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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.

Since the human immunodeficiency virus (HIV) epidemic was recognized in the United States in the early 1980s, there has been interest in determining the most effective strategies for delivering healthcare to people with HIV. Early studies found people with HIV experienced better outcomes when they received care from providers and clinics with more experience in HIV medicine [1–3]. Evidence also indicated that virologic outcomes (ie, suppression of HIV viremia among patients on antiretroviral therapy) were better in multidisciplinary-team based HIV clinics with colocated medical providers, nurses, psychologists, pharmacists, social workers, and case managers [4]. The multidisciplinary team-based HIV specialty clinic model has now become the gold standard in HIV care [5], and most people with HIV receive care in specialty clinics [1].

In the era of effective antiretroviral therapy, care for people with HIV increasingly focuses on common, chronic conditions associated with aging, such as hypertension and diabetes [6]. However, it is unclear how best to organize care for these conditions. Many HIV clinics have adapted to the evolving care needs of their patients by taking on primary care for chronic conditions that are commonly managed in general primary care settings, including hypertension. This "consolidated care" model provides colocated, integrated care for HIV infection and comorbid conditions, reducing the care fragmentation that can occur when patients obtain care from multiple providers.

The consolidated care model also has potential limitations. Compared with generalist primary care providers (PCPs), HIV specialists report lower levels of comfort caring for common chronic conditions, including hypertension and diabetes, potentially compromising quality [7]. For example, one study in an urban HIV clinic found that only 39% of patients with diabetes had an ophthalmologic exam in the past year (compared with >60% for all people with diabetes per the Centers

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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 7053 Veterans in 113 clinics.

From this cohort we excluded 1024 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 5794 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

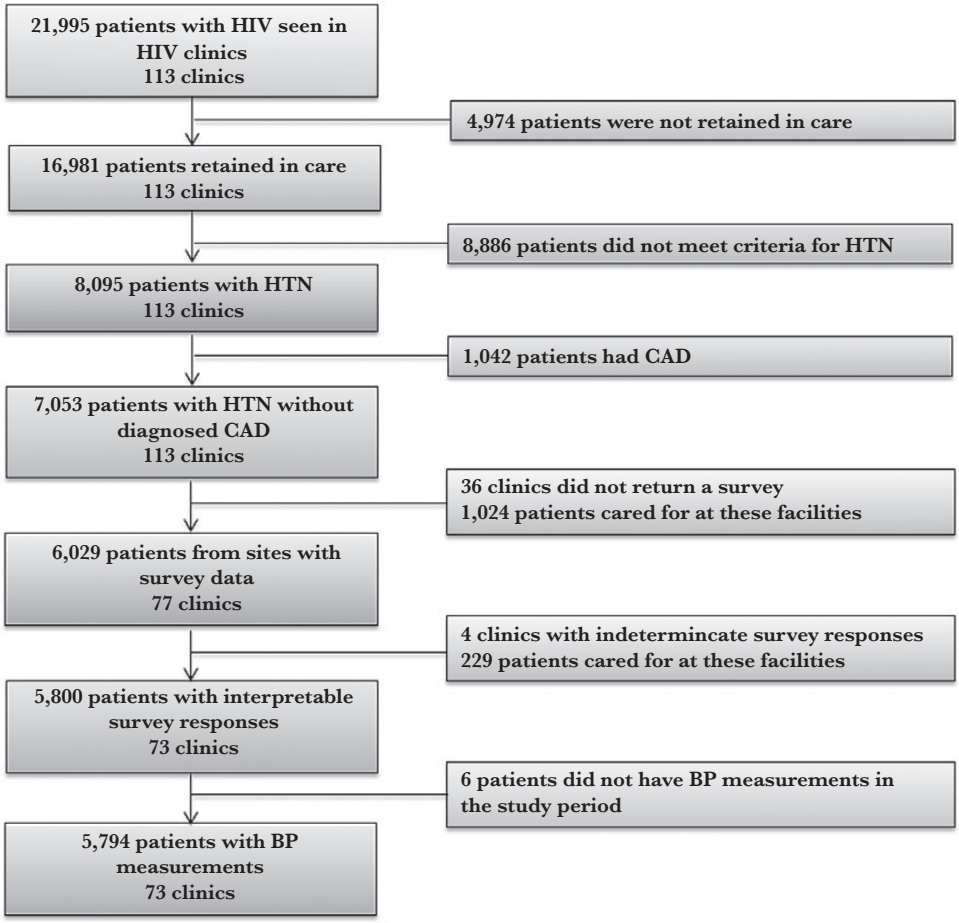

Figure 1. Cohort derivation flow chart.

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 χ^2 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 (%) n = 5794	Percentage With Controlled BP n = 3725	*P* Value
Age, years			.21
<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			
Male	5628 (97.1)	64.3	.77
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/m^2			**.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.

Table 2. Clinic Characteristics by Hypertension Delivery Model, N = 73 Clinics[a]

Facility Characteristic	Overall (n = 73)	Hypertension Delivery		*P* Value
		Consolidated Care (n = 42)	Shared Care (n = 31)	
Patient volume, mean (STD)	256 (230)	330 (262)	157 (124)	<.01
Multidisciplinary team, n (%)	39 (53.4)	30 (71.4)	9 (29.0)	<.01
Case Manager, n (%)	16 (21.9)	12 (28.6)	4 (12.9)	.34
Educator, n (%)	17 (23.3)	14 (33.3)	3 (9.7)	.08
Pharmacist, n (%)	49 (67.1)	30 (71.4)	19 (61.3)	.26

Abbreviations: STD, standard deviation.

[a]For facility volume, the *P* value is from a Wilcoxon rank-sum test. For multidisciplinary team, case manager, educator, and pharmacist, the *P* values are from χ^2 tests for contingency tables.

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

Table 3. Patient Characteristics by Clinic Hypertension Delivery Model, N = 5794 Patients[a]

Patient Characteristic	Overall (n = 5794)	Hypertension Delivery		*P* Value
		Consolidated Care (n = 4566)	Shared Care (n = 1228)	
Age (year), mean (STD)	59.2 (9.1)	59.3 (9.1)	58.9 (9.1)	.32
Black race, n (%)	3401 (58.6)	2691 (58.9)	710 (57.8)	.50
South region, n (%)	3241 (55.9)	2448 (53.5)	793 (64.6)	.39
Income (USD), median (IQR)	13 000 (31 531)	12 748 (30 273)	13 926 (35 800)	.64
Body mass index, mean (STD)	27.5 (5.6)	27.6 (5.6)	27.3 (5.6)	.24
Last viral load ≤200, n (%)	5039 (86.9)	3996 (87.4)	1043 (84.9)	.13
AIDS-defining illness, n (%)	533 (9.2)	408 (8.9)	125 (10.2)	.22
Chronic kidney disease, n (%)	911 (15.7)	710 (15.5)	201 (16.4)	.70
Depression, n (%)	1516 (26.1)	1205 (26.4)	311 (25.3)	.77
Diabetes, n (%)	1456 (25.1)	1136 (24.8)	320 (26.1)	.48
Liver disease, n (%)	213 (3.7)	175 (3.8)	38 (3.1)	.26
Substance abuse, n (%)	1823 (31.4)	1426 (31.2)	397 (32.3)	.60

Abbreviations: AIDS, acquired immunodeficiency syndrome; IQR, interquartile range; STD, standard deviation; USD, US dollars.

[a]For age, income, and body mass index, the *P* values are from linear mixed models with a random effect for facility. For the other patient characteristics, the *P* value is from generalized linear mixed models for data from a binomial distribution with a logit link and a random effect for facility.

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

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	

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

Table 5. Association Between Clinic Hypertension Care Model and BP Control in Multivariable Model

	Odds Ratios (Adjusted for Patient and Clinic Variables)
Clinic Characteristics	
Hypertension Delivery	
Consolidated Care	**1.32 (1.04, 1.68)**
Shared Care	Reference
Multidisciplinary Team	
Indeterminate	1.13 (0.71, 1.79)
Yes	1.07 (0.84, 1.37)
No	Reference
Case Manager	
Indeterminate	0.95 (0.65, 1.40)
Yes	1.03 (0.81, 1.30)
No	Reference
Educator	
Indeterminate	1.19 (0.84, 1.68)
Yes	1.08 (0.87, 1.34)
No	Reference
Pharmacist	
Indeterminate	0.89 (0.61, 1.30)
Yes	0.86 (0.66, 1.13)
No	Reference
Patient Characteristics	
Age, years	
<35	1.55 (0.78, 3.06)
35–49	**1.77 (1.13, 2.77)**
50–64	1.51 (0.99,2.31)
65–79	**1.56 (1.02, 2.39)**
80+	Reference
Race	
White	1.13 (0.99, 1.28)
Other	1.47 (0.96, 2.26)
Black	Reference
Region	
US Territory	1.07 (0.58, 1.99)
Northeast	1.09 (0.82, 1.44)
Midwest	1.01 (0.77, 1.35)
West	1.08 (0.85, 1.36)
South	Reference
Yearly Income, USD	
No income	0.97 (0.81, 1.16)
0–15 000	0.93 (0.78, 1.12)
15 000–30 000	0.97 (0.78, 1.21)
>30,000	Reference
Body Mass Index, kg/m^2	
Underweight (18.5)	1.41 (0.97, 2.05)
Normal (18.5–24.9)	**1.28 (1.11, 1.49)**
Overweight (25.0–29.9)	**1.14 (1.00, 1.31)**
Obese (30+)	Reference
Last Viral Load, IU/mL	
≥200	**1.59 (1.33, 1.89)**
>200	Reference
AIDS-Defining Illness	
Yes	1.08 (0.89, 1.31)
No	Reference
Chronic Kidney Disease	
Yes	**0.81 (0.69, 0.94)**
No	Reference

Table 5. Continued

	Odds Ratios (Adjusted for Patient and Clinic Variables)
Depression	
Yes	1.05 (0.92, 1.20)
No	Reference
Diabetes	
Yes	0.90 (0.79, 1.02)
No	Reference
Liver Disease	
Yes	0.90 (0.67, 1.20)
No	Reference
Substance Abuse	
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.

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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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
	437.2	Hypertensive encephalopathy
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
	586.xx	Renal failure, unspecified
	587.xx	Renal sclerosis, unspecified
	588.xx	Disorders resulting from impaired renal function
	V42.xx	Kidney transplant status

Table 1. Continued

Classification	ICD-9 Code	Description of Code
	V56.xx	Encounter for dialysis and dialysis catheter care
	792.5	Cloudy (hemodialysis) (peritoneal) dialysis effluent
	V45.1	Renal dialysis status
	V56.0	Extracorporeal dialysis
	V56.1	Fitting and adjustment of extracorporeal dialysis catheter
	V56.2	Fitting and adjustment of peritoneal dialysis catheter
	V56.3	Encounter for adequacy testing for dialysis
	V56.8	Other dialysis
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	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
	357.5	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 hallucinosis
	292.12	Pathologic drug intoxication
	304	Drug dependence