation?

The above research question translates into the following questions addressed in the research:

- What is the role of laboratory documentation in everyday clinical practice?
- How can laboratory documentation support interdisciplinary work?
- What are the quality-related lapses affecting the laboratory documentation?
- What kind of implementation strategy should be pursued to improve the quality of laboratory documentation?

4.1.2: Research Design

A research design entails various things which should be thought about and kept in mind when carrying out a research project. For instance, its general framework which gives some directionality to the whole research process, given that it consists of purpose(s), theory, research questions, methods, and sampling strategy. Broadly speaking, research designs can either be fixed or flexible (Robson, 2002, p. 80-81).

In order to obtain an in-depth understanding of the different roles of laboratory documentation and how to improve the documentation quality, the qualitative research design was chosen and interpretive research methods employed. The following text describes quantitative and qualitative research designs, making a comparison of them, and thus motivating for the design choice of the study.

a) Quantitative Research Design

According to Robson (2002, p. 81), the quantitative research design is referred to as the fixed research design, and it requires a tight pre-specification before you reach the main data collection stage. Quantitative research is most suitable in establishing the size, extent or duration of certain phenomena, or in establishing that a specific intervention results in a pre-specified effect. This kind of research uses different measurement techniques (for example, questionnaires, time studies, or tracking of clinical outcomes) to provide answers to 'how much' questions (Stoop & Berg, 2003). The reasoning here is usually deductive; the outcome is an acceptance or rejection of proposed theory, and the truth is seen as objective and universal (Horsch, 2010). The quantitative research design aims at determining the relationship between variables in a population. Such studies can either be descriptive (establishes only associations between variables) or experimental (establishes causality) whereby the subject characteristics in both studies can affect the relationship under investigation. Therefore, their effect can be limited by using a heterogeneous sample of subjects or by measuring the characteristics and including them in the analysis (Hopkins, 2000). The researcher in quantitative research is detached from the setting, impartial and portrays objectivity (Siegel, n.d.).

b) Qualitative Research Design

In contrast, the qualitative research is referred to as the flexible research design and it evolves during data collection as all aspects of it are being revisited (Robson, 2002, p. 81). Qualitative research is best suited to understand a phenomenon 'from participants' viewpoints, and in a particular social and institutional context'. This research kind is capable of penetrating the 'what', 'why', and 'how', of a

social phenomenon to pick out profound details (Kaplan & Maxwell, 1994). Thus, qualitative research can be used to explore 'taken for granted' practices within healthcare and evaluate the outcomes of care (Goffman, 1961; Mallinson, Harries, & Popay, 1996). In addition, it is concerned with negotiating and constructing meanings in social interaction, and it contains the concept of 'measurement' where it employs phrases like 'a lot', and 'most'. Much of qualitative research involves small samples, primarily because of the labour intensive nature of data collection and analysis. However, it is not just an easy option but it embodies some rigour which must be adhered to, while collecting interesting descriptive data. This is made possible by its shared framework which maintains standards and quality during the research (Popay & Williams, 1998). During qualitative research, the researcher is personally involved, and empathically understands the people and setting involved in the study (Siegel, n.d.).

Qualitative research can also be known as interpretive or descriptive in that the researcher is interested in process, meaning, and understanding gained through words or pictures. The reasoning here is usually inductive in that the researcher builds abstractions, concepts, hypotheses, and theories from details. The outcome of it is an illumination of a situation and the truth is seen as within a particular context (Horsch, 2010). Similarly, given that the interpretive approach focuses on the complexity of human sense making as the situation emerges (Kaplan & Maxwell, 1994) and attempts to understand phenomena through the meanings that people assign to them (Boland, 1985, 1991; Deetz, 1996; Orlikowski & Baroudi, 1991), it can be considered qualitative. Thus, the interpretive research approach is discussed below.

c) Interpretive Research Approach

An interpretive approach is increasingly used in IS research, and the latter can be classified as interpretive, critical, and positivist, qualitative research. In positivist research, there exist evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and drawing of inferences about a phenomenon. In critical research, the main task is seen as being one of social critique, whereby restrictive and alienating conditions of the status quo are illuminated. In interpretive research, we assume that we obtain our knowledge of reality only through social constructions. Hence, interpretive methods of research aim at producing an understanding of the IS context, and the process whereby the IS influences and is influenced by the context (Klein & Myers, 1999; Orlikowski & Baroudi, 1991; Walsham, 1993).

Interpretive field studies include in-depth case studies (Walsham, 1993) and ethnographies (Suchman, 1987; Wynn, 1979, 1991; Zuboff, 1988). The principal difference being the time spent in the field for

investigation, and the extent to which the researcher is immersed into the study. Unlike researchers working with in-depth case studies, ethnographers spend a longer time in the field acquiring data and they greatly immerse themselves into the settings of the study (Klein & Myers, 1999). Furthermore, a case study is aimed at developing a detailed, intensive knowledge about a single 'case' or small number of related 'cases'. But an ethnographic study seeks to capture, interpret, and explain how a group, organization, or community lives, experience and make sense of their lives and their world (Robson, 2002, p. 89).

Given that the worthiness of interpretive research has been questioned by some researchers, interpretive researchers have developed certain principles as discussed below, to guide research of this kind.

Klein & Myers (1999) have proposed a set of principles for conducting and reporting interpretive research, which to some extent are interdependent. However, the application of these principles is not bureaucratic or mandatory but requires considerable creative thought. These principles are discussed below, in their chronological order (from first to seventh).

The Fundamental Principle of the hermeneutic circle: It suggests that our understanding of a complex whole is obtained from preconceptions about the meanings of its parts and their interrelationships. Human interpretation is achieved through the constant movement from the whole to the part and back to the whole. In other words, taking into consideration meanings of parts and how they interrelate will help us understand the whole they form. An illustration of this principle is Gadamer's (1976) example of how the meaning of a sentence can be translated into a foreign language. He mentions that understanding is obtained when there is a harmony in the meanings of the different sentence parts.

The Principle of Contextualization: It is based on the fact that meaning should be sought in context. The object of study should be described in its social and historical context, to enable the reader understand how the current situation under study emerged. This is of great importance because the historical distance between the interpreter and author of a text creates an inevitable difference in understanding. This principle is related to the fact that thick descriptions are needed in order to understand interpretive case studies in IS research (Walsham, 1995).

The Principle of Interaction between the researcher(s) and the subjects: It requires the researcher to place himself/herself and the subjects into a historical perspective. This interaction generates facts as it involves a critical reflection on how data are socially constructed. Consequently, the participants and researcher are considered interpreters and analysts. Trauth (1997) attests to this principle in three

research projects which she carried out. She explains how she got a better understanding of all three situations as she became self-conscious and began questioning her assumptions.

The Principle of Abstraction and Generalization: It is such that details revealed by the interpretation of data are related to theoretical, general concepts that describe human understanding and social action in their nature. This enables readers to follow how the researcher arrived at his/her theoretical insights. For instance, the idiographic details revealed by the data interpretation could be related to theoretical, general concepts drawn from ANT. According to ANT, the world can be viewed as a linking together of humans and non-humans into actor-networks (Walsham, 1995). Lincoln & Guba (1985) share the same opinion as mentioned in one of their key axioms of naturalistic inquiry, which says that theory must emerge or be grounded in data.

The Principle of Dialogical Reasoning: In the construction of every research design, the researcher has preconceptions which guide him/her. But based on the data the researcher obtains from the study, he/she needs to confront and constantly revise those preconceptions at each stage, until a better understanding of the research is arrived at. Researchers are not required to bracket their preconceptions as some qualitative methods demand (Ray, 1994), but to move beyond the self-evident. This can be achieved by remaining skeptical of the immediately apparent and creating data collection pathways that challenge, rather than reinforce the earliest conceptualizations (Thorne, Reimer Kirkham, & O'Flynn-Magee, 2004). Otherwise, the findings may be similar to initial preconceptions and will offer minimal (if any), new evidence about the phenomenon under study (Kearney, 2001). Lee (1991) illustrates this principle in his example about Nardulli (1978) who revised his preconceptions from the findings of his research.

The Principle of Multiple Interpretations: It is based on the fact that participants interpret situations differently. Therefore, the researcher must consider and confront all of these different and sometimes conflicting interpretations. This may sometimes lead to a revision of the researcher's preconceptions. Therefore, this principle is of importance because it leads to probing beneath the surface (digging into details). Worth mentioning is the fact that people have different optic angles which are based on their respective settings, and from which they analyze situations. Consequently new things which were not foreseen always crop up during the study (Larsen, 2010). This also implies that there are multiple constructed realities. Thus, reality is described as complex, contextual, constructed, and ultimately subjective (Lincoln & Guba, 1985).

The Principle of Suspicion: It suggests that due to the biases or distortions that exist in the narratives from participants, they sometimes tend to make false claims. Consequently, researchers must critically question and analyze such situations, as well as reinterpret the behaviour of participants (Walsham, 1995).

In addition to the above mentioned principles from Klein & Myers (1999), the research findings need to be trustworthy and related to the research design. In this light, validity, reliability, and generalisability are core concepts which should be considered. Validity refers to whether the findings are 'really' about what they appear to be about. Reliability refers to how consistent or stable a measure is. Generalisability refers to the extent to which the findings can be applied to situations outside the study. (Robson, 2002, p. 93). Generally, the findings obtained from qualitative research can be generalized, that is, transferred to other settings (Popay & Williams, 1998).

Walsham (1995) is also of the opinion that validity is an important aspect of interpretive case studies in IS research. Anyone presenting findings from IS research should be able to establish validity in the eyes of the reader. This is an art of persuasion and a matter of rhetorical style and flair, which can be achieved by reporting theory and method accurately and carefully. Similarly, Golden-Biddle & Locke (1993) make mention of the fact that ethnographic texts must be convincing to the reader. They propose three dimensions central to the process of convincing which are: authenticity, plausibility, and criticality. Authenticity is established when readers accept that the researcher was indeed present in the field and grasped the members' understanding of their world. Plausibility is established when readers accept that the findings in the text make a distinctive contribution to issues of common concern. Criticality is established when the text probes readers to re-examine the taken-for-granted assumptions that underly their work.

Walsham (1995) as well argues that generalisability is of importance in interpretive research, and researchers should ensure that the results from their work can be generalised. Yin (1989) mentions that the issue of generalisability is often raised with respect to case studies, whereby the findings from interpretive case studies should be generalisable to theoretical propositions. Thus, there exist four types of such generalisations namely: the development of concepts, the generation of theory, the drawing of specific implications, and the contribution of rich insight.

In conducting interpretive research, information can generally be obtained from interviews, tape recordings, documents, observation and physical artifacts. The researcher has the difficult task of accessing other people's interpretations, filtering them through their own conceptual apparatus, and

feeding a version of events back to others, in some cases both their interviewees and other audiences. Therefore, his/her role is of great importance and can be underscored. The interpretive researcher should be able to figure out their role given that two different roles exist namely: the outside observer and the involved researcher (through participant observation or action research). None of these roles however is objective because data collection and analysis involves the researcher's own subjectivity (Walsham, 1995).

The outside observer is viewed as not being a part of the organization where he/she is performing their research. This could generate some frankness from the personnel once they are able to trust the researcher. However, the researcher cannot be present on many occasions to observe from the inside, and he/she is also not allowed to dig into confidential issues of the organization (Walsham, 1995).

The involved researcher on the other hand is viewed as being a part of the organization under research. Thus, he gets information from an inside view (detailed) and is never restricted from any confidentialities. However, the personnel in the organization become too cautious and not open to discuss their views with the researcher. This causes the researcher sometimes to become unethical by hiding his/her research motives in order to obtain desired information. Another demerit of this role is the fact that the researcher may tend to be bias when reporting their findings because he/she belongs to that organization. The researcher should therefore choose his/her role depending on the above merits and demerits in each case, and make the choice explicit and reflective, giving reasons when reporting the research results (Walsham, 1995).

Another role of the researcher can be viewed in the light of interpretive descriptive research, where the researcher comprehends data, synthesizes meanings, theorizes relationships, and re-contextualizes data into findings (Morse, 1994). Therefore the researcher drives the interpretation, no matter how participatory and collaborative the method is (Thorne, Reimer Kirkham, & O'Flynn-Magee, 2004).

Alternatively, Randal, Harper, & Rouncefield (2007) are of the opinion that in ethnography, the ethnographer has no fixed role to play but through interaction with subjects, his/her role is worked out. They mention that the ethnographer should approach the investigation without theoretical preconceptions/prejudgements because the social world is not just organized in ways that analysts and researchers want to find it. Otherwise, their familiarity with the field may just hinder them from making interesting discoveries during the study. The ethnographer should listen keenly, be interested in what people do and say, tolerate boredom, be a novice, respect the setting of the study, and choose

the focus of the research. In this way, he/she will be able to explore and obtain the desired data for the study.

4.2: Data Collection

Prior to my research, I had been actively involved with work at the medical laboratory of the Regional Hospital Bamenda, Cameroon. There I performed internship as a laboratory technologist and later on worked as data analyst/secretary before leaving for this course (Master's in Telemedicine and E-health) in 2009. So I gained insight into the work processes at the laboratory during this time. Prior to data collection I established contacts with the Statistics department, the Director, and 2 laboratory staff of the hospital to obtain firsthand information on the state of the laboratory documentation.

Before collecting data, an authorization letter permitting my fieldwork was used to obtain permission from the hospital administration. After this, the data collection process began and lasted from September to October 2010. A description of the sample size and the different modes used for data collection are discussed below.

4.2.1: Sample Size

Out of the 402 staff capacity of the hospital, 19 were sampled as well as 5 patients. In all, the sample size for this research was 24. The 19 staff were purposively selected based on their unique characteristics and in-depth knowledge of the topic understudied.

4.2.2: Participant Observation

This mode of data collection was aimed at work situations primarily involving laboratory staff, patients, and physicians. Thus, the schedule for observation was divided as seen in the table below.

Location	Duration
Registration unit	2 weeks
Sample Collection unit	2 weeks
Microbiology unit	3 days
Bacteriology unit	3 days
Biochemistry unit	3 days
Haematology unit	3 days
Serology unit	3 days
Parasitology unit	3 days
Blood Bank unit	3 days
Wards	2 days
Physicians' offices	1 week

Table 3: Distribution of Participant Observation

The rationale for spending much more time at the Registration and Sample collection units is because the largest portion of my study is related to the findings from these units, since interaction with laboratory documentation is highest here.

During this time, the work flow particularly centering on laboratory documentation was observed. For example, the generation, roles, archiving facilities, and quality of the laboratory documentation. In addition, the different components of laboratory documentation such as test orders, paper registers, and statistical records, were viewed. I was also able to listen to informal discussions amongst laboratory staff and patients, usually expressing their level of satisfaction with laboratory documentation.

A digital camera was carried along during the data collection process, with which interesting photos of work situations, were taken and presented in this write-up to illuminate the research context and site. A notebook was also used to take note of vital information to aid recall events, personal impressions, and inferences. These field notes were transcribed within the research period. On some occasions particular note was taken of certain work practices which I probed into during interviews. For example, the laboratory secretary entering patients' data into the paper register before typing it into the computer later on. In this way, I did not miss out on very tiny but relevant details necessary for my study.

4.2.3: Interviews

Interviews were performed both face-to-face and through telephone calls, most suitably after the working day. The interviews were semi-structured and contained open-ended questions. In addition to the interview guide which was used for all the interviews, questionable work practice situations observed were also raised and clarified appropriately. During the interviews as well, probing and follow-up on interviewees' (informants') responses was also done. In total, 24 interviews were conducted, 18 of which were face-to-face, and 6 via telephone. Some of the phone interviews were followed up with email communications. The informants consisted of health personnel and patients who frequently interact with the laboratory documentation. The table below gives a summary of the interview process.

Interviewee (Informant)	**Number interviewed**	**Interaction kind**
Laboratory staff	8	5 Face-to-face, 3 Telephone
Physicians	6	Face-to-face
Patients	5	Face-to-face
Patient carer	1	Face-to-face
Statistician	1	Telephone
Nurse	1	Face-to-face
Administrator	2	Telephone & Email

Table 4: Summary of the Interview Process

Worth noting is the fact that before each interview was conducted, permission was sought and appointments booked with the informants. No interview was tape recorded but notes were always taken during interviews, and later on transcribed. This was because most of the informants were very comfortable with note-taking than tape-recording. On the average, most of the interviews lasted between 15 to 30 minutes.

4.2.4: Literature Study

Given the background knowledge I already had concerning this study, I proceeded to do a thorough literature search to obtain information on any already performed research related to my study. In this process, my main search engines were the Internet sites of google.com and the University Library of Tromsø. Search phrases included: medical laboratory, developing countries, quality health care, amongst others. In general, finding information related to health care in developing countries was quite difficult and challenging, given that fewer research goes on there. But my supervisor assisted me with relevant literature.

4.3: Reflections on the Method

By virtue of the fact that this study gives insight into the different roles and quality aspects of laboratory documentation, I shall continue with the interpretive approach. The rest of this section offers some reflections related to some literature, and my role in the data collection process.

4.3.1: The 'Insider' Role

Several reasons abound as to my choice of the medical laboratory department for this study. First I desired to analyze the role of laboratory documentation in interdisciplinary work, and in addition my main working experience is related to medical laboratory work. As previously mentioned, I worked in this laboratory as a technologist intern for six months, and later as a data analyst/secretary for one year. As an intern I collected samples and performed analyses on them in all the units of the laboratory. As a data analyst/secretary I registered patients, handed out their results to them, and performed statistical analyses for the entire laboratory department. With this work experience, I am quite familiar with procedures, work-flow, documentation, and employees in the laboratory.

Consequently, my role in the data collection process can be described as the involved researcher (Walsham, 1995) or the 'insider' (Forsythe, 1999; Randal, Harper, & Rouncefield, 2007) or the practitioner-researcher (Robson, 2002, p. 534). This choice is in accordance with the fact that every researcher should be able to figure out his/her role (either the outside observer or the involved researcher) depending on the merits and demerits of either of them, and give reasons for their choice (Walsham, 1995). Robson (2002, p. 535-538) and Walsham (1995) mention several advantages and challenges of either roles which I discuss in relation to my case in the proceeding paragraphs.

4.3.2: Access to the Field

With respect to my case, I am of the opinion that my choice as the 'insider' researcher was most preferable. This is because one might say that medical records in general are considered highly confidential. Thus, they are normally viewed only by those directly concerned, usually patients and health personnel. This was greatly evidenced by the relative ease with which I viewed the laboratory documentation. Furthermore, when I contacted the informants to book appointments for interviews, they all responded positively after I introduced myself as a former staff of the RHB laboratory. This was backed-up by the fact that they also gave me lots of information during the interviews.

Being an 'insider' was of great advantage to me due to the following advanced reasons: Given my tight affiliation with this laboratory, access was relatively easy. This enabled me penetrate and obtain

firsthand information (information from the inside) about laboratory documentation without any restrictions. It was also more economical having me to do the research than employing a researcher from without. Finally, since I had some pre-existing knowledge and experience base on the work set-up and documentation in the laboratory, I was in a better position to identify and question any lapses, as well as propose possible solutions.

4.3.3: 'Insider' Challenges Encountered

Though being an 'insider', I faced a few challenging moments as explained subsequently. First of all, my former colleagues (the laboratory staff) were usually very cautious in their informal discussions whenever I was around. This is because the laboratory documentation has several lapses given that most of it is paper-based and handwritten. Thus, the laboratory staff sometimes express some amount of discontentment about it during their informal discussions. Secondly, I faced a little of the 'prophet in own country' phenomenon. This was illustrated by the fact that sometimes my informants did not value my advice as much, and my former colleagues often sent me to trace information which they had to give me by myself (for example, the statistical analyses records).

4.3.4: Could the 'Outsider' Role Have Been Better?

It can be argued that being an outside observer may have cancelled out few of the above mentioned challenges such as the 'prophet in own country' phenomenon (Robson, 2002, p. 535). In addition, despite the fact that the 'outsider' researcher's access in the laboratory department would have been kind of restricted, my former colleagues may have not been very cautious in his/her presence. Thus, permitting the 'outsider' researcher to obtain frank opinions from them (Walsham, 1995).

The generation of any possible biases from within the researcher may likely not occur with an 'outsider' as explained by Forsythe's (1999) clarification of a common misconception concerning ethnography, which says: "insiders are qualified to do ethnography in their own work setting." This misconception arises from the fact that non-anthropologists believe that ethnography is easy since they overlook invisible aspects of it. She is however of the opinion that an 'insider' is not an accurate observer. Instead, ethnographic work will be better performed by an outsider with considerable inside experience. This is because an ethnographer is not concerned with replicating insiders' perspective but eliciting and analyzing it objectively. Thus, he/she needs to compare inside and outside views of particular events and processes.

Taking into consideration the various viewpoints of the above mentioned authors, I am still of the opinion that my role in the data collection process was most preferable as the 'insider'. Therefore,

drawing inspiration from Walsham (1995) and Robson (2002, p. 537-538), I tackled the previously mentioned challenges by politely seeking support and advice from my former colleagues, working in teams with them whenever possible, and negotiating a time allowance to carry out my enquiries. I did not act as a 'novice' in the field else I may have tended to be very passive, causing the interviewees to think either I am not interested in their views and/or that I have no view of my own. This caused the interviewees not to doubt my professional competence, and as a result, they provided me with accurate and relevant information. Lastly, I constantly reminded my colleagues and myself that this research is for our common good, and I promised to present or explain the research findings to them.

4.3.5: Interpretive Fieldwork Principles

Other aspects which are loosely related to my role, and worthy of reflection include Klein & Myers (1999) principles and Golden-Biddle & Locke (1993) dimensions of convincing work.

The third, *Principle of Interaction between Researcher(s) and Subjects* stresses on a critical reflection on how data are socially constructed, through interaction between participants and researchers. By implication, it was not just about how long was spent in the field that guaranteed valuable data. I went beyond chatting with people and reporting what they said, to understanding and analyzing their sayings. This was because the data collected was simply my construction of other people's constructions of what they and their compatriots were up to.

The fourth, *Principle of Abstraction and Generalization* requires data interpretation to be related to theories and concepts. In this light, I employed systematic methods to detect patterns through careful data collection, useful field notes, and data analysis. Basing the study on ANT, I was able to map out the actors, their contrasting interests, and how a compromise could be attained. Similarly, employing the theory of II in the study, I was able to brainstorm into ways of improving the quality of laboratory documentation, as well as the challenges this process will involve.

The fifth, *Principle of Dialogical Reasoning* refers to possible contradictions between researchers' preconceptions about the research and actual findings from it. Despite my knowledge and experience about laboratory documentation, I remained open-minded as I interacted with participants, constantly revisiting and revising my preconceptions as the need arose. In this way, I believe my write-up has been able to better describe the reality from the field.

The sixth, *Principle of Multiple Interactions* meaning participants' interpretations of situations are different. For this reason I interviewed and got the viewpoints about laboratory documentation, from

people of different professions (for example, patients, laboratory scientists, medical doctors, nurses, administrators, and a statistician) who interact frequently with it.

The seventh, *Principle of Suspicion* suggests that participants sometimes tend to make false claims by virtue of their biases or distortions in narratives. Therefore I did not just rely on the answers given by participants, but assessed the importance of the questions posed, the reliability of the informants, and the contingency of responses in the course of the work. In addition, because participants' words are unreliable, they were observed over time and then questioned about their doings.

Due to the reliance on interpretation, interpretive researchers do not report "facts" but their interpretations of other people's interpretations, or "constructed truths" (Walsham, 1999). This may however generate some doubts in the minds of readers which can be dispelled because I have provided a detailed description of how I arrived at the results.

Finally, according to Golden-Biddle & Locke (1993), an ethnographic text can convince readers if it meets the three dimensions of convincing work which are: authenticity, plausibility, and credibility. Therefore, I believe I have attained the above dimensions in the presentation of the findings from the field work for the following reasons:

I achieved authenticity by establishing my presence ("been there") in the field and grasping of the members' understanding of their world. I did this by establishing my previous work experience in this laboratory and presence in the field. I have also reported in detail my relationship and interactions (interviews, and participant observation) with participants, which also reflected in my constant discussion of the findings with them, to ensure that I had grasped their understanding of their world.

I achieved plausibility by reporting what distinctive contribution the findings have made to issues of common concern. For example, considering the global call for an improvement in the quality of health care, I have discussed how the quality-related setbacks affecting the laboratory documentation can be adressed.

I achieved credibility by reporting the findings from the study pertaining to laboratory documentation. This I believe will provoke readers to recognize, examine, and imagine new possibilities. Thus, incorporating criticality into writing, conveying a rich and complex understanding of the members' world, adding to existing knowledge in the field, and providing a critical critique.

Notwithstanding the strengths of this study, the latter being part of an academic curriculum 'Master's Thesis' cannot reflect standard research. Furthermore, this write-up being based on a case study

implies that data was collected only in one institution. Thus, it may not perfectly represent similar institutions all over the country as a whole. Lastly, the availability of articles particularly related to medical laboratory documentation in Cameroon was quite rare.

However, the study tried as much as possible to employ standard guidelines for research. Therefore, it should be viewed as an effort to bring knowledge into focus and appeal for further research of its kind, since little or no research of this kind had been conducted in Cameroon.

CHAPTER 5: THE CASE STUDY

This chapter describes in detail the case being studied, that is, the laboratory department, documentation, and ongoing processes in the laboratory. In this respect, it describes the routine workflow in the laboratory, and the information infrastructures at the hospital and laboratory. It also elaborates on the laboratory documentation, that is, its different roles, the quality-related setbacks it encounters, and the IT system project aimed at improving it.

5.1: The Routine Workflow in the Laboratory

The day-to-day functioning of the laboratory is such that the patients needing to perform analyses assemble in the Registration unit by 8 a.m. Then together with the laboratory staff, they observe morning meditation and prayers coordinated by the hospital chaplains. After this, one of the staff educates the patients on how to conduct themselves in the laboratory and ensure that their samples are collected. Patients later queue up in front of the laboratory cashier[4] as they present their test orders usually written on forms or in their hospital books[5], and pay for their analyses to be performed. From the cashier, they proceed to the laboratory secretary who registers their data and assigns to each of them a unique Laboratory Identification Number (Lab IDN).

The patients continue to the Sample Collection unit where they again present their test orders, but have their samples collected and labelled with respect to their test order, unique Lab IDN, sex, and age. The only samples not collected per say in this unit are sputum samples. Such patients are given three labelled sputum mugs, and instructed on how to produce three different sputum samples. Then they are shown a toilet where they can produce the first sample. After sample collection patients deposit their test orders in this unit, because the results are usually written directly below the order. Then, they are told when to return for their results which they collect from the Registration unit, usually from 2 p.m.

On all patient samples/labels, names are not included to ensure patients' privacy, increase discreteness, and decrease biases during the analysis process; all of which are very vital in the ethics

[4] A qualified laboratory staff who receives payment for laboratory analyses

[5] Exercise books containing patients' medical records

of the medical profession. As the collected samples accumulate, one of the scientists at the Sample Collection unit dispatches them to their respective units for analyses.

At the various units, the analyses process is very organized. It is such that samples are identified with respect to their labels. The samples for the same analyses are grouped together, and each staff is assigned to perform each group of analyses. By 1 p.m., the Sample Collection unit stops collecting samples to be analyzed for that day, in order for the other units to fully concentrate on analyzing the samples which they had already received. However, in the case of emergencies (for example, accidents), or other very exceptional cases (for example, patients who have travelled from very far-off distances and do not have any means of accommodation in Bamenda), the units may go beyond this rule in order to help very desperate patients. After this time as well, units like Biochemistry, Haematology, and Serology, may also receive and freeze collected samples, to analyze the next day as the case may be.

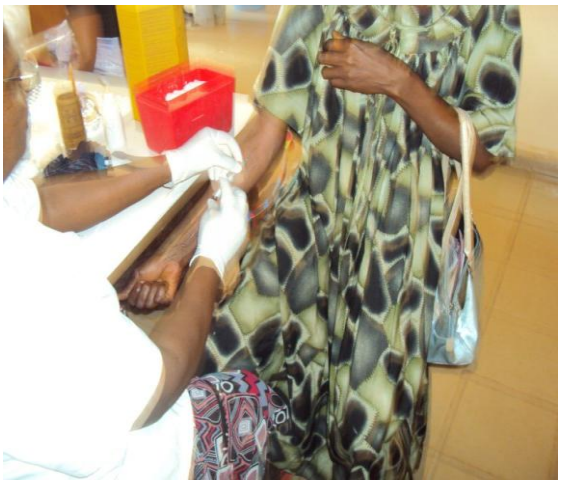
An interesting aspect in the laboratory workflow is the fact that the Sample Collection unit also performs particular analyses. These include: Fasting Blood Sugar using a glucometer[6] (just in emergency cases, or if the patient has just that analysis to perform), bleeding time, clotting time, and skin snips to test for filariasis, in a bid to save time.

In effect, the only units which directly interact with patients are the Registration and Sample Collection units. In addition however, the Blood Bank unit interacts directly with clients, that is, blood donors and patients. As such, these three units are the busiest in the laboratory. Blood donors are identified at the level of the Registration unit and sent directly to the Blood Bank unit, where their blood samples are collected and screened in the Serology unit before they donate blood pints. The Blood Bank unit runs on a 24/7 basis because it delivers blood pints to patients in the wards and emergency cases, upon requests.

[6] Medical device to measure blood glucose levels

The figure below illustrates the routine workflow in some of the units of the laboratory.

Registration Unit

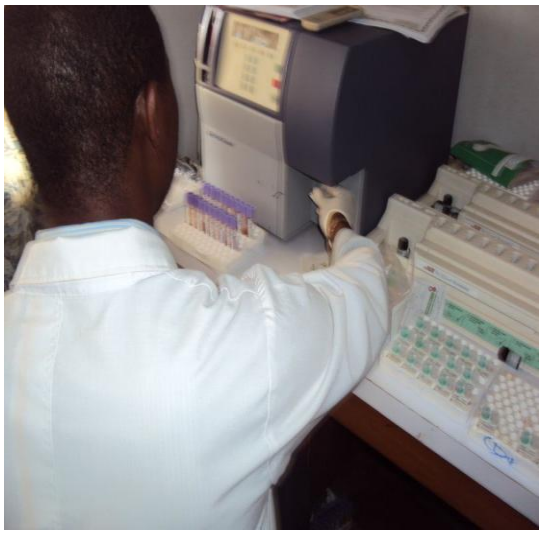


Sample Collection Unit

Biochemistry Unit

Microbiology Unit

Haematology Unit



Serology Unit (Main laboratory branch)

Figure 7: Photos of Routine Work at some of the Laboratory Units

The laboratory is open 24 hours a day and 7 days a week, but it employs a daily rotating working system commonly referred to as 'shifts'. There exist two shifts namely: the morning shift which runs from 8 a.m. to 3.30 p.m, and the evening shift which runs from 3.30 p.m. to 8 a.m. of the next day. During the morning shift from Mondays to Fridays, all of the staff are present and they perform routine analyses. However, during the morning shift on weekends and the evening shift from Mondays to Sundays, one staff is assigned on duty and is responsible for performing only emergency analyses. These include: Haemoparasite, white blood cell count, differential cell count, fluid analysis, cervical smears, pregnancy test, HIV screening, as well as the screening prior blood transfusions. This staff also acts as the laboratory cashier during his/her shift period, and produces a report narrating how the shift was run, with special emphasis being laid on blood transfusions. By 8 a.m. of the next day, this staff hands over the money collected to the official laboratory cashier, and the report to the staff working in the Blood Bank unit. This report usually serves as evidence and a backing for the staff concerned in case of any queries regarding already-transfused blood pints.

By virtue of the fact that the staff are all very qualified and capable of working in all the individual units, each of them is entitled to work during an evening shift or a weekend morning shift. Thus, the laboratory superintendent draws up a monthly roster assigning all the staff to evening and morning weekend shifts. This is always a very peaceful exercise as it is carried out in all fairness. However, if

a staff's shift is unsuitable for him/her, room is given for the staff to swap positions with colleagues upon their approval and a concrete arrangement between the concerned.

An important activity also carried out by this department of the hospital is training. It acts as a host laboratory for diploma and university students both nationally and internationally, who are preparing for diplomas, bachelor, master, and doctoral degrees. The government through the hospital administration from time to time also sponsors staff from this department to attend refresher courses at both national and international levels.

5.2: Information Infrastructures at RHB

In RHB, there exists an II between the various departments, via a Telephone Intercom System, the Internet (to a lesser extent), and physical contact.

The Telephone Intercom System connects every department and offices of medical doctors (MDs) in the hospital to each other through telephone lines, supplemented by a phonebook containing the telephone numbers of every department and MD's office. As such, information is exchanged between departments and/or MDs whenever the need arises. This system was instituted in 2007 by the then Director of RHB, and it is run by the North West Regional branch of Cameroon Telecommunications. So far, the system has proven to be very effective if its usage is not abused, in the sense that hospital staff do not use it for social purposes. However, because sometimes Cameroon Telecommunications encounters connection difficulties with telephone lines, staff are compelled to interact physically. This wastes a lot of time as staff have to walk to various departments and/or offices, to obtain whatever information they need.

Apart from the Telephone Intercom System, some hospital staff communicate information through the Internet. This communication refers particularly to emails or chat messages, because the hospital as of now has no computerized network system for data and information exchange. This form of information exchange is however used in a minimal extent because just about a quarter of the departments (mostly constituted of administrative staff) have the Internet connected to their computers. Apart from the wards, the Emergency Service, and the General Consultation which have only paper registers for information storage, the rest of the departments have 'isolated'[7] computers in

[7] Not connected to the internet

addition to these registers for the same purpose. These computers are not connected to the Internet for fear that staff may develop the habit of aimlessly browsing the web during working hours.

The oldest (has existed since the creation of RHB) and most often used system of information exchange is physical contact. It is such that when a staff requires some information from another department (different from where he/she is working), he/she moves to the department in question and collects the information from whoever is responsible. This method although cumbersome and not time-saving, has proven to be the most effective. This is because it is never a problem moving across departments in search of needed information, since every hospital staff has access to the various departments.

Due to the fact that the study is based on the Medical Laboratory department, I set out to particularly discover the nature of information flow in that department. Generally, information is circulated through various units of the laboratory by physical contact. However, the Biochemistry and Haematology units have 'isolated' computers and printers, connected to certain equipments like spectrophotometers (for serum biochemical analyses) and the Cell-Dyn (for full blood count analyses) respectively. Thus, test results of such analyses are archived in these computers with respect to the date patient(s) came for analyses/tests, patients' unique lab IDNs, age, and sex. These results are subsequently printed out and handed back to the patients by the end of the working day. The results are as well reprinted out in cases where the initial print-out gets missing, or a staff from another unit of the laboratory or another department of the hospital needs to check out information pertaining to such patients. Overall, the laboratory has an 'isolated' computer and printer, strictly operated upon by the laboratory secretary. He/she is responsible for typing out patients' results upon requests (because they are usually handwritten), monthly statistical records, and any other documents pertaining to the laboratory. For example, duty rosters, contact addresses of staff, just to name a few.

5.3: Different uses of Laboratory Documentation

In the past and currently, the hospital structure in Cameroon has been such that laboratories make use of paper documents mostly, in their clinical work. These paper documents are generally referred to as laboratory documentation, and they consist of laboratory test order and/or result forms, as well as registers. With the exception of the Sample Collection unit which has no register, the information generally recorded in the registers pertains to patients (patient data), and this information varies amongst the units (see table 5).

Unit	Patient data found in the register
Registration Unit	The date patient(s) came for analyses/tests, unique Lab IDN, name, age, sex, address, occupation, tests requested, amount paid, receipt number, and requesting doctor.
Blood bank Unit (has two registers: one for patients, and one for donors)	Patient register: The date patient(s) received blood pint(s), name, age, sex, address, ward name, blood group, and rhesus factor. Donor register: The date donor(s) gave blood pint(s), name, age, sex, address, blood group, rhesus factor, and screening test results.
Analyses' performing Units (Parasitology, Biochemistry, Serology, Haematology, and Bacteriology)	The date patient(s) came for analyses/tests, unique Lab IDN, age, sex, tests requested, and test results.

Table 5: Patient Data Recorded at the Various Laboratory Units

As illustrated from table 5, whenever samples are analyzed in the units concerned, the results are first of all written down in the registers. Therefore the registers serve as an archive for patients' results, and it is from them that results are copied out into patients' forms or hospital books, and issued out. The laboratory also has a register in which narrative reports of shift periods underscoring blood transfusions are written down. As a result, this register is usually kept in the Blood Bank unit.

Laboratory documentation is more or less uniform in the different units of the laboratory. The only difference is that the register at the Registration unit contains more detailed information about patients than the registers at the other units. However, unlike the one in the analyses' performing units where patients are identified only by their unique Lab IDNs, the Blood Bank unit identifies clients by their names as well. This is due to the delicate nature of blood transfusion procedures, which demand full

identification of clients in order to avoid blood transfusion mix-ups which could cost human lives. Since the analyses' performing units do not identify patient samples by their names, the laboratory secretary by the end of the day, sorts out the deposited patient test orders based on the information in the register at the Registration unit. He/she then traces the units concerned with analyzing the individual patient samples, and takes the test orders to those units to have them write down the results.

The figure below shows the laboratory documentation in some of the units of the laboratory.

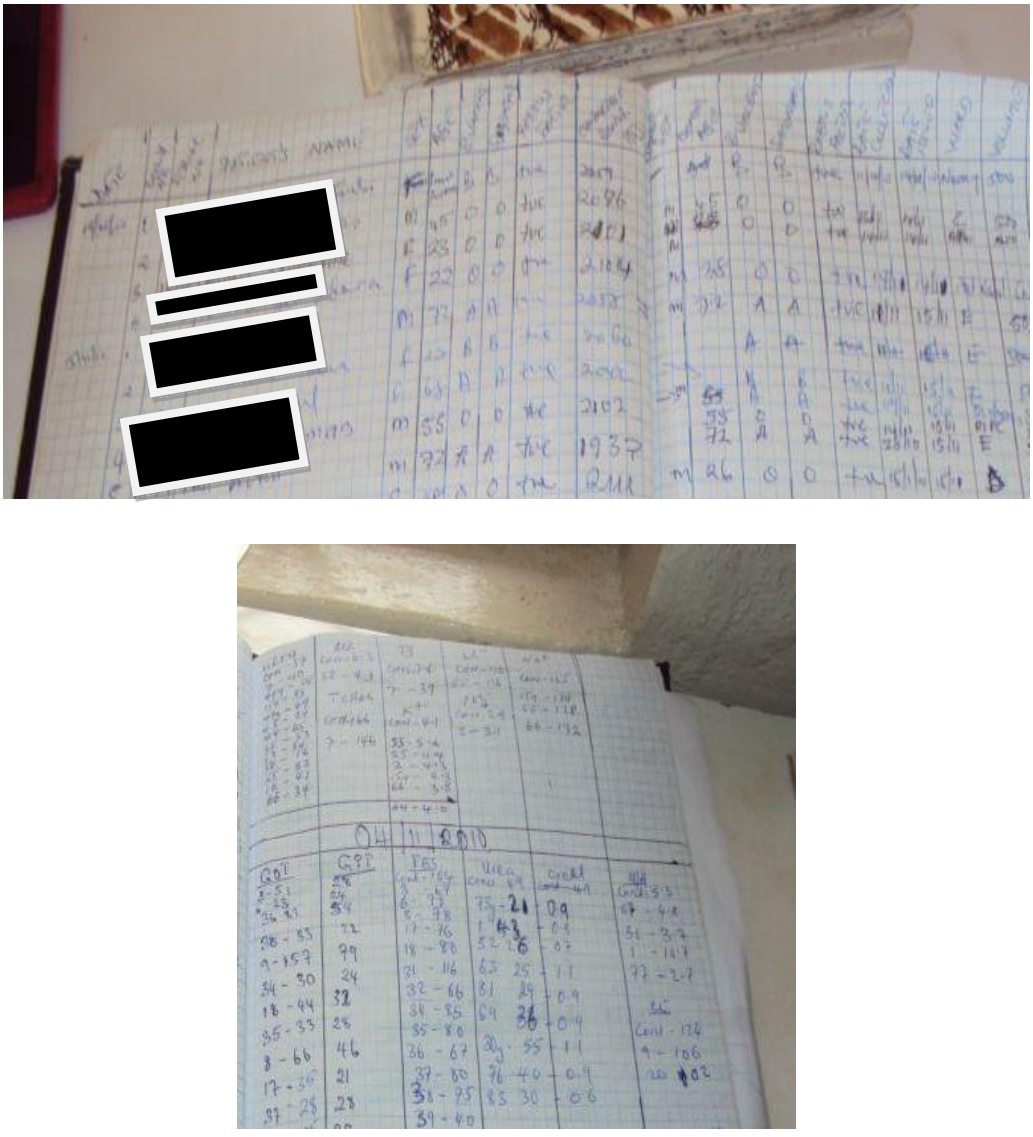


Figure 8: Laboratory Documentation (Registers at some of the Individual Units)

By virtue of the content of laboratory documentation, it is used by all health personnel most especially MDs, nurses, laboratory staff themselves, patients, as well as the hospital statistician.

Medical doctors are of the opinion that laboratory documentation particularly test results, aid in the diagnosis process. During their consultation with patients, they obtain subjective information, coupled with their own judgement, which enables them make an initial diagnosis. But it is at the level of the laboratory, that this diagnosis is proved right or wrong. Thus, laboratory staff must be very meticulous when performing analyses.

"Laboratory test results play a very vital role in the diagnosis of diseases. When a patient reports back to me with his/her test results from the laboratory, I am guided to make proper diagnoses and prescriptions, or refer the patient to a specialist." MD-General Practitioner 1

The nurses I interviewed shared the opinion that laboratory test results help them better educate, manage, and care for patients. This is because they keep a record of patients' results in their individual files, and use them during the care delivery process.

"A practical example involves patients diagnosed with tuberculosis. Such patients are kept in separate sections of the ward, where we give their medication at particular times of the day. We also educate such patients and their family members about their care,: no sharing of cups, no intimate hugs, amongst others." Nurse-Ward A

The laboratory staff use the laboratory documentation as a backing in case of any queries regarding procedures which they performed. This is especially common with the registers which document blood transfusions procedures. They also use it to trace and reprint missing result initially issued out.

"When patients misplace their initially issued results, we obtain detailed information from them (name, address, age, sex, occupation, and sometimes the date they came for the analyses as well as the amount he/she paid for them). This information enables us trace the analyses that were performed as well as the results from the registers, and issue them once more to the patients." Laboratory Secretary & Registration unit staff 1

Patients also revealed that based on their laboratory results, they are able to better cater for themselves, taking precautionary measures wherever necessary.

"As a diabetes patient, I report to the laboratory on a regular basis (at least once a month), to have my FBS analysis performed. From my test result, I am able to better monitor my health status and manage my disease condition with respect to my lifestyle and diet." Diabetic patient

Finally the Statistics department of the hospital also uses the laboratory documentation to produce her monthly statistical record. This record alongside those from other departments and wards of the hospital is channeled through the hospital administration, to the Regional Delegation of Public Health, and then to the Ministry of Public Health. These hierarchal authorities use these statistical records to improve the public health situation of the people.

5.4: Quality-related Setbacks Encountered with the Laboratory Documentation

Generally, because health personnel are able to communicate information through laboratory documentation, the latter is aimed at increasing the quality of healthcare delivered to patients. However, this aim is jeopardized given that the documentation system is mostly paper-based and handwritten. As a result, many quality-related setbacks continue to be noticed as discussed in the latter part of this section.

5.4.1: Time Constraints Involved in Ordering Laboratory Tests/Analyses

Laboratory test orders are generally handwritten and are usually made by physicians. But in the absence of physicians, the nurses working at the Casualty (Emergency Service) department may also order laboratory tests. The hospital has designed a special form which is used to order laboratory analyses, and on which the results of the analyses performed are written down (see figure below).

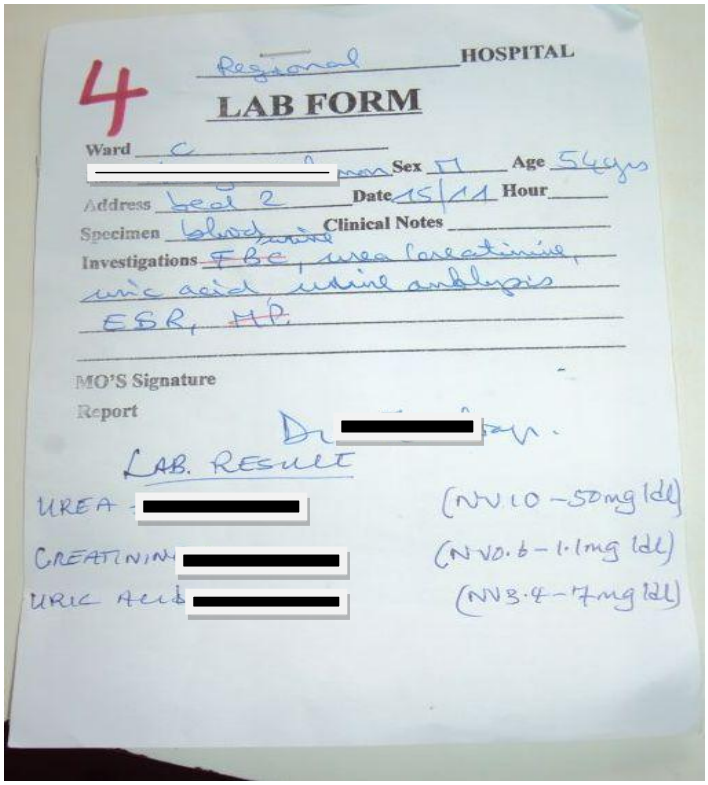


Figure 9: Laboratory Request Form

Usually, this form is used just for inpatients[8] because filing is more convenient. Since the form contains vital information necessary for continuity of care, it is filed into each patient's folder and kept in the nurses' station of the ward lodging the patient. Upon discharge of the patient, he/she leaves behind the file and all its contents because it is the hospital's property. However, if the patient desires to keep track of his/her laboratory records, the patient either photocopies this form or buys a hospital book and has a laboratory staff transfer the results into the book. This second option seldom occurs because it is very cumbersome for the laboratory staff who are concentrated on analyzing already-collected samples.

As concerns outpatients[9], their laboratory test orders and results are written down in their hospital books. Worth mentioning is the fact that as of 2007, RHB started producing her own exercise books for this purpose. New patients were encouraged to purchase this book while old patients only purchased this book when their old hospital books got finished.

[8] Hospitalized patients

[9] Patients who are not hospitalized

After laboratory tests are ordered, patients report to the laboratory with either their forms or hospital books, and have their samples collected and analyzed. They are also told when to report back for their results, which could either be from 2 p.m. that same day (usually for routine analyses), or from 10 a.m. the next day (for AgRV serology only). Units like Biochemistry, Haematology, and Bacteriology have little exceptions as to the issuing out of particular tests results as explained below.

In the Bacteriology unit, if a patient reports for a culture analysis, he/she can only collect results after a minimum of 3 days (excluding weekend days). Therefore, patients reporting for culture analysis are received from 8 a.m. on Mondays till 1 p.m. on Wednesdays. This is to ensure accuracy in analysis since the bacteria being cultured takes time to grow, and has to be constantly observed during its growth period.

The Biochemistry and Haematology units have particular days on which particular kinds of analyses are performed, primarily because such analyses are infrequently requested. In addition their analysis protocols/procedures are time-consuming, and the reagents[10] used for their analysis can be used just once (after initial opening). Thus, for economical purposes, samples for such analyses are kept to pile up before they are analyzed (in batches). In the Haematology unit, Electrophoresis "haemoglobin type" is the only example of such analyses. As such, when samples for this analysis are collected, they are refrigerated. In the Biochemistry unit, such analyses include: thyroid hormones, immunoglobulins, gonadotrophins, and *H. pylori* (for the detection of peptic ulcers). Since most biochemical analyses are serum-based, when such samples are collected, they are centrifuged to extract the serum, which is then refrigerated. In both units, all of the refrigerated samples are usually analyzed twice a week.

Patients are of the opinion that this procedure of ordering laboratory analyses is quite time-consuming, and even delays the care delivery process. This is because after being referred to the laboratory for analyses, the earliest they can collect their results is 2 p.m. of the same day. But by that time, physicians are usually either on ward rounds, or attending to a long queue of other patients before the standard closing time of 3.30 p.m. As such they may only be reviewed by the physician the next day, to either continue with diagnosis or begin treatment.

On the contrary, the laboratory staff appreciate the fact that they take responsibility for scheduling when the different analyses should be performed. This is due to several reasons as revealed by some of them in the proceeding paragraph.

[10] Chemicals used in laboratory analyses

"Personally, this procedure is relatively effective because it is economically suitable for the running of the laboratory. Secondly, we work without pressure from patients. Lastly, it gives us a feeling of ownership over our routine work. This in turn boosts our confidence level and motivates us to perform our job well and very meticulously." Haematology unit & Biochemistry unit staffs

The MDs have somehow a mixed feeling to this procedure and sometimes they wish it could have been much better.

"As an MD, I feel disturbed when I cannot review patients because they delayed at the laboratory to obtain their results. However, it is a good thing for the laboratory to have fixed times for sample analyses and issuing-out of results, because it makes work in the laboratory very organized." MD-General Practitioner 2

Overall, it tends to be difficult to solve this problem because the procedure of ordering and performing laboratory analyses involves MDs and laboratory staff who both operate on different schedules. Thus, patients most especially continue to suffer the consequences. However, in recent times, some patients have resort to psychologically preparing themselves before coming to the laboratory. This helps them because they do not get irritated by the long waiting time involved.

5.4.2: Unclaimed Laboratory Results

Usually, when patients' results are ready, they are assembled and kept at the Registration unit from where they are issued out. The issuing-out process is such that a laboratory staff calls out the names of patients, who respond by collecting their results. If a patient is absent during this process, his/her results are kept in the laboratory. However, only inpatients' results can be given to their carers or nurses in their wards, if such patients cannot report back to the laboratory due to health reasons. The laboratory results for HIV screening are the only exception to these rules because these results are considered highly confidential. As such, they are singled out and handed to patients after individual post-counselling sessions.

"After issuing out results, we are usually still left with a pile of results for which patients have not shown up to claim. So we keep the results in a particular box, in case their owners show up sometime in the future." Registration unit staff 2

The figure below shows where the laboratory stores unclaimed results.

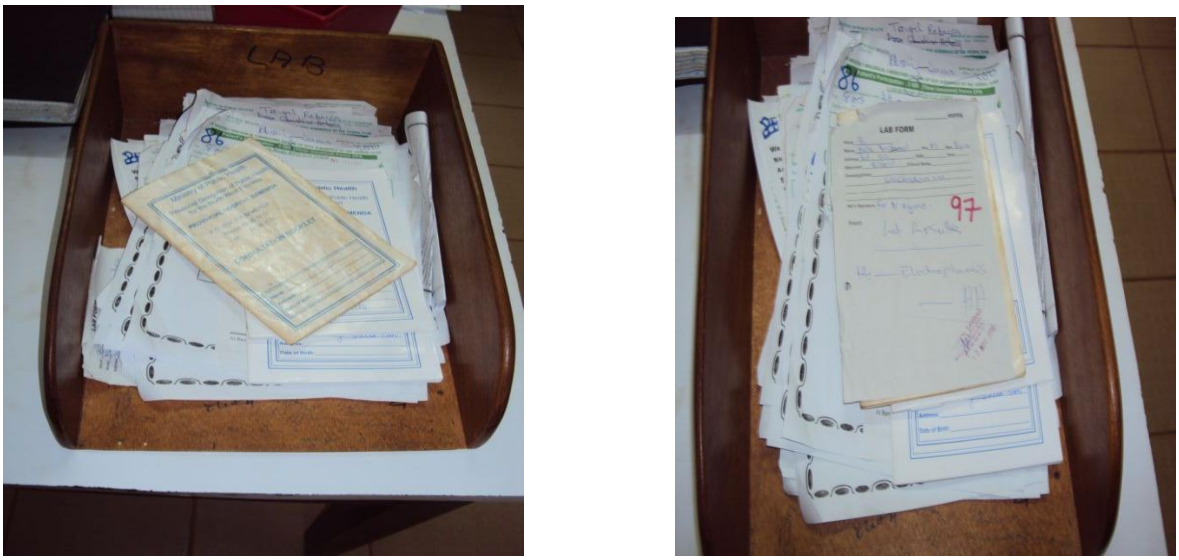


Figure 10: Unclaimed Laboratory Results

Most patients revealed that they do not return to claim their laboratory results due to forgetfulness. But most of them blame the long time gap between sample collection and issuing-out of results. This is because after their samples have been collected for analyses, they get back to their daily activities and easily get carried away with them. On the contrary, patient carers disclosed that sometimes they intentionally do not return to claim their patients' results as explained below.

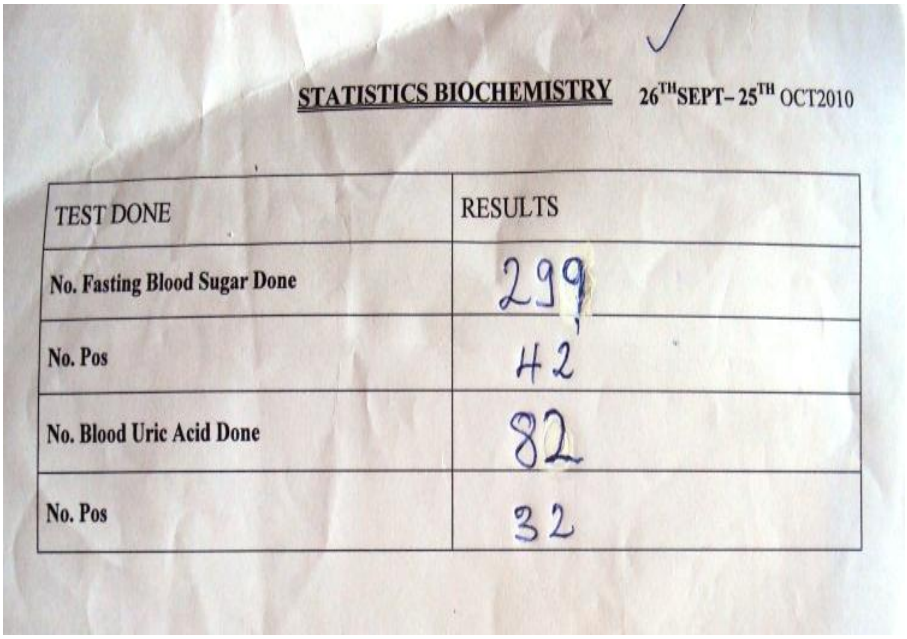
When I am in the hospital catering for a loved one who is hospitalized, I follow up on collecting his/her every result from the laboratory. However, if my patient happens to die after submitting his /her sample to the laboratory for analyses, I do not deem it necessary any longer to collect such results, since they will be of no use. I had better just concentrate on grieving for the loss and making arrangements to have the corpse kept in the mortuary in preparation for burial." Patient carer

Although the laboratory is very organized in storing unclaimed results, the latter have become an inconvenience in the laboratory. Thus, the laboratory staff after serious contemplation have resorted to redress this problem.

"*It is rather unfortunate that the box where we store unclaimed laboratory results has been full for quite some time now. As such, we have resolved to get rid of the results, most especially the very old ones which may not be useful anymore."* Assistant Laboratory Superintendent'

5.4.3: Statistical Analyses

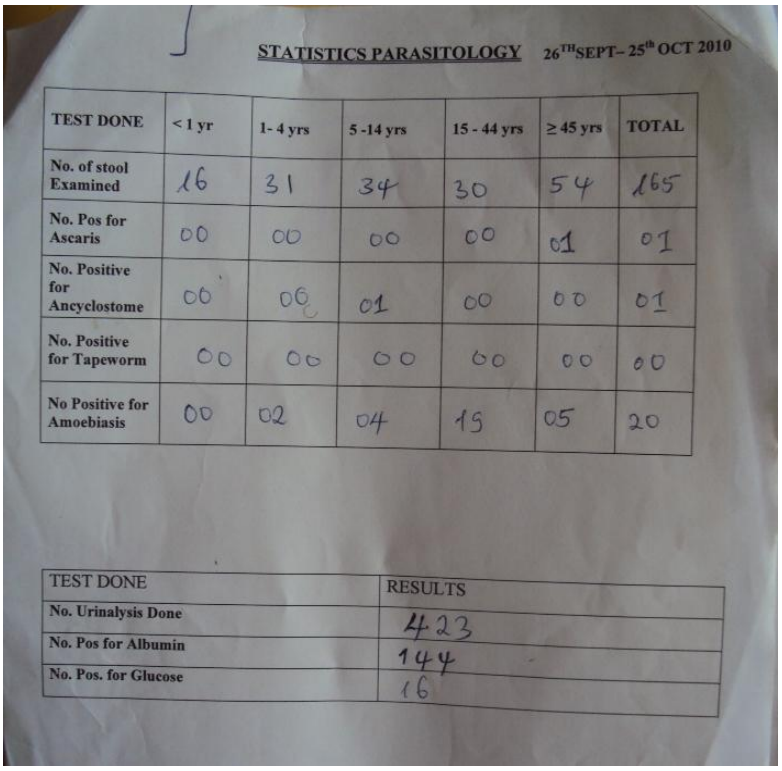
The process of producing statistical analyses in the laboratory is done on a monthly basis, and it involves the entire laboratory documentation from the various units. It is such that the laboratory staff working at the individual units go through their unit registers and manually count the features (parameters) of interest. Then, they record this information on a form given to them by the laboratory secretary, and specially designed for their unit. The forms for some of the individual units are illustrated below (see figures below).



STATISTICS BIOCHEMISTRY 26TH SEPT– 25TH OCT2010

TEST DONE	RESULTS
No. Fasting Blood Sugar Done	299
No. Pos	42
No. Blood Uric Acid Done	82
No. Pos	32

Figure 11: Monthly Statistical Record for the Biochemistry Unit (October 2010)



STATISTICS PARASITOLOGY 26TH SEPT– 25th OCT 2010

TEST DONE	< 1 yr	1- 4 yrs	5 -14 yrs	15 - 44 yrs	≥ 45 yrs	TOTAL
No. of stool Examined	16	31	34	30	54	165
No. Pos for Ascaris	00	00	00	00	01	01
No. Positive for Ancyclostome	00	06	01	00	00	01
No. Positive for Tapeworm	00	00	00	00	00	00
No Positive for Amoebiasis	00	02	04	19	05	20

TEST DONE	RESULTS
No. Urinalysis Done	423
No. Pos for Albumin	144
No. Pos. for Glucose	16

Figure 12: Monthly Statistical Record for the Parasitology Unit (October 2010)

After filling these forms, the unit heads hand them to the laboratory secretary who compiles and hands in to the Statistics department, on a special form designed by that department. Worth noting is the fact that the statistical analysis from the Registration unit which pertains to the number of test orders received by whichever physicians, is not included in the compiled form. It is handed to the Statistics department separately because this particular analysis was locally instituted (that is, by the hospital administration).

The hospital administration (particularly the Management board) uses the statistical analyses from the laboratory as a guide on the quantity of laboratory reagents to purchase. This is made possible by assessing the compiled statistical record obtained within the last two consecutive months, minimum.

The figures below illustrate a page each, of the compiled monthly statistical record for two consecutive months in the year 2010.

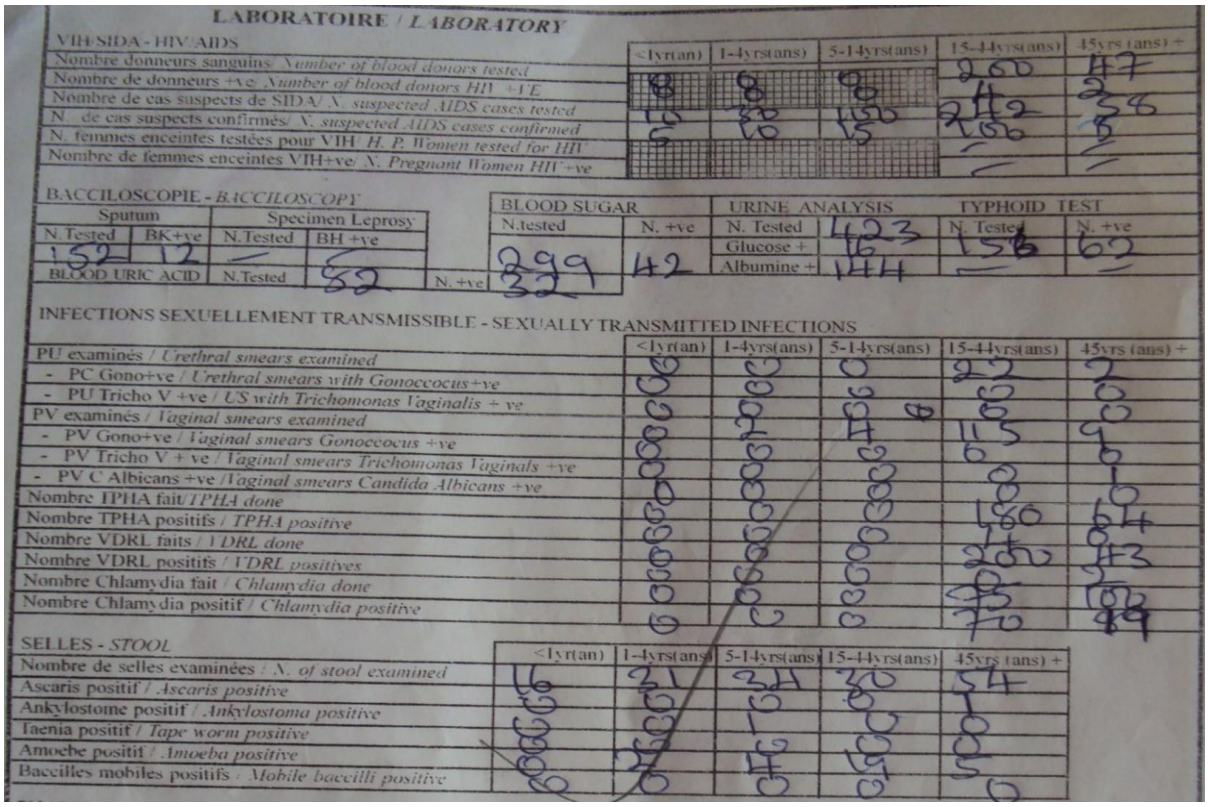


Figure 13: Compiled Monthly Statistical Record, Page 3 (October 2010)

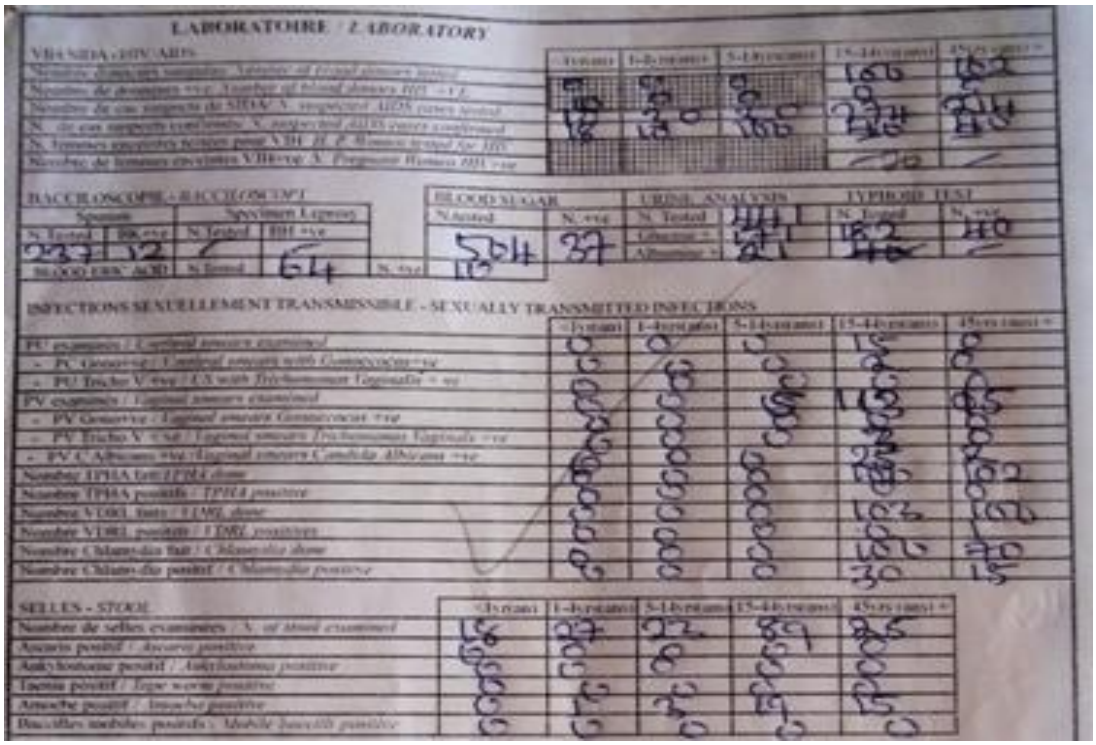


Figure 14: Compiled Monthly Statistical Record, Page 3 (November 2010)

From the above two-month statistical record, it can be deduced that many more patients continue to perform FBS and Sputum analyses, for example. Hence, for the proceeding months, the Management board is guided to purchase a greater quantity of reagents for these analyses. On the other hand, it can be deduced that fewer patients continue to perform Uric Acid analysis for example. Thus, the purchase of reagents for this analysis can be stepped down the next month. Finally, it can be deduced that the number of patients performing Chlamydia analyses for example is fairly constant. As such, the purchase of reagents for this analysis can be maintained the next month. Generally, because laboratory reagents are quite expensive, the hospital can save huge costs when the monthly statistical analyses are done accurately and submitted in time.

The Ministry of Public Health through its Regional Delegation also makes use of the statistical analyses to depict the prevalence of a disease and take necessary measures against it. For example, from the above two-month statistical record, it can be depicted that the presence of *Amoeba sp.* in stool samples is on the rise, as well as the number of positive HIV screening tests. Consequently, the surrounding population can be educated on preventive measures against Amoebiasis[11] (for example: thoroughly wash and cook all raw foods), and also sensitized through HIV/AIDS campaigns respectively.

International organizations like WHO use these statistical analyses when compiling the country's health profile. The latter serves as evidence for WHO and other international organizations like: Ensemble pour une Solidarité Thérapeutique Hospitalière En Réseau (Together for Therapeutic Solidarity in Hospitals Network), Clinton Foundation HIV/AIDS Initiative, and Maternal & Childhealth Advocacy International, who are presently funding projects pertaining to healthcare at RHB. The nature of these projects is such that patients pay little or nothing at all for their treatment. However, almost all of these projects involve and cater only for patients (both adults and children) suffering from HIV/AIDS or tuberculosis. Consequently, the particular statistics of vital importance to these organizations pertain to Cluster of Differentiation 4[12] and sputum analyses respectively.

Finally, the presence of statistical records in healthcare ensures continuity. This is due to the fact that staff are constantly being transferred from one laboratory to the other, either within or without a particular geographical location. Thus, any incoming staff viewing the statistical record of his/her new

[11] A gastroenteritis infection caused by an *Ameoba sp.*

[12] a glycoprotein that is found primarily on the surface of helper T cells, and a receptor for HIV in humans

environment, gets a better orientation of the environment and its peoples' health conditions. Such a staff encounters a smooth transition which enables him/her render quality healthcare to those in need of it.

Although the laboratory statistical analyses are very important for the above explained reasons, staff are usually reluctant doing it. By the end of every month, the laboratory secretary prints out the statistics forms and distributes to the various units, giving them a deadline (usually of one week) to hand in. Normally, it is the responsibility of the various unit heads to ensure that the statistical analyses are performed and handed in on time. However, their subordinates sometimes drag performing these analyses, giving excuses like: *'I do not know how to do it', 'it is too time-consuming and strenuous for me', and 'our financial benefits from performing these analyses are small.'* This forces the laboratory secretary to perform the analyses for the individual units, in order to obtain, compile, and promptly hand in the record to the Statistics department.

The hospital administration has tried to resolve this issue for a while now, but no solution seems long-lasting enough. At first the administration will appeal to the consciences of laboratory staff, saying: *'We need international organizations to support us in the healthcare delivery process because we cannot afford', and 'if you abstain from performing the statistical analyses, everybody suffers and most especially the patients you swore to serve'.* Later on the administration resolved to paying laboratory staff their monthly incentives only after they had submitted their monthly statistics. Finally, the administration slightly increased the monthly incentives for laboratory staff, as a means of motivating them. These measures however work for sometime but sooner or later, the laboratory staff return to their usual reluctance in performing the statistical analyses.

5.4.4: Quality Control Lapses

Generally, quality control in the laboratory is thought to embody the routine operational procedures instituted to ensure that its documentation is continually reliable. As such, it is concerned with detecting defects in the laboratory documentation. A recent assessment of laboratory systems in Cameroon showed the lack of an established National Laboratory Strategic Plan, which greatly affects laboratory capacity to support clinical diagnostic services and systems such as laboratory quality management, accreditation, and equipment maintenance. Thus, Centers for Disease Control and Prevention (CDC) Atlanta, has earmarked four pilot laboratories in Cameroon to implement this plan (CDC, 2010). Although the RHB laboratory happens to be one of these pilot centers, since the project has not yet commenced, this laboratory continues to witness some lapses which generally affect the

quality of healthcare delivered. These lapses include: illegibility (poor handwriting), common errors in test ordering and result reporting, unnecessary repetition of analyses, and competition from unskilled laboratories.

a) Legibility Problem

Handwriting has major implications in clinical practice because laboratory test orders are handwritten. However, it has been observed that most MDs do not write clearly as illustrated in the figure below.

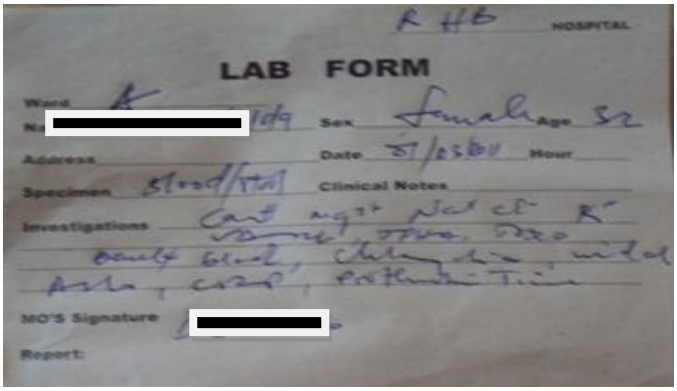


Figure 15: Illegible Laboratory Test Order

But most MDs consider it unfortunate that a majority of them do not write clearly. They are not taught at medical school to write that way, but the surrounding circumstances compel them to do so.

"In my opinion, the reason for this usual handwriting pattern amongst us is simply because we have so many patients to attend to. This therefore implies that we have a lot of writing down to do. Consequently, most of the time, we are in a hurry while writing, and you can bear with me that most things written down in a hurry are usually not legible." MDs-Specialists and General Practitioners

The legibility problem is suffered by both the laboratory staff and the patients concerned, and it causes a delay in the care delivery process.

"When test orders in illegible handwriting get to the laboratory, we sometimes face difficulties reading them. We therefore either skip out on such analyses or worst still perform analyses for what the order may seemingly be read as. This generates some misunderstanding between MDs and us, and

consequently, the patient's results are delayed since the tests have to be repeated." Sample Collection unit staff 1

The occurrence of the above phenomenon however has greatly reduced nowadays because MDs try as much as possible to write legibly, given the experiences they have encountered in the past. Furthermore, with the advent of the Telephone Intercom System, laboratory staff usually call MDs to clarify any doubts regarding illegible tests orders which they receive, before proceeding to perform the analyses.

b) Common Errors in Laboratory Test Ordering

Given that the full names of particular analyses are quite long, standard acronyms are being used when ordering for such analyses. This in a sense is good because it saves time for physicians who have to write out all test orders. On the other hand, using these acronyms sometimes generates confusion because some of them are ambiguous, and some are similar-differing very slightly, usually by a single letter only. Thus, errors are easily made while ordering for such analyses since the single letters could be easily interchanged. The latter results in laboratory staff performing analyses different from those which the physician actually intended for use in clinical diagnosis. Examples of analyses prone to such errors are illustrated in the tables 6 and 7 below.

No.	**Test Order**	**Full Meaning 1**	**Full Meaning 2**
1	PT	Prothrombin Time	Pregnancy Test
2	UA	Urine Analysis	Uric Acid

Table 6: Ambiguous Test Orders

When writing test orders which may have ambiguous meanings (as exemplified in table 6), MDs are advised not to use acronyms but rather write the test order in full. This goes a long way to curb misinterpretation by the laboratory staff.

No.	Test Order	Full Meaning	Similar Test Order	Full Meaning
1	FBC	Full Blood Count	FBS	Fasting Blood Sugar
2	AST	Aspartate aminotransferase	ALT	Alanine aminotransferase
3	RBS	Random Blood Sugar	FBS	Fasting Blood Sugar
4	ACP	Acid Phosphatase	ALP	Alkaline Phosphatase

Table 7: Tests with Slight Differences

In table 7, the underlined letters are those which vary, and as a result could easily be mistaken for each other, while writing a test order. Such errors are reduced by advising MDs to be more patient when writing down test orders, so that they avoid swapping the acronyms which differ only very slightly.

c) Common Errors in Laboratory Result Reporting

As previously mentioned, the process of reporting patients' results involves transcription from the laboratory registers into patients' hospital books or result forms. As a result, errors of transcription which occur during this process include: interchanging and omitting units of various analyses, as well as assigning units to analyses which are not supposed to be. The Serology, Biochemistry, and Haematology units of the laboratory are generally more prone to such errors. This is because in the Serology unit, the results of most routine analyses either bear units of 'mg/dl' or 'IU/mol', or do not bear units at all. Consequently, a unit may be mistaken for another or an analysis given a unit when it is not supposed to have one. In the Biochemistry unit, units may easily be interchanged because the results of most routine analyses bear units of either 'mg/dl', or 'mmol/l'. In the Haematology unit, long units are often omitted. For example, the unit for Erythrocyte Sedimentation Rate which is 'mmfall/h'. When such errors are however realized, corrections have to be made. Given that corrections are made using fluids (see figure below), the results tend to look unpresentable and may even give a funny impression about the laboratory to persons looking at the results.

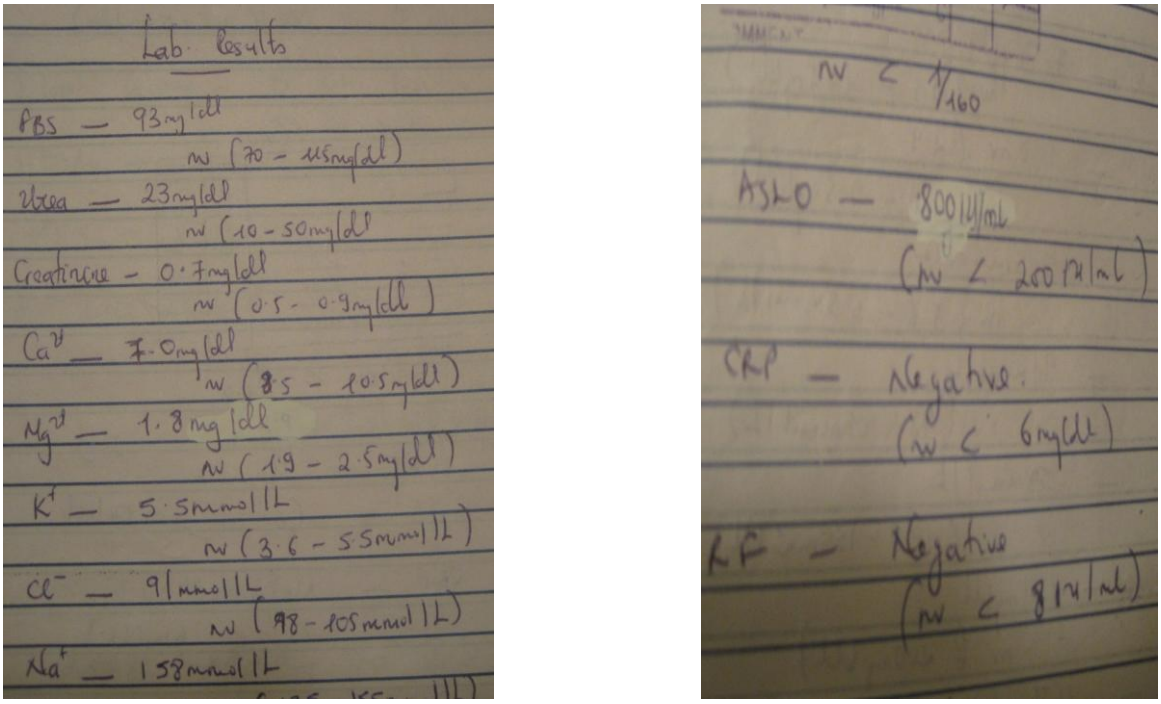


Figure 16: Transcription Errors

In recent times, all unit heads have been charged to crosscheck results before they are issued out to patients. In addition, the laboratory superintendent and his/her assistant sometimes re-crosscheck the results, and have them rewritten out neatly as the case may be.

d) Unnecessary Repetition of Laboratory Analyses

Given that laboratory test orders are only written down in books or on forms, the chances of analyses being unnecessarily repeated is increased. This is because after sample collection, patients usually can only withdraw their books or forms when collecting their results. But due to the long waiting time involved, patients get inpatient and sometimes switch to other physicians, with the hope that it may be faster. Unfortunately enough for them, the physicians may order some of the initial analyses again.

"At the end of the day, when such patients realize that they have unnecessarily performed a test more than once, they become a nuisance in the laboratory. They come attacking the laboratory cashier for a refund, which is impossible because reagents have already been consumed. However, most of the patients who fall prey to this situation are those who are illiterate since they cannot read their test orders. Sample Collection unit staff 2

In effect, the repetition of laboratory analyses is highly blamed on patients. This is because physicians always put in their best to avoid unnecessary repetition of their test orders since it causes patients to incur extra expenditure. Each physician has a register provided by the hospital, where he/she records the names of patients consulted, their test orders, and diagnoses. Thus, when consulting a patient for the second time, they verify the previous test orders before re-ordering some more laboratory analyses.

"A patient who switches to another physician without my knowledge will often fall prey to the analyses repetition situation. This is because our (physicians') registers are individual and we highly confidential. We disclose information about patients upon request only to our colleagues who are concerned with those patients health care." MD-Gynaecologist

Generally patients are advised to exercise a lot of patience and avoid clandestinely switching physicians during the diagnosis process. This is done in a bid to curb the occurrence of the above explained problem.

5.5: IT Support System as an Improver of Laboratory Documentation

As a follow up of the pilot project initiated by CDC Atlanta, to ensure quality in Cameroonian laboratories (CDC, 2010), the present quality-related challenges/setbacks faced by the laboratory documentation in RHB due to its paper-based nature, can be potentially addressed by an IT support system. The latter will to a great extent ensure quality in the laboratory practice as it will enable the proper management of laboratory data, and reduce the record-keeping and statistical analyses burdens on laboratory staff. In addition, this system will decrease the errors associated with transcription and workflow issues, to a significant degree.

As of early 2010, the computerized Basic Laboratory Information System (BLIS) was partially introduced in the laboratory, and it has already proven beneficial, although cumbersome to the Registration unit of the laboratory. Upon the initiation of this system, the Registration unit was equipped with a computer where patient data pertaining to this unit is archived (previously illustrated in table 2). As such, in situations which warrant the tracing of the analyses performed by a patient, the laboratory secretary simply enters the patient's name into this computer, and the archived data of the patient is generated.

This has proven quite beneficial especially in cases where patients' results have to be re-issued out (that is, when the initial print gets missing) or a follow-up/verification of patients' results has to be done at the various units. On the other hand, using this system is quite cumbersome because it is not being operated as was initially intended.

The computerized BLIS was initially designed with the intension of replacing the paper registers in the laboratory. All units in the laboratory were supposed to have computers connected to each other through this system. With the exception of the Registration unit, patients' results should be entered into the computers at the other units. At the Registration unit, as soon as patients report to the laboratory, their data should be entered into the computer. The latter should act as the Central Operating System (COS) because it is from this unit that patients' results are issued out. The computerized BLIS should be able to synchronize patients' data and their results, such that once the patients' names are entered into the system, their data and corresponding test results should be generated, and then issued out. In the case of similar patient names, the system should generate the various patient data and results pertaining to the names. Then the laboratory secretary should consult the patient and confirm his/her data before issuing out such results.

What has been realized so far has been the purchase of the computer at the Registration unit only. The laboratory secretary (working at this unit) has not been able to enter patients' data into this computer upon receipt of patients at the laboratory. He/she first of all enters the data into the paper register and later on types it into the computer, to ensure that the data is not lost in case of sudden power shortages. This entire process has proven to be quite cumbersome because it is like double work for the secretary. Secondly, because the other units have not been equipped with computers due to financial constraints, they are not connected to the BLIS. Hence, patients' results are not entered into this system. The laboratory secretary could as well enter the results at the end of the day but it will be much more cumbersome and rather inefficient. It will also slow down the workflow in the laboratory and delay the issuing out of patients' results.

The figure below illustrates how the laboratory secretary enters data into the BLIS.

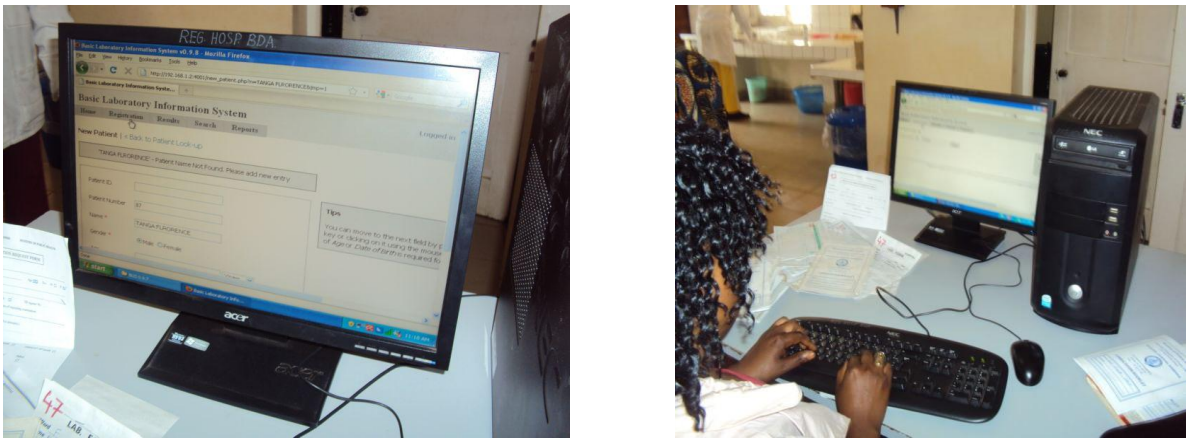


Figure 17: Basic Laboratory Information System

The computerized BLIS if operated as intended, and extended to physicians' consultation offices and the Casualty department (where nurses may order laboratory analyses), can serve as an effective tool for collaborative work. It will permit physicians (and/or nurses) to order laboratory analyses from their offices (and/or Casualty department) and receive the results electronically from the laboratory, as soon as they are ready or completed. In order to meet the needs of RHB, first of all, the system should be aimed at supplementing and not replacing the paper documents (i.e. integrating the system into the paper documents). Secondly, it should be tailored to include the following:

- Test order forms
- Test results display (should include notifications of completed test results)
- Registration of patients
- Laboratory fees paid
- Validity of test results (depending on a time frame)
- Secure email functionalities
- Statistical analyses functions
- Security checks

The security aspect of the computerized BLIS should spell out access levels for physicians, nurses, and laboratory staff involved. For instance, only physicians directly concerned with a particular patient's treatment should be able to access the patient's test results, and only unit heads should enter statistical analyses which the laboratory secretary will compile and hand to the Statistics department.

In addition to improving laboratory documentation, the computerized BLIS if properly integrated into the laboratory will therefore address areas like record management, statistical analyses, internal auditing, inventory control and forecasting, and every other aspect of information management.

CHAPTER 6: DISCUSSION

By virtue of the fact that quality-related problems are everywhere in the health care system (Institute of Medicine, 2001), combating them could be a big challenge. The laboratory documentation being an integral part of health care systems faces several of such challenges ranging from its composition and organization, to its roles in the general work practice. In the proceeding section, these challenges are being discussed, guided by the theories of Information Infrastructures and Actor-Network.

6.1: Infrastructure-related Challenges

Being a very old hospital (created in 1966), RHB faces serious infrastructural challenges. Most of its buildings are quite old and are small relative to the present day's population which the hospital serves. Unfortunately, the laboratory department is classified amongst such small buildings given that it is usually crowded. The crowding is primarily because the laboratory receives much more patients than its building can contain. In addition, all of the nine different units in the laboratory department are located in one building. As such, the individual units are small and can barely contain the necessary laboratory equipments as well as the staff themselves.

Another infrastructural problem is the inadequate supply of electricity, which has negative implications on the quality of data. This is because most essential ICTs are dependent on the supply of electricity (Lippeveld, 2001). Generally in Cameroon, the government tries as much as possible to minimize power shortage by providing her institutions with standby generators. For example, RHB has a standby generator to back up in case of brief power shortage. However, this back up is not sustained especially when black-outs occur abruptly (without prior notice), and extend for longer periods than expected. The effects of the latter are always catastrophic because work processes come to a halt since all of the units use electrical equipments (technologies), delaying the analysis process, and forcing laboratory staff to resort to manual analysis' methods where possible (for example, manual blood cell counts). Given that manual methods are generally of lower accuracy relative to automated methods, the generated patient results tend to be of lower quality.

The solution to these challenges however lies in the fact that infrastructures do not grow de novo, but new infrastructures are developed by extending and improving the old ones (Bowker & Star, 1999; Hanseth & Monteiro, 1998). This implies that in order for the laboratory to even accommodate the

computerized BLIS, its building should be enlarged and appropriately partitioned into the various units. Better still, more buildings should be constructed and allocated to the laboratory department. Secondly, to ensure that this system is effective, power shortage should be minimized, or adequately backed up for longer periods (that is, investing more into power supply or increasing the budget for the generator's fuel, respectively).

6.2: Lack of Human Resources

According to the WHO (2010a) Regional Office for Africa, the national health systems in the African region have inadequate human and financial resources, and limited infrastructure especially with regard to laboratories, information and communication systems. This results in a weak capacity to provide universal coverage and respond to outbreaks and disasters. The fact sheet (see Appendix C) showing human resources available for health in Cameroon indicates a great shortage in the health workforce (WHO, 2006a). This shortage is in turn responsible for the poor data quality because it implies the absence of more skilled personnel to ensure patient care (Azubuike & Ehiri, 1999) and the maintenance of software and hardware (Lippeveld, 2001).

In addition to the fact that the health workforce is limited in RHB's laboratory, the computer literacy level is still very low especially amongst those who graduated over a decade ago or more. But considering the promise of quality improvement which IT systems hold for health care systems (General Accounting Office, 1991), it is important that basic data processing modules be introduced into the curriculum of health professional training institutions. In addition, the hospital should employ IT specialists who can ensure the maintenance and sustainability of the IT support system. A health workforce observatory should also be established at the regional level, which will provide information on the health workforce situation. This will be a vital step towards improving the evidence base for advocacy, policy-making, strategic planning, and capacity building.

6.3: Financial Handicap

Despite the anxiety about the relief which the computerized BLIS will bring, the greatest puzzle is the availability of finances to effect this relief, given that RHB is located in a developing country of mild financial strength.

Although the prices of personal computers have relatively dropped over the past years due to the increase in globalization and modernization, it may still be expensive for RHB to purchase lots of them. More so, the cost of IT operations dwarfs the cost of hardware and software, and often accounts for 50% to 80% of IT budgets (Cappuccio, Keyworth, & Kirwin, 2002; MicroData, 2002). Therefore, designing a tailored IT support system for the RHB laboratory will require a huge financial capital.

The implementation phase of the computerized BLIS will also require lots of funding. This is because incentives will have to be disbursed to ensure that data of good quality is produced. These incentives will cover for the low wages earned by most workers, boost their morale, improve their working conditions, as well as educate and train them to efficiently use the system (Azubuike & Ehiri, 1999). Although the education and training of staff is costly and time-consuming, it is worthwhile because Orlikowski (1992) argues that users change their technological frames in response to a new technology based on the kind and amount of product information communicated to them, and the nature and form of training they receive on the product. Therefore, the staff will be able to use the knowledge and skills they have acquired about BLIS, to step up the quality of the laboratory documentation in every way possible.

Coupled with the cost of IT operations as a whole and the incentives disbursed, huge financial costs will be incurred as a result of undertaking infrastructural developments in order to sustain this system. Examples of such developments include boosting the electricity supply, and the building of bigger laboratory buildings.

6.4: Politics and Policy-related Challenges

Of the many projects ongoing in Cameroon, the Cameroon Health Sector Support Investment project funded by The World Bank is one of prominent importance. The objective of this project is to increase utilization and improve the quality of health services, with a particular focus on child and maternal health, and communicable diseases. This project addresses two components namely: the district service delivery of health care, and institutional strengthening. The latter component includes contract design and management as well as putting in place a unified information system to generate up-to-date and reliable data (World Bank, 2011). However, although a majority of such projects are funded by international organizations, the government of Cameroon has the main role of determining in which region of the country the project will be implemented.

The Republic of Cameroon is made up of ten regions, of which eight are francophone[13] and two are anglophone. Politically, since the anglophone[14] regions are in the minority, they are often marginalized. In most cases, the execution of projects begins in the capital city (one of the francophone regions) and sadly sometimes ends at this level, or extends to a few of the other francophone regions. RHB located in one of the anglophone regions of Cameroon (North West region) will undoubtedly encounter this problem, which could greatly slow down and even impede the introduction of the computerized BLIS in its laboratory. It will therefore require certain government officials to be very pushful in making requests to the President through the Ministry of Public Health; without which this project may not be considered a priority in that region of the country.

6.5: The Need to Manage Different Perspectives

A central feature of ANT is that humans and non-humans (for example, technology, organizations, and institutions) are treated as symmetrical actors (Aanestad & Hanseth, 2000; Walsham, 1997). Thus, technological and social elements are considered tied together into networks, based on the assumption that technologies are always defined to work in an environment including non-technological elements, without which the technology would be meaningless, and it would not work. ANT also holds that from the outset, actors have a diverse set of interests which prompt them to act differently. However, in order for stability, technological and social order to be attained, actors' interests must be aligned by continuous negotiation. (Aanestad & Hanseth, 2000).

"In ANT terms, design is translation: "users" and others' interests may, according to typical ideal models, be translated into specific "needs," the specific needs are further translated into more general and unified needs so that these needs might translate into one and the same solution." (Monteiro, 2000).

This concept of translation is offered as an alternative to diffusion by Latour (1987), who is of the opinion that when a technology diffuses, it is not an artifact with fixed meaning that is adopted in the same way by each user. But in each individual case, the adopter figures how to use the technology in

[13] Areas speaking French as their first language

[14] Areas speaking English as their first language

their respective work or life. Translation has also been used to describe IT diffusion (McMaster, Vidgen, & Wastel, 1997) and implementation (Linderoth, 1999).

Relating this to the case, it could be said that because the laboratory documentation is open, it has an unlimited number of users, and hence various actors who have different interests (as previously explained in sections 4.4 and 4.5 of Chapter 3). The different actors involved are illustrated below (see Figure 18).

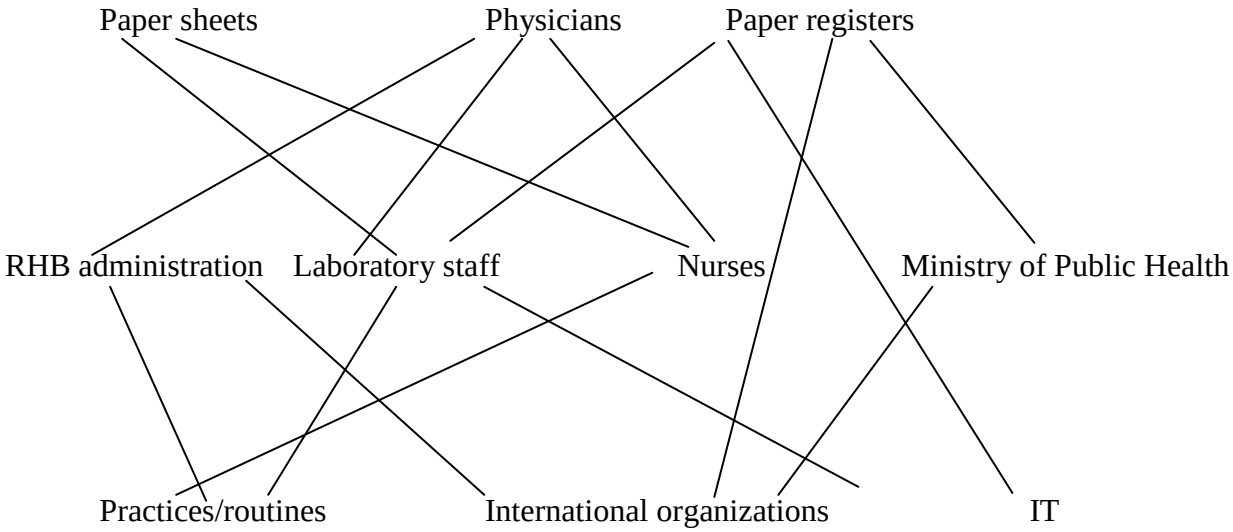


Figure 18: Actors involved in the Laboratory Documentation at RHB

Therefore, laboratory documentation could serve as a good tool in interdisciplinary work. But the different actors must continuously negotiate between their varied interests, a process which has proven to be quite challenging.

A common example of contrast of actors' interests exists most especially between the hospital administration and the laboratory staff. As opposed to the hospital administration who desperately needs the laboratory statistical analyses to source for funding and purchase reagents appropriately, the laboratory staff need these same analyses as evidence of the work they do. The laboratory staff thus consider this interest of theirs as secondary or tertiary, compared to the interest of the hospital administration, which can be considered primary (because it enables the day-to-day running of the laboratory). Consequently, the laboratory staff are usually hesitant to perform the statistical analyses

coupled with the fact that the process is quite cumbersome. But the hospital administration in an attempt to translate their interest into the laboratory staff, started withholding the monthly incentives of the laboratory staff until they had submitted the monthly statistical record. This however worked for a short time but could not last any longer as the laboratory staff soon damned the consequences of not performing the statistical analyses, and the hospital administration loosened its stiffness on the rule.

So, in order for the laboratory documentation to be of undisputable quality and maximum efficiency, these contrasting interests must be aligned. In order words, all actors will have to translate each others' interests, meaning that different actors with different goals may collaborate, compromise, and negotiate depending on the possibilities to reach their own goals respectively.

6.6: Redistribution of Costs and Benefits

Although a significant investment has been made in the development of many systems, applications, and features that support cooperative work, their successes consistently fall far short of expectations. A prominent explanation for this unfortunate situation is the disparity that exists between those who will benefit from the application and those who must do additional work to support it (Grudin, 1988).

As concerns the laboratory documentation, the above phenomenon is absolutely true because a disparity exists between the laboratory staff and other users. For example, as previously explained (see Section 4.5.3), the burden of performing monthly laboratory statistics weighs solely on the laboratory staff, meanwhile the hospital administration, international organizations, physicians, and MoPH benefit more from the statistics. Likewise, implementing the computerized BLIS will mean that the laboratory staff have to put in more effort (like being trained) than the other users of the laboratory documentation, to ensure the proper functioning of this system. Thus, they may tend to resist this system, given that they consider their benefit from the system as secondary, relative to the other users of the laboratory documentation.

Generally, this disparity gap is a common problem with the use of many applications, whereby it impedes the success of such applications. An example involves the designing and implementation of the electronic health record system in Cameroon, which failed to succeed because of heavy workload and poor motivation on the personnel most primarily concerned (Kamadjeu, Tapang, & Moluh, 2005). The only most probable exception to this disparity problem is with the use of electronic mails, whereby everyone generally shares the benefits and burdens equally.

However, it is thought that this problem could be resolved by ensuring that everyone benefits directly from using the application in question. Alternatively, existing job descriptions could be changed or new job descriptions invented when the systems are introduced (Cherns, 1980; Rowe, 1985). Therefore, it will be wise to redistribute the costs and benefits such that the laboratory staff can benefit much more from the introduction of this system. This could be done by financially motivating them to train in using the system, or better still employing IT trained persons to operate the system. In the case of RHB, the latter option may most likely be the best because these new employees (given their knowledge in IT) will better use the system and improve the quality of the laboratory documentation.

6.7: Permanent Instability

According to ANT, stability, technological and social order, are continually negotiated as a social process of aligning interests (Aanestad & Hanseth, 2000; Monteiro, 2000). The application of ANT in particular contexts enables us to try to trace and explain the processes whereby relatively stable networks of aligned interests are created and maintained, or alternatively to examine why such networks fail to establish themselves (Walsham, 1997).

In order to analyze the introduction and adaptation of a technology in an organization, we start from focusing on the work required in order to facilitate the meeting between the technology and the work practices. Thus, the existence of the term *stabilized network* in ANT, which connotes a "successful" implementation where the actants are aligned (Aanestad & Hanseth, 2000).

Examining the implementation of open network technologies in complex work practices, it was observed that some experimental activity was required to figure out how to use the technology properly. One might possibly believe that as the use of the technology becomes routine, more experience is gained, the degree of experimentation will decrease, and hence a decline in the problems and challenges of using the technology. However, using such technologies in organizations like large hospitals will regularly be of such experimental character. This is due to the open and network character of the technology; the complexity of the work practices into which the technology is introduced; the potential "revolutionary" benefits of the technology (Aanestad & Hanseth, 2000).

In this respect, it is envisaged that RHB being a large hospital will be in a state of permanent instability upon introduction of the computerized BLIS. Certainly the integrated computerized BLIS is perceived by most physicians as orderly because it would facilitate and quicken the ordering of

laboratory tests, and give physicians easy access to patients' laboratory results. On the other hand, Berg & Timmermans (2000) argue that creating order in one place simultaneously creates disorder in other places because order and disorder are engaged in a spiraling relationship (that is, they need and embody each other). By implication, the introduced system may have unexpected consequences, as the order that the system creates for some, creates a corresponding disorder for others.

Disorder is not eradicated but relocated and transformed. To be more specific, creating order for some creates disorder for others, which spawns work-arounds to amend. Consequently, the overall level of order and disorder, however, appears to be largely constant (Ellingsen & Monteiro, 2005). This is evidenced by a study illustrating how the benefits of nursing plans for nurses, simultaneously caused disadvantages for psychologist and medical doctors (Ellingsen & Munkvold, 2007).

Similarly, as the laboratory staff get acquainted with the new technology, some of them in the course of this may generate other uses for this same system. For example, performing free sample analyses clandestinely for friends and relatives, browsing the Internet, and playing computer games. Further disorder could be relocated and work-arounds performed, as explained below.

First of all, it is the responsibility of the individual units to enter patients' results into the unit computers from where they are channeled to the COS at the Registration unit. At this unit, the laboratory secretary is responsible for harmonizing the results and issuing them out. In case of any data entry problems, the secretary would have to manually collect and harmonize patients' results from the individual units, before issuing them out. This would be quite laborious and could make it more difficult to use the computerized BLIS.

Secondly, given the complex nature of medical data, the unit routines may become more cumbersome than before. Thus, the hospital may need to hire additional people to manage these routines. The laboratory staff may also have to put in a lot of efforts to further develop the functionality in the computerized BLIS. The unit most likely to suffer this problem is the Microbiology unit, given the complex nature of their data structure. By implication, the staff working at this unit may have to undertake additional work to significantly develop this system so as to make it acceptable.

On the whole, permanent instability is not necessarily a problem because it simply describes the norms in complex work practices. This implies that even if it is temporarily dealt with, it will eventually resurface in the future.

6.8: Manual Workflow and Patients Moving Between Power Domains

The manual workflow at the laboratory involves patients moving from consultation to the laboratory and vice versa. At these offices patients receive handwritten, paper-based, laboratory test orders which they convey to the laboratory to have their samples collected and analyzed. As previously mentioned, the earliest time the laboratory hands out patients' results is from 2 p.m. After collecting their results, patients rush back to the offices of the MDs who ordered the analyses. But sadly enough, most of the patients do not see the MDs who are either doing ward rounds, or attending to new cases[15]. As a result, the MDs close work at 3.30 p.m. (the standard closing time) without reviewing patients. The above described scenario indicates that there is a clash in interests between the MDs and laboratory staff, with respect to time. Consequently, the shuffling of patients between these two power domains (that is, the laboratory and MDs' offices) delays the care delivery process.

Introducing the computerized BLIS may significantly decrease this delay because the system will enable laboratory tests and results to be ordered and received electronically respectively. However, it will require some laboratory staffs to be assigned to collect patients' samples at consultation offices. This in turn will decrease the number of staff analyzing patients' samples in the laboratory, and increase the workload of those performing the routine analysis. All of which could have a negative impact on the quality of work they will eventually perform.

So in effect, the laboratory staff and MDs will always have contrasting interests with respect to time. This does not imply failure in the workflow but it just tallies with the fact that different actors always have different interests as illustrated in the theory of actor-network (Walsham, 1997) which should be constantly negotiated to ensure temporary alignment (Doolin & Lowe, 2002).

6.9: Quality as a Socio-technical Aspect

a) IT Acceptability

Generally it is thought that many people are usually reluctant to move beyond the decade in which they were schooled. Thus, they sometimes tend to view innovations in their routine work practice as time consuming and irrelevant, especially when the former methods have been effective to some degree. In addition, for example, asking laboratory scientists who have classified themselves as

[15] Patient(s) consulting a particular MD for the first time

experts to learn new processes and skills may generate some resistance from them. Reason being that the learning process may push them into a situation where they are no longer experts. But whatever the case may be, a stereotyped mentality is not advisable especially within the medical field where innovations to better the quality of health care delivered, are constantly being made.

However, a solution to this problem may be to involve the users of the computerized BLIS in its design and implementation phases. They should not be left out else the system takes them by surprise, giving them a feeling of being left out, and increasing the difficulty of them conceptualizing the system.

b) Collaborative Work

Given that RHB laboratory consists of nine different units, a challenge most likely envisaged with the introduction of the computerized BLIS is the smooth and timely flow of information between all of these units.

Generally, this system will expect the different units to send in patients results to the Central Operating System (COS) at the Registration unit, from where the results will be harmonized and issued out. However, in order for this to be effective, the system will have to be designed with a synchronizing function, and the various units will have to send in their results in time. By implication, these units should be given a timeframe within which they should have submitted these results to the COS at the Registration unit.

Failure to comply with this timeframe, will greatly delay patients results and this could be detrimental to the data quality, given that WHO (2003) holds that quality data should be timely and accessible when needed. Furthermore, the timely potential benefit of IT would not have been achieved since waiting times and harmful delays for both those who receive and those who give care, would not have been reduced.

c) Exaggerated Expectations

As previously outlined, the introduction of the computerized BLIS is being strongly motivated by the quest for quality improvement of laboratory data. As such, there is a danger of the hospital staff concerned perceiving that this system would replace the paper documents, and result in a perfect work set up. However, based on previous studies, the above situation is not always true because IT is usually integrated with pre-existing systems, a process which does not result in perfection (Ellingsen & Monteiro, 2005; Grimson et al., 2000).

It will be important that the staff be properly educated on the benefits and risks of IT. They should be made to understand that the introduction of the computerized BLIS may generate complications of some sort. It should also be clearly spelt out that BLIS is not meant to replace but to supplement the paper documentation. While users learn how and when to use BLIS, the paper documentation should still be used because it will serve as a backup in case of power failures or the inability to electronically retrieve data. All of the above measures will go a long way to dismiss users' exaggerated expectations (of perfection) about the system, and prepare them for whatever challenges it may generate.

d) Privacy Issues

The implementation of the computerized BLIS may present some challenges regarding patients' privacy. Given that this system will enable patients' health information to be electronically accessed, it is important that the scope of accessibility be properly defined. This should be such that only health care givers involved in the care process of particular patients should be able to view the patients' information. Otherwise, if this is not addressed from the very beginning, it may compromise confidentiality in the medical profession. As a result the system could be highly opposed or resisted by both health professionals and patients.

Although the code of conduct for all health professionals clearly assures patients of the confidentiality of their medical records, this is not sufficient to protect these records from external hackers. Stringent measures and appropriate access levels of various users of this IT support system will have to be enforced, to prevent the privacy rights of patients regarding their medical records from being defiled. For example incorporating and using complex passwords/codes in the system.

The current work practice set up will also have to be taken into serious consideration. For instance, the case of the nurses working at the Casualty department who have been conferred an exceptional right to order laboratory analyses, usually in the absence of a physician. This particular case warrants that access levels in the system be tailored to accommodate this exceptional right, without compromising patients' privacy. In addition, it should be made clear between physicians and these nurses, their roles and responsibilities in order to avoid negligence and dispel ambiguity.

CHAPTER 7: CONCLUSION

Over the years, quality improvement in health care systems has greatly evolved to include new technologies of great potential. However, this tends to be farfetched in most developing countries due to the huge financial costs entailed.

This research performed in a Cameroonian hospital sought to find out about the factors which shape the implementation of an IT support system to improve the quality of laboratory documentation. Thus, it addressed questions pertaining to the role of laboratory documentation in routine work, the laboratory documentation infrastructure (that is, its interdisciplinary nature), the quality-related lapses affecting this documentation, and the implementation strategy employed to combat these lapses.

In a bid to find answers to these questions, I found out that the laboratory documentation is being used by laboratory staff, MDs, nurses, and patients for the purposes of clinical diagnosis and patient care. In addition, the hospital administration, the Ministry of Public Health, and international bodies use the documentation for administrative purposes. Hence, all of the above users constitute and play active roles in the laboratory documentation infrastructure.

Findings further revealed that the quality of laboratory documentation is quite low as illustrated by the occurrence of the following: long waiting time involved in ordering laboratory analyses, unclaimed laboratory results, manual statistical analysis processes, illegible laboratory test orders, common errors in laboratory test ordering and result reporting, and unnecessary repetition of laboratory tests. All of these in the long run could cause the quality of the laboratory documentation to totally depreciate. As a result, the reputation of the laboratory and hospital could be tarnished and patients scared away from the hospital as a whole.

In my opinion, in order to avoid these negative implications, it is absolutely necessary for a tailored IT support system to be implemented in the laboratory, because it will facilitate the generation and improve the quality of laboratory documentation. Although the implementation of this system will meet with several challenges like the lack of adequate resources, challenges in themselves are not always negative. In this case, the challenges could rather provide opportunities for the laboratory to be equipped with better resources (human, infrastructural, amongst others), which will increase the hospital's credibility and quality as a whole.

I also strongly advise that the socio-technical approach should be employed when implementing this system. This is because in addition to the newly introduced IT system, this approach will help educate the users on how and when to use the system, as well as enforce other resources (for example, infrastructure) to support the technology. Another aspect of educating users will be about the possible challenges of the system as well as its supportive function. The system should not be aimed at totally replacing the paper documentation but supplementing and complementing it. This is because the new system may generate some disorder and work-arounds in the routine laboratory practice, coupled with the power shortage problem frequently encountered. Furthermore, realistic and attainable goals should be set because the new system will not magically improve the quality problems affecting the laboratory documentation. Otherwise, the goals may not be achieved resulting in the system failing, and hence discouragement. This in turn might lead to the abandonment of the system by the users.

Although the socio-technical approach may seem challenging in health care systems due to the above mentioned reasons, it is worth considering because introducing a new technology into a setting not only affects the users but the people surrounding them. More so, the utility of technology is socially shaped, that is, humans use the same social rules and values with which they relate to the world, to judge and interact with technologies. In effect, achieving quality improvement involves adding new resources to an organization, making changes in the organization to make the best use of the resources, and evaluating the progress from time-to-time.

Worth noting is the fact that because Cameroon is a developing country, the choice of projects to be implemented is heavily scrutinized based on the country's policy and political structure. As a result, a strong political support may be required to ensure quality improvement in its health care system. I therefore suggest that a strategic plan be made, which will outline the expectations of introducing IT systems in the health care system. This will go a long way to convince more politicians to support and source for funding for such projects.

In conclusion, areas for further research in health care worth considering could include: possible quality improvement resources, and the political commitment to quality improvement in developing countries.

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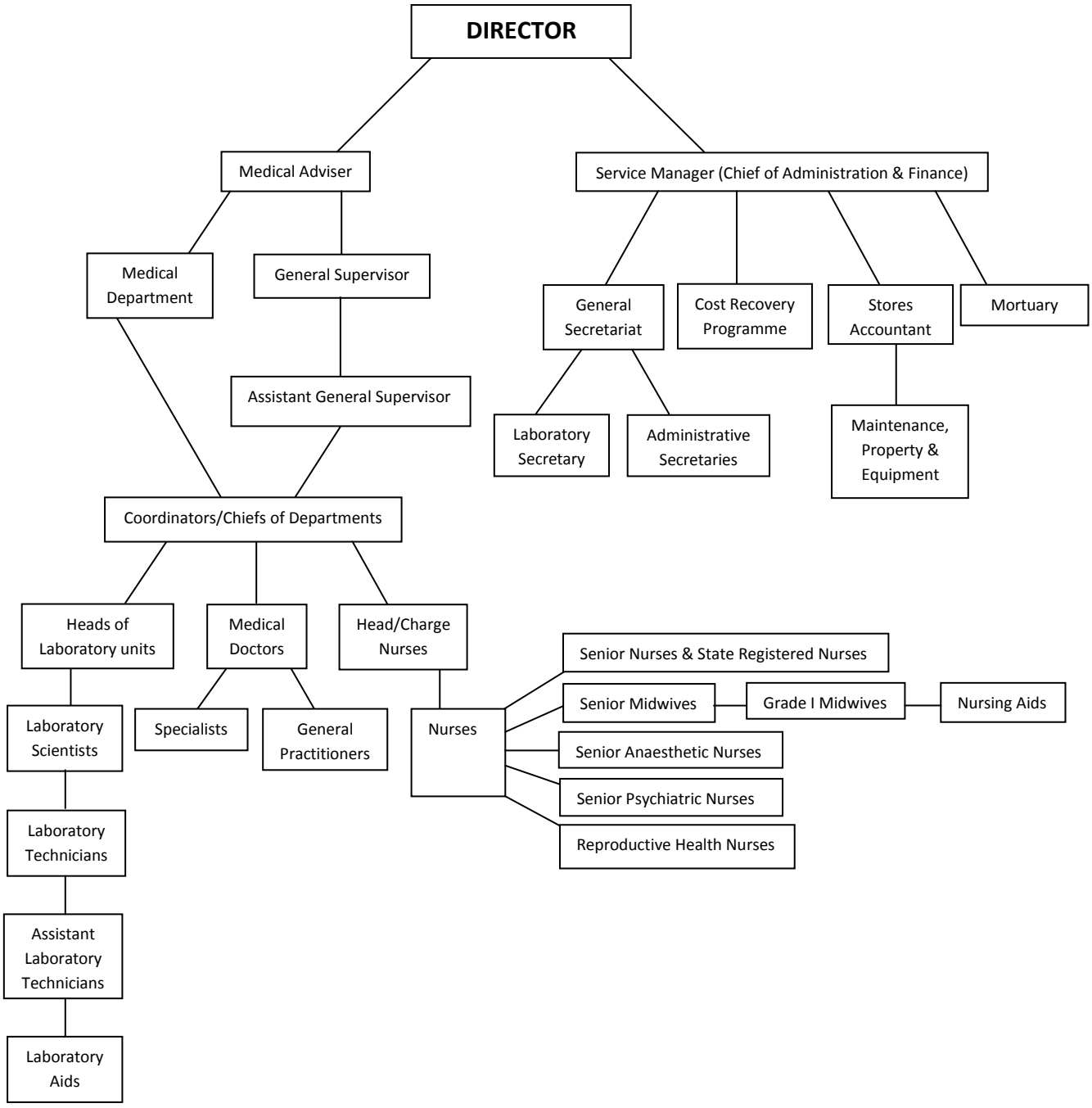
APPENDICES

a) APPENDIX A: Hierarchal structure of Regional Hospital Bamenda



b) APPENDIX B: Laboratory Analyses Performed in the Different Units

	HAEMATOLOGY		
1.	Haemoglobin (Hb)	8.	Reticulocyte Count
2.	Haematocrit (Hct)	9.	Differential Cell (D/C) Count
3.	White Blood Cell (WBC) count	10.	Haemoparasite or Malaria Parasite (MP)
4.	Red Blood Cell (RBC) count	11.	Prothrombin Time (PT)
5.	Full Blood Cell (FBC) count	12.	Emel's Test
6.	Erythrocyte Sedimentation Rate (ESR)	13.	Electrophoresis "Haemoglobin Type" (Hgb Type)
7.	Platelet Count		
	PARASITOLOGY		
1.	Direct Stool Examination	7.	Occult Blood Test
2.	Skin Microfilaria	8.	Skin Scrapings
3.	Blood Microfilaria	9.	Clotting Time
4.	Urinalysis or Urine Analysis (UA)	10.	Bleeding Time
5.	Urine Sugar	11.	Scotch Test
6.	Urine Protein		
	BIOCHEMISTRY		
1.	Serum (S) – Magnesium	25.	S – Uric Acid (UA)
2.	S – Calcium	26.	S – Phosphorus
3.	S – Potassium	27.	Blood Sugar: Fasting (FBS) or Random (RBS)

4.	S – Sodium	28.	Total Urine Protein
5.	S – Chloride	29.	Gamma GT
6.	S – Creatinine	30.	Luteinizing Hormone (LH)
7.	Creatinine Clearance	31.	Prolactin
8.	S – Urea	32.	Follicle Stimulating Hormone (FSH)
9.	S – Albumin	33.	Thyroid Stimulating Hormone (TSH)
10.	Blood Urea Nitrogen	34.	Triiodothyronine (T3)
11.	CK-MB NAC Activated (Creatinine Kinase)	35.	Thyroxine (T4)
12.	Total Cholesterol	36.	Prostatic Specific Antigen (PSA) quantitative
13.	S – Cholesterol	37.	Testosterone
14.	S – Triglyceride (TGD)	38.	Toxoplasmosis-IgG
15.	S – HDL	39.	Toxoplasmosis-IgM
16.	S – LDL	40.	HSV IgG
17.	S – Aspartate Aminotransferase (AST)	41.	HSV IgM
18.	S – Alanine Aminotransferase (ALT)	42.	Rubella IgM
19.	Amylase	43.	HSV-1-IgG
20.	S – Alkaline Phosphatase (ALP)	44.	Total IgE
21.	S – Acid Phosphatase (ACP)	45.	H. Pylori IgG
22.	S – Prostatic Acid Phosphatase	46.	HBs – Ag (Quantitative)
23.	S – Bilirubin (Total)	47.	24-Hours Urine
24.	S – Bilirubin (Direct)	48.	Chlamydia IgM, IgG

	SEROLOGY		
1.	Blood Grouping	11.	HBV-Ag
2.	Indirect Coomb's Test	12.	HCV-Ag
3.	Direct Coomb's Test	13.	Chlamydia
4.	HIV Screening or Antigen Retroviral (AgRV) Testing	14.	Toxoplasmosis (non-quantitative)
5.	Confirmation Test for HIV	15.	CRP
6.	VDRL Test	16.	Serodiagnosis of ameobiasis
7.	TPHA Test	17.	Widal or Typhoid Test
8.	Pregnancy Test (PT)	18.	ASLO
9.	Rheumatoid Factor (RF)	19.	CEA
10.	PSA (non-quantitative)		
	MICROBIOLOGY		
1.	Tuberculosis (TB) Examination i.e. Sputum X3 AFB		
	BACTERIOLOGY		
1.	Spermogramme		
2.	Fluid Analysis: Ceresbrospinal (CSF) and/ or Pleural Fluid (PF)-cell count, differential count, protein, sugar, and gram analyses		
3.	Exudate Transudate		
4.	Cervical or Vaginal Smear (VS)		
5.	Urethral Smear		
6.	Cultures: • Urethral discharge • Vaginal discharge • Blood		

	• Stool • CSF • Fungi • Spermoculture

c) APPENDIX C

World Health Organization Africa

Country Health System Fact Sheet 2006
Cameroon

Largest urban agglomeration or Capital city : YAOUNDE
Official language: FRENCH
Surface area (square kms) : 475442
Population density (per square km): 34

DEMOGRAPHIC AND SOCIOECONOMICS STATISTICS [a]			YEARS	CAMEROON	WHO AFRICAN REGION
Population	number	(000)	2005	16 322	738 083
	annual growth rate	(%)	1995–2004	1.9	2.2
	in urban	(%)	2005	53	38
Total fertility rate (per woman)			2004	4.5	5.3
Adolescent fertility proportion		(%)	2003	13.9	11.7
Adult literacy rate		(%)	2000–2004	67.9	60.1
Net primary school enrolment ratio	Males	(%)	1998–2004	...	70
	Females	(%)		...	63
Gross national income per capita		(PPP Int.$)	2004	2090	2 074
Population living below the poverty line		(% with <$1a day)	2001	17.1	44

… Data not available or not applicable.

[a] *WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*

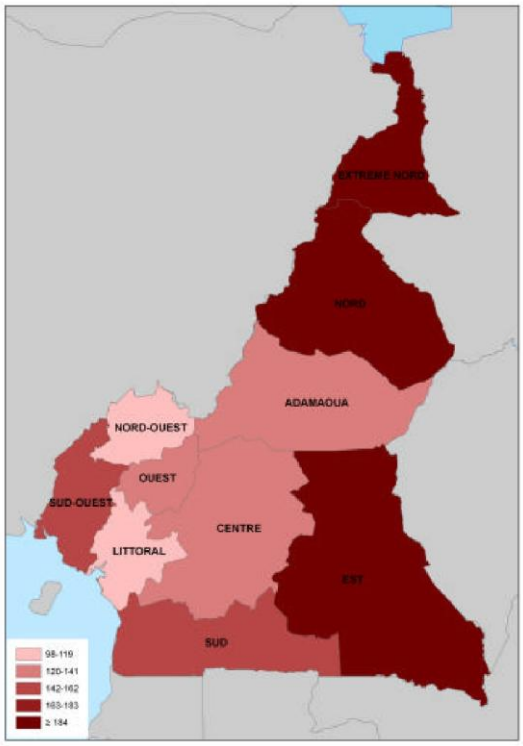
HEALTH STATUS STATISTICS MORTALITY [a]		YEARS	CAMEROON	WHO AFRICAN REGION
Life expectancy at birth (years)	Males	2004	50	47
Life expectancy at birth (years)	Females	2004	51	49
Healthy life expectancy (HALE) at birth (years)	Males	2002	41	40
Healthy life expectancy (HALE) at birth (years)	Females	2002	42	42
Probability of dying per 1 000 population between 15 and 60 years (adult mortality rate)	Males	2004	444	519
	Females	2004	432	465
Probability of dying per 1 000 live births under 5 years (under-5 mortality rate)	Both sexes	2004	149	167
Infant mortality rate (per 1 000 live births)	Both sexes	2004	87	100
Neonatal mortality rate (per 1 000 live births)	Both sexes	2000	40	43
Maternal mortality ratio (per 100 000 live births)	Females	2000	730	910
Cause-specific mortality rate (per 100 000 population) (Both sexes)	HIV/AIDS	2003	311	313
	TB among HIV-negative peo	2004	19	53
	TB among HIV-positive peo	2004	12	28
Age-standardized mortality rate by cause (per 100 000 population) (Both sexes)	Non-communicable disease	2002	848	800
	Cardio-vascular diseases	2002	436	404
	Cancer	2002	150	144
	Injuries	2002	118	133
Years of life lost by broader causes (%) (Both sexes)	Communicable diseases	2002	81	59
	Non-communicable disease	2002	11	10
	Injuries	2002	8	8
Causes of death among children under 5 years of age (%) (Both sexes)	Neonatal causes	2000	24.8	26.2
	HIV/AIDS	2000	7.2	6.8
	Diarrhoeal diseases	2000	17.3	16.6
	Measles	2000	4.1	4.3
	Malaria	2000	22.8	17.5
	Pneumonia	2000	21.5	21.1
	Injuries	2000	2.2	1.9
	Other	2000	0.0	5.6

… Data not available or not applicable.

[a] *WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*

Mortality Country Fact Sheet 2006

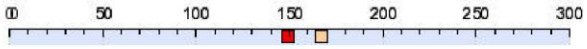
World Health Organization



Summary	Year	Males	Females	Both sexes
Population (millions)	2005	8.1	8.2	16.3
Life expectancy (years)	2004	50	51	50
Under-5 mortality (per 1 000 live births)	2004	156	143	149
Adult mortality (per 1 000)	2004	444	432	
Maternal mortality (per 100 000 live births)	2000		730	

Source: World Health Statistics 2006

Under-5 mortality rate (per 1 000 live births)
Cameroon, 2004



Legend:

WHO African Region
Cameroon

Source: World Health Statistics 2006

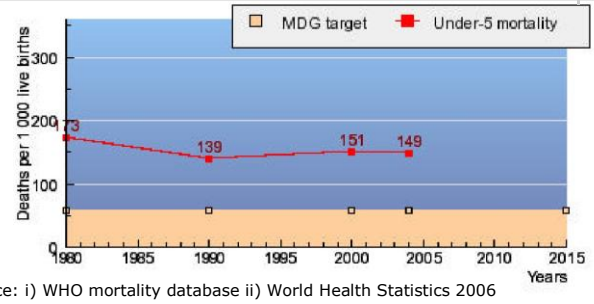
About the map
Note:

a. The interval of each of the categories have been derived by taking the difference between the minimum and maximum among the regional rates and dividing it equally into 5. The formula is: (maximum of regional rate - minimum of regional rate)/5
b. Rate for 5 years preceding the survey

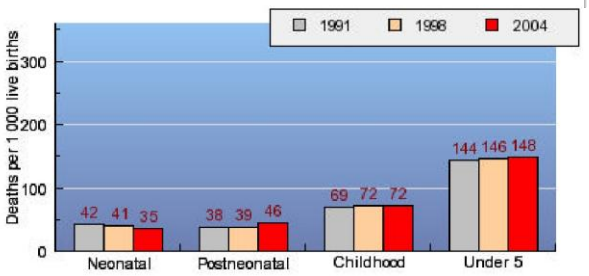
Source: DHS Cameroon 2004

Under-5 mortality

Under-5 mortality: Estimated trend and MDG goal
Cameroon, 1980-2004



Source: i) WHO mortality database ii) World Health Statistics 2006



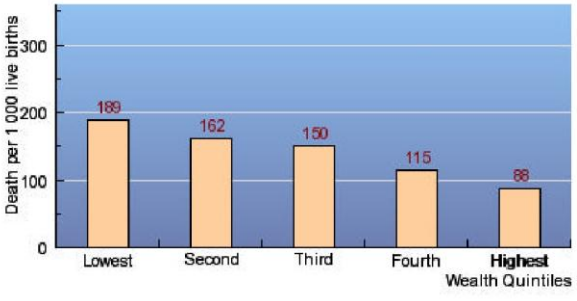
Note: rate for 5 years preceding the survey
Source: DHS 1991 , DHS 1998 DHS 2004

Under-5 mortality: for highest and lowest quintiles
Cameroon, DHS 2004

Wealth/assets quintiles	Lowest	Highest	Ratio
	189	88	2.1
Sex	Males	Females	Ratio
	154	141	1.1
Urban/Rural	Rural	Urban	Ratio
	169	119	1.4
Mother's education quintiles	None	Higher	Ratio
	186	93	2.0

Note: rate per 1 000 live births for 10-year period preceding the survey
Source: DHS 2004

Under-5 mortality rates by wealth quintile
Cameroon, DHS 2004



Note: rate for 10-year period preceding the survey
Source: DHS 2004

Mortality Country Fact Sheet 2006

World Health Organization

Causes of death in children under-5

Distribution of causes of death among children under 5 years of age Cameroon, 2000-2003

Causes	Deaths[b] (%)	Regional average (%)
Total neonatal deaths	100	100
Neonatal causes[a]	25	26
HIV/AIDS	7	7
Diarrhoeal diseases	17	17
Measles	4	4
Malaria	23	17
Pneumonia	22	21
Injuries	2	2
Others	0	6

a. Includes diarrhoea during neonatal period
b. Sum of individual proportions may not add up to 100% due to rounding.

Annual estimated proportions of death by cause for neonates Cameroon, 2000

Causes	Deaths[c] (%)	Regional average[c] (%)
Total neonatal deaths	100	100
Neonatal tetanus	5	9
Severe infection[a]	24	27
Birth asphyxia	25	24
Diarrhoeal diseases	3	3
Congenital anomalies	8	6
Preterm birth[b]	28	23
Others	7	7

a. Includes deaths from pneumonia, meningitis, sepsis/septicaemia and other infections during the neonatal period.
b. Includes only deaths directly attributed to prematurity and to specific complications of preterm birth such as surfactant deficiency, but not all deaths in preterm infants.
c. Sum of individual proportions may not equal 100% due to rounding.

Causes of Death

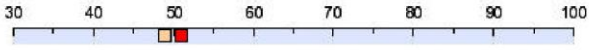
Top ten causes of death, all ages Cameroon, 2002

Causes	Deaths (000)	Deaths (%)	Years of Life Lost (%)
All causes	235	100	100
HIV/AIDS	49	21	24
Lower respiratory infections	32	14	17
Malaria	19	8	11
Diarrhoeal diseases	14	6	8
Perinatal conditions	11	5	7
Cerebrovascular disease	10	4	2
Ischaemic heart disease	9	4	1
Road traffic accidents	5	2	3
Tuberculosis	3	2	2
Whooping cough	3	2	2

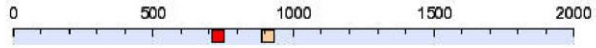
Source: Death and DALY estimates by cause, 2002
http://www.who.int/entity/healthinfo/statistics/bodgbddeathdalyestimates.xls

Life expectancy at birth among males (years) Cameroon, 2004

Life expectancy at birth among females (years) Cameroon, 2004



Maternal mortality ratio (per 100 000 live births) Cameroon, 2000



Legend:
WHO African Region
Cameroon

Source: World Health Statistics 2006

HEALTH STATUS STATISTICS MORBIDITY [a]		YEARS	CAMEROON	WHO AFRICAN REGION
HIV prevalence amond adults (15 - 49) (%)	Both sexes	2003	6.9	7.1
TB prevalence (per 100 000 population)	Both sexes	2004	227	518
TB incidence (per 100 000 population)	Both sexes	2004	179	356
Number of comfirmed polio cases	Both sexes	2005	1	854

… Data not available or not applicable.

[a] *WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*

BEHAVIOUR AND ENVIRONMENTAL RISK FACTORS [a]		YEARS	CAMEROON	WHO AFRICAN REGION
Non-communicable diseases - Infobase for the country	See ---> http://www.afro.who.int/dnc/infobase/Cameroon.pdf			
Chilfren under-5 stunted for age (Both sexes) (%)		2004	31.7	…
Children under-5 underweight for age (Both sexes) (%)		2004	18.1	…
Children under-5 overweight for age (Both sexes) (%)		2004	5.2	…
Newborns with low birth weigh (Both sexes) (%)		2000-2002	11	14
Adults (≥15) who are obese (%)	Males	2004	...	…
	Females	2004	4.2	…
Access to improved water sources(%)	Urban	2002	84	84
	Rural	2002	41	45
Access to improved sanitation (%)	Urban	2002	63	58
	Rural	2002	33	28
Population using solid fuels (%)	Urban	2003	62	…
	Rural	2003	98	…
Prevalence of current tobacco use (%) Adolescents (13 - 15)	Both sexes	…	...	…
Prevalence of current tobacco use (%) Adults (≥15)	Males	…	...	…
	Females	…	...	…
Condom use by young people (15 - 24) at higher risk sex (%)	Males	2004	57	…
	Females	2004	46	…

… Data not available or not applicable.

[a] *WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*

HEALTH SERVICES COVERAGE STATISTICS [a]			YEARS	CAMEROON	WHO AFRICAN REGION
Immunization coverage among 1-year-olds	Measles	(%)	2004	64	66
	DTP3	(%)	2004	73	66
	HepB3	(%)	2004	...	35
Antenatal care coverage	At least 1 visit	(%)	1998	77	…
	At least 4 visits	(%)	1998	52	…
Births attended by skilled health personnel		(%)	2004	62	…
Contraceptive prevalence rate		(%)	2004	26.0	…
Children under-5 sleeping under insecticide-treated nets		(%)	2004	0.9	…
Antiretroviral therapy coverage		(%)	Dec 2005	22	17
TB detection rate under DOTS		(%)	2004	91	48
TB detection treatment success DOTS		(%)	2003 cohort	...	72
Children under-5 with ARI symptoms taken to facility		(%)	2000	36.6	…
Children under-5 with diarrhoea receiving ORT		(%)	2004	47.7	…
Children under-5 with fever who received treatment with any antimalarial		(%)	2004	53.1	…
Children 6-59 months who received vitamin A supplementation		(%)	2002	86.1	…
Births by Caesarean section		(%)	1998	3	…

… Data not available or not applicable.

[a] *WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*

HEALTH SYSTEMS STATISTICS [a]		YEARS	CAMEROON
Physicians	Number	2004	3 124
	Density	2004	0.19
Nurses	Number	2004	26 042
	Density per 1000	2004	1.60
Midwives	Number	…	...
	Density per 1000	…	...
Dentists	Number	2004	147
	Density per 1000	2004	0.01
Pharmacists	Number	2004	700
	Density per 1000	2004	0.04
Public and environmental health workers	Number	2004	28
	Density per 1000	2004	0.00
Community Health workers	Number	…	...
	Density per 1000	…	...
Lab technicians	Number	2004	1 793
	Density per 1000	2004	0.11
Other health workers	Number	2004	16
	Density per 1000	2004	0.00
Health management and support workers	Number	2004	5 902
	Density per 1000	2004	0.36
Total expenditure on health as % of gross domestic product		2003	4.2
General government expenditure on health as % of total expenditure on health		2003	28.9
Private expenditure on health as % of total expenditure on health		2003	71.1
General government expenditure on health as % of total government expenditure		2003	8.0
External ressources for health as % of total expenditure on health		2003	3.2
Social security expenditure on health as % of general government expenditure on health		2003	0.1
Out-of-pocket expenditure as % of private expenditure on health		2003	98.3
Private prepaid plans as % of private expenditure on health		2003	...
Per capita total expenditure on health at average exchange rate (US$)		2003	37
Per capita total expenditure on health at international dollar rate		2003	64
Per capita government expenditure on health at average exchange rate (US$)		2003	11
Per capita government expenditure on health at international dollar rate		2003	19
Coverage of vital registration of deaths (%)		2002	<25
Hospital beds (per 10 000)		…	...

… Data not available or not applicable.

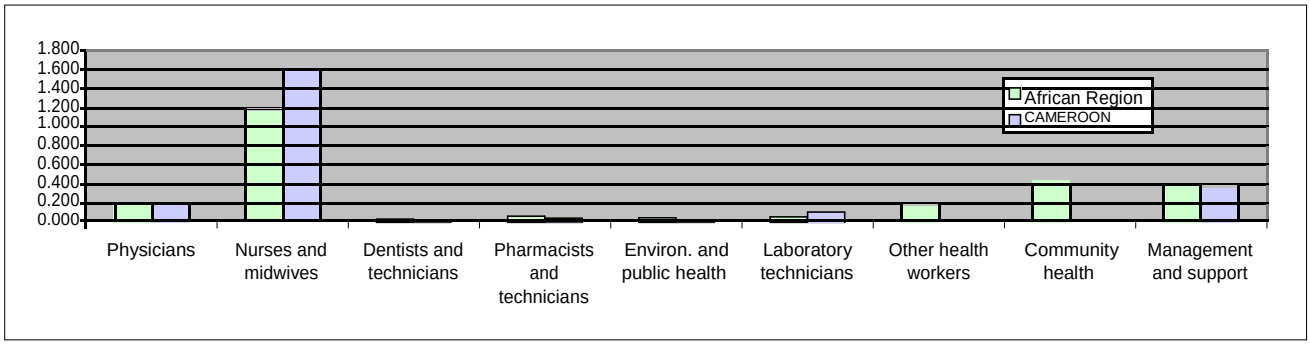
WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/

HUMAN RESOURCES FOR HEALTH
Country Fact Sheet Cameroon

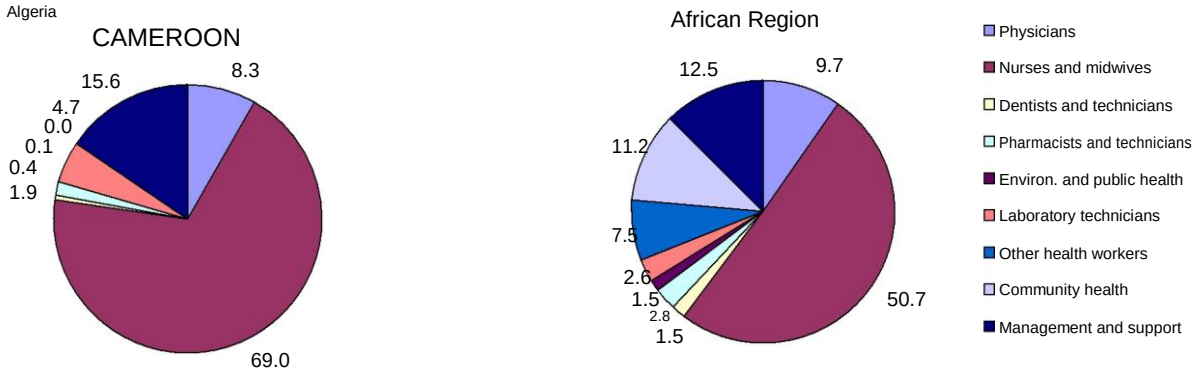
Total numbers and densities of the health workforce in CAMEROON (2002)

	Total number CAMEROON	Density per 1000 CAMEROON	Density per 1000 AFRO
Physicians	3124	0.192	0.217
Nurses and midwives	26042	1.598	1.172
Dentists and technicians	147	0.009	0.035
Pharmacists and technicians	700	0.043	0.063
Environmental and public health workers	28	0.002	0.049
Laboratory technicians	1793	0.110	0.057
Other health workers	16	0.001	0.173
Community health workers	n.a.	n.a.	0.449
Health management and support	5902	0.362	0.411
Sum total	37752		2.626

Densities of health workers in CAMEROON and in the African Region per 1000 population



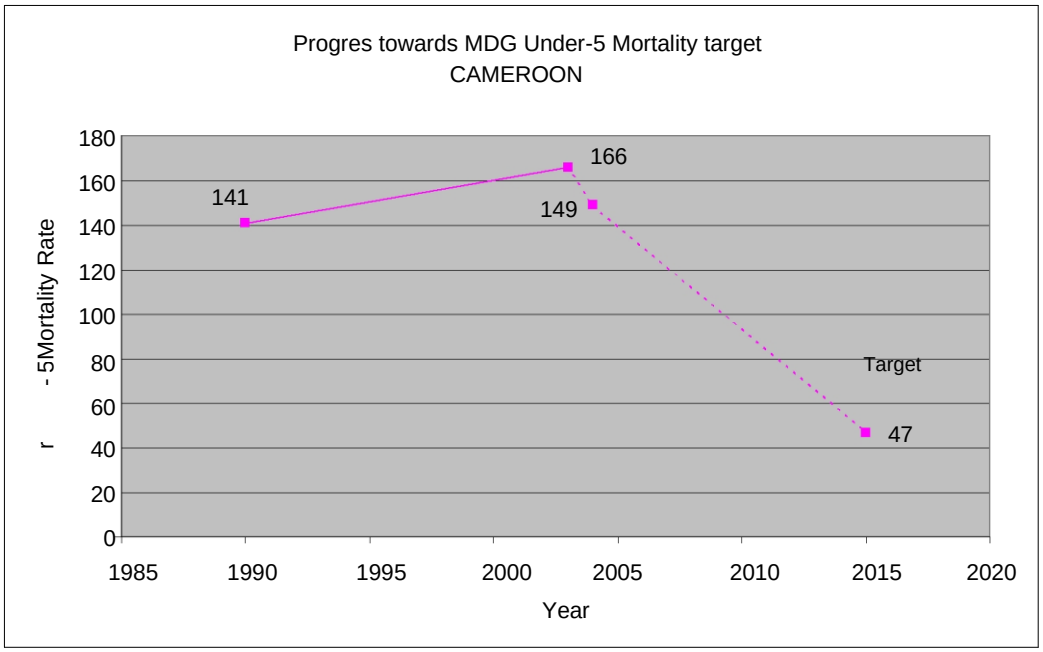
Distribution of health workforce by cadre

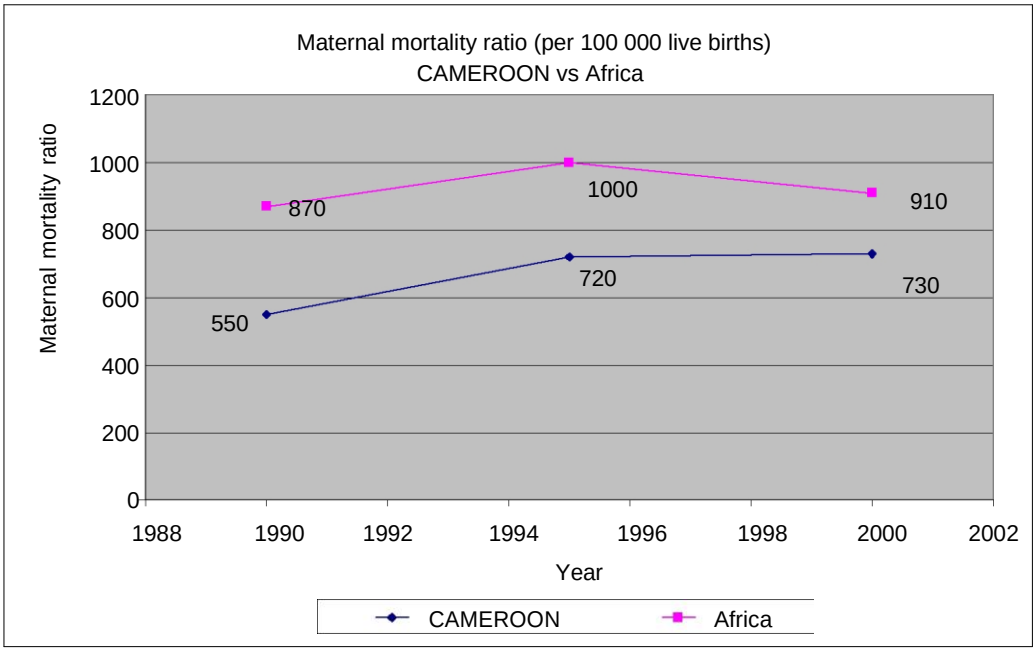


MILLENIUM DEVELOPMENT GOALS [a]	YEARS	CAMEROON	WHO AFRICAN REGION
GOAL 1: ERADICATE EXTREME POVERTY AND HUNGER			
4. Prevalence of underweight children under five years of age	1998	22.2	
5. Proportion of population below minimum level of dietary energy consumption	…	…	
GOAL 4: REDUCE CHILD MORTALITY			
13. Under-five mortality rate (per 1000 live births, %)	1990	141	
	2003	166	
	2004	149	
14. Infant mortality rate (per 1000 live births, %)	1990	81	
	2003	95	
	2004	87	
15. Proportion of one-year-old children immunized against measles, %	2003	61	
	2004	64	
GOAL 5: IMPROVE MATERNAL HEALTH		0	
16.Maternal mortality ratio (per 100 000 live births)	1990	550	
	1995	720	
	2000	730	
	2003	…	
	2004	…	
17. Proportion of births attended by skilled health personnel	2000	60	
GOAL 6: COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES		0	
18. HIV prevalence among pregnant women aged 15-24	…	…	
- HIV prevalence among adults (15-49) %, both sexes	2003	6.9	
19. Condom use rate of the contraceptive prevalence rate	…	…	
- Contraceptive prevalence rate	2000	26	
20. Number of children orphaned by HIV/AIDS	…	…	
21. Prevalence rate associated with malaria	…	…	
- Death rates associated with malaria (per 100 000)	2000	116	
22. Proportion of population in malaria-risk areas using effective malaria prevention and trreatment measures	…	…	
23. Prevalence rate associated with tuberculosis (per 100 000)	1990	163	
	2000	232	
	2004	227	
- Death rates associated with tuberculosis	1990	19	
	2000	25	
	2004	31	
24. Proportion of tuberculosis cases detected under DOTS	2003	86	
	2004	91.23	
- Proportion of tuberculosis cases cured under DOTS	2002	70	
	2003	...	
GOAL 7: ENSURE ENVIRONMENTAL SUSTAINABILITY		0	
29. Proportion of population using solid fuels	2002	83	
30. Proportion of population with sustainable access to improved water source, urban	2002	84	
- Proportion of population with sustainable access to improved water source, rural	2002	41	
31. Proportion of urban population with access to improved sanitation	2002	63	
- Proportion of rural population with access to improved sanitation	2002	33	
GOAL 8: DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT		0	
46. Proportion of population with access to affordable essential drugs on a sustainable basis	…	…	

… Data not available or not applicable.

[a] *THE WORLD HEALTH REPORT 2004 UPDATED WITH THE WORLD HEALTH STATISTICS 2006 http://www.who.int/whosis/en/*


Progres towards MDG Under-5 Mortality target
CAMEROON
r - 5Mortality Rate
180
160
140
120
100
80
60
40
20
0
141
166
149
Target
47
1985
1990
1995
2000
2005
2010
2015
2020
Year


Maternal mortality ratio (per 100 000 live births)
CAMEROON vs Africa
Maternal mortality ratio
1200
1000
800
600
400
200
0
870
1000
910
550
720
730
1988
1990
1992
1994
1996
1998
2000
2002
Year
CAMEROON
Africa