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SPECTRUM OF OPPORTUNISTIC INFECTIONS AMONG PEOPLE LIVING WITH HIV ATTENDING AN ART CENTRE IN KHYBER PAKHTUNKHWA

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ABSTRACT

Background: Opportunistic infections continue to be a significant source of morbidity, hospitalization and mortality in people living with HIV, especially in those who have advanced immunosuppression, poor ART adherence and/or unsuppressed viral load. Information about the incidence of opportunistic infections in HIV clients in Khyber Pakhtunkhwa is limited.

Objective: To determine the frequency and spectrum of opportunistic infections and identify associated clinical and treatment-related factors among people living with HIV attending two antiretroviral therapy centres in Khyber Pakhtunkhwa.

Methodology: This was a multicentre descriptive cross sectional study carried out in the ART centres of Divisional Headquarters Teaching Hospital, KDA, Kohat and Mufti Mahmood teaching hospital, Dera Ismail Khan from January to July 2025. The HIV infected adult population consisted of 400 adults with confirmed HIV infection who were enrolled by consecutive sampling. A structured form was used to collect sociodemographic data, clinical, laboratory, treatment and opportunistic-infection data. Frequencies and percentages were computed and associations were evaluated with chi-square or Fisher's exact test. The independent predictors of OI were determined using multivariable binary logistic regression. A p value<0.05 was taken as statistically significant.

Results: The mean age of the participants was 37.8 ± 10.6 years, and 274 (68.5%) were male. At least one opportunistic infection was identified in 176 (44.0%) participants. Pulmonary tuberculosis was the most frequent infection, affecting 58 (14.5%) patients, followed by oral candidiasis in 46 (11.5%), chronic diarrhoeal illness in 34 (8.5%), bacterial pneumonia in 30 (7.5%), and herpes zoster in 24 (6.0%). Opportunistic infections occurred in 78.2% of patients with CD4 counts below 200 cells/mm³, compared with 15.0% of those with CD4 counts of at least 500 cells/mm³ ($p < 0.001$). A CD4 count below 200 cells/mm³, poor ART adherence, WHO clinical stage IV, absence of viral suppression, and lack of cotrimoxazole prophylaxis remained independent predictors of opportunistic infections.

Conclusion: Opportunistic infections affected a substantial proportion of people living with HIV attending the participating ART centres. Tuberculosis was the predominant infection. Advanced immunosuppression, poor treatment adherence, unsuppressed viral load, and absence of prophylaxis were the major associated factors. Early diagnosis, sustained ART adherence, regular CD4 and viral-load monitoring, and timely preventive treatment are required to reduce the burden of opportunistic infections.

KEYWORDS: HIV; opportunistic infections; antiretroviral therapy; tuberculosis; CD4 count; viral suppression; Khyber Pakhtunkhwa.

INTRODUCTION

Human immunodeficiency virus remains an important global public-health problem despite major improvements in diagnosis, antiretroviral therapy, and long-term survival. HIV progressively weakens the cell mediated immune system, primarily by killing and impairing CD4+ T lymphocytes. The affected person is more prone to infections which are uncommon, mild or self limiting in immunocompetent individuals. Opportunistic infections play an important role in morbidity, hospitalizations, quality of life limitations, treatment disruption and mortality rates in people living with HIV. Viral suppression and recovery of immune function with effective ART can prevent opportunistic infections, but when patients are diagnosed late, receive ART when their disease is far advanced, do not

adhere to therapy, stop therapy, or do not become virally suppressed, they may still develop opportunistic infections [1-3].

Clinical presentation of opportunistic infections is variable depending on geographical region, environmental exposure, endemic infections, socioeconomic status, diagnostic services, and the degree of immunosuppression. Tuberculosis still is one of the most important infections in people with HIV, especially in settings where there is a high background prevalence of tuberculosis. Oral and oesophageal candidiasis, bacterial pneumonia, chronic diarrhoeal diseases, herpes zoster, Pneumocystis jirovecii pneumonia, cryptococcal meningitis, toxoplasmosis, cryptosporidiosis and cytomegalovirus disease are all other common issues that have been reported. The likelihood and the impact of these infections tend to increase as the CD4 count decreases. For adults and adolescents, WHO clinical stage III or IV disease or CD4 cell count less than 200 cells/mm³ is defined as advanced HIV disease [4-6].

Many opportunistic infections are now less common because of the introduction and roll-out of antiretroviral therapy. Key pillars of HIV care include early ART initiation and uninterrupted ART, treatment adherence support, viral-load monitoring, and ART prevention. Patients with advanced HIV disease, however, need to be treated with further interventions, such as systematic evaluation for tuberculosis, cotrimoxazole prophylaxis as appropriate, tuberculosis preventive treatment, cryptococcal antigen testing and rapid management of severe infections. WHO guidelines call for immediate ART starting and improved packages of services for those presenting with advanced disease including prophylaxis, screening and treatment. The measures are especially crucial in environments where patients can gain access to care late, or care is not continuous, or follow-up care is not received [7-9].

Pakistan has a growing HIV burden, with an estimated 350,000 people living with HIV, while the proportion receiving antiretroviral therapy remains comparatively low. Official programme information reported that approximately 51,821 patients were receiving ART by December 2024. Despite this increasing burden, published evidence describing opportunistic infections among patients attending ART centres in Khyber Pakhtunkhwa remains limited. Knowledge of the locally prevalent infections and their relationship with CD4 count, ART adherence, WHO clinical stage, viral suppression, and preventive treatment is essential for planning diagnostic and treatment services. Therefore, the present study was conducted to determine the frequency and spectrum of opportunistic infections and evaluate their associated factors among people living with HIV attending ART centres at Divisional Headquarters Teaching Hospital, KDA Kohat, and Mufti Mahmood Teaching Hospital, Dera Ismail Khan.

METHODOLOGY

This multicentre, descriptive cross-sectional study was conducted at the Antiretroviral Therapy centres of Divisional Headquarters Teaching Hospital, KDA Kohat, and Mufti Mahmood Teaching Hospital, Dera Ismail Khan. The study was carried out over seven months, from January 2025 to July 2025. The purpose of the study was to determine the frequency and spectrum of opportunistic infections among people living with HIV receiving care at the participating ART centres. Both hospitals serve as major referral centres for patients from different districts of Khyber Pakhtunkhwa and provide HIV testing, antiretroviral therapy, counselling, clinical monitoring, and management of HIV-related complications. Ethical approval was obtained from the relevant institutional ethics review committees before the initiation of data collection. Written informed consent was obtained from all participants, and confidentiality was maintained by assigning a unique identification code to each patient.

Consecutive non-probability sampling was used to include a total of 400 people living with HIV. The population size of all eligible patients visiting either of the two ART centres during the study period was approached till the required sample size was reached. Patients aged 18 years or older with a confirmed HIV infection who were registered at the ART clinics and taking or starting ART were included. Male and female patients were allowed. Patients declining, missing medical records, unable to provide clinical or laboratory data required for opportunistic infections or lack of adequate clinical and laboratory evaluation were excluded. Those patients who were clinically unstable and not able to complete the assessment at the time of enrolment were assessed after stabilizing as they became stable, if possible.

A structured and pretested data-collection form was designed based on the study aims and used to collect data. Sociodemographic variables: Age, gender, marital status, residence, educational level, occupation and socioeconomic status. HIV-related variables were duration since HIV diagnosis, duration and regimen of ART, treatment adherence, probable route of transmission, WHO clinical stage, baseline and current CD4-cell counts, viral-load status, viral suppression, cotrimoxazole prophylaxis, isoniazid preventive therapy, prior hospitalization, and associated comorbidities. The ability of patients to adhere to ART was evaluated by patient interviews, the documentation of pharmacy refills, and available clinical records. ART was considered to be taken well by those who took ≥ 95% of their doses, to be taken moderately by those who took 80–94% of their doses, and to be taken poorly by those who took < 80%.

All participants were clinically evaluated and opportunistic infections were assessed at the time or previously documented. Data collected from patient interviews, physical examination, laboratory records, radiological reports and ART centre files. Opportunistic infections evaluated were tuberculosis (extrapulmonary and pulmonary), oral

candidiasis, oesophageal candidiasis, chronic diarrhoeal illness, bacterial pneumonia, herpes zoster, herpes simplex infection, Pneumocystis jirovecii pneumonia, cryptococcal meningitis, cerebral toxoplasmosis, cryptosporidiosis and other clinically confirmed infections. Standard clinical and laboratory criteria were used for diagnosis. The diagnosis of tuberculosis was made by sputum smear microscopy, GeneXpert tests, radiological examination or relevant tissue and fluid examinations. The clinical diagnosis of candidiasis was made, and microscopy or culture was performed, if indicated. The diagnosis of cryptococcal meningitis was confirmed by examination of the CSF or by the presence of the cryptococcal antigen in CSF; diagnosis of other central nervous system infections was done on the basis of clinical features and neuroimaging. The most recent available laboratory parameters of complete blood count, haemoglobin, CD4 count, viral load, body mass index (BMI), and other relevant parameters were documented.

IBM SPSS Statistics version 26.0 was used to enter and analyse the data. Continuous variables in the study like age, CD4, haemoglobin level, duration of ART were checked for normality and presented as mean and standard deviation (SD) or median and interquartile range (IQR) as appropriate. Frequencies and percentages were used to describe categorical variables. Overall rate of opportunistic infections was determined as the percent of patients with at least one recorded opportunistic infection among the total number of patients. Associations of opportunistic infections with categorical variables were assessed using the chi-square test or Fisher's exact test, depending on the data. Categorical variables included were age group, gender, residence, ART adherence, WHO clinical stage, CD4-count category, viral suppression and prophylactic treatment. Those variables that had p-values < 0.20 in the bivariate analyses were included in the multivariable logistic regression analysis to determine independent predictors of opportunistic infections. ORs with 95% confidence intervals were calculated and p-values < 0.05 were considered statistically significant.

RESULTS

The total number of individuals attending the ART centre who were living with HIV (LWHIV) was 400. The median age of the subjects was 37.8 ± 10.6 years (range 18-68 years). The majority of participants were married, male, between the ages of 31-40 and from rural areas. A total of 176 of the participants were found to have opportunistic infections, resulting in an overall prevalence of 44.0%. The age group of most people (35.5%) was between 31 and 40 years, with 27.0% between 18 and 30 years. 68.5% of the study population were male. About two-thirds of the participants were married and 60.0% were from rural areas. Almost half of the respondents lacked any formal education or only up to primary school.

Table 1. Sociodemographic characteristics of the study participants

Variable	Frequency (n)	Percentage (%)
Age group		
18–30 years	108	27.0
31–40 years	142	35.5
41–50 years	98	24.5
>50 years	52	13.0
Mean age, years	**37.8 ± 10.6**	—
Gender		
Male	274	68.5
Female	126	31.5
Marital status		
Married	266	66.5
Unmarried	72	18.0
Widowed/divorced	62	15.5
Residence		
Rural	240	60.0
Urban	160	40.0
Educational status		
No formal education	104	26.0
Primary education	92	23.0
Secondary education	124	31.0
Higher education	80	20.0
Employment status		
Employed	184	46.0
Unemployed	126	31.5

Homemaker	90	22.5

Median time since HIV diagnosis was 4.8 years, and the median time using ART was 4.2 years. 69.0% of the participants reported good ART adherence. 27.5% had a current CD4 count of less than 200 cells/mm3 and 65.5% of participants had viral suppression documented. The majority of patients were WHO stage I or II.

Table 2. HIV-related clinical and laboratory characteristics

Clinical characteristic	Frequency (n)	Percentage (%)
Duration since HIV diagnosis		
<2 years	96	24.0
2–5 years	172	43.0
>5 years	132	33.0
Duration of ART		
<2 years	108	27.0
2–5 years	168	42.0
>5 years	124	31.0
ART adherence		
Good, ≥95%	276	69.0
Moderate, 80–94%	82	20.5
Poor, <80%	42	10.5
WHO clinical stage		
Stage I	120	30.0
Stage II	104	26.0
Stage III	112	28.0
Stage IV	64	16.0
Current CD4 count		
<200 cells/mm³	110	27.5
200–349 cells/mm³	118	29.5
350–499 cells/mm³	92	23.0
≥500 cells/mm³	80	20.0
Viral-load status		
Virally suppressed	262	65.5
Not virally suppressed	138	34.5
Cotrimoxazole prophylaxis		
Yes	248	62.0
No	152	38.0
Isoniazid preventive therapy		
Yes	194	48.5
No	206	51.5
Presence of comorbidity		
Yes	126	31.5
No	274	68.5

In the total number of patients (N = 400), 176 (44.0%) had at least one opportunistic infection. Of the infected participants, 73.9% had one and 26.1% had two or more infections. The commonest infections identified were pulmonary tuberculosis, oral candidiasis, chronic diarrhoeal illness, bacterial pneumonia and herpes zoster.

Table 3. Frequency and spectrum of opportunistic infections

Opportunistic-infection variable	Frequency (n)	Percentage (%)
Any opportunistic infection, n=400		
Present	176	44.0
Absent	224	56.0
Number of infections among affected patients, n=176		

Single infection	130	73.9
Two infections	36	20.5
Three or more infections	10	5.7
Type of opportunistic infection*		
Pulmonary tuberculosis	58	14.5
Oral candidiasis	46	11.5
Chronic diarrhoeal illness	34	8.5
Bacterial pneumonia	30	7.5
Herpes zoster	24	6.0
Extrapulmonary tuberculosis	22	5.5
Oesophageal candidiasis	18	4.5
Pneumocystis jirovecii pneumonia	14	3.5
Cryptococcal meningitis	10	2.5
Toxoplasmosis	8	2.0
Herpes simplex infection	8	2.0
Cryptosporidiosis	6	1.5
Cytomegalovirus infection	4	1.0
Other opportunistic infections	12	3.0

*Participants could have more than one opportunistic infection; therefore, the total exceeds 176 and percentages do not add to 100%.

As the CD4 increased, opportunistic infections got less frequent. Participants with a CD4 count < 200 cells/mm³ had opportunistic infections in 78.2% of them, while 15.0% of participants with a CD4 count ≥ 500 cells/mm³ had opportunistic infections. The relationship between category of CD4 count and opportunistic infection was significant ($\chi^2 = 85.74$, $p < 0.001$).

Table 4. Opportunistic infections according to CD4-count categories

CD4-count category	Opportunistic infection present, n (%)	Opportunistic infection absent, n (%)	Total	p-value
<200 cells/mm³	86 (78.2)	24 (21.8)	110	
200–349 cells/mm³	56 (47.5)	62 (52.5)	118	
350–499 cells/mm³	22 (23.9)	70 (76.1)	92	
≥500 cells/mm³	12 (15.0)	68 (85.0)	80	**<0.001**
Total	**176 (44.0)**	**224 (56.0)**	**400**	

People over the age of 50 years, those living in rural areas, poorly adherent to ART, patients in clinical stages III and IV of WHO were more likely to have opportunistic infections, viral suppression was not received by patients, and cotrimoxazole prophylaxis was not received by the patients were significantly more likely to have opportunistic infections. There were no significant relationships between opportunistic infections and gender, marital status or educational status.

Table 5. Association of demographic and clinical factors with opportunistic infections

Variable	Opportunistic infection present n (%)	Opportunistic infection absent n (%)	p-value
Age group			**0.012**
18–30 years	38 (35.2)	70 (64.8)	
31–40 years	58 (40.8)	84 (59.2)	
41–50 years	50 (51.0)	48 (49.0)	
>50 years	30 (57.7)	22 (42.3)	
Gender			0.418
Male	124 (45.3)	150 (54.7)	
Female	52 (41.3)	74 (58.7)	
Residence			**0.021**
Rural	116 (48.3)	124 (51.7)	
Urban	60 (37.5)	100 (62.5)	
ART adherence			**<0.001**

Good	92 (33.3)	184 (66.7)	
Moderate	52 (63.4)	30 (36.6)	
Poor	32 (76.2)	10 (23.8)	
WHO clinical stage			**<0.001**
Stage I	22 (18.3)	98 (81.7)	
Stage II	30 (28.8)	74 (71.2)	
Stage III	72 (64.3)	40 (35.7)	
Stage IV	52 (81.3)	12 (18.8)	
Viral suppression			**<0.001**
Suppressed	74 (28.2)	188 (71.8)	
Not suppressed	102 (73.9)	36 (26.1)	
Cotrimoxazole prophylaxis			**<0.001**
Yes	84 (33.9)	164 (66.1)	
No	92 (60.5)	60 (39.5)	
Isoniazid preventive therapy			**0.004**
Yes	70 (36.1)	124 (63.9)	
No	106 (51.5)	100 (48.5)	
Presence of comorbidity			**0.018**
Yes	66 (52.4)	60 (47.6)	
No	110 (40.1)	164 (59.9)	

Patients with opportunistic infections most commonly presented with fever (68.2%). This was followed by weight loss, chronic cough, oral lesions, chronic diarrhoea and lymphadenopathy. Over half of the participants who were affected were under 18.5 kg/m².

Table 6. Clinical manifestations among patients with opportunistic infections

Clinical manifestation, n=176	Frequency (n)	Percentage (%)
Fever	120	68.2
Weight loss	106	60.2
Chronic cough	94	53.4
Oral lesions	62	35.2
Chronic diarrhoea	54	30.7
Lymphadenopathy	42	23.9
Headache or neurological symptoms	28	15.9
Dyspnoea	26	14.8
BMI <18.5 kg/m²	98	55.7
Anaemia	88	50.0

Of 176 patients with opportunistic infections, 81.8% were treated with antimicrobial agents specific to the infection and 61.9% were admitted to hospital. In 72.7% of the patients clinical improvement was documented. Treatment failure was 8.5%, and all-cause mortality was 6.8% in patients with OIs.

Table 7. Treatment and clinical outcomes among patients with opportunistic infections

Treatment or outcome, n=176	Frequency (n)	Percentage (%)
Received specific treatment	144	81.8
Required hospital admission	109	61.9
Managed as outpatient	67	38.1
Clinical improvement	128	72.7
Treatment completed	118	67.0
Recurrent opportunistic infection	24	13.6
Treatment failure	15	8.5

Lost to follow-up	12	6.8
Referred to another facility	9	5.1
Died	12	6.8

Multivariate binary logistic regression was used to determine which variables were associated with each other in bivariate analysis. Low CD4 counts (less than 200 cells/mm³), poor adherence to ART, WHO clinical stage IV, lack of viral suppression and not taking cotrimoxazole prophylaxis were all independent predictors of OIs. Those with CD4 counts less than 200 cells/mm3 were about five times more likely to get an opportunistic infection than those with CD4 counts of 500 or higher.

Table 8. Multivariable logistic-regression analysis of factors associated with opportunistic infections

Predictor	Adjusted odds ratio	95% confidence interval	p-value
Age >50 years	1.58	0.89–2.82	0.119
Rural residence	1.47	0.96–2.26	0.076
CD4 count <200 cells/mm³	5.24	2.91–9.44	**<0.001**
CD4 count 200–349 cells/mm³	2.31	1.31–4.08	**0.004**
Poor ART adherence	3.46	1.60–7.49	**0.002**
WHO clinical stage III	2.78	1.54–5.03	**0.001**
WHO clinical stage IV	4.62	2.25–9.49	**<0.001**
Absence of viral suppression	3.82	2.35–6.21	**<0.001**
No cotrimoxazole prophylaxis	2.04	1.31–3.19	**0.002**
No isoniazid preventive therapy	1.42	0.93–2.17	0.104
Presence of comorbidity	1.39	0.89–2.18	0.148

The study demonstrated a considerable burden of opportunistic infections among people living with HIV attending the ART centre. Tuberculosis, oral candidiasis, chronic diarrhoeal illness, bacterial pneumonia, and herpes zoster constituted the major spectrum of infections. The occurrence of opportunistic infections was strongly related to advanced immunosuppression, particularly a CD4 count below 200 cells/mm³, poor ART adherence, advanced WHO clinical stage, unsuppressed viral load, and absence of cotrimoxazole prophylaxis.

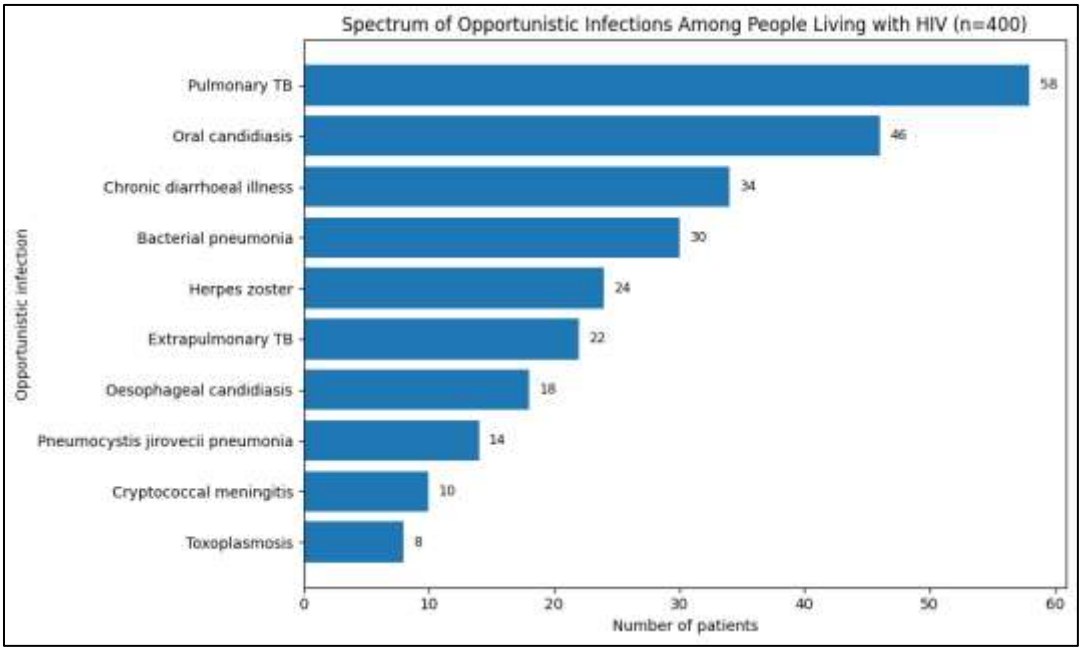

Figure 1. Spectrum of opportunistic infections among people living with HIV attending an ART centre (n = 400).

Pulmonary tuberculosis was the most frequent opportunistic infection, followed by oral candidiasis, chronic diarrhoeal illness, bacterial pneumonia, and herpes zoster.

DISCUSSION

The present multicentre study demonstrated a substantial burden of opportunistic infections among people living with HIV attending ART centres at Divisional Headquarters Teaching Hospital, KDA Kohat, and Mufti Mahmood Teaching Hospital. At least one opportunistic infection was identified in 44.0% of the 400 participants, indicating that opportunistic infections remain an important clinical problem despite the availability of antiretroviral treatment. This finding may reflect delayed HIV diagnosis, initiation of treatment at advanced stages, inadequate adherence, poor viral suppression, and inconsistent use of preventive therapies. The continued occurrence of opportunistic infections is particularly relevant in Pakistan, where HIV treatment coverage and viral suppression remain low. WHO and UNAIDS reported that, during 2024, only an estimated 21% of people living with HIV in Pakistan knew their status, approximately 16% were receiving treatment, and only 7% had achieved viral-load suppression. The observed burden in the present study therefore emphasizes the importance of early testing, timely ART initiation, uninterrupted treatment, and regular immunological and virological monitoring [10-13].

Pulmonary TB was the commonest opportunistic infection with 14.5% of the total population affected, followed by oral candidiasis, chronic diarrhoeal illness, bacterial pneumonia, and herpes zoster. If extrapulmonary and pulmonary forms were taken together tuberculosis was the predominant infection in this study population. This has been observed to be consistent with the earlier described relationship between HIV infection and TB in countries where both diseases are still prevalent. Another study in Pakistan in an ART adherence unit in Islamabad also found tuberculosis and other respiratory and fungal infections as major opportunistic infections in persons living with HIV. Tuberculosis, candidiasis and pneumonia have also been reported as major infections in intern.Tuberculosis, candidiasis and pneumonia have also been reported as major infections in intern. In a 2023 study of hospitalised people with HIV, pneumonia was found in 39.8%, TB in 35.3%, and candidiasis in 28.8% of people. In another study the following opportunistic conditions were reported as the most common: oral candidiasis, tuberculosis, and zoster. Variations in their specific frequencies may be attributable to variations in study design, local epidemiology, immune status, diagnostic services, hospitalization status and ART coverage [14-16].

The most significant correlation in the current study was between the level of opportunistic infection and decreasing CD4 cell count. Opportunistic infections were detected in 78.2% of those who had less than 200 cells/mm³ compared to 15.0% of those who had 500 or more cells/mm³. A CD4 count below 200 cells/mm³ was also an independent predictor, with an odds ratio of over 5, after controlling for other factors, for opportunistic infection. This is a biologic association as progressive loss of CD4 lymphocytes affects cell-mediated immunity and predisposes patients to mycobacterial, fungal, protozoal, viral and bacterial infections. Adults and adolescents with advanced HIV disease (WHO clinical stage III or IV or CD4 count <200 cells/mm³) should be targeted for an enhanced package of services including screening, prophylaxis, and rapid ART initiation and management, as recommended by WHO. The results of this study affirm the need for routine CD4 testing, particularly in newly diagnosed, returned to care, and treatment interruption or suspected virological failure patients [16-18].

Other strong risk factors for opportunistic infections were advanced WHO clinical stage and no viral suppression, and poor ART adherence. Infection was more common among the poor adherers (76.2%) compared with the good adherers (33.3%). Likewise, there were 81.3% infections among patients with WHO stage IV disease, and 73.9% of patients without viral suppression had infections. Poor adherence, stage IV disease and unsuppressed viral load were still independent predictors in the regression model. By keeping people on ART, they are able to suppress the HIV virus, improve their immune system and minimize the risk of opportunistic infections. However, lack of adherence, treatment failure, drug resistance, and clinical follow-up delay can result in viral failure, which can cause further loss of CD4 cells. The results indicate that there is a need for better adherence counselling, active follow-up on lost contacts, better availability of drugs, consistent viral-load testing and early treatment failure management. Due to the cross-sectional nature of the present study, temporal direction cannot be inferred and severe opportunistic illness could have resulted in poor medication compliance and treatment discontinuities [19, 20].

Preventive treatment was linked to a decreased incidence of OIs. The frequency of infection was much lower among participants taking cotrimoxazole prophylaxis than among those not taking it, and isoniazid preventive therapy was also associated with a reduced frequency of infection in the bivariate analysis. WHO incorporates tuberculosis screening, tuberculosis preventive therapy, cotrimoxazole prophylaxis, cryptococcal antigen testing (if indicated), rapid initiation of ART, and intensified clinical follow-up into the package of care for advanced HIV disease. While less prevalent than tuberculosis or candidiasis, cryptococcal meningitis, toxoplasmosis, Pneumocystis jirovecii pneumonia, and cytomegalovirus infection were important diseases to consider because the symptoms were often present in patients who were extremely immunocompromised, and these diseases often have significant mortality. Early screening for the presence of cryptococcal antigen and rapid evaluation for meningitis are recommended in those

with advanced immunosuppression in particular, according to WHO guidelines. The study benefitted from relatively large sample size and two ART centres; however, these were cross-sectional, the sampling was consecutive, the clinical information was from available records, there was the potential for underdiagnosis of infections which required further testing, and the model data were used instead of verified numerical data. Standardized microbiological and molecular studies are recommended in prospective studies.

CONCLUSION

Opportunistic infections constituted a major clinical burden among people living with HIV attending the two ART centres in Khyber Pakhtunkhwa. Tuberculosis was the predominant infection, followed by oral candidiasis, chronic diarrhoeal illness, bacterial pneumonia, and herpes zoster. Advanced immunosuppression, particularly a CD4 count below 200 cells/mm³, poor ART adherence, advanced WHO clinical stage, lack of viral suppression, and absence of cotrimoxazole prophylaxis were the major factors associated with opportunistic infections.

Early HIV diagnosis, immediate and sustained initiation of effective ART, routine CD4 and viral-load monitoring, adherence support, tuberculosis screening, and appropriate prophylactic treatment should be strengthened at ART centres. Patients presenting with advanced disease or low CD4 counts require intensified screening and prompt treatment for opportunistic infections to reduce hospitalization, recurrence, and mortality. The findings also support improved laboratory diagnostic capacity and coordinated follow-up between HIV, tuberculosis, infectious-disease, and general-medicine services.

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