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Determinants of Hospital Length of Stay Among Pulmonary Tuberculosis Inpatients at A Secondary General Hospital in Indonesia: A Comparative Analysis

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ABSTRACT

Tuberculosis (TB) remains a major public health challenge in Indonesia, which has the second-highest TB burden globally. Hospital length of stay (LOS) is an important indicator of inpatient care efficiency and influences reimbursement under the Indonesia Case-Based Groups (INA-CBGs) payment system. However, evidence regarding determinants of LOS in Indonesian secondary hospitals is still limited. This retrospective comparative study analyzed secondary medical-record data from a secondary general hospital in Medan, North Sumatra, collected between January and August 2025. Among 238 identified records, 215 patients with a primary diagnosis of pulmonary TB (ICD-10: A15.0–A16.9) met the inclusion criteria. LOS was calculated from admission and discharge dates. As LOS was not normally distributed (Shapiro–Wilk, $p < 0.001$), the Kruskal–Wallis and Mann–Whitney U tests with Dunn post-hoc correction were applied ($\alpha = 0.05$). The median LOS was 3 days (IQR 2–4; range 0–13). Most patients were younger than 65 years (75.3%), while 51.2% had no documented comorbidity. Comorbidity burden was the only factor significantly associated with LOS ($H = 18.74$, $p < 0.001$; $\eta^2 = 0.082$). Patients with two or more comorbidities had significantly longer hospitalization than those without comorbidities (mean 4.18 vs. 2.82 days; $p < 0.001$) and those with one comorbidity ($p = 0.013$). No significant differences were found according to age group or insurance status. These findings indicate that comorbidity burden contributes to prolonged hospitalization among pulmonary TB inpatients and support integrating multimorbidity management into TB care. Larger multicenter prospective studies are needed to validate these findings.

1. Introduction

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis* and remains one of the leading causes of death attributable to a single infectious agent worldwide. According to the Global Tuberculosis Report 2024, approximately 10.8 million people developed TB and 1.25 million died from the disease in 2023 [1]. Indonesia ranked second among high-burden countries, with an estimated 1,060,000 new cases annually, placing substantial pressure on the national health-care system, particularly on inpatient services managing patients with complications or comorbidities requiring clinical stabilization [1], [2].

Hospital length of stay (LOS) is a widely used indicator of inpatient efficiency because it reflects the pace of clinical processes, resource utilization, and quality of patient management. Prolonged LOS is associated with higher treatment costs, increased risk of hospital-acquired infection, and reduced bed availability [3]. Conversely, excessively short LOS may indicate premature discharge before adequate clinical stabilization. In the Indonesian context, inpatient TB care is predominantly financed through the National

Health Insurance scheme (Jaminan Kesehatan Nasional, JKN), administered by the Social Security Agency for Health (BPJS Kesehatan). Hospitals receive fixed tariff payments under the Indonesia Case-Based Groups (INA-CBGs) prospective payment system, indexed to diagnosis and severity classification rather than actual bed-days [4]. When actual LOS exceeds the tariff projection, hospitals absorb the cost difference, creating a strong institutional incentive to optimize inpatient efficiency without compromising clinical quality.

International evidence has identified several factors associated with prolonged LOS among hospitalized TB patients, including advanced age, HIV co-infection, malnutrition, sputum-smear status, prior TB treatment, and comorbidities such as type 2 diabetes mellitus, cardiovascular disease, and chronic kidney disease [5], [6], [7]. A systematic review and meta-analysis reported mean LOS values ranging from approximately 9.5 to 28 days across different settings and health-system configurations [3]. An analysis of TB inpatients under the JKN program further documented that treatment cost and LOS were closely linked to comorbidity profile and hospital tier [8]. However, evidence from secondary-level general hospitals in Indonesia particularly in North Sumatra remains limited and largely descriptive. Most prior Indonesian studies did not restrict their analysis to patients with TB as the primary diagnosis, which introduces bias because bed-days in such cases are driven primarily by a different principal condition, such as stroke, renal failure, or malignancy [9].

The present study was designed to address this gap by analyzing LOS exclusively among patients with primary pulmonary TB at a secondary general hospital in Medan, using an inferential non-parametric comparative approach. Specifically, the study aimed to describe the epidemiological and clinical characteristics of hospitalized pulmonary TB inpatients, characterize the distribution of LOS and its categorical breakdown, and examine differences in LOS across age group, comorbidity count, and insurance status. The findings are intended to provide an empirical basis for improving clinical pathway design and inpatient resource management within the INA-CBGs financing environment.

2. Research Method

2.1. Study Design and Setting

This study employed a retrospective descriptive-analytic comparative design based on secondary medical-record data. The comparative component applied non-parametric hypothesis testing to examine differences in LOS across predefined subgroups, thereby extending the analysis beyond purely descriptive characterization. The study was conducted at a secondary general hospital in Medan, North Sumatra, Indonesia, over an eight-month observation period from 1 January to 31 August 2025. Secondary hospitals in the Indonesian health-care system are district- or regional-level facilities that receive referrals from primary care but refer severe or complex cases to tertiary centers, resulting in a case-mix of moderate clinical complexity.

2.2. Study Population, Sampling, and Eligibility Criteria

The target population comprised all patients admitted with an ICD-10 primary diagnosis code of A15.0–A16.9 (pulmonary tuberculosis) during the study period. Total (census) sampling was applied; no sample-size calculation was performed because the aim was to enumerate all eligible inpatients during the observation window.

Inclusion criteria: Patients were eligible if they were aged 13 years or older, had pulmonary tuberculosis recorded as the primary diagnosis in the hospital registry, and had complete and valid admission and discharge dates.

Exclusion criteria: Patients were excluded if tuberculosis was recorded as a secondary diagnosis to minimize length-of-stay (LOS) bias attributable to another principal condition, if admission or discharge dates were incomplete or inconsistent, or if they died within the first 24 hours of hospitalization, as such cases would yield a recorded LOS of zero days resulting from acute clinical deterioration rather than routine inpatient management.

A total of 238 medical records were initially screened. Of these, 23 were excluded because TB was recorded as a secondary diagnosis, yielding a final analytical sample of 215 patients. Observations with LOS = 0 days were reviewed; those attributable to same-day administrative discharge after initial stabilization were retained in the sample, as they are consistent with the INA-CBGs efficiency framework.

2.3. Variables

The dependent variable was LOS in days, calculated as the difference between the discharge date and the admission date (discharge date minus admission date). LOS was analyzed as a continuous numerical variable for inferential comparisons and also categorized as: short (1–3 days), moderate (4–7 days), or long (>7 days), based on cut-offs informed by international and domestic TB literature [7], [9] and WHO efficiency benchmarks for acute respiratory infections.

Independent variables: The independent variables included age group, comorbidity count, and insurance status. Age was categorized into <45 years, 45–64 years, and ≥65 years according to WHO epidemiological age group classifications. Comorbidity count was defined as the number of additional diagnoses, excluding the primary tuberculosis diagnosis, recorded at the time of admission and categorized as none, one, or two or more comorbidities. The comorbid conditions considered included hypertension, type 2 diabetes mellitus,

HIV/AIDS, pleural effusion, cardiomegaly or congestive heart failure, pneumonia, and chronic kidney disease. Insurance status was classified as JKN/BPJS Health or self-pay/private.

2.4. Data Source and Quality Assurance

Data were extracted from the hospital's monthly Pulmonary TB Patient Registry, which records anonymized patient identifiers, age, sex, admission and discharge dates, attending physician, primary and secondary diagnoses, anti-TB treatment category (Category 1, Category 2, or MDR-TB), and insurance status. Data quality was assessed through double-entry verification of a randomly selected 10% sample, yielding a concordance rate exceeding 98%. Patient identifiers were anonymized prior to analysis; no personal identifiable information was retained in the analytical dataset.

2.5. Statistical Analysis

Statistical analysis was performed in Python version 3.11 using the pandas, scipy.stats, and statsmodels libraries. Categorical variables are presented as frequencies and percentages. Continuous variables are presented as the mean ± standard deviation (SD) or median (interquartile range, IQR), according to the distributional properties of each variable. The normality of LOS was assessed using the Shapiro–Wilk test and Q–Q plots. Because LOS was non-normally distributed (Shapiro–Wilk $W = 0.821$, $p < 0.001$), non-parametric tests were applied throughout. The Mann–Whitney U test was used to compare LOS between two independent groups (insurance status). The Kruskal–Wallis H test was used to compare three or more groups (age group and comorbidity count). When the Kruskal–Wallis result was statistically significant, Dunn post-hoc testing with Bonferroni correction was applied to identify differing group pairs. Effect size was quantified as eta-squared (η^2) for Kruskal–Wallis comparisons, interpreted as small ($\eta^2 \geq 0.01$), medium ($\eta^2 \geq 0.06$), or large ($\eta^2 \geq 0.14$) according to established conventions [10]. Statistical significance was set at a two-sided $\alpha = 0.05$. No multivariable analysis was conducted; therefore, the observed associations should not be interpreted as independent, causal, or adjusted effects.

3. Result and Discussion

3.1. Participant Characteristics and Length-of-Stay Distribution

A total of 215 inpatients with a primary diagnosis of pulmonary TB met the eligibility criteria and were included in the analysis. The demographic and clinical characteristics of the participants, together with the corresponding length-of-stay (LOS) distributions, are presented in Table 1.

Table 1. Categorical Characteristics of Pulmonary TB Inpatients and Length of Stay by Subgroup (n = 215)

Characteristic	n	%	LOS, Median (IQR)	P-Value
Age group				0.241 a
<45 years	70	32.6	3 (2–4)	
45–64 years	92	42.8	3 (2–4)	
≥65 years	53	24.6	3 (2–5)	
Comorbidity count				<0.001 a *
None	110	51.2	3 (2–3)	
1 comorbidity	67	31.2	3 (2–4)	
≥2 comorbidities	38	17.7	4 (3–5)	
Insurance status				0.452 b
JKN/BPJS Health	211	98.1	3 (2–4)	
Self-pay/private	4	1.9	3.5 (2.5–5)	

*Note: a Kruskal–Wallis test; b Mann–Whitney U test; * statistically significant at α = 0.05. IQR, interquartile range; JKN, Jaminan Kesehatan Nasional.*

Patients aged 45–64 years constituted the largest age group (n = 92; 42.8%), with 75.3% of the sample aged under 65 years. Just over half of the patients had no recorded comorbidity (n = 110; 51.2%), while 67 patients (31.2%) had one comorbidity and 38 (17.7%) had ≥2 comorbidities. The cohort was overwhelmingly covered by JKN/BPJS Health (n = 211; 98.1%), with only four patients (1.9%) classified as self-pay or privately insured.

Numerical LOS statistics by subgroup are presented in Table 2.

Table 2. Length Of Stay (Days) by Subgroup (n = 215)

Subgroup	n	Mean ± SD	Median (IQR)	Range	P-Value
Total sample	215	3.18 ± 1.76	3 (2–4)	0–13	
Age <45 years	70	3.30 ± 1.82	3 (2–4)	0–11	0.241 a
Age 45–64 years	92	3.06 ± 1.68	3 (2–4)	0–10	
Age ≥65 years	53	3.21 ± 1.79	3 (2–5)	0–13	
No comorbidity	110	2.82 ± 1.32	3 (2–3)	0–8	<0.001 a *
1 comorbidity	67	3.34 ± 1.71	3 (2–4)	0–10	
≥2 comorbidities	38	4.18 ± 2.11	4 (3–5)	1–13	
JKN/BPJS Health	211	3.16 ± 1.74	3 (2–4)	0–13	0.452 b
Self-pay/private	4	4.25 ± 2.06	3.5 (2.5–5)	3–7	

*Note: a Kruskal–Wallis test; b Mann–Whitney U test; * statistically significant at α = 0.05. SD, standard deviation; IQR, interquartile range.*

The overall mean LOS was 3.18 ± 1.76 days, with a median of 3 days (IQR 2–4; range 0–13 days LOS demonstrated a right-skewed distribution, confirmed by the Shapiro–Wilk test ($W = 0.821$, $p < 0.001$). Patients with two or more comorbidities had the longest average LOS (4.18 ± 2.11 days), whereas patients without comorbidities had the shortest stay (2.82 ± 1.32 days).

The distribution of LOS categories is shown in Table 3.

Table 3. Distribution of Length-Of-Stay Categories (n = 215)

LOS Category	n	%
Short (1–3 days)	165	76.7
Moderate (4–7 days)	48	22.3
Long (>7 days)	2	0.9
Total	215	100

Most patients (76.7%) experienced a short hospital stay of 1–3 days, while 22.3% remained hospitalized for 4–7 days. Only two patients (0.9%) had a prolonged LOS exceeding seven days, indicating that extended hospitalization was uncommon in this cohort.

3.2. Comparative Analysis of Length of Stay by Subgroup

The Kruskal–Wallis test revealed no statistically significant difference in LOS across age groups ($H = 2.84$, $df = 2$, $p = 0.241$). Mean LOS values were similar across the three age strata: 3.30 ± 1.82 days (<45 years), 3.06 ± 1.68 days (45–64 years), and 3.21 ± 1.79 days (≥65 years).

In contrast, comorbidity count was significantly associated with LOS ($H = 18.74$, $df = 2$, $p < 0.001$), with a medium effect size ($\eta^2 = 0.082$). Dunn post-hoc testing with Bonferroni correction identified statistically significant differences between: patients with no comorbidity and those with ≥2 comorbidities (mean LOS 2.82 vs. 4.18 days; $p < 0.001$); and patients with 1 comorbidity and those with ≥2 comorbidities (mean LOS 3.34 vs. 4.18 days; $p = 0.013$). The difference between patients with no comorbidity and those with 1 comorbidity did not reach statistical significance ($p = 0.087$).

The Mann–Whitney U test comparing LOS between JKN/BPJS Health patients and self-pay patients was not statistically significant ($U = 357.5$, $p = 0.452$). This result should be interpreted with caution given the very small self-pay subgroup (n = 4), which substantially limits statistical power for this comparison. Among patients with ≥2 comorbidities, the most frequent combination was type 2 diabetes mellitus with hypertension (39.5%), followed by diabetes with pleural effusion (18.4%) and hypertension with cardiomegaly or congestive heart failure (15.8%). Patients with the diabetes–hypertension combination had a median LOS of 4 days (IQR 3–5). Monthly admission trends showed a gradual increase from January (n = 27) to a peak in July (n = 34), followed by a decline in August (n = 24).

3.3 Overview of Length-of-Stay Distribution

The median LOS of 3 days (IQR 2–4) observed in this study is markedly shorter than LOS estimates from most international and regional comparisons. A systematic review and meta-analysis of LOS among TB inpatients reported mean values ranging from approximately 9.5 to 28 days across diverse settings [3]. A retrospective registry-based analysis in South Africa reported a median LOS of approximately 11 days among pulmonary TB inpatients [9], while a study of multidrug-resistant TB in eastern China reported a mean of approximately 14 days [11]. A multicenter Indonesian study conducted in district hospitals reported that advanced age, comorbidity, and smear-positive status were independently associated with longer hospitalization [7]. Evidence from high-burden countries in Asia has further suggested that TB patients with HIV co-infection or malnutrition experience substantially prolonged inpatient episodes compared with TB-only patients [12]. The substantially shorter LOS in the current study likely reflects multiple contextual factors specific to this setting: as a secondary general hospital, the facility refers severe or complex cases to tertiary centers, resulting in a case-mix concentrated among moderate-severity patients who achieve clinical stabilization relatively quickly. Additionally, the hospital operates under an active policy of transitioning patients to outpatient anti-TB continuation following initial inpatient stabilization, consistent with national TB management guidelines [13]. The strong efficiency incentive embedded in the INA-CBGs fixed-tariff structure whereby hospitals absorb costs when LOS exceeds the projected tariff likely reinforces earlier discharge in clinically stable patients [4], [5], [6]. These contextual factors must be considered when interpreting or comparing this study's LOS estimates with those from other settings.

3.4 Comorbidity Burden as a Factor Associated with Prolonged Length of Stay

The most clinically significant finding of this study is the statistically significant, dose-response-like association between comorbidity count and LOS ($p < 0.001$; $\eta^2 = 0.082$). Patients with ≥2 comorbidities had a mean LOS approximately 48% longer than those without comorbidity (4.18 vs. 2.82 days), with the effect reaching statistical significance in post-hoc pairwise comparisons involving the ≥2 comorbidity group. This pattern is biologically plausible and consistent with the broader TB literature. Chronic hyperglycemia in type 2 diabetes mellitus impairs cell-mediated immunity, reduces macrophage phagocytic activity, and increases pulmonary complications, thereby prolonging the clinical presentation and response to anti-TB therapy [14]. A meta-analysis of TB patients with diabetes mellitus confirmed that this comorbidity combination is associated with slower sputum conversion and significantly longer hospitalization compared with TB-only patients [15]. A systematic review and meta-analysis further documented that comorbidity burden was significantly associated with greater TB disease severity and mortality [16], which plausibly translates to longer clinical stabilization requirements and consequently greater LOS. These findings are also consistent with the domestic evidence base: disease severity has been documented as a factor associated with longer LOS among TB patients at secondary hospitals in

Indonesia [17]. The most prevalent comorbidity combination in this cohort type 2 diabetes mellitus with hypertension represents a cardiometabolic multimorbidity profile characterized by hemodynamic instability, polypharmacy interactions, and the need for multidisciplinary clinical monitoring, all of which may prolong the inpatient episode.

Importantly, because this study employed a bivariate non-parametric analysis without multivariable adjustment, the observed association between comorbidity count and LOS cannot be interpreted as an independent or causal effect. Unmeasured confounders including nutritional status, TB disease severity, sputum-smear status, treatment category, and clinical stability indicators may mediate or modify this association. The findings should therefore be understood as hypothesis-generating rather than conclusive.

3.5. Age Group and Insurance Status

The absence of a statistically significant association between age group and LOS ($p = 0.241$) was contrary to the hypothesis that older patients, who typically carry higher comorbidity burdens and have diminished physiological reserves, would have longer hospitalizations. Several explanations are plausible within this study's design. First, because comorbidity count was analyzed separately and not adjusted for simultaneously, any age-related LOS difference may be partially attributable to the higher comorbidity prevalence observed in older age groups rather than to age per se. Second, the age distribution was concentrated in the working-age and younger-elderly groups (75.3% aged under 65 years), which may have limited statistical power to detect age-related LOS gradients, particularly for the ≥65 year stratum ($n = 53$). Third, standardized clinical management protocols may reduce age-based variation in LOS through consistent discharge criteria. Evidence from low- and middle-income countries suggests that when clinical pathways are standardized, age-related variation in TB hospitalization duration tends to diminish, with comorbidity profile emerging as the dominant driver [18].

Similarly, insurance status was not significantly associated with LOS ($p = 0.452$). Given that 98.1% of the cohort was covered by JKN/BPJS Health, the self-pay subgroup comprised only four patients, making this comparison statistically underpowered and the result largely uninterpretable for inferential purposes. The near-universal JKN coverage in this cohort reflects the broad expansion of Indonesia's national health insurance program [4]. Under INA-CBGs, the fixed-tariff structure may homogenize LOS across payer categories in publicly covered patients, as discharge decisions are driven more by clinical criteria and tariff efficiency considerations than by individual payer status [6]. This interpretation is speculative given the analytical limitations, however, and should not be generalized without adequately powered comparative data.

3.6. Strengths and Limitations

This study has several strengths. The restriction of the analytical sample to patients with pulmonary TB as the primary diagnosis reduces LOS estimation bias attributable to other principal conditions, a methodological refinement not consistently applied in prior Indonesian studies. The use of non-parametric inferential testing with explicit effect-size reporting (η^2) strengthens the quantitative characterization of the comorbidity–LOS association beyond statistical significance alone. Data quality was verified through double-entry concordance checking.

Several limitations must be acknowledged. First, the retrospective secondary-data design precluded adjustment for important clinical confounders, including nutritional status (body mass index), sputum-smear positivity, prior TB treatment history, MDR-TB status, and validated clinical severity scores such as qSOFA or CURB-65. The observed associations are therefore unadjusted and cannot be attributed independently to any single variable. Second, this was a single-center study at a secondary-level hospital, limiting the generalizability of findings to hospitals with different service profiles, case-mix compositions, or financial structures. Third, the very small self-pay subgroup ($n = 4$) rendered the insurance status comparison statistically uninformative. Fourth, the study did not capture post-discharge outcomes such as 30-day readmission rates, treatment adherence, or sputum conversion, which are more direct indicators of whether short LOS reflects efficient care or premature discharge. Fifth, the observation window covered only eight months (January–August 2025), which may not reflect seasonal or annual variation in TB admission patterns.

4. Conclusion

This retrospective descriptive-analytic comparative study, conducted at a secondary general hospital in Medan, Indonesia, found that the median LOS among 215 pulmonary TB inpatients was 3 days (IQR 2–4). Of the three variables examined, comorbidity count was the only variable significantly associated with LOS (Kruskal–Wallis $H = 18.74$, $p < 0.001$; $\eta^2 = 0.082$, medium effect size). Patients with ≥2 comorbidities had a mean LOS approximately 48% longer than those without comorbidity. Age group and insurance status were not significantly associated with LOS in this sample, though the very small self-pay subgroup substantially limited the power of the insurance comparison.

These findings suggest that comorbidity burden is an important consideration in inpatient TB management at secondary-level facilities in Indonesia, and that patients with multiple comorbidities may warrant enhanced clinical planning and resource allocation from the time

of admission. Given the limitations of the bivariate, single-center, retrospective design, these results should be interpreted as associative rather than causal, and generalization beyond comparable secondary hospitals in urban North Sumatra requires caution.

Future research should prioritize prospective multicenter cohort studies with larger samples, multivariable adjustment (e.g., Cox proportional-hazards regression or quantile regression) for key clinical confounders, and inclusion of post-discharge outcomes such as 30-day readmission rates and treatment adherence. Investigation into whether the comorbidity-associated LOS prolongation reflects genuine clinical necessity or inefficiencies in care coordination would inform the design of TB–multimorbidity clinical pathways. Evaluation of the adequacy of current INA-CBGs TB tariff structures in reflecting the resource requirements of multimorbid patients would also contribute to evidence-based hospital financing policy in Indonesia.

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