UNIVERSITY OF RWANDA

ASSESSMENT OF HEPATITIS B VIRAL LOAD SUPPRESSION LEVELS AMONG HBV-INFECTED PATIENTS ON ANTIRETROVIRAL DRUGS AT UNIVERSITY TEACHING HOSPITAL OF BUTARE (CHUB).

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Celestin NZEYIMANA

"ASSESSMENT OF HEPATITIS B VIRAL LOAD SUPPRESSION LEVELS AMONG HBV-INFECTED PATIENTS ON ANTIRETROVIRAL DRUGS AT UNIVERSITY TEACHING HOSPITAL OF BUTARE (CHUB)".

By

Mr. Celestin NZEYIMANA, Ref. Number: 215041897

A dissertation submitted in partial fulfillment of the requirements for the degree:

MASTER OF SCIENCE IN BIOTECHNOLOGY

in the Department of Biology, School of Science

College of Science and Technology

at

University of Rwanda

Supervisor: Dr. Ismail Abiola ADEBAYO (PhD)

Co-supervisors: - Prof Antoine NSABIMANA(PhD)

-Felix HABARUGIRA (MSc), (PhD ©)

Kigali-Rwanda, 2025.

DECLARATION

I, the undersigned, NZEYIMANA Celestin, master's students at UR-CST Nyarugenge Campus, in Biotechnology hereby declare that this dissertation entitled "**Assessment of hepatitis B viral load suppression levels among HBV-infected patients on Antiretroviral drugs at the University Teaching Hospital of Butare** " and which is submitted in partial fulfillment of the requirements for a Master's degree in biotechnology, at the University of Rwanda, College of Sciences and Technology, is my project and has never been previously submitted somewhere else. As well, I declare that the list of references provided indicates all sources of information cited or quoted in this project.

Signature: 

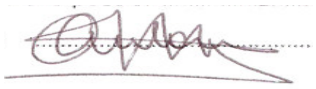
Names: Celestin NZEYIMANA

AUTHORITY TO SUBMIT DISSERTATION

I, Ismail Abiola ADEBAYO (PhD), in my capacity as a Supervisor, do hereby authorize Mr. Celestin NZEYIMANA MSc. Student in Biotechnology in the department of Biology, School of Science, College of Science and Technology, to submit his Dissertation entitled "**ASSESSMENT OF HEPATITIS B VIRAL LOAD SUPPRESSION LEVELS AMONG HBV-INFECTED PATIENTS ON ANTIRETROVIRAL DRUGS AT UNIVERSITY TEACHING HOSPITAL OF BUTARE (CHUB)**" to the department, ready for its defense.

Kigali, July31, 2025 Signature

Supervisor: Dr Ismail Abiola ADEBAYO (PhD)



Co-supervisors: 1) Prof Antoine NSABIMANA(PhD)

2) Felix HABARUGIRA (MSc), (PhD ©)

DEDICATION

I dedicate this dissertation to my supervisors for their guidance that enabled the execution of every activity for this study. As well, I dedicate this project to all my beloved family members, brothers and sisters, and colleagues for encouraging me during the progress of this Master's program. As well, I would like to dedicate this dissertation to everyone with an interest in Hepatitis B virus elimination programs.

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ABSTRACT

Background: HBV infection is still a major global health concern with about 1.5 million new cases of hepatitis B virus (HBV) infection occurring annually, and an estimated 296 million people worldwide live with chronic hepatitis B infection (Al-Busafi & Alwassief, 2024). As well, there are still limited statistics showing viral load suppression and non-suppression levels in Rwanda, and even in the entire East African region. Therefore, this study will determine the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients on antivirals attending CHUB.

Methods: A retrospective study was conducted within 3 months, whereby Hepatitis B viral loads data for HBV-infected patients were collected from the VLSMS system and OpenMRS (Open Medical Records System). The obtained data were analyzed using SPSS software, discussed against other studies, and a conclusion was established; thereafter, recommendations were raised for necessary users.

Results: A sample size of 64 participants determined the prevalence of viral load suppression in **51 (79.7%)** of participants whose viral load was less than 2000 IU/mL, whereas the prevalence of non-suppression was **13 (20.3%).** Of 64 participants, **63 (98.4%)** were treated with Tenofavir while only 1 (1.6%) was taking Entecavir.

Conclusion: As a conclusion this study determined the prevalence of Hepatitis B viral load suppression level of **79.7%** and non-suppression level of **20.3%**. Comparing viral load results before taking ART(baseline) with Current results after one year on ART demonstrated significant HBV DNA suppression. Ages people raised the number of non-suppression more than younger ones. As well, male people reduced the number of non-suppression rate more than males. Therefore, Further studies are needed to prove the relationship between age and gender using bigger of sample size.

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LIST OF ABREVIATIONS

ALT: Alanine aminotransferase

AST: Aspartate aminotransferase

CHB: Chronic Hepatitis B

CHUB: University Teaching Hospital of Butare (CHUB)

CST: College of Science and Technology

DNA: Deoxyribonucleic acid

EEA: European Economic Area

ETV: Entecavir

EU: European Union

HBV: Hepatitis B virus

HCC: Hepatocellular carcinoma

HIV: Human Immunodeficiency Virus

MoH: Ministry of Health

NA: Nucleos(t)ide analog

OpenMRS: Open Medical Records System.

TAF: Tenofovir alafenamide

TDF: Tenofovir disoproxil fumarate

UR: University of Rwanda

UR-CST: University of Rwanda-College of Science and Technology

VLSMS: Viral Load Sample Management System

WHO: World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Hepatitis B virus infection is still a major worldwide health concern, with around 1.5 million new cases of infection occurring each year, and approximately 296 million people live with chronic hepatitis B infection globally (Al-Busafi & Alwassief, 2024). Undoubtedly, HBV infection has been linked to high mortality rates; it has been proven by a study conducted in China in which hepatocellular carcinoma and cirrhosis caused by HBV infections were responsible for over 300,000 deaths annually in China alone (Liu et al., 2021). In the United States, chronic hepatitis B has been publicized with high prevalence, accounting for around 2.5 million individuals, where several US studies have highlighted the gap in the timely treatment of affected patients(Wong et al., 2024). It was also reported that in 30 nations of the European Union (EU) and European Economic Area(EEA), about 3.6 million people live with CHB, and this is attributed to deaths related to liver cancer at ~55% and deaths related to cirrhosis at ~45% (Buti & Duffell, 2024).

According to a publication by Sonderup and Spearman, up to 75% of the world's HBV burden is located in Africa, making the continent presently regarded as endemic (Sonderup & Spearman, 2024). In Rwanda, HBV screening among individuals with non-communicable disorders revealed a 2% prevalence (Musafiri et al., 2024). Furthermore, based on statistics, the prevalence of HBV is high in Rwanda, primarily among high-risk populations such as sex workers, HIV-positive patients, and prisoners; it was reported by two different studies on the prevalence of HBV in HIV-infected patients and prisoners, the prevalence was 4.3% for each group (Umutesi et al., 2021), (Umutesi et al., 2017).

Despite the burden caused by HBV infection, the treatment of CHB has been revolutionized by HBV antivirals that suppress viral load in patients(You et al., 2023). However, HBV mutations and drug resistance continue to rise as more people with HBV are exposed to antivirals. five years after lamivudine was used as the first treatment authorized to treat CHB patients, hepatitis B drug resistance was initially identified. Up to now, lamivudine is responsible for the largest prevalence, with about 65% of drug resistance (Woo et al., 2020).

It was documented that levels of viral load are essential for the indication of suppression & non-suppression of the virus, hence confirming the status of adherence to antiviral drugs (Ryan et al., 2024). Viral load testing plays a big role in various positions, including the recognition of high-risk individuals, support in diagnosis and treatment of early liver fibrosis and cirrhosis, and leading of monitoring and prevention actions, as well as assisting the public health HBV elimination target (Wang et al., 2025). To emphasize the significance of viral load findings, a study conducted in Eastern Ethiopia found that among HBV-infected patients who had cirrhosis at that time, they demonstrated higher viral load than those without cirrhosis (Kanda et al., 2025).

East African countries, including Rwanda, still face limited data on HBV viral load suppression status among HBV-infected patients. Therefore, this study determined the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients on antivirals attending CHUB. It analyzed viral load findings according to age categories, sex, and type of prescribed Antiviral drugs to appreciate factors contributing to viral load suppression & non-suppression results.

1.2 Problem statement

Approximately 296 million people live with chronic hepatitis B worldwide, and the disease continues to be a major universal health concern, impacting about 1.5 million newly infected individuals annually (Al-Busafi & Alwassief, 2024). Despite the management of CHB having been revolutionized by HBV antivirals that suppress viral load in patients, viral mutation and drug resistance are compromising drug efficacy, especially in patients on long-term treatment, as indicated by viral load non-suppression (Woo et al., 2020). There is still little evidence of viral load suppression levels in the Rwandan population, and even in the entire East African region. Therefore, this study will provide the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients on antivirals attending CHUB. As Rwanda continues to scale up its hepatitis B elimination efforts, this study will compare the prevalence of viral load suppression &non-suppression according to age groups, gender of participants, and Antiviral treatment prescribed to identify factors influencing non-suppression of the virus in the blood of infected patients.

1.3. General objective

- ✓ To determine the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients on antivirals attending CHUB.

1.3.1. Specific objectives

- ✓ To determine the prevalence of hepatitis viral load suppression among HBV-infected patients under antivirals attending CHUB.
- ✓ To determine the prevalence of hepatitis viral load non-suppression among HBV-infected patients under antivirals attending CHUB.
- ✓ To compare Hepatitis B viral load levels according to age categories, gender, and Antiretroviral drug prescribed to appreciate factors contributing to Hepatitis B viral load non-suppression.

1.4. Hypothesis

The prevalence of hepatitis B viral load non-suppression is high among HBV-infected patients on antivirals.

1.4. Research question

What is the prevalence of hepatitis B viral load suppression and non-suppression among infected patients under antiretroviral therapy?

1.5 Significance of the study

This study will provide reliable information about the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients under antivirals attending CHUB. As well, this study will compare the prevalence of viral load suppression levels according to age groups, sex groups, and Antiviral drugs applied in order to gain an understanding of factors influencing non-suppression of the virus in HBV-infected patients.

1.6 Inclusion criteria

Hepatitis B viral load results of HBV-infected patients on Antiretroviral therapy.

1.7 Exclusion criteria

Hepatitis B viral load results of HBV-infected patients not yet enrolled in Antiretroviral therapy.

CHAPTER TWO: LITERATURE REVIEW

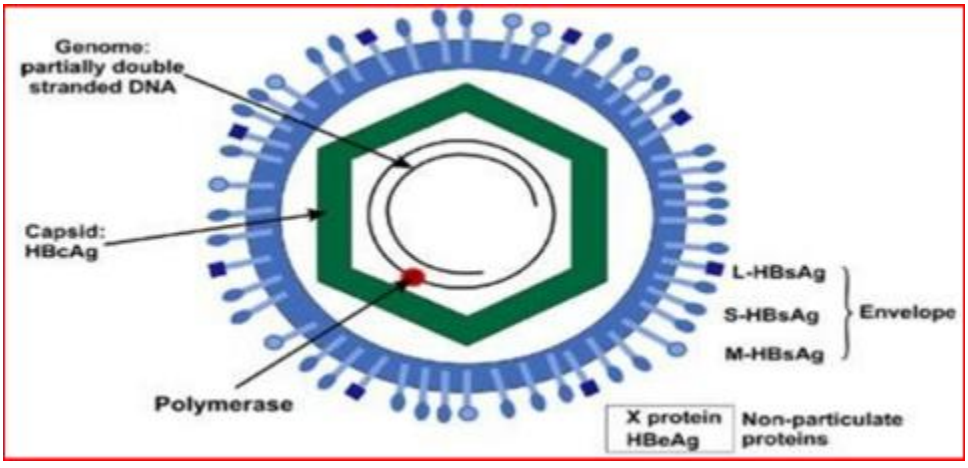
2.1 Introduction

Hepatitis B virus (HBV) infection is a major global health concern, with more than 250 million people worldwide living with chronic HBV(Freeland et al., 2024). Treatment with antiviral drugs such as nucleos(t)ide analogs (NAs) has revolutionized HBV management. However, the development of drug resistance remains a significant challenge, impacting the long-term effectiveness of therapy. Therefore, this literature review examines the structure of the hepatitis B virus (HBV), HBV transmission, the HBV life cycle, chronic hepatitis B signs and symptoms, its complications, how to diagnose HBV infection, treatment options, the mechanisms of HBV drug resistance, and strategies to overcome resistance.

2.2 Hepatitis B virus structure

Hepatitis B virus (HBV) is a partially double–stranded DNA virus classified in the hepadnaviridae family with a 3.2 kb long DNA (He et al., 2024).

Fig.1. **Structure of the hepatitis B virus**



(Banerjee, 2022)**.**

The above image represents the structure of Hepatitis B virus highlighting the envelope components, capsid, and its genome which is a partially double stranded DNA.

2.3 Hepatitis B virus transmission

HBV has similar means of transmission as HIV, but it is highly infectious, with an estimated 10 times more contagious than HCV, and 100 times transmissible than HIV. Therefore, it is transmitted through the following ways:

1.Exposure to blood or body fluids from an infected person, a contaminated needle, or accidental injury.

2.Insecure transfusion with a non-screened blood product transfusion for HBV.

3.Non-protected sex intercourse.

4.Mother-to-child transmission

5.Horizontal transmission: household contact, intra-familiar, child-to-child

6.Syringe sharing among venous drug utilizers.

7. Inappropriate practices with medical non-sterilized sharps (MoH, 2024)

2.4 Chronic hepatitis B signs and symptoms, and complications

Hepatitis B infection may cause fatigue, loss of appetite, nausea, vomiting, abdominal pain, dark urine, pale stools, joint pain, and jaundice. Acute cases often show flu-like symptoms, while chronic infection may remain silent for years but can lead to liver damage, causing weakness, abdominal discomfort, and jaundice. In some individuals, especially children, the infection may be asymptomatic (MoH, 2024). Apart from signs and symptoms, if not well treated, CHB can result into complications including liver failure, liver cirrhosis, liver cancer (HCC)(Zheng et al., 2020).

2.5 How to diagnose HBV infection

Hepatitis B virus (HBV) infection is diagnosed through **blood tests** that detect **viral antigens**, **antibodies**, and **viral DNA**. If HBsAg persists for more than six months, it confirms **chronic infection**. The **anti-HBs** test shows recovery or immunity, while **anti-HBc (core antibody)** indicates past or ongoing infection. **HBeAg (envelope antigen)** reflects active viral replication and higher infectivity. **HBV DNA testing** measures the viral load, which helps assess the severity and guide treatment decisions. Additional tests, like **liver function tests** (ALT, AST), evaluate liver damage. In some cases, imaging (ultrasound) or **liver biopsy** may be needed to assess liver health. Early and accurate diagnosis is essential to prevent complications such as liver cirrhosis or cancer and to determine if antiviral therapy is needed. Testing is especially important for pregnant women, high-risk groups, and blood donors (Alok Gupta et al., 2022).

2.6 Viral Load Determination Methods

Viral load refers to the quantity of DNA present in the blood of an infected patient, usually expressed in International Units per milliliter (IU/ml) or copies/ml(Marugán & Garzón, 2009). Viral load is a critical marker for diagnosis, disease monitoring, treatment eligibility, and evaluation of therapeutic response(MoH, 2024). Accurate determination of HBV viral load depends on molecular techniques that detect and quantify HBV DNA among the following methods:

A. Real-Time Quantitative PCR (qPCR)

This technique is highly sensitive, specific, and reproducible, making it the most widely used method in clinical laboratories (Arya et al., 2005). It is the gold standard for HBV viral load measurement with fluorescent dyes or probes that track DNA amplification in real time, allowing precise quantification over a wide dynamic range as low as 10–20 IU/mL (Mackay et al., 2002). Instruments such as Abbott m2000 RealTime (m2000sp/m2000rt), Roche cobas 4800 & cobas 6800 systems, Bio-Rad real-time PCR instruments, and Cepheid GeneXpert machine serve in the real-time quantification of various viruses, including HBV, and some bacteria like tuberculosis.

B. Branched DNA (bDNA) Assay

This signal-amplification method measures HBV DNA without direct amplification of the viral genome. Multiple probes hybridize to the target sequence, and branched DNA molecules amplify the detection signal. While less sensitive than qPCR (detection limit ~200–500 IU/mL), it is robust, less prone to contamination, and useful in high-throughput settings (Bustamante et al., 2022).

C. Transcription-Mediated Amplification (TMA)

TMA is an isothermal amplification method that targets HBV nucleic acids (DNA and RNA intermediates). It is highly sensitive, with rapid amplification, and is often used in screening blood donations to detect low-level viremia (Zanoli & Spoto, 2013).

D. Hybrid Capture Assay

This technique uses RNA probes that hybridize with HBV DNA, followed by signal detection through chemiluminescence. It is relatively simple and cost-effective but less sensitive compared to PCR-based methods, limiting its use for precise monitoring, but it can provide viral load information (Majid et al., 2014).

E. Emerging Technologies

1) **Digital PCR (dPCR)**: Provides absolute quantification of HBV DNA without the need for standard curves. It is more sensitive than qPCR and is valuable for detecting low-level viremia, monitoring drug resistance, and residual viral DNA during treatment (Hui et al., 2025).
2) **Next-Generation Sequencing (NGS)**: Primarily used in research to study HBV genetic variability and resistance mutations, while also enabling viral load estimation (Hebeler et al., 2020).

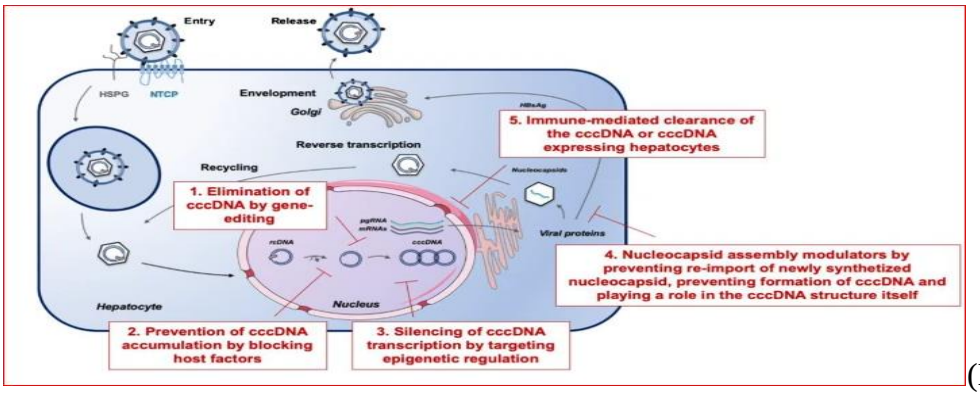
2.7 Treatment of HBV

Antiviral medications such as tenofovir disoproxil fumarate **(TDF)** for people ranging from 12 years to all adults without renal failure, and **Entecavir** for children of **2 to 11** years, and adults with renal failure are used, conforming with WHO guidelines. Treatment eligibility is determined using clinical assessments and simplified criteria that consider HBeAg status, viral load >2000 IU/ml**,** AST Platelet Ratio Index (APRI), ALT and AST levels, and cirrhotic history.

Priority groups include pregnant women, HIV co-infected individuals, and those with elevated liver enzymes. Ongoing care includes regular monitoring of liver function and adherence (MoH, 2024).

2.8 Life cycle with potential treatment strategies.

Fig.2. **Hepatitis B virus life cycle and possible therapeutic strategies**



(Ligat et al., 2020)

The life cycle of HBV demonstrated in Fig. 2, illustrates that the HBV penetrates the host cell by attaching itself to the sodium taurocholate, as a co-transporting polypeptide (NTCP) receptor. Then, the viral rcDNA is imported into the nucleus, where it changes into the covalently closed circular DNA (cccDNA), interlinking with the host genome. At the transcription process, this DNA yields several viral RNAs, including pgRNA, pre-S/S mRNAs, x mRNA, and pre-core mRNA. Afterwards, those mRNAs are translated into their corresponding viral proteins. The pgRNA is reverse-transcribed into progeny viral DNA. The HBx protein is important for the efficient transcription of cccDNA. Thus, it has been found that a complete cure for HBV infection is not easy to achieve due to the extremely steady properties of cccDNA in hepatocytes (Yu et al., 2024).

2.9 Mechanisms of HBV drug resistance

HBV is highly susceptible to mutations through processes of replication and reverse transcription, leading to reduced sensitivity to prescribed antiviral drugs (He et al., 2024).

i. **Lamivudine Resistance**: Lamivudine, an early NRTI used in Chronic Hepatitis B treatment, is highly prone to resistance. Mutations at positions 180 (M) and 204 (V/I) are the primary resistance mutations that significantly reduce lamivudine's antiviral activity (Lim, 2017).

ii. **Adefovir**: Resistance to Adefovir is less common but still possible. Mutations in the HBV RT domain at positions 148 (T) and 200 (V) are typically associated with resistance to adefovir.

iii. **Tenofovir Resistance:** This is rare due to its potent antiviral activity and low risk of cross-resistance with other agents(Lim, 2017).

iv. **Entecavir Resistance**: Entecavir resistance is relatively rare but can occur in patients with prior exposure to other NAs, especially lamivudine. The most commonly observed mutation is the substitution of threonine with alanine at position 184 (T184A). Entecavir has a higher barrier to resistance compared to lamivudine and adefovir, making it a preferred option in treatment-naïve patients(Lim, 2017).

2.10 Strategies to overcome the HBV drug resistance

Numerous mitigation approaches have been developed to fight the problem of drug resistance in HBV treatment, as follows:

1. **Combination Therapy**: Combining different classes of drugs, such as a nucleos(t)ide analog with interferon or two NAs with different resistance profiles such as entecavir (ETV) and tenofovir disoproxil fumarate (TDF) or tenofovir alafenamide (TAF), with pegylated interferon have been indicated with potential of about 71% of success rates when utilized as antiviral therapy (Putri et al., 2024).
2. **Monitoring and Early Detection of Resistance**: Early detection of resistance mutations through regular viral load monitoring and sequencing of the HBV genome is crucial for adjusting therapy. Several studies have demonstrated the utility of genotypic resistance testing to guide treatment decisions (Liang et al., 2021).
3. **Novel Agents**: Research into new antiviral agents targeting different stages of the HBV lifecycle holds promise for overcoming existing resistance. Recent clinical trials of agents like hepatitis B surface antigen (HBsAg) inhibitors, CRISPR/Cas9 gene-editing technologies, and immune modulators are showing potential for eliminating HBV (Cai et al., 2023).

2.11 Preventive strategies for hepatitis B virus infection

Control measures of hepatitis B infection involve the following:

1. **Vaccination**: vaccine is given in 3 three doses, starting at birth, and it provides long-term protection, starting at birth, and it provides long-term protection.
2. **Safe sex practices**: Using condoms reduces the risk of sexual transmission.
3. **Blood safety**: Screening all blood and organ donations for HBV is also essential.
4. **Infection control**: Ensuring sterile equipment in healthcare, dental clinics, and soon can contribute to HBV prevention.
5. **Avoid sharing needles**: Particularly among people who inject drugs.
6. **Mother-to-child prevention**: Testing pregnant women and giving HBV vaccine and hepatitis B immunoglobulin (HBIG) to exposed newborns within 24 hours of birth.
7. **Education and awareness**: Promoting public knowledge about transmission and prevention (MoH, 2024), (Easterbrook et al., 2024).

CHAPTER 3: METHODOLOGY

3.1. Introduction

This chapter outlines different methods that will be used in data collection, research design, such as how data will be collected, sample population, sample size, sampling procedures and techniques, research methods, data analysis, and ethical considerations.

3.2 Research design

The study was retrospective, which had a period of 3 months in which Hepatitis B viral load data for HBV-infected patients were collected from the VLSMS system and OpenMRS (Open Medical Records System). The obtained data were analyzed and discussed, and a conclusion was established then recommendations were given to the necessary users.

3.3 Research population

The study population was Hepatitis B patients on Antiretroviral therapy attending CHUB.

3.4 Sample size

Sample size was calculated basing on simple formula as published by Beard in 2024.

$$N = \frac{z^2 * p * (1-p)}{e^2}$$ (Beard, 2024)

Where:

N = sample size

z = it is equal to **1.96** at 95% level of confidence with 5% level of type I error.

p = prevalence (which can be obtained from previous existing similar type of studies (or) a pilot study conducted by the researchers.

e = Margin of error or precision (0.05)

Therefore, as the latest high prevalence of HBV is 4.3% (Umutesi et al., 2021). The sample size was 64 people according to the above formula.

3.5 Sampling procedures

A convenience sampling strategy was used in order to carry out this study. Convenience sampling technique is one of the research sampling methods characterized by easy access to data of participants who meet the inclusion criteria, non-biased, time-saving, and cost-effective. Therefore, Hepatitis B viral loads data for HBV-infected patients were collected from the VLSMS system and OpenMRS (Open Medical Records System). Afterwards, data collection was stopped by the time when the sample size was reached within the scheduled timeframe.

3.6 Research instruments and materials

Desktop computer designed for VLSMS (Viral Load Sample Management System). Obtained patient information, including results, age, sex, and the Name of the antiviral drug being taken, was recorded in an Excel sheet using an appropriate computer laptop, and on paper sheets as backup to avoid loss of data. IBM SPSS Statistics 25.0 x 64 software was used to analyze the data.

3.7. Data analysis

Collected data shall be analysed using IBM SPSS Statistics 25.0 x 64 software. Thereafter, results from those data were presented in the form of tables, charts, or graphs conforming to research objectives and questions.

3.8 Ethical considerations

This study was carried out after getting the authorization from the University of Rwanda, College of Science and Technology administration, allowing us to carry out the study, and this was presented to CHUB‘s administration asking for permission of data collection. All of the patients’ information was considered confidential to ensure the privacy of research participants.

CHAPTER 4: RESULTS PRESENTATION AND DISCUSSION

4.1 Results presentation

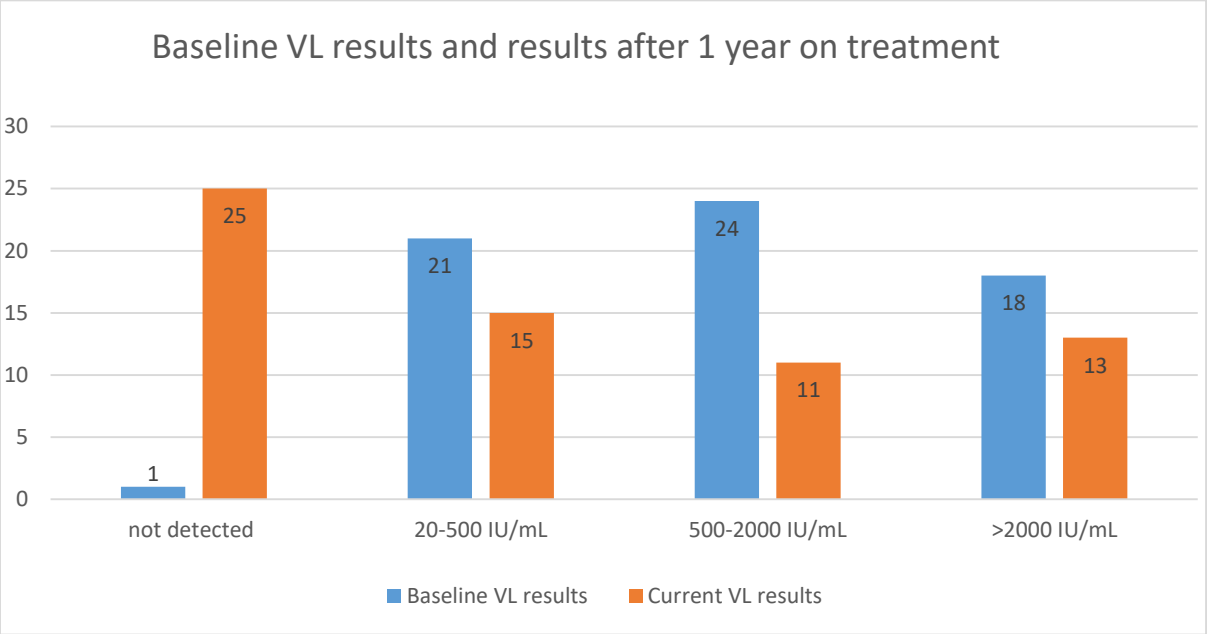
This section presents and describes the findings of 64 Hepatitis B-infected patients under Antiretroviral therapy. The results were analyzed using the following points: demographic information, the prevalence of Hepatitis B viral load suppression and non-suppression among HBV-infected patients on antivirals attending CHUB, and comparison of the prevalence of Hepatitis B viral load suppression and non-suppression according to age categories and gender of patients. It also reveals the frequency of antivirals used to treat Chronic Hepatitis B(CHB).

Table 1. **Demographic information with age categories and gender cross tabulated**

		GENDER			
			Female	**male**	**Total**	**Mean age**
AGE_CATEGORIES	**21-40 years**	**Count**	16	12	28	33 years
		% within Age Category	57.1%	42.9%	100%	
		% of Total	25%	18.8%	43.8%	
	41-60 years	**Count**	10	18	28	50 years
		% within Age Category	35.7%	64.3%	100%	
		% of Total	15.6%	28.1%	43.8%	
	61-80 years	**Count**	5	3	8	71 years
		% within Age Category	62.5%	37.5%	100%	
		% of Total	7.8%	4.7%	12.5%	
	Total	**Count**	31	33	64	
		%	48.4%	51.6%	100%	

This demonstrates the distribution of participants based on gender and age categories. Males had a higher frequency of **33(51.6%)** than Females, who had **31(48.4%).** People aged between 21 and 40 years, and those aged from 41 to 60 years showed the same frequency of **28(43.8%)** each, and the remaining age category (61-80 years) had **8 (12.5%).**

Fig 3. **Comparison between baseline VL results and Current viral load results**



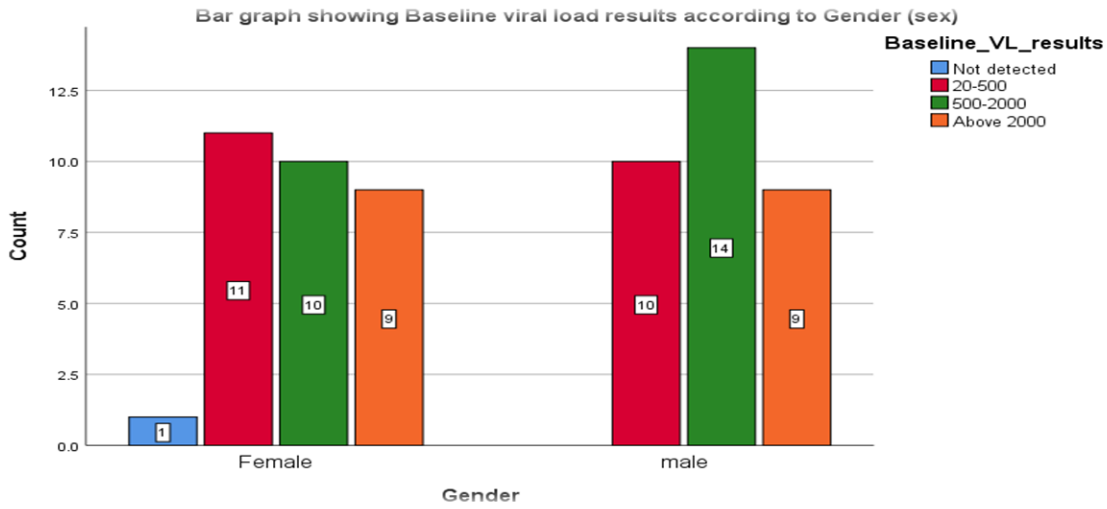
The viral load had been suppressed after 1 year of taking antiviral therapy, as the number of Not-detected VL results increased from 1 (1.6%) to 25 (39.1%), and the number of results above 2000IU/ml decreased from 18(28.1%) to 13 (20.3%).

Table 2. **Hepatitis B viral load baseline levels according to age categories.**

		BASELINE VIRAL LOAD RESULTS (IU/ml)				
		Not detected	20-500	500-2000	Above 2000	**Total**
AGE CATEGORY	21-40 Years	0	6	10	12	28
	41-60 Years	0	12	10	6	28
	61-80 Years	1	3	4	0	8
Total		1	21	24	**18**	64

Table 3 determines the prevalence of hepatitis B viral load levels before taking antiviral drugs (baseline results) according to the age of participants. Of 64 participants, **46 (71.9%)had** less than 2000iu/ml, while **18 (28.1%)** had HBV viral load > 2000iu/ml.

Fig.4 **Hepatitis B viral load baseline levels according to gender**



Based on the gender of participants and considering the WHO HBV DNA threshold (>2000iu/ml), males and females had a similar frequency of **9 (14.1%).**

Table 3. **Prevalence of Hepatitis B viral load suppression levels based on age categories.**

		CURRENT VIRAL LOAD RESULTS(IU/ml)				
		Not detected	**20-500**	**500-2000**	**Above 2000**	**Total**
Age category	21-40 Years	10	5	4	9	28
	41-60 Years	12	9	4	3	28
	61-80 Years	3	1	3	1	8
Total		25	15	11	**13**	64

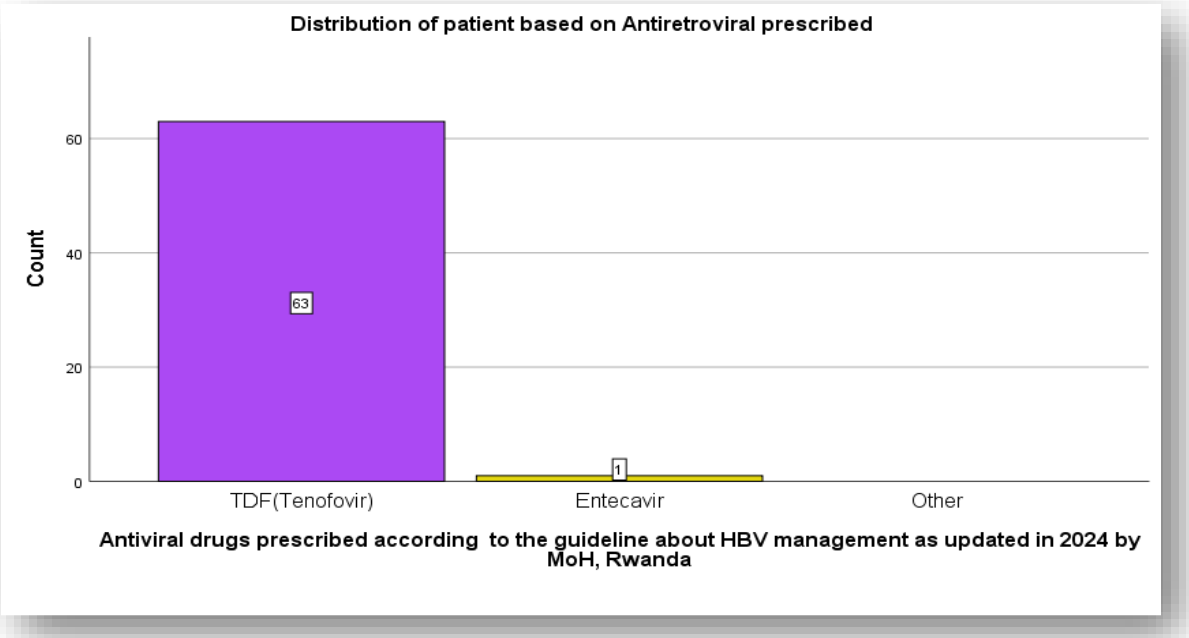
This table also demonstrated the prevalence of viral load suppression in **51 (79.7%)** of participants whose viral load was less than 2000iu/ml, whereas the prevalence of viral load non-suppression was **13 (20.3%)** of participants whose viral load was higher than 2000IU/ml. Two categories, 21-40 and 41-61, suppressed by **3(4.7%)** from 12 to 9, and 6 to 3, respectively, but the 61-80 years' category increased from 0 (baseline) to 1(1.6%) in the current viral load results.

Table 4.**Prevalence of Hepatitis B viral load suppression levels based on gender**

		CURRENT VIRAL LOAD RESULTS (IU/ml)				
		Not detected	**20-500**	**500-2000**	**Above 2000**	**Total**
Gender	Female	12	7	7	5	31
	Male	13	8	4	8	33
Total		25	15	11	**13**	64

Male participants suppressed the viral load from 9(14.1%) of baseline to 8(12.5%) indicated by current VL results taking into account higher than 2000IU/ml level, while females suppressed the viral load from 9 (14.1%) of baseline to 5 (7.8%) in the current results.

Fig. 5. **Hepatitis B viral load current results according to the drug prescribed**



The above figure illustrates the distribution of participants according to the Antiviral Drug prescribed after the diagnosis of the Hepatitis B virus. The majority, **63 (98.4%),** were given **Tenofavir** while only **1 (1.6%)** was given **Entecavir.**

4.1 Discussion

This section discusses the current study's findings and compares them with results published in other related research.

A total of 64 HBV-infected patients on Antiretroviral therapy were divided into three age categories: 21-40years, 41-60years, and 61-80 years. 28(43.8%) appeared in each one of the two separate age categories, namely 21 to 40 years and 41-60 years. This study matches with the researchers who conducted a study in Sudan in 2022, where they found the highest prevalence of hepatitis among people aged between 31-45 years of age, and the highest prevalence was found in male participants than females (Mohamed et al., 2022).

This study found that before initiation of ART, of 64 participants, **46 (71.9%)** had less than 2000iu/ml, while **18 (28.1%)** had HBV viral load > 2000iu/ml. However, after 1 year of therapy, the prevalence of viral load suppression was **51 (79.7%)** of participants whose viral load was less than 2000iu/ml, whereas the prevalence of non-suppression was **13 (20.3%)** for participants whose viral load was higher than 2000iu/ml. Viral loads reduced after taking antiviral therapy, as indicated by the findings of this study showing that the undetectable viral load levels (Not detected) increased from **1(1.6%)** to **12(18.8%),** and the prevalence of people with >2000IU/ml reduced from **28.1%** to **23.3%.** This agrees with the statement of saying that current Antivirals maintain a good HBV DNA suppression level if the patient adheres to prescribed drugs (Ignat et al., 2024).

It is clear that among two age categories, 21-40 and 41-61, decreased in the number of non-suppressions by **3(4.7%)** from 12 to 9, and 6 to 3, respectively, but the 61-80 years' category increased from 0 (baseline) to 1(1.6%) in the current viral load results. Thus, these statistics proved a significant relationship between aging and viral load suppression, as aged people increased in number for having higher than **2000IU/ml**. Similarly, a review published in 2022 declared that people above 60 years of age are at high risk of CHB hence when infected, they tend to develop HCC as their immunity ages and is weakened (Kang et al., 2022).

Non-suppression of HBV viral loads among male participants was **8 (12.5%),** indicated by current VL results of people with more than 2000 IU/ml, while among females, it was **5 (6.1%).** Therefore, the study indicated a significant relationship between viral load suppression and gender, which agrees with research conducted in Taiwan that discovered a significantly higher viral load in males than in females (Diawara et al., 2022).

The Distribution of participants according to the prescribed Antiviral drug for Hepatitis B virus showed that the majority of participants, **63 (98.4%),** were given **Tenofovir,** while only **1 (1.6%)** was given **Entecavir.** This implies that the one who received Entecavir had been diagnosed with renal insufficiency, and so, as the 2024 HBV management guideline recommends, apart from children aged between 2-11 years, adults with renal insufficiency are given **Entecavir.** As well, all Adults without renal disease are treated with **Tenofovir** (MoH, 2024).

5. CONCLUSION

As a conclusion, this study revealed that the prevalence of Hepatitis B viral load suppression was 79.7%, and that of non-suppression was 20.3% among hepatitis B-infected patients on Antiretroviral therapies at the University Teaching Hospital of Butare. Comparing viral load results before taking ART(baseline) with Current results after one year on ART demonstrated significant HBV DNA suppression. The finding, when analyzed based on gender, male participants had a greater prevalence of viral loads non-suppression, **8 (12.5%)** of people with more than 2000 IU/ml, than females, who had **5 (6.1%)**. According to the age categories, people aged 21 to 40 years and those from 40 to 61 years, reduced the number of non-suppression by **3(4.7%)** from 12 to 9, and 6 to 3, respectively, but the category of 61-80 years increased from 0 (baseline) to 1(1.6%) in the current viral load results. Therefore, this study found a significant relationship between either age or gender of patients and viral load suppression. The majority of participants, 63 (98.4%), were on **Tenofavir,** while only 1 (1.6%) was given **Entecavir.** As well, more studies are recommended for renal function tests, to decide if patients can switch from Tenofovir to Entecavir, as the appropriate Antiviral drug for HBV-infected adults with renal impairment, apart from children of 2 to 11 years.

6. RECOMMENDATION

I would like to recommend that policymakers, health facilities, and researchers continue making efforts to eliminate the Hepatitis B virus, and preventing the progression of diagnosed infections to severe stages. Assessment of renal function should be enforced while monitoring HBV therapy, to ensure the provision of appropriate treatments for individuals discovered with renal failure. More education to the public about the hepatitis B viral load suppression and the risks associated with non-suppression. Further studies are needed to prove the relationship between HBV DNA suppression/non-suppression based on both age and gender categories.

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8. APPENDICES

Date: 15th July 2025

Dear Sir/Madam,

TO WHOM IT MAY CONCERN

I the Undersigned, Prof, Antoine NSABIMANA hereby confirm that the research proposal entitled "**Assessment of Hepatitis B viral load suppression levels among HBV-infected patients on Antiretroviral drugs at CHUB (University Teaching Hospital of Butare)"** for Mr. **Celestin NZEYIMANA** with (Reg.No: **215041897**), has been approved by the Department of biology.

The study involves data collection from participants and/or departments within CHUB, Additionally, we request your support in **facilitating the data collection process** once ethical clearance is granted and therefore, He will submit his protocol to your committee for ethical review and approval at the institutional level.

Sincerely,

Prof. Antoine NSABIMANA
Program coordinator of MSc in Biotechnology
(CMHS, CAFF, CVAS and CST)
Hosted By CST
University of Rwanda

Cc: **Prof Leon Mutesa**.
PI of the Project

CHUB
University Teaching Hospital of Butare

CLINICAL EDUCATION AND RESEARCH DIVISION
DIRECTORATE: RESEARCH -ETHICS COMMITTEE

RESEARCH

Huye,23rd, July,2025

Approval Notice: No: REC/CHUB/088/2025

Mr. Celestin NZEYIMANA
Email: celenzeyi@gmail.com

Reference is made to your letter requesting ethical clearance for **"Assessment of Hepatitis B viral load suppression levels among HBV-infected patients on Antiretroviral drugs at CHUB: A retrospective study"** Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance and should be conducted within the University Teaching Hospital of Butare. Please note that approval of the protocol and consent form is valid for one year starting on the issue date and shall be renewed on request. You are responsible for fulfilling the following requirements:

- Changes, amendments and addenda to the protocol or consent form must be submitted to the committee for review and approval before activation of the changes
- Only approved consent forms are to be used in the enrollment of participants
- All consent forms signed by subjects should be retained on file.
- The committee may conduct audits of all study records. Consent documentation may be part of such audits
- A continuing review application must be submitted to the committee in a timely fashion and before the expiry of this approval
- Failure to submit a continuing review application results in termination of the study
- Notify the committee once the study is finished
- Identification of participants must be kept confidential for the duration of the study

Sincerely

RESEARCH ETHICS COMMITTEE (CHUB/REC)
UNIVERSITY TEACHING HOSPITAL
OF BUTARE

Dr. HABIMANA Emmanuel
Chairperson of Ethics Committee/CHUB

Cc: - Director General
- Head of Clinical Education and Research Division
- Head of Clinical Service Division
- Director of DTS
- Head of Pathology Department

Raw data for the study

Code of clients	AGE in Years	Gender	BASE LINE VL RESULTS (IU/ml)	CURRENT VL RESULTS (IU/ml)	Period of data collection	Name of Antiviral drug
01	36	Male	2038	4390	From 17/4/2025 to 21/7/2025	Tenofovir
02	38	Male	159	9150000	From 17/4/2025 to 21/7/2025	Tenofovir
03	29	Male	2114	49	From 17/4/2025 to 21/7/2025	Tenofovir
04	32	Male	1050	3190	From 17/4/2025 to 21/7/2025	Tenofovir
05	51	Male	3009	295	From 17/4/2025 to 21/7/2025	Tenofovir
06	33	Female	2028	1960	From 17/4/2025 to 21/7/2025	Tenofovir
07	69	Female	745	3370	From 17/4/2025 to 21/7/2025	Tenofovir
08	42	Male	102	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
09	31	Male	1009	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
10	58	Female	563	28	From 17/4/2025 to 21/7/2025	Tenofovir
11	47	Male	232	14700	From 17/4/2025 to 21/7/2025	Tenofovir
12	50	Female	107	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
13	50	Male	463	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
14	58	Male	13100	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
15	73	Female	38.8	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
16	21	Male	417	3290	From 17/4/2025 to 21/7/2025	Tenofovir
17	23	Female	5321	83200	From 17/4/2025 to 21/7/2025	Tenofovir
18	38	Female	2401	78	From 17/4/2025 to 21/7/2025	Tenofovir
19	64	Female	150	795	From 17/4/2025 to 21/7/2025	Tenofovir
20	50	Male	9001	188	From 17/4/2025 to 21/7/2025	Tenofovir
21	36	Female	1780	345	From 17/4/2025 to 21/7/2025	Tenofovir
22	35	Female	1020	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
23	35	Female	39200	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
24	34	Female	77	790	From 17/4/2025 to 21/7/2025	Tenofovir
25	40	Female	1002	94	From 17/4/2025 to 21/7/2025	Tenofovir
26	42	Male	101	2960	From 17/4/2025 to 21/7/2025	Tenofovir
27	48	Female	52	551	From 17/4/2025 to 21/7/2025	Tenofovir
28	26	Male	1681	498	From 17/4/2025 to 21/7/2025	Tenofovir
29	37	Female	87	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
30	59	Male	1321	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
31	36	Female	6890	8100	From 17/4/2025 to 21/7/2025	Tenofovir
32	46	Female	1019	316	From 17/4/2025 to 21/7/2025	Tenofovir
33	44	Male	417	1290	From 17/4/2025 to 21/7/2025	Tenofovir
34	35	Male	1088	3130	From 17/4/2025 to 21/7/2025	Tenofovir
35	31	Female	257	1120	From 17/4/2025 to 21/7/2025	Tenofovir
36	55	Female	4029	1130	From 17/4/2025 to 21/7/2025	Tenofovir
37	39	Female	2310	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
38	26	Male	1060	986	From 17/4/2025 to 21/7/2025	Tenofovir
39	40	Female	2701	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
40	74	Male	1523	755	From 17/4/2025 to 21/7/2025	Tenofovir
41	50	Male	1483	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
42	59	Male	93.8	91	From 17/4/2025 to 21/7/2025	Tenofovir
43	56	Male	897	37	From 17/4/2025 to 21/7/2025	Tenofovir
44	31	Female	1022	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
45	56	Male	89	121	From 17/4/2025 to 21/7/2025	Tenofovir
46	46	Female	130	2670	From 17/4/2025 to 21/7/2025	Tenofovir
47	33	Female	256000	46800000	From 17/4/2025 to 21/7/2025	Tenofovir
48	21	Male	1009	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
49	56	Female	628	340	From 17/4/2025 to 21/7/2025	Tenofovir
50	69	Female	126	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
51	74	Male	798	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
52	40	Male	2901	3830	From 17/4/2025 to 21/7/2025	Tenofovir
53	40	Female	329	319	From 17/4/2025 to 21/7/2025	Tenofovir
54	56	Male	121000	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
55	35	Male	10800	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
56	52	Female	406	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
57	45	Male	230	627	From 17/4/2025 to 21/7/2025	Tenofovir
58	41	Male	26100000	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
59	73	Female	Not detected	1080	From 17/4/2025 to 21/7/2025	Tenofovir
60	48	Male	600	Not detected	From 17/4/2025 to 21/7/2025	Entecavir
61	46	Female	1110	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
62	69	Male	1008	40	From 17/4/2025 to 21/7/2025	Tenofovir
63	44	Male	905	Not detected	From 17/4/2025 to 21/7/2025	Tenofovir
64	45	Female	707	24	From 17/4/2025 to 21/7/2025	Tenofovir

CELESTIN NZEYIMANA

Updated CV

CONTACTS

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Email: celenzeyi@gmail.com

Address: Kigali, Rwanda

KEY SKILLS

- Laboratory diagnosis of infectious diseases
- Biosafety and biosecurity risk management
- Covid-19 management

TECHNICAL SKILLS

- Microsoft office suite (Word, Excel and Power point)
- Internet browsers
- Google tools
- Video conferencing tools

REFERENCES

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PROFILE SUMMARY

Dedicated and passionate medical laboratory scientist with several years of experiences in clinical laboratory diagnosis of various diseases. Strongly motivated and Committed in health researches. Interested in working with senior researchers in areas of priority diseases and contributing to the promotion of people's health and wellbeing.

EDUCATION

BACHELOR OF BIOMEDICAL LABORATORY SCIENCES

University of Rwanda

2012-2016

Master of science in biotechnology

University of Rwanda

2023-to date (**ongoing**)

EXPERIENCE

Hospital laboratory technologist

- Kabgayi hospital, (Muhanga, Rwanda)
- 2017-2022

Laboratory technician in medical school

- University of Rwanda, College of medicine and health sciences, School of medicine and pharmacy
- 2022- up to date

Early career researcher: member of FIRAT, FOMSTIG (Future of medicine science, technology and innovation group).

- University of Rwanda
- 2022-up to now

LANGUAGE

Kinyarwanda:

English