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Universal Antiretroviral Treatment Eligibility for Children and Adolescents Living With HIV:

A New Era

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Abstract

Antiretroviral treatment coverage for children living with HIV is low, and new efforts are underway to expand eligibility so that all children and adolescents qualify for the treatment regardless of immune suppression or clinical stage. Although recent trials provide direct evidence of the benefit of this approach in adults, no such studies have been performed in children. This report examines the available body of evidence regarding universal HIV treatment for children and adolescents and assesses the benefits and challenges both at individual patient health, as well as at programmatic level. Universal treatment eligibility for children with HIV has great potential for improved growth and neurodevelopment and fewer morbidities for children, and treatment coverage would be expected to increase through guideline simplification. However, concerns regarding toxicities, drug resistance and costs require careful planning. Successful implementation will depend on effective strategies for case-finding, treatment adherence support and program monitoring that will contribute to the growing evidence base for this pivotal pediatric HIV policy shift.

Keywords

antiretroviral therapy; children; eligibility determination; guidelines; HIV

Remarkable success in decreasing new childhood HIV infections by 58% from 2000 to 2014[1] is attributable to strong local, national and global efforts to prevent mother-to-child transmission of HIV. However, an estimated 2.6 million children were living with HIV in 2014, with 88% residing in sub-Saharan Africa.[1] Without effective antiretroviral therapy (ART), this large majority will die in early childhood.[2] Despite steady improvements in ART access for children, coverage remains low at 32%, less than current adult coverage of 41%, despite higher rates of advanced disease in HIV-infected children.[1]

There are well-documented challenges to providing effective ART to children at each step in the continuum of care, including case identification, linkage to care, determining eligibility for treatment initiation, and ongoing medication adherence and clinic retention for virologic

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suppression.[3] Determination of ART eligibility can act as another step in this process where children may be missed or become lost to follow-up, and complex initiation criteria can necessitate referrals to specialty centers and hinder decentralized treatment. The 2013 World Health Organization (WHO) guidelines recommended that all HIV-infected children <5 years of age receive ART, as well as those 5 years of age or older with CD4+ cell counts <500 (cells/μL) or a WHO stage III or IV clinical condition.[4] Many countries now follow this guidance; however, by the beginning of 2014, many African countries, including Uganda,[5] Zambia,[6] Namibia[7] and Ethiopia,[8] had begun to adopt universal ART eligibility for children of *all* ages.

WHO has released the updated 2015 recommendation to provide ART for all persons living with HIV, but the recommendation was categorized as “strong” for adults and children <2 years old, and “conditional” for children and adolescents from 2 to 19 years of age, meaning the quality of supporting evidence may be low or the panel is not confident in the weight of benefits compared with risks.[9] A major catalyst for this eligibility expansion was the Strategic Timing of Antiretroviral Treatment trial, which was discontinued in 2015 because the survival benefit of early ART initiation in adults was clearly evident,[10] and similar results from the TEMPRANO trial demonstrating lower rates of severe illness when immediate ART was provided for those with high CD4 counts.[11] Advantages of “treatment as prevention”—to reduce transmission of new HIV infections through viral suppression—also support this policy in adults.[12] Although none of these clinical trials included children, some comparable benefits could be extrapolated. Other publications have examined the values and risks of ART for asymptomatic children <5 years of age.[13,14] However, data on older children and young adolescents are scarce, and these groups have other physiological and psychosocial considerations. This study examines the benefits and challenges associated with universal ART eligibility in all children and adolescents, both at individual patient and programmatic levels, based on currently available evidence and with attention to remaining gaps.

INDIVIDUAL PATIENT FACTORS

To date, there are no published studies providing direct evidence that ART for children and adolescents with CD4 cell counts >500 cells/μL improves survival or secondary morbidity outcomes affecting health and development. However, studies have shown the effects of ART that would suggest patient benefit in these situations. Much research to date has focused on neurodevelopmental effects of HIV in children unrelated to immune suppression, by direct viral effect on neural cells or inflammatory processes.[15,16] A US-based pediatric cohort study showed initiation of ART to be highly associated with lower rates of HIV encephalopathy independent of immunosuppression, occurring at high and low CD4 counts.[17] Other articles have described HIVs association with neurodevelopmental delay in children, with deferred ART initiation connected to worsening cognitive impairment[18] and associated with less improvement in neurodevelopmental scores once virologically suppressed.[19] More recently, an imaging study described greater white matter damage and myelin loss in ART-naïve South African children and adolescents compared with those on treatment.[20]

Other research and reviews question the severity of neurologic effects of HIV in older asymptomatic treatment-naïve children and the ability of ART to restore lost cognitive functioning.[21,22] This includes the 2006–2011 neurodevelopment substudy of the Pediatric Randomised Early versus Deferred Initiation in Cambodia and Thailand trial, which showed HIV infection to be associated with lower neurodevelopmental scores compared with uninfected controls, but no improvement in scoring was associated with earlier ART initiation for HIV-infected children surviving beyond 1 year of age.[23] The main Pediatric Randomised Early versus Deferred Initiation in Cambodia and Thailand trial also demonstrated no evidence that early ART initiation improved survival or reduced morbidities in children, with an AIDS-free survival rate of 98.9% in the deferred-treatment group.[24]

Beyond neurodevelopment, other clinical outcomes should also be considered if expanding eligibility to immune-competent children. Observational analysis of data from within a randomized clinical trial in Africa showed delayed ART initiation among those who qualified for ART by CD4 count to be associated with late onset of puberty[25]; previous US longitudinal cohort studies demonstrated similar findings.[26] Multicenter cohort data demonstrated cardioprotective effects of ART for children and adolescents, but this was observed during a time period when eligibility criteria were more restrictive.[27] Immune-competent children and adolescents not receiving ART are also at risk of chronic lung disease of small airways with unclear etiology, although it is not known if earlier ART initiation could avoid or reverse this process.[28] Growth and nutritional status in children are also known to improve on ART, and although those with moderate or severe acute malnutrition or severe stunting already qualify for ART by WHO clinical stage, studies suggest that growth improvements are found in less-malnourished children as well and can be independent of CD4 counts.[29–31]

In Uganda, ART has been associated with indirect suppression of Epstein-Barr virus infection in children, potentially reducing the risk of acquiring Epstein-Barr virus-related lymphomas.[32] Viral suppression while on ART can also allow for greater effectiveness of vaccines such as those for influenza through higher rates of postvaccination seroprotective titers, lessening risks of vaccine-preventable diseases to children as well as their communities.[33] Long-term immune function is also a factor; CD4 cell recovery in children has been found to be greater when ART is started at a higher nadir in modeling[34] and trial data,[35] even when considering those whose CD4 cell counts did not drop below 500 cells/μL. However, the clinical significance of recovered CD4 value at different degrees above 500 cells/μL is not well understood.

In addition to the potential benefits of ART in previously ineligible children, the risks must be regarded as well. Earlier initiation of any long-term medication increases exposure time and thus risk of adverse events. Although many of the older antiretroviral drugs with widespread toxicities are falling out of use, even in resource-limited settings, others such as zidovudine and nevirapine remain in use and monitoring of these effects is not always available or implemented.[36] Earlier ART initiation may also lead to earlier development of drug resistance and eventual treatment failure; in a setting where “pill fatigue” from ongoing

mediation use is a genuine concern, clinicians may hesitate to start antiretrovirals at an earlier stage of disease.[37]

ART PROGRAM FACTORS

A substantial expected benefit of universal ART eligibility in children and adolescents is the removal of programmatic barriers to treatment initiation, even in those who would have already qualified under previous, more restrictive criteria. Uganda reported that only 43% of HIV-infected children received a CD4 cell count within 3 months of clinic enrollment, and only 52% had a correct WHO clinical stage designation at most recent visit; an additional 15% had no documentation of WHO stage at all.[38] Common diagnoses leading to categorization of WHO stage III or stage IV, such as lymphocytic interstitial pneumonitis, developmental delay resulting from HIV encephalopathy or growth stunting can have subtle clinical presentations that could be easily overlooked in HIV clinics, especially those with low volumes and less pediatric-specific training.[38] Earlier ART initiation can avoid the barrier of these missing clinical evaluations and help prevent or reverse these morbidities, and the simpler decision-making process can facilitate more effective decentralization of ART services for children.

Clinic loss to follow-up for children living with HIV is often highest in the pre-ART period, decreasing the proportion of children who can become virologically suppressed on treatment once eligible.[39] Eliminating this step in the continuum of care, by moving rapidly from diagnosis to ART initiation, could mitigate this pre-ART loss. This impact was seen in implementation of Option B+, in which immediate ART initiation for pregnant and breastfeeding women regardless of CD4 count dramatically increased the number of women started on ART in early-adopting countries.[40] Concerns may be raised that these older children and young adolescents may have worse treatment retention, making a case for delaying ART initiation whenever safely possible. However, a number of reviews and cohort studies have shown better retention for this age group (5–14 years old) compared with younger children[41] and young people older than 15 years of age.[42,43] Some data show children with lower CD4 counts to have lower retention as well.[44] Another retrospective cohort of nearly 1800 adolescents demonstrated similar mortality to adults and less loss to follow-up, but higher rates of first-line failure.[45] The readiness of the children and their families to start the treatment cannot be assumed and would become the focus of ART preparation. As with Option B+, efforts to decentralize care, support adherence and retain children in clinic attendance would be important adjuncts to an ART eligibility policy change.

Another consideration for ART programs is the expected increase in patient volume with universal eligibility; this is particularly important in resource-limited settings where facilities are often already crowded and under-resourced. Drug forecasting would be an essential step to avoid disruptions to the supply chain for pediatric formulations of antiretroviral drugs. However, children comprise a small proportion of the overall burden of HIV, and clinic increases are more likely to result from better treatment coverage of those already eligible than newly eligible children. Modeling in Uganda estimated 83% of children are already

ART-eligible based on 2013 WHO criteria,[38] with similar results (80%–82%) for 2 other sub-Saharan African countries (authors' unpublished data).

The possibility that expanded eligibility, combined with adherence challenges, could lead to higher national rates of HIV drug resistance should also be explored,[46] and accessibility of routine viral load monitoring should be prioritized to minimize this potential effect. Cost is another essential consideration, and modeling has predicted increases in treatment costs, particularly in the short-term, associated with expansion of pediatric ART eligibility.[47] Other factors may mitigate some of these costs, however, such as reducing infant infections from adolescent mothers who show higher mother-to-child transmission rates, likely because of diminished or delayed utilization of prenatal services.[48]

SUCCESSFUL IMPLEMENTATION

The coverage gap between pediatric and adult HIV treatment coverage is striking, and novel approaches can help correct this disparity. Universal ART eligibility for all children would make a strong national statement about the value of these vulnerable children within society. As the international community already endorses treatment for all perinatal infections through support of eligibility for all children <5 years, this policy can promote equal access to ART for those children whose diagnosis was delayed until later childhood. Focus would move from *eligibility* to *readiness*, so that every child can be individually assessed and prepared for ART without concern or confusion regarding whether or not they "qualify."

Programs considering a universal eligibility approach still need to prioritize initiation of those children who require ART urgently for survival, including younger children and those with advanced disease. Furthermore, case identification of children living with HIV, through targeted high-yield testing, is a prerequisite for any treatment program success; expanded eligibility alone will not address this. Once children and, especially, adolescents are identified and initiated, adherence support that incorporates their particular needs is critically important—regardless of eligibility policy. Innovative approaches, including more models of community-based treatment, family-centered care and effective peer mentoring, will need to be strategically incorporated into programs as best practices continue to be identified and replicated. Global approaches to develop improved pediatric drug formulations and ensure supply chain reliability will also be crucial in improving treatment coverage.

A policy expanding HIV treatment eligibility to all children and adolescents has the potential to reduce barriers through guideline simplification, but it also could draw resources away from those in most urgent need. Data are sparse for children but suggest minimal individual risks for initiating ART in older children and young adolescents with higher CD4 counts, and results from the Strategic Timing of Antiretroviral Treatment trial and implementation of Option B+ give cause for optimism. National programs should assess their specific situations and monitor for unintended negative outcomes of implemented policies while having a strategy to correct any identified. In countries where universal pediatric ART eligibility is adopted, program evaluation is critical to monitor performance, quickly identify problems, re-assess policies and add to the global evidence base for this new era in pursuing an AIDS-free generation.

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REFERENCES

1. Joint United Nations Programme on HIV/AIDS. How AIDS Changed Everything Geneva, Switzerland: UNAIDS, 2015.
2. Violari A, Cotton MF, Gibb DM, et al.; CHER Study Team. Early antiretroviral therapy and mortality among HIV-infected infants. N Engl J Med 2008;359:2233–2244. [PubMed: 19020325]
3. Phelps BR, Ahmed S, Amzel A, et al.; Child Survival Working Group of the Interagency Task Team on the Prevention, Treatment of HIV infection in Pregnant Women, Mothers, Child. Linkage, initiation and retention of children in the antiretroviral therapy cascade: an overview. AIDS 2013;27(suppl 2):S207–S213. [PubMed: 24361630]
4. World Health Organization. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Recommendations for a Public Health Approach Geneva, Switzerland: World Health Organization; 2013.
5. Ministry of Health (Uganda). Pediatric and Adolescent HIV Care and Treatment Technical Support Kampala, Uganda: Ministry of Health; 2013:8–39.
6. Ministry of Health (Zambia). Consolidated Guidelines for Treatment and Prevention of HIV Infection Lusaka, Zambia: Ministry of Health; 2014:18–20.
7. Ministry of Health and Social Services (Namibia). National Guidelines for Antiretroviral Therapy 4th ed. Windhoek, Namibia: Ministry of Health and Social Services; 2014:65–66.
8. Ministry of Health (Ethiopia). National Guidelines for Comprehensive HIV Prevention, Care and Treatment Addis Ababa, Ethiopia: Ministry of Health; 2014:37–38.
9. World Health Organization. Guideline on When to Start Antiretroviral Therapy and on Pre-exposure Prophylaxis for HIV Geneva, Switzerland: World Health Organization; 2015.
10. Lundgren JD, Babiker AG, Gordin F, et al.; INSIGHT START Study Group. Initiation of antiretroviral therapy in early asymptomatic HIV infection. N Engl J Med 2015;373:795–807. [PubMed: 26192873]
11. Danel C, Moh R, Gabillard D, et al.; TEMPRANO ANRS 12136 Study Group. A trial of early antiretrovirals and isoniazid preventive therapy in Africa. N Engl J Med 2015;373:808–822. [PubMed: 26193126]
12. Cohen MS, Chen YQ, McCauley M, et al.; HPTN 052 Study Team. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med 2011;365:493–505. [PubMed: 21767103]
13. Collins IJ, Judd A, Gibb DM. Immediate antiretroviral therapy in young HIV-infected children: benefits and risks. Curr Opin HIV AIDS 2014;9:87–94. [PubMed: 24247666]
14. Prato M, Venturini E, Chiappini E, et al. Starting treatment in pediatric HIV infection: try to clarify a gray area. Pediatr Infect Dis J 2015;34(5 suppl 1):S31–S35. [PubMed: 25886774]
15. Smith R, Chernoff M, Williams PL, et al.; Pediatric HIV/AIDS Cohort Study (PHACS) Team. Impact of HIV severity on cognitive and adaptive functioning during childhood and adolescence. Pediatr Infect Dis J 2012;31:592–598. [PubMed: 22592486]
16. Whitehead N, Potterton J, Coovadia A. The neurodevelopment of HIV-infected infants on HAART compared to HIV-exposed but uninfected infants. AIDS Care 2014;26:497–504. [PubMed: 24125015]
17. Patel K, Ming X, Williams PL, et al.; International Maternal Pediatric Adolescent AIDS Clinical Trials 219/219C Study Team. Impact of HAART and CNS-penetrating antiretroviral regimens on HIV encephalopathy among perinatally infected children and adolescents. AIDS 2009;23:1893–1901. [PubMed: 19644348]
18. Le Doaré K, Bland R, Newell ML. Neurodevelopment in children born to HIV-infected mothers by infection and treatment status. Pediatrics 2012;130:e1326–e1344. [PubMed: 23118140]

19. Laughton B, Cornell M, Boivin M, et al. Neurodevelopment in perinatally HIV-infected children: a concern for adolescence. J Int AIDS Soc 2013;16:18603. [PubMed: 23782482]
20. Hoare J, Fouche JP, Phillips N, et al. White matter micro-structural changes in ART-naive and ART-treated children and adolescents infected with HIV in South Africa. AIDS 2015;29:1793–1801. [PubMed: 26372385]
21. Jelsma J, Davids N, Ferguson G. The motor development of orphaned children with and without HIV: pilot exploration of foster care and residential placement. BMC Pediatr 2011;11:11. [PubMed: 21299864]
22. Sherr L, Croome N, Parra Castaneda K, et al. Developmental challenges in HIV infected children—an updated systematic review. Child Youth Serv Rev 2014;45:74–89.
23. Puthanakit T, Ananworanich J, Vonthanak S, et al.; PREDICT Study Group. Cognitive function and neurodevelopmental outcomes in HIV-infected children older than 1 year of age randomized to early versus deferred antiretroviral therapy: the PREDICT neurodevelopmental study. Pediatr Infect Dis J 2013;32:501–508. [PubMed: 23263176]
24. Puthanakit T, Saphonn V, Ananworanich J, et al.; PREDICT Study Group. Early versus deferred antiretroviral therapy for children older than 1 year infected with HIV (PREDICT): a multicentre, randomised, open-label trial. Lancet Infect Dis 2012;12:933–941. [PubMed: 23059199]
25. Szubert AJ, Musiime V, Bwakura-Dangarembizi M, et al.; ARROW Trial Team. Pubertal development in HIV-infected African children on first-line antiretroviral therapy. AIDS 2015;29:609–618. [PubMed: 25710288]
26. Williams PL, Abzug MJ, Jacobson DL, et al.; International Maternal Pediatric and Adolescent AIDS Clinical Trials P219219C Study and the Pediatric HIVAIDS Cohort Study. Pubertal onset in children with perinatal HIV infection in the era of combination antiretroviral treatment. AIDS 2013;27:1959–1970. [PubMed: 24145244]
27. Lipshultz SE, Williams PL, Wilkinson JD, et al.; Pediatric HIV/AIDS Cohort Study (PHACS). Cardiac status of children infected with human immunodeficiency virus who are receiving long-term combination antiretroviral therapy: results from the Adolescent Master Protocol of the Multicenter Pediatric HIV/AIDS Cohort Study. JAMA Pediatr 2013;167:520–527. [PubMed: 23608879]
28. Ferrand RA, Desai SR, Hopkins C, et al. Chronic lung disease in adolescents with delayed diagnosis of vertically acquired HIV infection. Clin Infect Dis 2012;55:145–152. [PubMed: 22474177]
29. Musoke PM, Mudiope P, Barlow-Mosha LN, et al. Growth, immune and viral responses in HIV infected African children receiving highly active antiretroviral therapy: a prospective cohort study. BMC Pediatr 2010;10:56. [PubMed: 20691045]
30. Weigel R, Phiri S, Chiputula F, et al. Growth response to antiretroviral treatment in HIV-infected children: a cohort study from Lilongwe, Malawi. Trop Med Int Health 2010;15:934–944. [PubMed: 20561308]
31. Sutcliffe CG, van Dijk JH, Munsanje B, et al. Weight and height z-scores improve after initiating ART among HIV-infected children in rural Zambia: a cohort study. BMC Infect Dis 2011;11:54. [PubMed: 21362177]
32. Petrara MR, Penazzato M, Massavon W, et al. Epstein-Barr virus load in children infected with human immunodeficiency virus type 1 in Uganda. J Infect Dis 2014;210:392–399. [PubMed: 24550442]
33. Leahy TR, Goode M, Lynam P, et al. HIV virological suppression influences response to the AS03-adjuvanted monovalent pandemic influenza A H1N1 vaccine in HIV-infected children. Influenza Other Respir Viruses 2014;8:360–366. [PubMed: 24548473]
34. Lewis J, Walker AS, Castro H, et al. Age and CD4 count at initiation of antiretroviral therapy in HIV-infected children: effects on long-term T-cell reconstitution. J Infect Dis 2012;205:548–556. [PubMed: 22205102]
35. Picat MQ, Lewis J, Musiime V, et al.; ARROW Trial Team. Predicting patterns of long-term CD4 reconstitution in HIV-infected children starting antiretroviral therapy in sub-Saharan Africa: a cohort-based modelling study. PLoS Med 2013;10:e1001542. [PubMed: 24204216]

36. Bamford A, Turkova A, Lyall H, et al. Paediatric European Network for Treatment of AIDS (PENTA) guidelines for treatment of paediatric HIV-1 infection 2015: optimizing health in preparation for adult life. HIV Med 2015;(special suppl):1–42.

37. Claborn KR, Meier E, Miller MB, et al. A systematic review of treatment fatigue among HIV-infected patients prescribed antiretroviral therapy. Psychol Health Med 2015;20:255–265. [PubMed: 25110152]

38. Elyanu P, Magongo E, Asire B, et al. Impact of implementing "Test and Treat" policy on paediatric ART enrolments and coverage in Uganda. In: 8th International AIDS Society Conference on HIV Pathogenesis, Treatment and Prevention, July 19–22, 2015 Vancouver, Canada; 2015. Abstract WEAD0203.

39. Kranzer K, Govindasamy D, Ford N, et al. Quantifying and addressing losses along the continuum of care for people living with HIV infection in sub-Saharan Africa: a systematic review. J Int AIDS Soc 2012;15:17383. [PubMed: 23199799]

40. Centers for Disease Control and Prevention. Impact of an innovative approach to prevent mother-to-child transmission of HIV–Malawi, July 2011-September 2012. MMWR Morb Mortal Wkly Rep 2013;62:148–151. [PubMed: 23446514]

41. Ben-Farhat J, Gale M, Szumilin E, et al. Paediatric HIV care in sub-Saharan Africa: clinical presentation and 2-year outcomes stratified by age group. Trop Med Int Health 2013;18:1065–1074. [PubMed: 23782065]

42. Chan AK, Mateyu G, Jahn A, et al. Outcome assessment of decentralization of antiretroviral therapy provision in a rural district of Malawi using an integrated primary care model. Trop Med Int Health 2010;15 (suppl 1):90–97. [PubMed: 20586966]

43. Lamb MR, Fayorsey R, Nuwagaba-Biribonwoha H, et al. High attrition before and after ART initiation among youth (15–24 years of age) enrolled in HIV care. AIDS 2014;28:559–568. [PubMed: 24076661]

44. McNairy ML, Lamb MR, Carter RJ, et al.; Identifying Optimal Models of HIV Care and Treatment in Sub-Saharan Africa Consortium. Retention of HIV-infected children on antiretroviral treatment in HIV care and treatment programs in Kenya, Mozambique, Rwanda, and Tanzania. J Acquir Immune Defic Syndr 2013;62:e70–e81. [PubMed: 23111575]

45. Shroufi A, Gunguwo H, Dixon M, et al. HIV-infected adolescents in southern Africa can achieve good treatment outcomes: results from a retrospective cohort study. AIDS 2013;27:1971–1978. [PubMed: 23525033]

46. Cambiano V, Bertagnolio S, Jordan MR, et al. Predicted levels of HIV drug resistance: potential impact of expanding diagnosis, retention, and eligibility criteria for antiretsroviral therapy initiation. AIDS 2014;28 (suppl 1):S15–S23. [PubMed: 24468943]

47. McCarthy E, Munthali G, Lu M, et al. What does a national response to closing the gap in pediatric and adolescent HIV treatment cost? Zambian costing model for universal pediatric treatment. In: 8th International AIDS Society Conference on HIV Pathogenesis, Treatment and Prevention, July 19–22, 2015 Vancouver, Canada; 2015. Abstract WEPED888.

48. Horwood C, Butler LM, Haskins L, et al. HIV-infected adolescent mothers and their infants: low coverage of HIV services and high risk of HIV transmission in KwaZulu-Natal, South Africa. PLoS One 2013;8:e74568. [PubMed: 24073215]