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Characterizing Viral Load Burden Among HIV-Infected Women Around the Time of Delivery: Findings From Four Tertiary Obstetric Units in Gauteng, South Africa

Faith Moyo, MSc,[a,b,c] Ahmad Haeri Mazanderani, PhD,[a,d] Tanya Murray, PhD,[a,c] Karl-G. Technau, PhD,[e] Sergio Carmona, PhD,[f] Tendesayi Kufa, PhD,[a,b] and Gayle G. Sherman, PhD[a,c,e]

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Background: Elimination of mother-to-child transmission of HIV requires sustained viral load suppression during pregnancy and breastfeeding among women living with HIV (WLHIV). Antenatal antiretroviral therapy coverage is reported at >95% in South Africa, but viral load suppression rates are unknown. We describe maternal VL burden around time of delivery at 4 tertiary obstetric units (TOUs) in Gauteng Province.

Methods: Between June 2018 and March 2019, routine point-of-care (PoC) maternal HIV VL and early infant diagnosis (EID) testing were implemented at 3 TOUs in Johannesburg and 1 in Tshwane district. WLHIV and HIV-exposed neonates were eligible for HIV VL (Xpert HIV-1 VL) and EID (Xpert HIV-1 EID or m-PIMA HIV1/2 detection) testing around time of delivery, respectively. Proportions of viremic women and intrauterine (IU)-infected neonates were calculated among valid PoC results.

Results: Among 8147 live births to WLHIV, 2769 (34.0%) women and 4333 (53.2%) neonates had valid PoC results. Median VL at delivery was <40 copies/mL (interquartile range: 0–398). The proportion of women with a VL < 50, 50 to <1000, and ≥1000 copies/mL was 63.6%, 13.9% and 22.4%, respectively. There were 65/4333 (1.5%) IU-infected neonates. Among 1449 mother–neonate pairs with both VL and EID results, IU transmission by VL threshold was 3/946 (0.3%), 6/187 (3.2%), and 25/316 (7.9%) for VL < 50, 50 to <1000, and ≥1000 copies/mL, respectively ($P < 0.001$).

Conclusions: Despite high antiretroviral therapy coverage, >1/3 of WLHIV had a VL ≥50 copies/mL at delivery. Among mother–neonate pairs, maternal VL ≥50 copies/mL accounted for 31/34 (91%) IU infections. Improvement in the quality of HIV care among WLHIV is essential if South Africa is to achieve elimination of mother-to-child transmission.

Key Words: mother-to-child transmission, HIV, viral load suppression, intrauterine transmission, point-of-care, pregnancy

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INTRODUCTION

Antiretroviral therapy (ART) coverage among antenatal clinic clients is estimated at >95% within the public health sector in South Africa.[1] The public health sector is the major health care provider, serving >80% of the South African population.[2] ART coverage among pregnant and postpartum women has increased steadily with the evolution of the prevention of mother-to-child transmission (PMTCT) of HIV policy in the country. The success of the PMTCT program is well documented.[3–6] Currently, PMTCT services are available in >95% antenatal and maternal facilities in the public health sector.[6] Between 2004 and 2014, early infant HIV transmission rates dropped from >20% to <2% among infants aged <2 months.[7] More recently, the program has managed to maintain the national intrauterine (IU) transmission rate at <1.5% since 2015, in spite of high maternal HIV prevalence rates.[8,9] Notwithstanding the tremendous progress achieved to date, gaps in the program remain. High rates of seroconversion and poor viral suppression among women initiated on ART during pregnancy and the postpartum period contribute significantly toward ongoing mother-to-child (MTCT) transmission of HIV.[9] Pregnancy has been associated with poor viral suppression.[10] Underlying factors vary from biological to social.[10,11] HIV viral load (VL) monitoring during pregnancy and the breastfeeding period is therefore critical for patient management and surveillance purposes. However, there are limited data on VL suppression (VLS) rates among women living with HIV

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From the [a]National Health Laboratory Service, Centre for HIV & STIs, National Institute for Communicable Diseases, Johannesburg, South Africa; [b]School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa; [c]Paediatric HIV Diagnostics Division, Wits Health Consortium, Johannesburg, South Africa; [d]Department of Medical Virology, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa; [e]Empilweni Services and Research Unit, Rahima Moosa Mother and Child Hospital, Department of Paediatrics and Child Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa; and [f]National Health Laboratory Service, Department of Molecular Medicine and Haematology, University of the Witwatersrand, Johannesburg, South Africa.

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G.G.S., S.C., and A.H.M. conceived the study design and selected indicators for analysis. G.G.S., A.H.M., T.M., and K-.G.T. acquired the data. F.M., A.H.M., T.K., and G.G.S. analyzed/interpreted the data. F.M., A.H.M., T.K., T.M., and G.G.S. wrote the article. K-.G.T., S.C., T.K., A.H.M., and G.G.S. provided critical revision and final approval.

Correspondence to: Faith Moyo, MSc, Centre for HIV & STIs, National Institute for Communicable Diseases, No 1 Modderfontein Road, Sandringham, Johannesburg 2131, South Africa (e-mail: faithmo@nicd.ac.za).

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(WLHIV) during these periods,[10] which may be related to VL monitoring only recently introduced into national PMTCT guidelines.[12–15]

MTCT of HIV occurs when women with unsuppressed VLs transmit HIV to their children in utero, during labor, or during breastfeeding postpartum.[16–18] Treatment duration and maternal VL have been identified as the strongest predictors of MTCT risk.[16–18] Depending on the baseline VL, a maximum of 12–16 weeks is deemed sufficient to suppress plasma VL in pregnant women.[16–20] An 8% reduction in the odds of HIV transmission with each additional week of treatment among women initiating ART during pregnancy has been reported.[16] Zero in utero and intrapartum HIV transmission has been documented among infants born to women who conceived on ART, continued treatment during pregnancy, and delivered with a plasma VL <50 copies/mL.[20] However, HIV transmission has been shown to occur among women with low-level viremia (50–400 copies/mL) around the time of delivery.[20] Thus, ensuring WLHIV have a VL <50 copies/mL before conception and that VLS is maintained during pregnancy and breastfeeding is crucial if South Africa is to achieve elimination of MTCT of HIV (eMTCT)–defined as an overall MTCT rate of <5% among breastfeeding children and a case rate of <50 HIV infections per 100,000 population.[21] Maternal VLS may be facilitated by timely screening for HIV, early ART initiation, adequate psychosocial support, and effective VL monitoring among women of childbearing potential.[10,16]

National PMTCT guidelines since 2015 have recommended a first-line regimen of tenofovir (TDF) + lamuvidine (3 TC) or emtricitabine (FTC) + efavirenz (EFV) as a fixed dose combination. Viral load monitoring in pregnant and breastfeeding women is performed at 3–6 monthly intervals, with VLs ≥1000 copies/mL prompting clinical interventions to improve VLS.[22] However, this has proven difficult to implement because women present for antenatal care at different stages of their pregnancy and VLS need to be achieved in a relatively short period of time before delivery. Although routine maternal VL testing at time of delivery was not a standard practice at the time of writing, national PMTCT guidelines were reviewed and currently set the VLS threshold to <50 copies/mL during pregnancy and recommend a repeat VL at time of delivery for all WLHIV.[23]

Centralized laboratory HIV VL testing remains standard of care in South Africa. Unlike many countries in sub-Saharan Africa, South Africa benefits from having an established national laboratory network through the National Health Laboratory Service (NHLS).[24] The NHLS has approximately 260 laboratories across the country.[23] However, only 16/260 (6.2%) of the laboratories offer HIV VL testing.[24] This often results in the laboratories operating at maximum capacity with extended result turn-around times that can lead to patients never receiving their results and being lost to care.[24] This in turn may contribute toward preventable MTCT. Point-of-care (PoC) HIV VL testing assays have been recommended as a means of improving VL monitoring among people on ART by enabling patients to receive their VL results on the day of testing before leaving the clinic.[25,26] This provides opportunity for rapid clinical management and reduces the number of clinic visits required. Compared with routine care, patients managed using PoC HIV VL assays have been shown to have better virologic outcomes and are more likely to be retained in care.[25] PoC HIV VL testing may be one of the game changers to fast-track eMTCT in South Africa, with maternal testing at time of delivery providing an opportunity for prompt clinical management such as enhanced adherence counseling for mothers and provision of high- versus low-risk prophylaxis for neonates. Furthermore, PoC early infant diagnosis (EID) testing at birth provides the opportunity to identify IU-infected neonates for early ART initiation.

In this article, we describe maternal VL burden and IU transmission rates from a study implementing PoC testing among pregnant WLHIV and HIV-exposed neonates around the time of delivery at 4 sites in Gauteng, South Africa.

METHODS

Study Procedures

Between June 2018 and March 2019, PoC HIV VL and EID testing was introduced at 4 tertiary obstetric units (TOUs) in Gauteng as part of an implementation study to determine the feasibility of integrating PoC testing into routine care in busy obstetric units. Three sites were located in Johannesburg (subdistricts B, D, F) and 1 in Tshwane district. A routine birth testing program for all HIV-exposed neonates was already in place at all sites as per national guidelines,[22] but maternal VL testing around the time of delivery for WLHIV was not routinely provided.

All WLHIV admitted to labor or postnatal wards were eligible for a PoC HIV VL test around the time of delivery using Xpert HIV-1 VL (Cepheid, Sunnyvale, CA), which has a quantifiable range of 40–10,000 000 RNA copies/mL. Similarly, all HIV-exposed neonates were eligible for PoC EID testing at birth, defined as <72 hours after delivery, using either Xpert HIV-1 (Cepheid, Sunnyvale, CA) or m-PIMA (Abbot, Chicago, IL) EID assays. PoC testing was restricted to working hours (08:00–16:00) on weekdays. Mother–neonate pairs were tested where possible; however, either of the pair could be tested without the other. Samples of mothers and neonates with no reasonable chance of the PoC result being returned before discharge were not tested. For example, a neonate born by normal vaginal delivery on a Friday evening was likely to be discharged before a PoC test could be performed on Monday morning and was therefore not tested using the PoC assay. Routine hospital staff (usually nurses or junior doctors) collected maternal and neonatal specimens, whereas PoC operators, mostly nurses employed specifically for this purpose, tested the samples in designated PoC testing rooms at each site. In the case of errors or invalid PoC HIV VL or EID results, repeat testing was performed on the leftover sample. If an error or invalid result was obtained on retest, a second sample was requested for additional testing. For each specimen tested using PoC, a corresponding sample was collected and sent to the National Health Laboratory Service (NHLS) for centralized laboratory testing.

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Upon completion of PoC testing, neonates of mothers with a VL <1000 copies/mL were received low-risk prophylaxis of daily nevirapine for 6 weeks, as per standard of care.[22] Mothers of neonates with a negative EID PoC result were counseled to follow-up for a routine 10-week HIV PCR test at their local clinic. Hospital pediatric and obstetric staff were alerted through a mobile phone SMS (short messaging system) to maternal VLs ≥1000 copies/mL and positive EID results for intervention. Mothers with a VL ≥1000 copies/mL received adherence counseling, and their neonates were prescribed high-risk prophylaxis—either daily nevirapine for 12 weeks or dual prophylaxis (nevirapine and zidovudine) for 6 weeks, according to guidelines at the time of data collection.[22] Positive EID PoC test results prompted a second sample draw to confirm an HIV positive diagnosis and referral for ART initiation.

Study Data

Patient (name, surname, and hospital number) and sample details (collection date and time, sample barcode, result, name of assay, facility, and ward) were collected on a PoC test request form. These data were entered and managed in a REDCap database and imported into STATA for analysis. Analysis was restricted to participants with a valid PoC result. No additional clinical data were collected because this was beyond the scope of the PoC implementation study. Obtaining the necessary informed consent would have negatively affected the time-sensitive outcomes of the implementation study, namely testing coverage, turn-around times, and result return rates.

Study Outcomes

The proportion of viremic women at time of delivery was calculated at VL thresholds of ≥50, 50 to <1000, and ≥1000 copies/mL among women with a valid VL result. The IU transmission rate was calculated as the proportion of positive EID results in relation to the total EID PoC tests with a valid result. Programmatic HIV PCR data from the NHLS′ Data Warehouse (NHLS DW) were used to determine routine IU transmission rates for each TOU site. PoC testing coverage was defined as the proportion of eligible mothers and neonates with a valid VL or EID PoC result. The country's district health information system (DHIS) indicator "total live births to HIV-positive women" was used as a proxy for the total number of mothers and neonates eligible for PoC testing per TOU.

Two denominators were used for PoC testing coverage: a conservative estimate used total number of live births to HIV-positive women, whereas a second estimate used only total live births to HIV-positive women during weekdays, when PoC testing was available. The conservative estimate was used as a proxy for the minimum testing coverage achieved, whereas the second denominator measured the best-case scenario or maximum coverage (ie, assuming PoC testing was available every day of the week).

Data Analysis

The Pearson's χ^2 test was used to test for associations between categorical variables; otherwise, the Fischer exact test was used for sparse data. Logistic regression was used to assess the association between having a high VL (VL ≥1000 copies/mL) around the time of delivery and (1) quarter of the year when the PoC test was performed after PoC implementation and (2) TOU in which the PoC test was performed. Variables were included in the adjusted model based on purposeful selection (*P* value cut-off of 0.20 for statistical significance during univariate analysis and 0.05 during multivariate analysis). The "quarter of the year when the PoC test was performed" was included a priori.

Subanalysis

Additional clinical and demographic data (maternal age at delivery and duration on ART) for women who delivered at the Johannesburg B site during the study period were extracted from a database of routinely collected clinical data from consenting patients at the site. These data were described using median (interquartile range) and proportions. Logistic regression was used to determine the association between high VL at delivery and (1) maternal age at delivery and (2) duration on ART.

ETHICS CLEARANCE

This work was approved by the human research ethics committee (HREC) of the University of the Witwatersrand (M1711115) and the faculty of health sciences research ethics committee of the University of Pretoria (50/2018). Patient identity was protected by de-identifying data before analysis. Maternal clinical data were available for study participants from the Johannesburg B site because of a data-sharing agreement routinely used at that facility, HREC clearance number M170778.

RESULTS

Over the period of 10 months, the 4 sites had 8147 live births to WLHIV of whom 2769 (34.0%) had a valid VL result (Table 1) and 4333 (53.2%) neonates had a valid EID result (Table 2). Testing coverage of maternal VL and EID varied considerably across the TOU sites with an overall maximum coverage of 48.6% and 76.0%, respectively (Tables 1 and 2).

The median maternal VL around the time of delivery at all sites was <40 copies/mL, with an overall interquartile range of 0–398 copies/mL. Figure 1 shows the distribution of VLs among women with a detectable VL around the time of delivery by TOU. Of 2769 valid VL results, 1578 (57.0%) were quantifiable with 571 (20.6%) having results of <50 copies/mL. Overall, the proportion of women with a VL ≥50, 50 to <1000, and ≥1000 copies/mL was 36.4% (n = 1007), 13.9% (n = 386), and 22.4% (n = 621), respectively (Table 1). Similar trends in proportions of viraemic women were observed for the 3 Johannesburg units, whereas higher proportions were observed for the Tshwane unit at 45.1%, 16.6%, and 28.5%

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TABLE 1. Description of Maternal VL Around the Time of Delivery at 4 TOUs in Gauteng, South Africa

Variables	Total N = 2769	Location of TOU: Johannesburg B, n = 1230	Johannesburg D, n = 693	Johannesburg F, n = 309	Tshwane, n = 537	*P*
Total live births to WLHIV	8147	2103	3324	1543	1177	
Minimum PoC VL testing coverage*	34.0%	58.5%	20.8%	20.0%	45.6%	<0·001
Maximum PoC VL testing coverage†	48.6%	90.0%	28.2%	28.6%	62.5%	<0·001
VL suppression threshold						<0·001
<50 cps/mL	1762 (63.6%)	815 (66.3%)	445 (64.2%)	207 (67.0%)	295 (54.9%)	
≥50 cps/mL	1007 (36.4%)	415 (33.7%)	248 (35.8%)	102 (33.0%)	242 (45.1%)	
VL suppression threshold						0·001
50 to <1000 cps/mL	386 (13.9%)	161 (13.1%)	92 (13.3%)	44 (14.2%)	89 (16.6%)	
VL suppression threshold						0·001
<1000 cps/mL	2148 (77.6%)	976 (79.4%)	537 (77.5%)	251 (81.2%)	384 (71.5%)	
≥1000 cps/mL	621 (22.4%)	254 (20.7%)	156 (22.5%)	58 (18.8%)	153 (28.5%)	
Quarter of the year‡						<0·001
July–September 2018	862 (34.5%)	448 (41.1%)	144 (22.9%)	96 (34.0%)	174 (34.6%)	
October–December 2018	802 (32.1%)	317 (29.1%)	199 (31.7%)	141 (50.0%)	145 (28.8%)	
January–March 2019	838 (33.5%)	324 (29.8%)	285 (45.4%)	45 (16.0%)	184 (36.6%)	

*Denominator includes the total number of live births to WLHIV during the study period.
†Denominator includes the number of live births to WLHIV occurring on weekdays only during the study period.
‡June 2018, the first month of study initiation is excluded [n = 267 (9·6%) overall].
N, number; cps/mL, copies per milliliter.

for VL ≥50, 50 to <1000, and ≥1000 cps/mL, respectively (Table 1, $P = 0.001$). The proportion of IU-infected neonates ranged between 0.9% and 1.5% for the Johannesburg units, whereas the Tshwane unit had an IU rate of 2.7% ($P = 0.005$). When study data were aggregated to the district level to compare IU transmission rates between the 2 districts, a similar trend was noted with 40/3420 (1.2%) for Johannesburg and 25/913 (2.7%) for Tshwane ($P = 0.002$). Percentage positivity rates calculated from programmatic NHLS HIV PCR data from each site were comparable with overall IU transmission rates, suggesting generalisability ($P = 0.705$). Percentage neonatal positivity was associated with high maternal VL around the time of delivery. Among 1449 (33.4%) mother–neonate pairs with both a valid PoC VL and EID result, n (%), (95% confidence interval), 3/946 (0.3%) (0.1%–1.0%), 6/187 (3.2%) (1.4%–7.0%), and 25/316 (7.9%) (5·4%–11·5%) IU infections occurred among women

TABLE 2. Neonatal Point-of-Care EID at 4 TOUs in Gauteng, South Africa

Variables	Total, N = 4333	Location of TOU: Johannesburg B, n = 1292	Johannesburg D, n = 1305	Johannesburg F, n = 823	Tshwane, n = 913	*P*
Total live births to WLHIV	8147	2103	3324	1543	1177	
Minimum PoC EID testing coverage†	53.2%	61.4%	39.3%	53.3%	77.6%	<0·001
Maximum PoC EID testing coverage‡	76.0%	94·5%	53.0%	76.2%	>99.0%	<0·001
n (%) Positivity	65 (1.5%)	19 (1.5%)	14 (1.2%)	7 (0.9%)	25 (2.7%)	0·005
IU transmission, n (%) by VL threshold in mother–neonate pairs tested*	34 (52.3%)	14 (73.7%)	8 (57.1%)	3 (42.9%)	9 (36.0%)	<0·001
<50 cps/mL	3 (0.3%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	2 (2.0%)	
50 to <1000 cps/mL	6 (3.2%)	2 (1.6%)	1 (4.0%)	1 (7.1%)	2 (8.7%)	
≥1000 cps/mL	25 (7.9%)	11 (5.6%)	7 (14.9%)	2 (10.5%)	5 (9.6%)	
Total EID tests <3 days (birth)	8728 (100.0%)	2387 (27.3%)	3369 (38.6%)	1713 (19.6%)	1259 (14.4%)	
% IU transmission (Programmatic)	149 (1.7%)	39 (1.6%)	52 (1.5%)	20 (1.2%)	38 (3.0%)	<0·001

*n = 1449; mothers of twin babies were counted twice as the mother contributed in 2 EID PCR events.
†Denominator includes the total number of live births to WLHIV during the study period.
‡Denominator includes the number of live births to WLHIV during weekdays only during the study period.
N, number; IU, intrauterine.

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with a delivery VL threshold of <50, 50 to <1000, and ≥1000 copies/mL, respectively (Table 2, $P < 0{\cdot}001$). All 3 of the IU infections occurring in the VL <50 copies/mL threshold occurred to women with an HIV-1 RNA detectable VL result. A search for previous VL results from the NHLS′ DW showed that 2 of these women did not have a documented VL before delivery, whereas 1 woman had a VL ≥1000 3 months before delivery.

Proportions of high maternal VL remained constant during the study period, suggesting similarity in participants tested throughout the implementation period despite low testing coverage (Table 3). Although there was uniformity in the proportion of women with high VLs in the Johannesburg sites (Table 3), women who received their PoC HIV VL test in Tshwane were almost 2 times more likely to have a high VL compared with the site in Johannesburg F [AoR = 1·88, 95% CI: (1.31–2.71)].

Results of the subanalysis of demographic and clinical characteristics of women who delivered at the Johannesburg B site showed that high VL at delivery was predicted by younger maternal age: (age <25 years, n = 191/1129), [AoR = 2.17, 95% CI: (1.13–4.18)] and shorter duration on ART: (on ART for <3 months, n = 61/375), [AoR = 4.11, 95% CI: (2.20–7.66)].

DISCUSSIONS

These findings are among the first documenting maternal VL burden around the time of delivery across multisite, high-volume obstetric units in South Africa. Approximately 20% of women delivering across the 4 TOUs in Gauteng had a VL ≥1000 copies/mL with 36.4% having a VL of ≥50 copies/mL. Among mother–neonate pairs tested, higher maternal VL around the time of delivery was associated with higher IU transmission rates. Although women delivering in the Johannesburg sites had similar VL profiles, higher proportions of viraemic women were seen at the Tshwane site. A similar trend was observed for the neonatal IU transmission rate, which ranged from 0.9% to 1.5% in the Johannesburg sites but was 2.7% in Tshwane. Overall and site-specific IU transmission rates approximated programmatic IU transmission rates, suggesting generalisability of these findings to these sites. Data to investigate the reasons for the statistically significant differences observed in both the proportion of viraemic women and percentage IU transmissions between the Johannesburg and Tshwane sites were not available. We postulate that the Tshwane site may have provided care for younger women as well as treated a higher proportion of migrant patients who are more likely to have poorer treatment outcomes.[27,28] Our findings suggest that maternal VLS rates at the time of delivery are likely to vary between health districts, even within the same province. By monitoring maternal VL testing coverage and suppression rates at time of delivery, districts requiring targeted interventions to improve antenatal care can be identified to further reduce MTCT of HIV.

The 2017 National Antenatal Sentinel HIV survey confirmed that the PMTCT program has reached the first and second UNAIDS 90-90-90 targets for antenatal clients, in that 90% of all pregnant WLHIV know their status and 90% of these are on ART.[29] In spite of very high ART coverage during antenatal care in the public sector, our findings reveal suboptimal maternal VLS at time of delivery. Monitoring maternal VL during pregnancy and delivery instead of antenatal ART coverage, which fails to take duration of ART into account, may provide a better indicator as South Africa works toward eMTCT. In fact, because VLS before pregnancy is important for eMTCT, monitoring VLS of all women of childbearing potential is imperative. The proportion of viraemic (VL ≥1000 copies/mL) women at time of delivery was much higher than has been reported for WLHIV on ART in general of ≈ 10%.[30] This likely reflects the effect of new diagnoses and recent ART initiation during pregnancy, particularly among younger women. According to the DHIS in 2018, more than one-third of pregnant WLHIV were initiated on ART at their first antenatal visit and a similar proportion (34%) presented for their first antenatal clinic visit after 20 weeks of age. Thus, pregnant WLHIV often present for care after the first trimester with limited time to achieve VLS before delivery. The availability of maternal VL PoC testing during antenatal care may reduce the time to achieving VLS in pregnancy by reducing the time from sampling to

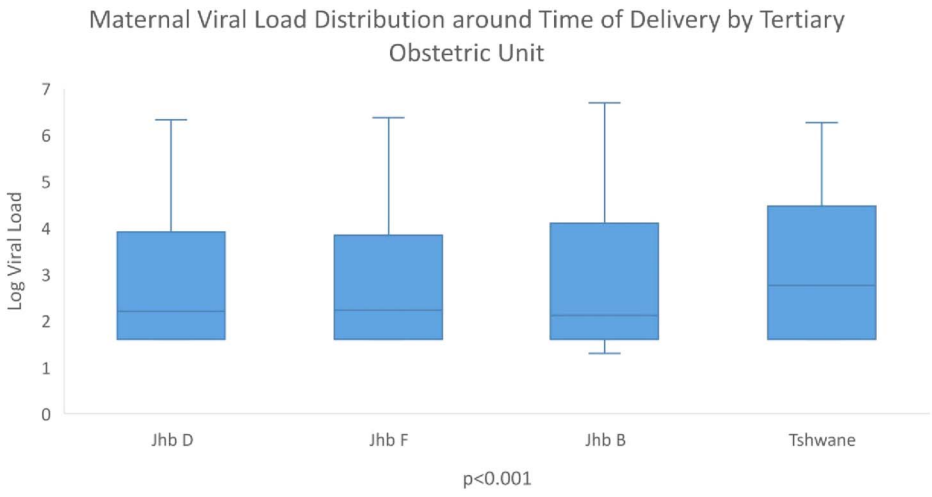


FIGURE 1. Distribution of maternal VL among women with detectable VL around the time of delivery by TOU, n = 1578 (57·0%) of maternal PoC VL results comprising 1007 VL ≥50 copies/mL and 571 VL <50 copies/mL but detectable. VL results "HIV less than detectable" were assigned values of 0 (n = 1191). Jhb, Johannesburg. full color online

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TABLE 3. Factors Associated With High Viral Load (VL ≥1000 Copies/mL) Around the Time of Delivery at 4 TOUs in Gauteng, South Africa

Variable	N (%)	Univariate OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Quarter of the year*					
July–September 2018	197 (35.6%)	Reference	Reference	Reference	Reference
October–December 2018	183 (33.1%)	0·99 (0.79–1.25)	0.99	1.01 (0.80–1.20)	0.95
January–March 2019	173 (31.3%)	0·88 (0.70–1.11)	0.27	0·84 (0.67–1.07)	0.16
Location of TOU					
Johannesburg F	58 (9.3%)	Reference	Reference	Reference	Reference
Johannesburg D	156 (25.1%)	1·26 (0.90–1.76)	**0.18**	1.34 (0.93–1.97)	0.11
Tshwane	153 (24.6%)	1·72 (1.22–2.43)	**0002**	1.88 (1.31–2.71)	**0.001**
Johannesburg B	254 (40.9%)	1·13 (0.82–1.55)	0.46	1.18 (0.84–1.65)	0.35

*June 2018, the first month of study initiation is excluded from this analysis [n = 267 (9·6%) overall]. Level of statistical significance is 0.20 for univariate ORs and 0.05 for adjusted ORs.

OR, odds ratio; N, number; mL, milliliter.

result and improving the result return rate among virologically unsuppressed WLHIV.

Our data are limited by lack of information on ART status, ART drug regimens, time on ART, and previous VL results among study participants. These are important predictors of virologic response, which we could not ascertain in most of our study population.[16–18] However, results of the Johannesburg B site subanalysis confirmed what is already known. Younger maternal age and shorter duration on ART were significantly associated with high VL at delivery.[16] Regardless of patient-level factors, conducting a PoC VL test at delivery within the high-volume TOUs identified a third of women with detectable VLs for intervention. Given the maturity of South Africa's PMTCT program and the need for potential game changers to achieve eMTCT, this study demonstrates the utility of PoC VL around the time of delivery within a high-burden setting.

Because the VL testing coverage was poor, the effect of targeted testing of high-risk mothers on our findings cannot be excluded. We may have disproportionately enrolled unbooked mothers, sick mothers with high VLs, or mothers with ART adherence issues. However, we found that the proportion of viremic women remained constant throughout the implementation period within each site. This suggests that despite low coverage, women included in the study were similar at each site or selection bias was uniform throughout implementation. Although most pregnant women presenting in labor wards had maternity case records with them around the time of delivery, few had documented VL results. As a result, clinical staff were less likely to be alerted to women with high VL results and unlikely to have selected women who were likely to have high VLs for PoC testing. Clinical staff also had the option to access PoC HIV VL testing on women if clinically indicated without enrolling them in the study and did not have to actively select women with high VL into the study. Finally, there were no provisions in the current PMTCT guidelines recommending that mothers with high VLs be managed in TOUs. WLHIV routinely obtain HIV care in primary health care facilities and are not referred for HIV management to TOUs. Therefore, it is unlikely that virologic profiles of women who participated in this study would differ from the surrounding primary health care facilities.

We present findings based on a single VL measurement at delivery. We did not have historic VL measurements to understand the evolution of virologic control of these women during pregnancy. As a result, we could not ascertain the VL patterns during pregnancy that culminated in neonatal infection. Myer et al found that episodes of viremia occurred frequently and were common in a cohort of women initiating ART during pregnancy in routine antenatal settings in the Western Cape.[31,32] This suggests that pregnant and postpartum WLHIV require close VL monitoring throughout pregnancy and during breastfeeding to minimize the risk of transmission. A follow-up study, describing the evolution of virologic control in pregnant and postpartum WLHIV at a national level, would be helpful to develop evidence-based VL monitoring algorithms. At the program level, individual monitoring of every pregnant and postpartum woman may go a long way toward eMTCT using HIV VL test data stored in the NHLS DW. Results for action reports such as the ones currently used for linking HIV PCR-positive infants to care[9] can be used by clinicians for WLHIV during pregnancy and postpartum to rapidly achieve VLS and avert transmission.

If the country is to achieve eMTCT, urgent prioritization of (1) VL monitoring, (2) ART adherence support, and (3) intervention for pregnant and breastfeeding WLHIV with unsuppressed VLs will be required.

CONCLUSIONS

Despite >95% antenatal ART coverage of pregnant WLHIV, approximately a third of WLHIV had a detectable VL around the time of delivery, thereby increasing risk of vertical transmission of HIV. Among mother–neonate pairs with valid PoC test results, 91% of IU infections occurred where maternal VL at the time of delivery was ≥50 copies/mL. Closer monitoring of VLS rates among pregnant and breastfeeding WLHIV may advance the PMTCT program's prospects of achieving eMTCT and will be more informative than ART coverage rates. Maternal PoC VL

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testing during pregnancy and at delivery may facilitate VLS and reduce MTCT transmission risk. Essentially, improvement in the quality of HIV care among WLHIV is required if South Africa is to achieve eMTCT.

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