Should Human Immunodeficiency Virus Specialty Clinics Treat Patients With Hypertension or Refer to Primary Care? An Analysis of Treatment Outcomes

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Background. Care for people with human immunodeficiency virus (HIV) increasingly focuses on comorbidities, including hypertension. Evidence indicates that antiretroviral therapy and opportunistic infections are best managed by providers experienced in HIV medicine, but it is unclear how to structure comorbidity care. Approaches include providing comorbidity care in HIV clinics (“consolidated care”) or combining HIV care with comorbidity management in primary care clinics (“shared care”). We compared blood pressure (BP) control in HIV clinics practicing consolidated care versus shared care.

Methods. We created a national cohort of Veterans with HIV and hypertension receiving care in HIV clinics in Veterans Administration facilities and merged these data with a survey asking HIV providers how they delivered hypertension care (5794 Veterans in 73 clinics). We defined BP control as BP ≤140/90 mmHg on the most recent measure. We compared patients’ likelihood of experiencing BP control in clinics offering consolidated versus shared care, adjusting for patient and clinic characteristics.

Results. Forty-two of 73 clinics (57.5%) practiced consolidated care for hypertension. These clinics were larger and more likely to use multidisciplinary teams. The unadjusted frequency of BP control was 65.6% in consolidated care clinics vs 59.4% in shared care clinics (P < .01). The likelihood of BP control remained higher for patients in consolidated care clinics after adjusting for patient and clinic characteristics (odds ratio, 1.32; 95% confidence interval, 1.04–1.68).

Conclusions. Patients were more likely to experience BP control in clinics reporting consolidated care compared with clinics reporting shared care. For shared-care clinics, improving care coordination between HIV and primary care clinics may improve outcomes.

Keywords. HIV; hypertension; shared care; Veterans.
for Disease Control and Prevention), and only 33% received indicated microalbuminuria screening [8]. Other studies found that patients in HIV specialty clinics were less likely than HIV-uninfected controls to receive indicated antihypertensive and lipid-lowering medications [9, 10], despite having higher rates of cardiovascular disease [11, 12].

An alternate approach to comprehensive care for comorbidities is the "shared care" model that combines care in HIV specialty clinics with comorbidity care by generalist providers in primary care clinics [13]. Proposed benefits of shared care include higher quality comorbidity care and a capacity to care for growing numbers of aging patients with HIV and multiple comorbidities. A potential drawback is the care fragmentation and lack of coordination that can occur when multiple providers from different clinics become involved.

Veterans Health Administration (VHA) is the largest provider of HIV care in the United States [14] and has historically concentrated care for Veterans with HIV in infectious disease (ID) and dedicated HIV specialty clinics [15] (hereafter referred to as "HIV clinics"). Approximately 85% of Veterans with HIV receive care in HIV clinics, yet care structure varies between clinics [16, 17]. We surveyed providers in VHA HIV clinics nationally to determine whether they reported using consolidated care or shared care models when caring for Veterans with HIV and hypertension. We then used data from VHA’s electronic health record to compare the frequency of hypertension control for patients in clinics using these approaches. We focused on hypertension because it is common among people with HIV, contributes to elevated rates of cardiovascular events in this population, and HIV specialists have reported lower levels of comfort providing care for hypertension [7, 9, 18]. We hypothesized that rates of hypertension control would be higher in facilities that reported using shared care for hypertension compared with consolidated care.

**METHODS**

This cross-sectional study combined 2 sources of data from 2013 and 2015. Patient-level data on Veterans in care for HIV infection were extracted from VHA’s Corporate Data Warehouse (CDW), which compiles data from VHA’s electronic health record and administrative files. We obtained clinic-level data on hypertension care models (consolidated vs shared care) and other clinic characteristics from a national survey of providers practicing in HIV clinics in VHA (survey questions in the Supplementary Material).

**Patient Cohort, Data Sources, and Variables**

We used CDW to create a cohort of 21,995 Veterans receiving care for HIV infection in 113 HIV clinics in VHA in 2013 (Figure 1). Patient data included demographics, laboratory values, diagnosis codes, outpatient clinic visits, pharmacy records, and vital signs. We used a previously validated case finding algorithm to identify Veterans in care for HIV infection [19], requiring at least 1 inpatient or 2 outpatient International Classification of Diseases, Ninth Revision, Clinical Modification-9 (ICD-9CM) codes for HIV infection (ie, V08 or 042) during 2013 (Figure 1). We also included Veterans with a single outpatient code for HIV infection and at least 2 fills for antiretroviral medications used only to treat HIV infection during 2013. Following methods used in tracking quality of hypertension care in large healthcare systems [20], we limited this cohort to Veterans with at least 1 ICD-9CM code for hypertension (see Appendix for codes) during a 1-year period between July 1, 2012 and June 30, 2013. We further limited this cohort to only those patients retained in care and without a diagnosis of coronary artery disease based on diagnosis codes (see below), because patients with coronary disease receive blood pressure (BP) management for secondary prevention. Retention in care was defined as at least 2 clinic visits in the HIV clinic in 2013, at least 60 days apart. This left us with 7,053 Veterans in 113 clinics.

From this cohort we excluded 1,024 Veterans from 36 clinics without adequate survey data, 229 Veterans in 4 clinics with indeterminate survey responses regarding how hypertension care was delivered (see below) and 6 Veterans lacking interpretable BP measurements, yielding a final analytic cohort of 5,794 Veterans in 73 clinics (Figure 1). The 36 clinics that did not have available survey data had lower patient volumes compared with the 77 clinics with survey data (median patient volume 56 vs 168), but they were distributed similarly across geographic regions of the United States.

The primary outcome variable was a patient-level measure of hypertension control defined as BP ≤140/90 mmHg on the last measurement in 2013. This definition was consistent with measures used to track hypertension care quality in VHA, the Healthcare Effectiveness Data and Information Set, and the National Quality Forum [21]. We also created a series of patient-level risk-adjustment variables for patient characteristics that—based on clinical experience and available literature—could confound associations between hypertension care models and outcomes. These included patient demographics, region, income, body mass index, HIV viral control (ie, last HIV serum ribonucleic acid value ≤200 copies/mL), acquired immune deficiency syndrome-defining illnesses, and comorbidities. Diagnoses of comorbid conditions required 1 inpatient or 2 outpatient diagnosis codes in 2013 (see Appendix for ICD-9CM codes).

**Clinic Survey and Clinic-Level Variables**

The exposure variable of interest was a clinic-level indicator of how providers in each HIV clinic reported delivering hypertension care (ie, consolidated care vs shared care). This variable was created from provider responses to a web-based survey about HIV care organization sent to providers participating in HIV care in VHA facilities in January 2015. The survey was sent by e-mail, with 3 follow-up e-mails to nonrespondents over a 3-month period. Because it was not
possible to link survey responses to specific providers and there was nearly complete agreement in provider responses regarding hypertension care within clinics, we used provider responses to classify consolidated versus shared care models at the clinic level.

The survey included a question: “How do you manage hypertension in your patients with HIV?” Response options were as follows: (1) managed in HIV/ID clinic, (2) managed in a general primary care clinic, (3) usually referred to a specialist, and (4) only referred to a specialist when complex. We classified a clinic’s hypertension care model as “shared care” if all providers in the clinic answered “managed in general primary care clinic.” If all providers answered “managed in HIV/ID clinic,” the clinic was classified as “consolidated care.” If providers only marked “usually referred to a specialist” or “referred to a specialist when complex,” classification was based on a prior question in the survey that asked, “How do the majority of patients with HIV receive their HIV and comorbidity care at your facility” (N = 11 clinics, all classified as consolidated care).

Multiple providers completed surveys in 40 of 73 clinics, and there was complete agreement in responses regarding hypertension care in 35 of 40 clinics with multiple respondents. In one clinic, 4 providers reported consolidated care and 1 reported shared care; this clinic was classified as consolidated care. In 4 clinics, equal numbers of providers reported shared care and consolidated care. These clinics were excluded from analyses as described above.

We used survey responses to create a series of clinic-level variables describing other clinic characteristics that may have been relevant to hypertension care, including presence of a dedicated case manager, an onsite health educator, or an onsite pharmacist. We used responses to the question “Do you have a multidisciplinary team within your clinic to care for Veterans with HIV?” to create a dichotomous variable indicating whether clinics used a multidisciplinary team-based care model. “Multidisciplinary team” was not defined in the survey and was left to the discretion of the survey respondents. Clinic characteristics other than approach to hypertension care were classified as “indeterminate” if there was not a majority in the survey responses within a clinic. To create the final analytic cohort, we linked patients to clinics where they received care and merged the patient and clinic-level variables.
Analyses
We began by examining bivariable associations between hypertension control and patient characteristics, with the patient as the unit of analysis. Using the clinic as the unit of analysis (N = 73 clinics), we then compared characteristics of clinics reporting consolidated care with those reporting shared care, including patient volume (ie, number of patients with HIV receiving care in the clinic, regardless of hypertension diagnosis), use of a multidisciplinary team, and presence of case managers, health educators, or pharmacists. We also compared the distribution of patient characteristics in clinics reporting consolidated care for hypertension with clinics reporting shared care. The χ² tests were used to evaluate statistical significance of associations, accounting for clustering of patients within clinics. We then compared associations between hypertension control and clinic characteristics, with the patient as the unit of analysis.

We used multilevel logistic regression to estimate associations between clinic-level approach to hypertension care (consolidated vs shared care) and patient-level hypertension control adjusting for patient and clinic characteristics, using a random effect for the intercept by clinic. Patient variables for inclusion in risk adjustment models were chosen using a multistep procedure as previously described [22]. Variables initially hypothesized to be associated with BP control were retained in final models, even if not statistically significant. All analyses were performed using SAS version 9.2 (Cary, NC), and analyses were approved by the Institutional Review Boards at the Iowa City, Bedford, and Palo Alto VAs.

RESULTS
The majority of the 5794 patients with HIV infection and hypertension were men (97.1%), older than 50 years of age (86.5%), black (58.6%), residents of the South (55.9%), had yearly incomes less than $15 000 (71.4%), were overweight or obese (64.6%), and had a suppressed HIV viral load (86.9%; Table 1). Approximately two-thirds (64.3%) had controlled hypertension. Hypertension control was more common among patients who were white compared with black (66.2% vs 62.9%), had normal or low weight compared with being overweight or obese (66.6% vs 63.0%), and had suppressed HIV viral load (65.7% vs 54.4%, P < .01). Hypertension control was less common among those with chronic kidney disease (59.5% vs 65.2%, P < .01) and diabetes (61.4% vs 65.3%, P < .01; Table 1).

The majority (57.5%) of clinics reported using a consolidated care model for patients with hypertension (Table 2). Compared with shared care clinics, consolidated care clinics were larger (mean patient volume 330 vs 157, P < .01) and more likely to use a multidisciplinary team model (71.4% vs 29.0%, P < .01; Table 2). Patient characteristics were generally similar in HIV clinics that used consolidated care versus shared care models (Table 3).

Table 1. Hypertension Control by Patient Characteristics, N = 5794 Patients

| Variables | Number of Patients (%) | Percentage With Controlled BP | PValue |
|-----------|------------------------|--------------------------------|--------|
| Age, years | n = 5794 | n = 3725 | |
| <35 | 59 (1.0) | 62.7 |
| 35–49 | 722 (12.5) | 66.2 |
| 50–64 | 3394 (58.6) | 63.6 |
| 65–79 | 1523 (26.3) | 65.5 |
| 80+ | 95 (1.6) | 54.7 |
| Missing | 1 (0) | 100.0 |
| Gender | | | .77 |
| Male | 5628 (97.1) | 64.3 |
| Female | 166 (2.9) | 63.3 |
| Race | | | .03 |
| White | 2121 (36.6) | 66.2 |
| Black | 3397 (58.6) | 62.9 |
| Other | 111 (1.9) | 71.2 |
| Missing | 165 (2.9) | 63.6 |
| Region | | | .13 |
| Northeast | 659 (11.4) | 66.2 |
| Midwest | 657 (11.3) | 65.1 |
| West | 1107 (19.1) | 66.3 |
| South | 3237 (55.9) | 62.9 |
| US Territory | 134 (2.3) | 68.7 |
| Yearly Income, $ | | | .43 |
| No income | 2337 (40.3) | 64.7 |
| 0–15 000 | 1801 (31.1) | 63.8 |
| 15 000–30 000 | 695 (12.0) | 64.5 |
| >30 000 | 750 (13.0) | 65.7 |
| Missing | 211 (3.6) | 58.8 |
| Body Mass Index, kg/m² | | | .03 |
| Underweight (18.5) | 145 (2.5) | 66.9 |
| Normal (18.5–24.9) | 1886 (32.6) | 66.6 |
| Overweight (25–29.9) | 2109 (36.4) | 64.3 |
| Obese (30+) | 1636 (28.2) | 61.4 |
| Missing | 18 (0.3) | 61.1 |
| Last Viral Load, IU/mL | | | <.01 |
| ≤200 | 5037 (86.9) | 65.7 |
| >200 | 621 (10.7) | 54.4 |
| Missing | 136 (2.4) | 56.6 |
| AIDS-Defining Illness | | | .68 |
| Yes | 533 (9.2) | 65.1 |
| No | 5261 (90.8) | 64.2 |
| Chronic Kidney Disease | | | <.01 |
| Yes | 911 (15.7) | 59.5 |
| No | 4883 (84.3) | 65.2 |
| Depression | | | .49 |
| Yes | 1515 (26.1) | 65.0 |
| No | 4279 (73.9) | 64.0 |
| Diabetes | | | .01 |
| Yes | 1455 (25.1) | 61.4 |
| No | 4339 (74.9) | 65.3 |
| Liver Disease | | | .47 |
| Yes | 213 (3.7) | 62.0 |
| No | 5581 (96.3) | 64.4 |
| Substance Abuse | | | .22 |
| Yes | 1822 (31.4) | 65.4 |
| No | 3972 (68.6) | 63.8 |

Abbreviations: AIDS, acquired immunodeficiency syndrome; BP, blood pressure; IU, international units; US, United States.
Consolidated care clinics cared for the majority of patients (78.8%; Table 4), and these patients were more likely to experience hypertension control than patients in clinics practicing shared care (65.6% vs 59.4%, P < .01; Table 4). The unadjusted odds ratio (OR) for BP control was 1.31 (95% confidence interval [CI], 1.08–1.58) for patients in consolidated care versus shared care clinics. This difference persisted in multilevel logistic regression models that adjusted for patient and clinic characteristics (OR, 1.32; 95% CI, 1.04–1.68) (Table 5).

**DISCUSSION**

In contrast to our hypothesis, we found patients were more likely to experience hypertension control in HIV clinics that reported managing hypertension care within the clinic (consolidated care) than in HIV clinics that reported shared care with PCPs. Shared care was more common in HIV clinics that were smaller and had fewer resources for team-based care. Better hypertension control in consolidated care clinics was not explained by differences in patient characteristics or other surveyed clinic characteristics.

Outside the area of HIV medicine, numerous studies have examined the impact of shared care models on the quality and outcomes of care for patients with a variety of chronic physical and mental health conditions, with mixed results [23, 24]. In general, when compared with care by generalists or specialists alone, these studies have not consistently found that shared care improves outcomes. A Cochrane review of studies examining the effectiveness of shared care in chronic disease management found insufficient evidence to demonstrate benefits aside from improved prescribing, although the quality of many of the studies was judged to be poor [24].

A systematic review of shared care in HIV medicine found no consistent association with improved clinical outcomes, cost effectiveness, or acceptability, but the quality of studies was again judged to be poor [25]. A study of patients in care for HIV infection in Ontario, Canada found colorectal cancer screening was more common among patients receiving care from both generalists and specialists, compared with only HIV specialists [26]. A recent study comparing HIV care models found only minor differences in HIV quality metrics and processes of care.
when care was provided by generalists only, ID providers only, or both (ie, shared care) [27].

As part of a systematic review, Foy et al [28] performed a meta-regression to identify characteristics of shared care models associated with improved outcomes for patients comanaged by generalists and specialists. This analysis suggested that outcomes were better in highly coordinated shared care relationships that included interventions to enhance the quality of information exchange between providers [28]. In our study, the survey regarding hypertension care did not gather detailed data on the specific processes used in shared care models or how information was exchanged. In some cases, shared care may have represented a highly coordinated relationship involving frequent and structured communication between HIV specialists and generalist PCPs. In other cases, shared care may have referred to fragmented care processes where patients received hypertension care outside the HIV clinic in a haphazard and uncoordinated fashion. Shared care for patients with HIV may have a more favorable impact on hypertension outcomes in settings with structured communication and coordination between providers.

We found that shared care arrangements were more common in smaller HIV clinics with fewer resources for team-based care including onsite case managers, health educators, and pharmacists. In contrast to large team-based HIV specialty clinics, smaller

| Clinic Characteristic | Number of Patients (%) | Percent With Controlled Blood Pressure (%) | P Value |
|-----------------------|------------------------|-------------------------------------------|---------|
| Hypertension Delivery |                        |                                           | <.01    |
| Consolidated care     | 4566 (78.8)            | 65.6                                      |         |
| Shared care           | 1228 (21.2)            | 59.4                                      |         |
| Multidisciplinary Team|                        |                                           | .31     |
| Yes                   | 4205 (72.6)            | 64.9                                      |         |
| No                    | 1179 (20.3)            | 62.2                                      |         |
| Indeterminate         | 276 (4.8)              | 60.1                                      |         |
| Missing               | 134 (2.3)              | 73.9                                      |         |
| Case Manager          |                        |                                           | .76     |
| Yes                   | 1218 (21.0)            | 66.0                                      |         |
| No                    | 3942 (68.0)            | 64.3                                      |         |
| Indeterminate         | 322 (5.6)              | 62.4                                      |         |
| Missing               | 312 (5.4)              | 59.6                                      |         |
| Educator              |                        |                                           | .70     |
| Yes                   | 1660 (28.6)            | 66.2                                      |         |
| No                    | 3193 (55.1)            | 63.5                                      |         |
| Indeterminate         | 629 (10.9)             | 65.5                                      |         |
| Missing               | 312 (5.4)              | 59.6                                      |         |
| Pharmacist            |                        |                                           | .95     |
| Yes                   | 4533 (78.2)            | 64.1                                      |         |
| No                    | 757 (13.1)             | 64.9                                      |         |
| Indeterminate         | 504 (8.7)              | 65.1                                      |         |
| Missing               | 0 (0.0)                | 0.0                                       |         |

Table 4. Hypertension Control by Clinic Characteristics, N = 5794 Patients

| Table 5. Association Between Clinic Hypertension Care Model and BP Control in Multivariable Model |
|--------------------------------------------------|--------------------------------------------------|
| Odds Ratios (Adjusted for Patient and Clinic Variables) | Odds Ratios (Adjusted for Patient and Clinic Variables) |
| Clinic Characteristics                             | Clinic Characteristics                             |
| Hypertension Delivery                              | Hypertension Delivery                              |
| Consolidated Care                                  | Consolidated Care                                  |
| Shared Care Reference                              | Shared Care Reference                              |
| Multidisciplinary Team                             | Multidisciplinary Team                             |
| Indeterminate                                     | Indeterminate                                     |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
| Case Manager                                      | Case Manager                                      |
| Indeterminate                                     | Indeterminate                                     |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
| Educator                                          | Educator                                          |
| Indeterminate                                     | Indeterminate                                     |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
| Pharmacist                                        | Pharmacist                                        |
| Indeterminate                                     | Indeterminate                                     |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
| Patient Characteristics                            | Patient Characteristics                            |
| Age, years                                        | Age, years                                        |
| <35                                               | <35                                               |
| 35–49                                             | 35–49                                             |
| 50–64                                             | 50–64                                             |
| 65–79                                             | 65–79                                             |
| 80+                                               | 80+                                               |
| Race                                              | Race                                              |
| White                                             | White                                             |
| Other                                             | Other                                             |
| Black                                             | Black                                             |
| Region                                            | Region                                            |
| US Territory                                      | US Territory                                      |
| Northeast                                         | Northeast                                         |
| Midwest                                           | Midwest                                           |
| West                                              | West                                              |
| South                                             | South                                             |
| Yearly Income, USD                                 | Yearly Income, USD                                 |
| No income                                         | No income                                         |
| 0–15,000                                         | 0–15,000                                         |
| 15,000–30,000                                     | 15,000–30,000                                     |
| >30,000                                          | >30,000                                           |
| Body Mass Index, kg/m²                             | Body Mass Index, kg/m²                             |
| Underweight                                       | Underweight                                       |
| Normal                                            | Normal                                            |
| Overweight                                        | Overweight                                        |
| Obese                                             | Obese                                             |
| Last Viral Load, IU/mL                             | Last Viral Load, IU/mL                             |
| ≥200                                              | ≥200                                              |
| >200                                              | >200                                              |
| AIDS-Defining Illness                              | AIDS-Defining Illness                              |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
| Chronic Kidney Disease                             | Chronic Kidney Disease                             |
| Yes                                               | Yes                                               |
| No                                                | No                                                |
HIV clinics may have lacked the resources to develop “in house” hypertension care programs. Infectious disease providers in smaller clinics may have had more competing demands related to roles outside HIV care, such as general ID consultation. If resources and time to focus on hypertension care are lacking in smaller HIV specialty clinics, then shared care may be the only practical option, and efforts should focus on improving care coordination and the quality of information exchange across clinics.

We focused on hypertension because it is common, contributes to elevated rates of cardiovascular events among people with HIV [9], and HIV specialists report lower comfort treating hypertension than generalists [7]. It is possible that consolidated care and shared care models have different impacts on treatment outcomes for other important chronic comorbidities that are commonly managed by generalists such as hyperlipidemia, diabetes, and osteoporosis. Future studies should examine how care strategies impact outcomes for these conditions.

This study had limitations. We used provider responses to a survey to define shared care at the clinic level. We did not define approach to hypertension care at the provider level because it was not possible to link survey responses to specific providers. However, we found that providers in a clinic were likely to agree on whether they used consolidated or shared care models for hypertension, supporting the creation of a clinic-level definition. In HIV clinics outside VHA, there may be more heterogeneity between providers in how hypertension care is delivered. We did not have data on whether patients actually received hypertension care in general primary care clinics or whether patients received care outside VHA. Our exposure variable was essentially a marker of the intentions of the providers within these clinics rather than a patient-level indicator of care received. It is possible that some patients in consolidated care clinics received hypertension care from PCPs outside the HIV clinic, whereas some in shared care clinics received hypertension care in the HIV specialty clinic.

This would have led to misclassification of the exposure variable in our analyses. In general, this form of misclassification of the exposure variable would generate a conservative bias toward the null hypothesis in measures of association between care model and BP control, assuming the misclassification was nondifferential by outcome [29]. If this was the case, then our study may have underestimated differences in hypertension control between consolidated care and shared care approaches in practice.

It is also possible that consolidated care clinics were located in VHA facilities with higher rates of hypertension control overall, due to factors not measured in this study, and that this confounded relationships between consolidated care and hypertension control. In addition, the population of Veterans with HIV is older and has a higher proportion of men than the overall population of people with HIV in the United States, limiting the generalizability of these findings [19]. We relied on administrative and electronic health record data to measure hypertension control and other patient characteristics, creating potential for measurement error compared with primary data collection. As in any observational study, there is potential for residual confounding related to unmeasured differences in patient characteristics between clinics (ie, case mix). There was also potential for nonresponse bias in the survey of clinic characteristics.

CONCLUSIONS

We found that Veterans with HIV and hypertension were more likely to experience hypertension control in HIV clinics that reported practicing consolidated care for hypertension when compared with shared care. Shared care models for hypertension were more common in smaller HIV clinics with fewer resources for team-based care. Human immunodeficiency virus clinics practicing shared care for hypertension should implement strategies to coordinate and monitor hypertension care with collaborating PCPs.

Supplementary Data

Supplementary materials are available at Open Forum Infectious Diseases online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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All authors have submitted the ICMJE Form for Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Table 5. Continued

| Depression | Odds Ratios (Adjusted for Patient and Clinic Variables) |
|------------|--------------------------------------------------------|
| Yes        | 1.05 (0.92, 1.20)                                      |
| No         | Reference                                              |

| Diabetes  | Odds Ratios (Adjusted for Patient and Clinic Variables) |
|-----------|--------------------------------------------------------|
| Yes       | 0.90 (0.79, 1.02)                                      |
| No        | Reference                                              |

| Liver Disease | Odds Ratios (Adjusted for Patient and Clinic Variables) |
|---------------|--------------------------------------------------------|
| Yes           | 0.90 (0.67, 1.20)                                      |
| No            | Reference                                              |

| Substance Abuse | Odds Ratios (Adjusted for Patient and Clinic Variables) |
|-----------------|--------------------------------------------------------|
| Yes             | 1.06 (0.93, 1.21)                                      |
| No              | Reference                                              |

Bold numbers indicate statistically significant odds ratios. Abbreviations: AIDS, acquired immunodeficiency syndrome; BP, blood pressure; IU, international units; USD, US dollars.
References

1. Wilson IB, Landon BE, Ding L, et al. A national study of the relationship of care to HIV: HIV generalization to early adoption of highly active antiretroviral therapy. Med Care 2005; 43:12–20.

2. Handford C, Tynan AM, Rackal JM, Glazier R. Setting and organization of care for persons living with HIV/AIDS. Cochrane Database Syst Rev 2006; CD004348.

3. Kitahata MM, Van Rompaey SE, Shields AW. Physician experience in the care of HIV-infected persons is associated with earlier adoption of new antiretroviral therapy. J Acquir Immune Defic Syndr 2000; 24:106–14.

4. Hoang T, Goetz MB, Yano EM, et al. The impact of integrated HIV care on patient health outcomes. Med Care 2009; 47:560–7.

5. Gallant JE, Adimora AA, Carmichael JK, et al. Essential components of effective HIV care: a policy paper of the HIV Medicine Association of the Infectious Diseases Society of America and the Ryan White Medical Providers Coalition. Clin Infect Dis 2011; 53:1043–50.

6. Greene M, Justice AC, Lampiris HW, Valcour V. Management of human immunodeficiency virus infection in advanced age. JAMA 2013; 309:1397–405.

7. Fultz SL, Goulet JL, Weissman S, et al. Differences between infectious diseases-certified physicians and general medicine-certified physicians in the level of comfort with providing primary care to patients. Clin Infect Dis 2005; 41:738–43.

8. Sheth AN, Moore RD, Gebo KA. Provision of general and HIV-specific health maintenance in middle aged and older patients in an urban HIV clinic. AIDS Patient Care STDS 2006; 20:318–25.

9. Okeke NL, Chin T, Clement M, et al. Coronary artery disease risk reduction in HIV-infected persons: a comparative analysis. AIDS Care 2016; 28:475–82.

10. Freiberg MS, Leaf DA, Goulet JL, et al. The association between the receipt of lipid lowering therapy and HIV status among veterans who met NCEP/ATP III criteria for the receipt of lipid lowering medication. J Gen Intern Med 2009; 24:334–40.

11. Trier IA, Lee H, Hadigan C, Grinspoon SK. Increased acute myocardial infarction rates and cardiovascular risk factors among patients with human immunodeficiency virus disease. J Clin Endocrinol Metab 2007; 92:2506–12.

12. Obel N, Thomsen HF, Kronborg G, et al. Ischemic heart disease in HIV-infected and HIV-uninfected individuals: a population-based cohort study. Clin Infect Dis 2007; 44:1625–31.

13. Chu C, Selwyn PA. An epidemic in evolution: the need for new models of HIV care in the chronic disease era. J Urban Health 2011; 88:556–66.

14. Department of Veterans Affairs. National HIV/AIDS Strategy Operational Plan 2011; Available at: https://www.aids.gov/federal-resources/national-hiv-aids-strategy/nhas-operational-plan-va.pdf. Accessed 19 August 2016.

15. Yano EM, Asch SM, Phillips B, et al. Organization and management of care for military veterans with human immunodeficiency virus/acquired immunodeficiency syndrome in Department of Veterans Affairs Medical Centers. Mil Med 2005; 170:952–9.

16. Ohl ME, Richardson K, Kaboli PJ, et al. Geographic access and use of infectious disease specialty and general primary care services by veterans with HIV infection: implications for telehealth and shared care programs. J Rural Health 2014; 30:412–21.

17. Fix GM, Asch SM, Safai HN, et al. Delivering PACT-principled care: are specialty care patients being left behind? J Gen Intern Med 2012; 27:695–702.

18. Department of Veterans Affairs. The State of Care for Veterans with HIV/AIDS. 2011 Summary Report. Available at: http://www.hiv.va.gov/pdf/VA2011-HIVSummaryRpt.pdf. Accessed 19 August 2016.

19. Fultz SL, Skanderson M, Moe LA, et al. Development and verification of a "virtual" cohort using the National VA Health Information System. Med Care 2006; 44:S25–30.

20. National Committee for Quality Assurance. Improving Hypertension Control. Available at: http://www.ncqa.org/publications-products/other-products/quality-profiles/focus-on-cardiovascular-disease/improving-hypertension-control. Accessed 2 September 2016.

21. National Committee for Quality Assurance, The Healthcare Effectiveness Data and Information Set (HEDIS). Available at: http://www.ncqa.org/hedis-quality-measurement. Accessed 23 June 2016.

22. Ohl ME, Richardson KK, Goto M, et al. HIV quality report cards: impact of case-mix adjustment and statistical methods. Clin Infect Dis 2014; 59:1160–7.

23. Smith SM, Allwright S, O'Dowd T. Does sharing care across the primary-specialty interface improve outcomes in chronic disease? A systematic review. Am J Manag Care 2008; 14:213–24.

24. Smith SM, Allwright S, O’Dowd T. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. Cochrane Database Syst Rev 2007; CD004910:1–58.

25. Mapp E, Hutchinson J, Escourt C. A systematic review of contemporary models of shared care HIV and HIV in primary care in high-income settings. Int J STD AIDS 2015; 26:991–7.

26. Kendall CE, Taljaard M, Younger J, et al. A population-based study comparing patterns of care delivery on the quality of care for persons living with HIV in Ontario. BMJ Open 2015; 5:e007428.

27. Rhodes CM, Chang Y, Regan S, et al. HIV quality indicators are similar across HIV care delivery models. Open Forum Infect Dis 2017;4(1):ofw240. doi:10.1093/ofid/ofw240.

28. Foy R, Hempel S, Rubenstein L, et al. Meta-analysis: effect of interactive communication between collaborating primary care physicians and specialists. Ann Intern Med 2010; 152:247–58.

29. Rothman J, Lash T, Greenland S. Modern Epidemiology, 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2012.

APPENDIX

For hypertension classification, patients needed at least one ICD-9CM code for hypertension during the 1-year run-in period from July 1, 2012 through June 30, 2013. For the comorbidity diagnoses, patients required at least 1 inpatient or 2 outpatient diagnosis codes in 2013. These codes are listed below.

Table 1.

| Classification   | ICD-9 Code | Description of Code |
|------------------|------------|---------------------|
| Hypertension     | 401.x      | Essential hypertension |
|                  | 402.x      | Hypertensive heart disease |
|                  | 403.x      | Hypertensive renal disease |
|                  | 404.x      | Hypertensive heart and renal disease |
|                  | 405.x      | Secondary hypertension |
| Coronary Artery Disease | 410      | Acute myocardial infarction |
|                  | 411       | Acute and subacute forms of ischemic heart disease |
|                  | 412       | Old myocardial infarction |
|                  | 413       | Angina pectoris |
|                  | 414.0     | Coronary atherosclerosis |
|                  | 414.8     | Other specified forms of chronic ischemic heart disease |
|                  | 414.9     | Chronic ischemic heart disease unspecified |
|                  | 429.7     | Certain sequelae of myocardial infarction, not elsewhere classified |
|                  | 414.00    | Of unspecified type of vessel, native or graft |
|                  | 414.01    | Of native coronary artery |
|                  | V45.81    | Aortocoronary bypass status |
|                  | V45.82    | Percutaneous transluminal coronary angioplasty status |
| Chronic Kidney Disease | 403.01   | Hypertensive renal disease—malignant with renal failure |
|                  | 403.11    | Hypertensive renal disease benign with renal failure |
|                  | 403.91    | Hypertensive renal disease unspecified with renal failure |
|                  | 404.02    | Hypertensive heart and renal disease—malignant with renal failure |
|                  | 404.03    | Malignant with renal and heart failure |
|                  | 404.12    | Benign with renal failure |
|                  | 404.13    | Benign with renal and heart failure |
|                  | 404.92    | Unspecified with renal failure |
|                  | 404.93    | Unspecified with heart and renal failure |
|                  | V56.32    | Encounter for adequacy testing for peritoneal dialysis |
|                  | 585.xx    | Chronic renal failure |
|                  | 598.xx    | Renal failure, unspecified |
|                  | 597.xx    | Renal sclerosis, unspecified |
|                  | 588.xx    | Disorders resulting from impaired renal function |
|                  | V42.xx    | Kidney transplant status |
| Classification | ICD-9 Code | Description of Code |
|----------------|------------|---------------------|
| **Depression** |            |                     |
|                | 296.20     | Major depressive disorder, single episode, unspecified |
|                | 296.21     | Major depressive disorder, single episode, mild |
|                | 296.22     | Major depressive disorder, single episode, moderate |
|                | 296.23     | Major depressive disorder, single episode, severe, w/o mention of psychotic behavior |
|                | 296.24     | Major depressive disorder, single episode, severe, specified as with psychotic behavior |
|                | 296.25     | Major depressive disorder, single episode, in partial or unspecified remission |
|                | 296.26     | Major depressive disorder, single episode, in full remission |
|                | 301.13     | Cyclothymic disorder |
|                | 296.3      | Major depressive disorder, recurrent episode |
|                | 300.4      | Neurotic depression |
|                | 309.0      | Brief depressive reaction |
|                | 309.1      | Prolonged depressive reaction |
|                | 311        | Depressive disorder, not elsewhere classified |
| **Diabetes**   | 250.xx     | Diabetes mellitus |
|                | 357.2      | Neuropathy in diabetes |
| **Liver Disease** | 571.2 | Alcoholic cirrhosis of liver |
|                | 571.5      | Cirrhosis of liver without mention of alcohol |
|                | 571.6      | Biliary cirrhosis |
|                | 070        | Viral hepatitis A with hepatic coma |
|                | 070.2x     | Viral hepatitis B with hepatic coma |
|                | 070.6      | Unspecified viral hepatitis with hepatic coma |
|                | 570        | Acute and subacute necrosis of liver |
|                | 572.2      | Hepatic coma |
|                | 572.3      | Portal hypertension |
|                | 572.4      | Hepatorenal syndrome |
|                | 456.0      | Esophageal varices with bleeding |
|                | 456.1      | Esophageal varices without bleeding |
|                | 456.2      | Esophageal varices in diseases classified elsewhere |
|                | 789.5      | Ascites |
|                | 070.22     | Viral hepatitis B with hepatic coma—chronic, without mention of hepatitis delta |
|                | 070.23     | Viral hepatitis B with hepatic coma—chronic, with hepatitis delta |

**Table 1. Continued**

| Classification | ICD-9 Code | Description of Code |
|----------------|------------|---------------------|
|                | 070.44     | Chronic hepatitis C with hepatic coma |
|                | 571.2      | Alcoholic cirrhosis of liver |
|                | 571.5      | Cirrhosis of liver without mention of alcohol |
|                | 571.6      | Biliary cirrhosis |
|                | 572.2      | Hepatic coma |
|                | 572.3      | Portal hypertension |
|                | 572.4      | Hepatorenal syndrome |
|                | 572.8      | Other sequelae of chronic liver disease |
|                | 456.0      | Esophageal varices with bleeding |
|                | 789.5      | Ascites |

**Substance Abuse**

| Classification | ICD-9 Code | Description of Code |
|----------------|------------|---------------------|
|                | 291        | Alcoholic psychosis |
|                | 303        | Alcohol dependence syndrome |
|                | 305.0      | Alcohol abuse |
|                | 790.3      | Excess blood-alcohol level |
|                | 980.0      | Toxic effect ethyl alcohol |
|                | 980.8      | Toxic effect of other specified alcohols |
|                | 980.9      | Toxic effect alcohol nos |
|                | 3575       | Alcoholic neuropathy |
|                | 425.5      | Alcoholic cardiomyopathy |
|                | 535.3      | Alcoholic gastritis |
|                | 571.0      | Alcoholic fatty liver |
|                | 571.1      | Acute alcoholic hepatitis |
|                | 571.2      | Alcohol cirrhosis liver |
|                | 571.3      | Alcohol liver damage nos |
|                | V11.3      | Alcoholism |
|                | E860.0     | Accidental poison-alcohol beverage |
|                | E860.8     | Accidental poisoning by other specified alcohols |
|                | E860.9     | Accidental poisoning by alcohol nos |
|                | 292.0      | Drug withdrawal syndrome |
|                | 292.1      | Paranoid and/or hallucinatory states |
|                | 292.2      | Drug-induced organic delusion |
|                | 292.11     | Drug-induced hallucination |
|                | 292.12     | Pathologic drug intoxication |
|                | 304        | Drug dependence |