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APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) ALGORITHMS AND TECHNIQUES IN HEALTHCARE AT POLYCLINIC YAWE RAPHE IN DEMOCRATICE REPUBLIC OF CONGO

BY

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ABSTRACT

Globally, Artificial Intelligence (AI) is enhancing medical practices, clinical procedures and patient care. The world first learned about artificial intelligence's capacity for transformation in 1950. However, early AI models had difficulties that at first prevented them from being widely used in the medical area, particularly in underdeveloped nations This study investigated how AI technologies are currently in use, their effects on patient outcomes and hospital productivity. The study evaluated AI's potential to enhance resource management, diagnosis, and therapy while also pointing up implementation issues. Based on theoretical models, the study emphasised how AI can revolutionise healthcare in environments with limited resources. The literature reviewed AI algorithms used in public health, radiography, cardiology, surgery, diagnosis and treatment, emphasising on how AI minimises human error increases accuracy, improves patient outcomes and expedites administrative chores. Using Polyclinique Yawe Raphe in the Democratic Republic of the Congo as a case study, it highlighted AI's potential to alleviate healthcare inequalities and fortify institutions in underdeveloped nations. The study used both qualitative and quantitative methods. A purposive, convenient and cluster sampling were used to choose a sample of 300 people. Both statistical representation and thematic evaluation were part of the data processing process. Strict adherence to ethical guidelines was maintained. Data on the use of artificial intelligence (AI) in healthcare at Polyclinique Yawe Raphe in the Democratic Republic of the Congo outlined awareness levels, perceived benefits and concerns of AI in radiology, cardiology, surgery, public health and community medicine based on the opinions of 300 respondents, including nurses, patients, administrators and physicians. The results showed that professionals are highly aware of AI, believe technology can improve services and have concerns about data protection and human contact. The awareness, attitudes and effects of integrating artificial intelligence (AI) at Polyclinic Yawe Raphe in the Democratic Republic of the Congo were examined. The results showed a high level of awareness among healthcare professionals, optimism over AI's potential to improve patient care and diagnostics, and a number of important concerns, including data privacy, job displacement and the loss of human interaction. The study comes to the conclusion that although AI has the potential to revolutionise healthcare delivery, successful integration necessitates ongoing training, robust data governance and regulations that support human expertise.

Key terms: Algorithms, Artificial Intelligence, Diagnostics, Healthcare delivery, Revolutionise

DECLARATION

I, Kabanga Tegra, hereby declare that this research project is my original work except for the references cited which have been duly acknowledged. It has not been submitted in substance for degree award in any other university.

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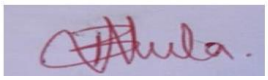
Mukhalela Braiton	
Supervisor's Full Name	Supervisor's Signature

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First and foremost, I would like to give thanks and glory to the almighty God for protecting me throughout this journey. To my supervisor and lecturer, Mr Mukhalela, thank you sir for your patience and guidance. I would like to extend my deepest gratitude to all those who have supported me throughout the journey of developing this research proposal. A special thanks to Priscilla Adom and Mbuyi Provide, whose invaluable insights and encouragement have shaped my thoughts and ideas. Their expertise and guidance have been instrumental in refining my research objectives and methodology. I am also grateful to my friends and family for their unwavering support and patience during this process. Your belief in me has been a constant source of motivations.

DEDICATION

This proposal is dedicated to my family specially my Mother. Your unwavering support and inspiration have been the driving force behind my academic pursuits. Thank you for believing in me and encouraging me to strive for excellence

LIST OF ABBREVIATIONS

AI: Artificial intelligence

AUREC: Africa University Research Ethics Council

CNNs: Convolutional Neural Networks

CT: Computed Tomography

CVD: Cardiovascular Disease

DR: Diabetic Retinopathy

DRC: Democratic Republic of Congo

HBM: Health Belief Model

IT: Information Technology

LMICs: Low- and Middle-Income Countries

WHO: World Health Organisation

DEFINITION OF TERMS

Algorithms: An algorithm is a finite set of instructions carried out in a specific order to perform a particular task.

Artificial intelligence: Artificial intelligence (AI) refers to the ability of a computer system to perform complex tasks that only a human could do, such as reasoning, making decisions, or solving problems.

Asphyxia: Asphyxia is also known as suffocation or asphyxiation and this happens when one's body does not get enough oxygen to keep one from passing out.

Diabetic retinopathy: Diabetic retinopathy is an eye condition caused by damage to the blood vessels in the tissue at the back of the eye (retina).

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Artificial intelligence (AI) in healthcare is improving patient care, streamlining clinical processes, and changing medical practices all around the world. The incorporation of AI algorithms and methodologies is effective at Polyclinique Yawe Raphe Hospital in the Democratic Republic of the Congo in tackling healthcare difficulties that are specific to the region. AI makes it possible for early diagnosis, individualised treatment regimens and efficient resource management by quickly and accurately analysing vast amounts of medical data. Machine learning models, for example, have the ability to forecast disease outbreaks, allowing for prompt interventions (Esteva et al., 2019).

Furthermore, medical practitioners can assess images with the help of AI-powered diagnostic tools, improving diagnostic accuracy and reducing human error (Topol, 2019). In settings with limited resources, such as the Democratic Republic of the Congo, these advancements are crucial to overcoming challenges including a shortage of medical professionals and inadequate infrastructure. By ensuring that all patients have fair access to high-quality medical care, the Polyclinique Yawe Raphe Hospital's application of AI technologies marks a significant milestone in the modernisation of healthcare delivery in developing countries. This hospital is opening the door for innovation in the Congolese healthcare system by harnessing AI's potential, which will ultimately enhance the standard of living and health outcomes for the nation's citizens.

1.1 Background of the Study

Artificial intelligence (AI) typically refers to computer technologies that simulate human intelligence-supporting systems, including cognition, deep learning, adaptation, engagement and sensory comprehension (Tagliaferri et al., 2020; Tran et al., 2019). According to Panch et al., (2018), some devices can perform tasks that often need human interpretation and judgement. Because of their multidisciplinary approach, these techniques can be applied in a number of fields, including medicine and health. Since doctors began experimenting with computer-aided programs to assist them diagnose patients more correctly in the 1950s, artificial intelligence (AI) has been a part of medicine (Yang et al., 2019).

The application of AI in healthcare can help a variety of medical fields, such as clinical, diagnostic, rehabilitative, surgical and prognostic procedures. Two significant medical domains where AI is influencing practice are clinical decision-making and disease diagnosis. To detect disease and guide medical decisions, AI systems can absorb, analyse and report enormous volumes of data from numerous modalities (Cho et al., 2020). The goal of artificial intelligence (AI) is to replicate human intelligence by fusing computer science with large datasets. AI subsets are being used in practically every area of surgery and medicine.

Artificial intelligence (AI) applications are able to manage the massive amount of data produced in the medical area and find new information that would otherwise be lost in the vast amount of medical data (Doyle et al., 2020). According to Burton et al. (2019), these technologies can also identify new drugs for managing health services and patient care. Examining the primary research databases demonstrates courage in the use of AI. However, Meskà et al. find that technology may reduce care costs and repetitive chores by focussing on clinical innovation and critical thinking in the medical area. Although Cho et al. and Doyle et

al. have pointed out that the AI method is intriguing, further research is necessary to ascertain the efficacy and applications of AI in the medical arena.

1.2 Problem Statement

The use of artificial intelligence (AI) methods and algorithms in the medical field has drawn increasing attention. It is commonly acknowledged that AI has the ability to transform the way healthcare is delivered, enhance patient outcomes and expedite clinical procedures. However, with major advances in AI technology, there are still challenges and opportunities in effectively incorporating these methods into healthcare systems (Rajkomar et al., 2019). Challenges with data privacy, interoperability, ethical issues and patient and healthcare professional trust arise when AI algorithms and techniques are included into healthcare. Furthermore, it is necessary to create AI models that are robust enough to be used in actual clinical settings and that can be understood and explained.

1.3 Research Objectives

1.3.1 Broad Objective

The broad objective of this study is to identify the current applications and innovative integration strategies at Polyclinique Yawe Raphe.

1.3.2 Specific objectives

1. To identify and evaluate the existing AI technologies being used at Polyclinique Yawe Raphe.
2. To explore new and innovative ways to integrate AI into the hospital's healthcare delivery system.
3. To analyse the impact of AI applications on patient outcomes and the hospital efficiency.
4. To identify the challenges and barriers to AI implementation in the hospital.

1.4 Research Questions

1. What are the current AI applications used at Polyclinique Yawe Raphe in Democratic Republic of Congo?
2. How can AI be innovatively integrated into the hospital's healthcare system?
3. What is the impact of AI on patient outcomes and hospital operations?
4. What are the main challenges and barriers to implementing AI in the hospital?

1.5 Significance of the Study

Artificial intelligence (AI) systems evaluate vast medical databases to help doctors make quick and accurate diagnoses, enabling early disease detection and customised treatment plans (Esteva A, 2019). Decision support systems driven by AI enhance patient safety, reduce errors and maximise treatment regimens. By predicting patient outcomes, predictive analytics enables proactive measures to prevent complications (Obermeyer & Emanuel, 2016). By increasing access to specialised knowledge through telemedicine and remote monitoring, AI also helps to address healthcare disparities and promotes health equity among marginalised individuals.

1.6 Study Assumptions

According to a study's hypothesis by Smith & Jones (2022), artificial intelligence (AI) technology has the potential to improve diagnostic accuracy, optimise treatment plans, reduce administrative expenses and enable personalised medicine in hospital settings. This study also made the assumption that when AI technologies are used in the healthcare sector, ethical issues, data protection, health delivery and regulatory compliance will all be sufficiently addressed (Brown & White, 2019).

1.8 Study Delimitations

This study was exclusively concerned with investigating the use of AI methods and algorithms in the healthcare industry. It looked at the study's actual application in practice rather than examining more general AI applications in other fields. Since the study was geographically limited, its findings and conclusions might not be applicable to other hospitals or healthcare facilities in the DRC or elsewhere. In addition, even though the instrument was pretesting for validity and reliability, the study results may not be precise and comprehensive, which could distort the findings.

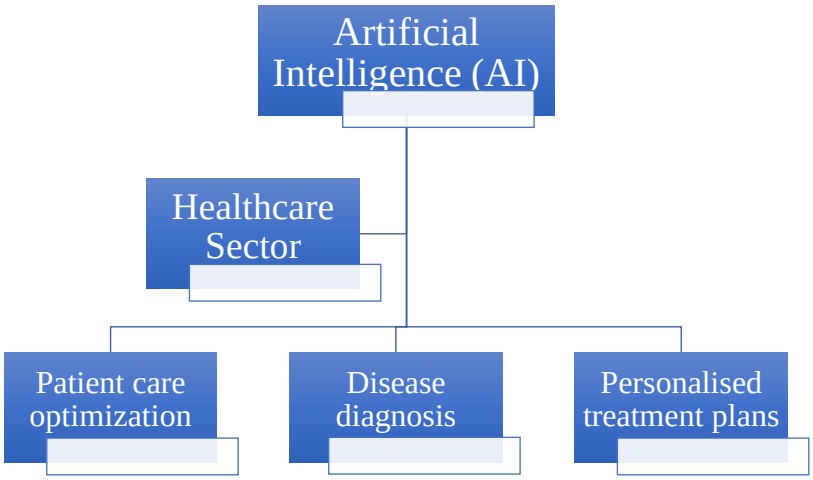
1.9 Theoretical Framework

The theoretical framework of the study is founded on several basic theories and models pertaining to artificial intelligence (AI) and healthcare. The theory of machine learning, which provides the basis for developing algorithms that can learn from and anticipate data, is the main foundation of the field (Mitchell, 1997). Another pertinent theory that clarifies how AI could enhance individualised treatment plans and diagnosis accuracy, hence impacting patient behaviour and healthcare results, is the Health Belief Model (HBM) (Rosenstock, 1974). The Systems Theory, which views the healthcare environment as a complex system in which artificial intelligence (AI) may optimise interdependent aspects to boost efficacy and efficiency, is also taken into consideration in this study (Von Bertalanffy, 1968).

1.10 Conceptual Framework

The conceptual framework of this study explains the relationship between healthcare delivery and AI algorithms at the Polyclinique Yawe Raphe Hospital. A key component of the concept is the use of AI methods such as machine learning, natural language processing, and predictive analytics. According to Huang et al. (2019), that the use of artificial intelligence (AI) in healthcare could enhance patient care, detect diseases and personalise treatment plans. With

the framework, integrating AI will improve patient satisfaction, reduce error rates and raise operational effectiveness. Important factors include the types of AI algorithms used, the healthcare domains they impact and the measurable outcomes they yield, such as diagnosis accuracy and patient recovery rates. AI has more to offer the healthcare sector in terms of cost-effectiveness, accuracy, and efficiency, which will ultimately lead to better outcomes for individuals and society as a whole.



1.11 Summary of the chapter

This chapter addressed the introduction, background, problem statement, objectives and research questions. The significance of the study, delimitations, theoretical and conceptual frameworks of the study were also highlighted. The next chapter addresses the literature review.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Artificial Intelligence (AI) has brought about significant changes and breakthroughs in the healthcare industry. Among other areas of healthcare, AI techniques and algorithms have demonstrated promise in transforming patient care management, diagnosis and treatment. This literature review examines the many AI algorithms and methodologies utilised in healthcare, focussing on their successes, challenges and potential future advancements.

2.1 Application of AI Algorithms and Techniques in Healthcare

In 1950, the world first became aware of the transformative potential of artificial intelligence (Li et al., 2018). However, early AI models had issues that initially kept them from being widely applied in the medical field, especially in developing countries. Deep learning, which enabled AI systems capable of autonomous learning and decision-making similar to the human brain, marked a significant change in the 2000s (Oduoye et al., 2024). Both in developed and developing nations, this advancement could enhance healthcare in general. A range of pre-built machine learning algorithms enable AI to assess the situation, make the necessary adjustments and make a decision. This can be important for healthcare, especially in developing countries where risk factors, prompt decisions and well-informed decisions are issues (Yang et al., 2020).

According to Onu et al. (2019), Ubenwa, a Nigerian start-up, employs signal processing and machine learning to enhance and predict the diagnosis of birth asphyxia, particularly in low-resource nations. The effectiveness of diabetic retinopathy (DR) screening in underdeveloped countries is limited by inadequate eye care infrastructure, particularly in rural regions. A brand-new AI-based DR screening technique has surfaced, with promising sensitivity and specificity

for accurate diagnosis. By offering prompt and precise evaluations, this invention lessens the strain brought on by subpar facilities and a shortage of ophthalmologists. In a similar spirit, Bellemo et al.'s 2019 study in Zambia shown that, in comparison to human evaluations, AI is a promising diagnosis tool for diabetic retinopathy. However, AI-powered screening is less expensive than traditional methods relying on ophthalmologists.

In situations like a heavy patient load and a lack of medical records, which can lead to major human error, the use of AI in healthcare is very important. Machine learning models offer a powerful means of improving scheduling, resource allocation and record-keeping practices in poor countries with high patient loads. In South Africa, for instance, these models have been used to evaluate administrative data that helps predict the length of time medical staff will remain in impoverished areas (Moyo et al., 2018). AI also offers solutions by rapidly analysing vast volumes of healthcare data and identifying trends and illness indicators that humans might otherwise overlook. Machine learning algorithms are crucial for spotting complex patterns in clinical settings.

Virtual health assistants are vital to the modern healthcare system because they can easily handle a variety of tasks, such as scheduling doctor's appointments, responding to routine patient enquiries by phone and email, safeguarding patient medical data and assisting patients with follow-ups and reminders (Iroju & Olaleke, 2015). These capabilities are made possible by the integration of complex systems that include augmented reality, cognitive computing, and voice and body movements (Zhou et al., 2022). Data entry, claim processing and appointment scheduling are among the administrative tasks in the healthcare sector that AI streamlines. Robotic process automation of these functions has the potential to drastically lower overall costs in developing nations with limited healthcare budgets by simplifying

administrative tasks and thereby lowering salaries for clerical and administrative positions within healthcare systems.

2.2 Artificial Intelligence in Radiology

AI has significantly increased productivity, diagnostic accuracy and overall capabilities, causing a fundamental shift in the area of radiology. A key AI approach, convolutional neural networks (CNNs) can handle a range of image processing problems and achieve remarkable image identification accuracy (Dingler et al., 2021). CNNs can automatically recognise intricate patterns and assess radiography parameters quantitatively. Hinrichs-Krapels et al. (2023) list a number of advantages of this technology, such as increased diagnostic confidence, reduced workload, improved guidance for patient prognosis and treatment plans, and improved radiologists' efficiency in prioritising critical cases. Two of the biggest obstacles to offering radiology services are a lack of opportunities for skill development and a paucity of qualified radiology personnel. AI can help with this issue by automating the process of analysing radiological images, which reduces the need for human interpretation and speeds it up. This is especially helpful in regions with limited resources and a shortage of competent radiologists (Kuziemsky et al., 2019).

According to a Van Leeuwen study, AI can increase the diagnostic accuracy of breast cancer by 9.4%, reduce the reading time of chest X-rays by 33% and increase the detection rate of lung nodules by 5% (Hamet & Tremblay, 2017). Decentralising diagnostic testing is being made easier by AI-based diagnostic technology, which presents a workable solution to healthcare issues in developing countries like India where there is a shortage of medical personnel (Mahajan et al., 2019). According to World Bank data from 2020, there were only 6 surgeons per 100,000 people in South Asia, while high-income countries had 71 surgeons per 100,000. Similarly, high-income nations have 3.0 doctors per 1000 population, compared to

0.8 in South Asia. It prioritises scans based on case severity and assists radiologists in identifying significant issues. To identify cases of tuberculosis, a disease that is very prevalent in developing countries, machine learning and signal processing techniques have been used to digital chest radiographs (Lopes 7 Valiati., 2017).

2.3 Artificial Intelligence in Cardiology

Artificial intelligence (AI) in cardiology encompasses a wide range of cardiac care activities, from data analysis and electronic health record mining to automated heart structure detection and segmentation (Mendel et al., 2019). By enabling real-time image analysis, improving the precision of cardiac assessments, and aiding in the diagnosis of conditions like valvar heart disease, AI improves echocardiography. This underscores the need for improved cardiac care in low- and middle-income countries, which account for over 80% of all cardiovascular disease (CVD) deaths worldwide. It also automatically detects coronary artery stenosis from computed tomography (CT) angiography pictures (Choy et al, 2018). Additionally, AI plays a significant influence in predicting cardiovascular outcomes. About 28% of deaths in low- and middle-income nations are attributable to cardiovascular disease (CVD) (Horton et al., 2006). AI can reduce the death rate from CVD by predicting strokes, heart failures and arrhythmias using predictive models and risk scores. This allows for timely interventions and informed treatment decisions.

2.4 Artificial Intelligence in Surgery

The incorporation of AI has revolutionised surgical care and caused a paradigm change in surgery. In robotic surgery, robots such as the Da Vinci Surgical System are utilised to precisely and securely mimic a surgeon's hand movements (De Backer et al., 2022). General surgery, surgical oncology and urology are just a few of the medical specialities that benefit from robotic assisted surgery. Robotics in surgery has the potential to decrease hospital stays, physician

burnout and surgical site infections, especially in low- and middle-income countries (LMICs), where labour and resources are limited. In developing nations like Pakistan, public hospitals are discovering that robotic surgery is a practical and effective option. Its feasibility was evaluated using clinical outcomes, with special focus on readmission rates, length of hospital stays, and surgical complications (Mehta et al., 2022).

AI has also significantly improved surgical accuracy, efficiency, and overall results. One of the incredible applications of AI in surgery is the optimisation of operating room management. Algorithms using artificial intelligence (AI) have demonstrated a high degree of accuracy in predicting surgical schedules and identifying surgeries that are most likely to be cancelled. This enhances resource allocation and speeds up operation planning in resource-constrained contexts (Valente et al., 2023). Additionally, AI-driven technologies have greatly enhanced preoperative planning. For instance, 3-dimensional reconstructions from MRI scans are made possible by neural radiance field technology, which helps doctors visualise anatomical structures even when data is scarce (Iddrisu, Malec & Crimi, 2023).

2.5 Artificial Intelligence in Public Health and Community Medicine

Disease epidemiology is changing as a result of AI's innovative solutions. In low- and middle-income nations, infectious diseases like malaria and tuberculosis continue to contribute significantly to the overall disease burden, attracting substantial donor attention and funding (Lozano et al., 2018). In community medicine, AI has proven to be a helpful tool for disease epidemiology. For instance, researchers have employed this technique to forecast dengue fever outbreaks and monitor the spread of influenza (Xu et al., 2017). These initiatives show how artificial intelligence (AI) might help public health initiatives that aim to enhance the tracking and control of infectious diseases in low- and middle-income nations.

In underdeveloped nations, particularly those in the WHO African Region, malaria remains a serious public health concern. Nearly 94% of all recorded cases of malaria and 95% of associated fatalities occurred in this region in 2022. Health ministries can more easily monitor shifting disease patterns by identifying the regions or people most affected by malaria thanks to improved tracking of cases and fatalities. Strong malaria monitoring systems also assist countries in assessing the effectiveness of their malaria control initiatives and developing efficient health interventions. It is simpler to evaluate pandemic trends, outbreak patterns and disease epidemiology because of AI's rapid data interpretation capabilities, which enable software-based epidemiological surveillance to study massive datasets (Bibault & Zing, 2021).

2.6 Summary of the chapter

This chapter reviewed the literature related to the applications and innovative integration strategies of Artificial Intelligence at Polyclinique Yawe Raphe in DRC. The chapter comprised of artificial intelligence in radiology, cardiology, surgery, public health and community medicine. The next chapter will focus on the research methodology of the study.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The purpose of this study was to investigate the current applications and innovative integration strategies of healthcare in the Democratic Republic of Congo through artificial intelligence at Polyclinique Yawe Raphe. This chapter addressed the methods that were used in conducting the study. It focused on the research design, setting, population and sampling procedure. It also highlighted the data collecting instrument, the data collecting procedure, data analysis and ethical considerations.

3.1 Research Design

Research design is the framework that guides and controls a research. Therefore, the goal of research design explains the steps involved in creating the study and shows how the particular research design the investigator chooses to utilize, contributing to organizing the collection, analysis, and interpretation of data. A qualitative and quantitative research deign such as surveys, questionnaires and interviews were used in this study.

3.2 Study Setting

The study was conducted at the Polyclinique Yawe Raphe which is based in Lubumbashi, Democratic Republic of Congo. The Polyclinique Yawe Raphe operates in services such as General medicine, internal medicine, cardiology, dentistry, surgery, gynaecology/Obstetrics, neonatology, paediatrics, occupational medicine, ophthalmology, medical imaging (scanner, radiology and ultrasound), laboratory examinations and samples and vaccinations.

3.3 Study Population

This study's target population included a wide range of individuals working in the healthcare ecosystem at the Polyclinique Yawe Raphe in the Democratic Republic of Congo (DRC), including physicians, nurses, administrative staff, department heads, senior management, and patients. By examining these various groups, the researcher was able to obtain a comprehensive understanding of the responses from this population regarding their opinions on how good AI integration can improve healthcare delivery in the DRC.

3.4 Exclusion Criteria

- Institutions or organizations that are not healthcare facilities or do not directly provide healthcare services were excluded from the study.
- Studies, projects or initiatives that do not incorporate artificial intelligence or related technologies were not considered.
- Patients, healthcare providers or stakeholders who were unable to provide informed consent due to legal, cognitive or linguistic barriers were excluded.

3.5 Inclusion Criteria

- Healthcare professionals, such as doctors, nurses and administrative staff currently working at Polyclinique Yawe Raphe.
- Patients of all age groups and genders who have been treated or are currently being treated at Polyclinique Yawe Raphe and were willing to give their consent to participate in the study.
- Access to medical records and relevant patient data necessary for the study, with proper ethical and legal clearance for data usage.

3.6 Sample Size

A sample is a limited portion of a statistical population whose characteristics are researched to learn more about the entire population (Webster, 1985). It can be described as a group of

respondents chosen from a broader population for the purpose of a survey when referring to people. The sample size for this study consisted of 200 healthcare professionals (including doctors, nurses, technicians and administrative staff) and 100 patients to assess their perceptions, experiences and satisfaction with AI-enhanced healthcare services.

Using the Dobson's formula for sample size estimation, $n = \frac{z^2 \times p\,(1-p)}{d^2}$

where:

n is the minimum sample size

Z standard error from the mean corresponding to 95% confidence interval, that is 1,96

P standard deviation is 0.5

D is absolute precision which is 6%, 0.06

$$n = \frac{(1.96)^2\,(0.5)\,(1-0.5)}{(0.06)^2}$$

$$n = \frac{(3.842)\,(0.5)\,(0.5)}{(0.0036)}$$

n= 266.80

n=267

The maximum sample size = minimum sample size/response rate

If we anticipate that 15% of the record will not be useable, then the response rate will be 85%

Therefore, maximum sample size = 267/85%
= 384/0.85
= 311

Therefore, sample size is any number between 267 and 311. The investigator decided to study 300 participants since it is within the range of sample size.

3.7 Sampling Technique

Sampling was carried out using the purposive, convenience and cluster sampling technique. This ensured that we got expertise such as healthcare providers and IT professionals working

with AI or similar technology, random patient selection and participants who were readily available and accessible at the Polyclinique Yawe Raphe in the Democratic Republic of Congo.

3.8 Data Collection Tool

A standardised data questionnaire that was created and pre-tested was used to gather information from physicians, nurses, technicians and administrators at the Polyclinique Yawe Raphe. The survey comprised both open-ended questions for qualitative insights and closed-ended questions for quantitative analysis. Additionally, semi-structured interviews with healthcare professionals were carried out to provide qualitative data that was rich in context. There was an analysis of pertinent papers, including reports, research articles and hospital records pertaining to AI applications and healthcare innovation in the Democratic Republic of the Congo.

3.9 Pretesting of the Instrument

The purpose of the pre-test was to determine the viability of the study's key elements. Any flaws in the instrument that required to be fixed were discovered during pre-testing. The checklist was pre-tested by the researcher on ten hospital employees, including nurses, physicians, administrators, and patients. The pre-test results were not included in the main study.

3.10 Data Collection Procedure

Data was gathered by gathering questionnaires to collect information from a wider variety of medical professionals working in the hospital, a thorough analysis of the body of research on AI applications in healthcare, especially in low-resource environments like the DRC and interviews with important stakeholders at Polyclinique Yawe Raphe, such as patients, administrators, IT personnel and medical professionals.

3.11 Data Analysis

Data analysis provided a summary of the information gathered. Responses from patients and healthcare professionals about how they currently use and perceive AI technology in healthcare were analysed. Interviews with hospital employees about their experiences with AI technology yielded important themes and insights. There was an assessment of workflow efficiency improvements, including shorter wait times or higher patient volume. Once more, a summary of the opinions expressed by patients, carers and hospital employees regarding the perceived influence of AI integration on healthcare delivery was provided. The study's results were displayed using tables, charts and graphs.

3.12 Ethical Considerations

Permission to carry out the study was sought from the Africa University Research Ethics Council (AUREC), Polyclinique Yawe Raphe (DRC) Research Ethics Committee and Medical Superintendent at Polyclinique Yawe Raphe in DRC. Informed consent was provided to healthcare providers and patients before participating in the study. Confidentiality and anonymity of patient records were respected.

3.13 Summary of the Chapter

This chapter addressed the research design, study population, study setting, inclusion and exclusion criteria. The sample size, sampling procedure, data collection tool, data collection procedure, data analysis and ethical considerations of the study were also highlighted. The next chapter addressed the data presentation and analysis of the study.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

In this chapter, the data collected and analysed on the use of Artificial Intelligence (AI) algorithms and techniques at Polyclinique Yawe Raphe in the Democratic Republic of the Congo were presented. Nurses, patients, administrators and physicians made up the 300 responders in the study population. The results were arranged in accordance with the main questions, emphasising the use of AI in community medicine, cardiology, radiology, surgery and public health. Tables, graphs and charts were employed to clearly display the results of both quantitative and qualitative methodologies.

4.1 Awareness of Artificial Intelligence Technologies

Table 4.1: Awareness of Artificial Intelligence Technologies among nurses, administrators, patients and doctors, N=300

GROUP	**YES**		**NO**		**TOTAL**	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage(%)
Nurses	65	65	35	35	100	100
Administrators	45	90	5	10	50	100
Patients	40	40	60	60	100	100
Doctors	48	96	2	4	50	100
Total	198	-	102	-	300	-

Table 4.1 shows that 65 (65%) of nurses were aware of Artificial intelligence technologies while 35 (35%) did not know about it. 45 (90%) of administrators were aware of Artificial intelligence technologies while 5 (10) was not aware. A lower number of 40 (40%) of patients were aware of Artificial intelligence technologies being used while a larger number 60 (60%) was not aware of Artificial intelligence technologies being used. 48 (96%) of doctors at the

Polyclinique Yawe Raphe were aware of Artificial intelligence technologies while very few, 2 (4%) was not aware.

4.2 Belief in Artificial Intelligence's Impact in Healthcare

Table 4.2: Belief in Artificial Intelligence's impact in healthcare among nurses, administrators, patients and doctors, N=300

Response	Nurses	Administrators	Patients	Doctors	Total
Strongly agree	35	40	45	42	162
Agree	50	10	40	5	105
Neutral	10	0	10	2	22
Disagree	3	0	5	1	9
Strongly disagree	2	0	0	0	2
Total	100	50	100	50	300

Table 4.2 shows the responses of participants who were asked whether they believed AI could improve healthcare services. 162 (54%) strongly agreed that AI could improve healthcare services with strongest belief among administrators and doctors, 105 (35%) agreed, 22 (7.3%) had neutral beliefs, 9 (3%) disagreed and 2 (<1%) strongly disagreed that AI could improve healthcare services.

4.3 Potential benefits of Artificial Intelligence (AI) in Healthcare

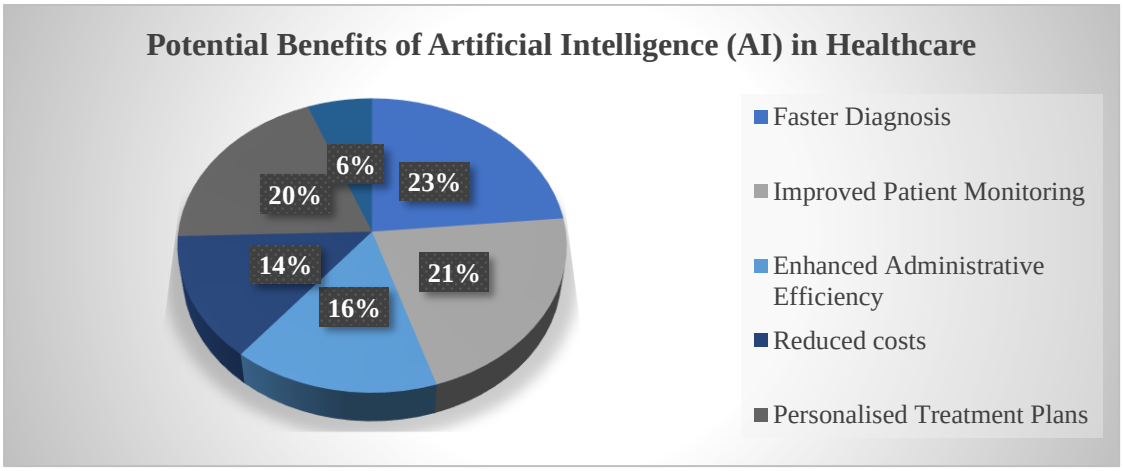


Figure 4.1: Potential benefits of Artificial Intelligence (AI) in Healthcare, N=300

Figure 4.1 illustrates that 69 (23%) of the participants saw potential benefits in faster diagnosis with AI in healthcare, 63 (21%) stated potential benefits in patients monitoring being improved, 48 (16%) in administrative efficiency being enhanced, 42 (14%) saw potential benefits in reduced cost, 60 (20%) participants chose potential benefits in personalised treatment plans and 18 (6%) had other ideas of how AI could potentially benefit the healthcare industry.

4.4 Concerns regarding Artificial Intelligence in Healthcare

Table 4.3: Concerns regarding Artificial Intelligence in Healthcare among nurses, administrators, patients and doctors, N=300

Concern	Nurses	Administrators	Patients	Doctors	Total
Data privacy and security	45	18	36	19	118
Job displacement	5	7	24	4	40
Accuracy and reliability	14	9	12	10	45
Ethical issues	11	6	4	5	26
Lack of human touch	25	10	24	12	71
Total	100	50	100	50	300

Table 4.3 highlights participants' concerns regarding the use of Artificial Intelligence (AI) in healthcare. 118 (39.3%) showed concern in data privacy and security, 40 (13.3%) showed concern in job displacement, 45 (15%) showed concern in accuracy and reliability, 26 (8.7%) showed concern in ethical issues and 71 (23.7%) showed concern in AI lacking human touch. Data privacy (65%) and lack of human touch (62%) emerged as the biggest concerns among respondents.

4.5 Training and Support Needs in Artificial Intelligence (AI) in Healthcare among nurses, administrators and doctors

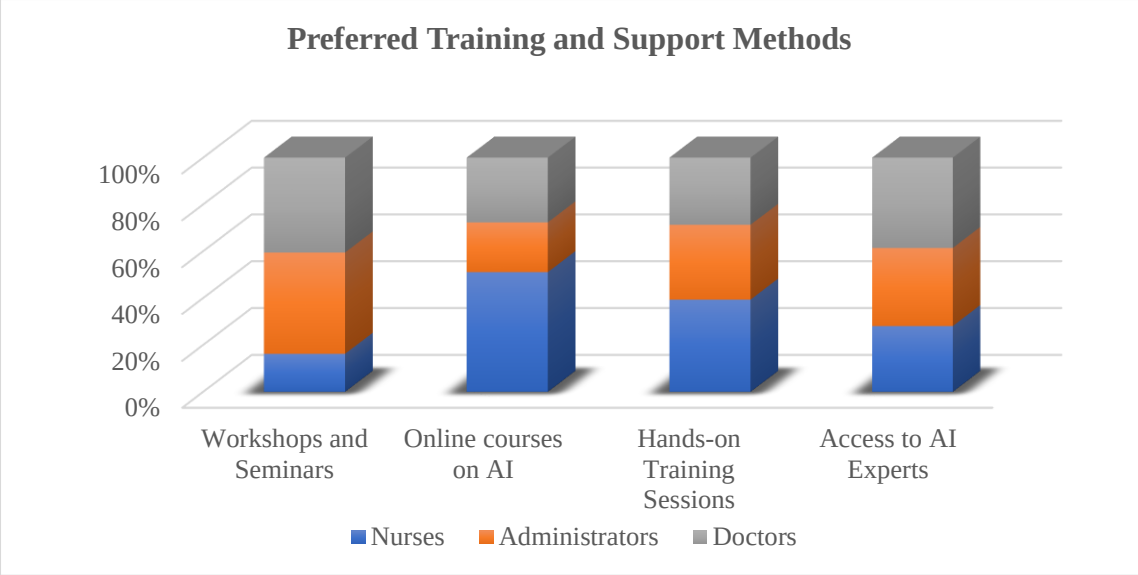


Figure 4.2 Training and Support Needs in Artificial Intelligence (AI) in Healthcare among nurses, administrators and doctors, N=300

Figure 4.2 illustrates that 12 (12%) nurses preferred workshops and seminars, 24 (24%) preferred online courses on AI, 48 (48%) preferred hands-on training sessions and 16 (16%) preferred access to AI experts. 16 (32%) administrators preferred workshops and seminars, 5 (10%) preferred online courses on AI, 19 (39%) preferred hands-on training sessions and 10 (19%) preferred access to AI experts. Doctors that preferred workshops and seminars are 15 (30%), those that preferred online courses on AI are 7 (13%), those that preferred hands-on training sessions are 17 (35%) and those that preferred access to AI experts are 11 (22%).

4.6 Importance of Artificial Intelligence Investment in Healthcare

Table 4.4 Importance of Artificial Intelligence Investment in Healthcare among nurses, administrators, patients and nurses

Response	Nurses	Administrators	Patients	Doctors	Total
Very Important	52	27	33	30	142
Important	35	15	40	16	106

Neutral	5	5	19	3	32
Not very important	6	3	5	1	15
Not important at all	2	0	3	0	5
Total	100	50	100	50	300

Table 4.4 highlights the importance of Artificial Intelligence investment in Healthcare among nurses, administrators, patients and nurses. 142 (47.3%) participants rated the investment of AI in healthcare as very important, 106 (35.3%) rated it as important, 32 (10.7%) rated it neutral, 15 (5%) rated it as not very important and 5 (1.7%) rated the investment of AI in healthcare not important at all.

4.7 Summary of the chapter

This chapter addressed the awareness of artificial intelligence technologies, beliefs in artificial intelligence's impact in healthcare, potential benefits of artificial intelligence in healthcare, concerns regarding artificial intelligence in healthcare, training and support needs in artificial intelligence in healthcare and the importance of artificial intelligence investment in healthcare among nurses, administrators, patients and nurses of Polyclinique Yawe Raphe in the Democratic Republic of Congo. The next chapter emphasized on the discussion, conclusion, recommendations, limitations and dissemination of results of the study.

CHAPTER 5

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The study results were discussed in this chapter. This chapter addressed the conclusion and gave some recommendations. The study limitations and dissemination of study results were also highlighted in this chapter. The findings reflected growing awareness and positive attitudes among hospital staff and patients toward AI integration, though some challenges and concerns were also identified.

5.1 Discussion

The study investigated the use and effects of artificial intelligence (AI) technologies at Polyclinic Yawe Raphe in the Democratic Republic of the Congo. Although certain difficulties and worries were also noted, the results showed that hospital employees and patients are becoming more conscious of and have good opinions regarding the incorporation of AI.

5.1.1 Awareness and Understanding of AI

Most participants 198 (66%) knew of the AI technologies being used at the hospital with administrators (90%) and physicians (96%) being more informed. This suggests that because of their involvement in hospital management and medical decision-making, healthcare workers are more likely than patients to be exposed to AI tools. The need for better patient education regarding the advantages and limitations of AI is highlighted by the 40% awareness gap between patients and healthcare providers.

5.1.2 Perceptions of AI's Impact on Healthcare Quality

According to the data, there was a great optimism that AI will improve healthcare services. Approximately 89% of participants agreed that AI can enhance healthcare results by facilitating quicker diagnosis, more individualised therapy and better patient monitoring. This favourable view is consistent with worldwide patterns, since AI remains essential in medical domains such as cardiology, radiology and public health (Topol, 2019). However, a small percentage were sceptical, mostly because they were worried about the ethical ramifications and dependability.

5.1.3 Potential Benefits of AI

Faster diagnosis (60%), individualised treatment (50%) and improved patient monitoring (55%), the three main advantages noted, demonstrate AI's capacity to optimise clinical results and streamline healthcare procedures. These results are in line with studies that demonstrate how AI-powered solutions improve patient outcomes and diagnostic precision (Jiang et al., 2017). The understanding of AI's potential to lower operational expenses and administrative workloads emphasises its wider applicability outside of clinical treatment.

5.1.4 Concerns and Challenges

Even though AI was embraced, serious concerns surfaced. Concerns about employment displacement (38%) and losing the human touch (62%) were the most common, followed by data privacy and security (65%). These issues are a reflection of continuous discussions over the moral use of AI in healthcare and the necessity of strong data governance systems. Concerns about AI replacing human labour also highlight how crucial it is to have well-balanced policies that incorporate AI without diminishing the relevance of human roles.

5.1.5 Areas for Further AI Integration

The top areas where AI can have the biggest influence, according to the respondents, are patient management, treatment planning and diagnostics. The literature that suggests AI algorithms can improve diagnostic accuracy and enhance precision medicine is supported by this (Topol, 2019). When considering the use of AI, healthcare professionals may prioritise clinical functions over operational benefits, as indicated by the comparatively low emphasis on administrative automation.

5.1.6 Training and Support Needs

Staff members' preference for workshops (60%) and hands-on training (70%) emphasises the necessity of experiential learning strategies. Even while online courses are becoming more and more popular, in-person meetings with AI specialists and hands-on demonstrations are still more successful in boosting healthcare workers' confidence. By taking care of these training requirements, AI adoption will go more smoothly and resistance to new technology would be lessened.

5.2 Conclusion

According to the study's findings, AI has a lot of potential to enhance Polyclinic Yawe Raphe Hospital's healthcare delivery. A willingness for technological growth is demonstrated by the high levels of awareness and favourable views towards AI. AI meets the expectations of patients and healthcare workers by improving diagnostics, patient management and personalised care. To guarantee sustainable implementation, however, issues like job security, data privacy and the ethical ramifications of adopting AI must be resolved.

Additionally, the report emphasises how important it is for healthcare professionals to get ongoing education and training. Successful capacity-building programs will enable hospital

employees to use AI tools with competence and confidence. The findings suggest that while AI can transform healthcare delivery, it must complement - not replace - human expertise to maintain the personal connection that is central to patient care.

5.3 Recommendations

The study findings lead to the following recommendations to improve the hospital's adoption and integration of AI:

1. To safeguard patient information and guarantee adherence to global standards, the hospital should put in place thorough data privacy rules.
2. The hospital should regularly host workshops, seminars and practical training sessions to give healthcare professionals the know-how to use AI tools efficiently.
3. Human skill should be enhanced by AI, not replaced. Retaining the human element in patient care will be made easier by policies that prioritise cooperation between medical staff and AI systems.
4. Constant observation and assessment will guarantee that AI technologies are accurate, dependable and in line with the hospital's goals. Staff and patient feedback loops will promote advancements.
5. To educate patients about AI tools and their advantages, educational programs must to be set up. This will lessen anxiety and increase confidence in the technology.

5.4 Study Limitations

This study solely focused on artificial intelligence in the healthcare industry while there are many other areas where AI can be used, including robotics, automotive, entertainment, e-commerce, social media, gaming and surveillance. Also, improperly digitised, inconsistent and insufficient healthcare data significantly affected the efficacy and reliability of AI models. Furthermore, the researcher is a student and was subjected to the university's academic

calendar, which influenced the study to be done quickly within the allotted time frame. The study's findings could be distorted by this.

5.5 Dissemination of the study results

A report on findings from this study will be presented as soft copies to the College of Business, Peace, Leadership and Governance and the University library at Africa University. Another report on the study findings will be given to Polyclinic Yawe Raphe Hospital management in the Democratic Republic of Congo.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

I am conducting research to understand the current applications and potential integration strategies of Artificial Intelligence (AI) in healthcare at Polyclinique Yawe Raphe. Your participation in this survey is highly valuable. Please answer the following questions based on your experience and knowledge.

Section 1: Demographic Information

1. Role at the Hospital
a. Patient
b. Doctor
c. Nurse
d. Administrative Staff

2. Age
a. Under 18
b. 18-24
c. 25-34
d. 35-44
e. 45-54
f. 55-64
g. 65 and above

3. Gender
a. Male
b. Female
c. Prefer not to say

4. Years of Experience (For Staff Only)
a. Less than 1 year
b. 1-5 years
c. 6-10 years
d. 11-15 years
e. More than 15 years

Section 2: Current Applications of AI in Healthcare

5. Are you aware of any AI technologies currently being used at Polyclinique Yawe Raphe?
a. Yes
b. No

6. If yes, please specify which AI technologies you are aware of. (e.g., diagnostic tools, patient monitoring, administrative automation, etc.)
……..

7. How frequently do you interact with AI-based systems at the hospital? (For Staff Only)
a. Daily
b. Weekly
c. Monthly
d. Rarely
e. Never

8. On a scale of 1-5, how effective do you find the current AI applications in improving healthcare services? (1 - Not effective, 5 - Very effective)
a. 1
b. 2
c. 3
d. 4
e. 5

Section 3: Perceptions and Attitudes Towards AI

9. How comfortable are you with the use of AI in healthcare?
a. Very comfortable
b. Somewhat comfortable
c. Neutral
d. Somewhat uncomfortable
e. Very uncomfortable

10. Do you believe AI can improve the quality of healthcare services?
a. Strongly agree
b. Agree
c. Neutral
d. Disagree
e. Strongly disagree

11. What potential benefits do you see in using AI in healthcare? (Select one)
a. Faster diagnosis
b. Improved patient monitoring
c. Enhanced administrative efficiency
d. Reduced costs
e. Personalized treatment plans
f. Other (please specify)

12. What concerns do you have regarding the use of AI in healthcare? (Select one)
a. Data privacy and security
b. Job displacement
c. Accuracy and reliability
d. Ethical issues
e. Lack of human touch
f. Other (please specify)

Section 4: Innovative Integration Strategies

13. In which areas do you think AI could be further integrated to enhance healthcare at the hospital? (Select one)
a. Diagnostics
b. Treatment planning
c. Patient management
d. Administrative tasks
e. Research and development
f. Other (please specify)

14. What kind of training or support would help you feel more comfortable with AI technologies? (For Staff Only, select one)
a. Workshops and seminars
b. Online courses
c. Hands-on training sessions
d. Access to AI experts
e. Other (please specify)

15. How important do you think it is for Polyclinique Yawe Raphe to invest in AI technology?
a. Very important
b. Important
c. Neutral
d. Not very important
e. Not important at all

16. Do you have any suggestions or ideas for improving the use of AI in healthcare at Polyclinique Yawe Raphe?

Thank you for your participation in this survey. Your feedback is crucial in helping us enhance healthcare services through innovative AI strategies at Polyclinique Yawe Raphe.

APPENDIX II: INFORMED CONSENT

You are invited to participate in a research study conducted by Kabanga Tegra Katembwe, a student at Africa University, as part of a dissertation project. This study aims to explore the application of AI algorithms and techniques in healthcare at the Polyclinique Yawe Raphe. The purpose of this study is to understand how AI algorithms and techniques are being used in healthcare settings at the Polyclinique Yawe Raphe Hospital and their impact on patient care and clinical outcomes.

If you agree to participate, you will be asked to complete a questionnaire that will take approximately 15-20 minutes. The questions will focus on your experiences, perceptions, and knowledge related to the use of AI in healthcare at this hospital. Your participation in this study is entirely voluntary. You may choose not to participate or to withdraw from the study at any time without any consequences.

Your responses will be kept confidential. The results of this study may be published, but your identity will remain confidential. There are no direct benefits or risks to you for participating in this study. Your participation will contribute to a better understanding of the application of AI in healthcare. By completing the questionnaire, you indicate that you have read and understood this information and agree to participate in the study.

Thank you for your time and participation.

Sincerely,

Kabanga Tegra Katembwe.

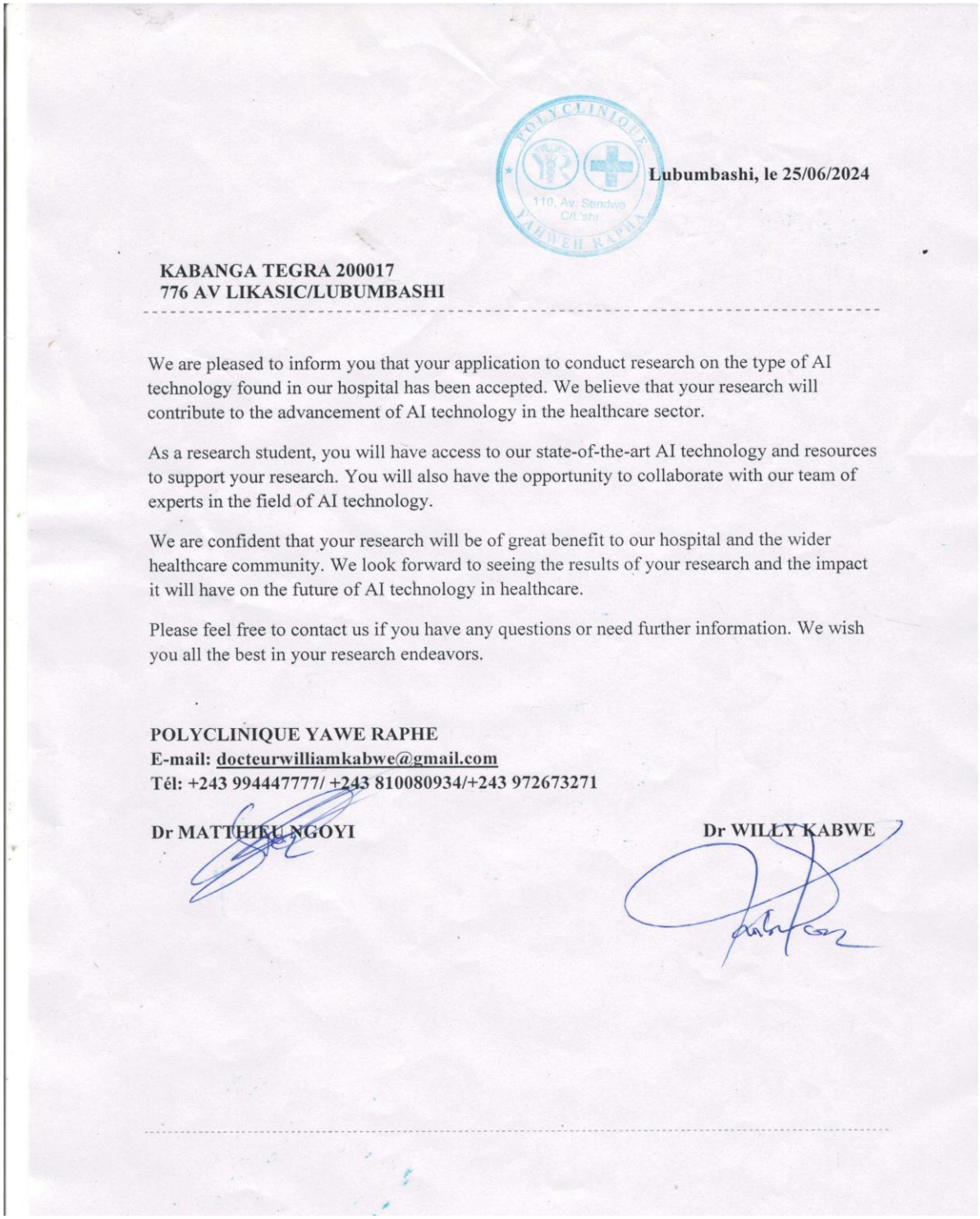
APPENDIX III: TIMELINE FOR RESEARCH STUDY

MONTH					
ACTIVITY	APR-MAY 2024	JUL 2024	AUG-DEC 2024	JAN-FEB 2025	MAR 2025
Development of proposals	→				
Submission of proposals to AUREC		→			
Data collection			→		
Write up of chapters 4 and 5				→	
Finalization and submission					→

APPENDIX IV: STUDY BUDGET

Activity	Amount (USD)
AUREC	$15
Printing of project questionnaire	$40
Total	$55

APPENDIX V: APPROVAL LETTER FROM POLYCLINIQUE YAWE RAPHE IN DRC.



POLYCLINIQUE YAWEH RAPHA
110, Av. Sendwe
C/L'shi

Lubumbashi, le 25/06/2024

KABANGA TEGRA 200017
776 AV LIKASIC/LUBUMBASHI

We are pleased to inform you that your application to conduct research on the type of AI technology found in our hospital has been accepted. We believe that your research will contribute to the advancement of AI technology in the healthcare sector.

As a research student, you will have access to our state-of-the-art AI technology and resources to support your research. You will also have the opportunity to collaborate with our team of experts in the field of AI technology.

We are confident that your research will be of great benefit to our hospital and the wider healthcare community. We look forward to seeing the results of your research and the impact it will have on the future of AI technology in healthcare.

Please feel free to contact us if you have any questions or need further information. We wish you all the best in your research endeavors.

POLYCLINIQUE YAWE RAPHE
E-mail: docteurwilliamkabwe@gmail.com
Tél: +243 994447777/ +243 810080934/+243 972673271

Dr MATTHIEU NGOYI

Dr WILLY KABWE

APPENDIX VI: APPROVAL LETTER FROM AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

"Investing in Africa's future"

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africau.edu

Ref: AU 3414/24 21 August, 2024

KABANGA TEGRA KATEMBWE
C/O Africa University
Box 1320
MUTARE

RE: **APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) ALGORITHMS AND TECHNIQUES IN HEALTHCARE AT POLYCLINIC YAWE RAPHE IN DEMOCRATIC REPUBLIC OF CONGO**

Thank you for the above-titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC 3414/24
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** August 21, 2024
- **EXPIRATION DATE** August 21, 2025
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

APPROVED

Yours Faithfully

MARY CHINZOU
ASSISTANT RESEARCH OFFICER: FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE