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Analysis of clinical characteristics and risk factors for in-hospital death among HIV co-infected tuberculosis patients in ethnic minority areas of Sichuan Province, China

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Research Article

Keywords: HIV, AIDS, Tuberculosis, HIV-TB co-infection, in-hospital mortality, risk factors, ethnic minority

Posted Date: November 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11591690/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

HIV-tuberculosis (HIV-TB) co-infection contributes substantially to inpatient mortality, especially in ethnic minority-concentrated high-burden regions of southwest China. Real-world clinical evidence focusing on multi-ethnic HIV-TB co-infected inpatients remains limited, and independent predictors for in-hospital death require further clarification for local clinical practice.

Methods

A retrospective single-center cohort study was performed among HIV-TB co-infected inpatients admitted between 2017 and 2025, whose admissions originated from Liangshan, Garzê and Ngawa prefectures in Sichuan Province. Demographic, clinical, laboratory and treatment-related data were extracted from electronic medical records. Primary endpoint was in-hospital death; composite adverse outcome combining in-hospital death and non-medical self-discharge was applied for sensitivity analysis. Univariable and multivariable binary logistic regression were used to identify independent risk factors for in-hospital mortality. Subgroup analyses were conducted across tuberculosis subtypes and ethnic populations.

Results

A total of 3093 HIV-TB co-infected hospitalized patients were enrolled, among whom 104 (3.36%) experienced in-hospital death. Multivariable logistic regression demonstrated that critical condition upon admission (adjusted odds ratio [aOR] = 2.260, 95%CI:1.360-3.760, $P = 0.002$), sepsis (aOR = 7.430, 95%CI:4.310-12.830, $P < 0.001$), respiratory failure (aOR = 4.720, 95%CI:2.980-7.480, $P < 0.001$), Pneumocystis jirovecii pneumonia (PCP, aOR = 4.490, 95%CI:2.830-7.130, $P < 0.001$), tuberculous meningitis (aOR = 2.280, 95%CI:1.230-4.200, $P = 0.008$), candidiasis (aOR = 2.330, 95%CI:1.500-3.630, $P = 0.002$), renal failure (aOR = 3.110, 95%CI:1.320-7.320, $P = 0.009$), hypoproteinemia (aOR = 1.760, 95%CI:1.100-2.820, $P = 0.018$), and carbapenem usage (aOR = 1.630, 95%CI:1.040-2.560, $P = 0.033$) were independent risk factors for in-hospital mortality. Subgroup analyses revealed ethnic disparities in mortality. Patients with high-burden mixed opportunistic infections displayed significantly worse short-term survival ($P < 0.0001$). Sensitivity analysis validated the robustness of the above findings.

Conclusion

In-hospital death among HIV-TB co-infected patients in multi-ethnic regions of Sichuan is driven by admission critical status, severe opportunistic infections, sepsis, organ dysfunction and hypoproteinemia. Early identification of high-risk patients based on these predictors may facilitate risk

stratification and improve inpatient management and clinical outcomes in high-burden ethnic minority areas.

Introduction

- Tuberculosis (TB) is the leading cause of death among people living with HIV (PLWH) worldwide[1]. HIV-TB co-infection accelerates disease progression and worsens clinical outcomes [2]. Despite advances in antiretroviral therapy and TB control, co-infected patients remain at high risk of severe opportunistic infections, extrapulmonary TB, rapid deterioration and in-hospital death, especially in resource-limited high-burden regions.In China, HIV-TB co-infection exhibits prominent regional heterogeneity. Sichuan in southwest China carries a heavy dual epidemic burden, with cases concentrated among Yi and Tibetan minorities [3]. Delayed presentation, advanced disease at admission, superimposed infections and complex comorbidities complicate inpatient management. Previous studies on mortality predictors mainly rely on immune biomarkers, while real-world inpatient data for these ethnic populations are scarce. Few reports systematically compare clinical profiles and mortality risks between isolated pulmonary TB and extrapulmonary TB among HIV-infected patients [4].
- Retrospective electronic medical records support real-world assessment of clinical features and short-term prognosis even with incomplete laboratory data. In-hospital mortality reflects acute disease severity and care quality. Non-medical self-discharge is frequent in critically ill patients in these minority areas, which may underestimate true mortality and requires sensitivity analysis for reliable interpretation. This study aimed to characterize demographic and clinical profiles, co-infection spectrum, complications and inpatient outcomes of HIV-TB co-infected patients from ethnic minority-concentrated regions of Sichuan. Multivariable logistic regression identified independent risk factors for in-hospital mortality. Subgroup analyses compared clinical features and mortality across TB subtypes and ethnic groups (Han, Yi, Tibetan). Sensitivity analysis incorporating non-medical discharge as composite adverse outcomes validated result stability. Our findings may aid risk stratification and optimize inpatient management for HIV-TB co-infected patients in high-burden ethnic regions of southwest China.

Materials and Methods

Study setting and study population

- This retrospective single-centre hospital-based cohort study included HIV-TB co-infected inpatients admitted from 2017 to 2025. Participants were from high-burden regions in Sichuan Province, including Liangshan, Garzê and Ngawa prefectures with dense Yi and Tibetan populations.
- Patients were included if they: (1) had an inpatient diagnosis of HIV/AIDS; (2) had concurrent tuberculosis (including pulmonary, haematogenous disseminated, tuberculous meningitis, pleurisy,

abdominal, osteoarticular and lymph node tuberculosis); (3) had complete demographic and discharge outcome data.

- Exclusion criteria: (1) non-tuberculous mycobacterial infection without tuberculosis; (2) repeated hospitalisations of the same individual; only the first admission per medical record number was kept; (3) missing core discharge outcome information (Fig. 1).

Variables definition

- Data were abstracted from electronic medical records, covering demographics, hospitalisation information, disease characteristics, interventions and discharge endpoints. Demographic variables included age (continuous and categorical: <18, 18-40, 41-60, > 60 years), sex, ethnicity, marital status, geographic origin and occupation. Hospitalisation-related variables comprised admission year, admission route, admission condition, length of hospital stay, severe/critical illness notification and resuscitation events.
- Tuberculosis was classified as isolated pulmonary tuberculosis or extrapulmonary tuberculosis (including tuberculous meningitis). Opportunistic infections, severe complications and comorbidities. Treatment-related variables (antibiotics, antifungals, invasive procedures, lumbar puncture, mechanical ventilation, blood transfusion) were also coded dichotomously.
- The primary outcome was in-hospital death. Non-medical discharge against medical advice and physician-approved discharge were treated as survival in the main analysis. A composite adverse outcome (in-hospital death combined with non-medical discharge) was constructed for sensitivity analysis. $CD4^+$ T-cell counts, HIV viral load, antiretroviral therapy records and tuberculosis drug susceptibility results were unavailable; only short-term in-hospital outcomes were evaluated.

Statistical Analysis

- All analyses were performed in SPSS 26.0 and R. A two-sided $P < 0.05$ indicated statistical significance. Continuous variables were presented as mean ± standard deviation (normal distribution) or median (interquartile range) (non-normal distribution). Categorical variables were summarised as n (%). Group comparisons adopted χ^2 test (Fisher's exact test where appropriate), t-test or Mann-Whitney U test. Multivariable binary logistic regression identified independent risk factors for in-hospital death. Variables with $P < 0.2$ in univariate analysis entered the initial model. Five clinically important variables (critical admission, tuberculous meningitis, sepsis, respiratory failure, mechanical ventilation) were forced into the model irrespective of univariate *P* values. Adjusted odds ratios (aOR), 95% confidence intervals (CI) and *P* values were reported, with the Hosmer-Lemeshow test for model fit.
- Subgroup comparisons were conducted between isolated pulmonary and extrapulmonary TB groups, as well as among Han, Yi and Tibetan patients. Only descriptive analyses were performed for tuberculous meningitis patients when sample size was insufficient for regression. Sensitivity analysis was implemented using composite adverse outcomes to assess result robustness. Cases

with missing key outcomes were excluded. List-wise deletion was applied for variables with missing rate < 5%, and multiple imputation for 5–20% missingness.

Results

Baseline characteristics of patients with HIV combined with TB

This study enrolled 3,093 patients with HIV-TB co-infection: 2,989 (96.64%) survived to discharge, and 104 (3.36%) died during hospitalization. Baseline features of the whole cohort and subgroups stratified by in-hospital survival are summarized in Table 1.

Table 1. Baseline clinical characteristics of the HIV-TB co-infected inpatients.

Most patients were male (80.31%). Age distribution was concentrated in 18–40 (41.03%) and 41–60 (41.38%) years; 16.52% were older than 60 years. The majority were Han Chinese (74.88%), followed by Yi (15.65%) and Tibetan (8.50%). 67.70% came from inland prefecture-level cities of Sichuan, and 65.28% were married. On admission, 24.86%, 28.65%, and 46.49% were critical, urgent, and general cases, respectively. Median hospital stay was 20.46 days, and 71.42% were assessed as severe or critical during hospitalization. The predominant opportunistic infections included candidiasis (14.42%), PCP (7.69%), and tuberculous meningitis (6.08%); 3.94% had ≥ 2 opportunistic infections. Common comorbidities were hypoproteinemia (40.77%), moderate-to-severe anemia (36.24%), hepatic insufficiency (18.04%), respiratory failure (11.61%), agranulocytosis (10.41%), and sepsis (3.59%). Invasive procedures (66.12%), triazole antifungals (22.31%), and carbapenems (16.81%) were widely applied.

Multiple baseline variables differed significantly between survivors and non-survivors. Non-survivors were more likely to be aged > 60 years, Han ethnicity, and from inland Sichuan (all $P < 0.05$). They had a higher proportion of critical admission status and in-hospital severe/critical alerts (both $P < 0.001$). Non-survivors also showed higher prevalence of PCP, tuberculous meningitis, sepsis, respiratory failure, renal failure, moderate-to-severe anemia and hypoproteinemia (all $P < 0.05$). Carbapenem and triazole antifungal use was more frequent among non-survivors ($P < 0.001$). No intergroup differences were observed in sex, marital status, length of stay, cryptococcosis, talaromyces marneffei, cytomegalovirus infection, toxoplasmosis, agranulocytosis or hepatic insufficiency (all $P > 0.05$). Univariate comparison for in-hospital mortality

Multivariate logistic regression for in-hospital mortality

To identify independent predictors of in-hospital mortality, a multivariate logistic regression analysis was performed, adjusting for variables that were significant in the univariate analysis (Table 1) and clinically relevant confounders.

Several factors emerged as independent risk factors for in-hospital death. Admission critical status significantly increased the risk of mortality (adjusted OR [aOR] 2.260, 95% CI 1.360–3.760, $P = 0.002$), as did sepsis (aOR 7.430, 95% CI 4.310–12.830, $P < 0.001$) and respiratory failure (aOR 4.720, 95% CI 2.980–7.480, $P < 0.001$). Among opportunistic infections, Pneumocystis jirovecii pneumonia (PCP; aOR 4.490, 95% CI 2.830–7.130, $P < 0.001$), tuberculous meningitis (aOR 2.280, 95% CI 1.230–4.200, $P = 0.008$), and candidiasis (aOR 2.330, 95% CI 1.500–3.630, $P = 0.002$) were independently associated with in-hospital death. Renal failure (aOR 3.110, 95% CI 1.320–7.320, $P = 0.009$) and hypoproteinemia (aOR 1.760, 95% CI 1.100–2.820, $P = 0.018$) also independently predicted mortality. In addition, the use of carbapenem antibiotics was an independent risk factor for death (aOR 1.630, 95% CI 1.040–2.560, $P = 0.033$). In contrast, co-infection with ≥ 2 kinds of opportunistic infections did not reach statistical significance after adjustment (aOR 1.890, 95% CI 0.910–3.910, $P = 0.087$). The results are presented in Fig. 2.

Table 2. Comparison of clinical characteristics among HIV-TB co-infected patients in different ethnic groups.

Subgroup Analysis of Factors Associated with In-Hospital Mortality

The bar chart presents the in-hospital mortality rates of different ethnic groups. It shows that the mortality rates of other ethnic groups and the Han ethnicity are relatively high, revealing certain racial differences in mortality rates among HIV-TB co-infected patients (Fig. 3).

The composition ratios of opportunistic infections between the survival group and the death group were further compared through a pie chart. The results showed that severe opportunistic infections were significantly enriched in the non-survivors (Fig. 4). Kaplan–Meier survival analysis stratified patients according to the burden of mixed opportunistic infections. Patients with a low infection burden maintained a high survival probability within 150 days, whereas those with a high burden of mixed opportunistic infections exhibited a continuously declining survival trend. The difference in short-term survival between the two groups was statistically significant ($P < 0.0001$), indicating that heavy mixed opportunistic infection burden serves as a strong adverse prognostic factor for hospitalized HIV-TB patients (Fig. 5). Consistent with the above findings, the heatmap analysis visually reflects the distinct distribution patterns of opportunistic infections and severe complications between survivors and non-survivors. Multiple severe infections and organ dysfunctions were prominently concentrated in the death group, further confirming that complicated co-infection status and systemic deterioration were closely associated with increased in-hospital mortality (Fig. 6).

Discussion

- This retrospective real-world cohort study enrolled 3093 hospitalized HIV-TB co-infected patients from multi-ethnic high-burden regions of Sichuan Province, yielding an overall in-hospital mortality of 3.36%. We identified multiple independent risk factors for inpatient death, including critical

admission status, sepsis, respiratory failure, key opportunistic infections (PCP, tuberculous meningitis, candidiasis), renal failure, hypoproteinemia, and carbapenem antibiotic exposure. Further subgroup and survival analyses highlighted the prognostic importance of mixed opportunistic infection burden and revealed ethnic heterogeneity in mortality profiles among HIV-TB co-infected individuals. These observations provide locally-relevant evidence for clinical risk stratification and hospital-based care optimization in southwest China.

- Consistent with existing global reports, severe clinical presentation at admission remained a powerful predictor of poor prognosis for HIV-TB co-infected patients [5, 6]. Patients admitted in critical condition often present with advanced immune impairment, multiple overlapping infections and decompensated organ function. In resource-limited ethnic minority regions, delayed healthcare-seeking behaviour, long-distance transportation and insufficient pre-hospital care frequently contribute to late-stage admission, partially explaining the high proportion of severe cases in our cohort. Early screening for HIV and tuberculosis at primary healthcare facilities in Liangshan, Garzê and Ngawa should be strengthened to reduce advanced-stage hospital admissions [7].
- Opportunistic infections constitute major drivers of mortality among people living with HIV complicated with tuberculosis [8]. In our study, PCP, tuberculous meningitis and candidiasis were independently associated with elevated in-hospital death risk. Pneumocystis jirovecii pneumonia triggers severe hypoxaemia and acute respiratory failure, which is life-threatening in HIV-infected hosts with poor immune status. Tuberculous meningitis represents the most fatal subtype of extrapulmonary tuberculosis; complex intracranial inflammation, cerebral oedema and neurological complications substantially increase inpatient fatality, even under standardized anti-tuberculosis treatment [6, 9]. Notably, although patients with two or more concurrent opportunistic infections did not reach statistical significance in multivariate adjustment, Kaplan-Meier curves demonstrated that high mixed-infection burden was strongly linked to worse short-term survival. This discrepancy may result from mutual confounding among different opportunistic infection types in regression models, indicating that clinicians should comprehensively evaluate the overall infection burden rather than merely counting infection numbers[8].
- Sepsis, respiratory failure, renal failure and hypoproteinemia emerged as strong independent risk factors in our analysis. HIV-TB co-infection triggers excessive inflammatory activation, which can progress to sepsis and sequential multiple-organ injury [10, 11]. Hypoproteinemia reflects long-term disease consumption, malnutrition and chronic inflammation, and further aggravates immune dysfunction and poor drug tolerance, forming a vicious cycle. Our findings underline the necessity of timely organ-function support, nutritional intervention and inflammatory-status monitoring during hospitalization. Carbapenem usage was independently correlated with higher in-hospital mortality in this cohort. This association should be interpreted cautiously: carbapenem exposure is not a direct causal risk factor, but acts as a surrogate marker for severe bacterial infection, critical illness and complicated comorbid conditions in clinical practice.

- Ethnic subgroup analysis suggested mortality disparities among Han, Yi and Tibetan patients in this cohort. Local socioeconomic characteristics, accessibility of medical services, health-seeking habits and differences in disease awareness may jointly contribute to such inter-ethnic variations. Non-medical self-discharge is common in these mountainous minority areas, which potentially underestimates true mortality [12]. Therefore, we constructed composite adverse outcomes for sensitivity analysis and verified the stability of our core results. This analytical strategy is of great practical value for real-world clinical research in similar high-burden resource-limited settings.
- Several limitations of this study should be acknowledged. First, as a single-centre retrospective study based on electronic medical records, $CD4^+$ T-cell counts, HIV viral load and anti-retroviral therapy information were not available, so we could not evaluate the modifying effect of immune status and ART on inpatient prognosis. Second, we focused only on short-term in-hospital endpoints; long-term survival after discharge could not be assessed. Third, despite sensitivity analysis for non-medical discharge, residual selection bias cannot be fully excluded. Fourth, lack of uniform tuberculosis drug susceptibility data restricted our ability to analyse the impact of drug-resistant tuberculosis on mortality.
- In summary, HIV-TB co-infected patients admitted with critical illness, complicated opportunistic infections, sepsis, respiratory or renal dysfunction and hypoproteinemia carry substantially higher risk of in-hospital death in multi-ethnic regions of Sichuan. Clinical teams can implement risk stratification according to these readily-available clinical indicators upon admission. Integrated management strategies including early opportunistic-infection screening, timely organ-support therapy and nutritional support are expected to reduce inpatient fatality. Future multi-centre prospective studies incorporating immune biomarkers and follow-up after discharge are required to further improve care for HIV-TB co-infected populations in southwest China.

Abbreviations

TB Tuberculosis

- PLWH people living with HIV

PHCC Public Health Clinical Center of Chengdu

- PCP pneumocytsis carinii pneumonia

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Public Health Clinical Center of Chengdu (China) under the approval number YJ-K2025-08-01. All methods/study procedures were carried out in

accordance with the Helsinki Declaration of the World Medical Association in 2024. As a retrospective study utilizing routinely collected patient data from the mandatory notification system, the Ethics Committee waived the requirement for informed consent.

Consent for publication

Not applicable

Competing interests

The authors declare no competing interests.

Clinical trial number

not applicable.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study was supported by 2023 Chengdu Medical Research Project, Sichuan, China (202311013240) (to D-MW).

Author Contribution

YL is the corresponding author. DMW: first draft writing, review, editing, conceptualization, methodology, data acquisition; XSF and QA: data acquisition, review and editing YL: conceptualization, review, editing, methodology and supervision.

Acknowledgement

The authors would like to thank Dr. Yi Liao for his valuable guidance on the experimental design and critical revision of the manuscript. Thank Dr Qi An for technical support and assistance with the data analysis.

Data Availability

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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Tables

Table 1 and 2 are available in the Supplementary Files section.

Figures

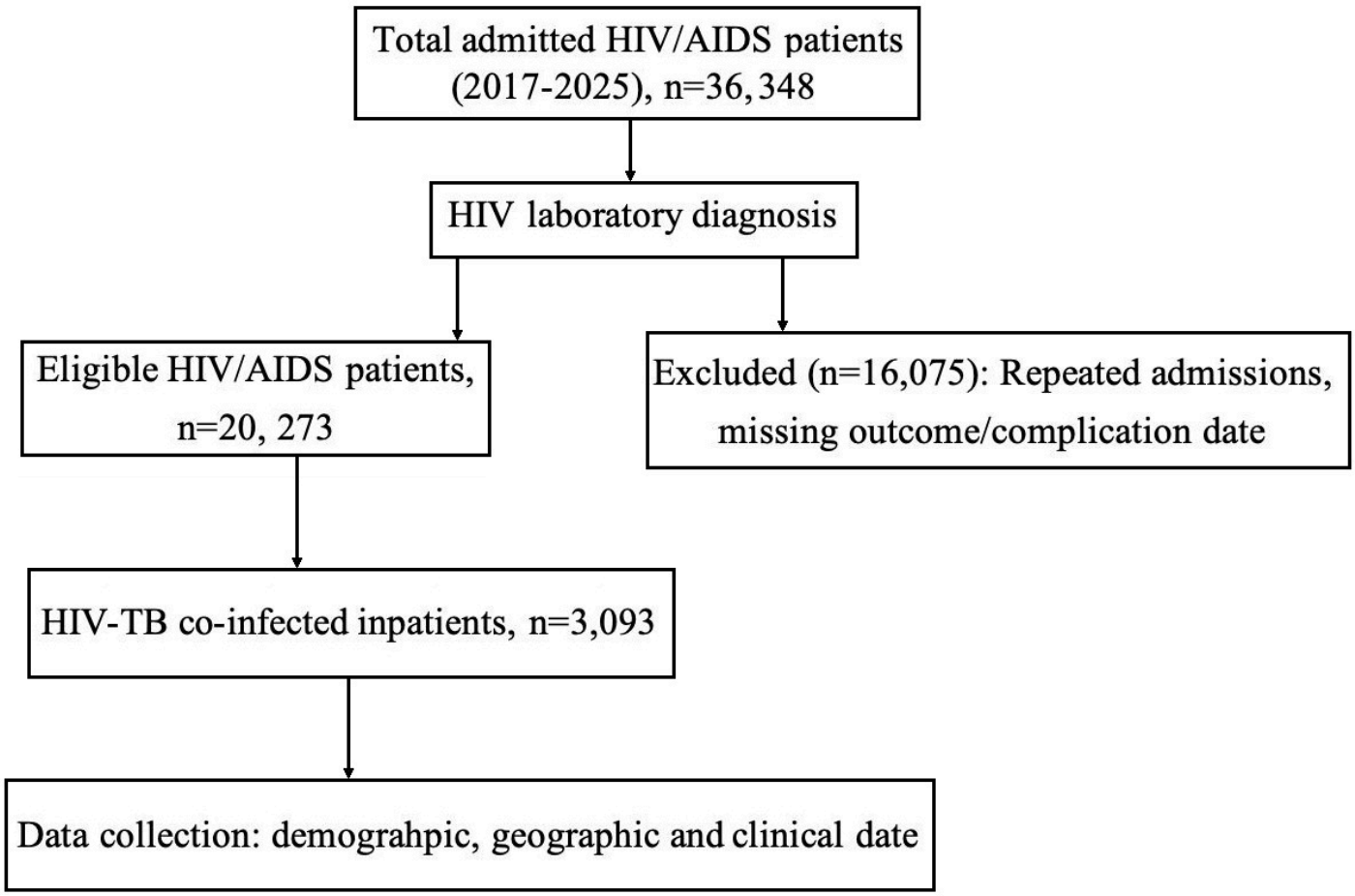


Figure 1

The flow diagram of our study. Demographic information and clinical data was reviewed from the Public Health Clinical Center of Chengdu, Sichuan, China.

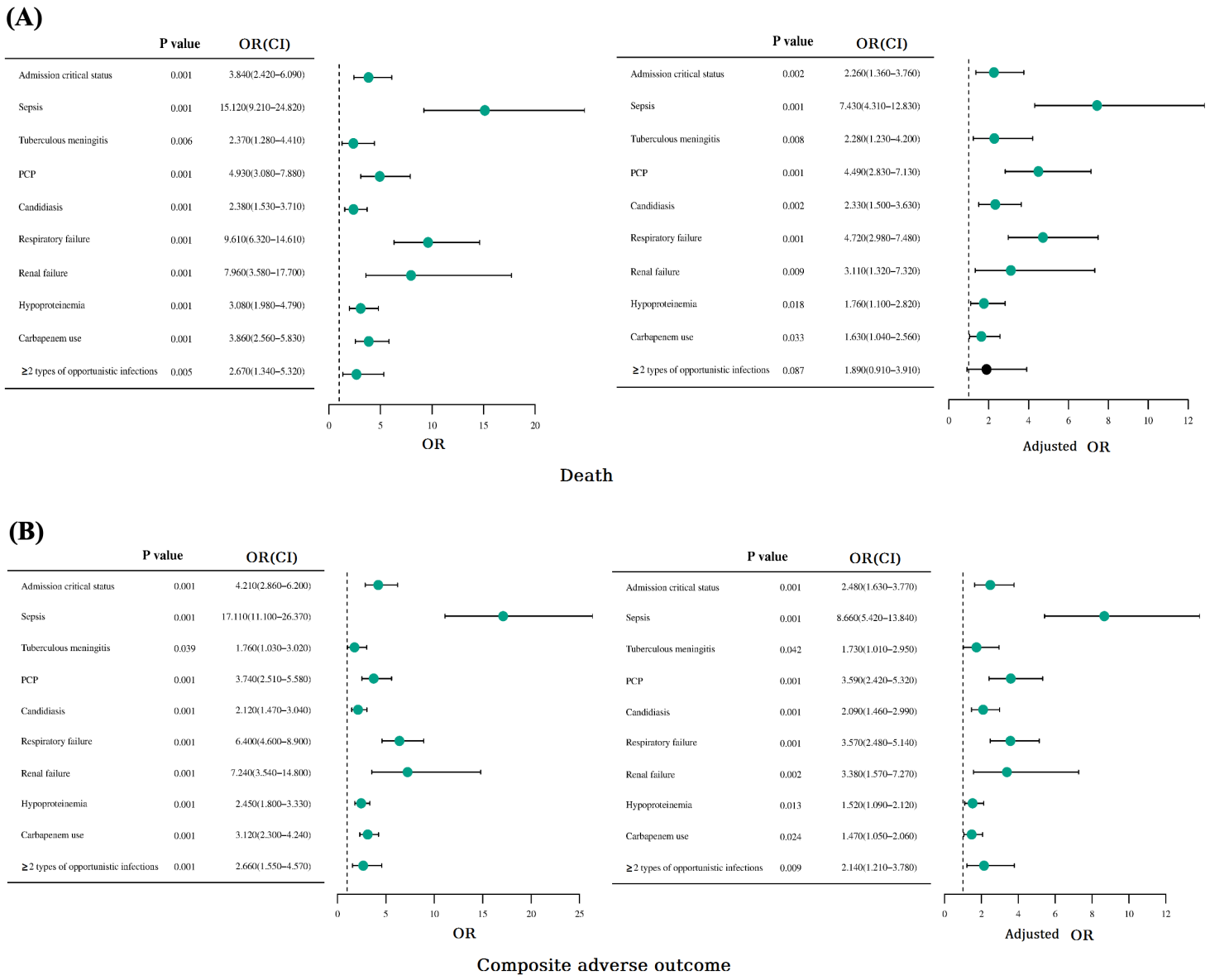


Figure 2

Forest plot of multivariate logistic regression analysis for risk factors of in-hospital mortality

and composite adverse outcome. Adjusted odds ratios (aOR) and corresponding 95% confidence intervals

were presented. The vertical line at OR=1 indicates no significant association.

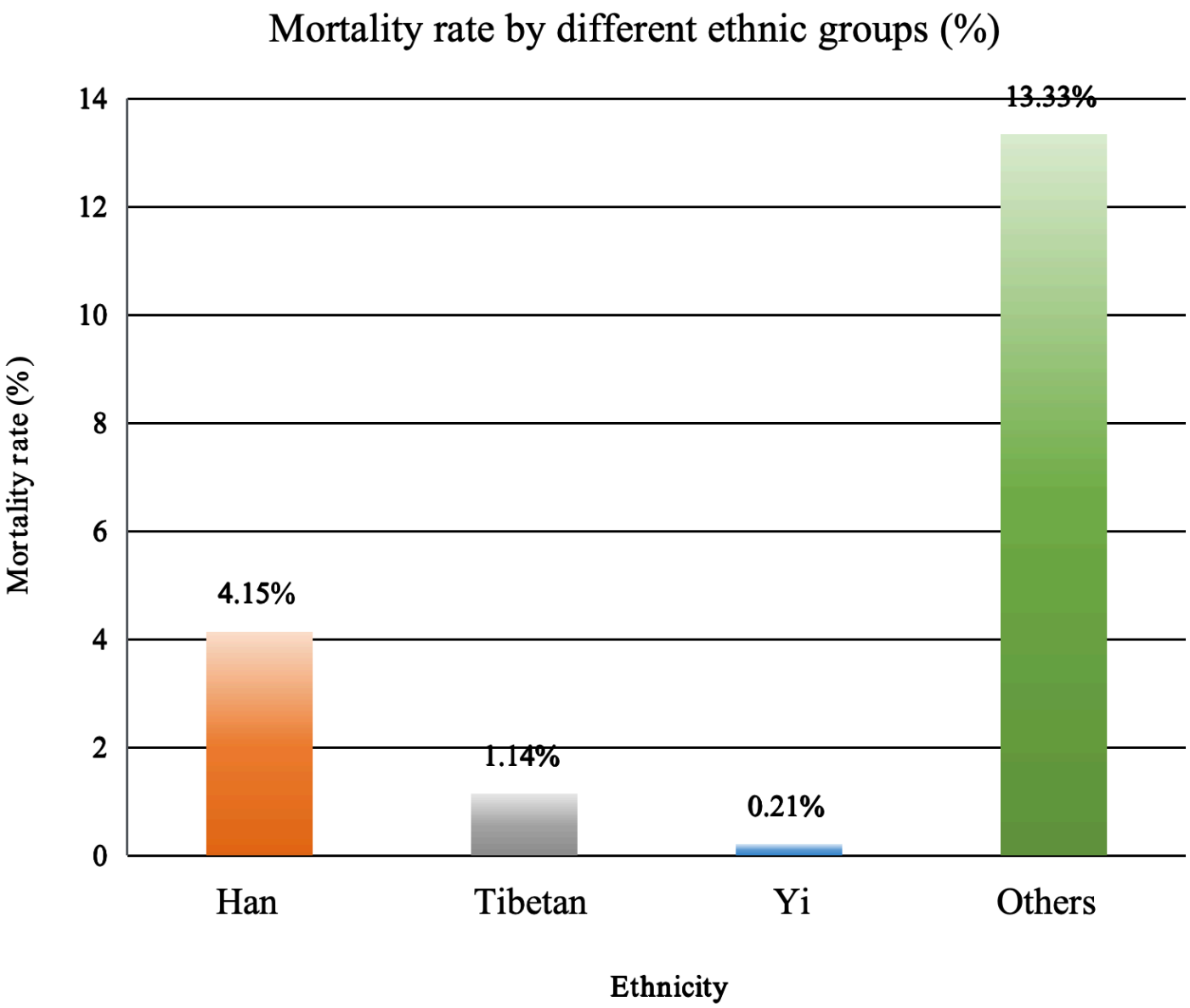


Figure 3

Comparison of in-hospital mortality rates of patients with both AIDS and tuberculosis among different ethnic groups.

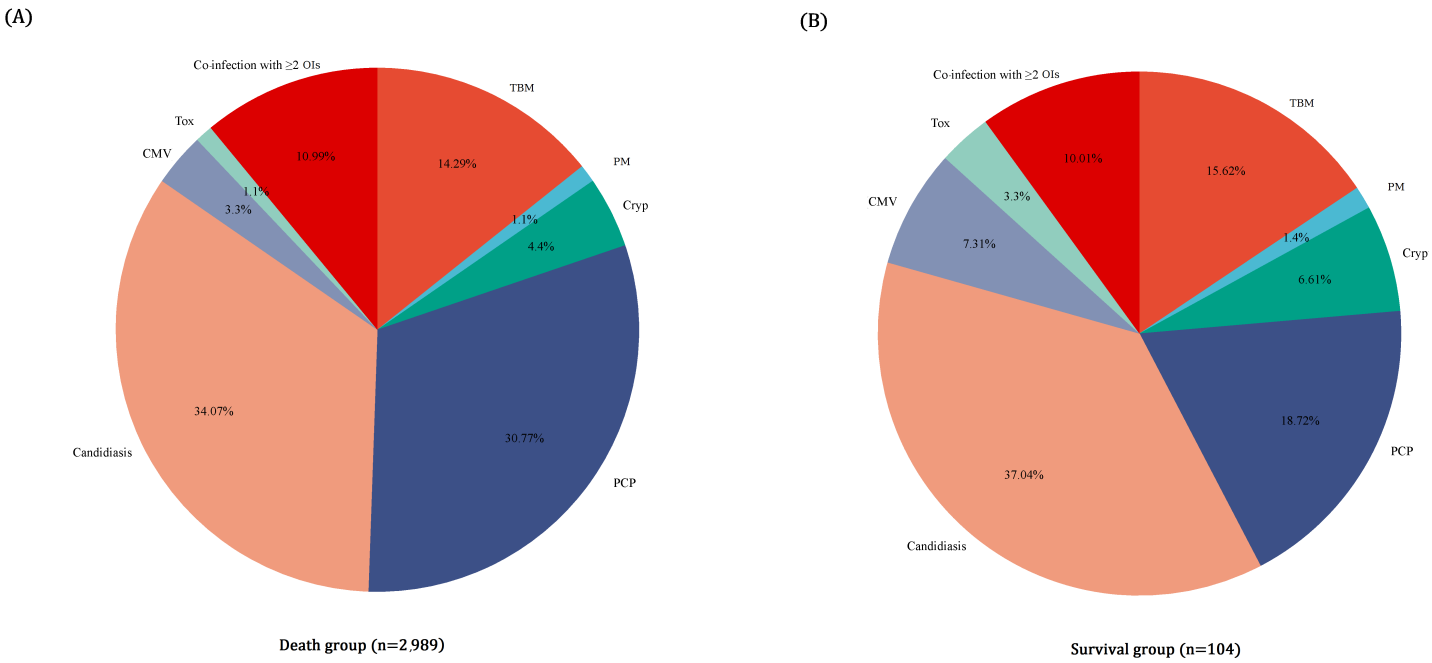


Figure 4

Composition of opportunistic infections in the death group and survival group of patients with HIV combined with tuberculosis.

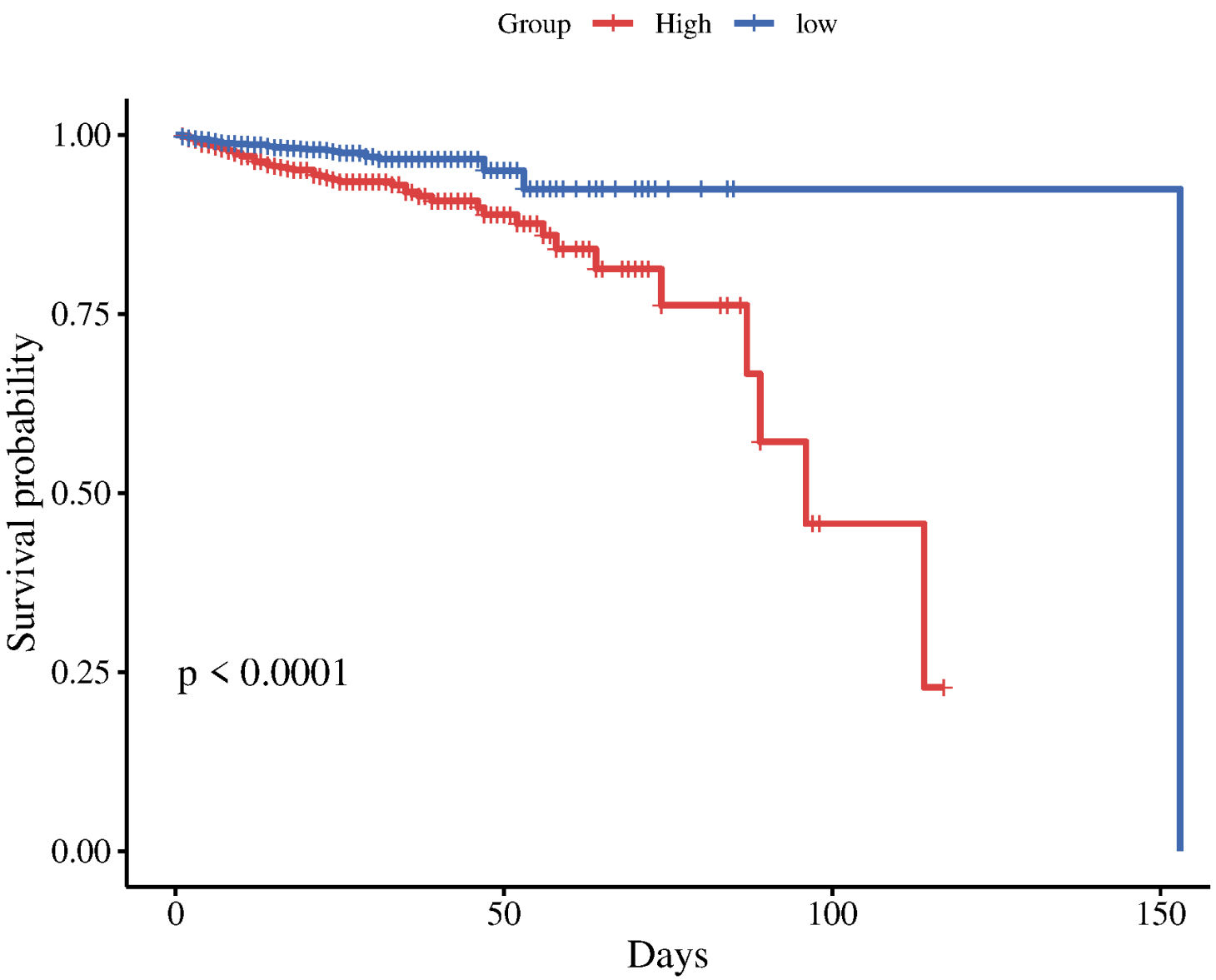


Figure 5

Kaplan-Meier survival analysis was performed to compare survival between patients with high and low mixed opportunistic infections.

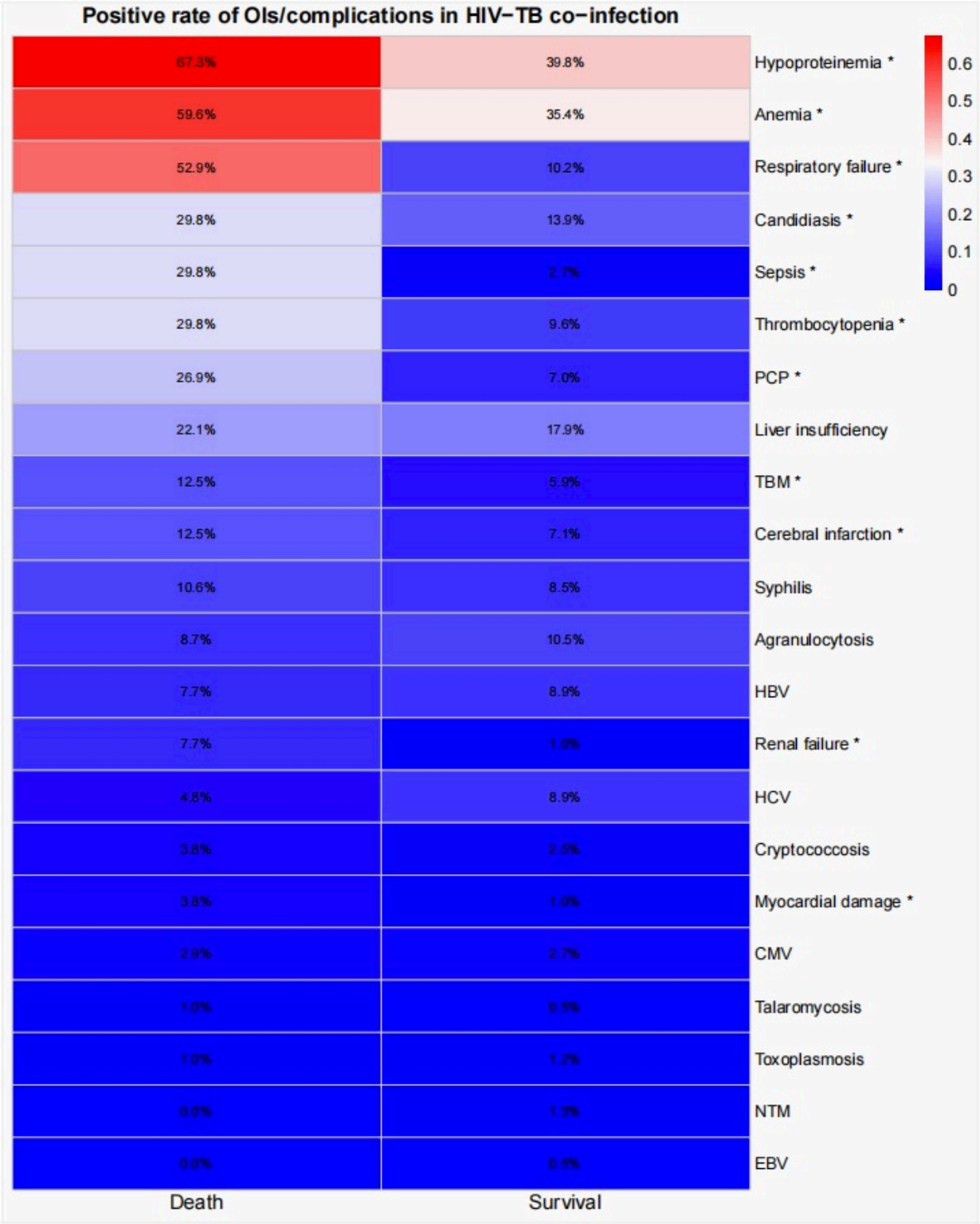


Figure 6

The heat map presenting various opportunistic infections, severe complications in the death group and survival group of patients with HIV combined with tuberculosis.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.xlsx
- Table2.xlsx