Journal of Infection and Public Health (2016) 9, 396—407

http://www.elsevier.com/locate/jiph

REVIEW

Eliminating mother-to-child transmission of the human immunodeficiency virus in sub-Saharan Africa: The journey so far and what remains to be done

Olatunji O. Adetokunboh[a,*], **Mojisola Oluwasanu**[b]

[a] *Division of Community Health, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa*
[b] *Department of Health Promotion and Education, Faculty of Public Health, University College of Health, University of Ibadan, Ibadan, Nigeria*

Received 17 February 2015; received in revised form 10 June 2015; accepted 12 June 2015

KEYWORDS
Global Plan;
Mother-to-child transmission;
HIV;
Priority countries;
Sub-Saharan Africa

Summary This review was carried out to provide a comprehensive overview of efforts toward elimination of mother-to-child transmission (MTCT) of human immunodeficiency virus (HIV) with respect to progress, challenges, and recommendations in 21 sub-Saharan African priority countries. We reviewed literature published from 2011 to April 2015 using 3 databases; PubMed, Scopus, and Web of Science, as well as the 2014 Global Plan Progress Report. A total of 39 studies were included. Between 2009 and 2013, there was a 43% reduction in new HIV infections, the final MTCT rate was reduced from 28% to 18%, and antiretroviral therapy (ART) coverage increased from 11% to 24%. Challenges included poor adherence to antiretroviral therapy, poor linkage between mother—child pairs and post-natal healthcare services low early infant diagnosis coverage, low pediatric ART coverage, and high unmet needs for contraceptive services. Future recommendations include identification of key barriers, health system strengthening, strengthening community involvement, and international collaboration. There has been significant progress toward eliminating MTCT of HIV, but more effort is still needed.

* Corresponding author at: Division of Community Health, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town 7505, South Africa. Tel.: +27 732115373.
E-mail address: adetok_sic@yahoo.com (O.O. Adetokunboh).

http://dx.doi.org/10.1016/j.jiph.2015.06.010

Contents

Introduction

Human immunodeficiency virus (HIV) infection contributes significantly to causes of death in sub-Saharan African countries [1]. Mother-to-child transmission (MTCT) of HIV occurs during pregnancy, labor, and breastfeeding [2]. New pediatric HIV infections have declined since prevention of MTCT (PMTCT) programs were initiated in the 1990s, but 2009 records show that about 370,000 children were newly infected globally [3]. In 2009, it was estimated that 42,000—60,000 HIV-infected women died from HIV infection and its complications [3]. As at 2009, over 90% of the countries with high childhood HIV infection and high MTCT rates are located in sub-Saharan Africa. The majority of HIV-infected women requiring antiretroviral therapy (ART) for PMTCT are located in these countries. These countries also account for over 90% of HIV-infected children who need ART [3]. There is significant global disparity in rates of MTCT of HIV. High income countries record almost zero new pediatric HIV infections or maternal and infant mortalities due to HIV infection. However, most low and middle income countries, especially those located in sub-Saharan Africa, record substantial numbers of new infections, since relatively few women can access HIV prevention and treatment services. The same situation applies to their children, resulting in new pediatric infections and death [4].

In May 2009, the Joint United Nations Programme on HIV/AIDS (UNAIDS) made a clarion call for global elimination of MTCT (EMTCT). This call was supported by many other multilateral and bilateral agencies such as African Development Bank, Bill & Melinda Gates Foundation, Global Fund to Fight AIDS, Tuberculosis and Malaria etc. Other bodies such as regional coordinating bodies like African Union, Caribbean Community (CARICOM) and New Partnership for Africa's Development, national governments, and their HIV/acquired immunodeficiency syndrome (AIDS) control agencies were also involved. To further this noble cause, in 2010 the World Health Organization published new guidelines, which included the best available scientific and programmatic tools to accelerate reduction of MTCT and achieve the virtual EMTCT of HIV.

In the effort to eliminate new pediatric HIV infections, an initiative known as ''*Global Plan Towards the Elimination of New HIV Infections among Children by 2015 and Keeping their Mothers Alive*'' was launched in July 2011. This Global Plan covered low- and middle-income countries, but focused on high burden countries with the highest numbers of pregnant women living with HIV and new pediatric HIV infections. There are 22 such countries, referred to as priority countries, accounting for about 90% of pregnant women living with HIV globally. Twenty-one of these countries are located in sub-Saharan Africa, the 22nd being India, located in Asia. These countries need exceptional efforts to achieve the virtual elimination goal [3].

The Global Plan initiative focuses on HIV-infected women prior to pregnancy, through pregnancy, and until the end of the breastfeeding period, as well as their children. The treatment needs of the women and children, as well as the HIV preventive needs of the children aim to be met

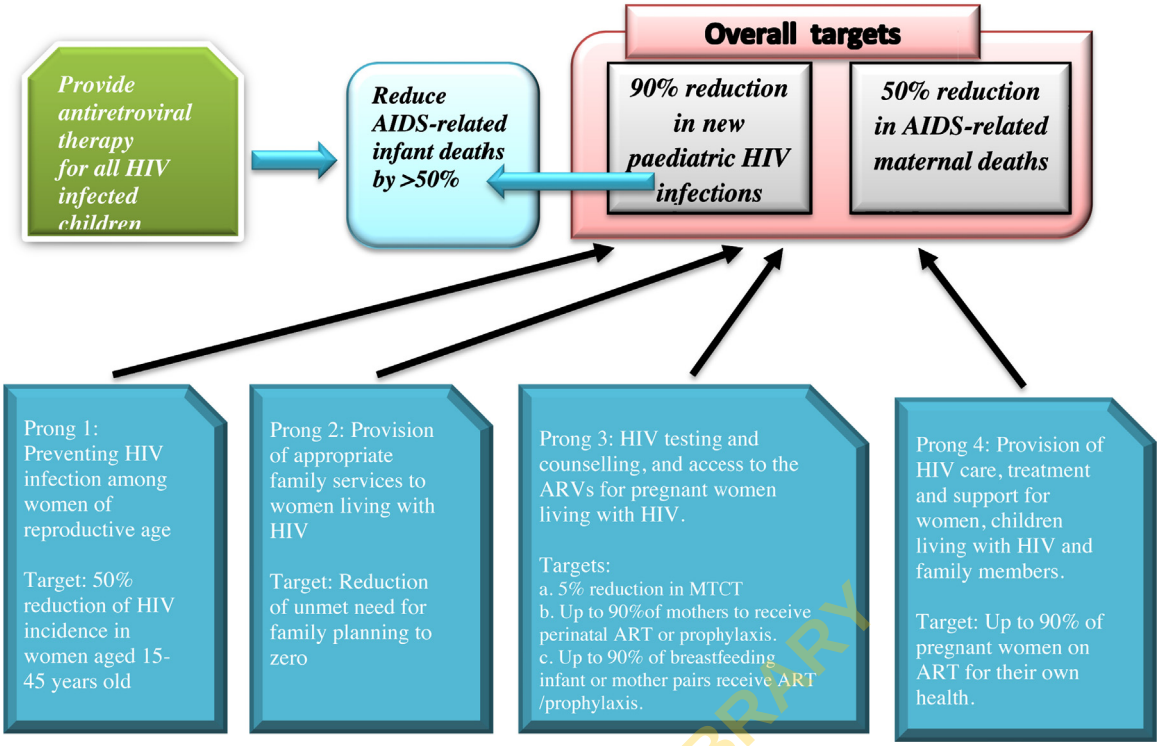

Figure 1 Global Plan main targets and indicators.

within the existing comprehensive healthcare programs in each of the affected countries.

Global Plan implementation program framework

The implementation of the Global Plan is based on 2 global targets and a 4-pronged strategy (Fig. 1). The strategy encompasses maternal and child treatment indicators, treatment and HIV prevention for newborns, child health services, and family planning services. The Global Plan is guided by the following 4 principles [3]:

1. Women and children living with HIV are at the epicenter of the initiative
2. Ownership by each country by developing national context-specific operational plans
3. Integration and linkage of existing healthcare programs for HIV, maternal and child health, family planning etc. for better sustainability
4. Shared responsibilities for preventing new HIV infections among children and keeping their mothers alive between families, communities, and countries, and specific accountability of resources and progress made by local and international developmental partners.

The Global Plan is also important for attaining Millennium Development Goals (MDGs) 4 (child survival), 5 (maternal health), and 6 (halting HIV/AIDS, malaria, and other diseases, and reversing the spread of HIV/AIDS) [5]. It was expected that the Global Plan targets and MDGs would be met by the end of 2015.

Objectives and purpose of this overview

This review was carried out to provide an overview of EMTCT of HIV efforts in sub-Saharan Africa priority countries with respect to the progress and challenges, and to make recommendations to address these challenges.

Although several reports (as shown in the Appendix 1) have addressed the progress, challenges, and recommendations concerning EMTCT of HIV in sub-Saharan Africa, most were limited to a single country in the region, or primarily discussed only 1 aspect of the initiative. We are not aware of any report extensively investigating all 3 aspects highlighted in this review. We expect the findings of this overview to be useful for healthcare policy makers and practitioners to re-strategize how to accomplish eliminating HIV infection in children, and to identify gaps for future research. This report is expected to inform and guide planning and decision-making mechanisms of national PMTCT/EMTCT programs.

Methods and designs

We conducted searches of 3 online databases: PubMed, Scopus, and Web of Science. The search was performed on April 8, 2015, and included literature published between July 2011, when the Global Plan was fully launched, and April 2015. No language limitations were imposed. The key words used for the search were elimination' and 'eradication' for all searches and added 'mother-to-child transmission', 'MTCT', and 'HIV'. Studies that did not clearly articulate the pre-specified themes of progress, challenges, and recommendations were excluded. The search was also limited to studies conducted in or involving sub-Saharan African countries. Search strategies using PubMed can be found in Appendix 1. Fig. 2 shows the flow diagram of the search and selection process.

We also searched the UNAIDS online database of 2014 progress reports submitted by the priority countries [4].

To assess the progress made in reduction of new HIV infections in children, the global targets and Prong 1, 2, and 4 target percentages for the priority countries were quantitatively analyzed with respect to the May 2013 expected targets and milestones.

Two of the targets and milestones assessed were:

- Reduction of new pediatric HIV infections by 50% from 2009 levels in 10 high burden countries (country-specific target and milestone).

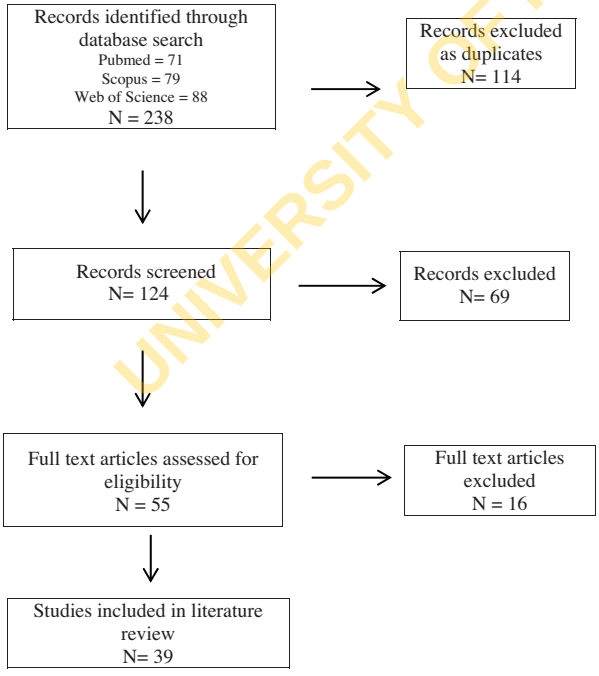

Figure 2 Flow diagram for article selection process of the review.

- Reduction of new pediatric HIV infections by 50% (global target and milestone) from 2009.

One limitation of the UNAIDS data was the lack of availability of current data with respect to AIDS-related deaths during pregnancy or within 42 days of the end of pregnancy. The most current available data was from 2010. Unmet needs for contraceptives among women living with HIV could not be properly assessed for most countries due to lack of current statistics and data from the priority countries. Some of the available data were collected more than 10 years ago. Another challenge was in quantitatively measuring the progress of the initiative, because a well-defined measurement of new pediatric HIV infections is not well developed in most countries. The majority of the progress report data were based on modeled estimates [4].

Results

A total of 238 abstracts were identified through searching the databases, and 124 articles were screened after removal of duplicates. A total of 55 full text articles were assessed for eligibility. A flow chart of the search and selection process is shown in Fig. 2. A final 39 relevant studies on the progress, challenges, and recommendations for EMTCT in sub-Saharan Africa since 2011 were included. Appendix 1 shows the general characteristics of the included studies.

Progress made by sub-Saharan African countries to eliminate MTCT of HIV

Expansion of PMTCT services in many sub-Saharan countries has contributed enormously to a progressive reduction in new pediatric HIV infections, which decreased by 58% between 2002 and 2013 [6]. Table 1 shows that the estimated number of new infections among children in the priority countries in sub-Saharan Africa reduced from 346,600 to 214,000 between 2009 and 2013 [4]. The total reduction in new pediatric HIV infections among the African priority countries was 42% between 2009 and 2013. The MTCT rate reduced from 28% in 2009 to 18% in 2013. New HIV infections among women 15—49 years old reduced from 742,500 in 2009 to 611,100 in 2013 (Table 2). There was a 40% reduction in AIDS-related mortality among children during this period [6]. Unmet needs for family planning services for women in general ranged between 13 and 34% among the priority countries. AIDS-related deaths during pregnancy or within the

Table 1 Global overall and prong targets data.

Priority countries	Overall target 1 Number of new infections among children			Overall target 2 AIDS-related deaths during pregnancy or within 42 days of the end of pregnancy		
	2009	2013	Percentage difference	2005	2010	Percentage difference
Angola	4400	4000	9	480	380	21
Botswana	<1000	<500	50	220	80	64
Burundi	2600	1300	50	380	300	21
Cameroun	14,000	9500	32	1100	980	11
Chad	4900	3700	25	460	380	17
Cote d'Ivoire	8200	4900	40	1400	940	33
Congo Democratic Rep.	10,000	7400	26	1140	1100	4
Ethiopia	20,000	8300	59	1740	760	56
Ghana	4800	2400	50	520	400	23
Kenya	21,000	13,000	38	3400	2200	35
Lesotho	4400	3400	23	420	320	24
Malawi	23,000	7400	68	2600	1800	31
Mozambique	27,000	12,000	56	2200	2400	-9
Namibia	2400	1100	46	220	150	31
Nigeria	63,000	51,000	19	7400	6600	11
South Africa	33,000	16,000	52	3600	3800	-6
Swaziland	1900	1100	42	220	150	31
Uganda	30,000	16,000	47	3000	2400	20
United Rep. of Tanzania	31,000	16,000	48	4000	3000	25
Zambia	19,000	12,000	37	2200	1620	26
Zimbabwe	21,000	9000	57	2800	1680	40
Total	346,600	214,700		39,500	31,430	

postpartum period reduced from 39,500 in 2005 to 31,430 in 2010 [4].

HIV testing for pregnant women and HIV-exposed infants has improved [6]. Early infant diagnosis (EID) increased, with an estimated 44% of HIV-exposed infants being tested before the age of 2 months old [6]. EID programs have been found to be an effective approach for evaluating EMTCT programs in some sub-Saharan African countries [7]. Medical laboratory data can now be utilized for cost-effective, real-time monitoring of EID aspect of PMTCT programs in parts of sub-Saharan Africa [8]. Provision of ART for pregnant women living with HIV has improved when compared to that in 2009; likewise, provision of ART for HIV-infected children is gradually gaining momentum [4]. The percentage of women receiving ART for PMTCT increased from 33% in 2009 to 63% in 2013, and the percentage of mothers or infants receiving ART during breastfeeding increased from 11% in 2009 to 51% in 2013. The percentage of ART coverage among children aged 0—14 years increased from 11% to 24% in the period 2009—2013 (as shown in Table 2) Targeted service integration of PMTCT and maternal, newborn, and child health services in public health settings has enhanced the timely initiation of ART among HIV-infected pregnant women [9]. Most of the countries are also adopting the Option B+ treatment model, which recommends initiation of ART for pregnant and breastfeeding women irrespective of their CD4 count [9]. This has led to adequate viral replication suppression among women living with HIV, thereby giving a promising EMTCT prospectus [10].

Challenges

Neither healthcare providers nor HIV-infected women always adhere to guidelines and recommendations made by PMTCT programs [2,11—13]. Low HIV testing rates during pregnancy, suboptimal healthcare coverage, and poor patient retention are other issues to overcoming HIV infection [6]. The accessibility to continuous care for HIV-infected mothers during the post-natal period and EID for HIV-exposed infants are both low [14]. Delayed testing of HIV-exposed infants delays initiation of ART, and results in missed perinatal care opportunities [15]. A study conducted in Senegal showed that HIV testing and treatment is not yet fully integrated into reproductive

Table 2 Prong targets data.

Priority countries	Prong target 1 New HIV infections among women 15–49 years old			Prong target 2a Final mother to child transmission rate (%)		Prong target 2c Percentage of women or infants receiving antiretroviral medicines During breastfeeding to prevent MTCT (%)		Prong target 4 Antiretroviral therapy coverage among children 0–14 years old (%)	
	2009	2013	Percentage difference	2009	2013	2009	2013	2009	2013
Angola	10,000	13,000	−30	33	25	0	39	7	14
Botswana	5900	4500	24	5	2	31	>95	43	84
Burundi	<500	<500	–	34	25	0	22	9	12
Cameroun	22,000	20,000	9	32	25	8	16	3	6
Chad	5800	4700	19	34	32	7	19	2	5
Cote d'Ivoire	5800	7200	−24	29	23	6	20	5	8
Congo Dem Rep	15,000	14,000	7	36	29	0	17	8	8
Ethiopia	6200	7800	−26	39	25	2	55	4	9
Ghana	6700	3000	55	32	21	0	30	4	11
Kenya	52,000	48,000	8	26	16	17	63	12	31
Lesotho	13,000	12,000	8	27	22	11	41	11	15
Malawi	22,000	14,000	36	32	13	4	79	8	24
Mozambique	55,000	54,000	2	26	12	7	84	8	22
Namibia	5300	5700	−8	22	10	11	56	34	45
Nigeria	120,000	88,000	27	31	26	4	19	5	12
South Africa	220,000	160,000	27	12	6	63	90	8	44
Swaziland	6800	5200	24	19	10	18	49	23	46
Uganda	66,000	67,000	2	31	13	0	75	9	22
United Rep of Tanzania	40,000	30,000	25	27	16	28	73	4	16
Zambia	26,000	20,000	23	24	15	16	43	13	33
Zimbabwe	39,000	33,000	15	30	13	1	78	10	27
Total	742,500	611,100		28	18				

health services, misconceptions about ART contributes to poor adherence to treatment regimens, and the organization of health services hampers HIV prevention in families [16]. Inadequate use of ART and insufficiently skilled care workers also pose challenges [17]. Other challenges were late presentation for health care delivery service during pregnancy, inadequate ante-natal visits, poor opportunistic infection screening, non-disclosure of HIV-positive status to partners, and inadequate family planning counseling [11,18,19]. Sociocultural challenges such as pressures from family members and cultural practices were associated with a risk of mixed infant feeding as a result of feeding preferences and poor maternal adherence to recommended infant feeding guidelines [20]. Feucht et al. found that access to HIV services prior to conception, family planning, tuberculosis screening, HIV disclosure, psychosocial support, and post-natal care had not improved within the PMTCT services in a South African hospital, and that there had been an overall deterioration in consistent infant feeding messages conveyed to HIV-positive women [21]. Plans to involve men in PMTCT services were limited to mostly HIV testing and counseling with minimal provision for men treatment, care and support and all these tended to alienate them rather than sustaining their involvement [22].

Recommendations

There is a need to identify key barriers to EMTCT and to develop strategies to address unmet needs, such as for family planning services for women living with HIV [11,23—27]. Interventions to improve accessibility of ART and other essential medicines, improve the quality of obstetric services, and encourage institutional delivery should be implemented [14,26]. Efforts should be made to adapt audience-specific informational and educational materials, strengthen existing community involvement and address patient-related factors like unknown maternal HIV infection status before pregnancy, late commencement of antenatal care services, unplanned pregnancies, and low levels of educational status [17,19]. There is also need to increase family oriented and culture-friendly community-based PMTCT programs [28—33]. Dillabaugh et al. showed that a Rapid Results Initiative (RRI) which is an approach that affect organization change and improve performance in order to expedite projects and optimize limited resources, could be used to tackle key challenges encountered during delivery of PMTCT services. The team used RRI approach based on continuous quality improvement and Plan, Do, See, Act methods to implement execute a PMTCT project with 60 days implementation time frame. There was a significant improvement in PMTCT services with benefits to the HIV-infected mothers and their infants [34].

Women living with HIV should be encouraged to disclose their HIV status to their partners [18], and should be helped to overcome barrier like retaining women in care which is responsible for poor treatment adherence through dedicated efforts [35,36]. Monitoring of HIV-1 RNA levels in breastfeeding populations is crucial for reducing HIV-1 MTCT [18]. Integrating childhood immunization with mother-infant clinics may improve patient retention. Provision of maternal HIV testing during childhood immunization visits may enhance earlier detection of HIV-exposed infants [37]. Mother-infant care within both breastfeeding and non-breastfeeding populations should go beyond the postpartum period [38].

Health system challenges faced by most priority countries should be addressed by prioritization of implementation actions, optimization of PMTCT services, and efforts to remove various local bottlenecks via the application of implementation science [21,39]. This can be done using quality improvement tools and by applying data-driven decentralized planning and monitoring [40]. There is need to strengthen and improve access to diagnostic services, particularly focusing on EID, improved patient retention, and encouraging pregnant women to start ante-natal care early [15,41]. Preventive measures should be strengthened, particularly with regard to effective treatment delivery and development of new preventive measures, such as vaccines [19,41]. Behavioral economics can be incorporated into PMTCT programs to increase uptake and improve patient retention with minimal investment with the use of mentor mothers, economic incentives, default bias in form of opt-out testing and loss aversion [42]. Male-specific services and benefits should be established and integrated into the PMTCT framework [22]. Countries may also need to request technical and financial support from international and bilateral partners [43]. All international and national stakeholders should ensure wise utilization of resources to strengthen healthcare delivery services [43,44]. National leadership and international partners should endeavor to rapidly translate recent evidence-based findings into policy and practice [45]. Integration of stigma-reduction components into PMTCT and other reproductive health services is crucial. Stigma can be reduced by identifying, listening and involving women living with HIV in PMTCT service delivery. The communities and the

male partners of women living with HIV should be engaged [46]. To adopt Option B+ policy recommendations, there is need for patient-level research to determine which ''models of care'' are appropriate and feasible for HIV-infected pregnant women to initiate and continue on lifelong ART [47].

Discussion

The level of reduction of MTCT of HIV in children is still sub-optimal and bedeviled with challenges in many priority countries, in spite of the progress made in the last few years. Malawi achieved the highest reduction (68%) in new pediatric HIV infections between 2009 and 2013 compared to other priority countries [4]. This seemed attributable to adopting Option B+ in 2011, which tremendously improved the effectiveness of their PMTCT program [47]. Other countries like Botswana, Burundi, Ghana, Ethiopia, Mozambique, South Africa, and Zimbabwe also achieved remarkable reduction in new pediatric HIV infections. However, Angola, Chad, Democratic Republic of Congo, Lesotho, and Nigeria lag behind. Nigeria being included in this list is concerning considering that the highest number (1:3) of all new pediatric infections in sub-Saharan Africa occur in Nigeria. Nigeria has low coverage of PMTCT interventions, patient retention, and treatment adherence rates among HIV-positive women [48]. Angola is also a concern because the country experienced only a 9% reduction in pediatric HIV infections since 2009 [4]. There has been a reduction in AIDS-related deaths among pregnant women or during the puerperal period between 2005 and 2010, with the exception of Mozambique and South Africa. HIV infections among reproductive-aged women have significantly decreased, with Botswana and South Africa having the most reduced numbers of infections. These 2 countries had already reached the 5% target for the reduction in MTCT rate as result of the implementation of Global Plan by 2013 [4].

More women are currently accessing ART, thereby reducing the possibility of MTCT of HIV compared to 2009. There was a significant increase in ART coverage for pregnant women living with HIV in most countries. Botswana, Namibia, Swaziland, and South Africa had already achieved the 90% target for the percentage of women receiving ART to PMTCT while Chad is still underperforming in this aspect of intervention. The priority countries made commendable strides in increasing ART for both the mother and children during the breastfeeding period to PMTCT. The majority of countries did not have this program in place in 2009 but it was in place in all the priority countries as soon as Global Plan initiative started. Further increases in ART usage are expected to translate into lower MTCT rates. There has been a gradual increase in the number of children on ART, but more than two-thirds of eligible children could not assess the needed medication in most priority countries due to non-availability and inadequate supply provision of ART for children is still far below optimal level, especially when compared to adult ART coverage. Preventive services such as family planning have stagnated in many countries, with many women unable to access sufficient contraceptives.

There has been great disparity among the priority countries since inception of the Global Plan initiative with respect to healthcare infrastructures, capital, and human resources needed to achieve the ambitious goals and targets [42]. Implementation of various PMTCT programs throughout Africa was not homogenous, which has resulted in many women not having access to the appropriate interventions to PMTCT. Variant levels of coverage exist between countries. Some countries had good—moderate healthcare systems and national policies that were already yielding positive results before 2011, while others were not doing well. These factors may explain better performance in Southern Africa compared to other parts of Africa. South African countries had the highest disease burden, but had better infrastructure and resources than other parts of Africa.

This review identified several challenges hampering the virtual EMTCT of HIV in sub-Saharan Africa. The challenges could be classified as patient-, healthcare worker-, health system-, or policy maker-related. Several recommendations were given to overcome challenges in African countries, which should inform future strategies and policies. Challenges varied from country to country and require country/challenge specific approaches. Most recommendations are generally applicable to all sub-Saharan African priority countries, while some are crucial for certain countries. Targeting HIV preventive programs for at-risk women will contribute significantly to reduced HIV burden and need for prophylactic and continued ART [49].

Conclusion

There has been significant progress among most sub-Saharan African priority countries in the fight against HIV infection, as seen by reduced MTCT,

fewer children newly infected by HIV, improved and increased access to care and treatment for infected mothers and children, increased ART coverage for pregnant women living with HIV, and reduced deaths associated with AIDS during pregnancy or within the postpartum period.

However, only 8 countries have achieved a 50% reduction in estimated new HIV infections among children aged 0—14 years, thereby falling short of the target of 10 countries by May 2013 [3]. New pediatric HIV infections within the priority countries declined by 42%, while the target was 50%. More effort is needed in countries including Angola, Nigeria, and the Democratic Republic of Congo, or achieving the Global Plan's goals will remain elusive [4,41]. It is also important to sustain the momentum in well performing priority countries. Achieving a virtual EMTCT of HIV by the end of 2015 is not likely possible. However, there is undoubtedly a gradual achievement of MDGs 4, 5, and 6 which deal with reduction of child mortality, improving maternal health, and combating HIV/AIDS and other diseases Just like the Global Plan goals, attaining these MDGs in all African countries by the end of 2015 requires extraordinary collaborative efforts such as increased funding and infrastructural development. Further research is needed to critically evaluate the impact of the Global Plan post-2015, and to frame strategies to complete the task of eliminating new pediatric HIV infections and keeping mothers alive in sub-Saharan Africa and other parts of the world.

Authors' contributions

OOA conceived of the study and the two authors were involved in the design, data collection, and analysis. The initial manuscript draft was prepared by OOA, and MMO revised the final draft. Both authors approved the final draft for submission.

Funding

No funding sources.

Competing interests

None declared.

Ethical approval

Not required.

Acknowledgement

The authors thank the Joint United Nations Programme on HIV/AIDS for the use of the Global Plan Progress Report data for research purposes.

Appendix 1. Characteristics of the included studies

Author	Type of study	Study settings/coverage	Interventions
Abrams 2013	Review	Global	Progress, challenges, recommendations
Ackerman Gulaid 2012	Review	Global	Recommendations
Aizire 2013	Review	Sub-Saharan Africa	Recommendations
Berhan 2014	Cross-sectional	Ethiopia	Challenges, recommendations
Bhardwaj 2014	Surveillance	South Africa	Recommendations
Binagwaho 2013	Cost effectiveness analysis	Rwanda	Recommendations
Bucagu 2013	Cohort	Rwanda	Challenges, recommendations
Busza 2012	Review	Global	Recommendations
Chi 2013	Review	Global	Recommendations
Chi 2012	Review	Sub-Saharan Africa	Progresses, challenges, recommendations
Ciaranello 2012	Cohort	Zimbabwe	Recommendations
Colombini 2013	Review	Sub-Saharan Africa	Recommendations
Dillabaugh 2012	Rapid result initiative	Kenya	Progress
Doherty 2013	Review	Global	Recommendations
du Plessis 2014	Facility survey	Kenya	Challenges, recommendations
Feucht 2015	Descriptive study	South Africa	Progress, challenges, recommendations
Gamell 2013	Cross-sectional	Tanzania	Challenges, recommendations

Author	Type of study	Study settings/coverage	Interventions
Govender 2014	Review	Sub-Saharan Africa	Recommendations
Horwood 2012	Cross-sectional	South Africa	Progress
Hurst 2015	Review	Global	Recommendations
Iwelunmor 2014	Review	Nigeria	Recommendations
Lawani 2014	Cross sectional	Nigeria	Challenges
Lilian 2013	Cohort	South Africa	Challenges, recommendations
Mazzeo 2012	Review	Global	Recommendations
Mirkuzie 2011	Cohort	Ethiopia	Challenges, recommendation
Mnyani 2014	Case control	South Africa	Challenges, recommendations
Mugasha 2014	Cross-sectional	Uganda	Progress
Okafor 2014	Cross sectional	Nigeria	Progress
Onono 2015	Case control	Kenya	Challenges
Prendergast 2015	Review	Global	Progresses, challenges
SaoundeTemgoua 2015	Cross-sectional	Cameroun	Progress
Sherman 2014	Population surveillance	South Africa	Progress
Sherr 2012	Review	Global	Challenges, recommendations
Shetty 2013	Review	Sub-Saharan Africa	Progresses, recommendations
Sturke 2014	Review	Sub-Saharan Africa	Recommendations
Taylor 2013	Review	Global	Recommendation
Turan 2013	Review	Low-income countries	Challenges, recommendations
van Lettow 2014	Facility survey	Malawi	Recommendations
Wilcher 2013	Review	Global	Challenges, recommendations

References

[1] Verguet S, Norheim OF, Olson ZD, Yamey G, Jamison DT. Annual rates of decline in child, maternal, HIV, and tuberculosis mortality across 109 countries of low and middle income from 1990 to 2013: an assessment of the feasibility of post-2015 goals. Lancet Global Health 2014;12:e698—709.

[2] Mofenson LM. Antiretroviral drugs to prevent breastfeeding HIV transmission. Antivir Ther 2010;15:537—53.

[3] Joint United Nations Programmes on HIV/AIDS. Countdown to zero. Global plan towards the elimination of new HIV infections among children by 2015 and keeping their mothers alive. 2011—2015; 2011. Available at: http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/20110609_JC2137_Global-Plan-Elimination-HIV-Children_en.pdf [accessed 10.04.15].

[4] Joint United Nations Programmes on HIV/AIDS. Progress report on the global plan towards the elimination of new HIV infections among children by 2015 and keeping their mothers alive; 2014. Available at: http://www.unaids.org/sites/default/files/documents/JC2681_2014-Global-Plan-progress_en.pdf [accessed 10.04.15].

[5] World Health Organization. PMTCT strategic vision 2010—2015: preventing mother-to-child transmission of HIV to reach the UNGASS and Millennium Development Goals; 2010. Available at: http://www.who.int/hiv/pub/mtct/strategic_vision.pdf?ua=1 [accessed 19.04.15].

[6] Prendergast AJ, Essajee S, Penazzato M. HIV and the millennium development goals. Arch Dis Child 2015;100:S48—52.

[7] SaoundeTemgoua EM, Nkenfou CN, Zoung-Kanyi Bissek AC, Fokam J, Billong SC, Sosso SM, et al. HIV-1 early infant diagnosis is an effective indicator of the prevention of mother-to-child transmission program performance: Experience from Cameroon. Curr HIV Res 2015 [Apr 7: Epub ahead of print].

[8] Sherman GG, Lilian RR, Bhardwaj S, Candy S, Barron P. Laboratory information system data demonstrate successful implementation of the prevention of mother-to-child transmission programme in South Africa. S Afr Med J 2014;104:235—8.

[9] Chi BH, Bolton-Moore C, Holmes CB. Prevention of mother-to-child HIV transmission within the continuum of maternal, newborn, and child health services. Curr Opin HIV AIDS 2013;8:498—503.

[10] Okafor I, Ugwu E, Obi S, Odugu B. Virtual elimination of mother-to-child transmission of human immunodeficiency virus in mothers on highly active antiretroviral therapy in Enugu, South-Eastern Nigeria. Ann Med Health Sci Res 2014;4:615—8.

[11] du Plessis E, Shaw SY, Gichuhi M, Gelmon L, Estambale BB, Lester R, et al. Prevention of mother-to-child transmission of HIV in Kenya: challenges to implementation. BMC Health Serv Res 2014;14:S10.

[12] Gamell A, Letang E, Jullu B, Mwaigomole G, Nyamtema A, Hatz C, et al. Uptake of guidelines on prevention of mother-to-child transmission of HIV in rural Tanzania: time for change. Swiss Med Wkly 2013;143:w13775.

[13] Onono M, Owuor K, Turan J, Bukusi EA, Gray GE, Cohen CR. The role of maternal, health system, and psychosocial factors in prevention of mother-to-child transmission failure in the era of programmatic scale up in western Kenya: a case control study. AIDS Patient Care STDS 2015;29:204—11.

[14] Mugasha C, Kigozi J, Kiragga A, Muganzi A, Sewankambo N, Coutinho A, et al. Intra-facility linkage of HIV-positive mothers and HIV-exposed babies into HIV chronic care: rural and urban experience in a resource limited setting. PLOS ONE 2014;9:e115171.

[15] Lilian RR, Kalk E, Technau KG, Sherman GG. Birth diagnosis of HIV infection in infants to reduce infant mortality and monitor for elimination of mother-to-child transmission. Pediatr Infect Dis J 2013;32:1080—5.

[16] Desclaux A, Sow K, Mbaye N, Signaté H. Moving from prevention to elimination of mother-to-child transmission of HIV before 2015, an unrealistic objective? Social stakes in Senegal. Med Sante Trop 2012;22:238—45.
[17] Berhan Z, Abebe F, Gedefaw M, Tesfa M, Assefa M, Tafere Y. Risk of HIV and associated factors among infants born to HIV positive women in Amhara region, Ethiopia: a facility based retrospective study. BMC Res Notes 2014;7:876.
[18] Bucagu M, Bizimana Jde D, Muganda J, Humblet CP. Socio-economic, clinical and biological risk factors for mother-to-child transmission of HIV-1 in Muhima health centre (Rwanda): a prospective cohort study. Arch Public Health 2013;71:4.
[19] Mnyani CN, Simango A, Murphy J, Chersich M, McIntyre JA. Patient factors to target for elimination of mother-to-child transmission of HIV. Global Health 2014;10:36.
[20] Lawani LO, Onyebuchi AK, Iyoke CA, Onoh RC, Nkwo PO. The challenges of adherence to infant feeding choices in prevention of mother-to-child transmission of HIV infections in South East Nigeria. Patient Prefer Adherence 2014;8:377—81.
[21] Feucht UD, Meyer A, Kruger M. Missing HIV prevention opportunities in South African children-A 7-year review. BMC Public Health 2014;14:1265.
[22] Sherr L, Croome N. Involving fathers in prevention of mother to child transmission initiatives—what the evidence suggests. J Int AIDS Soc 2012;15(Suppl 2):17378.
[23] Chi BH, Adler MR, Bolu O, Mbori-Ngacha D, Ekouevi DK, Gieselman A, et al. Progress, challenges, and new opportunities for the prevention of mother-to-child transmission of HIV under the US President's Emergency Plan for AIDS Relief. J Acquir Immune Defic Syndr 2012;60(Suppl 3):S78—87.
[24] Wilcher R, Petruney T, Cates W. The role of family planning in elimination of new pediatric HIV infection. Curr Opin HIV AIDS 2013;8:490—7.
[25] Aizire J, Fowler MG, Coovadia HM. Operational issues and barriers to implementation of prevention of mother-to-child transmission of HIV (PMTCT) interventions in Sub-Saharan Africa. Curr HIV Res 2013;11:144—59.
[26] Mazzeo CI, Flanagan EH, Bobrow EA, Pitter CS, Marlink R. How the global call for elimination of pediatric HIV can support HIV-positive women to achieve their pregnancy intentions. Reprod Health Matters 2012;20(39 Suppl):90—102.
[27] Ackerman Gulaid L, Kiragu K. Lessons learnt from promising practices in community engagement for the elimination of new HIV infections in children by 2015 and keeping their mothers alive: summary of a desk review. J Int AIDS Soc 2012;15(Suppl 2):17390.
[28] Ciaranello AL, Perez F, Keatinge J, Park JE, Engelsmann B, Maruva M, et al. What will it take to eliminate pediatric HIV? Reaching WHO target rates of mother-to-child HIV transmission in Zimbabwe: a model-based analysis. PLoS Med 2012;9:e1001156.
[29] Iwelunmor J, Ezeanolue EE, Airhihenbuwa CO, Obiefune MC, Ezeanolue CO, Ogedegbe GG. Socio-cultural factors influencing the prevention of mother-to-child transmission of HIV in Nigeria: a synthesis of the literature. BMC Public Health 2014;14:771.
[30] Mirkuzie AH, Hinderaker SG, Sisay MM, Moland KM, Mørkve O. Current status of medication adherence and infant follow up in the prevention of mother to child HIV transmission programme in Addis Ababa: a cohort study. J Int AIDS Soc 2011;14:50.
[31] Abrams EJ, Myer L. Can we achieve an AIDS-free generation? Perspectives on the global campaign to eliminate new pediatric HIV infections. J Acquir Immune Defic Syndr 2013;63(Suppl 2):S208—12.
[32] Busza J, Walker D, Hairston A, Gable A, Pitter C, Lee S, et al. Community-based approaches for prevention of mother to child transmission in resource-poor settings: a social ecological review. J Int AIDS Soc 2012;15(Suppl 2):17373.
[33] Dillabaugh LL, Lewis Kulzer J, Owuor K, Ndege V, Oyanga A, Ngugi E, et al. Towards elimination of mother-to-child transmission of HIV: the impact of a rapid results initiative in Nyanza Province, Kenya. AIDS Res Treat 2012;2012:602120.
[34] Colombini M, Stöckl H, Watts C, Zimmerman C, Agamasu E, Mayhew SH. Factors affecting adherence to short-course ARV prophylaxis for preventing mother-to-child transmission of HIV in sub-Saharan Africa: a review and lessons for future elimination. AIDS Care 2014;26:914—26.
[35] Doherty K, Ciaranello A. What is needed to eliminate new pediatric HIV infections: the contribution of model-based analyses. Curr Opin HIV AIDS 2013;8:457—66.
[36] Kellerman SE, Ahmed S, Feeley-Summerl T, Jay J, Kim M, Phelps BR, et al. Beyond prevention of mother-to-child transmission: keeping HIV-exposed and HIV-positive children healthy and alive. AIDS 2013;27(Suppl 2):S225—33.
[37] Hurst SA, Appelgren KE, Kourtis AP. Prevention of mother-to-child transmission of HIV Type 1: the role of neonatal and infant prophylaxis. Expert Rev Anti Infect Ther 2015;13:169—81.
[38] Sturke R, Harmston C, Simonds RJ, Mofenson LM, Siberry GK, Watts DH, et al. A multi-disciplinary approach to implementation science: the NIH-PEPFAR PMTCT Implementation Science Alliance. J Acquir Immune Defic Syndr 2014;67(Suppl 2):S163—7.
[39] Bhardwaj S, Barron P, Pillay Y, Treger-Slavin L, Robinson P, Goga A, et al. Elimination of mother-to-child transmission of HIV in South Africa: rapid scale-up using quality improvement. S Afr Med J 2014;104:239—43.
[40] Ghadrshenas A, Ben Amor Y, Chang J, Dale H, Sherman G, Vojnov L, et al. Improved access to early infant diagnosis is a critical part of a child-centric prevention of mother-to-child transmission agenda. AIDS 2013;27(Suppl 2):S197—205.
[41] Govender T, Coovadia H. Eliminating mother to child transmission of HIV-1 and keeping mothers alive: recent progress. J Infect 2014;68:S57—62.
[42] Taylor NK, Buttenheim AM. Improving utilization of and retention in PMTCT services: can behavioral economics help? BMC Health Serv Res 2013;13:406.
[43] Mofenson LM. Prevention of mother-to-child HIV transmission: can we meet the goal of global elimination of new pediatric infections? Curr Opin HIV AIDS 2013;8:443—6.
[44] Lyons C, Mushavi A, Ngobeni-Allen F, Yule R, Abrams E. Ending pediatric AIDS and achieving a generation born HIV-free. J Acquir Immune Defic Syndr 2012;60(Suppl 2):S35—8.
[45] Shetty AK. Epidemiology of HIV infection in women and children: a global perspective. Curr HIV Res 2013;11:81—92.
[46] Turan JM, Nyblade L. HIV-related stigma as a barrier to achievement of global PMTCT and maternal health goals: a review of the evidence. AIDS Behav 2013;17:2528—39.
[47] van Lettow M, Bedell R, Mayuni I, Mateyu G, Landes M, Chan AK, et al. Towards elimination of mother-to-child transmission of HIV: performance of different models of care for initiating lifelong antiretroviral therapy for pregnant women in Malawi (Option B+). J Int AIDS Soc 2014;17:18994.

[48] World Health Organization. Antiretroviral drugs for treating pregnant women and preventing HIV infection in infants towards universal access: Recommendations for a public health approach; 2006. Available at: http://www.who.int/hiv/pub/mtct/arv_guidelines_mtct.pdf [accessed 10.04.15].

[49] Sam-Agudu NA, Cornelius LJ, Okundaye JN, Adeyemi OA, Isah HO, Wiwa OM, et al. The impact of mentor mother programs on PMTCT service uptake and retention-in-care at primary health care facilities in Nigeria: a prospective cohort study (MoMent Nigeria). J Acquir Immune Defic Syndr 2014;67(Suppl 2):S132—8.