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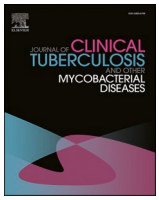

A predictive score for early in-patient tuberculosis mortality: A case-control study

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ABSTRACT

Introduction: In-hospital mortality rates for tuberculosis (TB) patients are high within the first seven days of admission. This study sought to identify predictors of early inpatient mortality and assess the performance of a predictive score for early mortality in a Ugandan tertiary hospital.

Materials and methods: A case-control study was conducted at Kiruddu National Referral Hospital in Kampala, Uganda. Cases included patients admitted with TB who died within seven days of admission, while controls survived beyond this period. Logistic regression was utilized to identify early mortality predictors. The performance of an adapted predictive score (**PROS** score) was evaluated, assigning scores based on the following criteria: **P**ulse rate >100 beats/min (1 point), **R**espiratory rate >20 breaths/min (2 points), **O**xygen saturation <92 % (4 points), and **S**ystolic blood pressure <90 mmHg (2 points).

Results: Of 602 hospitalized TB patients, 187 (31.0 %) died during admission. Among these, 78 (41.7 %) died within seven days. Wasting (adjusted odds ratio [aOR] = 5.76, 95 % confidence interval [CI] 2.12–15.63, p = 0.001) and respiratory rate >20 breaths/min (aOR = 2.89, 95 % CI 1.19–7.00, p = 0.019) predicted early mortality. PROS score of ≥1 demonstrated a sensitivity of 87.8 % and negative predictive value of 90.0 %. The ultimate TB treatment success rate of all hospitalized patients (n = 599) was 47.4 % with 275 (45.9 %) dying during TB treatment.

Conclusion: Early and long term mortality rates among hospitalized TB patients are high. Wasting and tachypnea predict early inpatient mortality. The PROS score could be useful in ruling out low-risk patients in low-resource settings.

1. Introduction

Tuberculosis (TB) is a leading causes of death from an infectious agent, only second to COVID-19 pneumonia [1]. In Africa, the TB treatment success rate (TSR) for drug susceptible TB is only 79 % and mortality contributes 48 % of the unfavorable treatment outcomes [2]. Strategies are needed to reduce TB-related mortality in order to achieve the ≥90 % TSR target set by the End TB Strategy [3]. About 11–68 % of TB inpatients die during hospitalization, although data from Africa is limited [4]. A few studies in Africa report an inpatient mortality rate ranging from 10 % in Papua New Guinea [5] to 25 % in Ethiopia [6]. Some evidence suggests that majority (32 %–78 %) of these inpatient deaths occur in the first seven days of admission [7–9]. Unfortunately, predictors and predictive scores of early (within seven days) inpatient mortality are not well described. Although overall TB mortality predictors are well-studied, predictors of early mortality often differ from those of long-term mortality, necessitating a clear delineation of early mortality predictors [10]. Additionally, the lack of a standardized definition for "early mortality" complicates comparisons across studies, which variously define early mortality as occurring within one week one week [11], 30-days [10], and two months [12]. We argue that adopting a seven-day cut-off offers a critical window for timely interventions to

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reduce mortality. In a study from India, hypoxemia, tachypnea, tachycardia, hypotension, severe malnutrition, severe anemia, hyponatremia, hypoproteinemia, hypercapnia and advanced chest X-ray abnormalities were associated with early inpatient mortality (within seven days) [13]. That study proposed a low-cost prognostic score for early inpatient mortality that demonstrated a high positive predictive value of 94.9 % and a negative predictive value of 19.9 %. However, only 1.6 % of the participants in that study were co-infected with HIV in contrast to the high TB/HIV co-infection rate in Africa (32 %) [14]. Therefore, these predictors and predictive score may not apply to TB/HIV high-burdened settings. Moreover, the inclusion of chest X-ray imaging findings in their score makes the score not widely applicable in low-resource settings that have no access to chest imaging. This necessitates a simpler score for low-resource settings.

Uganda is a TB and TB/HIV high-burdened country [15]. TB contributes more than 15 % of in-hospital deaths in Uganda [16]. Although data on the mortality rate of hospitalized TB patients in Uganda are scarce, one study reports mortality of 17 % among hospitalized children with TB [17]. This study aimed to identify predictors of early inpatient mortality among TB patients with drug susceptible TB at a tertiary hospital in Uganda and to assess the performance of an adapted predictive score (from Singla and colleagues [13]) for early inpatient mortality. Predictors of mortality and a robust predictive score can inform the patient risk stratification, escalation of care and specific interventions to improve hospital outcomes.

2. Methods

2.1. Study design and setting

This unmatched case-control study utilized retrospective data from Kiruddu National Referral Hospital (KNRH) in Kampala, Uganda. Cases consisted of TB patients who died within seven days of admission at KNRH, while controls were TB patients who survived beyond seven days. KNRH is a 200-bed tertiary hospital that diagnoses approximately 40–60 TB patients monthly and operates a dedicated TB outpatient clinic along with general admission services for respiratory diseases. Patients with drug sensitive pulmonary TB (no rifampicin resistance of the GeneXpert Ultra assay) are typically initiated on a 6 months' regimen of anti-TB therapy consisting of two months of rifampin, isoniazid, ethambutol and pyrazinamide and a further four months of rifampicin and isoniazid as fixed drug combinations.

2.2. Eligibility criteria

The study population consisted of admission records of adults (≥18 years) admitted to KNRH between January 2018 and December 2022 with bacteriologically confirmed or clinically diagnosed TB and registered in the KNRH TB register. Participants with missing inpatient files, missing dates of discharge (or dates of death).

2.3. Sample size and sampling

We conducted a census of all patient files meeting the eligibility criteria. Eligible patients were identified from the KNRH unit TB register and consecutively sampled. Inpatient files were retrieved from the KNRH records department using unit TB numbers. Subsequently, the files were evaluated for eligibility and enrolled consecutively.

2.4. Data collection

A standardized abstraction tool was used to collect patient data from both medical files and the unit TB register. This comprehensive data collection encompassed socio-demographic information, detailed medical histories (including pre-existing conditions, and presenting symptoms), and baseline laboratory findings, such as urine lipoarabinomannan (LAM) grade, GeneXpert grade, sputum smear grade, serum creatinine, liver enzymes, and full hemogram results. Additionally, HIV status, TB category and treatment history were documented. Baseline clinical assessments captured admission vital signs (blood pressure, pulse rate, respiratory rate, oxygen saturation [SpO_2], and temperature), wasting status as determined by the admitting physician, and any abnormalities detected in the physical examination. Finally, outcome data, including date of death or discharge, length of hospital stay, and the final TB outcome, were extracted. The final TB outcomes were cure, treatment completion, death, loss-to-follow up, treatment failure and unevaluated defined according to the World Health organization's definitions.

2.5. Data analysis

Data were analyzed using STATA 16.0. Categorical variables were summarized as proportions, and continuous variables were summarized as means (with standard deviations) or medians (with interquartile ranges), as appropriate. Logistic regression was employed to identify factors associated with early inpatient mortality. A multivariable model was constructed including all factors with $p < 0.05$ in bivariate analyses. HIV status, age and sex were intentionally added to the model because of their possible effect on early TB mortality. The mean corpuscular hemoglobin and cardiometabolic disease were excluded from the model due to insufficient data despite having a $p < 0.05$ at bivariate analysis. Statistical significance was set at $p < 0.05$.

To develop a clinical prediction model for early inpatient mortality, we adapted the model by Singla et al. [13], which originally assigned points based on specific criteria: $SpO_2 \leq 90$ % (4 points), respiratory rate >20 breaths/min (2 points), systolic blood pressure <90 mmHg (2 points), advanced disease on chest radiography (1 point), and heart rate >100 beats/min (1 point). Due to the unavailability of imaging in low-resource settings, the chest radiography criterion was excluded from the score. We further adjusted the SPO_2 cut off to <92 % as the proposed cut-off of 90 % critically underestimates rates of hypoxemia in critically ill black people [18,19]. We therefore adapted their score into a **PROS** score as: **P**ulse rate >100 beats/min (1 point), **R**espiratory rate >20 breaths/min (2 points), **O**xygen saturation <92 % (4 points), and **S**ystolic blood pressure <90 mmHg (2 points).

Subsequently, we calculated the sensitivity, specificity, positive predictive value, and negative predictive value of the PROS score by comparing a total patient score of 0 vs. ≥1.

2.6. Ethics approval and consent

All procedures were performed in compliance with relevant laws and institutional guidelines. The study was approved by the Mildmay Uganda Research and Ethics Committee (#REC REF 0101-2023). The committee gave a waiver of consent because the study posed minimal risk by using retrospective data. KNRH also provided administrative approval for the use of patient data.

3. Results

Of 625 charts reviewed, 602 were included in this analysis. Among those excluded 23 did not have dates of death and/or discharge (Fig. 1).

3.1. Characteristics of hospitalized TB patients

Of 602 hospitalized TB patients, 188 (31.2 %) died during their admission. Among these, 78 (41.5 %) died within seven days and were categorized as cases. Therefore, 13.0 % of all inpatients experienced early mortality. The overall median (IQR) length of hospital stay (LOS) was 8 (5–14) days for all patients. Cases had a shorter LOS than controls (5 (4–7] days vs. 9 [6–15], $p < 0.0001$). Tables 1 and 2 show a comparison of the characteristics of cases and controls.

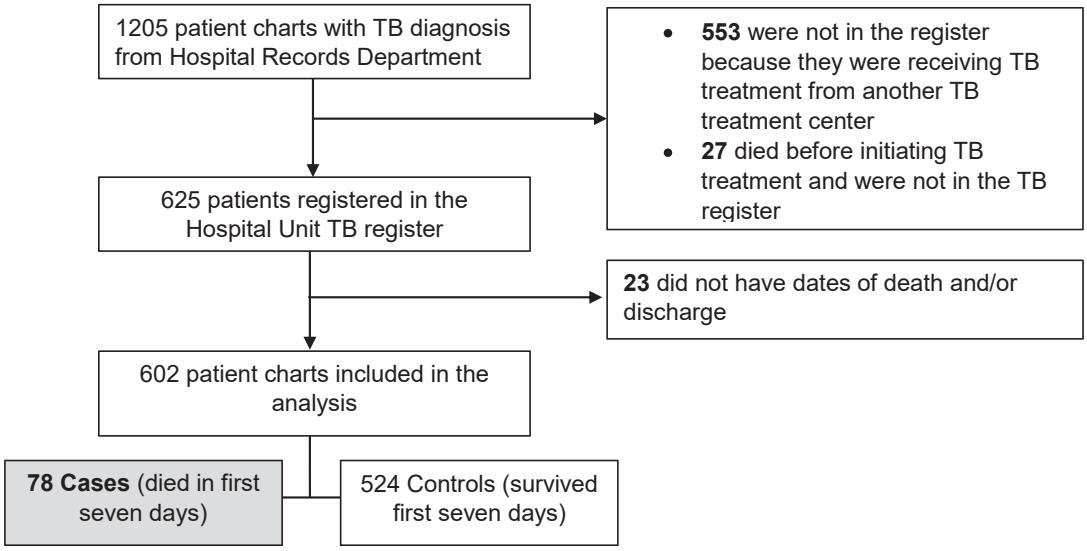

Fig. 1. Study flow diagram.

Compared to controls, a significantly higher proportion of cases were on TB treatment at admission (32.1 % vs. 14.5 %, $p < 0.001$), had cardiometabolic disease (23.9 % vs. 20.3 %, $p < 0.001$), and presented with respiratory distress (respiratory rate >20 breaths/min: 64.2 % vs. 46.8 %, $p = 0.022$; SpO2 < 92 %: 41.7 % vs. 23.4 %, $p = 0.003$). Cases also more frequently reported fever (36.9 % vs. 35.3 %, $p = 0.038$) and loss of consciousness (15.4 % vs. 5.2 %, $p = 0.001$).

Physical examination revealed a greater prevalence of wasting (29.0 % vs. 6.4 %, $p < 0.001$), lymphadenopathy (9.2 % vs. 3.9 %, $p = 0.037$), splenomegaly (7.9 % vs. 2.3 %, $p = 0.008$), neck stiffness (12.3 % vs. 4.1 %, $p = 0.003$), positive Kerning's sign (8.2 % vs. 2.3 %, $p = 0.006$), and impaired consciousness (GCS < 15: 36.4 % vs. 18.4 %, $p < 0.001$) among cases. Additionally, mean corpuscular hemoglobin was significantly lower in cases (28.8 pg [IQR 26.1–30.1] vs. 25.9 pg [IQR 23.0–28.3], $p = 0.004$) than controls (Table 2).

3.2. Factors associated with early in-hospital mortality among TB patients

Multivariable analysis, adjusted for HIV status, age, and sex, revealed that wasting (adjusted odds ratio [aOR] = 5.76, 95 % confidence interval [CI] 2.12–15.63, $p = 0.001$) and respiratory rate >20 breaths/min (aOR = 2.89, 95 % CI 1.19–7.00, $p = 0.019$) predicted early mortality. Table 3 shows the bivariable and multivariable models for factors associated with early inpatient mortality.

3.3. A predictive score for early inpatient mortality among TB patients

Table 4 shows the stratification of mortality by total patient scores from the PROS score (n = 225). A score of ≥1 demonstrated a sensitivity of 87.8 % (95 % CI 83.5–92.1 %), specificity of 24.5 % (95 % CI 18.8–30.1 %), negative predictive value of 90.7 % (95 % CI 86.1–93.2 %), and positive predictive value of 20.6 % (95 % CI 15.3–25.9 %).

3.4. Long-term tuberculosis treatment outcomes among hospitalized TB patients

Among patients with a TB treatment outcome (n = 599), 275 (45.9 %) died, 157 (26.2 %) completed TB treatment successfully, 127 (21.2 %) cured, 28 (4.7 %) were unevaluated, 9 (1.5 %) were lost to follow up and 3 (0.5 %) failed treatment. The overall TB treatment success rate (cure + treatment completion) was 47.4 %.

4. Discussion

In this study, we found a high proportion of inpatient TB mortality where almost 1 in 3 inpatients died during hospitalization. Moreover, the overall TB treatment success rate of hospitalized patients was less than 50 %, way below the WHO target of 90 %. This showcases a high mortality rate among inpatients in this setting for which urgent interventions are needed. Our results on overall in-patient mortality are comparable to high in-patient mortality in Ethiopia (30 %) [20]. However, this is significantly higher than what is reported in better resourced, low-HIV burdened countries such as Japan (17 %) [21], Saudi Arabia (14 %) [22] and Türkiye (13 %) [23].

Our finding on early mortality of 13 % of all inpatients is lower than the 20 % reported in India plausibly because the study in India was conducted in an emergency unit setting [13]. Similar to our study which shows that more than 40 % of inpatient deaths occur in the first seven days of hospitalization, studies in Malawi, South Africa and Nigeria reported that 37 %–50 % of TB inpatient deaths occurred within seven days [11,12,24]. This indicates that the first seven days of admission are critical to the survival of TB patients in TB/HIV settings. Identifying risk factors and developing predictive scores for early mortality are essential for designing effective interventions.

We found low SPO_2 to be associated with early mortality. This should be expected as low oxygen saturations indicate respiratory failure which carries an almost 50 % rate of inpatient TB mortality [25]. TB severity scores that include hypoxemia have proved to have good accuracy in predicting TB mortality [13,26,27]. As such inpatients with TB should have ready access to oxygen and respiratory support. However, oxygen delivery systems are not readily available in Africa and health workers are ill-equipped to identify patients with hypoxemia, provide oxygen, and titrate or discontinue oxygen appropriately [28]. This also calls for health worker training on oxygen eligibility and delivery in these settings.

Wasting was the also associated with early inpatient TB mortality in our study. Wasting has been shown previously to be associated with TB mortality in this urban setting in Uganda [29]. Wasting signifies a degree of immunosuppression that correlates with TB disease severity due dampened cellular immune responses [30,31]. While nutritional support has been shown to reduce in-hospital mortality readmission rates among medical patients [32], clinical trials are needed to show that this is the case among TB inpatients.

A PROS score of ≥1 in our study showed good sensitivity (88 %) and a high negative predictive value (91 %), though its positive predictive

Table 1
Comparison of Sociodemographic and Past Medical History of Cases and Controls.

Characteristic	Totaln (%) N = 602	Casesn (%) n = 78	Controlsn (%) n = 524	p-value
Age, median (interquartile rage, IQR) (n = 595)	38.0 (30.0–45.0)	39.0 (31.0–47.0)	37.0 (29.0–45.0)	0.309
Males (n = 601)	311 (51.8)	38 (49.4)	273 (52.1)	0.652
Urban residence (n = 587)	430 (73.3)	59 (75.6)	371 (72.9)	0.609
Married (n = 293)	197 (67.2)	28 (80.0)	169 (65.5)	0.086
Unemployed (n = 423)	46 (10.9)	9 (16.1)	37 (10.1)	0.180
Self-referral (n = 504)	280 (55.6)	42 (58.3)	238 (55.1)	0.608
Already on TB treatment at admission	101 (16.8)	25 (32.1)	76 (14.5)	**<0.001**
TB Category (n = 591)				
Pulmonary Bacteriologically confirmed TB	397 (67.2)	45 (60.0)	352 (68.2)	0.151
Extrapulmonary TB	71 (12.0)	8 (10.7)	63 (12.2)	
Pulmonary clinically diagnosed TB	123 (20.8)	22 (29.3)	101 (19.6)	
Prior TB episode (TB retreatment)	39 (6.5)	2 (2.6)	37 (7.4)	0.127
Mycobacterial grade[¥] (n = 216)				
High	46 (21.3)	5 (17.9)	41 (21.8)	0.561
Medium	67 (31.0)	7 (25.0)	60 (31.9)	
Low	103 (47.7)	16 (57.1)	87 (46.3)	
HIV status (n = 602)				
Positive	441 (73.3)	59 (75.6)	382 (72.9)	0.222
Negative	145 (24.1)	15 (19.2)	130 (24.8)	
Unknown	16 (2.7)	4 (5.1)	12 (2.3)	
Cardiometabolic disease (n = 222)[#]	53 (23.9)	11 (73.3)	42 (20.3)	**<0.001**
Diabetes (n = 202)	20 (9.9)	5 (38.5)	15 (7.9)	**<0.001**
Hypertension (n = 216)	40 (18.5)	7 (58.3)	33 (16.2)	**<0.001**
Chronic kidney disease (n = 209)	17 (8.1)	2 (16.7)	15 (7.6)	0.265
CD4 count at admission, median (IQR), cells per mm^3 (n = 129)[β]	62.0 (26.0–164.0)	84.0 (34.0–109.0)	57.0 (25.0–164.0)	0.915
Currently on Antiretroviral therapy (ART) (n = 440) [β]				0.464
Yes	293 (66.6)	39 (66.1)	254 (66.7)	
No	138 (31.4)	20 (33.9)	118 (31.0)	
Unknown	9 (2.1)	0 (0.0)	9 (2.4)	
ART duration, median (IQR), months (n = 274)[β]	24.0 (1.0–96.0)	24.0 (3.0–72.0)	24.0 (1.0–96.0)	0.673
History of ART default (n = 307)[β]	104 (33.9)	13 (38.2)	91 (33.3)	0.569

Bp – blood pressure, SPO_2 – oxygen saturation, bolded p-values indicate a statistically significant difference; [#] includes diabetes, hypertension and chronic kidney disease, [¥]determined by GeneXpert Ultra cycle threshold values, urine LAM and baseline sputum smear microscopy; [β]among people with HIV.

value was low (21 %). This suggests the score's potential utility as a screening tool for early mortality risk in TB inpatients. Specifically, inpatients with a score of zero are at low risk for early mortality. Given these findings, the PROS score warrants consideration for broader use and/or validation in TB/HIV high-burden settings. The key strength of the PROS score is the use of easily measurable components in a low-resource setting: pulse rate, respiratory rate, oxygen saturation and systolic blood pressure. Additionally, these components are modifiable, in that there are interventions that can be instituted to address hypotension, tachycardia, hypoxemia and respiratory distress. This is a distinction from Singla and colleagues' [13] score that incorporates chest X-ray severity that is neither modifiable or readily available in low-resource settings. Trials are needed to demonstrate that the use of the PROS score and specific interventions such as oxygen therapy, intravenous fluids and/or beta blockers improve survival among hospitalized TB patients.

The major strength of the study is the large sample size and consideration of easily measurable parameters in a TB/HIV low-resource setting. Nonetheless, there are some limitations that deserve consideration. First, this is a single center study at a national referral hospital that could be prone to selection and referral bias. However, we attempted to mitigate this by conducting a census of all patients. Moreover, referral status was not associated with mortality and may not be a key confounder. Secondly, the retrospective nature of the study is prone to documentation bias which partly manifests as missing data from our study. This is demonstrated by the low counts of patients with laboratory findings. Our efforts to perform only complete analysis to mitigate this meant that our final sample size for the multivariable model and the PROS score was lower than the study population. The generalizability of the study findings to HIV negative TB patients might be limited because over 70 % of the study population was HIV co-infected. However, we did not observe an association between HIV co-infection and early inpatient mortality. Moreover, high HIV co-infection rates (>65 %) are typical among hospitalized TB patients in Uganda [33]. The lack of an association between HIV and early inpatient TB mortality has also been observed in other cohorts [9]. It is nonetheless desirable to evaluate the performance of the PROS score in an HIV negative cohort. Lastly, our study seems to present an unexpectedly very high mortality rate among inpatients at this study site. However, this is not a result of admission bias or the COVID-19 pandemic that occurred during the period under study. While there is no specific admission criteria (admissions are at the discretion of the clinician), there has been no change in rates of TB admissions at this center over the last 10 years [16]. Therefore, admission rate bias is unlikely. Secondly, our previous work at this hospital is consistent with the current study findings: a 70 % rate of HIV co-infection among inpatients with TB and TB contributes 24 % of all in-hospital mortality over the last 10 years [16]. Moreover, we did not observe a significant change in TB mortality before and after the COVID-19 pandemic [34], suggesting that COVID-19 did not significantly impact TB outcomes at this center. We therefore think that the results are true reflection of TB hospital mortality at similar centers in Uganda [33].

5. Conclusion

Early and long-term mortality rates among hospitalized TB patients are high with nearly one-third of inpatients dying during their hospital stay and less than half achieving TB treatment success. Our findings emphasize that early mortality, occurring within the first seven days of admission, constitutes a significant portion of these deaths, highlighting the critical need for timely interventions in the initial days of hospitalization. Moreover, hospitalization seems to be associated with long-term mortality even after TB cure and treatment completion in this setting [33,35].

Two predictors of early mortality identified in this study are wasting and an elevated respiratory rate (>20 breaths/min). These factors highlight the severe state of debilitation and respiratory distress experienced by these patients. The PROS score, which incorporates the respiratory rate along with systolic blood pressure, oxygen saturation, and pulse rate, proved to be highly sensitive with a good negative predictive value. The score could facilitate the early identification of low-risk patients (those with low scores), allowing healthcare providers to prioritize and tailor interventions accordingly.

Table 2
Comparison of Clinical Characteristics and Laboratory Work-Up of Cases and Controls.

Characteristic	Totaln (%) N = 602	Casesn (%) n = 78	Controlsn (%) n = 524	p-value
Weight, median (interquartile range [IQR]), Kg (n = 503)	50.0 (45.0–59.0)	50.0 (45.0–60.0)	50.0 (45.0–58.3)	0.802
BMI, kg/m^2 (n = 21)	19.9 (16.1–26.9)	No observations	19.9 (16.1–26.9)	–
Vital signs				
Systolic blood pressure (Bp), median (IQR), mmHg (n = 548)	110.0 (98.0–123.5)	110.0 (95.0–118.0)	110.0 (98.0–124.0)	0.135
Systolic Bp < 90 mmHg (n = 548)	71 (13.0)	13 (17.8)	58 (12.2)	0.185
Diastolic Bp, median (IQR), mmHg (n = 548)	70.0 (60.0–82.0)	69.5 (57.5–80.0)	71.0 (60.0–83.0)	0.123
Diastolic Bp < 60 mmHg (n = 548)	109 (20.0)	18 (25.0)	91 (19.2)	0.251
Pulse rate, median (IQR), beats/min (n = 546)	106.0 (89.0–121.0)	113.5 (89.5–131.0)	105 (89.0–120.0)	0.057
Pulse rate >100 beats/minute (n = 546)	317 (58.1)	46 (63.9)	271 (57.2)	0.282
Respiratory rate, median (IQR), breaths/min (n = 305)	20.0 (18.0–28.0)	24.0 (18.0–30.0)	20 (18.0–28.0)	0.069
Respiratory rate >20 breaths/min (n = 305)	152 (49.8)	34 (64.2)	118 (46.8)	**0.022**
Temperature, median (IQR), °C (n = 211)	37.0 (36.4–38.1)	37.1 (36.2–38.1)	37.0 (36.4–38.1)	0.729
Oxygen saturation (SPO_2), median (IQR), %, (n = 427)	96.0 (92.0–98.0)	94.0 (90.0–97.5)	96.0 (93.0–98.0)	**0.032**
SPO_2 < 92 %, (n = 427)	111 (26.0)	25 (41.7)	86 (23.4)	**0.003**
Symptoms				
Cough (n = 335)	333 (99.4)	43 (100.0)	290 (99.3)	0.586
Fever	222 (36.9)	37 (47.4)	185 (35.3)	**0.038**
Night sweats (n = 114)	108 (94.7)	22 (100.0)	86 (93.5)	0.218
Weight loss (n = 151)	145 (96.0)	24 (100.0)	121 (95.3)	0.277
Loss of consciousness	39 (6.5)	12 (15.4)	27 (5.2)	**0.001**
Headache	79 (13.1)	10 (12.8)	69 (13.2)	0.932
Body weakness	156 (25.9)	24 (30.8)	132 (25.2)	0.294
Convulsions	19 (3.2)	4 (5.1)	15 (2.9)	0.286
Abdominal swelling	43 (7.1)	2 (2.6)	41 (7.8)	0.092
Nausea and vomiting	94 (15.6)	14 (18.0)	80 (15.3)	0.543
Abdominal pain	77 (12.8)	12 (15.4)	65 (12.4)	0.462
Physical examination findings				
Limb edema (n = 593)	74 (12.5)	12 (15.8)	62 (12.0)	0.350
Pallor (n = 593)	243 (41.0)	39 (51.3)	204 (39.5)	0.050
Jaundice (n = 593)	54 (9.1)	11 (14.5)	43 (8.3)	0.082
Wasting (n = 593)	55 (9.3)	22 (29.0)	33 (6.4)	**<0.001**
Lymphadenopathy (n = 593)	27 (4.6)	7 (9.2)	20 (3.9)	**0.037**
Respiratory crackles (n = 595)	128 (21.5)	22 (29.0)	106 (20.4)	0.091
Splenomegaly (n = 595)	18 (3.0)	6 (7.9)	12 (2.3)	**0.008**
Hepatomegaly (n = 595)	35 (5.9)	8 (10.3)	27 (5.2)	0.065
Neck stiffness (n = 586)	30 (5.1)	9 (12.3)	21 (4.1)	**0.003**
Positive kerning's sign (n = 586)	18 (3.1)	6 (8.2)	12 (2.3)	**0.006**
Glasgow's comma scale, mean (SD), (n = 576)	14.1 (2.3)	13.1 (2.9)	14.2 (2.1)	**<0.001**
Glasgow's comma scale <15 (n = 576)	120 (20.8)	28 (36.4)	92 (18.4)	**<0.001**
Heart murmur (n = 595)	9 (1.5)	1 (1.3)	8 (1.5)	0.880
Laboratory work up				
Anemia (n = 150)[α]	125 (83.3)	20 (76.9)	105 (84.7)	0.335
Mean corpuscular volume, median (IQR), femtolitres (n = 106)	82.2 (75.0–91.6)	88 (80.6—91.6)	80.1 (74.0–91.5)	0.078
Mean corpuscular hemoglobin, picograms (n = 92)	26.3 (23.6–28.8)	28.8 (26.1–30.1)	25.9 (23.0–28.3)	**0.004**
Leucocyte count, median (IQR), $\times 10^9$/L (n = 130)	6.4 (3.4–10.2)	7.5 (5.0–10.4)	6.2 (3.8–10.2)	0.296
Neutrophil count, median (IQR), $\times 10^9$/L (n = 84)	4.4 (2.1–8.0)	6.2 (3.0–11.2)	3.9 (2.1–7.9)	0.131
Lymphocyte count, median (IQR), $\times 10^9$/L (n = 90)	1.2 (0.5–2.0)	1.4 (0.8–4.1)	1.0 (0.5–1.9)	0.236
Monocyte count, median (IQR), $\times 10^9$/L (n = 84)	0.62 (0.35–1.5)	0.9 (0.4–2.0)	0.6 (0.3–1.3)	0.135
Platelet count, median (IQR), $\times 10^3$ per microliter (n = 121)	206.0 (144.0–304)	166.5 (101.5–271.5)	219.0 (149.0–306.0)	0.137
Creatinine, median (IQR), mmol/L (n = 64)	92.4 (47.5–212.5)	93.1 (44.5–137.5)	50.3 (92.4–257.7)	0.850
Urea, median (IQR), mmol/L (n = 58)	7.1 (3.4–12.8)	8.4 (5.8–21.4)	6.6 (3.4–35.2)	0.417
Random blood glucose, median (IQR), mmol/L (n = 100)	7.4 (6.3–8.5)	7.8 (6.4–10.2)	7.4 (6.2–8.2)	0.351
Sodium, median (IQR), mmol/L (n = 65)	131.8 (123.9–136.9)	128.6 (124.2–134.3)	132.7 (123.7–137.0)	0.706
Potassium, median (IQR), mmol/L (n = 59)	4.2 (3.6–5.0)	4.1 (3.9–4.9)	4.2 (3.5–5.1)	0.778
Aspartate aminotransferase, median (IQR), units per liter (U/L), (n = 61)	56.0 (31.0–88.0)	84.5 (42.5–158.0)	46.1 (29.0–75.0)	0.057
Gamma-glutamyl transpeptidase, median (IQR), U/L, (n = 54)	88.0 (40.0–200.3)	91.0 (46.0–96.0)	83.0 (30.8–208.7)	0.534
Albumin, median (IQR), g/dl (n = 57)	19.0 (3.0–25.8)	22.1 (3.0–30.1)	17.1 (3.1–25.4)	0.196
Protein, median (IQR), g/dl (n = 40)	44.7 (6.4–71.7)	29.8 (5.8–68.0)	44.7 (7.2–77.2)	0.310
Total bilirubin, median (IQR), mmol/L, (n = 39)	11.6 (5.4–23.7)	14.4 (7.6–14.4)	11.4 (4.4–22.3)	0.301

[α] Hemoglobin levels of <12.0 g/dl in women and <13.0 g/dl in men. Bolded p-values indicate a statistically significance difference.

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CRediT authorship contribution statement

Joseph Baruch Baluku: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Priscilla Sheilla Apolot:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Brenda Namanda:** Writing – review & editing, Project administration, Investigation, Data curation. **Sharon Namiiro:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation. **Shamim Katusabe:** Writing – review & editing, Investigation, Data curation. **Diana Karungi:** Writing – review & editing, Investigation, Data curation. **Reagan Nkonge:** Writing –

Table 3
Bivariable and multivariable for factors associated with early inpatient tuberculosis mortality.

Characteristic	Crude odds ratio (95 % confidence interval)	p-value	Adjusted odds ratio (95 % CI)*	p-value
Oxygen saturation				
<92 %	1		1	
≥92 %	0.43 (0.24, 0.75)	0.003	0.69 (0.29, 1.65)	0.405
Respiratory rate				
≤20 breaths/min	1		1	
>20 breaths/min	2.02 (1.09, 3.73)	0.025	2.89 (1.19, 7.00)	**0.019**
Fever				
No	1		1	
Yes	1.64 (1.02, 2.67)	0.040	1.30 (0.58, 2.89)	0.526
Wasting				
No	1		1	
Yes	5.98 (3.25, 10.98)	<0.001	5.76 (2.12, 15.63)	**0.001**
TB treatment status				
Already on treatment at admission	1		1	
Not yet on treatment at admission	0.36 (0.21, 0.61)	<0.001	0.49 (0.20, 1.23)	0.130
Glasgow comma scale				
15	1		1	
<15	2.52 (1.51, 4.24)	<0.001	2.20 (0.78, 6.24)	0.137
Loss of consciousness				
No	1		1	
Yes	3.35 (1.62, 6.92)	0.001	0.92 (0.17, 5.07)	0.922
Lymphadenopathy				
Yes	1		1	
No	0.40 (0.16, 0.97)	0.043	0.42 (0.08, 2.19)	0.303
Splenomegaly				
Yes	1		1	
No	0.28 (0.10, 0.76)	0.013	0.69 (0.10, 4.84)	0.712
Neck stiffness				
Yes	1		1	
No	0.30 (0.13, 0.69)	0.005	1.05 (0.13, 8.40)	0.961
Positive kerning's sign				
Yes	1		1	
No	0.27 (0.10, 0.74)	0.011	0.83 (0.05, 14.23)	0.897
HIV status				
Unknown	1		1	
Positive	0.46 (0.14, 1.48)	0.195	0.57 (0.06, 5.81)	0.633
Negative	0.35 (0.01, 1.21)	0.097	0.43 (0.04, 4.84)	0.496
Age	1.00 (0.99, 1.02)	0.634	1.00 (0.96, 1.61)	0.816
Sex				
Male	1		1	
Female	1.12 (0.70, 1.82)	0.630	0.72 (0.32, 1.56)	0.418

*N = 225 for multivariable model. Bolded p-values indicate a statistically significant result.

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Table 4
Proportion of TB patients who died within seven days stratified by the PROS score.

PROS Risk score*	Total number with score	Mortality within 7 days of hospitalization
0	50	10.0 %
1	64	12.5 %
2	57	21. 1 %
≥3	43	29.6 %

*__PROS__ scoring: **P**ulse rate >100 beats/min (1 point), **R**espiratory rate >20 breaths/min (2 points), **O**xygen saturation <92 % (4 points), and **S**ystolic blood pressure <90 mmHg (2 points).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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None.

Data availability

Datasets used in this analysis are available from the corresponding author upon reasonable request.

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