

Abacavir (ABC, Ziagen)

Updated: Apr.11, 2022

Reviewed: Apr.11, 2022

| Formulations | |
|--|---|
| <p><i>Pediatric Oral Solution: 20 mg/mL</i></p> <p>Tablet: 300 mg (scored)</p> <p><i>Generic Formulations</i></p> <ul style="list-style-type: none"> • 300 mg tablet • 20 mg/mL pediatric oral solution <p><i>Fixed-Dose Combination Tablets</i></p> <ul style="list-style-type: none"> • [Epzicom and generic] Abacavir 600 mg/lamivudine 300 mg • [Triumeq] Abacavir 600 mg/dolutegravir 50 mg/lamivudine 300 mg <p><i>When using fixed-dose combination (FDC) tablets, refer to other sections of Appendix A: Pediatric Antiretroviral Drug Information for information about the individual components of the FDC. See also Appendix A, Table 2. Antiretroviral Fixed-Dose Combination Tablets: Minimum Body Weights and Considerations for Use in Children and Adolescents.</i></p> <p><i>For additional information, see Drugs@FDA or DailyMed.</i></p> | |
| Dosing Recommendations | Selected Adverse Events |
| <p>Neonate (Aged Birth Through <1 Month) Dose</p> <p>Oral Solution</p> <ul style="list-style-type: none"> • Abacavir (ABC) is not approved by the U.S. Food and Drug Administration (FDA) for use in neonates aged <1 month. • The Panel on Antiretroviral Therapy and Medical Management of Children Living with HIV (the Panel) recommends ABC 2 mg/kg twice daily for full-term infants from birth through <1 month of age. This recommendation is based on data from pharmacokinetic (PK) modeling of neonatal ABC dosing to target adult plasma ABC exposures, and observational data supporting safety of ABC in neonates. The World Health Organization (WHO) HIV guidelines Annex 1: Dosages for ARV Drugs provide weight-band dosing recommendations for full-term neonates based on the same data (see Approval, Pharmacokinetics in Neonates and Infants, and Safety in Neonates and Infants sections below). <p>Infant (Aged ≥1 Month to <3 Months) Dose</p> <p>Oral Solution</p> <ul style="list-style-type: none"> • ABC is not approved by the FDA for use in infants aged <3 months. | <ul style="list-style-type: none"> • Hypersensitivity reactions (HSRs) can be fatal. HSRs usually occur during the first few weeks of starting therapy. Symptoms may include fever, rash, nausea, vomiting, malaise or fatigue, loss of appetite, and respiratory symptoms (e.g., cough, shortness of breath). |
| | Special Instructions |
| | <ul style="list-style-type: none"> • Test patients for the HLA-B*5701 allele before starting therapy to predict the risk of HSRs. Patients who test positive for the HLA-B*5701 allele should not be given ABC. Patients with no prior HLA-B*5701 testing who are tolerating ABC do not need to be tested. • Warn patients and caregivers about the risk of serious, potentially fatal HSRs. Occurrence of an HSR requires immediate and permanent discontinuation of ABC. Do not rechallenge. • ABC can be given without food. The oral solution does not require refrigeration. • Screen patients for hepatitis B virus (HBV) infection before using ABC FDC tablets that contain lamivudine (3TC). Severe acute exacerbation of HBV infection can occur when 3TC is discontinued, see Lamivudine. |

- The Panel recommends ABC 4 mg/kg twice daily in full-term infants aged ≥ 1 month to < 3 months. This recommendation is based on modeling data of the ABC 4 mg/kg twice-daily dose using PK simulation for full-term infants aged ≥ 1 month to < 3 months. The International Maternal Pediatric Adolescent AIDS Clinical Trials (IMPAACT) P1106 study and two observational cohorts provide reassuring data on the safety of ABC in infants with HIV aged < 3 months. See Approval, Pharmacokinetics in Neonates and Infants, and Safety in Neonates and Infants sections below.

Infant and Child (Aged ≥ 3 Months) Dose

Oral Solution

- ABC 8 mg/kg twice daily (maximum 300 mg per dose) or ABC 16 mg/kg once daily (maximum 600 mg per dose)
- In infants and young children who are being treated with liquid formulations of ABC, initiation with once-daily ABC is not generally recommended. In older children who can be treated with tablet formulations, therapy can be initiated with once-daily administration. In clinically stable patients who have undetectable viral loads and stable CD4 T lymphocyte counts while receiving the liquid formulation of ABC twice daily, the ABC dose can be changed from twice daily to once daily with the liquid or tablet formulations (see text below).

Weight-Band Dosing for Children and Adolescents Weighing ≥ 14 kg

| Weight | Scored 300-mg Tablet | | |
|---------------------------|----------------------|----------------------|---------------------|
| | Twice-Daily Dose, AM | Twice-Daily Dose, PM | Once-Daily Dose |
| 14 kg to < 20 kg | ½ tablet (150 mg) | ½ tablet (150 mg) | 1 tablet (300 mg) |
| ≥ 20 kg to < 25 kg | ½ tablet (150 mg) | 1 tablet (300 mg) | 1½ tablets (450 mg) |
| ≥ 25 kg | 1 tablet (300 mg) | 1 tablet (300 mg) | 2 tablets (600 mg) |

Child and Adolescent (Weighing ≥ 25 kg) and Adult Dose

- ABC 300 mg twice daily or ABC 600 mg once daily

[Epzicom] Abacavir/Lamivudine

Child and Adolescent (Weighing ≥ 25 kg) and Adult Dose:

- One tablet once daily

[Triumeq] Abacavir/Dolutegravir/Lamivudine

Child and Adolescent (Weighing ≥ 25 kg) and Adult Dose

- One tablet once daily

Metabolism/Elimination

- ABC is systemically metabolized by alcohol dehydrogenase and glucuronyl transferase.
- The majority of ABC is excreted as metabolites in urine.

Abacavir Dosing in Patients with Hepatic Impairment

- ABC requires a dose adjustment in patients with mild hepatic insufficiency and is contraindicated with moderate or severe hepatic insufficiency.
- Do not use** Epzicom and Triumeq (or the generic equivalents of these FDC tablets) in patients with impaired hepatic function, because the dose of ABC cannot be adjusted.

Abacavir Dosing in Patients with Renal Impairment

- ABC does not require dose adjustment in patients with renal impairment.
- Do not use** Epzicom and Triumeq (or the generic equivalents of these FDC tablets) in patients with creatinine clearance < 50 mL/min or patients on dialysis, because the doses of 3TC (in all three FDCs) cannot be adjusted.

- | | |
|--|--|
| <ul style="list-style-type: none"> • This FDC tablet can be used in patients who are antiretroviral (ARV)-naive or ARV-experienced (but integrase strand transfer inhibitor-naive) and who are not being treated with uridine diphosphate glucuronosyltransferase 1A1 or cytochrome P450 3A inducers. • The FDA-approved dose for pediatric patients is one tablet once daily for patients weighing ≥ 40 kg (see Dolutegravir for more information). | |
|--|--|

Drug Interactions

Additional information about drug interactions is available in the [Adult and Adolescent Antiretroviral Guidelines](#) and the [HIV Drug Interaction Checker](#).

- Abacavir (ABC) neither inhibits nor is metabolized by hepatic cytochrome P450 enzymes. Therefore, it does not cause significant changes in the clearance of agents that are metabolized through these pathways, such as protease inhibitors (PIs) and non-nucleoside reverse transcriptase inhibitors.
- ABC plasma concentrations can decrease when ABC is used concurrently with the ritonavir-boosted PIs atazanavir/ritonavir, lopinavir/ritonavir, and darunavir/ritonavir.¹⁻³ The mechanism and the clinical significance of the drug interactions with these PIs are unknown. Currently, no recommendations exist for dose adjustments when ABC is coadministered with one of these boosted PIs.
- Alcohol exposure (0.7 g per kg ethanol, which is equivalent to five alcoholic drinks) interferes with ABC metabolism; it affects the activity of alcohol dehydrogenase and glucuronyl transferase. This interference increased ABC area under the curve (AUC) plasma exposure by 41% in adult men with HIV who received ABC 600 mg daily.⁴
- ABC oral solution contains sorbitol, which decreased the exposure of lamivudine (3TC) oral solution in adults when the drugs were administered concurrently.⁵

Major Toxicities

- *More common:* Nausea, vomiting, fever, headache, diarrhea, rash, anorexia
- *Less common (more severe):* Serious and sometimes fatal hypersensitivity reactions (HSRs) have been observed in approximately 5% of adults and children (the rate varies by race/ethnicity) receiving ABC. HSRs generally occur during the first 6 weeks of therapy, but they have also been reported after a single dose of ABC. The risk of an ABC HSR is associated with the presence of the HLA-B*5701 allele; the risk is greatly reduced by not using ABC in those who test positive for the HLA-B*5701 allele. The HSR to ABC is a multiorgan clinical syndrome usually characterized by rash, or signs or symptoms in two or more of the following groups:
 - Fever
 - Constitutional symptoms, including malaise, fatigue, or achiness
 - Gastrointestinal signs and symptoms, including nausea, vomiting, diarrhea, or abdominal pain
 - Respiratory signs and symptoms, including dyspnea, cough, or pharyngitis
 - Laboratory and radiologic abnormalities, including elevated liver function tests, elevated creatine phosphokinase, elevated creatinine, lymphopenia, and pulmonary infiltrates. Lactic acidosis and

severe hepatomegaly with steatosis—including fatal cases—also have been reported. Pancreatitis **with laboratory abnormalities** can occur.

If an HSR is suspected, ABC **should be stopped immediately and not restarted because hypotension and death may occur upon rechallenge.**

- *Rare:* Increased levels of liver enzymes, elevated blood glucose levels, elevated triglycerides (see cardiovascular risk below). Pancreatitis, lactic acidosis, and severe hepatomegaly with steatosis—including fatal cases—have been reported.
- *Rare:* Drug reaction (or rash) with eosinophilia and systemic symptoms (DRESS) syndrome.
- *Rare:* Several observational cohort studies suggest that an increased risk of myocardial infarction exists in adults who are currently using ABC or who have recently used ABC; however, other studies have not substantiated this finding, and no prospective data are available on the cardiovascular risks associated with ABC use in children. One cohort study of South African adolescents (in which 385 participants had HIV and 63 participants were HIV-negative controls) with a median age of 12 years reported an association between ABC exposure and insulin resistance, which was evaluated using homeostatic model assessment. These findings suggest that the use of ABC may be a cardiovascular risk factor for young people with perinatally acquired HIV.⁶

Resistance

The International Antiviral Society–USA (IAS-USA) maintains a [list of updated HIV drug resistance mutations](#), and the [Stanford University HIV Drug Resistance Database](#) offers a discussion of each mutation.

Pediatric Use

Approval

ABC is approved by the U.S. Food and Drug Administration (FDA) for use in children with HIV aged ≥ 3 months as part of the nucleoside reverse transcriptase inhibitor (NRTI) component of antiretroviral therapy (ART). The World Health Organization (WHO), however, **provides dosing guidance** for ABC as a component of the NRTI backbone for **full-term neonates starting at birth and weighing ≥ 2 kg** (see Annex 1: Dosages for ARV Drugs in the [WHO HIV guidelines](#)). The WHO guidance for ABC dosing in neonates increases the choices of antiretroviral (ARV) agents for the management of newborns in special situations where stock outs of nevirapine or zidovudine (ZDV) may affect the ability to effectively provide postnatal prophylaxis or treatment of neonatal HIV. The WHO recommendation of ABC dosing for infants starting at 1 month of age is based on the inclusion of ABC as a preferred NRTI component of the first- and second-line ARV regimens for children in the [WHO HIV guidelines](#). This recommendation also takes into account the availability of the President’s Emergency Plan for AIDS Relief (PEPFAR) tentatively approved pediatric generic ABC formulations—including coformulations that include 3TC—and the cost of ARV drugs in resource-limited settings.

Efficacy

Both the once-daily and twice-daily doses of ABC have demonstrated durable antiviral efficacy in pediatric clinical trials that is comparable to the efficacy observed for other NRTIs in children.⁷⁻¹¹

Pharmacokinetics

Pharmacokinetics in Neonates and Infants

The International Maternal Pediatric Adolescent AIDS Clinical Trials (IMPAACT) P1106 trial reported PK data in 25 infants aged <3 months who were initiated on a median ABC dose of 10 mg/kg (range, 6–13 mg/kg) twice daily in combination with lamivudine and lopinavir/ritonavir. Median age was 6 weeks (range, 1.5–11 weeks); median weight was 2,250 g (range, 1,360–3,320 g); median gestational age was 36 weeks (range, 27–39 weeks). Sparse and pre-dose PK ABC samples were repeatedly obtained throughout 24 weeks of study follow-up, and population PK modeling was applied. ABC plasma exposures were high compared to the published data in infants aged >3 months and decreased rapidly between 2 and 8 months of age as the infants matured and ABC clearance increased.¹²

PK modeling of ABC starting at birth has been conducted using pooled data from 308 ABC concentration measurements obtained from three studies administering ABC liquid to 45 young infants (including 21 full-term neonates <15 days of age with intensive PK).¹³ Two of these studies, the Pediatric AIDS Clinical Trials Group (PACTG) 321 study and Tygerberg cohort, performed intensive PK sampling in full-term neonates receiving ABC for HIV prophylaxis. The third study, IMPAACT P1106, performed sparse PK sampling on full-term and low-birth weight (LBW) <2,500 g infants with HIV, initiating ABC-based ART after 1 month of age. LBW infants were older at the first PK assessment, with a median postnatal age of 78 days (range, 41–190) and weight of 3.6 kg (range, 2.4–5.8). ABC PK parameters in neonates were estimated using PK simulations to achieve plasma ABC exposures (AUC₀₋₁₂) within the expected adult range (3.2–25.2 mcg•hr/mL). ABC elimination was greatly reduced at birth but rapidly increased during the first weeks of life. Simulations predicted that an ABC dose of 2 mg/kg twice daily in full-term neonates from birth to <4 weeks and an ABC dose of 4 mg/kg twice daily in infants aged 4 to 12 weeks would achieve target AUC₀₋₁₂; however, data in LBW infants are lacking.¹³ Based on these data, the weight-band dosing of ABC for neonates has been developed for neonates from birth to age <1 month and is included in the WHO HIV Guidelines Annex 1: Dosages for ARV Drugs.¹⁴ This weight-band dosing for neonates approximates the ABC dosing per kg based on the postnatal age (see Table 1 below).

Table 1. Simplified Weight-Band Dosing for Full-Term Neonates from Birth to <1 Month of Age (WHO HIV guidelines Annex 1: Table A1.4)

| Birth to <1 Month of Age | | |
|--------------------------|--|--|
| Weight | Volume of ABC Oral Solution 20 mg/mL Twice Daily ^{a,b} | ABC Dose in mg Twice Daily (ranges mg/kg, from lowest to highest weight within the weight band) ^{a,b} |
| 2 kg to <3 kg | 0.4 mL | 8 mg (4.0–2.8 mg/kg) |
| 3 kg to <4 kg | 0.5 mL | 10 mg (3.3–2.6 mg/kg) |
| 4 kg to <5 kg | 0.6 mL | 12 mg (3.0–2.4 mg/kg) |

^a Simplified weight-band dosing exceeds recommended mg/kg ABC dosing in neonates and infants.

^b Neonatal ABC dose is based on birth weight and does not require weight-based adjustment during the first month of life.

Key: ABC = Abacavir

For infants aged ≥ 1 month with weight 3 to < 6 kg, the [WHO HIV guidelines](#) currently recommend a twice-daily dose of 3 mL (60 mg) of ABC 20 mg/mL solution (range, 20.0–10.2 mg/kg). The weight-band dosing for neonates and infants within the WHO HIV guidelines is higher than the modeled weight-based dosing for practical considerations in resource-limited settings. As new, generic pediatric formulations of ABC become available in resource-limited settings, there is potential for the revision of the WHO weight-band dosing of ABC for young infants.

Based on the PK modeling from three infant studies¹³ and the neonatal and infant safety data from IMPAACT 1106 study and two observational cohort studies (see Safety in Neonates and Infants below), the Panel on Antiretroviral Therapy and Medical Management of Children Living with HIV recommends an ABC dose of 2 mg/kg twice daily for neonates from birth to < 1 month of age and an ABC dose of 4 mg/kg twice daily for full-term infants aged ≥ 1 month and < 3 months.

Pharmacokinetics in Children

PK studies of ABC in children aged < 12 years have demonstrated that metabolic clearance of ABC in adolescents and young adults (aged 13–25 years) is slower than that observed in younger children and approximates clearance seen in older adults.¹⁵

The PKs of ABC administered once daily in children with HIV aged 3 months through 12 years were evaluated in three crossover, open-label PK trials of twice-daily versus once-daily dosing of ABC and 3TC (PENTA 13 [n = 14], PENTA 15 [n = 18], and ARROW [n = 36]).^{4,16-19} The data from these three pediatric trials were used to develop a model for ABC PKs; this model predicted that systemic plasma ABC exposure after once-daily dosing would be equivalent to the exposure seen after twice-daily dosing in infants and children aged ≤ 12 years.¹⁶⁻²⁰ Both these trials and PK modeling have demonstrated that once-daily dosing with either the tablet or the liquid formulation of ABC produces plasma exposures comparable to those seen with a twice-daily dosing schedule that uses the same total daily dose of ABC.⁴

Dosing

Dosing and Formulations

Initially, the recommended dose for pediatric use was ABC 8 mg/kg twice daily for a total of 16 mg/kg per day. A 2015 FDA review suggested that a total daily dose of ABC 600 mg could be used safely in a person weighing 25 kg (i.e., ABC 24 mg/kg per day, a 50% increase from the previously recommended dose). The weight-band dosing table recommends total daily doses as high as ABC 21.5 mg/kg per day to ABC 22.5 mg/kg per day when treating patients with the tablet formulation.⁴ No difference is seen in the ABC plasma C_{max} and area under the curve for the ABC liquid formulation compared to the tablet formulation.²¹ Doses of the liquid ABC formulation are similar to those used for weight-band dosing with tablet formulations and should be considered for use in younger children who are unable to swallow a pill.

In the three ABC dosing pediatric trials described above,¹⁶⁻¹⁹ only children who had low viral loads and who were clinically stable on the twice-daily dose of ABC were eligible to change to once-daily ABC dosing. Efficacy data from a 48-week follow-up in the ARROW trial demonstrated clinical non-inferiority of once-daily ABC (n = 336) versus twice-daily ABC (n = 333) in tablet form combined with a once-daily or twice-daily 3TC-based ARV regimen.¹¹ To date, no clinical trials have been conducted involving children who initiated therapy with once-daily dosing of the ABC liquid formulation. In children who can be treated with pill formulations, initiating therapy with once-daily dosing of ABC at a dose of 16 mg/kg (with a maximum dose of ABC 600 mg) is recommended. However, twice-daily dosing is recommended for infants and young

children who initiate therapy with the liquid formulation of ABC. Switching to once-daily dosing with the liquid or pill formulation could be considered in clinically stable children with suppressed viral loads and stable CD4 T lymphocyte counts.

Toxicity

Safety in Neonates and Infants

Recent data from the IMPAACT P1106 trial and two observational European and African cohorts provided reassuring data on the safety of ABC in infants when initiated at <3 months of age, including infants with weight <3 kg.^{12,22,23} The IMPAACT P1106 trial reported 24 weeks of safety data in 25 infants who initiated ABC at the median age of 6 weeks. Of the 25 infants, one infant died of unknown cause 3 days after entry. Fourteen infants had Grade 3/4 adverse events (AEs); the most common were gastroenteritis (n = 4) and respiratory infection (n = 4). No hypersensitivity was reported. All AEs were assessed as unrelated to ABC, except for one possibly related Grade 2 alanine aminotransferase in which all ARVs were stopped for 2 weeks until resolution and were restarted without further complications.¹² The European Pregnancy and Paediatric Infections Cohort Collaboration (EPPICC) reported safety outcomes among 139 children from 13 cohorts in 11 countries in Europe who initiated ABC at age <3 months. By 12 months on ABC, 3.6% (n = 4) had discontinued ABC because of an ART safety concern and 11.8% (n = 15) discontinued ABC for any reason.²² Another observational study of nine cohorts from the International Epidemiology Databases to Evaluate AIDS (IeDEA) Southern Africa collaboration compared safety outcomes between infants who started ABC aged <28 days (n = 96) and those aged ≥28 days (n = 835) and between infants who started ABC with weight <3 kg (n = 246) and those with weight ≥3 kg (n = 53).²³ ABC discontinuations at 6 and 12 months were not significantly different in infants who started ART aged <28 days and ≥28 days or in infants who weighed <3 kg and ≥3 kg.²³

ABC has less of an effect on mitochondrial function than the NRTI ZDV^{7,8} and less bone and renal toxicity than tenofovir disoproxil fumarate.^{24,25}

References

1. Waters LJ, Moyle G, Bonora S, et al. Abacavir plasma pharmacokinetics in the absence and presence of atazanavir/ritonavir or lopinavir/ritonavir and vice versa in HIV-infected patients. *Antivir Ther.* 2007;12(5):825-830. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17713166>.
2. Pruvost A, Negrodo E, Theodoro F, et al. Pilot pharmacokinetic study of human immunodeficiency virus-infected patients receiving tenofovir disoproxil fumarate (TDF): investigation of systemic and intracellular interactions between TDF and abacavir, lamivudine, or lopinavir-ritonavir. *Antimicrob Agents Chemother.* 2009;53(5):1937-1943. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19273671>.
3. Jackson A, Moyle G, Dickinson L, et al. Pharmacokinetics of abacavir and its anabolite carbovir triphosphate without and with darunavir/ritonavir or raltegravir in HIV-infected subjects. *Antivir Ther.* 2012;17(1):19-24. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22267465>.
4. Abacavir (Ziagen) [package insert]. Food and Drug Administration. 2020. Available at: https://www.accessdata.fda.gov/drugsatfda_docs/label/2020/020977s035,020978s0381bl.pdf.
5. Adkison K, Wolstenholme A, Lou Y, et al. Effect of sorbitol on the pharmacokinetic profile of lamivudine oral solution in adults: an open-label, randomized study. *Clin Pharmacol Ther.* 2018;103(3):402-408. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/29150845>.
6. Frigati LJ, Jao J, Mahtab S, et al. Insulin resistance in South African youth living with perinatally acquired HIV receiving antiretroviral therapy. *AIDS Res Hum Retroviruses.* 2019;35(1):56-62. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/30156434>.
7. Paediatric European Network for Treatment of AIDS (PENTA). Comparison of dual nucleoside-analogue reverse-transcriptase inhibitor regimens with and without nelfinavir in children with HIV-1 who have not previously been treated: the PENTA 5 randomised trial. *Lancet.* 2002;359(9308):733-740. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/11888583>.
8. Green H, Gibb DM, Walker AS, et al. Lamivudine/abacavir maintains virological superiority over zidovudine/lamivudine and zidovudine/abacavir beyond 5 years in children. *AIDS.* 2007;21(8):947-955. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/17457088>.
9. Adetokunboh OO, Schoonees A, Balogun TA, Wiysonge CS. Efficacy and safety of abacavir-containing combination antiretroviral therapy as first-line treatment of HIV infected children and adolescents: a systematic review and meta-analysis. *BMC Infect Dis.* 2015;15:469. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/26502899>.
10. Mulenga V, Musiime V, Kekitiinwa A, et al. Abacavir, zidovudine, or stavudine as paediatric tablets for African HIV-infected children (CHAPAS-3): an open-label, parallel-group, randomised controlled trial. *Lancet Infect Dis.* 2016;16(2):169-179. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/26481928>.

11. Musiime V, Kasirye P, Naidoo-James B, et al. Once vs. twice-daily abacavir and lamivudine in African children. *AIDS*. 2016;30(11):1761-1770. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/27064996>.
12. Cressey TR, Bekker A, Cababasay M, et al. Abacavir safety and pharmacokinetics in normal and low birth weight infants with HIV. Abstract#843. Presented at: Conference on Retroviruses and Opportunistic Infections; 2020. Boston, MA Available at: <https://www.croiconference.org/abstract/abacavir-safety-and-pharmacokinetics-in-normal-and-low-birth-weight-infants-with-hiv/>.
13. Bekker A, Capparelli EV, Violari A, et al. Abacavir dosing in neonates from birth: a pharmacokinetic analysis. Presented at: Conference on Retroviruses and Opportunistic Infections; 2021. Virtual Conference. Available at: <https://www.croiconference.org/abstract/abacavir-dosing-in-neonates-from-birth-a-pharmacokinetic-analysis/>.
14. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach. [press release]. Geneva: World Health Organization; Licence: CC BY-NC-SA 3.0 IGO., 2021.
15. Sleasman JW, Robbins BL, Cross SJ, et al. Abacavir pharmacokinetics during chronic therapy in HIV-1-infected adolescents and young adults. *Clin Pharmacol Ther*. 2009;85(4):394-401. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19118380>.
16. LePrevost M, Green H, Flynn J, et al. Adherence and acceptability of once daily lamivudine and abacavir in human immunodeficiency virus type-1 infected children. *Pediatr Infect Dis J*. 2006;25(6):533-537. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/16732152>.
17. Bergshoeff A, Burger D, Verweij C, et al. Plasma pharmacokinetics of once- versus twice-daily lamivudine and abacavir: simplification of combination treatment in HIV-1-infected children (PENTA-13). *Antivir Ther*. 2005;10(2):239-246. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/15865218>.
18. Paediatric European Network for Treatment of AIDS. Pharmacokinetic study of once-daily versus twice-daily abacavir and lamivudine in HIV type-1-infected children aged 3-<36 months. *Antivir Ther*. 2010;15(3):297-305. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20516550>.
19. Musiime V, Kendall L, Bakeera-Kitaka S, et al. Pharmacokinetics and acceptability of once-versus twice-daily lamivudine and abacavir in HIV type-1-infected Ugandan children in the ARROW Trial. *Antivir Ther*. 2010;15(8):1115-1124. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21149918>.
20. Zhao W, Piana C, Danhof M, Burger D, Della Pasqua O, Jacqz-Aigrain E. Population pharmacokinetics of abacavir in infants, toddlers and children. *Br J Clin Pharmacol*. 2013;75(6):1525-1535. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/23126277>.

21. Kasirye P, Kendall L, Adkison KK, et al. Pharmacokinetics of antiretroviral drug varies with formulation in the target population of children with HIV-1. *Clin Pharmacol Ther*. 2012;91(2):272-280. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/22190066>.
22. Crichton S, Collins IJ, Turkova A, et al. Abacavir dosing, effectiveness, and safety in young infants living with HIV in Europe. Abstract #844. Presented at: Conference on Retroviruses and Opportunistic Infections 2020. Boston, MA Available at: <https://www.croiconference.org/abstract/abacavir-dosing-effectiveness-and-safety-in-young-infants-living-with-hiv-in-europe/>.
23. De Waal R, Rabie H, Technau K, et al. Abacavir safety and efficacy in young infants in South African observational cohort. Abstract #845. Presented at: Conference on Retroviruses and Opportunistic Infections 2020. Boston, MA.
24. Post FA, Moyle GJ, Stellbrink HJ, et al. Randomized comparison of renal effects, efficacy, and safety with once-daily abacavir/lamivudine versus tenofovir/emtricitabine, administered with efavirenz, in antiretroviral-naive, HIV-1-infected adults: 48-week results from the ASSERT study. *J Acquir Immune Defic Syndr*. 2010;55(1):49-57. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/20431394>.
25. McComsey GA, Kitch D, Daar ES, et al. Bone mineral density and fractures in antiretroviral-naive persons randomized to receive abacavir-lamivudine or tenofovir disoproxil fumarate-emtricitabine along with efavirenz or atazanavir-ritonavir: AIDS clinical trials group A5224s, a substudy of ACTG A5202. *J Infect Dis*. 2011;203(12):1791-1801. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21606537>.