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Background

- The key to successful HIV treatment and prevention is testing, early diagnosis, linkage and retention in care. In 2010 the White House released the National HIV/AIDS Strategy (NHAS) (1). Key priorities in this report include: reducing new infections, increasing access to care and improving health outcomes for persons living with HIV and reducing HIV-related health disparities (1). Although progress has been made in achieving these goals, regional disparities persist (2,3)
- A previous study in South Carolina (SC) from 2001-2005 found 41.3% of new HIV diagnoses were late testers (diagnosed with AIDS within 1 year of HIV diagnosis) (4). According to the recent States HIV Progress Report (SPR) in 2011, SC ranked in the 4th quartile for late-stage HIV diagnosis, while ranking 43/51 (50 states and Washington DC) in the percent of individuals with late stage HIV diagnosis (2)
- Late HIV diagnosis is associated with increased HIV related complications, worse health outcomes, shorter life expectancy, and increased HIV transmission events (5). Test and treat initiatives and recent guidelines recommending that antiretroviral therapy (ART) should be started as soon as possible after HIV diagnosis regardless of the CD4 cell count have increased the number of individuals who are eligible for ART (5)
- This means an increased initial cost of care for HIV-infected patients. However, it is anticipated that early diagnosis, linkage to care, initiation of ART and retention in care would lead to reduced risks of development of opportunistic infections, reduction in HIV-related morbidity and mortality and reduced rates of HIV transmission (5)

Objective

- This study aims to analyze existing data to determine to what extent early vs. late HIV diagnosis impacts lifetime cost of care

Methods

- SC electronic HIV/AIDS reporting system (eHARS) data were used for analysis
- The analysis includes individuals with a new diagnosis of HIV in SC from January 2013 - December 2015
- The first CD4 reported to eHARS was used to categorize early vs. late diagnosis
- Late HIV diagnosis was defined as an initial CD4 count ≤ 200 cells/mm³, intermediate as an initial CD4 count 201 – 500 cells/mm³ and early as an initial CD4 > 500 cells/mm³
- A previously validated simulation model developed by the John Snow Institute (JSI) was used to determine the lifetime cost of care (LCC) and quality adjusted life-years (QALYs)
- The Incremental Cost Effectiveness Ratio (ICER), a measure of cost effectiveness based on QALYs saved, was also determined
- The model was also used to determine the differences in QALYs lost, additional years life expectancy and lifetime HIV transmission if all individuals included were diagnosed late (CD4 ≤ 200 cells/mm³) compared to early (> 500 cells/mm³)
- The model was developed by reviewing previous studies (6,7,8) to identify measures used to determine cost savings for early intervention and linkage to care
- A draft cost analysis model was then developed using Excel software and was reviewed by SC DHEC and their CDC project officer and medical consultant. Further review was conducted by a CDC economist
- In determining additional life expectancy the model assumed that the mean age of infection is 35 years. The model also assumed that an intervention is cost effective if the ICER is $< \$100,000$ per QALY gained

Table 2: Lifetime Cost of Care (LCC), Lifetime HIV Transmission, Lost Quality Adjusted Life Years (QALYs) and Additional Life Expectancy Stratified by Initial CD4 Count

Initial CD4 (cells/mm ³)	N	LCC/person	Lifetime HIV Transmission/person	Lost QALY/person	Additional Life Expectancy (years)
≤ 200	509	\$262,374	1.40	7.95	30.7
201-500	822	\$361,409	1.09	4.85	37.2
> 500	627	\$416,776	0.72	4.45	38.1

Table 1 : Showing Demographic Information of Study Individuals (percentages in parentheses)

Age (yrs)	
Range	18 – 87
Mean	35
Median	31
Gender	
Male	1705 (79.8)
Female	433 (20.2)
Race	
Black or African American	1460 (68.3)
White	487 (22.8)
Asian	4 (0.2)
American Indian or Alaska Native	4 (0.2)
Native Hawaiian or Pacific Islander	1 (0.05)
Mixed	35 (1.6)
Unknown or Declined to report	38 (1.8)
Ethnicity	
Hispanic or Latino	109 (5.1)
Mode of Transmission	
MSM	1149 (53.7)
IDU	50 (2.3)
MSM and IDU	22 (1.0)
Heterosexual	271 (12.7)
Perinatal	1 (0.05)
No identifiable risk factor	645 (30.2)

Table 3: Incremental Cost Effectiveness Ratio (ICER) Comparing Different CD4 Categories

CD4 comparisons	ICER
CD4 > 500 vs. CD4 ≤ 200	\$44 112 (per QALY gained)
CD4 201-500 vs. CD4 ≤ 200	\$31 947 (per QALY gained)

Results

- From January 2013 – December 2015, 2,138 persons were diagnosed with HIV in SC but initial CD4 count data was only available for 1,958
- The age at diagnosis ranged from 18 to 87 with a mean age at diagnosis of 35 years. Most individuals were male (80%) with the most common mode of transmission being MSM (men having sex with men) (54%)
- The overall LCC was \$569,633,352.75 (\$290,926/person). Table 2 shows the LCC and lifetime HIV transmission risk stratified by initial CD4 count
- The lost QALYs/person was 7.95 for those with initial CD4 ≤ 200 cells/mm³ compared to 4.45 for CD4 > 500 cells/mm³
- Additional life expectancy was 30.7 years for those with initial CD4 ≤ 200 cells/mm³ compared to 38.1 years for CD4 > 500 cells/mm³
- The ICER for diagnosis with an initial CD4 > 500 cells/mm³ vs. CD4 ≤ 200 cells/mm³ was \$44,112 per QALY gained
- If all 1,958 individuals included in the study were diagnosed early (CD4 > 500 cells/mm³) rather than late (CD4 ≤ 200 cells/mm³) then overall there would have been 6853 fewer QALYs lost, 14,392 years additional life expectancy and 1331 fewer lifetime HIV transmissions

Discussion

Individuals diagnosed earlier in HIV disease course were found to have a higher overall LCC. This is explained by a shorter life expectancy and less overall time receiving ART in individuals with late diagnoses. However, individuals diagnosed earlier were also found to have less lost QALYs, greater additional life expectancy and lower rates of lifetime HIV transmission compared to those with late diagnoses. Since data on time to linkage to care were not available, it was assumed that all individuals were linked to care early (i.e. within 90 days) when estimating the lifetime cost of care. Late linkage to care (i.e. > 90 days) is associated with lower costs for the same reasons as late diagnosis as discussed above. Therefore, the actual overall lifetime cost of care would be expected to be lower than reported in our study. The ICER is a measure of the cost effectiveness of an intervention based on QALYs saved. An intervention is considered to be cost effective if the ICER is $< \$100,000$. In this study the ICER indicated that earlier HIV diagnosis was cost effective.

Limitations

- This was a retrospective analysis based on surveillance data
- In determining the additional life expectancy the model assumed that the mean age of infection is 35 years
- In determining the lifetime cost of care the assumption was made that all patients had early linkage to care (i.e. within 90 days)
- Model does not look at outcomes for those previously diagnosed and returning to care

Conclusion

Individuals with early HIV diagnosis have a higher lifetime cost of care which is offset by an increase in additional life expectancy and reduction in lost QALYs and lifetime HIV transmissions

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