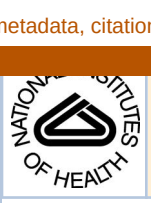

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Opportunities for Sexual Transmission of Antiretroviral Drug Resistance among HIV-Infected Patients in Care

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Introduction

Primary acquisition of drug-resistant HIV at the time of initial infection, referred to as transmitted drug resistance (TDR), is an underappreciated public health challenge. Of the estimated 48,600 HIV infections in the U.S. in 2006 [1], approximately 7,100 involved acquisition of HIV already resistant to ≥1 antiretroviral (ARV) [2]. Two different mechanisms for TDR have been proposed. In the first, patient in care but sub-optimally adherent to ARVs acquire resistance mutations [3–6] and transmit them to others. In the second scenario, viremic persons initially infected with resistant HIV pass it on to recipients [7] during sexual or needle-sharing risk behavior [8–10]. Both mechanisms likely contribute to the stable ~10–20% prevalence of TDR seen in North America [11–15] and Europe [16–19]. Though opinions differ on which is the more significant of the two [7, 20, 21], opportunities clearly exist for persons already engaged in HIV care to transmit resistant viruses to others.

Over 70% of HIV-infected persons report some form of sexual activity following their HIV diagnosis [22], but estimates of the proportion engaging in unprotected sex vary considerably. As many as 60% of seropositive men and women use condoms inconsistently

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Author contributions: H.M.S. extracted data, conducted all statistical analyses, produced the tables, and co-wrote and revised the manuscript; S.N. provided statistical advice and helped revise the manuscript; O.M.Z. supervised data collection for the clinical cohort, assisted with data extraction, and helped revise the manuscript; J.J.E. assisted in the design of the study and helped revise the manuscript; C.B.H. designed and supervised the study, performed literature searches, produced the figures, and co-wrote and revised the manuscript.

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with primary or casual sex partners [22–26]. Investigations into behavioral change following HIV diagnosis among men who have sex with men (MSM) demonstrate a period of decreased risk-behavior [27], with half relapsing to unprotected sex within three years [28, 29]. A small but significant proportion of individuals (<5%) report no change in risk behaviors following diagnosis [29].

Patients who engage in ongoing risk behavior tend to be less adherent to prescribed ARV regimens [30–34]. This combination of poor ARV adherence and sexual (or injection drug) risk activity provides a pathway for the transmission of resistance. Evidence suggests that although this subgroup of non-adherent patients is small, they may contribute disproportionately to the forward transmission of resistant viruses [32, 34]. We sought to better characterize the extent to which non-adherent patients contribute to the risk of TDR, using cross-sectional clinical and behavioral data from the University of North Carolina at Chapel Hill (UNC) Center for AIDS Research HIV Clinical Cohort (UCHCC). The present study had two aims: to examine patterns of non-adherence, high-risk sexual behavior, detectable HIV viremia, and ARV drug resistance and to identify factors associated with potential transmission of drug-resistant HIV among patients engaged in HIV care.

Methods

Patients and Design

All HIV-infected patients aged ≥18 and receiving HIV care at the UNC Infectious Diseases Clinic are approached for their willingness to participate in the ongoing, observational UCHCC study. Written informed consent is obtained from all subjects; <5% of patients decline participation. Clinical and demographic data are collected through standardized medical record abstractions at enrollment and every 6 months thereafter. Details about data collection, laboratory measurements and clinical care were previously described [35]. To improve capture of social and behavioral data not consistently available in medical records, UCHCC participants were offered the opportunity to complete a comprehensive, standardized, face-to-face interview, the Clinical, Sociodemographic and Behavioral Survey (CSDS), that incorporates multiple validated instruments, including 4-day adherence recall [36] and alcohol and substance use assessments [37, 38]. The present study is a retrospective, cross-sectional analysis at the time of interview. If a participant completed multiple interviews over time, only the most recent was included. Only patients with complete outcome data were included in our analysis.

Measures

Our primary outcome was a combination of having unprotected sex, detectable HIV viremia, and evidence of ARV resistance around the time of the interview. We defined unprotected sex as having ≥1 sex partner in the past six months and not consistently using condoms. Detectable viremia was defined as HIV RNA ≥400 copies/mL; the level closest to the interview date was used, within a window beginning 6 months prior and ending one month thereafter. As HIV RNA assays used during the collection of this data had lower limits of detection of either 400 or 50, patients with undetectable HIV RNA were assigned average values of 200 and 25, respectively, for use in calculating viral load distributions.

Resistance was defined by the 2009 World Health Organization list of surveillance drug resistance mutations (SDRMs) [39], a curated list specifically created for epidemiological analyses of TDR prevalence [40]. Genotypic resistance tests (GRTs) conducted prior to or on the interview day were included.

Two interview questions concerned ARV adherence: "How many doses have you missed in the last 4 days: 0, 1, or 2 or more?" and "Thinking about the past 4 weeks, on average how would you rate your ability to take all of your HIV medications as your doctor prescribed: excellent, very good, good, fair, poor or very poor?" We considered ≥1 missed dose in the prior 4 days as not adherent. "Very good" and "good" were grouped together, as were "fair," "poor," and "very poor."

Statistical analyses

Demographic, behavioral and clinical variables were described, and associations with unprotected sex and presence of a known SDRM were assessed. Wilcoxon rank-sum tests were used to compare continuous variables and Pearson's χ^2 test was used for categorical variables, with exact *P* values calculated where appropriate. Statistical significance was defined as $P < 0.05$.

Based on the number of sexual partners, condom utilization, HIV RNA detectability, and presence of any SDRM, we constructed a flow chart to help define those individuals at greater risk of transmitting drug resistance to others. Log-linear binomial regression models were used to calculate prevalence ratios (PR) and 95% confidence intervals (CI) associated with predictors of membership in this high-risk group. Bivariate associations with *P* values <0.1 were considered for inclusion in the multivariable analysis. All analyses were performed with SAS (version 9.3, SAS Institute, Cary, NC, USA).

A number of sensitivity analyses were performed. Because patients may underestimate the number of partners or overestimate condom utilization, a bounded analysis was conducted to assess the range in the proportion of the study population at risk for transmitting drug-resistant HIV. Regression models were repeated to examine if predictors remained the same with the expanded definition of the high-risk group.

Ethics approval

The UNC Institutional Review Board previously approved the UCHCC and CSDS, which also covered associated secondary data analyses.

Results

Demographics

Of 482 unique face-to-face interviews completed between 2000–2011, 244 met inclusion criteria (Supplemental Figure). Median age was 43 years (range, 19–74; Table 1), and 37% were female. Non-white participants represented 79% of the sample; Blacks accounted for 70%. A majority had at least a high school education, and 13% were college graduates. One fifth of respondents described being homeless at some point since their HIV diagnosis. Thirty-eight percent were MSM (60% of male respondents). Thirty-two percent of included

patients were interviewed in 2000–2003; 19% in 2004–2006; and 50% in 2007–2011. Demographics of interviewees were very similar to the overall UCHCC [35]. Patients excluded from analysis due to incomplete data did not differ demographically, but had fewer diagnoses of clinical AIDS, higher CD4 counts, and less ARV experience than those included in analysis (Supplemental Tables 1 and 2).

Clinical characteristics

Median time from HIV diagnosis to interview was 8 years (range, 0.1–21.9; Table 2), with 28% meeting a clinical definition of AIDS during their care. Median CD4 count among interviewees was 426 cells/μL (range, 9–1496), and 59% had HIV RNA viral loads below 400 copies/mL. Eighty-four percent of the group were on ARVs, with a median of 6.7 years since their first regimen was prescribed (range, 0.1–20.4). Forty-four percent of participants were heavily treatment experienced, with exposure to >4 ARV regimens. Only 8 were ARV-naïve (3%).

Depression and substance use

Just over half had a history of depression (Table 1). Thirty-eight percent of participants noted active substance use at the time of the interview. Marijuana (23%) and crack cocaine (19%) were most common; injection drug use was rare (n=2, 0.8%). Only 9% of respondents used alcohol heavily, defined as consumption ≥4 times per week.

Adherence

Among the 204 participants on ARVs when interviewed, 58% self-reported “excellent” adherence (Table 2). Eight percent missed ≥2 doses in the prior 4 days. Viral loads were strongly associated with adherence; 80% of those self-reporting “excellent” adherence had undetectable HIV RNA, compared to 48% and 24% among those with “good” and “poor” adherence, respectively ($P<0.01$).

Sexual behavior and condom utilization

Seventy percent of subjects reported some sexual activity in the prior six months (n=172); among these, 23% had 2–4 partners (n=39), and 6% reported >4 partners (n=10). Nearly two-thirds of sexually active participants reported vaginal sex (56 women, 49 men), with 65 (61%) indicating they used a condom “all of the time” for vaginal intercourse. Three women and 56 men had anal sex; only 49% consistently used condoms.

Factors associated with unprotected sexual activity

Participants reporting unprotected sex were younger than those who either consistently used condoms or were abstinent (41 versus 45 years, $P < 0.01$; Table 1). No gender differences existed in frequency of unprotected sex, but MSM were more likely to report unprotected sexual activity than heterosexual males ($P=0.04$). Unprotected sex was more common among active substance users ($P=0.04$), and we observed non-significant trends toward more unprotected sex among whites and Native Americans (P=0.40).

Persons with a clinical history of AIDS were less likely to report unprotected intercourse ($P<0.01$; Table 2). Median viral loads were higher among interviewees reporting unprotected sex (295 copies/mL, interquartile range [IQR], 25–13000) compared to those who consistently used condoms or were abstinent (62 copies/mL, IQR, 25–3687; $P=0.04$). Suboptimal adherence was nonsignificantly associated with unprotected sexual activity. Among individuals who reported unprotected sex, 20% missed at least one ARV dose in the prior 4 days, compared with 13% among those not engaging in unprotected sex ($P=0.12$). Those with self-assessed "good" or "poor" adherence were more likely to have unprotected intercourse than those with "excellent" adherence ($P=0.33$).

Prevalence of drug-resistance mutations

One hundred thirty-one study participants (54%) had ≥1 SDRM (Figure 1) – including 12 ARV-naïve individuals with any SDRM at entry to care. The most frequently observed reverse transcriptase mutation was M184V, seen in 94 subjects (39%). K103N and K70R were also frequently detected (23% and 13% prevalence, respectively). The most common protease mutations were L90M (9%) and I54V (7%). Overall, 45% harbored SDRMs for NRTIs (n=110), 31% had NNRTI resistance (n=76), and 23% had PI resistance (n=56). Triple-class resistance was noted in 26 cases (11%).

Factors associated with drug-resistance mutations

Age, sex and race were not associated with having SDRMs (Table 1). However, those with a history of homelessness, depression, or active cocaine use were more likely to have resistance (all $P\leq0.04$). Participants with a longer time since HIV diagnosis, a longer time on ARVs, or a greater number of regimens were more likely to have an SDRM (all $P<0.01$). Compared to poorly adherent participants, those with excellent adherence harbored SDRMs less often (86% vs. 51%; $P=0.03$). The proportion with newly identified resistance decreased over time (P=0.1).

Potential transmission of drug resistance

As shown in Figure 2, 70% reported sexual activity in the prior 6 months, and a majority used condoms inconsistently (n=94). Among the 44 subjects with inconsistent condom use and HIV RNA >400 copies/mL, 30 had documented resistance (12% of the subset). Viremia in this high-risk group was significant; 90% had HIV RNA >1500 copies/mL. Nine subjects had single-class resistance, 14 had dual-class, and 7 had triple-class SDRMs.

In bivariate analyses (Table 3), we found that subjects who completed some college education had a two-fold greater prevalence in the high-risk group (PR 2.03, 95% CI, 1.02, 4.02) and noted a non-significant trend toward a greater prevalence of MSM (PR 1.89, 95% CI, 0.97, 3.69). However, in bivariate and multivariate analyses, substance use and homelessness emerged as having the two strongest associations with membership in the high-risk group. Participants who used any illicit substance in the prior year or who reported heavy alcohol use had a three-fold greater prevalence in the high-risk group than non-users (adjusted PR [aPR] 3.12, 95% CI, 1.47, 6.62). Interviewees who reported any homelessness since HIV diagnosis had an adjusted high-risk group prevalence 2.2 times that of individuals with continuous housing (95% CI, 1.16, 4.18).

Sensitivity analysis

Participant underestimation of sexual activity and/or overestimation of condom use would alter the proportion categorized into our defined high-risk group. Considering all patients with detectable drug-resistant viremia as members of our high-risk group increased the size of this group to 56, or 23% of those with complete data. Our findings were consistent using this expanded high-risk group definition, with substance abuse (aPR 1.82, 95% CI, 1.15, 2.88) and homelessness since HIV diagnosis (aPR 1.99, 95% CI, 1.28, 3.10) remaining associated with risk of transmitting ARV resistance to others.

Discussion

Given revised U.S. treatment guidelines advocating ARV initiation for all HIV-infected persons regardless of CD4 count [41] and a shift toward “test, link, and treat” models of HIV care[42], we are poised to see greater numbers of patients on therapy in the coming years. With this increase in the number of people taking ARVs, we will likely observe an increase in the number of non-adherent patients engaged in sexual risk behavior – even if the proportions of such patients observed in our study (12%) and other cohorts (5–20%) [31–34] remain unchanged. Since this group may contribute disproportionately to transmission of resistant HIV [32], an expansion of TDR could be seen over time. Thus, improving our understanding of potential sources of TDR is perhaps more important than ever before.

In our cross-sectional study of HIV-infected patients in care, we observed all the requisite factors needed for sexual transmission of resistant HIV to occur. Forty percent reported suboptimal adherence to their ARVs. Nearly 60% of sexually active participants had unprotected sex at least once in the previous 6 months and tended to be younger and active substance users. The presence of an SDRM was associated with active cocaine use, a history of homelessness since HIV diagnosis, depression, and poor ARV adherence. Finally, we found the risk of having an opportunity to transmit resistant HIV was doubled by a history of homelessness and tripled by active substance use. The relationship of homelessness to the presence of ARV mutations and potential TDR has not been previously reported, but housing instability is a recognized contributor to poorer adherence [43].

These findings add to the limited existing literature on the potential for sexual transmission of resistant HIV among patients in care. Because poor adherence often leads to the development of ARV resistance [3], studies of opportunities for TDR have primarily examined the link between non-adherence and sexual risk behavior. Several clinic-based cohort studies in the United States have shown that the odds of high-risk sexual behavior are increased 1.5–2.5 times among patients with suboptimal ARV adherence, despite significant differences among the studies in terms of demographics, geography, and participant behaviors [30, 31, 34, 44]; the prevalence of patients in this group ranged from 8.5% [34] to 18% [31]. Three additional studies took a more direct approach, focusing on patients with genotypically-proven ARV resistance who reported high-risk behavior. Kozal et al. studied 333 patients in care (but not necessarily taking ARVs) and found 23% reported unprotected anal or vaginal sex in the prior 3 months; among these, 18 had resistance, for an overall prevalence of 4.5% [32]. Notably, this small subset reported 207 sexual events in the recall period, 80% of which were unprotected – providing evidence that a few individuals might

account for a disproportionately large number of potential transmission events. Chin-Hong et al. evaluated 279 patients in San Francisco, noting 17% of MSM and 6% of heterosexual men and women with resistant viruses had unprotected sex with serodiscordant or status-unknown partners in the prior 4 months [33]. Finally, at 14% of encounters with members of a Baltimore IDU cohort, participants with significant ARV resistance described unprotected sex and/or needle-sharing during periods of incomplete virological suppression on ARVs [45].

Clearly, not every patient who develops resistance has unprotected sex. However, the strength of this association – observed across multiple, diverse clinical cohorts – suggests that non-adherence and the accumulation of resistance could serve as a marker of coincident sexual risk behavior. Since many HIV providers check HIV RNA more often than they update a patient's sexual history [46], any detectable viremia should prompt a discussion with the patient about not only adherence, but also transmission risk behavior. Targeted interventions to reduce sexual partner number and improve condom utilization among patients with new or documented resistance could be important first steps toward reducing the spread of TDR. Finally, the role of substance abuse as a factor in both non-adherence and transmission risk cannot be underestimated; appropriate treatment for addiction is essential for preventing resistance and reducing high-risk sexual behaviors.

Our study is not without limitations. Only 250 of 482 participants completing face-to-face interviews had ever undergone resistance testing (52%). We felt the likelihood was low that undocumented mutations were present among the 232 who never had a GRT, since our institutional practice has long been to check for resistance in the setting of treatment failure. Social desirability bias during the face-to-face interview may have led participants to underestimate the number of sexual partners or overestimate adherence, but we explored this with our bounded sensitivity analysis and found similar factors associated with our primary outcome. Finally, our composite primary outcome reflects the factors necessary for transmission of resistant HIV to occur; it is impossible to know what viruses were circulating in the blood or genital tract at exactly the time of potential transmission events.

In summary, we found a small but significant proportion of clinic patients with viremia and documented resistant HIV continue to engage in sexual behaviors that place others at risk for TDR. Clinic-based, targeted secondary prevention and adherence interventions could substantially reduce opportunities for forward transmission of resistant HIV in the future.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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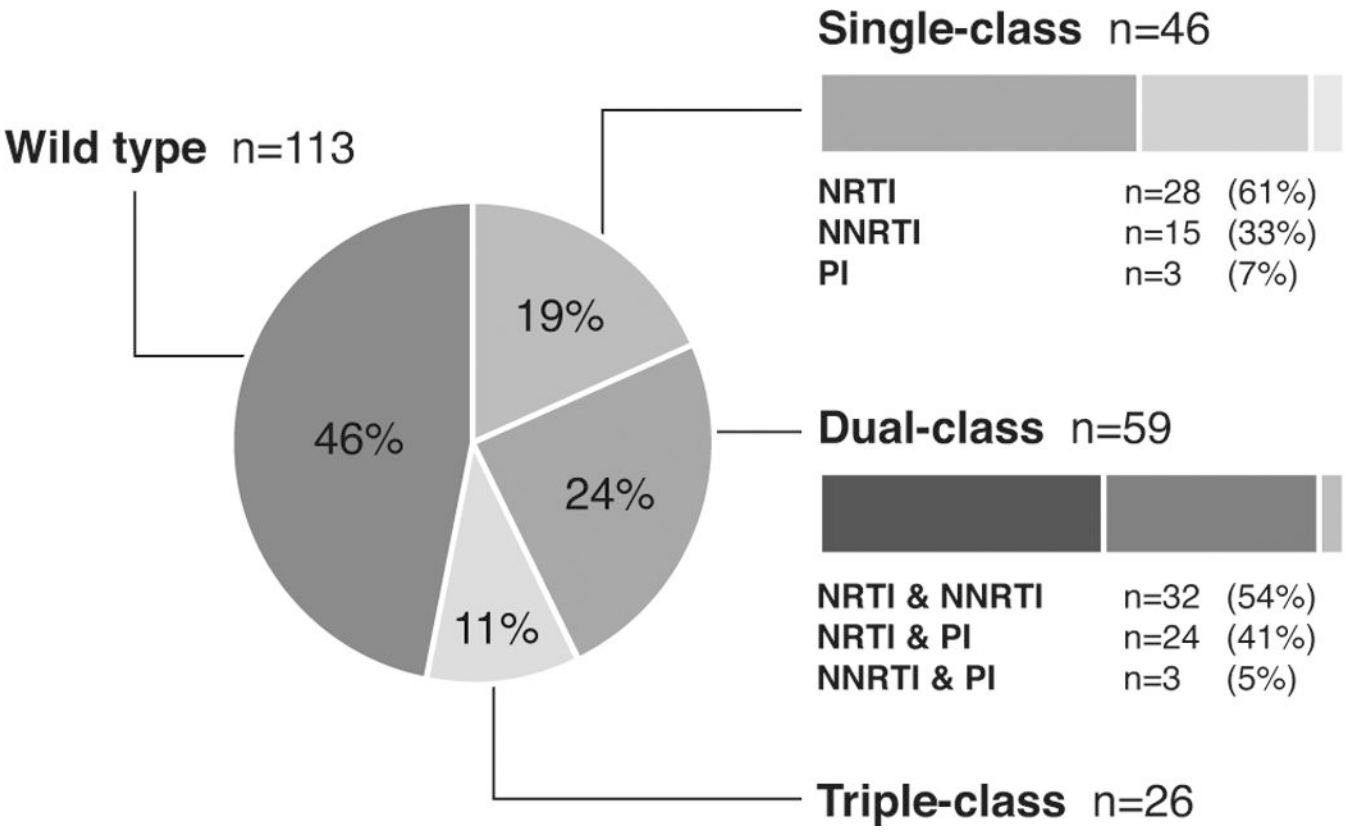

Figure 1.

Results of genotypic resistance testing among 244 participants in the UNC CFAR HIV Clinical Cohort. Abbreviations: NNRTI, non-nucleoside reverse transcriptase inhibitor; NRTI, nucleoside reverse transcriptase inhibitor; PI, protease inhibitor.

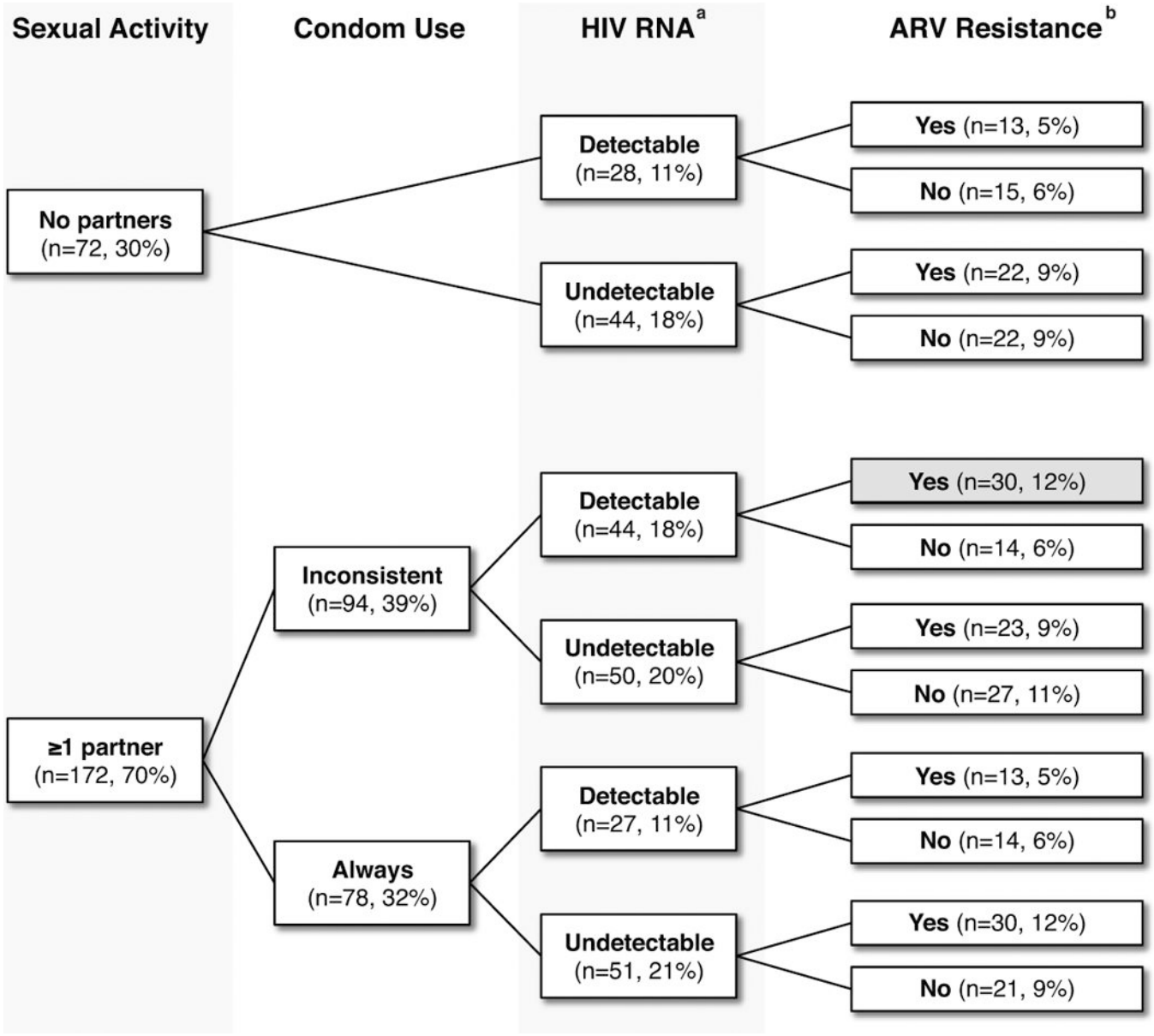

Figure 2.

Flow diagram of risk factors for transmitting drug-resistant HIV among 244 participants in the UNC CFAR HIV Clinical Cohort.[a] Detectable HIV RNA was defined as ≥400 copies/mL.[b] Antiretroviral (ARV) resistance was defined as the presence of ≥1 surveillance drug resistance mutation [39].

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Table 1

Demographic and behavioral characteristics of 244 HIV-infected adult participants in the UNC CFAR HIV Clinical Cohort, by sexual activity and antiretroviral resistance

Characteristic	N (%) or median (IQR)		Patients reporting unprotected sex		*p*[a]	Patients with a known SDRM		*p*[a]
No. of patients	244	(100.0)	94/244	(38.5)		131/244	(53.7)	
Age	43	(38–50)	41	(37–47)	<.01	43	(39–49)	.85
19–29	11	(4.5)	9/11	(81.8)	<.01	3/11	(27.3)	.10
30–39	60	(24.6)	27/60	(45.0)		30/60	(50.0)	
40–49	108	(44.3)	43/108	(39.8)		66/108	(61.1)	
≥50	65	(26.6)	15/65	(23.1)		32/65	(49.2)	
Sex								
Female	91	(37.3)	31/91	(34.1)	.27	48/91	(52.7)	.82
Male	153	(62.7)	63/153	(41.2)		83/153	(54.2)	
Race								
Black	171	(70.1)	60/171	(35.1)	.40	91/171	(53.2)	.28
White	52	(21.3)	24/52	(46.2)		28/52	(53.8)	
Hispanic/Latino	3	(1.2)	1/3	(33.3)		0/3	(0.0)	
Native American	8	(3.3)	5/8	(62.5)		6/8	(75.0)	
Other	10	(4.1)	4/10	(40.0)		6/10	(60.0)	
Education								
< HS or HS grad	142	(58.2)	46/142	(32.4)	.01	77/142	(54.2)	.69
Some college	70	(28.7)	37/70	(52.9)		39/70	(55.7)	
College grad or post-grad	32	(13.1)	11/32	(34.4)		15/32	(46.9)	
Homelessness[c]	52	(21.3)	22/52	(42.3)	.53	37/52	(71.2)	<.01
Man who has sex with men	92	(37.7)	44/92	(47.8)	.04	48/92	(52.2)	.53
Depression[d]	134	(54.9)	45/134	(33.6)	.08	80/134	(59.7)	.04
Substance use[e]								
Any	92	(37.7)	43/92	(46.7)	.04	54/92	(58.7)	.22
Marijuana	55	(22.5)	23/55	(41.8)	.57	31/55	(56.4)	.65
Crack	46	(18.9)	18/46	(39.1)	.93	26/46	(56.5)	.67

Characteristic	N (%) or median (IQR)		Patients reporting unprotected sex		*P*[a]	Patients with a known SDRM		*P*[a]
Alcohol (4+ times per week)	23	(9.4)	13/23	(56.5)	.07	15/23	(65.2)	.24
Cocaine (powder)	12	(4.9)	6/12	(50.0)	.54	10/12	(83.3)	.03
Oral opiates	5	(2.1)	4/5	(80.0)	.07	4/5	(80.0)	.38
Injection drug use	2	(0.8)	1/2	(50.0)	1.00	2/2	(100.0)	.50
Other[f]	4	(1.6)	3/4	(75.0)	.30	2/4	(50.0)	1.00

Abbreviations: CFAR, Center for AIDS Research; HIV, human immunodeficiency virus; HS, high school; IQR, interquartile range; SDRM, surveillance drug resistance mutation; UNC, University of North Carolina.

[a] Wilcoxon rank-sum testing was used to compare continuous variables; Pearson's χ^2 test was used for categorical variables, with exact *P* values calculated where appropriate. Statistical significance defined as $P < 0.05$ for all tests.

[c] Homeless at any time since HIV diagnosis.

[d] A diagnosis of depression listed in the patient's medical chart at any point prior to CSDS interview.

[e] Substance use was defined as regular consumption in the year prior to CSDS interview, except for alcohol – which was defined as drinking 4 or more times per week.

[f] Includes amphetamine-type stimulants, hallucinogens, inhalants, and sedatives/sleeping pills.

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Table 2

Clinical and treatment-related characteristics of 244 HIV-infected adult participants in the UNC CFAR HIV Clinical Cohort, by sexual activity and antiretroviral resistance

Characteristic	N[a] (%) or median (IQR)		Patients reporting unprotected sex		p[a]	Patients with a known SDRM		p[a]
No. of patients	244	(100.0)	94/244	(38.5)		131/244	(53.7)	
Years since HIV diagnosis	8.0	(4.3–12.8)	7.6	(3.6–12.4)	.07	9.8	(6.7–14.7)	<.01
History of clinical AIDS	68	(27.9)	16/68	(23.5)	<.01	37/68	(54.4)	.88
CD4 count (cells/μL)[b]	426	(214–619)	437	(254–620)	.69	403	(194–619)	.17
<200	55	(22.6)	20/55	(36.4)	.69	34/55	(61.8)	.18
≥200	188	(77.4)	74/188	(39.4)		97/188	(51.6)	
HIV RNA (copies/mL)[c]	124	(25–6567)	295	(25–13000)	.04	175	(25–13000)	.11
<400	145	(59.4)	50/145	(34.5)	.12	75/145	(51.7)	.46
≥400	99	(40.6)	44/99	(44.4)		56/99	(56.6)	
Antiretroviral therapy								
Naïve	8	(3.3)	4/8	(50.0)	.46	0/8	(0.0)	<.01
On	204	(83.6)	75/204	(36.8)		115/204	(56.4)	
Off	32	(13.1)	15/32	(46.9)		16/32	(50.0)	
Years since first antiretroviral[d]	6.7	(3.1–10.7)	6.6	(3.1–8.8)	.26	8.4	(5.5–12.5)	<.01
Number of regimens[e]	4	(2–7)	4	(2–6)	.24	5	(3–8)	<.01
1–2	81	(35.2)	35/81	(43.2)	.14	21/81	(25.9)	<.01
3–4	49	(21.3)	13/49	(26.5)		27/49	(55.1)	
>4	100	(43.5)	41/100	(41.0)		79/100	(79.0)	
Number of missed doses in past 4 days[d]								
0	165	(81.2)	55/165	(33.3)	.12	89/165	(53.9)	.25
1	22	(10.8)	12/22	(54.6)		16/22	(72.7)	
≥2	16	(7.9)	7/16	(43.8)		9/16	(56.3)	
Self-reported adherence[d]								
Excellent	118	(58.1)	38/118	(32.2)	.33	60/118	(50.8)	.03
Good	71	(35.0)	30/71	(42.3)		43/71	(60.6)	
Poor	14	(6.9)	6/14	(42.9)		12/14	(85.7)	

Abbreviations: AIDS, acquired immune deficiency syndrome; CFAR, Center for AIDS Research; HIV, human immunodeficiency virus; IQR, interquartile range; RNA, ribonucleic acid; SDRM, surveillance drug resistance mutation; UNC, University of North Carolina.

[a] Wilcoxon rank-sum testing was used to compare continuous variables; Pearson's χ^2 test was used for categorical variables, with exact *P* values calculated where appropriate. Statistical significance defined as $P < 0.05$ for all tests.

[b] CD4 count measured closest to date of interview, within a window of 6 months before to 6 months after interview. No available CD4 count for 1 patient.

[c] HIV RNA measured closest to date of interview, within a window of 6 months before to 1 month after interview.

[d] Among those on antiretroviral therapy at the time of interview (n = 204). Adherence data was missing for 1 patient.

[e] Among antiretroviral-experienced patients (n = 236). Number of regimens was unknown for 6 patients.

Table 3

Associations between demographic and clinical characteristics and risk for transmitting drug resistant HIV, in the UNC CFAR HIV Clinical Cohort (N = 244)

Characteristic	Crude PR (95% CI)	p[a]	Adjusted PR (95% CI)	p[a]
Age (per 10 year increase)	1.00 (0.99, 1.00)	.13		
Sex				
Female	1.0			
Male	1.95 (0.87, 4.37)	.10		
Race				
Black	1.0			
White	1.05 (0.47, 2.31)	.91		
Other	0.37 (0.05, 2.61)	.32		
Education				
< HS or HS grad	1.0			
Some college	2.03 (1.02, 4.02)	.04		
College grad or post-grad	0.63 (0.15, 2.65)	.53		
Homelessness[b]				
Yes	2.82 (1.47, 5.43)	<.01	2.20 (1.16, 4.18)	.02
No	1.0		1.0	
Man who has sex with men				
Yes	1.89 (0.97, 3.69)	.06	1.75 (0.93, 3.28)	.08
No	1.0		1.0	
Depression[c]				
Yes	1.42 (0.71, 2.85)	.33		
No	1.0			
Substance use[d]				
Yes	3.86 (1.85, 8.05)	<.01	3.12 (1.47, 6.62)	<.01
No	1.0		1.0	
Years since HIV diagnosis				
<3	0.20 (0.03, 1.44)	.11		
3–10	1.0			
11–15	1.54 (0.76, 3.09)	.23		
16+	0.57 (0.14, 2.33)	.43		
History of clinical AIDS				
Yes	1.50 (0.75, 2.98)	.25		
No	1.0			

Abbreviations: AIDS, acquired immune deficiency syndrome; CFAR, Center for AIDS Research; HIV, human immunodeficiency virus; HS, high school; PR, prevalence ratio; SDRM, surveillance drug resistance mutation; UNC, University of North Carolina.

[a] Statistical significance defined as $P < 0.05$ for all tests.

[b] Homeless at any time since HIV diagnosis.

[c] A diagnosis of depression listed in the patient's medical chart at any point prior to the interview.

[d] Substance use was defined as drinking alcohol 4 or more times per week, or regular consumption of any illegal drugs in the year prior to interview.