

# Exploring the knowledge and perceptions of viral load testing and low-level viremia among health-care workers in Uganda: A qualitative study

Nicholus Nanyeenya<sup>1,2,\*</sup>, Gertrude Nakigozi<sup>3</sup>, Godfrey Siu<sup>4</sup>, Noah Kiwanuka<sup>1</sup>, Fredrick Makumbi<sup>1</sup>, Esther Nasuuna<sup>5</sup>, Susan Nabadda<sup>2</sup>, Charles Kiyaga<sup>2</sup>, Simon P. S. Kibira<sup>6</sup>, and Damalie Nakanjako<sup>7</sup>

Provision of human immunodeficiency virus (HIV) care including viral load (VL) testing and management of low-level viremia (LLV) depends on the knowledge and perceptions of health-care workers. This qualitative study was conducted in Uganda and aimed to provide health-care worker perceptions and knowledge gaps that need to be addressed to improve VL testing and management of LLV. We conducted 15 key informant interviews with health-care workers (clinicians, nurses, laboratory staff, and counselors). Participants were purposively selected from 8 high-volume HIV clinics across Uganda. The clinics were purposively selected based on provision of VL services and having high numbers of people with LLV. All the interviews were audio-recorded and transcribed verbatim. Thematic analysis was used for data analysis, with the help of ATLAS.ti 6. We identified 7 main themes, and these included: understanding of VL testing, perceived benefits of VL testing, best practices in improving VL testing, challenges to VL testing, strengthening VL testing, understanding LLV, and implications of LLV. All the health-care workers were proficient in VL testing and its associated benefits. Different best practices like the use of linkage facilitators among others were reported to be useful in VL testing. The main challenges to VL testing were lack of transport, long waiting times at the clinics, delayed return of results, and HIV-related stigma. Health-care workers could not define the term, "low-level viremia." However, most of them were aware that a VL range between 50 and 999 copies/ml was not desirable. LLV was perceived to be caused by suboptimal drug adherence. There is need for centralized VL testing to be complemented with point-of-care testing to reduce results turnaround time. Similarly, there is also an imminent need to establish comprehensive interventions to manage LLV such as targeted health education of health workers in Uganda.

**Keywords:** HIV/AIDS, Viral load testing, Low-level viremia, Viral suppression

<sup>1</sup>Department of Epidemiology and Biostatistics, School of Public Health, Makerere University College of Health Sciences, Kampala, Uganda

<sup>2</sup>Central Public Health Laboratories, Ministry of Health, Kampala, Uganda

<sup>3</sup>Rakai Health Sciences Project, Rakai, Uganda

<sup>4</sup>Child Health and Development Centre, School of Medicine, Makerere University College of Health Sciences, Kampala, Uganda

<sup>5</sup>Infectious Diseases Institute, Makerere University College of Health Sciences, Kampala, Uganda

<sup>6</sup>Department of Community Health and Behavioral Sciences, School of Public Health, Makerere University College of Health Sciences, Kampala, Uganda

<sup>7</sup>Department of Medicine, School of Medicine, Makerere University College of Health Sciences, Kampala, Uganda

\* Corresponding author:  
Email: [nanyeenya@gmail.com](mailto:nanyeenya@gmail.com)

## Introduction

Since the 2013 World Health Organization (WHO) recommendation of using viral load (VL) testing as the preferred method of monitoring people living with human immunodeficiency virus (PLHIV) on antiretroviral therapy (ART) [1], Uganda has made several strides in the scale-up of VL testing from about 16,411 VL samples (2% of PLHIV on ART) in 2014 to 1,442,373 VL samples (95% of PLHIV on ART) in 2022 [2]. Despite this progress, full scale-up and coverage of VL testing has been hindered by several challenges including unawareness about VL testing among HIV health-care workers [3, 4]. Furthermore, the previous use of a threshold of 1,000 copies/ml to determine VL non-suppression prior to this study resulted into accumulation of many PLHIV with a VL of at least 50 copies/ml but less than 1,000 copies/ml, which is referred to as low-level viremia (LLV).

An estimated 1.4 million people were living with HIV in Uganda, of which 1.2 million were accessing ART by 2022 [5]. As per the WHO recommendation, VL testing is used to monitor the efficacy of ART among PLHIV [6] and also recommended in Uganda [7]. HIV VL is the number of HIV viral RNA copies per milliliter of blood, and the test is used to determine the efficacy of ART. A VL of 1,000 copies/ml or higher is crucial in early detection of either poor drug adherence or virologic treatment failure [8]. A decreased VL is associated with better clinical outcomes and slowed disease progression [9] and is also associated with reduced HIV incidence at community level [9, 10]. VL non-suppression can be due to various risk factors including sociodemographic and psychological factors, comorbidities, poor absorption of ARVs, poor adherence to ART, and drug toxicity among others [11–14]. PLHIV on ART with non-suppressed VL have an increased risk of fastened progression to acquired immune deficiency syndrome (AIDS) and have poor clinical outcomes [14, 15].

The use of 1,000 copies/ml as a threshold for viral non-suppression has previously resulted into increased PLHIV with LLV [16]. Previous studies have associated LLV with HIV drug resistance and increased risks of HIV transmission and virologic failure [17–25]. This is why the U.S. Centers for Disease Control and Prevention (CDC) and the International Association of Providers of AIDS Care (IAPAC) recommend using a threshold of 200 copies/ml for VL non-suppression [26, 27], against the WHO recommendation of a threshold of 1,000 copies/ml for viral non-suppression. Furthermore, LLV has been shown to be an emerging concern in Sub-Sahara Africa [28].

Health-care workers are the springboard of all HIV care at health facilities, including VL testing and management of LLV among PLHIV. However, their ability and willingness to provide these services is heavily influenced by their knowledge and perceptions [29]. Lack of knowledge on how to diagnose and manage common disease conditions, HIV inclusive is often associated with ineffective, suboptimal, and dangerous health-care practices, which can lead to delayed interventions and poor treatment outcomes [30]. Despite this, to date, there is no study that has explored knowledge and perceptions of VL testing and LLV, among health-care workers in Uganda. Therefore, in the efforts to scale up VL testing and institute interventions to manage LLV, this study aims to explore the knowledge and perceptions of VL testing and LLV among health-care workers in Uganda. This will contribute toward Uganda's efforts to achieve the global targets of ending the HIV epidemic by 2030.

## Methods

### *Study design and setting*

An exploratory qualitative study was conducted with a purposively selected sample of 15 health-care workers who work in 8 high-volume HIV clinics, with more than 1,000 active PLHIV, from the Central, Eastern, Northern, and Western geographical regions of Uganda. From each geographical region, 1 rural and 1 urban health facility providing VL services (to include participants with both rural and urban exposures) and having high numbers of PLHIV with LLV (compared to the other health facilities) was

selected. The consolidated criteria for reporting qualitative research (COREQ) have been used to report these study findings [31].

### *The VL program description*

The national VL program was started in 2014, and this is housed and coordinated at the Department of National Health Laboratory and Diagnostic Services (NHLDS/CPHL) in Kampala. The VL samples are transported from across the country to NHLDS/CPHL where they are tested by the national VL reference testing laboratory. The VL samples are transported through the hub sample transport system [32]. The VL data are managed through a comprehensive Laboratory Information Management System, hosted by a data center at NHLDS/CPHL, and the VL results are returned electronically through the electronic results download module [2]. The first VL test is done for PLHIV who have been on ART for 6 months, and then another VL test is done at 12 months. PLHIV with a VL result above 200 copies/ml and 400 copies/ml for plasma and dried blood spot samples, respectively, are now offered intensive adherence counseling (IAC) for 3 months, and a repeat VL test is repeated after 3 months. If PLHIV with a VL of 1,000 copies/ml or more does not attain viral suppression after IAC, a switch committee is convened, and the patient is switched to another ART line [7].

At the health facilities, the files of PLHIV due for VL testing are flagged with a sticker and sorted out on the day when they are due for testing. When the PLHIV come for the drug refill, they are reviewed by the Clinician, informed that they are due for VL testing and then sent to the laboratory for VL sample collection. A sample is then collected and transported to NHLDS/CPHL for testing, and the results turnaround time is about 2 weeks. The client is given their drugs, and they will receive their VL results at the next visit.

### *Participant selection*

Health-care workers providing HIV care at the HIV clinic were selected by stratified purposive sampling based on age, sex, region, and cadre to create study variability [33]. These involved clinicians, nurses, laboratory staff, and counselors with different levels of experience. Each was invited to participate in the study by the research assistant and taken through an informed consent process. Two participants chose not to participate in the study because they had other conflicting priorities.

### *Data collection*

Key informant interviews (KIIs) were conducted with health-care workers in a safe place of their choice to collect information about their knowledge and perceptions of VL testing and LLV. A semi-structured interview guide was used, after piloting it with 2 PLHIV at 2 HIV clinics and reviewed for appropriateness by the study team. Several questions in the interview guide were restructured to make them more understandable, following the piloting of the guide. The guide included questions exploring the knowledge and perceptions of health-care workers regarding VL testing and LLV, the importance of these concepts in the management of HIV, and any challenges or barriers

they may have encountered in VL testing and management of LLV. Interviews were conducted in English, by an experienced team of qualitative researchers, and each interview lasted approximately 30–45 min. Each interview was conducted in a quiet private room by 2 members of the study team, 1 interviewing and the other taking notes. The research team had daily reviews of the interviews conducted, and the data collection process was stopped when we reached saturation. Originally, we had planned to conduct a minimum of 16 KIIs but reached saturation at 15 KIIs and hence ended the data collection process [34].

### Data management and analysis

Audio files were transcribed verbatim and checked for accuracy. Transcripts were imported in ATLAS.ti 6 for coding and we used thematic analysis to analyze the data [35]. Three analysts read through the transcripts to generate the initial codes. A meeting was then convened to review these codes and agree on the codebook that was applied to the rest of the data. We then identified the patterns and themes related to the perceptions and knowledge of VL testing and LLV among the participants, using a mixture of both inductive and deductive approaches.

### Ethical approval

The study acquired ethical approval from Makerere University School of Public Health Research and Ethics Committee (approval number is SPH-2021-144) and clearance from the Uganda National Council for Science and Technology (approval number is HS2008ES). We obtained informed consent from all the study participants prior to being interviewed.

## Results

### Characteristics of the study participants

The characteristics of the study participants are shown in **Table 1**. **Figure 1** shows the major themes identified.

### VL testing

#### Understanding of VL testing

All the participants had a good understanding of VL testing, which matched its biomedical definition. Despite being of different cadres, all the participants described a VL test as the number of HIV viral copies in the blood of a PLHIV, and they indicated that a VL test is done to show the efficacy of ART.

*We term viral load as the quantity of the HIV virus in a millimeter of blood of an individual living with HIV.*  
(39 years old female counsellor from Central region)

They confidently used different biomedical terms to describe the different VL results, whereby a suppressed VL referred to results below 1,000 copies/ml and a result of 1,000 copies/ml or more was a non-suppressed VL. They associated a suppressed VL to both good treatment adherence and efficacy of ART while a non-suppressed VL was associated with either poor adherence or drug resistance.

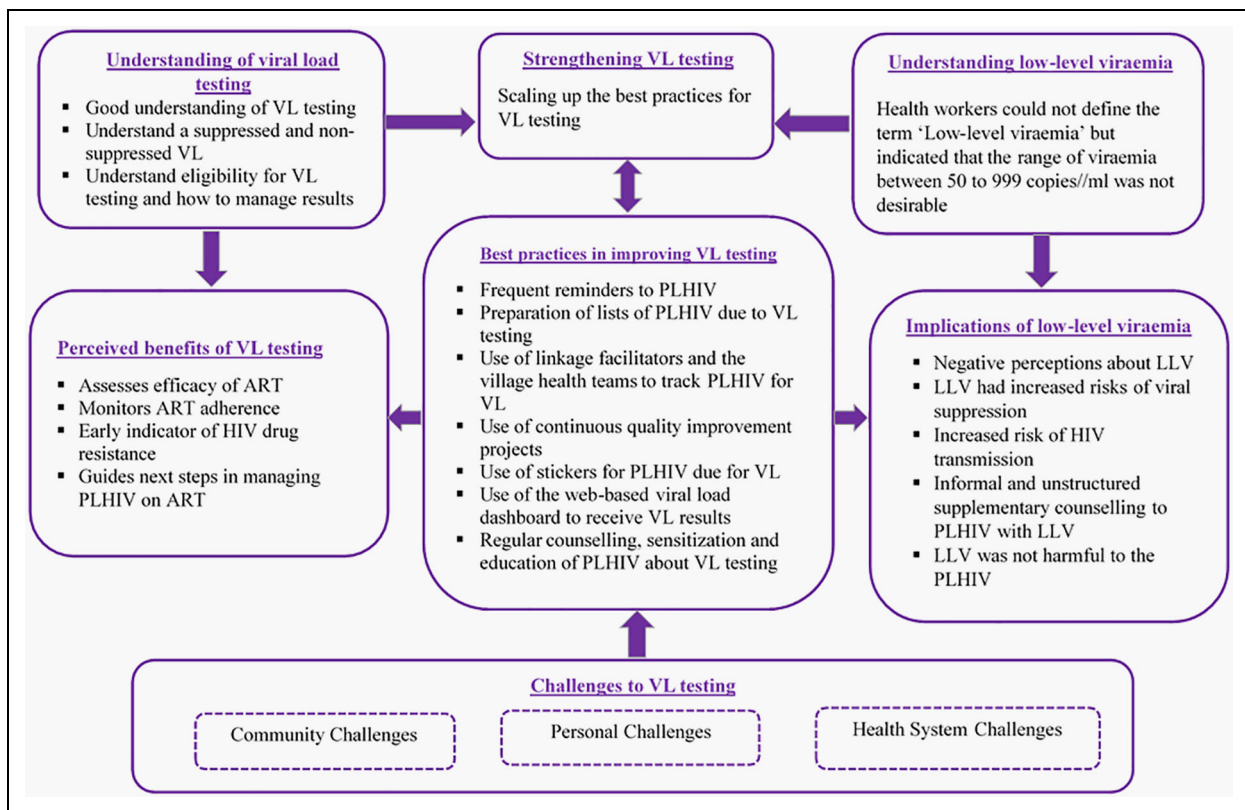
**Table 1. Characteristics of the study participants**

Characteristics	n = 15
Median age (IQR), years	37 (30–43)
Gender	
Female, n (%)	7 (46.7)
Male, n (%)	8 (53.3)
Median duration in the current position (IQR), years	7 (3–9)
Cadre of health worker	
Clinicians, n (%)	3 (20.0)
Nurses, n (%)	1 (6.7)
Counselors, n (%)	6 (40.0)
Laboratory staff, n (%)	5 (33.3)
Education level	
Secondary, n (%)	2 (13.3)
Certificate, n (%)	4 (26.7)
Diploma, n (%)	3 (20.0)
Degree, n (%)	6 (40.0)

*When we do your viral load and the results come back below 1,000 copies/ml or sometimes it may come back when it is not detected, it means that drug is doing well on that person and that person is taking his/her medication well. It also means that the person is following the time for taking the medication, and that the person has understood everything about the medication. But also, when the results come back when the viral load is above 1,000 copies/ml, it shows that, the person is non-suppressed, and is not taking their drugs very well and with that, we shall start giving you IAC.*  
(41 years old female counsellor, Eastern Uganda)

The health-care workers were knowledgeable about the eligibility of PLHIV for VL testing, and they described with ease the different time intervals when a VL test is done. For example, they noted that a PLHIV who has been on ART for 6 months or more is the only 1 who is eligible for VL testing. They also highlighted that a VL test is repeated at 12 months, and then once every year for suppressed PLHIV. They however emphasized that a repeat VL is offered to non-suppressed PLHIV after 3 IAC sessions.

*In simple terms, viral load is the number of the HIV virus within the blood of an HIV positive person. We normally do it for the newly diagnosed patients after 6 months on treatment, and when suppressed, we repeat it once a year. We do it every 6 months for children, pregnant mothers and breastfeeding mothers. When the viral load is above 1,000 copies/ml, we give intensive adherence counselling to the*



**Figure 1. Major themes identified.**

*patient, and repeat the viral load after 3 months. (25 years old male laboratory staff, Northern region)*

**Perceived benefits of VL testing**

The health-care workers described VL testing as an important monitoring tool, which enables them to assess the efficacy of ART and how well the patient adheres to the prescribed drugs, which triggers them to take the next course of management action if the patient is not achieving the desired treatment outcomes of viral suppression.

*Viral load testing is good because it gives us a picture on how the patient is taking the medicine and it guides us on how we should maintain the patient on that regimen or switch him/her to another regimen. It also helps us to identify those who have treatment failure and those who are doing well and I think that viral load is very important. (31 years old male clinician from Western region)*

VL testing was perceived as an important indicator of HIV drug resistance, and this is a key guide of switching PLHIV from one ART line to another.

*When the viral load is high, it means that there is a problem, either the person is not taking the drugs well, or the drug is not working well. But if the drug is not working well, after we have given IAC and then bleed the patient and the viral load comes back again non-suppressed, then we know that there is*

*a problem, and that the virus is resistant to the drug and not because the patient kept missing swallowing the drugs. This makes us to think of how to help the patient, and normally, we switch the patient to the second line. (39 years old female nurse from Eastern region)*

The participants further described VL testing as a vital tool for monitoring and evaluation of the quality of HIV care that they offer to PLHIV in their respective health facilities. They linked this to UNAIDS “95 95 95” goals where VL is one of the targets and indicated that they track the percentage of suppressed and non-suppressed PLHIV routinely. They indicated that they were motivated by having high numbers of suppressed PLHIV.

*To the health worker, viral load helps us to know whether we are doing our work very well because we are supposed to ensure that viral load suppression is achieved, as one of the targets of UNAIDS “95, 95, 95” targets. So when we see that a big percentage of people living with HIV in our facility are suppressed, we also feel motivated because it makes us feel that we are also doing a great job towards the control of the HIV epidemic. (43 years old male clinician from Central region)*

**Best practices in improving VL testing**

The participants described several best practices, which they were undertaking to improve VL services in their respective facilities. The most common best practice

described was sending frequent reminders to PLHIV due for VL testing. The participants indicated that a list of PLHIV due for VL testing is prepared in advance, and these PLHIV are either sent text message reminders or called by phone. For those who fail to turn up for their VL appointments, the health-care workers call them, encouraging them to come for their appointments.

*What we normally do, is that for us, we prepare our list, we know who is supposed to do VL next month and so on. So, what we do, we call them and give them information in advance, "You are supposed to do viral load." So, they are given information in advance for them to come for viral load. (49 years old male counsellor from Eastern region)*

The use of linkage facilitators and the village health teams to track PLHIV in the communities, who are due for VL testing but have missed their appointments was described as a key strategy to improve VL testing and other HIV care services.

*But when it comes to follow-ups, we most times use the village health teams, the linkage facilitators and the expert clients to track those who have missed their appointment for viral load. (37 years old female laboratory staff from Western region)*

Another key strategy highlighted in improving VL testing was the use of continuous quality improvement (CQI) projects. Participants described that several CQI projects are undertaken to improve different thematic areas of the VL testing cascade.

*We have quality improvement projects that we have tried to do in the lab to reduce the results turnaround time from one month to two weeks and we are able to receive results and give them to the PLHIV in time. (43 years old female laboratory staff from Northern region)*

The participants reported that stickers are put on the files of PLHIV who are due for VL testing, and this enables such PLHIV to be easily identified for VL testing. Furthermore, they indicated that they sort out files of PLHIV due for VL testing earlier before the actual day when the VL is supposed to be done.

*For this clinic, for example at triage, we have stickers which show that a patient is due for viral load, so if the peer mentor or triage nurse is checking to see if the patient is due for viral load, they put the sticker to remind the clinician. (31 years old male clinician from Western region)*

The use of the web-based VL dashboard to receive VL results and download them remotely in health facilities was reported as a key strategy that had improved VL testing. The dashboard is fundamental in reducing VL results turnaround time and ensuring that the PLHIV get their

results in time, after being tested and uploaded at the national VL testing reference laboratory at NHLDS/CPHL.

*It's good now we have the dashboard where we can check and get results. We can print out the results quickly, and if the patient is non-suppressed, we call him/her back and counsel him/her through IAC. (45 years old female counsellor from Central region)*

Regular counseling, sensitization, and education of PLHIV about VL testing were also described as an important strategy that has improved VL testing. The participants indicated that through regular counseling and education, PLHIV understand and appreciate the use of VL testing, and this motivates them to come back for the testing on the given appointment dates. Creating good health worker–patient relationship through understanding the PLHIV, showing empathy and creating bonds with them was also reported as being useful in improving HIV care, VL testing inclusive.

*We have created awareness and demand through continuous health education of our clients. We want them to own it and take charge of their own health. In fact they come in knowing on which day they are to provide a viral load sample. We also continuously counsel them when they come to the facilities, though some of them are always in a rush to go and do other things. (43 years old male clinician from Central region)*

### Challenges to VL testing

The participants described the different challenges affecting VL testing in 3 main categories, including personal, health system, and community challenges, as shown in **Figure 2**.

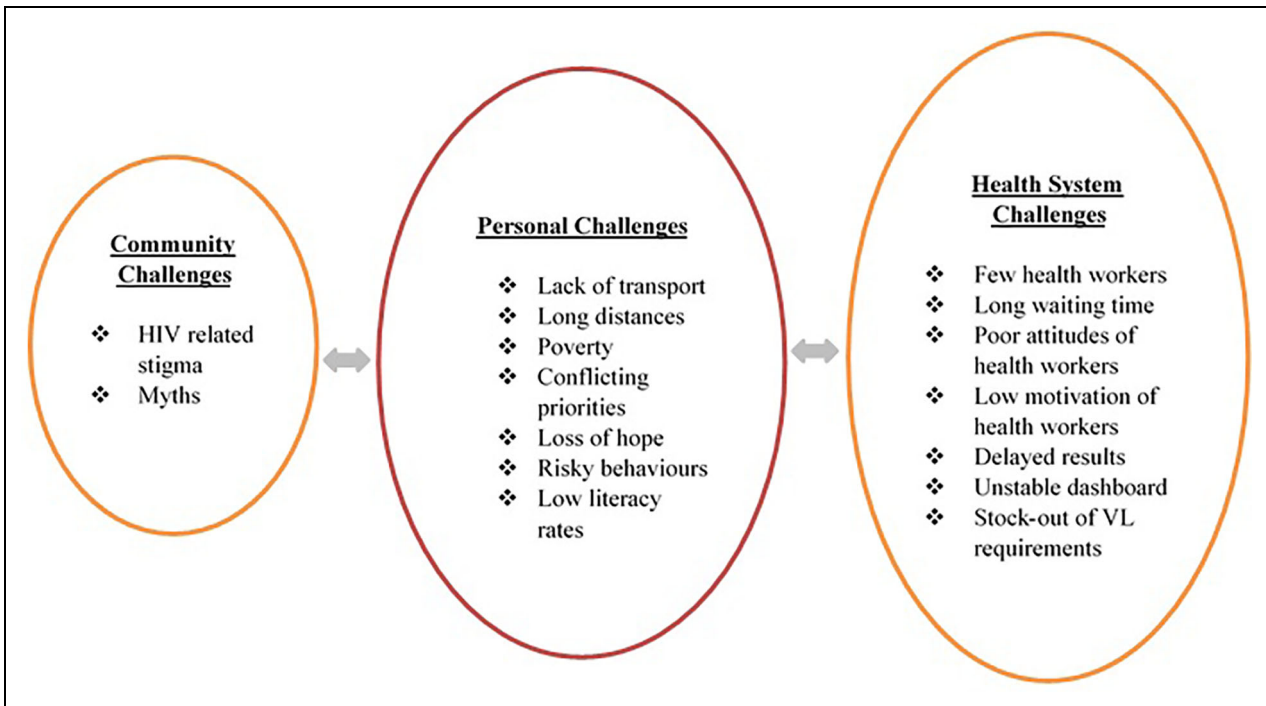
#### Personal challenges

The main personal challenge highlighted was lack of transport to move to the facilities for VL testing and other HIV services. This was worsened by long distances between homes and the health facilities, and the high rates of poverty.

*When we follow the patients up, they can tell you "Ohh . . . nurse, I didn't have transport." (39 years old female nurse from Eastern region)*

The health-care workers reported that some PLHIV have conflicting priorities like work that affect their ability to go for VL testing. Nondisclosure of the HIV status by most PLHIV was also discussed as a key personal challenge, which interferes with the ability to seek HIV services including VL testing.

*Most of the patients are very busy and when you tell them that it is time to test their viral load, they tell you that they have little time. Because they are busy, some of them even send relatives to pick drugs for them, and you cannot test the relatives! (32 years old male counsellor from Western region)*



**Figure 2. Challenges to viral load testing in Uganda.**

Furthermore, loss of hope among PLHIV and risky behaviors such as taking excessive alcohol and having multiple sexual partners were reported to be negatively affecting VL testing. PLHIV with suppressed VL were said to be indulging in such risky behaviors because they have a suppressed VL, which they interpret as safe. Hence, this leads them to engage in various risky behaviors, which increases their risks of non-suppression.

*So at times when you tell them that their viral load is suppressed, at times some of them become so reckless and start engaging into those sexual things. The next time you take a person’s sample for viral load testing, the results return when the person is non-suppressed and others, after they are suppressed, they start missing the appointments again because they are looking very healthy and looking better. (26 years old male clinician from Northern Uganda)*

The participants reported that some PLHIV have very low literacy rates and cannot follow proper medical advice. Poor attitudes of some PLHIV in following medical advice was also described as a key challenge to VL testing, as it affects the uptake of the service.

*But for some patients, we call them and try to talk to them informing them to come and get tested but instead, the person begins quarrelling and it becomes a problem. You are trying to help someone but the person begins quarreling and makes it a big deal. (41 years old male counsellor from Eastern Uganda)*

*Health system challenges*

Among the health system challenges, the participants indicated that there were few health-care workers as compared to the number of PLHIV, and these were overwhelmed with loads of work, resulting into long waiting times for PLHIV at the health facilities. This challenge was also coupled with poor attitudes and low motivation of the health-care workers.

*My major concern here first of all is human resource. There is understaffing for example I am one clinician and two nurses seeing all those patients, so I feel we are really overwhelmed and that at one time, it can hinder our quality of service delivery. (31 years old male clinician from Western Uganda)*

There was a protracted VL results turnaround time, creating delays in patient management. Some VL results would completely not return, hence the need to bleed the PLHIV again. The VL web-based dashboard was also reported to be offline and inaccessible at times, hence patient results could not be downloaded quickly.

*Then about viral load, the biggest challenge is turnaround time. Some results take long to come back and you find that you have to repeat bleeding the patient which is frustrating to the patients. (43 years old female laboratory staff from Northern Uganda)*

Occasional stock out of the different sample collection materials like syringes, gloves, and vacutainers among others was also reported to interrupt VL services. At times, there was also stock out of stationery, hence VL results

could not be printed. Furthermore, many of the lower health facilities could not access the web-based dashboard to print their VL results and could only rely on other health facilities to receive their results.

*Then also sometimes you find that the viral load request forms are out of stock and the regulations do not allow to use plain paper and that one can cause the patients to miss to be bled for viral load on that day. (45 years old female counsellor from Central Uganda)*

#### Community-related challenges

HIV-related stigma was noted as the key community-related challenge affecting VL testing services. Due to stigma and discrimination associated with living with HIV in communities, many PLHIV feared to seek HIV care from facilities, including VL testing.

*First of all, some people have stigma, they fear being seen walking into the facility to access these services. "How will other people see me when am at the HIV clinic? People will know that I am HIV positive." So a person stays in that kind of state without accessing viral load testing services. (39 years old female counsellor from Central Uganda)*

HIV stigma was also associated with many myths about HIV, and these created unnecessary fear about going for VL testing.

*Yes, in most cases they are not willing to test actually because they say the test is painful. Others feel that we are going to finish their blood. They were told that their blood is taken to machines and sold for research. They start giving excuses that you tested me during the last visit and when you check the records, you find the patient has tested like a year ago and she is due for another test and then you go with the book records and carry out the test. (32 years old male counsellor from Western region)*

#### Strengthening VL testing

Participants emphasized that there was need to scale up the different best practices to strength and improve VL testing services like continuous sensitization and counseling, use of linkage facilitators, use of stickers, and CQI projects among others. Important to note was the need to reduce VL results turnaround time, which could be achieved through scaling up the use of the web-based VL dashboard and integrating the centralized VL testing with VL point-of-care testing.

*Preferably if we had these viral load machines on site whereby we could re-run samples in real time in case of result discrepancies but currently it's out of our hands in that we have to bleed again the client in such a scenario which is very frustrating for the*

*patient. Having the machine on site would also reduce the time taken to receive the results. (39 years old female nurse from Eastern region)*

#### Low-level viremia

##### Understanding LLV

Nearly all the participants could not define the term "low-level viremia" and this was new to them.

*Low . . . what? Am trying to relate. Ummh, I may get embarrassed. (30 years old female laboratory staff from Central region)*

Those who struggled to define LLV interpreted it as having a suppressed VL, which is the aim of antiretroviral treatment.

*For me the way I understand it, is like when an HIV positive patient is having viral load less than 1,000 copies, sometimes we normally say that this person is suppressed, and that is how I can say it. You are having a viral load which is equivalent to or below 1,000 copies of the virus which we normally say it is suppressed. (26 years old male clinician from Northern region)*

When we described LLV as a range of viremia between 50 and 999 copies/ml among PLHIV on ART, many participants reported that this range of viremia was caused by sub-optimal drug adherence among PLHIV.

*From your explanation, I am not comfortable with my patient having low-level viraemia. If they are properly adhering to the drugs, then their viral load test results would come back undetectable or at least less than 50 viral copies per milliliter of blood. (41 years old male counsellor from Eastern region)*

However, a few participants highlighted that this range could also be caused by drug resistance.

*The issue of drug adherence is a major factor that leads to low level viraemia. Other factors such as alcohol use and smoking could have an effect on the drug interactions. Drug resistance and abuse could lead to low level viraemia. (25 years old male laboratory staff, Northern region)*

LLV was also reported to be more common in children and adolescents, as compared to the adult PLHIV.

*For the time I have been in the art clinic, the experience I have got actually is a bit sad when it comes to low-level viraemia, it is more common among children and adolescents. They are the majority that have some copies in the blood, and at times, this is because they really don't take their drugs on time. (39 years old female nurse from Eastern region)*

The participants highlighted that LLV was also associated with risky behaviors like excessive consumption of alcohol, drug abuse, and having multiple partners among others. They explained that behaviors like alcohol consumption interfere with the ability to take drugs very well, hence leading to detectable viremia in blood.

*Normally such patients have bad behaviours like drinking a lot of alcohol and drug abuse. Some of them have unprotected sex with multiple sexual partners all the time. And all these really cause the virus to remain in blood. (31 years old male clinician from Western region)*

#### Implications of LLV

Many participants had negative perceptions about LLV, and the main concern was that PLHIV with LLV had increased risks of becoming virally non-suppressed. Having detectable viremia in blood was also described to increase the risk of HIV transmission.

*Yes, low-level viraemia is an issue because first of all our goal is to have zero copies from our viral load tests. If there are copies, that means there is a problem and it is somewhere with adherence. The presence of copies increases risk of HIV transmission and worse more if not managed early enough, the patient could backslide into non-suppression which we don't want. (43 years old male clinician from Central region)*

The participants explained that they were occasionally doing supplementary counseling to PLHIV with LLV to improve their drug adherence and manage the LLV. However, they reported that this counseling was informal and unstructured, being offered to PLHIV at will.

*In fact in most cases, when the results come when the viral copies are above 50, we talk to such a patient. We counsel them to change whatever they are not doing right to make changes. In most cases the person taking the pills knows where the issue is. (36 years old male counsellor from Northern Uganda)*

However, a few participants indicated that LLV was a suppressed state of viremia and hence did not worry about it at all. These participants said that LLV was not harmful to the PLHIV.

*No, because I think low level viraemia means a viral load of below 1,000 copies. We are aiming at having our clients having copies of below 1,000 and this means they are suppressing. (37 years old female laboratory staff from Western region)*

#### Discussion

The knowledge and perceptions of health-care workers are a key determinant in provision of health-care services, including HIV VL testing and management of LLV [29].

This is why in this study, we set out to explore the knowledge and perceptions of VL testing and LLV among health-care workers in Uganda. Our findings indicated that the health-care workers at the different HIV clinics were proficient in VL testing. They described the eligibility for VL testing and also explained the different benefits of VL testing with ease. These findings could partly explain the progress achieved in scaling up of VL testing in Uganda since 2014 [2].

On contrary, the health-care workers could not define LLV, and they were not familiar with the term. However, most of them were aware that a VL range between 50 and 999 copies/ml was not desirable for PLHIV, since it had increased risks of viral non-suppression and HIV transmission, and this perception was in line with the various studies, which have associated LLV to virologic failure and HIV transmission [18–20]. The LLV range was perceived to be caused by sub-optimal drug adherence among PLHIV, and this finding is similar with another study which indicated that reduced drug adherence causes residual LLV [36]. LLV was also reported to be more common in children and adolescents, as compared to adults, and this could be explained by the sub-optimal drug adherence which is common among children and adolescents, as indicated in many recent studies [13, 36–40].

Participants indicated that interventions like supplementary counseling to manage PLHIV with LLV were very informal and unstructured, based on individual will of the health-care worker. This unfortunate finding was explained by the lack of guidance and national policy in the national HIV consolidated guidelines previously to emphasize that LLV was an emerging concern in Uganda, which needed to be adequately managed and addressed [41]. However, IAC has recently been instituted as an intervention to be offered to PLHIV with LLV in Uganda [7]. Furthermore, this was also caused by the sub-optimal understanding of LLV and its implications by the health-care workers, as indicated by the study findings.

Our study identified different best practices in scaling up and improving VL testing. The use of linkage facilitators to follow-up PLHIV due for VL testing was reported to be critical for the service, and this has also been highlighted to be very useful in improving other HIV services [42–45]. Previous studies have shown that continuous reminders are very useful in health care [46, 47], and likewise, our participants noted that sending continuous reminders to PLHIV due for VL testing was very important. The participants emphasized that continuous patient counseling and education was the change-idea in scaling up and improving VL services, and this is in line with recent research [48, 49]. The use of a web-based VL dashboard was also noted to be very key in ensuring early return of VL results; and a similar study in Ivory Coast also indicated similar results about using a VL dashboard [50].

The main personal challenge was lack of transport to go to the clinics for VL testing, and this was coupled with by long distances and poverty; and this is similar to other studies that have highlighted transport and poverty challenges in seeking HIV care [51–53]. Hence, there is need



to decentralize ART services and VL testing to lower health facilities and to community level, so that PLHIV do not have to move long distances to do their VL testing.

Few health-care workers resulting into long waiting times for PLHIV at the clinics and delayed return of VL results were noted as the key health system challenges, and these have also been reported in several other studies [54–56]. To reduce this challenge, several strategies like task-shifting and advocacy with the government to increase the human resource at the different health centers providing HIV care are recommended, since these have been found to be effective in HIV care in other studies [56–58]. Among the community-related challenges, HIV-related stigma associated with nondisclosure and myths about HIV were described as the key challenges, just like in several other studies [51, 52]. Hence, there is still need to create massive community education and awareness to overcome the issue of stigma.

From our study, there is an urgent need to create massive and targeted health education and sensitization about LLV among health-care workers and institute interventions to either reduce the number of PLHIV with LLV or manage the LLV. Furthermore, there is need to complement VL centralized testing with point-of-care testing to reduce the VL results turnaround time. Continuous awareness and education of both health-care workers and PLHIV about VL testing are also still vital in improving VL services.

### **Strengths and limitations**

This study included a diverse range of health-care workers from various clinics across the different regions of Uganda. This study is not without limitations. The study involved interviewing different health-care workers at selected HIV clinics in Uganda, and hence, we relied on what we were informed by the participants. As a result, social desirability bias could have affected our results. However, we created rapport with the participants and also kept the questions simple, not biased, neutral and not threatening.

### **Conclusion**

The findings of this study suggest that many health-care workers still lack sufficient knowledge and understanding about LLV. To effectively address LLV and help Uganda reach UNAIDS viral suppression targets, a range of interventions will be necessary, and these mainly may include health education and sensitization programs for health-care workers. In addition, it will be important to improve access to VL testing by implementing point-of-care testing. Finally, comprehensive community awareness and sensitization efforts will be necessary to reduce HIV stigma.

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### **Competing interests**

The authors declare that they have no competing interests.

### **Author contributions**

NN, GN, GS, SPSK, NK, FM, and DN developed and conceptualized the study. NN, SPSK, CK, GS, EN, and SN organized the data collection process and also analyzed the data. NN, GN, and EN wrote the article draft, which was then reviewed by all the authors.

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