



Published in final edited form as:

AIDS. 2016 June 19; 30(10): 1663–1668. doi:10.1097/QAD.0000000000001077.

Cancer Risk among the HIV-Infected Elderly in the United States

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Abstract

Objective—HIV-infected people and elderly people have higher risk of cancer, but the combined effects of aging and HIV are not well described. As the HIV population is aging, we aimed to evaluate the magnitude of cancer risk in the HIV-infected elderly population.

Design—We conducted a case-cohort study including a 5% sample of US Medicare enrollees and all cancer cases aged ≥65 in linked cancer registries.

Methods—HIV was identified through Medicare claims. Among the HIV-infected, absolute cancer risk was calculated accounting for the competing risk of death. Associations between HIV and cancer were estimated with weighted Cox regression adjusting for demographic characteristics.

Results—Among 469,954 people in the 5% sample, 0.08% had an HIV diagnosis. Overall, 825,776 cancer cases were identified in cancer registries. Over five years, 10.1% of the HIV-infected elderly developed cancer, the most common diagnoses comprising lung (5-year cumulative incidence=2.2%), prostate (2.7%, among men), and colorectal cancer (0.9%), and non-Hodgkin lymphoma (0.8%). HIV was strongly associated with incidence of Kaposi sarcoma (adjusted hazard ratio [aHR]=94.4, 95% CI=54.6-163), anal cancer (aHR=34.2, 95% CI=23.9-49.0) and Hodgkin lymphoma (aHR=6.3, 95% CI=2.8-14.3). HIV was also associated with incidence of liver cancer (aHR=3.4, 95% CI=2.2-5.1), non-Hodgkin lymphoma (aHR=2.6, 95% CI=1.9-3.4), and lung cancer (aHR=1.6, 95% CI=1.3-2.0).

Conclusions—In the elderly, HIV infection is associated with higher risk for many cancers, although some associations were weaker than expected, perhaps reflecting effects of non-HIV pathways on cancer development. Due to the effects of HIV and aging, the HIV-infected elderly have a sizeable absolute risk, highlighting a need for cancer prevention.

Keywords

Aging; HIV; Cancer; Epidemiology

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Conflicts of Interest: The authors have no conflicts of interest to declare.

This work was previously presented at the Conference for Retroviruses and Opportunistic Infections, Seattle, WA, February 23-26, 2015.

Introduction

HIV-infected individuals have elevated risk for a number of cancers^[1, 2]. In the general population, risk of most cancers increases with age, including cancers frequently diagnosed in HIV-infected people, e.g., non-Hodgkin lymphoma (NHL), lung cancer, and liver cancer^[3]. Understanding the magnitude of cancer risk in the HIV-infected elderly can inform screening or prevention programs. As effective antiretroviral treatment has greatly prolonged life expectancy, the proportion of the HIV population in older age groups has increased and will likely continue increasing in the future. Because of these changes, obtaining robust data on cancer risk in the HIV-infected elderly is particularly important^[4].

Because a small proportion of the current HIV population is older than 65^[5, 6], examining the relationship between HIV and cancer in the elderly has been difficult. We used a linkage between data from cancer registries in the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute and Medicare claims (SEER-Medicare) to estimate absolute cancer risk among people aged ≥ 65 with an HIV diagnosis and evaluate the association between HIV and cancer in this age group^[7].

Methods

SEER-Medicare links 17 SEER cancer registries covering approximately 28% of the U.S. population with claims from Medicare, the U.S. government health insurance program for people aged ≥ 65^[7, 8]. SEER cancer registry areas covered approximately 9.4 million Medicare enrollees during 2004-2011. SEER-Medicare includes Medicare claims for all linked SEER cancer cases, and for a random 5% sample of the entire Medicare population living in SEER areas, referred to hereafter as the 5% subcohort.

To evaluate the relationship between HIV and cancer, we conducted a case-cohort study^[9], including the 5% subcohort and 100% of cancer cases within SEER-Medicare during 2004-2011. Follow-up started at the latest of: age 65; January 1, 2004; residence in a SEER area; start of cancer registry coverage; beginning of Medicare coverage for inpatient and provider care outside of a health maintenance organization; and first Medicare claim. Time in a health maintenance organization was excluded, because Medicare does not routinely receive individual claims under such coverage. Follow-up ended at the earliest of: death, migration out of a SEER area, first discontinuation of the specified Medicare coverage, or December 31, 2011. For analyses of the incidence of each cancer type, follow-up ended at the first diagnosis of that cancer type, but not for other cancer types.

HIV diagnosis was based on a claim in Medicare for International Classification for Diseases, version 9 codes 042.X-044.X or V08. HIV diagnoses were defined as the presence of 1 hospital HIV claim or 2 outpatient/provider HIV claims ≥ 30 days apart within the follow-up defined above. HIV exposure was time-varying, with individuals categorized as HIV-uninfected until they met our HIV diagnosis definition.

Cancers were identified through SEER cancer registries. We included cancers with an incidence among HIV-uninfected individuals that was high enough to expect ≥ 10 HIV-infected cases under the null hypothesis of no HIV-cancer association. We also included

Kaposi sarcoma (KS), which is rare in the general population, but one of the most common cancers in the HIV population. For NHL, analyses were also done separately for AIDS-defining subtypes.

We conducted a case-cohort study wherein sampling weights were applied to create an analytic population representative of the entire Medicare population^[9, 10]. Using the resulting weighted person-time, we calculated cancer incidence rates among HIV-infected and HIV-uninfected people. Among the HIV-infected, the 5-year cumulative incidence of cancer was estimated accounting for the competing risk of death^[11, 12], both overall and by sex.

We estimated the association between HIV and cancer incidence with weighted Cox regression. Hazard ratios (aHRs) were adjusted for sex, age, race and calendar year. For colorectal, breast, and prostate cancers, analyses were also done by cancer stage at diagnosis.

Results

In the 5% subcohort, there were 469,954 people aged ≥65 with Medicare during 2004-2011. In the subcohort, 41,604 people had a cancer diagnosis, which (as expected) comprised 5% of the 825,776 cancer cases among all Medicare enrollees aged ≥65 both within and outside the subcohort. In total, our study population thus included 1,254,126 Medicare enrollees (469,954 in the subcohort, including 41,604 with cancer, plus 784,172 cancer cases outside the subcohort; Supplementary Figure). The most frequently diagnosed cancers were lung (N=145,775), prostate (N=142,940), breast (N=93,919), and colorectal cancers (N=93,555).

In the subcohort, 0.08% of people had an HIV diagnosis (N=361). For these people, the median time between the start of follow-up and HIV diagnosis was 6 months (interquartile range=3-23 months). Compared to people without an HIV diagnosis, HIV-infected individuals were more frequently male (73% vs. 42%) and of black race (36% vs. 9%). HIV-infected people were younger at the start of follow-up (median of 66 vs. 70 years), but were more likely to die during follow-up (28% vs. 23%).

There were 653 cancer cases among HIV-infected people, including 55 AIDS-defining and 598 non-AIDS defining cancers. Among HIV-infected individuals, 10.1% were diagnosed with cancer over the course of five years of follow-up (95% CI=8.7-11.5%, Figure 1). The most common cancer was lung cancer (five-year cumulative incidence=2.2%), followed by prostate cancer (1.9%), colorectal cancer (0.9%), NHL (0.8%), and anal cancer (0.6%) (Figure 1).

Among HIV-infected men, 11.5% (95% CI=9.6-13.3%) were diagnosed with cancer over five years, while 6.7% (95% CI=4.7-8.6%) of HIV-infected women were diagnosed with cancer over five years (Figure 1). The most frequent cancers among men were prostate cancer (five-year cumulative incidence=2.7%), lung cancer (2.4%), NHL (0.9%), colorectal cancer (0.9%), and anal cancer (0.8%). Among women, the most frequent cancers were lung cancer (five-year cumulative incidence=1.6%), colorectal cancer (1.0%), breast cancer (1.0%), NHL (0.4%), and pancreatic cancer (0.3%).

Cancer incidence was approximately 50% higher in HIV-infected compared to HIV-uninfected individuals (aHR=1.52, 95%CI=1.32-1.75; Table 1). HIV was most strongly associated with KS (aHR=94.4, 95%CI=54.6-163). HIV was also associated with elevated incidence of anal cancer (aHR=34.2), Hodgkin lymphoma (aHR=6.30), liver cancer (aHR=3.35), NHL (aHR=2.55), oral cavity/pharyngeal cancer (aHR=1.79), and lung cancer (aHR=1.61; Table 1). HIV was inversely associated with prostate cancer (aHR=0.78, 95%CI=0.63-0.98).

For NHL, associations were strongest for the AIDS-defining subtypes, which comprised 65% of NHLs in HIV-infected people. Central nervous system lymphoma was most strongly associated with HIV (aHR=15.3, 95%CI=6.81-34.6). Incidence was also elevated for diffuse large B cell lymphoma (aHR=5.61) and Burkitt lymphoma (aHR=18.8; Table 1). Other specified lymphomas were not associated with HIV (aHR=0.74, 95%CI=0.40-1.35), though they made up 20% of NHL cases among HIV-infected people.

Prostate cancer incidence of both localized/regional and distant stage cases appeared decreased among HIV-infected people, though the association was only significant for localized/regional prostate cancer (aHR=0.74, 95%CI=0.59-0.94; Table 1). HIV was not associated with breast cancer incidence at any stage. Incidence of localized and distant colorectal cancer was the same in individuals with and without HIV, while incidence of regional stage colorectal cancer was elevated among HIV-infected people (aHR=1.70, 95%CI=1.12-2.58).

Discussion

Total cancer burden was high among the HIV-infected U.S. elderly, with 1 out of 10 people getting cancer over 5 years. This reflected an elevated risk for many HIV-associated cancers and a high frequency of cancers that are common among older adults but unassociated with HIV. The resulting cancer distribution reflects both HIV and aging effects. Overall, cancer risk was 50% higher in HIV-infected people than in HIV-uninfected people.

The most frequently diagnosed cancers were those associated with aging: lung, prostate, colorectal, and breast cancers, and NHL. Lung cancer and NHL risks are likely impacted by both HIV and age-related processes^[13-16]. Lung cancer was the most common cancer, and it is a common cause of death in HIV-infected people^[17, 18]. These observations point to the potential importance of smoking cessation. Given the high incidence of lung cancer overall, current smokers in the elderly HIV population might particularly benefit from lung cancer screening with low-dose computed tomography^[19].

As in other studies, HIV was associated with higher incidence of many virus-related cancers, such as KS related to human herpesvirus-8, lymphomas related to Epstein-Barr virus, anal cancer related to human papillomavirus, and liver cancer related to hepatitis C and B viruses^[1]. These associations provide further evidence that elevated cancer risk is at least partly because HIV-infected individuals have poor immunologic control of oncogenic viruses. However, some associations were weaker than those identified in younger people. In our study, KS incidence was about 100 times higher and NHL incidence was 2-3 times higher in

HIV-infected people compared to HIV-uninfected people. By comparison, in studies of younger HIV-infected populations, KS incidence is 200-800 times higher and NHL incidence is 6-17 times higher than in the general population^[6, 20, 21]. This lower relative increase could reflect more widespread HIV treatment, viral suppression, and immune reconstitution compared with younger HIV populations^[21, 22], which may result in better control of oncogenic viruses and, for KS, possible regression of tumors before they reach a clinically detectable stage^[23]. Associations could also be weaker because of larger contributions of HIV-unrelated causal pathways in the elderly. For instance, our NHL associations were more similar to findings in younger HIV populations when evaluated by NHL subtype^[20, 24], but the HIV-associated subtypes (diffuse large B cell lymphoma, Burkitt lymphoma, and central nervous system lymphoma) made up a smaller portion of the NHL burden in our population.

Even though they contributed substantially to the cancer burden in our HIV population, overall incidence of breast and colorectal cancer was not associated with HIV, and prostate cancer incidence appeared lower. Reduced risk was suggested for distant stage prostate cancer, arguing against a deficit of prostate cancer screening in HIV-infected men. As screening detects cancers early, reduced screening typically manifests as a reduced risk of only localized cancer, sometimes accompanied by an increase in regional/distant stage cancer. Importantly, prostate cancer screening through prostate-specific antigen testing is not generally recommended, due to a lack of survival benefit^[19]. However, for breast and colorectal cancer, current recommendations support screening up to age 75^[19]. Because these cancers are common in the older HIV population, and risk was largely similar to risk observed in HIV-uninfected adults, our findings support adherence to these guidelines for HIV-infected people.

Our study has several strengths. Using an efficient case-cohort design, we were able to leverage the SEER-Medicare database to study a large, population-based sample of elderly HIV-infected adults and calculate absolute risk. This sample also provided a comparable HIV-uninfected population. Reliable cancer diagnoses were provided by SEER cancer registries, which apply rigorous data quality standards for case ascertainment.

Our study is limited by missing information. We did not have claims information for individuals before age 65, so we did not know how long individuals had been HIV diagnosed. Medication claims were only available after 2006, when prescription benefits were introduced, and so we could not systematically assess antiretroviral use, which influences risk for HIV-associated cancers. We also lacked information on other cancer risk factors, such as tobacco use or human papillomavirus infection.

In conclusion, the absolute risk of cancer in the U.S. HIV-infected elderly is sizeable, reflecting effects of both HIV and aging. HIV infection in the elderly is associated with higher risk for many cancers previously identified as HIV-associated. However, the relative elevation is lower for some of these cancers, likely due in part to contributions of HIV-unrelated causes of cancer in the elderly population. In fact, the most frequently identified cancers were those related to aging. These patterns highlight a clear need for cancer

prevention in this age group and the importance of screening, particularly for lung, colorectal, and breast cancers, for which accepted screening modalities are available.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The interpretation and reporting of these data are the sole responsibility of the authors. ELY and EAE conceived the study concept and the initial study design. ELY analyzed the data and wrote the initial draft of the manuscript. All authors were involved in the development of the methodologic approach, the interpretation of the results, and revision of the manuscript. All authors approved the final manuscript.

ELY, HAK, and EAE were supported by the Intramural Research Program of the National Cancer Institute at the National Institutes of Health. ELY was also supported by an Intramural AIDS Research Fellowship Award from the Office of AIDS Research at the National Institutes of Health.

The authors acknowledge the efforts of the Applied Research Program, National Cancer Institute; the Office of Research, Development and Information, Centers for Medicare and Medicaid Services; Information Management Services, Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database.

Funding: E.L. Yanik, H.A. Katki, and E.A. Engels were supported by the Intramural Research Program of the National Cancer Institute at the National Institutes of Health. E.L. Yanik was also supported by an Intramural AIDS Research Fellowship Award from the Office of AIDS Research at the National Institutes of Health.

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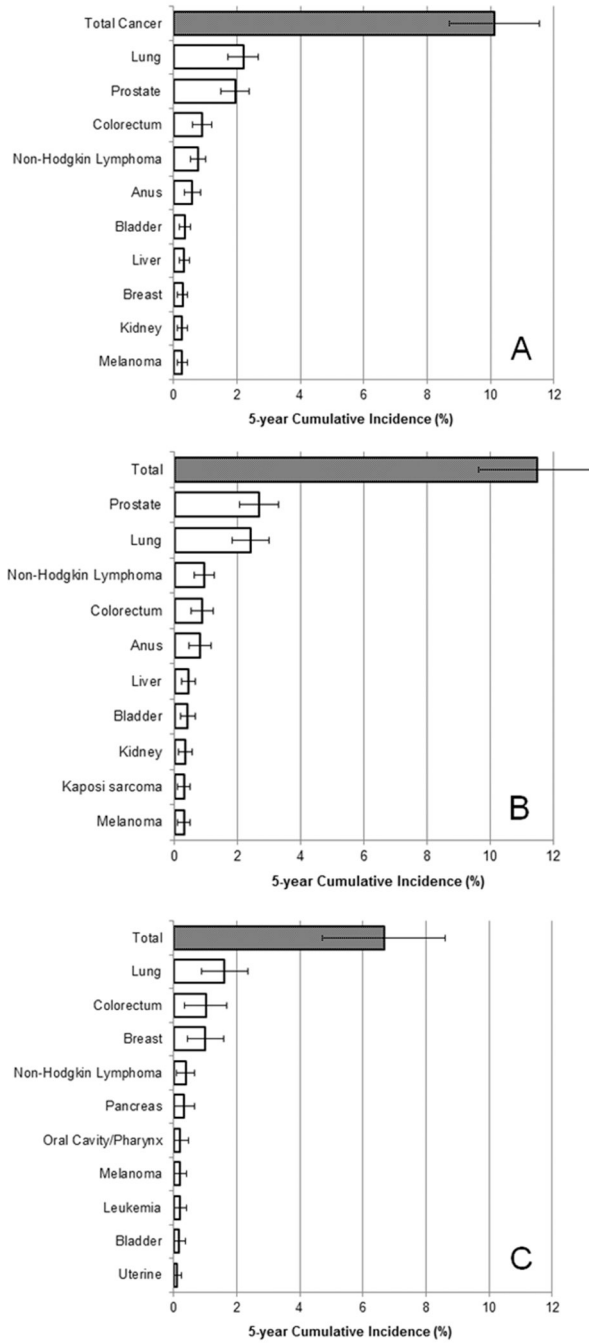


Figure 1. Cumulative Incidence of Cancer by Type among Elderly HIV-infected Adults Among Medicare recipients age 65 and older, five-year cumulative incidence estimates are shown for all HIV-infected individuals (A), HIV-infected men (B), and HIV-infected women (C) after accounting for the competing risk of death. Included are the estimates for total cancer, as well as the ten most frequently diagnosed cancer types in each population. Error bars represent 95% confidence intervals calculated using jackknife resampling.

Table 1
Associations between HIV diagnosis and cancer among elderly adults in the United States

Cancer Type	Total N	Incidence Rate [*]		Adjusted Hazard Ratio [†] (95% CI)
		HIV+	HIV-	
Total	825,776	2690	1950	1.52 (1.32-1.75)
AIDS-defining cancers				
Non-Hodgkin lymphoma	50,708	241	120	2.55 (1.91-3.39)
Diffuse large B-cell lymphoma	13,257	129	31.3	5.61 (3.87-8.13)
Burkitt lymphoma	300	13.4	0.68	18.8 (5.96-59.2)
Other specified lymphoma	30,764	49.1	72.8	0.74 (0.40-1.35)
Unspecified lymphoma	6,387	49.1	15.1	5.19 (2.96-9.10)
Central nervous system lymphoma [‡]	788	13.4	1.86	15.3 (6.81-34.6)
Kaposi sarcoma	384	80.3	0.83	94.4 (54.6-163)
Non-AIDS-defining cancers				
Prostate ^{**}	142,940	758	803	0.78 (0.63-0.98)
Localized/regional prostate ^{††}	127,329	687	715	0.74 (0.59-0.94)
Distant prostate	6,792	29.6	38.4	0.79 (0.32-1.92)
Lung	145,775	607	345	1.61 (1.31-1.98)
Colorectum	93,555	227	221	1.15 (0.86-1.55)
Localized colorectum	39,166	85	89	1.00 (0.63-1.57)
Regional colorectum	31,258	97.9	73.8	1.70 (1.12-2.58)
Distant colorectum	16,600	31.2	39.2	0.83 (0.39-1.77)
Breast ^{**}	93,919	226	359	0.64 (0.37-1.11)
Localized breast	61,885	166	237	0.73 (0.39-1.37)
Regional breast	22,586	45.2	86.3	0.49 (0.15-1.55)
Distant breast	6,224	15.1	23.8	0.57 (0.08-4.07)
Anus	2,299	143	5.37	34.2 (23.9-49.0)
Bladder	51,282	103	121	0.80 (0.52-1.23)
Liver	10,304	103	24.3	3.35 (2.21-5.07)
Melanoma	28,794	80.3	68.1	1.37 (0.84-2.23)
Kidney	25,816	71.4	61.1	0.91 (0.55-1.51)
Oral cavity/pharynx	15,549	71.4	36.8	1.79 (1.11-2.90)
Pancreas	28,433	66.9	67.3	1.13 (0.69-1.86)
Leukemia	17,440	53.5	41.3	1.44 (0.81-2.58)
Uterus ^{**}	18,909	45.2	72.3	0.56 (0.18-1.76)
Stomach	15,375	44.6	36.4	1.27 (0.73-2.23)
Myeloma	13,211	31.2	31.3	0.84 (0.42-1.71)
Ovary ^{**}	11,330	30.2	43.3	0.82 (0.20-3.36)

Cancer Type	Total N	Incidence Rate [*]		Adjusted Hazard Ratio [†] (95% CI)
		HIV+	HIV-	
Hodgkin lymphoma	1,797	26.8	4.24	6.30 (2.79-14.3)
Myelodysplastic syndrome	14,036	26.8	33.2	0.98 (0.43-2.20)

A total of 7,103 colorectal cancer, 3,338 breast cancer, and 8,819 prostate cancer cases were unstaged and are not included in the stage-specific results.

^{*} Incidence rates are presented per 100,000 person-years.

[†] Hazard ratios were adjusted for age, sex, race, and calendar year at the start of follow-up.

[‡] Central nervous system lymphomas overlap with the other lymphoma subtype categories, because they are defined by the topographic site while all other lymphoma subtypes are defined by histology.

^{**} Analyses for cancer of the breast, ovary and the uterus were done only among women. Analyses for prostate cancer were done only among men.

^{††} SEER historic staging categorizes localized and regional stage prostate cancer together.