AIDS 2020, **34**:1567–1572

High levels of resistance to nucleoside/nucleotide reverse transcriptase inhibitors in newly diagnosed antiretroviral treatment-naive children in sub-Saharan Africa

Seth C. Inzaule[a], Michael R. Jordan[b], George Bello[c], Nellie Wadonda-Kabondo[d], Salou Mounerou[e], Innocent A. Mbulli[f], Sulaimon A. Akanmu[g], Adolfo Vubil[h], Gillian Hunt[i], Pontiano Kaleebu[j], Simangele Mthethwa-Hleza[k], Janet Dzangare[l], Patrick Njukeng[f], Martina Penazzato[a], Tobias F. Rinke de Wit[m], Susan H. Eshleman[n], Silvia Bertagnolio[a], for the Infant HIV Drug Resistance Survey Team

Exposure of infants to antiretroviral drugs for prevention of mother-to-child transmission can induce resistance to nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs). Data from nine national surveys of pretreatment drug resistance in children newly diagnosed with HIV show high levels of resistance to NRTIs included in first-line antiretroviral treatment (ART) regimens (dual abacavir-lamivudine/emtricitabine resistance). Additional research is needed to determine the impact of NRTI resistance on treatment response and optimize infant ART.

Exposure of infants to antiretroviral drugs for prevention of mother-to-child transmission (PMTCT) can induce resistance to nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs) [1–5].

We assessed the prevalence of NRTI resistance in ART-naïve children 18 months or less of age who were newly diagnosed with HIV through early infant diagnosis programs. Data were obtained from nine nationally representative surveys in sub-Saharan Africa, conducted between 2011 and 2016 in Eswatini (2011), Uganda (2011), Mozambique (2012), Togo (2012), Zimbabwe (2012), Cameroon (2014), South Africa (2014), Nigeria (2016), and Malawi (2016).

Drug resistance was predicted using the Stanford HIVdb algorithm Version 8.3 [6]. Sequences classified as having low-level, intermediate-level or high-level resistance were designated 'resistant'. Prevalence estimates were calculated for each country using Stata 14 (StataCorp, College Station, Texas, USA) as per the survey analysis plan [7]. Differences between groups were assessed on unweighted data by logistic regression. Nonresearch determination approval for routine surveillance studies was obtained from the individual countries' national research ethics committees.

Data on HIV drug resistance and antiretroviral prophylaxis were available for 2684 and 2282 (85%) infants (all surveys except South Africa), respectively (Table 1). Of the infants, 1229 (53.9%) were exposed to maternal prophylaxis.

The prevalence of NRTI resistance in the nine surveys ranged from 2.0% (95% CI: 0.1–4.0) to 25.8% (95% CI: 17.5–36.4) and was significantly higher in surveys conducted after in-country adoption of the WHO's policy for maternal lifelong ART [23.4 (95% CI: 19.4–27.9) vs. 9.9 (95% CI: 8.6–11.1, $P < 0.0001$]. The prevalence of NRTI resistance was also higher among infants exposed to maternal prophylaxis (with or without infant prophylaxis) compared with those exposed to only infant prophylaxis or with unknown exposure history (Table 1).

NRTI resistance was mainly driven by abacavir (ABC) and emtricitabine/lamivudine (XTC) resistance. The prevalence of dual ABC/XTC resistance ranged from 2% in Eswatini (2011) to 28.1% in Nigeria (2016) (Table 1).

Overall, the prevalence of resistance to zidovudine (ZDV) and tenofovir (TDF) was less than 10% across all surveys except in Togo where ZDV resistance was 11.6%, and in Nigeria where ZDV and TDF resistance were 15% and 11.3%, in infants exposed to maternal prophylaxis, respectively.

We made several key observations in this study. First, children exposed to maternal prophylaxis had higher levels of NRTI resistance compared with infants not exposed to maternal prophylaxis. This is consistent with previous studies that showed selection of drug-resistant HIV in children exposed to sub-therapeutic concentrations of maternal drugs ingested during breast-feeding [1,5]. Similar to findings from recent studies, we observed higher levels of NRTI resistance in surveys conducted after adoption of WHO recommendations for maternal lifelong ART; this suggests that the prevalence of NRTI resistance could increase further over time as the WHO policy is more widely implemented [3,4].

Second, although WHO recommends ritonavir-boosted protease-inhibitor (PI/r)-based first-line pediatric regimens in children greater than 4 weeks of age who weigh less than 20 kg, this recommendation has not been widely implemented in many sub-Saharan African countries because of limited availability and high cost of pediatric-friendly formulations. Consequently, NNRTI-based regimens are still widely used [8]. The increasing

Table 1. Prevalence of NRTI resistance in treatment-naive children less than 18 months of age in national surveys from 9 countries in sub-Saharan Africa.

Country (*N*, percent of those exposed to maternal prophylaxis[a])	% (95% CI)								
	NRTI resistance			[0,5-7]ABC resistance	XTC resistance				
	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]
Surveys implemented after country adoption of maternal lifelong ART									
Nigeria (423, 36%)	**22.9 (18.4–28.0)**	**35.0 (27.2–43.7)**	**14.9 (10.2–21.3)**	**19.8 (15.6–24.8)**	**31.0 (23.6–39.7)**	**12.4 (8.1–18.6)**	**15.7 (12.0–20.3)**	**27.8 (20.6–36.4)**	7.8 (4.6–12.8)
Malawi (232, 84.5%)	**25.8 (17.5–36.4)**	**28.1 (18.8–39.6)**	7.2 (1.7–25.4)	**20.6 (13.2–30.8)**	**23.1 (14.8–34.3)**	0	**15.1 (9.0–24.0)**	**16.9 (10.1–26.7)**	0
Surveys implemented before country adoption of maternal lifelong ART									
Cameroon (380, 27%)	**10.3 (7.6–13.8)**	**12.7 (7.5–20.7)**	9.5 (6.6–13.5)	7.2 (5.0–10.3)	**11.7 (6.7–19.6)**	5.7 (3.5–9.2)	6.2 (4.2–9.1)	**10.8 (6.0–18.5)**	4.7 (2.7–7.9)
South Africa (402)[c,d]	**13.9 (10.5–17.3)**			**12.2 (9.3–15.8)**			**10.2 (7.6–13.5)**		
Togo (199, 46%)	**16.6 (12.0–22.5)**	**15.7 (9.5–24.9)**	**17.3 (11.3–25.6)**	**10.1 (6.6–15.1)**	**10.1 (5.3–18.4)**	7.5 (4.6–12.2)	7.3 (3.7–13.9)	7.5 (4.6–12.2)	7.9 (3.8–15.7)
Zimbabwe (227, 61%)[d]	9.7 (5.8–13.5)	**13.8 (9.0–20.5)**	3.4 (1.2–9.4)	7.5 (4.7–11.7)	**10.1 (6.1–16.3)**	3.4 (1.2–9.4)	5.7 (3.4–9.6)	8.7 (5.0–14.6)	1.1 (0.2–6.1)
Uganda (224, 73%)[d]	8.5 (4.8–12.1)	8.5 (5.2–13.8)	8.3 (3.6–18.1)	4.0 (2.1–7.5)	4.9 (2.5–9.3)	1.7 (0.3–8.9)	3.1 (1.5–6.3)	3.7 (1.7–7.8)	1.7 (0.3–8.9)
Mozambique (400, 65%)[d]	6.5 (4.1–8.9)	6.5 (4.1–10.2)	6.4 (3.4–11.8)	3.5 (2.1–5.8)	3.8 (2.1–6.9)	2.9 (1.1–7.1)	2.5 (1.4–4.5)	3.1 (1.6–6.0)	1.4 (0.4–5.1)
Eswatini (197, 63%)[d]	2.0 (0.1–4.0)	3.2 (1.3–7.9)	0.0	1.5 (0.5–4.4)	2.4 (0.8–6.8)	0.0	1.0 (0.3–3.6)	1.6 (0.4–5.6)	0

Country (*N*, percent with maternal exposure)	% (95% CI)								
	ABC+XTC resistance			ZDV resistance			TDF resistance		
	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]	All infants regardless of prophylaxis exposure	Infants exposed to maternal prophylaxis[a]	Infants not exposed to maternal prophylaxis[b]
Surveys implemented after country adoption of maternal lifelong ART									
Nigeria (423, 36%)	**15.8 (12.1–20.3)**	**28.1 (20.8–36.7)**	7.8 (4.6–12.8)	9.7 (6.8–13.6)	**15.0 (9.7–22.6)**	6.2 (3.4–10.9)	7.2 (4.6–11.0)	**11.3 (6.6–18.7)**	4.4 (2.1–9.2)
Malawi (232, 84.5%)	**15.1 (9.0–24.0)**	**16.9 (10.1–26.7)**	0	7.2 (2.9–16.7)	7.6 (2.9–18.4)	3.7 (0.5–22.7)	7.5 (3.3–16.3)	8.4 (3.7–18.2)	0
Surveys implemented before country adoption of maternal lifelong ART									
Cameroon (380, 27%)	6.2 (4.2–9.1)	10.9 (6.1–18.6)	4.7 (2.7–7.9)	6.3 (4.2–9.2)	6.0 ((2.0–12.7)	6.4 (4.0–9.9)	2.8 (1.5–5.0)	5.7 (2.6–12.3)	1.8 (0.7–4.2)
South Africa (402)[c,d]				2.0 (1.0–3.9)			4.2 (2.7–6.7)		
Togo (199, 46%)	7.5 (4.6–12.2)	7.9 (3.8–15.7)	7.3 (3.7–13.9)	**11.6 (7.8–16.8)**	**12.4 (6.9–21.0)**	**10.9 (6.3–18.3)**	**4.5 (2.4–8.5)**	3.4 (1.1–10.0)	5.5 (2.5–11.7)
Zimbabwe (227, 61%)[d]	5.7 (3.4–9.6)	8.7 (5.0–14.6)	1.1 (0.2–6.1)	2.6 (1.2–5.7)	4.3 (2.0–9.2)	0	3.1 (1.5–6.2)	5.1 (2.5–10.1)	0
Uganda (224, 73%)[d]	3.1 (1.5–6.3)	3.7 (1.7–7.8)	1.7 (0.3–8.9)	4.9 (2.8–8.6)	6.7 (2.6–15.9)	4.3 (2.1–8.5)	1.3 (0.46–3.9)	1.8 (0.6–5.2)	0
Mozambique (400, 65%)[d]	2.5 (1.4–4.5)	3.1 (1.6–6.0)	1.4 (0.4–5.1)	4.3 (2.7–6.7)	4.3 (2.0–9.0)	4.2 (2.4–7.4)	1.0 (0.4–2.5)	1.2 (0.4–3.3)	0.71 (0.13–3.9)
Eswatini (197, 63%)[d]	1.0 (0.3–3.6)	1.6 (0.4–5.6)	0	0.51 (0.1–2.8)	0.80 (0.14–4.4)	0	0.51 (0.1–2.8)	0.80 (0.14–4.4)	0

The number and percentage (%) of infants with resistance to nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs), based on their exposure to maternal and infant prophylaxis (antiretroviral drugs administered for prevention of mother-to-child transmission of HIV) are shown. NRTI prevalence estimates at least 10% are shown in bold text. The analysis includes 2684 infants; data on prophylaxis exposure history were not available for 402 infants from South Africa. ABC, abacavir; ART, antiretroviral therapy; CI, confidence intervals; *N*, number; %: percentage; NRTI, nucleoside reverse transcriptase inhibitors; TFV, tenofovir; XTC, emtricitabine (FTC) and/or lamivudine (3TC); ZDV, zidovudine.

[a]This group includes 1229 infants exposed to maternal prophylaxis, with or without infant ARV prophylaxis.

[b]This group includes 1053 infants who were not exposed to maternal prophylaxis. This group includes: infants exposed to infant prophylaxis only, infants with no maternal or infant prophylaxis exposure, and infants with unknown prophylaxis exposure.

[c]Data on exposure status were not available.

[d]Weighted prevalence was not estimated because of inadequate information for sampling weights.

prevalence of NRTI resistance, combined with still substantial use of NNRTI-based ART (for which resistance exceeds 50%) in infants [9,10], suggests that most young children may be treated ineffectively and risks poor treatment outcomes. These findings emphasize the urgent need to accelerate access to child-friendly PI/r-based regimens.

Third, although PI/r regimens have been shown to remain effective in those who have resistance to two co-administered NRTIs [11], most studies have been conducted in adults receiving regimens that include TDF/XTC or ZDV/XTC. It is not clear whether these findings can be extrapolated to children receiving regimens with ABC/XTC. The efficacy of PI/r-based regimens in the setting of NRTI resistance is partially attributed to an antagonistic effect of the M184 V mutation; this mutation causes hyper-susceptibility of HIV to ZDV and TDF, but not to ABC [12]. Additional studies are needed to assess the efficacy of PI/r-based regimens in children with resistance to ABC.

Although ZDV and TDF are potential alternatives to ABC, we find that resistance to these drugs may also be high in some countries. This suggests the need to accelerate research and access to newer NRTIs and nucleoside-sparing ART combinations particularly for this population.

Fourth, our findings have direct implications for pediatric regimens recommended in the 2019 WHO guidelines (i.e. raltegravir in infants <4 weeks of age and dolutegravir in children weighing >20 kg) [13]. As raltegravir has a low genetic barrier for resistance [14], its use in neonates with NRTI resistance may lead to emergence of resistance, potentially compromising future use of dolutegravir [15,16]. There is limited evidence to support the use of dolutegravir in infants with NRTI resistance. Therefore, caution is needed when considering use of dolutegravir with ABC/XTC in young children in countries with a high prevalence of ABC/XTC resistance.

Given the limited number of ART regimens available to children living with HIV, careful attention is needed to avoid inducing NRTI resistance early in life. The WHO recommendation for use of triple-drug neonatal prophylaxis (or presumptive treatment) should be considered in low-income and middle-income countries [17].

This study has several limitations. First, we may have overestimated the prevalence of ABC resistance by using the Stanford HIVdb algorithm; this algorithm classifies the M184V mutation as causing low-level ABC resistance (https://hivdb.stanford.edu, accessed 21 November, 2019). However, findings from the CNA3003 study [18], as well as the REGA and French ANRS drug resistance interpretation algorithms, suggest a minimal impact of this mutation on ABC resistance (https://hivdb.stanford.edu, accessed 21 November, 2019). When we excluded M184V as a cause of ABC resistance, the prevalence dropped from 19.8% to 12.7% in Nigeria and from 20.6% to 12.6% in Malawi. Second, our findings were from regions where most women on ART were receiving NNRTI-based therapy. Additional studies are needed to estimate the prevalence of NRTI resistance in infants, whose mothers were taking dolutegravir-based regimens. Dolutegravir is also transferred through breastmilk at concentrations that are unlikely to suppress HIV replication fully [19], and may potentially select for both dolutegravir and NRTI resistance.

In conclusion, the increasing prevalence of ABC and XTC resistance in infants who are infected with HIV despite antiretroviral prophylaxis merits attention. Further studies are needed to understand the impact NRTI on pediatric regimens.

Acknowledgements

Conflicts of interest

Funding: Funding for these surveys was provided by the President's Emergency Plan for AIDS Relief through the Centers for Disease Control and Prevention, the Global Fund, Amsterdam Institute of Global Health and Development (AIGHD) and countries' ministry of health.

Infant HIV Drug Resistance Survey Team: Centers for Disease Control & Prevention, Malawi (Andrew Auld); Data First Consulting, Belmont, California (Neil Parkin); Division of Global HIV and TB, Center for Global Health, Centers for Disease Control and Prevention, Atlanta, Georgia (Chunfu Yang); Foundation for Innovative New Diagnostics, Geneva, Switzerland (Sergio Carmona); Global Health Systems Solutions, Douala, Cameroon (Akemfua Fualefac, Regina N. Mugri); Instituto Nacional de Saúde, Mozambique (Ileshi Jani); IRD UMI 233, INSERM U1175, Université de Montpellier, Unité TransVIHMI, France (Amandine Cournil, Martin Peeters); Ministry of Health Eswatini, Mbabane, Eswatini (Maphalala Gugu);Ministry of Health, Malawi (Matthew's Kagoli, Rose Nyirenda, Sikhona Chipeta); Uganda Virus Research Institute, Entebbe, Uganda (Christine Watera); National Reference Laboratory, Surveillance Laboratory, Eswatini (Gugu Maphalala); World Health Organization, Dar es Salaam, United Republic of Tanzania (Christine Chiedza Musanhu); National Microbiology Reference Laboratory, Harare, Zimbabwe (Sekesai Mtapuri-Zinyowera).

[a]*HIV/Hepatitis/STI Department, World Health Organization, Geneva, Switzerland;* [b]*Tufts University School of Medicine, Boston, USA;* [c]*Ministry of Health, Lilingwe, Malawi;* [d]*Centers for Disease Control &*

Prevention, Lilongwe, Malawi; [e]Faculty of Health Sciences, Molecular Biology Laboratory, University of Lomé, Lomé, Togo; [f]Global Health Systems Solutions, Douala, Cameroon; [g]Department of Haematology and Blood Transfusion, Lagos University Teaching Hospital, and College of Medicine of the University of Lagos, Lagos, Nigeria; [h]Instituto Nacional de Saúde, Maputo, Mozambique; [i]National Institute for Communicable Diseases, Johannesburg, South Africa; [j]Uganda Virus Research Institute, Entebbe, Uganda; [k]Ministry of Health Eswatini, Mbabane, Eswatini; [l]Ministry of Health and Child Care, Harare, Zimbabwe; [m]Amsterdam Institute for Global Health and Development, and Department of Global Health, Amsterdam UMC, University of Amsterdam, The Netherlands; and [n]Johns Hopkins University. School of Medicine, Baltimore, Maryland, USA.

Correspondence to Silvia Bertagnolio, Department of HIV, Hepatitis, and STI, World Health Organization, Avenue Appia 20, Geneva, Switzerland.
Tel: +41 79 7288078; e-mail: bertagnolios@who.int

Received: 17 January 2020; revised: 30 March 2020; accepted: 7 April 2020.

References

1. Fogel J, Li Q, Taha TE, Hoover DR, Kumwenda NI, Mofenson LM, *et al*. **Initiation of antiretroviral treatment in women after delivery can induce multiclass drug resistance in breastfeeding HIV-infected infants.** *Clin Infect Dis* 2011; **52**:1069–1076.
2. Inzaule SC, Weidle PJ, Yang C, Ndiege K, Hamers RL, de Wit TFR, *et al*. **Prevalence and dynamics of the K65R drug resistance mutation in HIV-1-infected infants exposed to maternal therapy with lamivudine, zidovudine and either nevirapine or nelfinavir in breast milk.** *J Antimicrob Chemother* 2016; **71**:1619–1626.
3. Louis FJ, Segaren N, Desinor O, Beard RS, Jean-Louis R, Chang J, *et al*. **High levels of HIV-1 drug resistance in children who acquired HIV infection through mother to child transmission in the era of option B+, Haiti, 2013 to 2014.** *Pediatr Infect Dis J* 2019; **38**:503–507.
4. Poppe LK, Chunda-Liyoka C, Kwon EH, Gondwe C, West JT, Kankasa C, *et al*. **HIV drug resistance in infants increases with changing prevention of mother-to-child transmission regimens.** *AIDS* 2017; **31**:1885–1889.
5. Zeh C, Weidle PJ, Nafisa L, Lwamba HM, Okonji J, Anyango E, *et al*. **HIV-1 drug resistance emergence among breastfeeding infants born to HIV-infected mothers during a single- arm trial of triple-antiretroviral prophylaxis for prevention of mother-to-child transmission: a secondary analysis.** *PLoS Med* 2011; **8**:1–10.
6. Liu TF, Shafer RW. **Web resources for HIV type 1 genotypic-resistance test interpretation.** *Clin Infect Dis Published Online First:* 2006; **42**:1608–1618.
7. World Health Organization. Surveillance of HIV drug resistance in children newly diagnosed with HIV by early infant diagnosis. Published Online First: 2017. Available at: https://www.who.int/hiv/pub/drugresistance/hivdr-concept-note-2017/en/. (Accessed 30 March 2020)
8. Clinton Health Access Initiative. HIV market report: The state of the HIV treatment, testing, and prevention markets in low- and middle-income countries, 2017-2022.; 2018. https://clintonhealthaccess.org/wp-content/uploads/2018/09/2018-HIV-Market-Report_FINAL.pdf . (Accessed 30 March 2020)
9. Boerma RS, Sigaloff KCE, Akanmu AS, Inzaule S, Boele van Hensbroek M, Rinke de Wit TF, *et al*. **Alarming increase in pretreatment HIV drug resistance in children living in sub-Saharan Africa: a systematic review and meta-analysis.** *J Antimicrob Chemother* 2017; **72**:365–371.
10. World Health Organization. HIV drug resistance report:2019. https://www.who.int/hiv/pub/drugresistance/hivdr-report-2019/en/. (Accessed March 18, 2020).
11. Stockdale AJ, Saunders MJ, Boyd MA, Bonnett LJ, Johnston V, Wandeler G, *et al*. **Effectiveness of protease inhibitor/nucleos(t)ide reverse transcriptase inhibitor–based second-line antiretroviral therapy for the treatment of human immunodeficiency virus type 1 infection in Sub-Saharan Africa: a systematic review and meta-analysis.** *Clin Infect Dis* 2017; **66**:1846–1857.
12. Diallo K, Gotte M, Wainberg MA. **Molecular impact of the M184 V mutation in human immunodeficiency virus type 1 reverse transcriptase.** *Antimicrob Agents Chemother* 2003; **47**:3377–3383.
13. World Health Organization. Update of recommendations on first- and second-line antiretroviral regimens Policy brief. https://apps.who.int/iris/bitstream/handle/10665/325892/WHO-CDS-HIV-19.15-eng.pdf?ua=1. (Accessed 15 August 15 2019)
14. Clutter DS, Jordan MR, Bertagnolio S, Shafer RW. **HIV-1 drug resistance and resistance testing.** *Infect Genet Evol* 2016; **46**:292–307.
15. Eron JJ, Young B, Cooper DA, Youle M, Dejesus E, Andrade-Villanueva J, *et al*., SWITCHMRK 1 and 2 investigators. **Switch to a raltegravir-based regimen versus continuation of a lopinavir-ritonavir-based regimen in stable HIV-infected patients with suppressed viraemia (SWITCHMRK 1 and 2): two multicentre, double-blind, randomised controlled trials.** *Lancet (London, England)* 2010; **375**:396–407.
16. Nachman S, Alvero C, Teppler H, Homony B, Rodgers AJ, Graham BL, *et al*. **Safety and efficacy at 240 weeks of different raltegravir formulations in children with HIV-1: a phase 1/2 open label, nonrandomised, multicentre trial.** *lancet HIV* 2018; **5**:e715–e722.
17. DHHS. Recommendations for use of antiretroviral drugs in pregnant HIV-1-infected women for maternal health and interventions to reduce perinatal HIV transmission in the United States.; 2016. Available at: https://aidsinfo.nih.gov/contentfiles/lvguidelines/PerinatalGL.pdf. (Accessed 05 April 2017)
18. Ait-Khaled M, Rakik A, Griffin P, Cutrell A, Fischl MA, Clumeck N, *et al*., CNA3003 International Study Team. **Mutations in HIV-1 reverse transcriptase during therapy with abacavir, lamivudine and zidovudine in HIV-1-infected adults with no prior antiretroviral therapy.** *Antivir Ther* 2002; **7**:43–51.
19. Dickinson L, Walimbwa S, Singh Y, Kaboggoza J, Kintu K, Sihlangu M, et al. Infant exposure to dolutegravir through placental and breastmilk transfer: a population PK analysis of Dolphin-1. In: 20th International Workshop on Clinical Pharmacology of HIV, Hepatitis & Other Antiviral Drugs Noordwijk, The Netherlands. 2019.

DOI:10.1097/QAD.0000000000002580

Nonmelanoma skin cancer and melanoma in HIV-1-infected patients

Alessandra Latini[a], Lavinia Alei[a], Francesca Magri[b], Laura Eibenschutz[c], Carlo Cota[d], Maria Gabriella Dona'[a], Norma Cameli[a], Antonio Cristaudo[a] and Mauro Zaccarelli[e]

In the cART era, the incidence of AIDS-defining cancers decreased, whereas a persistence of non-AIDS-defining cancers has been observed. In particular, concerning the risk of melanoma and nonmelanoma skin cancers in HIV patients, conflicting data are available. In this study, our aim was to assess the occurrence of cutaneous malignancies in 97 HIV-positive individuals visited in our Institute,