Published in final edited form as:
AIDS Behav. 2013 January ; 17(1): 1–4. doi:10.1007/s10461-012-0321-z.

Is the US AIDS Drug Assistance Program Cost-effective?

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Abstract

Each year, the US AIDS Drug Assistance Program provides access to prescription drugs—including antiretrovirals—to more than 110,000 persons living with HIV (PLWH) who lack adequate medical insurance. PLWH on effective antiretroviral therapy live longer lives, with enhanced quality of life, and are less likely to transmit HIV to others. There are thus significant benefits associated with the ADAP program. But there also are substantial costs. A mathematical model was used to assess the cost-effectiveness of the US ADAP program. Findings indicate that by providing antiretrovirals to underinsured persons, the ADAP program prevented 3191 secondary infections and saved 24,922 quality-adjusted life years in 2008. The net cost per quality-adjusted life year saved was $11,955, which suggests that the ADAP program is cost-effective by conventional standards.

Keywords

AIDS Drug Assistance Program; antiretroviral therapy; cost-effectiveness

Introduction

The US AIDS Drug Assistance Program (ADAP) is a federally-funded, state-administered program that serves as a prescription drug payer of last resort for persons living with HIV (PLWH) in the US. The ADAP program was created in 1987 to help states provide prescription drug access to HIV-infected people who lack adequate drug coverage from Medicaid or other forms of insurance.[1] In 1990, this program was incorporated into the Ryan White Comprehensive AIDS Resources Emergency (CARE) Act. ADAP is the single largest federal program for people living with HIV and the third largest source of federal funding for HIV care in the US after Medicare and Medicaid. This program assists one out of every three individuals with HIV who receive care in the US.[2] ADAP clients are primarily low-income: An estimated 42% of these clients live below the federal poverty level and 72% are uninsured.[3] A disproportionate number of these clients belong to traditionally underserved racial and ethnic minority groups.[4]

In June 2008, the ADAP program provided antiretroviral and other prescription medications to more than 110,000 PLWH, nationwide.[3] Persons with HIV who receive effective

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antiretroviral therapy (ART) before developing AIDS live longer lives, with enhanced quality of life.[5–7] They also are less likely to transmit HIV to sexual and syringe-sharing partners.[8,9] There are thus significant benefits associated with the ADAP program. But there also are substantial costs. Total expenditures for ADAP programs totaled nearly $110 million in June 2008, including approximately $100 million for antiretroviral medications. [3]

This brief article uses a mathematical model of HIV transmission to address the question: Is the US AIDS Drug Assistance Program cost-effective from a societal perspective?

Methods

The analyses considered two main benefits of ART: First, the reduction in morbidity due to ART, which can be summarized as an increase of Q_1 quality-adjusted life years, per PLWH per annum, for persons on ART versus those not on ART; and second, the reduction in secondary HIV infections for persons on ART. (Of note, the analyses did not consider the possible reduction in mortality, if any, from earlier initiation of ART.) Each prevented secondary infection saves society the lifetime medical care costs, T, associated with treating a case of HIV infection and also prevents the loss of Q_2 lifetime quality-adjusted life years (QALYs) due to HIV infection. The cost-effectiveness ratio associated with the nationwide ADAP program—that is, the net cost per QALY saved by the ADAP program—can be expressed as $(C - AT)/(PQ_1 + AQ_2)$, where C is the annual cost of the ADAP program, P is the number of PLWH receiving antiretroviral medications through ADAP, and A is the reduction in the total number of secondary HIV infections, per year, for PLWH receiving antiretroviral medications through ADAP. The latter quantity can be estimated as $A = P(\gamma_2 - \gamma_3)$, where γ_3 and γ_2 are the annual HIV transmission rates for serostatus-aware PLWH who are or are not, respectively, receiving ART. (The transmission rate for a given group of PLWH is the expected number of secondary infections per PLWH per year.[10])

The analyses considered the costs and benefits of ADAP over a single year. All costs and savings were expressed in 2008 base-year dollars. Table 1 lists the values of the main parameters utilized in the model. AIDS Drug Assistance Program values (program costs and number of PLWH receiving medications through ADAP) were obtained from the most recent Kaiser Foundation ADAP fact sheet.[3] Lifetime HIV-related medical care costs (discounted at a 3% annual rate) were drawn from a published source [11] and inflated to 2008 dollars. The number of QALYs saved by preventing a secondary case of HIV infection, $Q_2 = 6.43$,[12] also was discounted at a 3% rate. Consistent with this estimate of Q_2, which was derived using quality-of-life estimates from Tengs and Lin,[13] Q_1 was estimated at 0.04, reflecting a 4.35% improvement in quality-of-life 1 year after ART initiation [14] for persons living with asymptomatic HIV (quality-of life weight = 0.94 [13]).

Secondary transmission rates were derived using the methods described by Pinkerton [10], using updated parameter values. The full transmission rate model is specified by the following 4 equations:

$$\gamma_0 = I/[N_0 + \mu(0,1)N_1 + \mu(0,1)\,\mu(1,2)N_2 + \mu(0,1)\,\mu(1,2)\,\mu(2,3)N_3] \quad 1)$$

$$\gamma_1 = \mu(0,1)\gamma_0 \quad 2)$$

$$\gamma_2 = \mu(1,2)\gamma_1 \quad 3)$$

$$\gamma_3 = \mu(2,3)\gamma_2. \quad 4)$$

In these equations, I is the annual incidence of HIV infection in the US; N_0 is the number of persons living with (presumably undiagnosed) acute HIV infection; N_1 is the number of PLWH with non-acute infection who are unaware of their serostatus; N_2 is the number of serostatus-aware PLWH who are not on ART; N_3 is the number of serostatus-aware PLWH who are receiving ART; γ_k is the transmission rate for group N_k; and the $\mu(k,k+1)$ terms are transmission risk reduction factors.

The parameter values used to derive the transmission rates are listed in Table 2. Of note, the transmission rate model assumed that 77% of ADAP clients receiving ART have suppressed viral load (≤ 200 copies/mL) [15] and that persons with suppressed viral load are incapable of transmitting HIV.[16–18] Secondary transmission rates were estimated at $\gamma_3 = 0.0087$ per PLWH per year for PLWH on ART and $\gamma_2 = 0.0377$ for those not receiving ART. These transmission rates correspond to a 77% reduction, due to the transmission reduction benefits of ART, in the likelihood of secondary HIV transmission.

Univariate sensitivity analyses were conducted for all key modeling parameters (T, Q_1, Q_2, and $\gamma_2 - \gamma_3$). A multivariate (Monte Carlo) sensitivity analysis also was conducted to assess the impact of interactions among parameter values.

Results

The direct gain in QALYs for the estimated 110,047 PLWH receiving ART through ADAP programs nationwide in 2008 equaled 4402. The provision of ART to these persons prevented an estimated 3191 secondary HIV infections per year. These prevented infections were associated with $1.1 billion in averted HIV-related medical care costs and 20,050 additional QALYs saved. The net cost of the national ADAP program equaled $298 million and the total number of QALYs saved equaled 24,922. The cost per QALY saved therefore equaled $11,955, which is substantially smaller than the accepted threshold of $50,000 per QALY saved that often is considered the hallmark of a cost-effective health promotion program or intervention.[19,20]

The results of the sensitivity analyses are displayed in Table 3. The estimated cost-effectiveness ratio (CER) was less than $25,000 per QALY saved for all the parameter values considered in the univariate sensitivity analyses. The CER was most sensitive to the lifetime cost of HIV treatment, T, and to the difference in secondary transmission rates, $\gamma_2 - \gamma_3$. The multivariate (Monte Carlo) simulation was run 10,000 times. The median CER was $12,928 per QALY saved, with an interquartile range of $10,708 to $21,705 per QALY saved..

Discussion

The analyses presented above suggest that the nation's AIDS Drug Assistance Program is cost-effective from a societal perspective. The cost-effectiveness ratio for this program, $11,955 per QALY saved, is smaller than the ratio for many of the public health and HIV prevention interventions that commonly are considered cost-effective.[21,22]

The nation's ADAP programs prevented an estimated 3191 secondary HIV infections in 2008. This estimate represents approximately 6.7% of the 47,800 incident infections that occurred in 2008.[23] Currently, there are approximately 8000 PLWH on ADAP waiting lists nationwide.[24] Providing medical care and antiretroviral therapy to these persons could prevent an additional 232 secondary infections.

To fully realize the benefits identified in this analysis requires not only that PLWH are enrolled in ADAP and receive appropriate medical care, but also that they remain in care and are adherent to prescribed antiretroviral medications.

Uncertainty in the values of some key parameters is the main limitation of the mathematical modeling analyses described above. However, all of the univariate sensitivity analyses produced cost-effectiveness ratios substantially less than $50,000 per QALY saved. The upper bound of the interquartile range obtained in the multivariate sensitivity analysis also was less than this threshold.

The ADAP program is expensive, but appears to be cost-effective overall. Policy makers should consider expanding this program to eliminate wait lists and thereby ensure that all eligible persons receive appropriate HIV-related medical care.

Acknowledgments

This study was supported by center grant P30-MH52776 from the National Institute of Mental Health (NIMH), by NIMH grant R01-MH077511, and by a grant from the Robert Wood Johnson Foundation.

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Table 1

Base-case parameter values

Model parameter	Base-case value
Annual cost of ADAP nationwide, C	$1.43 billion[a]
PLWH receiving medications through ADAP, P	110,047[b]
Lifetime HIV-related medical care cost, T	$354,724
QALYs saved by preventing a case of HIV, Q_2	6.43
QALYs saved by ART, per PLWH per annum, Q_1	0.04
Annual HIV transmission rate, PLWH on ART, γ_3	0.0087
Annual HIV transmission rate, PLWH not on ART, γ_2	0.0377

[a] Based on monthly expenditures of $119.2 million in June 2008.[3]

[b] Data for June 2008.[3]

Table 2

Transmission rate model parameter values

Model parameter	Parameter value
HIV incidence (2008), I	47,800 [23]
Persons living with HIV in the US (2008), $N = N_0 + N_1 + N_2 + N_3$	1,178,350 [25]
Acutely-infected persons on any given day, N_0	6417 [a]
Non-acutely infected PLWH who are unaware of their status, N_1	229,983 [b]
Serostatus-aware PLWH who are not receiving ART, N_2	515,360 [15]
Serostatus-aware PLWH who are receiving ART, N_3	426,590 [15]
Ratio of transmission rates for N_0 and N_1, $\mu(0,1) = \gamma_1/\gamma_0$	0.1235 [26]
Ratio of transmission rates for N_1 and N_2, $\mu(1,2) = \gamma_2/\gamma_1$	0.43 [10,17]
Ratio of transmission rates for N_2 and N_3, $\mu(2,3) = \gamma_3/\gamma_2$	0.23 [c]

[a] Calculated from annual incidence using method described in [10].

[b] Obtained by subtracting acutely-infected persons from total number of PLWH who are unaware of their infection, 236,400.[25]

[c] Calculated as 1 - 0.77, based on estimate that 77% of PLWH on ART have suppressed viral load (≤ 200 copies/mL).[15]

Table 3

Base-case and univariate sensitivity analysis results

	Infections prevented	Net program cost ($*1000)	QALYs saved	Cost per QALY saved (CER, $)
Base-case results	3191	297,947	24,922	11,955
T = $380,877	3191	214,483	24,922	8606
T = $271,108	3191	564,796	24,922	22,663
$Q_2 = 6.95$	3191	297,947	26,582	11,209
$Q_2 = 5.87$	3191	297,947	23,135	12,879
$Q_1 = 0.05$[a]	3191	297,947	26,022	11,450
$Q_1 = 0.03$[b]	3191	297,947	23,821	12,508
$\gamma_2 - \gamma_3 = 0.0304$[c]	3345	243,296	25,913	9389
$\gamma_2 - \gamma_3 = 0.0276$[d]	3037	352,598	23,932	14,733

[a] Based on 5.5% improvement in quality-of-life 1 year after ART initiation.[14]

[b] Based on 3.2% improvement in quality-of-life 1 year after ART initiation.[14]

[c] Corresponds to 80% reduction, due to ART, in the likelihood of secondary transmission.

[d] Corresponds to 74% reduction, due to ART, in the likelihood of secondary transmission.