

AIDS

DOI: 10.1097/QAD.0000000000001215

Title: Chronic health conditions in Medicare beneficiaries 65 years and older with HIV infection

Short title: Chronic illness among HIV infected persons ≥ 65

Authors: Eleanor E. FRIEDMAN¹, Wayne A. DUFFUS¹

¹ Office of Health Equity, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention

Number of words in text: 3,106

Contact information:

Eleanor Friedman, ASPPH/CDC Public Health Fellow Centers for Disease Control and Prevention 1600 Clifton Road, Mailstop E-07 Atlanta, GA 30329-4027

Email: Uvv8@cdc.gov Telephone: 404-718-8631

Funding: This work was supported by Cooperative Agreement Number U36/CCU300430 from the Centers for Disease Control and Prevention and the Association of Schools and Programs of Public Health. The findings and conclusions of this publication do not necessarily represent the official views of CDC or ASPPH.

Abstract:

Objectives: to examine sociodemographic factors and chronic health conditions of people living with HIV (PLWHIV/ HIV+) \geq 65 years, and to compare their chronic disease prevalence to beneficiaries without HIV.

Design: National fee for service (FFS) Medicare claims data (parts A and B) from 2006-2009 were used to create a retrospective cohort of beneficiaries $>$ 65 years old.

Methods: Beneficiaries with 1 inpatient or skilled nursing facility claim, or 2 outpatient claims with HIV diagnosis codes were considered HIV+. HIV+ beneficiaries were compared to uninfected beneficiaries on demographic factors and on the prevalence of hypertension, hyperlipidemia, ischemic heart disease, rheumatoid arthritis/osteoarthritis, and diabetes. Odds ratios (OR), 95% confidence intervals (CI), and p-values were calculated. Adjustment variables included age, sex, race/ethnicity, end stage renal disease (ESRD), and dual Medicare-Medicaid enrollment. Chronic conditions were examined individually, and as an index from zero to all five conditions.

Results: Of 29,060,418 eligible beneficiaries, 24,735 (0.09%) were HIV+. HIV+ beneficiaries were more likely to be Hispanic, African American, male, and younger ($p > 0.0001$), and were 1.5 to 2.1 times as likely to have a chronic disease (diabetes (aOR) 1.51 95% CI (1.47, 1.55); rheumatoid arthritis/osteoarthritis 2.14 95% CI (2.08, 2.19)), and 2.4 to 7 times as likely to have 1-5 co-morbid chronic conditions (1 condition (aOR) 2.38 95% CI (2.21, 2.57); 5 conditions 7.07 95% CI (6.61, 7.56)).

Conclusions: Our results show that PLWHIV \geq 65 years are at higher risk of comorbidities than other FFS Medicare beneficiaries. This finding has implications for both the management and cost of the health of PLWHIV \geq 65.

5 keywords: HIV, Chronic conditions, older, Medicare

Introduction:

Recent epidemiologic reviews of persons living with human immunodeficiency virus (PLWHIV) in the United States have indicated that those ≥ 50 years old represent an increasing proportion of those infected (1). In 2011 about 36% of all PLWHIV in the United States and six territories were persons ≥ 50 years of age (2). This group of PLWHIV is expanding largely due to increased length of survival after HIV infection, rather than increased numbers of infections and diagnoses (1). Survival time for PLWHIV has increased significantly since the introduction of highly active antiretroviral therapy (HAART) in 1996. Recent cohort trials have indicated that PLWHIV now have a lifespan close to that of non-HIV infected persons (3, 4). With appropriate antiretroviral management, it is expected that increasing numbers of PLWHIV will survive into older age, with some estimating that by 2020, half of all PLWHIV will be ≥ 50 years (5).

Research has begun to focus on the threats to health of older PLWHIV, both those due to normal aging processes, as well as those due to their HIV infection. There is evidence that older PLWHIV experience age-related illnesses earlier in life, or in a more severe form than their non-HIV infected counterparts (6). It is hypothesized that the greater severity and earlier onset of these diseases may be due to the changes in immunity and inflammation caused by HIV infection (5). PLWHIV appear to be more likely to suffer from classic age-related comorbidities such as cardiovascular disease, diabetes, and renal failure than their non-infected, age-matched counterparts (7). There are also concerns that HAART drug regimens may cause damage to the kidneys and liver in certain PLWHIV, and that drug toxicity could interact with age-related declines in organ function (8, 9). Many HAART drugs have also been associated with abnormal lipid profiles, which can increase the risk of cardiovascular diseases and

diabetes (10, 11). It is also possible that PLWHIV are more prone to age related chronic diseases due to high prevalence of harmful behaviors, such as substance abuse (12-14).

Despite recent attention on older PLWHIV, there is still the need for more specific and in-depth research in this population. In particular, although many studies have included or even focused on persons ≥ 50 years of age, few studies have subdivided this category further, or included substantial numbers of persons ≥ 65 years of age (15, 16). According to the Centers for Disease Control and Prevention in 2010 there were an estimated 35,000 PLWHIV who were ≥ 65 years of age, a number that will only get larger in the coming years (2). There is a lack of knowledge about the health of PLWHIV ≥ 65 years compared to that of their non-HIV infected counterparts, including their prevalence of chronic diseases. The objective of this study is to examine sociodemographic factors and chronic health conditions of PLWHIV aged ≥ 65 years and older, and to compare their chronic disease prevalence to beneficiaries without HIV.

Methods:

Americans ≥ 65 years almost universally receive their health insurance coverage from Medicare, and the majority (84-77% during 2006-2009) of these Medicare beneficiaries were fee for service (FFS) enrollees, making FFS claims a comprehensive source to investigate the health of PLWHIV ≥ 65 years (17). Inclusion criteria for this study were as follows: enrollment in Parts A and B of Medicare excluding those enrolled in a Health Maintenance Organization (Medicare Advantage/Medicare managed care programs), enrollment of 11 continuous months or more (or death) during the years 2006-2009, and age range of ≥ 65 to 116 years of age (Figure 1). The minimum 11 month enrollment criteria, the inclusion of data from dead beneficiaries until their date of death, and the exclusion of persons enrolled in an Health Maintenance Organizations are all practices recommended by the Chronic

Condition Warehouse (CCW) for determining FFS beneficiaries (18). The upper age limit was chosen in order to include all beneficiaries who were plausibly alive, while excluding beneficiaries who were dead but did not have a confirmed death date. All data were de-identified and each individual was assigned a unique identifier by the Centers for Medicare & Medicaid Services (CMS) prior to analysis.

To determine which beneficiaries had HIV, we created an algorithm that used the presence of an International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis code (ICD-9-CM) or diagnosis related group code (DRG) for HIV or AIDS (ICD-9-CM 42-44, V08, or 79.53; DRG 969-977 or DRG 488-490 for claims prior to September 2007). Beneficiaries were considered to have HIV if they had one inpatient, skilled nursing, or long-term care facility claim with an ICD-9-CM or DRG code indicating HIV; or two claims on different days from other therapy services (part B) or outpatient services with an ICD-9-CM or DRG code indicating HIV over the course of one year. This algorithm is similar in methodology to that used by CCW to identify beneficiaries with chronic diseases, and is also similar, but does not duplicate the method CCW recently developed to identify beneficiaries with HIV/AIDS in future data releases (19, 20). Eligible persons without indications of HIV were referred to as HIV- or non-HIV infected.

The prevalence of the five most common chronic health conditions in the Medicare population ≥ 65 years was investigated in those with and without HIV (21). These conditions included hypertension, hyperlipidemia, ischemic heart disease, rheumatoid arthritis/osteoarthritis, and diabetes, as defined by CCW from the presence of ICD-9-CM diagnosis, Current Procedural Terminology Fourth Edition (CPT4) codes, or Healthcare Common Procedure Coding System (HCPCS) codes (19). Beneficiaries who met each chronic conditions criteria were indicated by CCW prior to data analysis. These chronic condition variables are used in numerous publications from both CMS and in the general literature (21, 22). A list of the codes and specified reference periods that CCW uses to identify persons with

hypertension, hyperlipidemia, ischemic heart disease, arthritis, and diabetes are included in the appendix.

The race/ethnicity of individuals were determined using the Research Triangle ‘corrected race ethnicity’ codes to allow for comparison reports on chronic disease prevalence in Medicare issued by CMS (21). Age was determined based on birthdate and the date of enrollment, with beneficiaries only eligible for inclusion for the years when they were ≥ 65 years. Some CMS administrative variables were included in our analysis, including the original reason for qualifying in Medicare for persons enrolled before age 65 (Social Security Administration declaration of disability, end stage renal disease (ESRD), or both disability and ESRD), current reason for Medicare enrollment (age, disability, ESRD, or both disability and ESRD), Medicaid coverage start date (historical to January 1999), and months of dual enrollment in Medicaid and Medicare. Based on administrative summaries, we also were able to determine if a beneficiary had enrolled in optional Medicare part D prescription coverage during the course of the study.

All hypothesis testing was two-tailed, and p-values of less than 0.05 were considered significant. To examine differences in sociodemographic factors and health conditions between HIV+ beneficiaries and their HIV-counterparts, Wald χ^2 tests Wilcoxon Z tests, and logistic regression modeling with odds ratios and confidence intervals were used. Models for chronic conditions were run both with and without adjustment for variables that are either commonly included in the chronic disease literature, or are known to affect the prevalence of chronic disease, including: age, sex, and race/ethnicity, a measure of socioeconomic status, and ESRD (23, 24, 25). In adjusted models, persons with missing values for any adjustment variables were dropped. Models examined the individual risk for each of the five chronic conditions among PLWHIV compared to non-HIV infected adults. Additionally, an index was created to consider the number of co-morbid chronic conditions from zero to five conditions (regardless of the

combination of conditions). All statistical analyses were conducted using SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC).

Results:

Approximately 29 million FFS Medicare beneficiaries met the inclusion criteria for the years 2006-2009. Beneficiaries had varying year of enrollment depending on when they became ≥ 65 years, and also on when they met FFS inclusion criteria. Out of all eligible persons, 99.7% of beneficiaries without HIV and 99.5% of beneficiaries with HIV were eligible starting on January 1st 2006, and contributed four full years of data to this study. Of the 29,060,418 eligible persons for this study 99.9% were HIV-, and 24,735 (0.09%) were HIV+.

The median age of PLWHIV was about 5 years younger than their non-HIV infected counterparts (p-value <0.0001). HIV+ beneficiaries were nearly twice as likely to be male, five times as likely to be African American or Hispanic and were also more likely to live in Florida, New York, California, Texas, or New Jersey (Table 1). Beneficiaries with HIV infection were more likely to have had Medicaid coverage since 1999 OR 3.02 95% CI (2.94, 3.10), to have had dual Medicaid and Medicare coverage for one or more months during the study OR 3.19 95% CI (3.11, 3.27), and to have enrolled in Medicare prescription coverage (Medicare Part D) OR 1.89 95% CI (1.84, 1.94) than age-eligible persons without HIV infection. Beneficiaries with HIV infection were also more likely to have originally been eligible for Medicare via disability OR 2.64 95% CI (2.55, 2.72), ESRD OR 6.46 95% CI (5.18, 8.06), or disability and ESRD OR 5.57 95% CI (4.22, 7.35) (Table 1). PLWHIV were also approximately five times as likely to have the current reason for Medicare enrollment be listed as ESRD OR 4.77 95% CI (4.03, 5.66), but were about 60% less likely to die during the time of the study OR 0.38

95% CI (0.36, 0.40) (Table 1), a result partially due to the younger age of HIV+ beneficiaries (data not shown).

HIV+ beneficiaries were approximately twice as likely as those without HIV infection to have chronic condition flags indicating hypertension, hyperlipidemia, ischemic heart disease, rheumatoid arthritis/osteoarthritis, or diabetes (Table 2). Adjusted risks for these chronic conditions ranged from aOR 1.51 95% CI (1.47, 1.55) for diabetes to aOR 2.14 95% CI (2.08, 2.19) for rheumatoid arthritis/osteoarthritis (Table 3). Adjustment factors associated with HIV infection in multivariable models included being male, being of African American race or Hispanic ethnicity, having end stage renal disease, and dual eligibility for Medicaid and Medicare (Table 3). For male African American and Hispanic beneficiaries with chronic conditions, the likelihood of HIV infection was especially elevated in comparison to that of white female beneficiaries with the same chronic condition, with adjusted odds ratios ranging from 8.99 to 6.33 (data not shown).

For models that examined the number of chronic diseases as an index, PLWHIV were more likely than their non-infected counterparts to have one or more chronic conditions, with increasing risks seen for each additional comorbidity. While frequencies of having 2-4 chronic conditions were similar for persons with and without HIV, HIV+ beneficiaries were less likely to have no chronic conditions or one chronic condition (13.22% versus 25.66%), and were more likely to have 5 chronic conditions (22.11% versus 8.41%) (Table 2). Adjusted odds of having HIV infection and one or more comorbidities ranged from aOR 2.38 95% CI (2.21, 2.57) for having one condition to aOR 7.07 95% CI (6.61, 7.56) for having all five chronic conditions (Table 4). Adjustment Factors that were significant in each of the five individual models of chronic conditions remained significant in the model that considered the number of chronic conditions as an index. Male African American and Hispanic beneficiaries were more

than 3 times as likely to have HIV for each level of the chronic condition index as compared to white females with the same number of chronic conditions (data not shown).

Discussion:

This study found that age-eligible PLWHIV in Medicare were more likely to be of Hispanic ethnicity, African American race, male sex and younger than other age eligible Medicare beneficiaries. Beneficiaries with HIV infection were more likely to have originally enrolled in Medicare under disability benefits, to have been enrolled in Medicaid since 1999, and to have been dually enrolled in Medicaid and Medicare. Beneficiaries with HIV infection were also more likely than those without HIV infection to have one or more of the five most common chronic health conditions, increasing the complexity of their medical issues, care, and likelihood of ill health after age 65.

Increasing numbers of PLWHIV will use Medicare as their primary source of insurance as survival of HIV-positive persons extends to 50 years post-infection (3, 4). While historically Medicaid has been a major source of health insurance for PLWHIV, Medicaid is only responsible for insurance costs after all other third-party insurance payers, including Medicare, are billed for services (26). As greater numbers of PLWHIV enter Medicare as age-eligible beneficiaries, the majority of their care costs will shift from Medicaid to Medicare (27). This is important given that costs for HIV care are considerable, even without the additional costs seen when multiple chronic conditions are also considered. Cost estimates of living with HIV in the U.S. range considerably depending on demographic and HIV related factors; but estimates using 2005 and 2006 data range from \$10,000 to \$40,000 per year (28, 29). Costs associated with multiple chronic health problems are also high. Data from 2005 Medicare expenditure costs, indicate that the annual costs for Medicare beneficiaries with one chronic condition are \$7,172, and for beneficiaries with three or more chronic conditions \$32,498 (30).

This study adds to the growing body of literature on older PLWHIV in the U.S. Historically PLWHIV have entered the Medicare health system as beneficiaries with social security disability benefits. However with the aging HIV-positive patient population, HIV providers in the Medicare network will have to prepare for patients with different medical needs, including a higher likelihood of chronic co-morbid health conditions. Similarly, chronic disease practitioners who serve in the Medicare network, such as cardiologists and endocrinologists, should be aware that their Medicare patients may be receiving treatment for HIV infection. Greater collaboration between infectious disease and chronic disease practitioners will be needed to ensure the appropriate medical management of these patients including complex medication regimes (31, 32).

This is the first and largest study to the authors' knowledge to examine chronic conditions among PLWHIV who are exclusively ≥ 65 years of age. Previous studies have examined frequencies of chronic conditions among PLWHIV ≥ 50 years but few of these studies have included large numbers of participants 65 years and older (33-37). This study is in agreement with many previous studies that have found higher prevalence of disease, or increased risk for cardiovascular diseases, arthritis, and diabetes among persons with HIV, both among those ≥ 50 years of age and those not focused on older persons with HIV (7, 11, 38).

This study identified 24,735 FFS Medicare beneficiaries who were ≥ 65 years with HIV infection, which represents 78% of the total number of PLWHIV ≥ 65 years identified in the Centers for Disease Control and Prevention National surveillance data for 2009 (2). The discrepancy between the number of PLWHIV identified in this study and in surveillance reports is likely due to this study excluding beneficiaries enrolled in Health Maintenance Organizations care plans. During the years 2006-2009, 16-23% of all Medicare beneficiaries were members of Medicare Advantage/managed care plans (17).

There are several limitations to this work. The time period of the study was restricted to the most recent available data for persons with dual Medicare-Medicaid benefits, which at the time of analysis was 2009. It is important to note that Medicare claims data are reimbursement based and contain only information for provided health services. Therefore, information on some demographic factors of interest (education level, income), results of clinical tests (viral load tests, CD4 T cell tests), and other patient history information (e.g., diet, exercise and presence of risk behaviors such as smoking) were not available. This study also developed a novel algorithm for FFS Medicare beneficiaries with HIV. This algorithm was based on early formulations of the CCW other chronic or potentially disabling condition HIV flag. The CCW has recently finalized their HIV flag, but it has not yet been retrospectively applied to historic data (20). Whereas the codes used to define HIV+ beneficiaries in this paper and those used in the CCW algorithm are the same, there are slight differences between the algorithm in this paper and that developed by the CCW. The number of claims needed for the CCW algorithm is two for all claim types except for inpatient, whereas this paper considered one claim sufficient for all but outpatient and other therapy (part B) claims. Similarly, the CCW algorithm uses a two year retrospective period, whereas this paper used a single year retrospective period. It is possible that the shorter retrospective period used in this paper will underestimate the number of HIV+ beneficiaries in comparison to the algorithm used by CCW. In contrast, the fewer claims used in this paper as compared to the CCW criteria may result in an overestimation of HIV+ beneficiaries.

The CCW algorithms were used to determine persons who had chronic conditions. These algorithms are commonly used in the analysis of Medicare data, but are known to be less sensitive in identifying diseases than the clinical medical record (39). Some studies have indicated that the CCW algorithms are likely to underestimate chronic illnesses, especially those that may not require frequent medical care (40). It is also possible that a higher proportion of chronic conditions that ordinarily do not

require frequent medical care would be diagnosed among individuals with HIV who are adherent to care and regularly encounter medical professionals. In addition, astute health care personnel may have preferentially screened HIV positive beneficiaries for particular chronic conditions known to be associated with long term HIV infection and antiretroviral treatment, such as diabetes and cardiovascular diseases, leading to increased diagnosis of some chronic conditions among PLWHIV. Prevalence of both HIV and chronic conditions was measured in this paper, not incidence. The temporal relationship between HIV infection and chronic conditions cannot be determined due to the lack of original clinical diagnosis dates. Survivor bias is likely to have affected the available Medicare beneficiary population, both those with and without HIV. Medicare prescription drug plans were only introduced in 2006 (Part D), and not all beneficiaries in this study had prescription drug information available to researchers. This includes a lack of information on HAART, which is likely to influence chronic condition prevalence for HIV+ beneficiaries. Beneficiaries who had HIV infection and Part D Medicare drug coverage will be explored in depth in a future analysis.

In conclusion this is the first and largest study of PLWHIV ≥ 65 years old. Using an original data source, our results show that this population is at significantly higher risk of comorbidities than other non-HIV infected Medicare beneficiaries. Medicare data represent a rich source of information to create HIV-positive cohorts with information on multiple chronic conditions that affect older PLWHIV.

Acknowledgements:

E.E.F. and W.A.D. designed the study. E.E.F. analyzed the data. All authors contributed to writing the manuscript.

The authors would like to thank Angela Thompson-Paul PhD, from the CDC's National Center for Chronic Disease Prevention & Health Promotion, Division of Heart Disease and Stroke Prevention for her suggestions on this manuscript.

This work was supported by Cooperative Agreement Number U36/CCU300430 from the Centers for Disease Control and Prevention and the Association of Schools and Programs of Public Health. The findings and conclusions of this publication do not necessarily represent the official views of CDC or ASPPH.

References

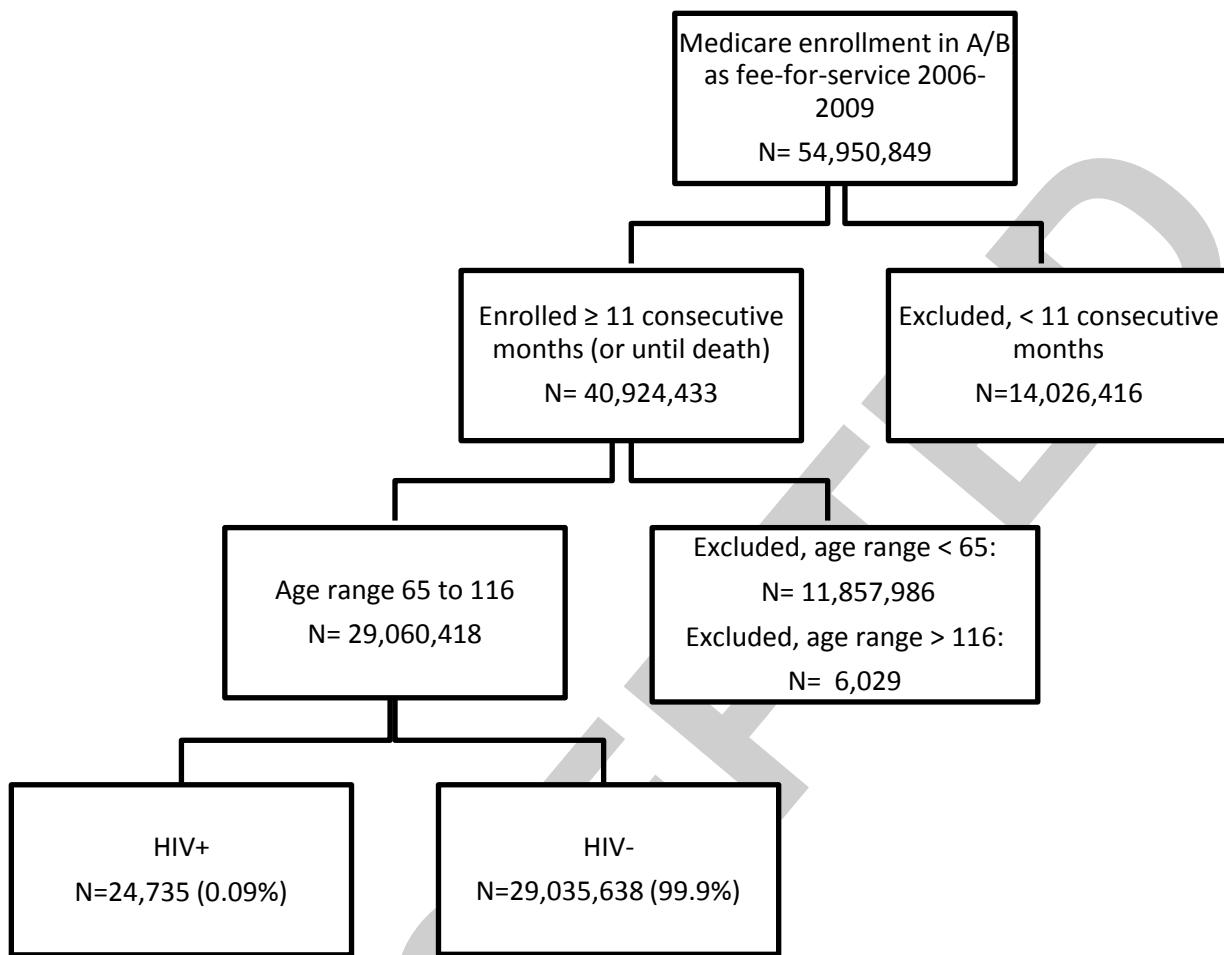
1. Centers for Disease Control and Prevention. Diagnoses of HIV infection among adults aged 50 years and older in the United States and dependent areas, 2007–2010. 2013.
2. Centers for Disease Control and Prevention. HIV Surveillance Report, 2011. 2013 [5/29/2014]; Available from: <http://www.cdc.gov/hiv/topics/surveillance/resources/reports/>.
3. Samji H, Cescon A, Hogg RS, Modur SP, Althoff KN, Buchacz K, et al. Closing the gap: increases in life expectancy among treated HIV-positive individuals in the United States and Canada. *PloS one*. 2013;8(12):e81355.
4. Patterson S, Cescon A, Samji H, Chan K, Zhang W, Raboud J, et al. Life expectancy of HIV-positive individuals on combination antiretroviral therapy in Canada. *BMC infectious diseases*. 2015;15:274.
5. Brooks JT, Buchacz K, Gebo KA, Mermin J. HIV infection and older Americans: the public health perspective. *American journal of public health*. 2012 Aug;102(8):1516-26.
6. Deeks SG, Phillips AN. HIV infection, antiretroviral treatment, ageing, and non-AIDS related morbidity. *Bmj*. 2009;338:a3172.
7. Guaraldi G, Orlando G, Zona S, Menozzi M, Carli F, Garlassi E, et al. Premature age-related comorbidities among HIV-infected persons compared with the general population. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*. 2011 Dec;53(11):1120-6.
8. Scarpino M, Pinzone MR, Di Rosa M, Madeddu G, Foca E, Martellotta F, et al. Kidney disease in HIV-infected patients. *European review for medical and pharmacological sciences*. 2013 Oct;17(19):2660-7.
9. Falade-Nwulia O, Thio CL. Liver disease, HIV and aging. *Sexual health*. 2011 Dec;8(4):512-20.
10. Giannarelli C, Klein RS, Badimon JJ. Cardiovascular implications of HIV-induced dyslipidemia. *Atherosclerosis*. 2011 Dec;219(2):384-9.
11. Lake JE, Currier JS. Metabolic disease in HIV infection. *The Lancet infectious diseases*. 2013 Nov;13(11):964-75.
12. Mdodo R, Frazier EL, Dube SR, Mattson CL, Sutton MY, Brooks JT, et al. Cigarette smoking prevalence among adults with HIV compared with the general adult population in the United States: cross-sectional surveys. *Annals of internal medicine*. 2015 Mar 3;162(5):335-44.
13. Freiberg MS, Kraemer KL. Focus on the Heart: Alcohol Consumption, HIV Infection, and Cardiovascular Disease. *Alcohol Research & Health*. 2010;33(3):237-46.
14. Kumar S, Rao PS, Earla R, Kumar A. Drug-drug interactions between anti-retroviral therapies and drugs of abuse in HIV systems. *Expert opinion on drug metabolism & toxicology*. 2015 Mar;11(3):343-55.
15. Emlet CA, Tozay S, Raveis VH. "I'm not going to die from the AIDS": resilience in aging with HIV disease. *The Gerontologist*. 2011 Feb;51(1):101-11.
16. Nguyen N, Holodniy M. HIV infection in the elderly. *Clinical interventions in aging*. 2008;3(3):453-72.
17. K. Davis CS, and F. Bandeali, . Medicare: 50 Years of Ensuring Coverage and Care. Commonwealth Fund, 2015.
18. Chronic Condition Data Warehouse. CCW Technical Guidance: Getting Started with CMS Medicare Administrative Research Files. 2016 [1/25/2016]; Available from: <https://www.ccwdata.org/web/guest/technical-guidance-documentation>.

19. Chronic Condition Data Warehouse. Condition Categories. 2015 [9/3/2015]; Available from: <https://www.ccwdata.org/web/guest/condition-categories>.
20. Chronic Condition Data Warehouse. Other Chronic or Potentially Disabling Conditions. 2015 [11/10/2015]; Available from: <https://www.ccwdata.org/web/guest/condition-categories>.
21. Centers for Medicare & Medicaid Services. Chronic Conditions among Medicare Beneficiaries, Chartbook. Baltimore, MD.: 2012.
22. Chi MJ, Lee CY, Wu SC. The prevalence of chronic conditions and medical expenditures of the elderly by chronic condition indicator (CCI). *Archives of gerontology and geriatrics*. 2011 May-Jun;52(3):284-9.
23. Horowitz B, Miskulin D, Zager P. Epidemiology of hypertension in CKD. *Advances in chronic kidney disease*. 2015 Mar;22(2):88-95.
24. Jones DW, Chambliss LE, Folsom AR, Heiss G, Hutchinson RG, Sharrett AR, et al. Risk factors for coronary heart disease in African Americans: the atherosclerosis risk in communities study, 1987-1997. *Archives of internal medicine*. 2002 Dec 9-23;162(22):2565-71.
25. Gaskin DJ, Thorpe RJ, Jr., McGinty EE, Bower K, Rohde C, Young JH, et al. Disparities in diabetes: the nexus of race, poverty, and place. *American journal of public health*. 2014 Nov;104(11):2147-55.
26. Centers for Medicare & Medicaid Services. Deficit Reduction Act Important Facts for State Policymakers. Third Party Liability in the Medicaid Program. Baltimore, MD.: US Department of Health and Human Services; 2007.
27. Foote SM, Hogan C. Disability profile and health care costs of Medicare beneficiaries under age sixty-five. *Health affairs (Project Hope)*. 2001 Nov-Dec;20(6):242-53.
28. Schackman BR, Gebo KA, Walensky RP, Losina E, Muccio T, Sax PE, et al. The lifetime cost of current human immunodeficiency virus care in the United States. *Medical care*. 2006 Nov;44(11):990-7.
29. Gebo KA, Fleishman JA, Conviser R, Hellinger J, Hellinger FJ, Josephs JS, et al. Contemporary costs of HIV healthcare in the HAART era. *AIDS (London, England)*. 2010 Nov 13;24(17):2705-15.
30. Schneider KM, O'Donnell BE, Dean D. Prevalence of multiple chronic conditions in the United States' Medicare population. *Health and quality of life outcomes*. 2009;7:82.
31. Greene M, Justice AC, Lampiris HW, Valcour V. Management of human immunodeficiency virus infection in advanced age. *JAMA : the journal of the American Medical Association*. 2013 Apr 3;309(13):1397-405.
32. Holtzman C, Armon C, Tedaldi E, Chmiel JS, Buchacz K, Wood K, et al. Polypharmacy and risk of antiretroviral drug interactions among the aging HIV-infected population. *Journal of general internal medicine*. 2013 Oct;28(10):1302-10.
33. Patel R, Moore T, Cooper V, McArdle C, Perry N, Cheek E, et al. An observational study of comorbidity and healthcare utilisation among HIV-positive patients aged 50 years and over. *International journal of STD & AIDS*. 2015 Jun 10.
34. Buchacz K, Baker RK, Palella FJ, Jr., Shaw L, Patel P, Lichtenstein KA, et al. Disparities in prevalence of key chronic diseases by gender and race/ethnicity among antiretroviral-treated HIV-infected adults in the US. *Antiviral therapy*. 2013;18(1):65-75.
35. Oursler KK, Goulet JL, Crystal S, Justice AC, Crothers K, Butt AA, et al. Association of age and comorbidity with physical function in HIV-infected and uninfected patients: results from the Veterans Aging Cohort Study. *AIDS patient care and STDs*. 2011 Jan;25(1):13-20.
36. Rodriguez-Penney AT, Iudicello JE, Riggs PK, Doyle K, Ellis RJ, Letendre SL, et al. Comorbidities in persons infected with HIV: increased burden with older age and negative effects on health-related quality of life. *AIDS patient care and STDs*. 2013 Jan;27(1):5-16.

37. Hasse B, Ledergerber B, Furrer H, Battegay M, Hirschl B, Cavassini M, et al. Morbidity and aging in HIV-infected persons: the Swiss HIV cohort study. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*. 2011 Dec;53(11):1130-9.
38. Kebodeaux CD, Wilson AG, Smith DL, Vouri SM. A review of cardiovascular and renal function monitoring: a consideration of older adults with HIV. *HIV/AIDS (Auckland, NZ)*. 2013;5:263-74.
39. Romano PS, Roos LL, Luft HS, Jollis JG, Doliszny K, The Ischemic Heart Disease Patient Outcomes Research T. A comparison of administrative versus clinical data: coronary artery bypass surgery as an example. *Journal of Clinical Epidemiology*. 1994;47(3):249-60.
40. Gorina Y, Kramarow EA. Identifying chronic conditions in Medicare claims data: evaluating the Chronic Condition Data Warehouse algorithm. *Health services research*. 2011 Oct;46(5):1610-27.

ACCEPTED

Figure 1. Inclusion criteria and number of eligible beneficiaries in Medicare 2006-2009



* HIV+ beneficiaries were those with ICD-9-CM, or DRG codes with a diagnosis of HIV, HIV- were beneficiaries without these codes

Table 1. Demographics and Medicare Coverage in beneficiaries ≥ 65 years with and without HIV infection*, 2006-2009.

Sociodemographic factors (N=29,060,418)	HIV- Median (Standard deviation) or Number (Percent)	HIV+ Median (Standard deviation) or Number (Percent)	HIV+ vs. HIV - odds ratio (95% CI)	Wilcoxon Z p- value or Wald χ^2 p-value
Age	75.2 (+ 7.7)	71.1 (+ 6.3)	NA	<0.0001
Sex				
Unknown	16 (0%)	0 (0%)	NA	NA
Male ^T	12,203,017 (42.2%)	14,419 (58.3%)	1.93 (1.88, 1.98)	<0.0001
Female ^T	16,832,650 (58.0%)	10,316 (41.7%)	Reference	Reference
Race/ethnicity				
Unknown	29,196 (0.1%)	9 (0%)	0.57 (0.30, 1.03)	0.10
Non-Hispanic White	24,321,073 (83.8%)	13,068 (52.8%)	Reference	Reference
African-American	2,240,959 (7.7%)	6,492 (26.3%)	5.39 (5.23, 5.56)	<0.0001
Other	154,649 (0.5%)	137 (0.6%)	1.65 (1.39, 1.95)	<0.0001
Asian/Pacific Islander	627,525 (2.2%)	338 (1.4%)	0.99 (0.89, 1.10)	0.96
Hispanic	1,556,497 (5.4%)	4,634 (18.7%)	5.51 (5.33, 5.70)	<0.0001
Native American	105,784 (0.4%)	57 (0.2%)	1.00 (0.90, 1.12)	0.98
State of residence				
Any other state	20,048,783 (69.0%)	11,668 (47.2%)	Reference	Reference
Florida	2,068,065 (7.1%)	5,402 (21.8%)	4.49 (4.34, 4.63)	<0.0001
New York	1,738,310 (6.0%)	2,443 (9.9%)	2.40 (2.30, 2.51)	<0.0001
California	23,525,562 (8.1%)	2,432 (9.8%)	1.78 (1.71, 1.86)	<0.0001
Texas	1,911,494 (6.6%)	1,443 (5.8%)	1.30 (1.23, 1.37)	<0.0001
New Jersey	932,094 (3.2%)	1,347 (5.5%)	2.48 (2.35, 2.63)	<0.0001
Died during study	6,879,447 (23.7%)	2606 (10.5%)	0.38 (0.36, 0.40)	<0.0001
Ever had Medicaid coverage§	6,216,824 (21.4%)	11164 (45.1%)	3.02 (2.94, 3.10)	<0.0001

Had dual coverage °	5,394,511 (18.6%)	10418 (42.1%)	3.19 (3.11, 3.27)	<0.0001
Had Medicare Part D coverage	15,483,704 (53.3%)	16898 (68.3%)	1.89 (1.84, 1.94)	<0.0001
Original Medicare category				
Old Age/ Survivors Insurance	26,762,008 (92.2%)	20,150 (81.5%)	Reference	Reference
Disability Insurance Benefits	2,245,503 (7.7%)	4,456 (18.0%)	2.64 (2.55, 2.72)	<0.0001
End stage renal disease	16,243 (0.1%)	79 (0.3%)	6.46 (5.18, 8.06)	<0.0001
Both Disability and renal	11,929 (0.0%)	50 (0.2%)	5.57 (4.22, 7.35)	<0.0001
Current Medicare category				
Old Age /Survivors Insurance	28,995,402 (99.9%)	24,594 (99.4%)	Reference	Reference
Disability Insurance Benefits	7,078 (0%)	7 (0%)	1.17 (0.56, 2.45)	0.68
End stage renal disease	3,3091 (0.1%)	134 (0.5%)	4.77 (4.03, 5.66)	<0.0001
Both Disability and renal	112 (0 %)	0 (0%)	NA	0.89

* HIV+ beneficiaries were those with ICD-9-CM, or DRG codes with a diagnosis of HIV, HIV- were beneficiaries without these codes

† There were individuals whose sex response differed from their gender response, and two individuals whose sex and gender were both unknown.

§ Had a Medicaid coverage start date (historical to 1999)

¥ Dual coverage was defined as having Medicaid and Medicare coverage for one or months 2006-2009

Table 2. Prevalence and unadjusted odds ratios for each of the five chronic conditions and for the number of chronic conditions as an index in Medicare beneficiaries ≥ 65 years, with and without HIV infection*.

Chronic condition [€] (N=29,060,418)	HIV-	HIV+	HIV+ vs. HIV -
	Number (Percent)	Number (Percent)	Odds ratio (95% CI)
Hypertension	21,460,895 (73.9%)	21,146 (85.5%)	2.08 (2.00, 2.15)
Hyperlipidemia	17,039,249 (58.7%)	17,759 (71.8%)	1.79 (1.74, 1.84)
Ischemic heart disease	13,476,065 (46.4%)	15,190 (60.1%)	1.84 (1.79, 1.89)
Rheumatoid/osteoarthritis	12,310,604 (42.4%)	14,277 (57.7%)	1.86 (1.81, 1.90)
Diabetes	9,249,614 (31.9%)	12,181 (49.3%)	2.08 (2.02, 2.13)
Number of chronic conditions^Ψ			
0	3646397 (12.6%)	1030 (4.2%)	Reference
1	3803118 (13.1%)	2241 (9.1%)	2.09 (1.93, 2.25)
2	5883662 (20.3%)	3760 (15.2%)	2.26 (2.11, 2.42)
3	7282313 (25.1%)	5493 (22.2%)	2.67 (2.50, 2.85)
4	5981919 (20.6%)	6742 (27.3%)	3.99 (3.74, 4.26)
5	2438274 (8.4%)	5469 (22.1%)	7.94 (7.43, 8.49)

* HIV+ beneficiaries were those with ICD-9-CM, or DRG codes with a diagnosis of HIV, HIV- were beneficiaries without these codes

€ Chronic health conditions were defined by ICD-9-CM, diagnosis or procedure codes, or HCSPCS codes

Ψ The number of chronic diseases as an index (regardless of the combination of conditions)

Table 3. Adjusted odds ratios for five chronic conditions in Medicare beneficiaries ≥65 years with HIV infection*.

HIV+ vs. HIV - (N=29,060,402)	Hypertension aOR° (95% CI) Wald χ ² p-value	Hyperlipidemia aOR° (95% CI) Wald χ ² p-value	Ischemic heart disease aOR° (95% CI) Wald χ ² p-value	Rheumatoid/osteoarthritis aOR° (95% CI) Wald χ ² p-value	Diabetes aOR° (95% CI) Wald χ ² p-value
Chronic conditions[€]	2.01 (1.94, 2.09) <0.0001	1.81 (1.76, 1.86) <0.0001	1.82 (1.77, 1.86) <0.0001	2.14 (2.08, 2.19) <0.0001	1.51 (1.47, 1.55) <0.0001
Sex					
Male	2.05 (2.00, 2.11) <0.0001	2.06 (2.01, 2.12) <0.0001	1.90 (1.85, 1.95) <0.0001	2.24 (2.18, 2.30) <0.0001	1.98 (1.93, 2.04) <0.0001
Female	Reference	Reference	Reference	Reference	Reference
Age (for each year younger)	0.94 (0.93, 0.94) <0.0001	0.94 (.094, 0.94) <0.0001	0.93 (0.93, 0.94) <0.0001	0.93 (0.93, 0.94) <0.0001	0.94 (0.94, 0.94) <0.0001
Race/ethnicity					
Unknown race	0.74 (0.39, 1.43) 0.40	0.75 (0.39, 1.45) 0.40	0.74 (0.39, 1.43) 0.38	0.76 (0.39, 1.46) 0.41	0.72 (0.37, 1.38) 0.3
Non-Hispanic White	Reference	Reference	Reference	Reference	Reference
African-American	3.75 (3.64, 3.87) <0.0001	4.06 (3.93, 4.19) <0.0001	4.00 (3.88, 4.13) <0.0001	3.99 (3.87, 4.12) <0.0001	3.72 (3.61, 3.84) <0.0001
Other race	1.16 (0.98, 1.37) 0.08	1.14 (0.97, 1.35) 0.12	1.17 (0.99, 1.39) 0.07	1.20 (1.02, 1.42) 0.03	1.11 (0.94, 1.32) 0.2
Asian/Pacific Islander	0.62 (0.55, 0.69) <0.0001	0.60 (0.53, 0.66) <0.0001	0.65 (0.58, 0.72) <0.0001	0.64 (0.57, 0.72) <0.0001	0.60 (0.54, 0.67) <0.0001
Hispanic	3.56 (3.44, 3.69) <0.0001	3.52 (3.39, 3.65) <0.0001	3.58 (3.45, 3.71) <0.0001	3.53 (3.41, 3.66) <0.0001	3.34 (3.23, 3.50) <0.0001
Native American	0.68 (0.52, 0.88) 0.004	0.72 (0.55, 0.93) 0.013	0.70 (0.54, 0.91) 0.008	0.69 (0.52, 0.89) <0.0001	0.65 (0.50, 0.84) <0.001
Had dual coverage	2.50 (2.42, 2.57) <0.0001	2.68 (2.61, 2.76) <0.0001	2.44 (2.37, 2.51) <0.0001	2.47 (2.40, 2.54) <0.0001	2.50 (2.43, 2.60) <0.0001
End stage renal disease	1.58 (1.36, 1.85) <0.0001	1.72 (1.47, 2.01) <0.0001	1.46 (1.25, 1.70) <0.0001	1.78 (1.52, 2.08) <0.0001	1.54 (1.32, 1.80) <0.0001

* HIV+ beneficiaries were those with ICD-9-CM, or DRG codes with a diagnosis of HIV, HIV- were beneficiaries without these codes

° Adjusted odds ratios (aOR)

€ Chronic health conditions were defined by ICD-9-CM, diagnosis or procedure codes, or HCSPCS codes

Table 4. Adjusted odds ratios for the number of chronic conditions as an index among Medicare beneficiaries ≥65 years with HIV infection*.

HIV+ vs. HIV - (N=29,060,402)	Adjusted odds ratio (95% CI)	Wald χ^2 p-value
Number of chronic conditions[€]		
0	Reference	Reference
1	2.38 (2.21, 2.57)	<0.0001
2	2.63 (2.46, 2.83)	<0.0001
3	2.98 (2.46, 2.83)	<0.0001
4	4.13 (3.87, 4.41)	<0.0001
5	7.07 (6.61, 7.56)	<0.0001
Sex		
Male	2.11 (2.06, 2.17)	<0.0001
Female	Reference	Reference
Age (for each year younger)		
	0.94 (0.93, 0.94)	<0.0001
Race/ethnicity		
Unknown race	0.77 (0.40, 1.48)	0.43
Non-Hispanic White	Reference	Reference
African-American	3.86 (3.75, 4.00)	<0.0001
Other race	1.16 (0.98, 1.37)	0.09
Asian/Pacific Islander	0.62 (0.60, 0.70)	0.18
Hispanic	3.41 (3.29, 3.54)	<0.0001
Native American	0.70 (0.54, 0.91)	0.007
Had dual coverage		
	2.31 (2.24, 2.38)	<0.0001
End stage renal disease		
	1.44 (1.23, 1.68)	<0.0001

* HIV+ beneficiaries were those with ICD-9-CM, or DRG codes with a diagnosis of HIV, HIV- were beneficiaries without these codes

€ Chronic health conditions were defined by ICD-9-CM, diagnosis or procedure codes, or HCSPCS codes

Appendix: Codes used by Chronic Condition Warehouse to indicate hypertension, hyperlipidemia, ischemic heart disease, rheumatoid arthritis/osteoarthritis, diabetes.

Chronic condition	Valid ICD-9 / CPT4 / HCPCS Codes	Number / Type of
		Claims to Qualify
Hypertension	DX 362.11, 401.0, 401.1, 401.9, 402.00, 402.01, 402.10, 402.11, 402.90, 402.91, 403.00, 403.01, 403.10, 403.11, 403.90, 403.91, 404.00, 404.01, 404.02, 404.03, 404.10, 404.11, 404.12, 404.13, 404.90, 404.91, 404.92, 404.93, 405.01, 405.09, 405.11, 405.19, 405.91, 405.99, 437.2 (any DX on the claim)	At least 1 inpatient, SNF, HHA OR 2 HOP or Carrier claims with DX codes within the year
Hyperlipidemia	DX 272.0, 272.1, 272.2, 272.3, 272.4 (any DX on the claim)	At least 1 inpatient, SNF, HHA OR 2 HOP or Carrier claims with DX codes within the year
Ischemic Heart Disease	DX 410.00, 410.01, 410.02, 410.10, 410.11, 410.12, 410.20, 410.21, 410.22, 410.30, 410.31, 410.32, 410.40, 410.41, 410.42, 410.50, 410.51, 410.52, 410.60, 410.61, 410.62, 410.70, 410.71, 410.72, 410.80, 410.81, 410.82, 410.90, 410.91, 410.92, 411.0, 411.1, 411.81, 411.89, 412, 413.0, 413.1, 413.9, 414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.10, 414.11, 414.12, 414.19, 414.2, 414.3, 414.8, 414.9. PROC 00.66, 36.01, 36.02, 36.03, 36.04, 36.05, 36.06, 36.07, 36.09, 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19, 36.2, 36.31, 36.32. HCPCS 33510, 33511, 33512, 33513, 33514, 33515, 33516, 33517, 33518, 33519, 33521, 33522, 33523, 33533, 33534, 33535, 33536, 33542, 33545, 33548, 92975, 92977, 92980, 92982, 92995, 33140, 33141 (any DX, PROC or HCPCS on the claim)	At least 1 inpatient, SNF, HHA, HOP or Carrier claim with DX, Procedure or HCPC codes during the 2-yr period

RA/OA	DX 714.0, 714.1, 714.2, 714.30, 714.31, 714.32, 714.33, 715.00, 715.04, 715.09, 715.10, 715.11, 715.12, 715.13, 715.14, 715.15, 715.16, 715.17, 715.18, 715.20, 715.21, 715.22, 715.23, 715.24, 715.25, 715.26, 715.27, 715.28, 715.30, 715.31, 715.32, 715.33, 715.34, 715.35, 715.36, 715.37, 715.38, 715.80, 715.89, 715.90, 715.98 (any DX on the claim)	At least 2 inpatient, SNF, HHA, HOP or Carrier claim with DX codes during the 2-yr period
Arthritis/ Osteoarthritis		Any combination of claims at least one day apart
Diabetes	DX 249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93, 357.2, 362.01, 362.02, 366.41 (any DX on the claim)	At least 1 inpatient, SNF or HHA claim or 2 HOP or Carrier claims with DX codes during the 2-yr period

DX: disease ICD-9-CM code

PROC: Procedure ICD-9-CM code

HCSPCS: The Healthcare Common Procedure Coding System code