ORIGINAL INVESTIGATION

Antiretroviral Therapy and the Prevalence and Incidence of Diabetes Mellitus in the Multicenter AIDS Cohort Study

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Background: The risk of diabetes mellitus (DM) in human immunodeficiency virus (HIV)–infected patients receiving highly active antiretroviral therapy (HAART) has not been well defined.

Methods: We conducted an analysis in the Multicenter AIDS Cohort Study to determine the prevalence and incidence of DM in this cohort of HIV-infected and HIV-seronegative men. Prevalence analysis included 1278 men (710 HIV seronegative and 568 HIV infected, 411 receiving HAART) with fasting glucose concentration determinations at baseline. Incidence analysis included 680 of these 1278 men who at the baseline visit had a fasting glucose concentration of 98 mg/dL (5.4 mmol/L) or less, no self-reported history of DM, and no self-reported use of antidiabetic medication. Diabetes mellitus was defined as a fasting glucose concentration of 126 mg/dL (7 mmol/L) or higher, self-reported diagnosis of DM, or self-reported use of antidiabetic medication.

Results: Fifty-seven (14%) of the 411 HIV-infected men using HAART at the baseline visit had prevalent DM compared with 33 (5%) of the 711 HIV-seronegative men (prevalence ratio=4.6; 95% confidence interval, 3.0-7.1, adjusted for age and body mass index[calculated as weight in kilograms divided by the square of height in meters]). The rate of incident DM was 4.7 cases per 100 person-years among HIV-infected men using HAART compared with 1.4 cases per 100 person-years among HIV-seronegative men (rate ratio=4.11; 95% confidence interval, 1.85-9.16, adjusted for age and body mass index), during the 4-year observation period, based on a median follow-up of 2.3 years.

Conclusion: The incidence of DM in HIV-infected men with HAART exposure was greater than 4 times that of HIV-seronegative men, representing a risk that is higher than previous estimates.

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SINCE THE ADVENT OF HIGHLY active antiretroviral therapy (HAART) in the mid-1990s, abnormalities in glucose homeostasis have been reported with increasing frequency in persons infected with human immunodeficiency virus (HIV).[1-4] Insulin resistance has been described in 41 (61%) of 67 protease inhibitor (PI)–treated, HIV-infected patients,[5] and impaired glucose tolerance was observed in 25 (35%) of 71 HIV-infected patients using HAART.[6] Prevalence estimates of diabetes mellitus (DM) are lower. In a cross-sectional study, 28 (6%) of 493 HIV-infected patients had DM.[7]

Prospective data estimating the incidence of DM are beginning to emerge.[2,3] In the Women's Interagency HIV Study, 20 (3% or 2.8 cases per 100 person-years) of the 609 HIV-infected women receiving a PI-containing HAART regimen were diagnosed as having DM during 2.9-year median follow-up period.[8] In that study, case ascertainment was determined by self-reports at semiannual visits. Without the use of fasting glucose (FG) concentration determinations, however, the true incidence of DM is likely to be underestimated.

Estimates of the incidence of DM and fasting hyperglycemia based on active surveillance using recommended diagnostic techniques are needed. In this prospective study, we sought to determine the prevalence and incidence of DM in a well-characterized cohort of HIV-seronegative and HIV-infected men with heterogeneous exposure to antiretroviral therapies.

METHODS

STUDY PARTICIPANTS

The Multicenter AIDS Cohort Study (MACS) enrolled 5622 homosexual and bisexual men between 1984 and 1991. These men have been seen at semiannual study visits at sites located in Pittsburgh, Pa; Baltimore, Md; Chicago, Ill; and Los

Author Affiliations are listed at the end of this article.
Group Information: A listing of the members of the Multicenter AIDS Cohort Study appears in the box on page 1184.
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Angeles, Calif.[9] Institutional review boards at each site approved the MACS protocol and forms, and each participant gave written informed consent. The semiannual study visits consist of a detailed interview, physical examination, and collection of biological specimens, including serologic HIV antibody tests on HIV-seronegative men. Beginning in April 1, 1999, the biological specimens obtained included a fasting serum sample.

Of the 5622 men enrolled in MACS, 1857 HIV-seronegative men were administratively censored in 1996, and 1750 had died by April 1, 1999, leaving 2015 men. Of these 1773 (88%) were observed between April 1, 1999, and March 31, 2003, and 1627 had at least 1 blood specimen drawn including 1278 fasting (≥8 hours) serum samples on which the glucose concentration was determined. The visit at which a participant had an initial FG concentration determination was defined as the index visit. At the index visit, the prevalence of DM was determined, defined as an FG concentration of 126 mg/dL (7 mmol/L) or higher, self-reported DM, or self-reported use of an antidiabetic medication (ie, insulin, sulfonylureas, thiazolidinediones, biguanides, meglitinides, or α-glucosidase inhibitors). Age, body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters), waist-hip ratio, educational attainment, and total cholesterol level, all measured at the index visit, and race (ie, white vs nonwhite) were ascertained for all participants.

The study population for incident analysis was composed of 680 of 1278 men. Of the 1278 men, 970 had an FG concentration of 98 mg/dL (5.4 mmol/L) or less at the index visit. Of these 970, seven hundred five had follow-up data. The exclusion of those with self-reported DM (n=22) or self-reported use of an antidiabetic medication at the index visit (n=3) yielded the 680 men used in the analysis. The FG concentration cutoff point of 98 mg/dL (which is the lower boundary of the definition of fasting hyperglycemia [ie, 100 mg/dL][10] minus about 1 SD for the glucose assay [ie,1.8 mg/dL {0.09 mmol/L}]) was chosen to ensure that the incident study population excluded men with prevalent hyperglycemia.

END POINT ASCERTAINMENT

Two end points were examined in the incident study population. First, the date of incident DM was defined as the midpoint between the date of the last visit seen free of DM and the date of the first visit seen with DM. Incident DM was defined as an FG concentration of 126 mg/dL (7 mmol/L) or higher, self-reported DM, or current self-reported use of antidiabetic medication, each of which was ascertained at each semiannual study visit beyond the index visit. All FG concentrations were measured by the combined hexokinase/glucose-6-phosphate dehydrogenase method[11] using serum samples that had been stored at −80°C and shipped to a central laboratory (Heinz Laboratory, Pittsburgh). Self-reported DM was ascertained using the following questions: "Have you seen a doctor or other medical practitioner for any condition since your last visit? If yes, was there a diagnosis for your condition?" Current antidiabetic medication use was determined from a report of all medications used since the previous visit. The definition of DM as an FG concentration of 126 mg/dL or higher is consistent with the guidelines of the American Diabetes Association.[12]

The second end point was a combination of incident DM and incident hyperglycemia and was used in the exploratory analyses of the effects of specific antiretroviral medications and disease stage. The date of incident hyperglycemia was defined as the midpoint of the date of the last visit seen with an FG concentration of 100 mg/dL (5.5 mmol/L) or less and the date of the first visit seen with an FG concentration between 100 and 125 mg/dL (5.5 and 6.9 mmol/L). The date of the combined end point was the first of incident DM or incident hyperglycemia. This combined end point, which included both clinically significant hyperglycemia and DM,[10] was constructed to improve the precision of these analyses by increasing the number of events.

ASSESSMENT OF EXPOSURE TO ANTIRETROVIRAL THERAPY

The detailed interview given at each semiannual study visit includes extensive questions about the use of specific antiretroviral therapies. The definition of HAART followed the Department of Health and Human Services/Kaiser Panel guidelines[13] and has been previously described.[14] Adherence to antiretroviral therapy was assessed by response to interviewer query, "On average, how often did you take your medication as prescribed?" recorded in categories of 100%, 95% to 99%, 75% to 94%, or less than 75%, and stratified herein as 95% or higher or less than 95%.

The primary exposures of interest were HIV infection and antiretroviral therapy use. We classified men into the following 3 groups: (1) HIV seronegative, (2) HIV infected not using HAART, and (3) HIV infected using HAART. We combined HIV-infected men not using HAART (ie, 103 who were antiretroviral free, 5 using monotherapy, and 49 using combination therapy at the index visit) because of the small number of men and similar event rates. To create time-varying exposure categories, men were classified at each semiannual visit according to HIV serostatus and self-reported use of antiretroviral therapy in the prior 6 months.

Based on the results of prior studies,[5,8] we explored the effect of the individual PIs most frequently used at the index visit on the rate of the combined end point by stratifying the HIV-infected HAART group by exposure to ritonavir, nelfinavir mesylate, saquinavir mesylate, and indinavir sulfate. Self-reported exposure to PIs was classified as time varying (ie, updated at each semiannual visit). To explore the effect of disease severity on the rate of the combined end point among men exposed to HAART at the index visit, we compared men with a nadir CD4 cell count greater than 300 cells/mm^3 to men with nadir CD4 cell counts of 300 cells/mm^{3}or less. Nadir CD4 cell counts greater than 300 cells/mm^3 represented approximately the upper quartile of values. This cutoff point was chosen after noting similar rates of the combined end point in the lowest 3 nadir CD4 count quartiles.

STATISTICAL ANALYSIS

The Fisher exact and Wilcoxon nonparametric tests, as appropriate, were used to test differences in proportions and distributions between groups. The prevalence ratio (PR) and 2-sided 95% confidence intervals (CIs) for DM was calculated using a modified Poisson regression[15] that allowed adjustment for age and BMI measured at the index visit. Age and BMI were modeled as restricted cubic splines with knots at the 5th, 50th, and 95th percentiles, thereby creating a smoothly joined piecewise polynomial that allowed for a flexible association between each covariate and the end point.[16] Further adjustment for educational attainment did not alter the results (data not shown).

For the analysis of incident DM (or the combined end point), person-time for each participant was calculated from the date of the index visit to the date of incident DM (or the date of the combined end point) or censoring at the last observed visit free of the end point, whichever came first. Incidence rates were obtained by dividing the number of end points by the number of person-years contributed to a specific category. Two-sided 95% CIs were obtained for rates using the Poisson distribution. Rate

Table 1. Characteristics of 1278 Men at the Index Visit Between April and October 1999*

Characteristic	MACS (n = 5622)	Current Study Population (N = 1278)	HIV-Seronegative (n = 710)	HIV-Infected Not Using HAART (n = 157)	HIV-Infected Using HAART (n = 411)	*P* Value†
White subjects, No. (%)	4681 (83)	1089 (85)	618 (87)	119 (76)	352 (86)	.53
College degree, No. (%)	3121 (56)	787 (62)	477 (67)	74 (47)	236 (57)	<.001
Age (IQR range), y	33 (28, 38)	48 (43, 53)	50 (45, 56)	46 (41, 50)	46 (42, 51)	<.001
Body mass index‡	23 (22, 25)	26 (24, 28)	26 (24, 29)	25 (23, 28)	25 (23, 27)	<.001
Waist-hip ratio	NA	0.95 (0.91, 0.99)	0.94 (0.90, 0.99)	0.94 (0.91, 0.97)	0.95 (0.91, 0.99)	.17
Total cholesterol level, mg/dL	NA	202 (176, 229)	201 (178, 227)	188 (158, 218)	210 (182, 239)	<.001
Glucose level, mg/dL	NA	90 (83, 98)	90 (83, 97)	88 (82, 98)	91 (84, 101)	.03
Nadir CD4 count, cells/mm^3	NA	NA	NA	318 (187, 432)	211 (108, 318)	NA
Duration of receiving HAART§	NA	NA	NA	NA	3.26 (2.63, 3.81)	NA

Abbreviations: HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; IQR, interquartile range; MACS, Multicenter AIDS Cohort Study.
SI conversion factors: To convert total cholesterol to millimoles per liter, multiply by 0.0259; glucose to millimoles per liter, multiply by 0.0555.
*Data are given as medians (interquartile range), unless otherwise indicated.
†Compared HIV-infected receiving HAART group with the HIV-infected group, by the Fisher exact test or the Wilcoxon nonparametric test, as appropriate.
‡Calculated as weight in kilograms divided by the square of height in meters.
§Years from initiation of HAART to the date of index visit.

ratios (RR) and 2-sided 95% CIs were estimated by hazard ratios obtained from the Cox proportional hazards regression model,[17] adjusting for age and BMI as restricted cubic splines. The assumption of proportional hazards was deemed to hold based on visual inspection of plots of the log[–log S(t)] vs time.

Owing to the scarcity of end points among HIV-infected subjects not receiving HAART, this group was excluded from all but descriptive analysis. Men with a missing BMI at study enrollment (n=113) had values carried forward from the most recent prior value within 2 years (n=55) or, if these data were unavailable, were excluded (n=58) from the multivariable regression models. Men with absent self-reports of antiretroviral therapy use (ie, 104 [6%] of 1824 of the expected data points contributed by HIV-infected men) were considered not to be using antiretroviral therapy. Intermittently missing glucose values (ie, 1047 [29%] of 3605 of the expected data points) were carried forward from the most recent prior value. With a 2-sided α=.05, an observed sample of 229 HIV-infected HAART-exposed men and 361 HIV-seronegative men, of whom 93 (26%) developed the combined end point in our data, we had 80% statistical power to detect a risk ratio of about 1.5. All statistical analyses were performed using SAS software, version 8 (SAS Institute Inc, Cary, NC).

Table 2. Prevalence of Diabetes Mellitus Among 1278 Men at the Index Visit Between April and October 1999

Patient Group	Diabetes Mellitus* No. (%) of Patients	Diabetes Mellitus* PR (95% CI)†
Overall (N = **1278**)	**101** (8)	NA
HIV seronegative (n = 710)	33 (5)	1
HIV infected not using HAART (n = 157)	11 (7)	2.21 (1.12-4.38)
HIV infected using HAART (n = 411)	57 (14)	4.64 (3.03-7.10)

Abbreviations: CI, confidence interval; HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; NA, not applicable; PR, prevalence ratio.
*Fasting glucose level of 126 mg/dL (7.0 mmol/L) or higher, self-report of diabetes mellitus, or self-reported use of antidiabetic medication.
†Prevalence ratio and 95% CI by modified Poisson regression, adjusted for age and body mass index (calculated as weight in kilograms divided by the square of height in meters) measured at the index visit.

RESULTS

PREVALENCE OF DM

The 1278 men who were alive and under follow-up and had at least 1 FG concentration determination between April 1, 1999, and March 31, 2003, had similar race and educational level but were 15 years older (as expected) and had a slightly higher BMI than the entire 5622 men enrolled in MACS in 1984 (**Table 1**). Compared with the 411 HIV-infected men receiving HAART, the 710 HIV-seronegative men were older, had a slightly higher BMI, and a lower total cholesterol level and were more likely to have a college degree but were otherwise similar. Of the 411 HIV-infected men receiving HAART at the index visit, 110 were receiving more than 1 PI (including 13 who were receiving lopinavir therapy), 207 were receiving 1 PI (105 were receiving indinavir; 68, nelfinavir; 15, saquinavir; 13, amprenavir; and 6, ritonavir), and 94 were not receiving a PI (40 of 94 had never reported use of a PI). Of the same 411 HIV-infected men receiving HAART, 6 were receiving more than 1 nonnucleoside reverse transcriptase inhibitor (NNRTI), 178 were receiving 1 NNRTI (92 were receiving efavirenz; 73, nevirapine; and 13, delavirdine mesylate), and 227 were not receiving any NNRTI (187 of 227 had never reported NNRTI use).

Prevalent DM was more common among the HIV-infected group receiving HAART compared with the HIV-seronegative group (14% vs 5%) (**Table 2**). Because the HIV-infected group receiving HAART were younger and had a lower BMI than the HIV-seronegative group, the PRs of DM increased after adjustment for these factors (PR for DM=4.64; 95% CI, 3.03-7.10). The HIV-infected men not using HAART had an increased risk of prevalent DM relative to the HIV-seronegative group after adjustment for age and BMI (Table 2).

Table 3. Incidence of Diabetes Mellitus Among 680 Men Between April 1999 and March 2003

Patient Group (n = 680)	No. of End Points	Person-years	Rate Per 100 Person-Years (95% CI)	Crude Rate Ratio* (95% CI)	Adjusted Rate Ratio* (95% CI)
Overall	**38**	1451.4	2.6 (1.9-3.6)	NA	NA
HIV seronegative	10	709.3	1.4 (0.8-2.6)	1	1
HIV infected not using HAART	4	236.3	1.7 (0.6-4.5)	NA	NA
HIV infected using HAART	24	505.8	4.7 (3.2-7.1)	3.32 (1.58-6.94)	4.11 (1.85-9.16)

Abbreviations: CI, confidence interval; HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; NA, not applicable.
*Rate ratio and 95% CI estimated by Cox regression; adjusted for age and body mass index (calculated as weight in kilograms divided by the square of height in meters) at the index visit.

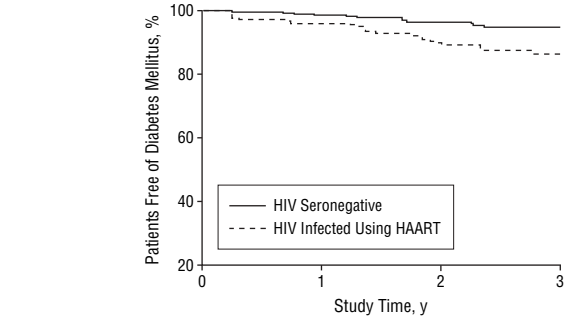

Figure. Kaplan-Meier survival curve for incident diabetes mellitus among human immunodeficiency virus (HIV)–seronegative men and HIV-infected men using highly active antiretroviral therapy (HAART).

INCIDENCE OF DM

The 680 men in the incidence analysis had characteristics similar to the overall study group of 1278 men shown in Table 1 (data not shown). Of these 680, thirty-eight developed DM, 458 completed follow-up without DM, and 184 (27%) were lost to follow-up. The median follow-up was 2.3 years (quartiles: 1.1, 3.0). Nineteen incident cases were due to an elevated FG concentration, 11 were due to a self-reported diagnosis of DM, and 8 were due to self-reported use of antidiabetic medication. At the index visit, 261 of 319 HIV-infected men were receiving antiretroviral therapy. Of these 261, 255 provided adherence data and 222 (87%) reported regimen adherence of 95% or more of the time.

The 229 HIV-infected men using HAART at the index visit had a higher rate of incident DM than the 361 HIV-seronegative men (RR=4.11; 95% CI, 1.85-9.16; **Table 3**) after adjustment for age and BMI (Table 3 and **Figure**). The associations of a 5-unit increase in BMI and age on the rate of incident DM were 1.34 (95% CI, 0.91-1.96) and 1.31 (95% CI, 1.04-1.64), respectively.

EFFECT OF SPECIFIC PI USE AND NADIR CD4 CELL COUNT

Of the 680 men in the incidence analysis, 209 developed the combined end point of DM or hyperglycemia (**Table 4**), yielding an adjusted RR of 1.64 (95% CI, 1.21-2.33) in the HIV-infected group using HAART compared with the HIV-seronegative group. The incidence of the combined end point of DM or hyperglycemia based on the use of specific PIs is given in **Table 5**. Only ritonavir was significantly associated with an increased rate of the combined end point (RR=1.70; 95% CI, 1.08-2.68) relative to men not using ritonavir, adjusting for age, BMI, nadir CD4 cell count, and cumulative use of nucleoside reverse transcriptase inhibitors (NRTIs) and NNRTIs. Classification of exposure to the PIs as "ever or never" use did not change our inferences (data not shown).

Among the 229 HIV-infected men using HAART, the 157 with a nadir CD4 cell count of 300 cells/mm^3 or less at the index visit developed the combined end point at a significantly increased rate compared with the 72 with a nadir CD4 cell count greater than 300 cells/mm^3 (RR=1.67; 95% CI, 1.00-2.80, adjusted for age, BMI, and duration of HAART (<2 years vs >2 years).

COMMENT

We report that during a 4-year follow-up period in the MACS, 24 (10%) of 229 HIV-infected subjects receiving HAART developed DM compared with 10 (3%) of 361 HIV-seronegative men. After adjustment for BMI and age, this difference represents a greater than 4-fold increase in the risk of incident DM among HIV-infected subjects receiving HAART.

These findings support and extend previously observed increases in both prevalent and incident fasting hyperglycemia and DM among HIV-infected patients receiving HAART. Initial reports estimated a 5% to 7% cumulative incidence of DM in HIV-infected patients receiving HAART,[2,3,18] but these studies were relatively small, were based on retrospective record review, and used less rigorous ascertainment techniques, such as random blood glucose values.[3,18] In addition, the lack of an internal comparison group in many of the initial studies precluded accurate estimates of relative risk. Justman et al[1] recently reported a relative risk of incident self-reported DM of 2.0 (95% CI, 1.0- 4.1) when HIV-infected women receiving a PI were compared with an HIV-seronegative subgroup prospectively followed in the Women's Interagency HIV Study. The higher crude rate of incident DM in the HIV-infected, HAART-exposed group in the MACS compared with the Women's Interagency HIV Study (4.7 vs 2.8 [95% CI, 1.6-4.1] cases per 100 person-years) may

Table 4. Incidence of Combined End Point of Diabetes Mellitus or Fasting Hyperglycemia Among 680 Men Between April 1999 and March 2003

Patient Group (n = 680)	No. of End Points	Person-years	Rate per 100 Person-Years (95% CI)	Crude Rate Ratio* (95% CI)	Adjusted Rate Ratio* (95% CI)
Overall	**209**	1251.7	16.7 (14.6-19.1)	NA	NA
HIV seronegative	93	609.2	15.3 (12.5-18.7)	1	1
HIV infected not using HAART	23	207.3	11.1 (7.4-16.7)	NA	NA
HIV infected using HAART	93	435.2	21.4 (17.4-26.2)	1.38 (1.03-1.84)	1.64 (1.21-2.33)

Abbreviations: CI, confidence interval; HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; NA, not applicable.
*Rate ratio and 95% confidence interval estimated by Cox regression; adjusted for age and body mass index (calculated as weight in kilograms divided by the square of height in meters) at the index visit.

reflect a more sensitive case ascertainment method in our study. However, other differences between the cohorts, such as sex, race, medication adherence, or severity of HIV disease may also have contributed to the different DM incidence rates. Because fasting serum samples were obtained in the MACS only after mid-1999, many men who were susceptible to the effect of HAART on glucose control could have incurred DM by mid-1999 and, thus, may have been classified as prevalent in this study. Therefore, the relative incidence rates of DM due to HAART that we observed may be conservative estimates.

Antiretroviral medications likely play a causative or permissive role in the pathogenesis of hyperglycemia in HIV-infected patients.[1,2,8] In our study, we explored the association of several specific PIs with the risk of incident hyperglycemia and DM. Only ritonavir use was significantly associated with an increased risk of a combined end point of DM or hyperglycemia. In vitro evidence suggests that ritonavir is associated with both the development of insulin resistance[19] and impaired β-cell function.[20] In clinical studies and in healthy volunteers, administration of ritonavir-containing regimens has been linked to worse glucose homeostasis.[21,22] Because 94% of men in our study who were receiving ritonavir therapy were also receiving at least 1 other PI, it is unclear if the effect is due to ritonavir per se or the combination of PIs. Given the few end points, however, these results require independent replication.

Human immunodeficiency virus–related factors may be important in the development of metabolic abnormalities in HIV-infected patients. Severity of HIV disease, as estimated by the nadir CD4 cell count, has been associated with increased risk of lipoatrophy,[23] combined lipodystrophy,[24] and cardiovascular disease.[25] In the present study, HIV-infected men with lower nadir CD4 cell counts had an increased risk of incident glucose abnormalities compared with those with higher nadir CD4 cell counts. The possibility that confounding factors, such as more diabetogenic antiretroviral regimens in the more severely ill patients, contributed to this finding cannot be excluded. To assess the contribution of disease-related factors in the pathogenesis of hyperglycemia and DM in the setting of HAART, HIV-infected patients not exposed to HAART are an essential comparison group. In our study, the small size of this group precluded a thorough analysis.

The present study had several additional limitations. First, owing to the semiannual visit schedule, our end points were based on a single FG concentration measurement and were not confirmed by a duplicate measurement on a subsequent day as suggested by the American Diabetes Association.[12] Second, our end point definition included the self-reported diagnosis of DM as one of the criteria, which may have compromised specificity, although in other populations false-positive self-reported diagnoses are infrequent.[26] Also, since 1278 of the original 5622 MACS participants were included in the study, it is possible that selection biases may have influenced our results. In addition, incident rates may have been slightly underestimated because of the intermittently missing FG concentration data. Finally, we did not examine the effect of hepatitis C infection on incident or prevalent DM[2]; we are investigating this important issue.

Table 5. Exploratory Analysis of the Risk of the Combined End Point of Incident Diabetes Mellitus or Fasting Hyperglycemia Based on Exposure to the Protease Inhibitors Used Most Often at the Index Visit in 229 Men Receiving HAART

Type of Protease Inhibitor	Use at Index Visit, No. of Patients		Rate Ratio (95% CI)*
	Yes	No	
Any protease inhibitor	178	51	1.06 (0.65-1.75)
Ritonavir	56	173	1.70 (1.08-2.68)
Saquinavir	47	182	1.17 (0.67-2.03)
Indinavir	81	148	0.89 (0.54-1.45)
Nelfinavir	44	185	0.97 (0.51-1.84)

Abbreviation: CI, confidence interval.
*Rate ratio and 95% CI estimated by Cox regression adjusted for age, body mass index (calculated as weight in kilograms divided by the square of height in meters), nadir CD4 cell count, and cumulative nucleoside reverse transcriptase inhibitor and cumulative nonnucleoside reverse transcriptase inhibitor use.

CONCLUSIONS

We found greater than a 4-fold increase in the rate of incident DM in HIV-infected participants receiving HAART compared with HIV-seronegative participants. The 4-year risk of 10% is higher than previous estimates and supports the importance of regular screening for hyperglycemia among HIV-infected persons.

Multicenter AIDS Cohort Study

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Correction

Error in Renumbering References in Text and Reference List. In the Original Investigation titled "Antiretroviral Therapy and the Prevalence and Incidence of Diabetes Mellitus in the Multicenter AIDS Cohort Study" by Brown et al, published in the May 23rd issue of the ARCHIVES (2005;165:1179-1184), the references were renumbered incorrectly in our publications office before publication. The list is correctly republished herein.

Also on page 1182 in the "Comment" section, paragraph 2, lines 11 to 16 should have read as follows:

"Justman et al[8] recently reported a relative risk of incident self-reported DM of 2.0 (95% CI, 1.0- 4.1) when HIV-infected women receiving a PI were compared with an HIV-seronegative subgroup prospectively followed in the Women's Interagency HIV Study."

On page 1183, "Comment" section, right hand column, lines 13 to 16 should have read as follows:

"Finally, we did not examine the effect of hepatitis C infection on incident or prevalent DM[27]; we are investigating this important issue."

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