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Clinical Validation of the Lambaréné Organ Dysfunction Score (LODS) and its influence on Survival in Congolese children presenting with Severe Malaria

Validation clinique du LODS (Lambaréné Organ Dysfunction Score) et son influence sur la Survie chez les enfants Congolais atteints de Paludisme grave

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Résumé

Contexte et objectif. Le paludisme grave de l'enfant (PGE) demeure une cause majeure de mortalité dans les pays à faibles ressources. Le *LODS (Lambaréné Organ Dysfunction Score)*, un score clinique simple, permet d'estimer le risque de décès chez ces enfants. Cette étude visait à évaluer sa performance prédictive dans une population pédiatrique atteinte de paludisme grave (PG). *Méthodes.* Cette étude de suivi longitudinal rétrospectif a inclus des enfants âgés de 2-9 ans avec PG, hospitalisés entre le 30 janvier et le 31 juillet 2017 à l'Hôpital Mère-Enfant Monkole et au Centre Pédiatrique Kimbondo à Kinshasa, en République Démocratique du Congo (RDC). Les performances du LODS ont été évaluées par une analyse de la courbe ROC (Receiver Operating Characteristic), avec la discrimination mesurée par l'aire sous la courbe (AUC). Son impact sur la survie a été analysé à l'aide des courbes de Kaplan–Meier et du modèle de régression à risques proportionnels de Cox. *Résultats.* Au total, 100 enfants ont été inclus (âge médian : 4 ans [IQR : 3-4] ; 61 % de garçons). La mortalité hospitalière était de 17 %, avec un temps médian de survie de 3 jours. Le LODS a montré une performance discriminative modérée (AUC : 0,78 **;** IC à 95 % : 0,49-1,00), légèrement inférieure aux études antérieures. Des valeurs élevées du LODS (≥2) étaient significativement associées à une diminution de la survie (HR : 6,57 ; IC à 95 % : 1,36-8,27 ; p = 0,003). *Conclusions***.** Le LODS prédit la mortalité et la survie chez les enfants atteints de PG. Des validations supplémentaires dans d'autres populations restent nécessaires pour confirmer son utilité dans l'orientation des interventions ciblées.

Mots-clés : Lambaréné Organ Dysfunction Score, Paludisme grave de l'enfant, Prédiction de la

Summary

Context and objective. Pediatric severe malaria (PSM) remains a leading cause of morbidity and mortality among children in resource-limited settings. Reliable risk prediction tools are critical for timely and effective management. The *Lambaréné Organ Dysfunction Score* (LODS) is a simple bedside tool for estimating mortality risk in children with severe malaria (SM), particularly in low-resource environments. This study evaluated the predictive performance of LODS and its impact on survival in Congolese children with SM. *Methods.* This retrospective longitudinal follow-up study included children aged 2-9 years with SM, hospitalized between January 30 and July 31, 2017, at Monkole Mother and Child Hospital and Kimbondo Pediatric Center in Kinshasa, Democratic Republic of Congo (DRC). LODS performance for predicting in-hospital mortality was evaluated using receiver operating characteristic (ROC) analysis, with discrimination quantified by the area under the curve (AUC). Its impact on survival was examined using Kaplan–Meier and Cox proportional hazard analyses. *Results.* A total of 100 children were included (median age 4 years [Interquartile range (IQR):3-4]; 61% male). In-hospital mortality was 17%, with a median survival time of 3 days. The LODS showed moderate discriminative performance for mortality prediction [AUC: 0.78; 95% CI: 0.49-1.00], slightly lower than prior reports. Higher LODS values (≥2) were significantly associated with reduced survival (HR: 6.57, 95% CI: 1.36-8.27, p = 0.003). *Conclusions.* The LODS predicts mortality and survival in PSM. Further

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mortalité,
Validation clinique

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validations across populations are needed to support its use in guiding targeted interventions.
Keywords: Clinical validation, Lambaréné Organ Dysfunction Score, Mortality prediction, Pediatric severe malaria, Survival analyses

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Introduction

Pediatric severe malaria (PSM) remains a leading cause of morbidity and mortality among children in resource-limited settings (1). Given its substantial healthcare burden and societal impact, improved tools for early prediction and prevention are critical to strengthen clinical management. Severe malaria (SM) is increasingly recognized as a form of parasitic sepsis, characterized by intense systemic inflammation and multiple organ dysfunction (MOD) (2). Consequently, an optimal prognostic model for PSM should incorporate variables reflecting SM-induced MOD to accurately estimate mortality risk and guide timely interventions (3).

Several clinical prognostic scoring systems have been proposed for PSM, including the *Lambaréné Organ Dysfunction Score* (LODS) **(**4)**,** *Signs of Inflammation in Children that Kill* (SICK) (5, 6), and the *Pediatric Early Death Index for Africa* (PEDIA) (7). Although these models do not fully capture SM-related organ dysfunction, they remain valuable in resource-limited contexts. Nevertheless, their implementation in clinical practice presents challenges, particularly regarding whether their predictive accuracy is sufficient to guide early therapeutic interventions. Therefore, validating PSM-associated mortality risk models and assessing their generalizability across independent pediatric populations remain essential steps toward their clinical adoption.

Recent work by Conroy *et al.*(8) tested the utility of these three scoring systems to predict PSM-associated outcome in Uganda children presenting with malaria and non-malaria febrile illness and compared their discrimination power. Their findings indicate that all three scoring systems can predict PSM-associated death risk, but LODS yielded good discrimination power and was described as the most promising clinical prognostic score. Here, we validated the LODS and assessed its influence on survival in Congolese children presenting with SM.

Methods

Study design and setting

This is a retrospective longitudinal follow-up study of existing data from 100 children aged 2-9 years who were admitted with SM between January 30 and July 31, 2017 at the Monkole Mother and Child Hospital and the Kimbondo Pediatric Center, two healthcare facilities in Kinshasa City, Democratic Republic of the Congo, selected through a purposive sampling approach. Both hospitals are located on the outskirts of Kinshasa and serve large populations from areas with high malaria transmission, where infection risk remains particularly high among children aged 2-9 years.

Patient selection

Inclusion criteria

The study included all children aged 2-9 years admitted to the emergency department or intensive care unit between January 30 and July 31, 2017, with SM diagnosed according to the World Health Organization (WHO) case definition (9, 10).

No inclusion criteria

Patients were excluded from the study if data of interest were unavailable, or if admission was due to non-parasitic infections, disorders capable of inducing anemia or associated abnormalities, or SM accompanied by other comorbid conditions.

Study procedures

The study consisted of a secondary analysis of existing data. The initial database included 52 clinical and biological variables collected during hospitalization period for a previous study on the *prognostic evaluation of measured anions in children with SM* (unpublished data). From this dataset, 20 variables were selected for the present analyses, encompassing demographic, clinical, and laboratory parameters. Demographic variables included age and sex. Clinical variables covered fever episodes, body temperature, coma, prostration, deep breathing, seizures, pallor, heart rate, respiratory rate, Kussmaul (ketoacidosis) respiration, duration of stay in the paediatric intensive care unit (PICU), and antimalarial treatment received.

Laboratory variables included hematocrit measurement and parasitemia assessment using a finger-prick thick blood film and a rapid diagnostic test (RDT) for *Plasmodium* species identification. Children with SM were further classified according to disease complications, including cerebral malaria (CM), severe malarial anaemia (SMA), and severe respiratory malaria (SRM), as defined by WHO definition criteria(9-11).

Operational definitions

The following definitions were used in this study: *(i) A standardized diagnosis of SM* was established using the WHO case definition(9,

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10), as a composite of any *Plasmodium* parasitemia (falciparum or other species), detected by asexual stages on a peripheral blood slide or a positive RDT in combination with one or more clinical and/or laboratory indicators of severe disease.

(ii) In-hospital mortality was defined as any death occurring during the same hospitalization for SM, irrespective of the time elapsed between admission and death.

(iii) Survival Time was defined as the interval between hospital admission for SM and death occurring during the hospitalization period. The hospitalization period extended from admission for SM to death (for non-survivors) or discharge (for survivors). Patients who were still alive at the end of the hospitalization period of up to 7 days (follow-up period for each patient = 7 days) or those lost to follow-up were considered censored.

(iv) Clinical validation of the LODS aimed to assess its performance and transferability in predicting the risk of death among Congolese children with SM. This step sought to determine whether the model (LODS), originally developed and validated in other African settings, retained its discriminative ability and clinical relevance in an independent population.

(v) The Lambaréné Organ Dysfunction Score:

The LODS is a simple bedside clinical tool used to assess SM severity and predict the SM-associated mortality risk, particularly in resource-limited settings. The score comprises three clinical parameters, including prostration**,** coma**,** and deep breathing, each assigned one point when present, for a total score ranging from 0 to 3. Prostration was defined as the inability of a child to sit, stand, or drink/breastfeed according to age, coma was determined using a Blantyre Coma Score (BCS) ≤ 2, and deep breathing indicated respiratory distress consistent with metabolic acidosis.

prostration, coma, and deep breathing, were defined according to the original derivation study(4). The LODS model was computed using multivariable logistic regression. The discriminative and predictive abilities of the LODS were assessed using standard point for each present predictor. The optimal cutoff value for classifying patients as high or low risk, based on the continuous LODS, was determined using Youden's Index (12), which maximizes sensitivity and specificity. Finally, the categorical LODS variable was entered into a binary logistic regression model to estimate the risk of SM-associated death.

A total LODS of 0 indicates no organ dysfunction and corresponds to a low risk of death, scores of 1–2 reflect moderate organ dysfunction and an intermediate risk, while a score of 3 denotes multiple organ dysfunction and a high risk of death. In the original study by Helbok *et al.*(4), the LODS demonstrated good discriminatory performance, with an area under the receiver operating characteristic curve (AUC) of approximately 0.83. Subsequent validation studies, such as that by Conroy *et al.*(8), confirmed its prognostic value with an AUC ranging from 0.70 to 0.80.

Statistical analyses

The data were compiled into an Excel 2025 database (version 16.102.1 (25101829) and subsequently exported to RStudio version 2025.05.1+513 (Copyright (C) 2025 by Posit Software, PBC) for analyses. Statistical analyses were conducted in two stages: (i) descriptive statistics of the study population and (ii) analyses according to study objectives. The primary endpoint was survival**,** defined as time to death. The LODS was validated using logistic regression analyses and its impact on survival assessed through survival analyses.

(i) Descriptive Statistics of the Study Population: Continuous variables were first evaluated for normality using the Shapiro-Wilk test. Normally distributed variables were expressed as mean ± standard deviation (SD) and compared using Student's *t*-test. Variables with a non-normal distribution were reported as median (interquartile range [IQR]) and compared using the Wilcoxon rank-sum test or Welch's two-sample *t*-test, as appropriate. Categorical variables were summarized as counts (N) with corresponding percentages (%) and compared using the χ^2 test or Fisher's exact test, as applicable.

(ii) LODS Model Computation and Validation: Predictor variables for the LODS, including classification metrics, including the AUC, F1-score, accuracy, sensitivity**,** specificity**,** precision, recall, and Cohen's kappa coefficient. Subsequently, an individual LODS value (0-3) was calculated for each patient by assigning one

(iii) Survival Model Development and Evaluation: Patients' LODS were dichotomized at the optimal threshold into LODS<1 and LODS≥2. Survival and hazard functions were

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first explored, and Kaplan–Meier curves stratified by LODS category were generated, with differences assessed via the log-rank test. A Cox proportional hazards model was then fitted to evaluate the independent effects of LODS and its individual predictors on survival. Model performance was assessed using the concordance index (C-index) for discrimination, time-dependent Brier score for prediction error, and calibration plots for agreement between predicted and observed survival. A *P*-value < 0.05 was considered statistically significant for all analyses.

Ethical Approval

The study was conducted in accordance with the principles outlined in the Declaration of Helsinki and international scientific standards(13, 14). The data collection was approved by the local Ethics Committee of the Center for Training and Health Support (CEFA-Centre de Formation et d'Appui Sanitaire)-Monkole (004/CEFA-MONKOLE/CEL/2016) for both the initial and subsequent studies. This approval covered both healthcare facilities involved, given their partnership. At the time of data collection, written informed consent was obtained from the legal guardian of each enrolled child, and all data were fully anonymized prior to analysis or review.

Results

Characteristics of the Study Population

The study included 100 children with a confirmed diagnosis of SM. Of these, 61 (61%) were male. Seventeen (17%) patients died during hospitalization, while 83 (83%) survived. The median survival time was 3 days (IQR: 2-3), and the median age of the cohort was 4 years (IQR: 3-4). Clinical features including febrile episodes, coma, prostration, deep breathing, and ketoacidosis respiration were significantly associated with SM-associated mortality risk (p<0.05 for all). Regarding specific clinical diagnoses, 37 (37%) children presented with CM, 50 (50%) with SMA, and 29 (29%) with SRM. These SM complications were significantly associated with in-hospital mortality (p<0.05 for all). Detailed clinical and laboratory characteristics of the study population are presented in Table 1.

Table 1. Characteristics of the study population

Characteristics	Overall (N=100)	Survivors (n=83)	Deceased (n=17)	*P*-value
Demographic Characteristic				
Age, years	4 [3-4]†	4 [3-4]†	4 [3-4]†	0.443
Male sex, No (%)	61 (61)	50 (60)	11 (65)	0.943
Examination Findings				
Febrile episodes	4 [3-4]†	3 [3-4]†	4 [4-5]†	**0.0002**
Temperature, ºC	38.25 [37.78-39]†	38.20 [37.8-39]†	38.30 [37.7-39.5]†	0.577
Coma, No (%)	40 (40)	28 (33.73)	12 (70.6)	**0.011**
Prostration, No (%)	57 (57)	54 (65.06)	3 (17.65)	**0.0009**
Deep breathing, No (%)	29 (29)	19 (22.89)	10 (58.82)	**0.007**
Convulsions, No (%)	37 (37)	24 (28.91)	13 (76.47)	**0.0006**
Pallor, No (%)	85 (85)	69 (83.13)	16 (94.12)	0.433
Heart rate, per minute	121.28 (20.31)*	121.08 (16.94)*	122.24 (32.88)*	0.889
Resp_rate, per minute	32 [28-40]†	36 [30.5-40]†	24 [20-31]†	**2.28e-05**
Ketoacidosis_Resp, No (%)	31 (31)	18 (21.69)	13 (76.47)	**3.16e-05**
Length of stay at PICU	3 [2-3]†	3 [2-4]†	1 [1-1]†	**< 2.2e-16**
Antimalarial therapy, No (%)	90 (90)	75 (90.36)	15 (88.24)	1
Final Diagnoses				
CM, No (%)	37 (37)	24 (28.92)	13 (76.47)	**0.0006**
SMA, No (%)	50 (50)	46 (55.42)	4 (23.53)	**0.033**
SRM, No (%)	29 (29)	19 (22.89)	10 (58.82)	**0.007**
Laboratory Test results				
Hematocrit, %	16 [13-22.25]†	15 [13-22]†	21 [16-23]†	0.628
Parasitemia[b], parasites/µL	54.43 (2.15)[b]	52.35 (2.22)[b]	65.87 (1.75)[b]	0.629
RDT, No (%)	72 (72)	64 (77.11)	8 (47.06)	**0.026**

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The table presents data for children aged 2-9 years diagnosed with severe malaria. Statistically significant ***P*** values are shown in bold. For continuous variables, distributions are summarized as follows: (i) normally distributed variables are reported as mean with standard deviation (SD) in parentheses and marked with an asterisk (*), while (ii) non-normally distributed variables are expressed as median with interquartile range [IQR] in brackets and denoted with a dagger (†). The variable for parasitemia, indicated by the subscript letter *b*, is summarized using the geometric mean along with the 95% geometric confidence interval (GCI) and geometric standard deviation (gSD). Categorical variables are reported as counts (N) with corresponding percentages in parentheses (%).

Abbreviations: CM, Cerebral malaria; Ketoacidosis_Resp, ketoacidosis respiration; PICU, pediatric intensive care unit; RDT, rapid diagnosis test; Resp_rate, respiratory rate; SMA; Severe malaria anaemia; SRM, Severe respiratory malaria.

LODS Validation in Congolese Children with Severe Malaria

A logistic regression model was computed using the three LODS predictors, including prostration, coma, and deep breathing, to predict SM-associated mortality. In univariate logistic regression, all three predictors were significantly associated with death ($p < 0.05$ for all, Table 2). However, in multivariable analysis, only prostration and deep breathing remained strong independent predictors ($p < 0.05$ for all), while coma showed a positive association but did not reach statistical significance ($p = 0.21$, Table 2).

Table 2. Logistic Regression Model Predicting Severe Malaria-Associated Mortality Based on individuals LODS Predictors

LODS' Predictors	**Univariable**			**Multivariable**		
	***β* (SE)**	**OR (95% CI)**	***P*-value**	***β* (SE)**	**Adjusted OR (95% CI)**	***P*-value**
Coma	1.56 (0.58)	4.7 (1.58- 16.06)	**0.008**	3.43 (2.75)	0.32 (0.12- 1.68)	0.21
Prostration	2.16 (0.68)	0.12 (0.03- 0.39)	**0.001**	6.11 (2.82)	0.26 (0.62- 1.29)	**0.03**
Deep breathing	0.24 (0.06)	0.78 (0.69- 0.88)	**5.08e^{-05}**	0.16 (0.04)	8.49 (7.73- 9.14)	**9.73e^{-05}**

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Abbreviations: LODS, The *Lambaréné Organ Dysfunction Score*, OR, odds ratio; SE, standard error; CI, confidence interval

Model performance metrics showed a recall of 0.51, F1-score of 0.59, and Cohen's kappa of 0.29. The model achieved a moderate AUC of 0.78 [95% confidence interval (CI): 0.49-1.00, Figure 1] and an overall accuracy of 0.87 (95% CI: 0.69-0.96), suggesting that while LODS alone has limited predictive power, it may still be clinically useful as part of a composite prognostic tool. The LODS, calculated for each patient, ranged between 1 and 2, with a threshold ≥ 2 offering a reasonable cutoff for identifying higher-risk patients. Patients with LODS ≥2 had significantly higher odds of death [Odds ratio (OR): 4.40; 95% CI: 1.22-17.06; *p*: 0.025], with 100% sensitivity for predicting mortality and a specificity of 20% for identifying survivors.

*Influence of the LODS on Survival Outcomes in Congolese Children with Severe Malaria*Cox proportional hazards analyses showed that all three LODS components were independently associated with higher mortality in children with SM ($p < 0.05$, Table 3). A LODS≥2 significantly predicted poorer survival (HR: 6.57; 95% CI: 1.36-8.27; $p = 0.003$, Table 3), with each one-unit increase in LODS corresponding to a 6.6-fold higher risk of death.

Table 3. Univariate and Multivariate Cox Proportional Hazards Models Assessing the Association Between LODS as well as its Individual Predictors with Mortality Risk

Variables	Univariable			Multivariable		
	Log HR (SE)	HR (95% CI)	*P*-value	Log HR (SE)	Adjusted HR (95% CI)	*P*-value
LODS≥2	1.88 (0.29)	6.57 (1.36-8.27)	**0.003**	NA	NA	NA
Individual Predictors of LODS						
Coma	1.69 (0.37)	5.42 (2.61-11.24)	**5.55^{e-06}**	1.88 (0.59)	6.57 (1.06-32.64)	**0.002**
Prostration	2.29 (0.47)	9.87 (4.04-14.26)	**$1.4e^{-06}$**	3.49 (0.73)	32.61 (2.01-142.8)	**$1.62e^{-06}$**
Deep breathing	1.12 (0.02)	3.06 (1.85-4.92)	**$3.23e^{-09}$**	1.09 (0.02)	2.97 (2.41-3.62)	**$7.57e^{-06}$**

Abbreviations: CI, confidence interval; HR, hazard ratio; LODS, The *Lambaréné Organ Dysfunction Score*; NA, not applicable

Severe Malaria Using the Receiver Operating Characteristic Curve (AUC = 0.78)

Abbreviations: AUC: Area Under the Curve, LODS: ***Lambaréné Organ*** predictor of mortality in Congolese children with SM

Dysfunction score

The model achieved a C-index of 0.60 (95% CI: 0.53-0.67**)** and an Integrated Brier Score (IBS) of 0.117, performing slightly below the reference model (IBS = 0.105) but showing good discrimination (concordance = 0.798) and strong overall significance ($p < 0.001$). Children remained event-free for an average of 4.21 days and survived a mean of 4.72 days overall. Mortality increased with LODS, from one death every seven days (LODS<2) to one every three days (LODS≥2). As shown in Figure 2A-B, survival curves diverged after day 2, with significantly poorer survival for higher LODS values (log-rank $p = 0.0085$), confirming LODS as a strong**.**

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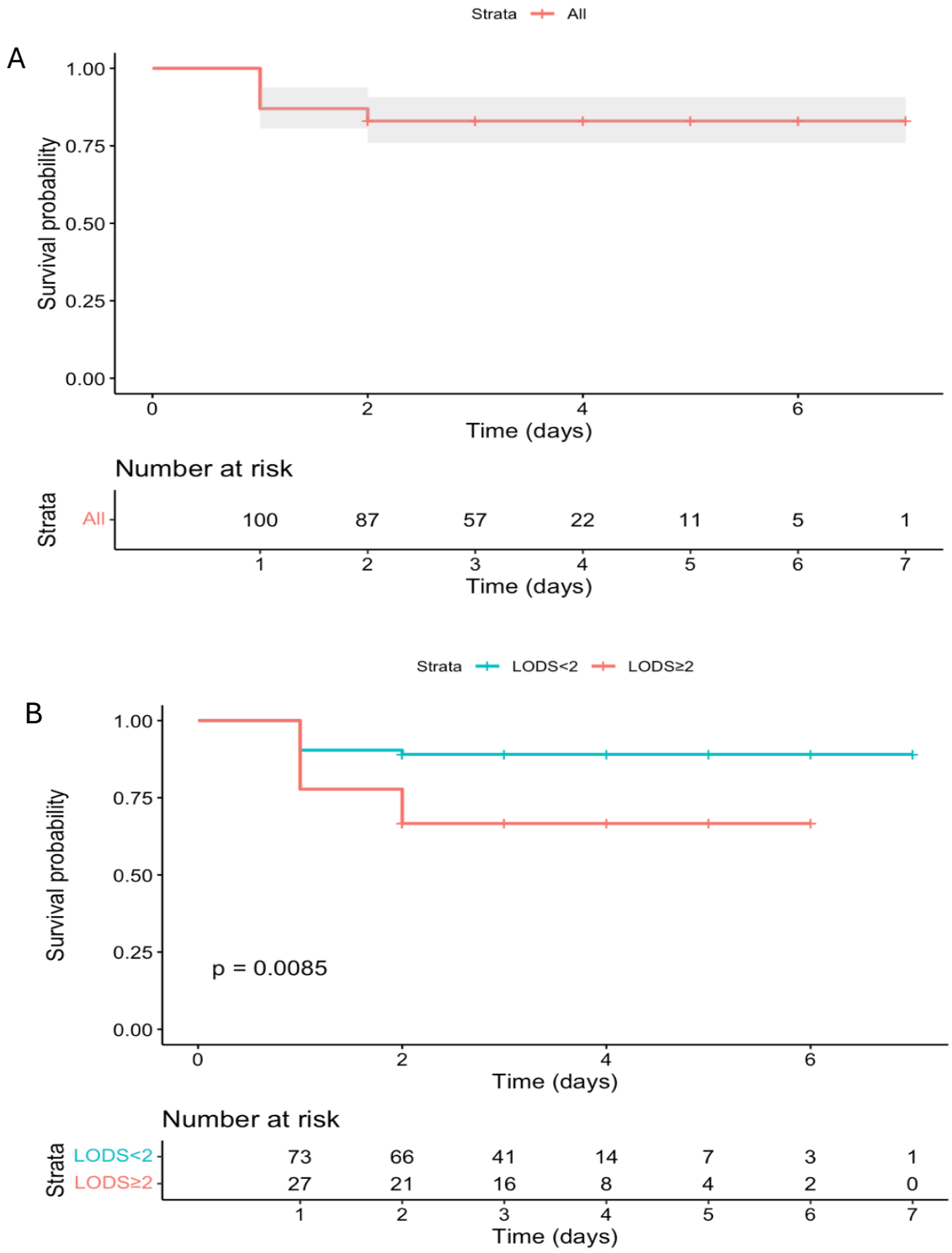

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Figure 2. Kaplan-Meier Survival Curves of Children with Severe Malaria according to the LODS. **Panel A**: Overal survival of all patients (n=100). Most deaths occurred in the first few days. **Panel B**: Survival by LODS. Children with LODS≥2 had a much lower survival rate than those with LODS<2 (p =0.0085).
Abbreviations: AUC: Area Under the Curve, LODS: *Lambaréné Organ Dysfunction Score*

Discussion

Main Findings

Clinical prognostic scoring systems for PSM are simple, practical tools with considerable potential in resource-limited settings. Early identification of children at high risk of death could enable timely allocation of resources and implementation of effective therapeutic interventions. To this end, we conducted a scoping review and identified three relevant clinical models, including LODS (4), SICK (5, 6) and PEDIA (7), and selected the LODS for validation based on its demonstrated discrimination and calibration in prior studies(4, 8).

This study provides important clinical validation of the LODS as a prognostic tool for predicting mortality in Congolese children with SM. Our findings confirm that the LODS, based on three simple clinical variables, including prostration, coma, and deep breathing, can effectively stratify children by death risk, consistent with previous reports in other African populations(4, 8). Specifically, a higher LODS was strongly associated with increased risk of in-hospital mortality, with children scoring ≥2 demonstrating significantly poorer survival outcomes.

Despite moderate discrimination performance (AUC 0.78), the LODS offers a practical and easily implementable scoring system suitable for resource-limited settings where advanced diagnostics are unavailable. The high sensitivity and low specificity observed indicate that, although the LODS alone may not fully capture all mortality risks compared with more comprehensive models integrating clinical and laboratory parameters reflective of SM-related multi-organ dysfunction and metabolic or electrolyte disturbances(3, 17), it remains a valuable preliminary screening tool for identifying high-risk patients who may benefit from closer monitoring and timely interventions.

Our survival analyses revealed distinct survival trajectories between low- and high-LODS limited settings. Overall, these strengths reinforce

Our findings confirm that the LODS is a useful predictor of PSM-associated mortality; however, its predictive performance was moderate in our cohort of Congolese children with SM. This reduction in performance may reflect the limited sample size (15, 16) or suggest that LODS alone is insufficient as a standalone prognostic tool, but may be valuable as part of a broader predictive model. Notably, the coma variable, while showing increased odds of death in univariate analysis, lost statistical significance in multivariate modeling (p = 0.21, Table 2), potentially due to multicollinearity with prostration, given the clinical overlap between these signs.

Using survival analysis, we further demonstrated that LODS significantly influences survival time, with LODS ≥2 being associated with a high risk of death. Although the validated model exhibited acceptable discrimination and precise estimates, the wide confidence intervals for prostration and coma hazard ratios likely reflect sample size limitations (15, 16).
groups, highlighting its potential utility not only for risk stratification but also for prognostication over time. The significant hazard ratios observed reinforce the clinical relevance of organ dysfunction markers in SM pathophysiology, emphasizing the role of systemic complications in driving mortality in SM.

Strengths and Limitations

Our study offers several important strengths. First, it provides a rigorous clinical validation of the LODS in Congolese children, addressing a critical gap by evaluating the tool in a Central African setting where malaria burden and clinical presentation may differ from previous study populations. The use of real-world clinical data from a high-burden Congolese setting strengthens the external validity and practical applicability of the findings. Additionally, the study evaluates not only the predictive performance of LODS but also its influence on survival outcomes, offering a comprehensive assessment of its prognostic value. By focusing on a particularly vulnerable pediatric population, the study contributes evidence capable of improving risk stratification, triage, and management of PSM in resource-

the utility of LODS as a simple and effective tool

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that can support clinical decision-making and potentially inform local or national guidelines for PSM care.

Several limitations should be acknowledged. The relatively small sample size represents a major constraint, as it may reduce the model's ability to distinguish true signal from background noise, thereby increasing estimation error and lowering predictive performance compared with larger datasets. Future prospective, multicenter studies with larger cohorts are needed to validate LODS thresholds and assess its integration into clinical practice. Finally, the moderate predictive performance suggests that integrating LODS with additional clinical or laboratory variables could enhance its overall accuracy.

Conclusion

In summary, the LODS was clinically validated in a cohort of Congolese children presenting with SM. The score demonstrated the ability to predict SM-associated mortality, showing moderate discriminative power, though slightly lower than previously reported in other settings. Importantly, higher LODS values were significantly associated with poorer survival outcomes, underscoring its relevance as a prognostic tool in this population.

Although it may take time before prognostic scoring systems for PSM are routinely implemented in clinical practice to predict disease severity and mortality risk, their potential utility in identifying critically ill children and guiding decisions on the appropriate level of care is considerable. Purely clinical models such as the LODS remain particularly valuable in resource-limited settings. This study supports its clinical utility for early identification of children at greatest risk of SM-associated death in resource-constrained environments. Its simplicity and feasibility position it as a promising tool to guide triage, resource allocation, and timely therapeutic decisions, ultimately improving patient outcomes. However, meaningful advances in the prediction of PSM-associated severity will depend on continuous efforts to critically assess the strengths and limitations of existing models and to develop more comprehensive tools that integrate clinical, laboratory, and imaging parameters reflective of PSM-induced multi-organ dysfunction.

Conflict of interest

The authors have no conflicts of interest to disclose.

Contribution for authors

KBK, VNM, GLM, JMB and CNN contributed to the study concept and design. VNM was responsible for data collection. KBK performed statistical analysis, data analysis and interpretation. KBK and CNN drafted the initial version of the manuscript. CNN and JMB supervised the study. All authors critically revised the manuscript for important intellectual content and approved the final as well revised version of the manuscript.

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