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High rates of exposure to tuberculosis patients among HIV-infected healthcare workers in Botswana

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Abstract

Setting and Objective: We compared daily exposure to tuberculosis (TB) patients between HIV-infected and HIV-uninfected health care workers (HCWs), and examined uptake of antiretroviral therapy (ART) and isoniazid preventive therapy (IPT) among HIV-infected HCWs in Botswana.

Design: We conducted a cross-sectional study among HCWs in 30 hospitals and clinics. We determined self-reported exposure frequency to TB patients and HIV status through in-person interviews. HCWs with unknown or negative HIV status were offered rapid HIV tests. Multivariable Poisson regression modeling with robust variance was used to estimate the association between HIV status and daily exposure to TB patients.

Results: Of 1877 participants enrolled, 1388 (73.9%) with complete data were included in this study. Among 277 (20.0%) HIV-infected participants, 14.3% were newly diagnosed, 57.8% were on ART, and 34.3% reported previously receiving IPT. Daily exposure to TB patients was reported by 48.4% and 52.9% of HIV-infected and HIV-uninfected participants, respectively. After adjusting for sex, age, occupation, and department, rates of daily TB exposure remained similar between HIV-infected and HIV-uninfected participants (prevalence ratio=0.96; 95% confidence interval=0.85-1.08).

Conclusions: We found similar rates of exposure to TB patients between HIV-infected and HIV-uninfected HCWs. Improved efforts are needed to reduce nosocomial TB exposure among HIV-infected HCWs.

INTRODUCTION

In countries with high tuberculosis (TB) burden, healthcare workers (HCWs) are at high risk of acquiring TB from nosocomial transmission, and TB is considered an occupational illness.[1,2] The risk for nosocomial TB transmission is particularly high in resource-limited settings where infection control measures are inadequately implemented. Studies in Africa have shown that, compared to the general population, HCWs are up to 24 times more likely to develop TB due to exposure to infectious patients in the workplace.[3–5] Nosocomial transmission of TB among HCWs could lead to increased TB risk for other HCWs and patients, and contribute to TB transmission in the community.

HIV-infected HCWs are at increased risk for nosocomial TB compared to HIV uninfected HCWs. HIV-related immunodeficiency is the strongest risk factor for progression from *Mycobacterium tuberculosis* infection to TB disease, and TB is the leading causes of death among HIV-infected persons in resource-limited settings.[6,7] Nosocomial transmission among HIV-infected patients and HCWs was an important driver of the extensively drug-resistant (XDR)-TB outbreak in KwaZulu-Natal Province of South Africa, with case fatality rate as high as 98%.[8]

The World Health Organization's TB infection control policy recommends assignment of HIV-infected HCWs to job tasks that involve limited exposure to patients with confirmed or presumptive TB.[1,9] A mathematical modeling study found that an integrated infection control intervention including reassignment of HIV-infected HCWs to low risk areas could significantly reduce XDR-TB transmission in South Africa.[10] Reassignment of HIV-infected HCWs may also contribute to combating TB and drug-

resistant TB epidemics in other high TB burden countries. The Botswana Ministry of Health (MOH) recommends that health facilities implement administrative measures to allow HIV-infected HCWs to avoid TB exposure.[13] Despite this, little is known regarding the practice of reducing exposure to TB patients for HIV-infected HCWs at health facilities in Botswana.

The aim of our study was to compare exposure to TB patients between HIV-infected and HIV-uninfected HCWs in health facilities in Botswana, a country that is hyperendemic for TB and HIV. Botswana ranks among the highest countries in TB incidence and HIV prevalence globally[11] − HIV prevalence is greater than 60% among TB patients, and 40% of deaths among HIV-infected persons are attributable to TB.[12] We also examined administration of antiretroviral therapy (ART) and isoniazid preventive therapy (IPT) among HIV-infected HCWs, which are recommended measures to reduce TB risk in this population.[1]

STUDY POPULATION AND METHODS

Study population and setting

We conducted the present study in six districts with high TB burden in southern Botswana: Gaborone, Francistown, South East, Southern, Kgatleng, and Kweneng East. Between March 2009 and April 2010, all HCWs from the selected health facilities were invited to a TB infection control training. HCWs consisted of medical doctors, nurses, health care auxiliaries, and support staff. Health care auxiliary staff work in the clinical setting and support patient care, carrying out responsibilities such as movement of patients and equipment, delivery of specimens to the lab. HCWs who attended the TB

infection control training were also invited to participate in a Workplace Wellness Program that involved an in-person interview and screening for TB and HIV.

Procedures

In-person interviews were conducted as part of a clinical ‘wellness’ consultation using a standardized data collection form, which included measures of HIV status, CD4+ T cell count, history of TB, position of employment, current department, years working in healthcare, and demographic information. The frequency of exposure to TB patients was determined by asking participants to select one of the following categories: daily, weekly, less frequently, and don’t know.

HIV testing was offered to all HCWs with a negative or unknown HIV status. A rapid HIV test was given to those who accepted in accordance with Botswana’s national guidelines.[12] HCWs who tested positive for HIV were referred to appropriate healthcare services and management. Participants were categorized as HIV positive if they reported having been diagnosed with HIV or if they tested positive on the rapid HIV test administered at the time of ‘wellness’ consultation. Participants who were eligible for an HIV test but did not receive a rapid HIV test were coded as missing and were excluded from the analysis.

Statistical analysis

The primary outcome in our study was self-reported daily contact with TB patients in the workplace. We estimated the probability of daily contact with TB patients for HIV-infected and HIV-uninfected participants by calculating the proportion of

participants reporting daily contact with TB patients in each category. Prevalence ratios (PRs) and 95% confidence intervals (CIs) were estimated using normal approximation.[14] Next, we constructed a multivariable Poisson regression model with robust variance to estimate PRs adjusted for potentially confounding variables.[15–17] This method has been shown to generate unbiased PR estimates with good statistical coverage for binary outcome variables.[15–17] We specified daily contact with TB patients as the dependent variable. The covariates for inclusion in the final model were selected *a priori* based on a conceptual model of factors associated with HIV status and exposure to TB patients. The final model included the following covariates: HIV status, sex, age (x 10 years), occupation, and department. Statistical analysis was performed using R version 3.3.0 (The R Project for Statistical Computing; http:/www.r-project.org). As recommended by recent statistical guidelines, we did not specify an alpha cutoff for statistical significance.[18]

Ethical considerations

This study was approved by the Botswana MOH Human Research Development Committee and the University of Pennsylvania IRB. Written informed consent was obtained from all participants.

RESULTS

We enrolled 1,877 HCWs during March 2009 to April 2010. Participants with unknown HIV status (n = 464) and missing data for exposure to TB patients (n = 25) were excluded from the analysis. Participants who were excluded from the study were more likely to be nurses (50.2%), male (28.7%), and report daily exposure to TB patients (59.7%) compared to included participants. Other characteristics were similar between included and excluded participants.

Of the remaining 1,388 (73.9%) participants, 277 (20.0%) were HIV-infected (Table 1). Compared to HIV-uninfected participants, HIV-infected participants were more likely to be female, older, occupied as porter/cleaner/driver, and report history of prior TB treatment (Table 1). Among HIV-infected participants, 38 (13.7%) were newly tested positive for HIV by our study, 152 (54.9%) were taking ART, and 95 (34.3%) reported prior IPT use (Table 1).

Table 2 shows bivariate analysis of factors associated with daily exposure to TB patients. Due to small number of participants in the medical officers/interns/students occupation group, we combined that category with nurses for this analysis. HIV-infected participants were slightly less likely to report daily exposure to TB patients compared to HIV-uninfected participants (Table 2; 48.4% vs. 52.9%; PR = 0.91; 95% CI = 0.80 – 1.04). Excluding the newly diagnosed HIV participants, daily exposure to TB patients remained slightly lower among those who already knew their HIV status compared to HIV-uninfected participants (Table 2; 47.3% vs. 52.9%; PR = 0.89; 95% CI = 0.77 – 1.03). In multivariable analysis, we found similar levels of daily exposure to TB patients between HIV-infected and HIV-uninfected participants (adjusted PR = 0.96; 95% CI =

0.85 – 1.08). Working in HIV/TB clinic or other clinics was associated with higher levels of reported daily exposure to TB patients compared to working in inpatient facilities (Table 2).

DISCUSSION

We report findings from a large cross-sectional study of HIV-infected and HIV-uninfected HCWs in Botswana. Our finding that nearly 20% of HIV-infected participants had a prior history of TB treatment suggests that HIV-infected HCWs in our study are at high risk for TB. Despite existing policy recommendations for reassigning HIV-infected HCWs to low TB risk areas, we found only a small difference in daily exposure to TB patients between HIV-infected and HIV-uninfected HCW participants.

Our findings are consistent with studies of TB infection control practices in southern Africa, which show that few heath facilities redeploy HIV-infected HCWs to lower TB risk assignments.[19,20] For example, one study found that only 5 out of 10 HIV clinics in Botswana reported following this recommendation prior to a TB infection control intervention.[20] Our findings suggest that policy recommendation for administrative reassignment of HIV-infected HCWs may have led to only a small decrease in exposure to infectious TB patients among HIV-infected HCWs.

Our findings underscore the difficulty of reassigning HIV-infected HCWs. Studies have shown that stigmatization of HIV and TB among HCWs is a strong barrier against HIV testing, which impairs the ability to reassign HIV-infected HCWs.[21–24] HCWs experience particularly high levels of stigma due to internal and external expectations for health professionals to be negative for HIV.[23] Even among HIV-infected HCWs who

are aware of their status, stigma poses a barrier to disclosure of HIV status to administrators and refusal of reassignment.[22] HIV-infected HCWs may be concerned that reassignment to lower-risk areas would raise suspicion about their HIV status among their colleagues.[22] Workplace interventions, such as the project upon which this study is based, may reduce stigma, improve HIV testing and disclosure, and facilitate reassignment of HIV-infected HCWs.[24,25]

Reassignment is also difficult in many health facilities because of the limited options available for reassignment within the facility. For example, in HIV and TB clinics, the entire facility may be considered high risk for exposure to TB patients.[22] In addition, the true risk of TB exposure is difficult to assess. Patients in departments and wards where TB is not suspected may have undiagnosed and untreated TB – posing a higher risk of TB exposure than expected.

In addition to reassignment, HIV-infected HCWs should be provided with free access to ART and IPT to reduce TB risk.[1] We found that over 40% of the HIV-infected participants in our study were not on ART and nearly two out of three never received IPT. At the time of this study, the CD4+ T cell threshold for ART eligibility in Botswana was 250 cells/mm^3. The Botswana MOH recently instituted a policy of extending ART eligibility for all HIV-infected persons regardless of their CD4+ T cell count. Implementation of this policy may decrease TB risk among HCWs receiving HIV care.

Strengths of this study include enrollment of a large sample size of HCWs, including 277 HIV-infected HCWs. Study participants were enrolled from diverse departments and occupations, allowing for comparisons between various occupational categories. Confirmatory HIV testing was offered to all participants with unknown or

previously negative HIV status, and a conservative definition was used to categorize HIV-uninfected participants as only those with confirmed negative test result.[26]

Limitations include the exclusion of nearly 25% of the enrolled population due to unknown HIV status, which could have led to an incorrect HIV prevalence estimate. Excluded participants were more likely to report daily exposure to TB patients. If HIV-infected HCWs were less likely to disclose their HIV status for this study due to HIV-related stigma, excluding these participants may have led to underestimation of daily exposure to TB patients among HIV-infected HCWs. Therefore, this limitation is not likely to have affected our overall finding of high rates of daily exposure to TB patients among HIV-infected HCWs. Finally, frequency of exposure to TB patients was ascertained through self-report, and we did not collect data on the duration of exposure to TB patients. Both could have led to misclassification of the risk of TB acquisition among participants. Future studies should utilize more objective methods of ascertaining this outcome, including comparison of medical records with dates of work assignment to measure exposure time.

CONCLUSIONS

We report findings from a large cross-sectional study of HIV-infected and HIV-uninfected HCWs who are at high risk for nosocomial TB. We found little evidence that HIV-infected HCWs are reassigned to low TB risk areas. Furthermore, ART and IPT use among HIV-infected HCWs was suboptimal. Efforts to improve the implementation of TB infection control recommendations are urgently needed. Future research should

investigate methods to overcome barriers in implementation of TB infection control interventions.

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Author contributions: S.S.S. formulated the research question and performed statistical analysis. Q.W. and S.S.S. wrote the first draft of the manuscript. M.K. and T.P. designed the data collection instruments and supervised the data collection. A.H.F. led data management. All authors reviewed, provided critical comments, and approved the final version of the manuscript.

Conflicts of interest: All authors declare that there are no conflicts of interests.

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Table 1. Characteristics of health care workers attending Workplace Wellness Program, March 2009 - April 2010, Botswana.

Characteristic		HIV-uninfected n = 1111	HIV-infected n = 277
Sex	Female	263 (24.5%)	35 (12.8%)
	Male	810 (75.5%)	238 (87.2%)
Age in years, median (IQR)		36 (29-48)	38 (33-45)
Occupation	Medical officers/interns/students	33 (3.0%)	0 (0%)
	Nurses	366 (32.9%)	35 (12.6%)
	Auxiliary/physiotherapists/dentists / counselors	158 (14.2%)	34 (12.3%)
	Clerks/technicians/orderlies	187 (16.8%)	46 (16.6%)
	Porters/cleaners/drivers	188 (16.9%)	110 (39.7%)
	Cooks/administrative	179 (16.1%)	52 (18.8%)
Years as HCW	< 1	89 (8%)	14 (5.1%)
	1-5	310 (28%)	73 (26.4%)
	6-15	369 (33.3%)	117 (42.4%)
	16-25	201 (18.2%)	59 (21.4%)
	> 25	138 (12.5%)	13 (4.7%)
Department	Inpatient	351 (31.6%)	82 (29.6%)
	HIV/TB Clinic	49 (4.4%)	11 (4.0%)
	Other Clinic	325 (29.3%)	85 (30.7%)
	Non-Clinical	135 (12.2%)	40 (14.4%)
	Other[1]	251 (22.6%)	59 (21.3%)
Prior TB at any time	No	1030 (92.7%)	225 (81.2%)
	Yes	81 (7.3%)	52 (18.8%)
Diagnosed with TB during past year	No	1105 (99.5%)	272 (98.2%)
	Yes	6 (0.5%)	5 (1.8%)
Frequency of exposure to TB patients	Daily	588 (52.9%)	134 (48.4%)
	Weekly	53 (4.8%)	12 (4.3%)
	Less frequently	320 (28.8%)	91 (32.9%)
	Unknown	150 (13.5%)	40 (14.4%)
Newly detected HIV	No		239 (86.3%)
	Yes		38 (13.7%)
On antiretroviral therapy	No		111 (40.1%)
	Yes		152 (54.9%)
	Unknown		14 (5.1%)
History of isoniazid preventive therapy	No		182 (65.7%)
	Yes		95 (34.3%)

Abbreviations: IQR=Interquartile range; HCW=Healthcare workers; TB=Tuberculosis. [1] The Other Department category includes: laboratory, radiology, kitchen, inpatient Pharmacy, outpatient Pharmacy, and laundry.

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Table 2. Factors associated with daily exposure to TB patients among health care workers attending Workplace Wellness Program, March 2009 – April 2010, Botswana.

Category		% (n/N)	Crude PR (95% CI)	Adjusted PR (95% CI)
Sex	Male	51.3% (153/298)	1.00	1.00
	Female	53.0% (555/1048)	1.03 (0.91-1.17)	0.96 (0.88-1.04)
Age, years	20-29	54.8% (188/343)	1.00	1.00
	30-39	50.7% (238/469)	0.93 (0.81-1.06)	0.91 (0.8-1.03)
	40-49	47.9% (136/284)	0.87 (0.75-1.02)	0.88 (0.75-1.02)
	50+	55.9% (156/279)	1.02 (0.89-1.18)	0.98 (0.85-1.13)
Occupation	Medical/nurses	55.1% (239/434)	1.00	1.00
	Auxiliary/physiotherapists/ dentists/counselors	66.1% (127/192)	1.20 (1.05-1.37)	1.06 (0.93-1.2)
	Clerks/technicians/orderlies	51.9% (121/233)	0.94 (0.81-1.1)	1.01 (0.86-1.18)
	Porters/cleaners/drivers	55.0% (164/298)	1.00 (0.87-1.14)	1.04 (0.92-1.18)
	Cooks/administrative	30.7% (71/231)	0.56 (0.45-0.69)	0.64 (0.51-0.8)
Department	Inpatient	42.3% (183/433)	1.00	1.00
	HIV/TB Clinic	83.3% (50/60)	1.97 (1.68-2.31)	2.00 (1.7-2.35)
	Other Clinic	77.3% (317/410)	1.83 (1.62-2.07)	1.91 (1.68-2.17)
	Non-Clinical	35.4% (62/175)	0.84 (0.67-1.05)	1.02 (0.8-1.31)
	Other[1]	35.5% (110/310)	0.84 (0.7-1.01)	0.95 (0.79-1.16)
HIV status	Negative	52.9% (588/1111)	1.00	1.00
	Positive	48.4% (134/277)	0.91 (0.8-1.04)	0.96 (0.85-1.08)
Newly diagnosed HIV				
	No	47.3% (113/239)	1.00	Not included in model
	Yes	55.3% (21/38)	1.17 (0.85-1.60)	Not included in model
On antiretroviral therapy				
	No	52.3% (58/111)	1.00	Not included in model
	Yes	46.7% (71/152)	0.89 (0.70-1.14)	Not included in model
	Unknown	35.7% (5/14)	0.68 (0.33-1.41)	Not included in model
History of isoniazid preventive therapy	No	47.3% (86/182)	1.00	Not included in model
	Yes	50.5% (48/95)	1.07 (0.83-1.37)	Not included in model

Abbreviations: PR=Prevalence ratio; CI=Confidence interval.

[1] The Other Department category includes: laboratory, radiology, kitchen, inpatient Pharmacy, outpatient Pharmacy, and laundry.

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