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Predictive Value of Clinician Impression for Readmission and Post-Discharge Mortality among Neonates and Young Children in Dar es Salaam, Tanzania and Monrovia, Liberia

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Word Count: 2,500
Abbreviations: AUC: area under the receiver operating characteristic curve; 95% CI: 95% confidence interval

Data Sharing Agreement

Data may be made available upon reasonable request to the corresponding author.

Ethics Approval

The study received ethical clearance from the Tanzania National Institute of Medical Research (#NIMR/HQ/R8a/Vol.IX/3494), the Muhimbili University of Health and Allied Sciences Research and Ethics Committee (#307/323/01), the John F. Kennedy Medical Center Institutional Review Board (#08062019), the Boston Children's Hospital Institutional Review Board (#P00033242), and the use of de-identified data was exempted from review by the Emory University Institutional Review Board (no number provided for exempted studies).

Transparency Declaration

This manuscript is an honest and accurate account of the study being reported. No aspects of this study have been omitted or withheld.

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Abstract

Background: There are no validated clinical decision aids to identify neonates and young children at risk of hospital readmission or post-discharge mortality in sub-Saharan Africa, leaving the decision to discharge a child to a clinician's impression. Our objective was to determine the accuracy of clinician impression to identify neonates and young children at risk for readmission and post-discharge mortality.

Methods: We conducted a survey study nested in a prospective observational cohort of neonates and children aged 1-59 months who were followed up to 60 days after hospital discharge from Muhimbili National Hospital in Dar es Salaam, Tanzania or John F. Kennedy Medical Center in Monrovia, Liberia. Clinicians who discharged each enrolled patient were surveyed at the time of discharge to determine their perceived probability of the patient's risk of 60-day hospital readmission or post-discharge mortality. We calculated the area under the receiver operating characteristic curve (AUC) to determine the accuracy of clinician impression for both outcomes.

Results: Of 4,247 discharged patients, 3,896 (91.7%) had available clinician surveys and 3,847 (98.7%) had 60-day outcomes available: 187 (4.8%) were readmitted and 120 (3.1%) died within 60 days of hospital discharge. Clinician impression had poor discriminatory value in identifying neonates and young children at risk of hospital readmission (AUC 0.46, 95% CI 0.43 to 0.49) and post-discharge mortality (AUC 0.53, 95% CI 0.50 to 0.55). Patients for whom clinicians attributed inability to pay for future medical treatment as the reason for risk for unplanned hospital readmission had 4.76 times the odds hospital readmission (95% CI 1.31 to 17.25, P=0.02).

Conclusions: Given the poor discriminatory value of clinician impression alone to identify neonates and young children at risk of hospital readmission and post-discharge mortality, validated clinical decision aids are needed to aid in the identification of young children at risk for these outcomes.

What is already known on this topic?

- In parts of sub-Saharan Africa, hospital readmissions and post-discharge mortality rates are estimated to be as high as 18% within months of hospital discharge
- There are no validated clinical decision aids to accurately identify neonates, infants, and young children at risk of hospital readmission or post-discharge mortality in sub-Saharan Africa

What this study adds?

- In a survey study nested in a prospective observational cohort study conducted at referral hospitals in Tanzania and Liberia that included clinician surveys on 3,896 neonates, clinician impression alone had poor discriminatory value in identifying neonates, infants, and children at risk of hospital readmission within 60 days of hospital discharge
- Clinician impression also did not accurately identify neonates, infants, and children at risk of 60-day post-discharge mortality

How this study might affect practice?

- Clinician impression alone is not sufficient to accurately identify neonates, infants, and children at risk of hospital readmission or post-discharge mortality
- Validated and objective clinical decision aids are urgently needed to better identify neonates, infants, and children at risk of hospital readmission and post-discharge mortality

Introduction

The time after an inpatient hospital admission is particularly vulnerable in the life of a child in sub-Saharan Africa, where readmissions are common[1,2] and where more than half of the estimated 5 million annual deaths among children aged <5 years occurred in 2020.[3,4] Childhood mortality rates in the period immediately after hospitalization for an illness (i.e., the post-discharge period) may outpace rates of mortality during hospitalization.[5,6] In parts of sub-Saharan Africa, readmission and post-discharge mortality rates are estimated to be as high as 18% within six months after hospital discharge.[5,7]

Although clinical prediction rules for all-cause hospital readmissions among children in high-income settings have been developed,[8] to our knowledge, there are currently no clinical prediction rules for hospital readmissions among children in resource-limited settings. There are clinical prediction rules that have been developed to identify children at risk of post-discharge mortality in some settings in sub-Saharan Africa.[6,9,10] However, these clinical prediction rules lack external validation and thus are not widely used in clinical practice. Given the absence of validated risk assessment tools to identify young children at risk of readmission and post-discharge mortality in sub-Saharan Africa, the decision to safely discharge a young child from a hospital is often driven by clinical judgement.

Clinician impression relies on the clinician's ability to recognize pattens that may be associated with severe disease or an adverse outcome.[11] However, the accuracy of clinician impression to predict outcomes, such as severe disease from infections, among children has varied in previous studies conducted in high-income settings.[12–14] In a survey of 39 providers in Kenya, clinicians under-estimated the overall incidence of post-discharge mortality among children.[15] However, that study did not assess clinician impression of post-discharge mortality for individual patients and, to our knowledge, that has not been studied previously.

Given the absence of validated prognostic tools for hospital readmission and post-discharge mortality among children in sub-Saharan Africa, we aimed to determine the accuracy of treating clinicians' clinical impression to identify neonates and young children at risk for hospital readmission and post-discharge mortality in Dar es Salaam, Tanzania and Monrovia, Liberia.

Methods

Study Design

We conducted a survey nested in a prospective observational cohort study of pediatric patients discharged from Muhimbili National Hospital in Dar es Salaam, Tanzania and John F. Kennedy Medical Center in Monrovia, Liberia from October 2019 to January 2022. Details of our study protocol have been published previously.[16] Neonates and young children aged 1-59 months were enrolled at discharge from the neonatal or pediatric wards at each facility. Follow-up consisted of caregivers receiving phone calls up to 60 days after hospital discharge. Caregivers provided written consent for participation in Tanzania and oral consent in Liberia because of cultural preference and low rates of caregiver literacy.

Patient and public involvement statement

The development of the research question was informed by the disease burden of readmission and post-discharge mortality among children in sub-Saharan Africa. Patients were not involved in the design, recruitment, or conduct of the study, nor were they advisers in this study. Results of this study will be made publicly available through publication.

Study Setting

This study was conducted at two large, national referral hospitals supported by each country's Ministry of Health. They are in urban areas in their respective countries. Muhimbili National Hospital has a catchment of approximately 6 million people and John F. Kennedy Medical Center has a catchment of approximately 1.5 million people. Both hospitals are training hospitals for pediatric residents who are completing their specialty training.

Study Populations

Neonates and young children discharged from the wards were consecutively enrolled. Neonates and young children who died during initial hospitalization were excluded. Neonates and young children whose caregivers did not have telephones for follow up or those who declined enrollment were excluded.

Surveyed clinicians included consultants/specialists, interns/residents, or medical officers. Consultants/specialists were certified pediatricians or pediatric specialists who completed medical school, residency, and subspecialty training (for specialists). Interns/residents had completed medical school and were completing residency training in pediatrics. Medical officers received three years of clinical training prior to providing clinical care to patients.

Study Procedures

After obtaining informed consent from caregivers, trained research coordinators at each site approached the clinician who discharged each enrolled patient, obtained consent, and asked them to complete a survey near the time of the patient's hospital discharge. This survey modeled previous surveys that assessed clinician impression[13] and was developed through an iterative process by the research team with multiple opportunities to each investigator to refine the content. The survey was also reviewed by an expert in survey design (i.e., a survey methodologist) to ensure question clarity and appropriate response types (Appendix Survey). This survey was designed to allow clinician respondents to describe their perceived probability that each patient would experience both outcomes. Responses were recorded on standardized, electronic case report forms in electronic tablets using SQL (Tanzania) and KoboToolbox (Liberia).

Measurement and Outcomes

The exposure variable was the impression of the discharging clinician of the patient's risk of: 1) unplanned hospital readmission within 60 days of hospital discharge or 2) all-cause, 60-day post-

discharge mortality. Aligned with previous studies,[13] probabilities of perceived risk of readmission or post-discharge mortality included categorical options of 0%, 1-5%, 6-20%, 21-40%, 41-60%, 61-80%, 81-99%, and 100%. This survey also assessed discharging clinicians' perceptions of why readmission or post-discharge mortality were possible for those who were identified as at-risk for each outcome. Surveyed clinicians were familiar with the patients' clinical history and laboratory results during hospital admission. To assess for outcomes, phone calls to patients' caregivers were made by research staff at 7, 14, 30, 45, and 60 days after hospital discharge. Outcomes were determined as reported by caregivers to research staff.

Statistical Analyses

The association of the discharging clinicians' predicted probability of readmission or post-discharge mortality and proportion of patients at each clinician-estimated risk threshold (e.g., 0%, 1-5%, etc.) who were readmitted or died was compared using Chi-square or Fisher's exact testing (P<0.05 for significance).[13] We calculated sensitivity, specificity, positive predictive value, and negative predictive value of treating clinician's impression at each percent risk threshold using caregiver-reported readmission or post-discharge mortality as the reference standards. We determined the accuracy of clinician impression for identifying patients at risk of readmission or post-discharge mortality by calculating the area under the receiver operating characteristic curve (AUC). 95% confidence intervals (95% CI) for the AUC were calculated through 2,000 bootstrap replicates. We conducted sub-analyses by the discharged patient's age group (i.e., neonate or young child), clinician experience level (i.e., consultant/specialist, intern/resident, or medical officer), site, and time to outcome. We conducted binary logistic regression analyses to assess whether the perceived reason for risk for each outcome was associated with the patient's likelihood of each outcome. All tests were two-sided tests and used a 0.05 significance level. AUC analyses were conducted through the pROC package in R.[17] All analyses were performed in R Version 4.1.3 (R Foundation for Statistical Computing, Vienna, Austria) and SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

There were 4,460 discharged patients, 4,247 (95.2%) enrolled, and 3,896 (91.7%) had complete clinician surveys (Figure 1). Enrollment was approximately equal between the two sites (Tanzania n=1,997, 51.3%, Liberia n=1,899, 48.7%) (Table 1). There were 2,173 (55.8%) neonates and 1,723 (44.2%) young children who had clinician surveys available.

Sixty-day outcomes were available for 3,847 (98.7%) enrolled patients. The median age of enrolled neonates was 2 days (interquartile range [IQR] 1-7) and 12 months (IQR 5-24) for infants and children. The most common discharge diagnoses among neonates were sepsis (29.7%, n=609), prematurity (28.8%, n=591), and birth asphyxia (15.8%, n=323). Among infants and children, pneumonia (12.1%, n=223), diarrheal disease (10.1%, n=186), and malaria (7.2%, n=133) were the most common discharge diagnoses.

There were 187 (4.8%) patients readmitted and 120 (3.1%) died within 60 days of discharge. There were 80 (3.6%) neonates who were readmitted and 61 (2.8%) died within 60 days of hospital discharge. Among infants and children, 107 (6.2%) were readmitted and 59 (3.4%) died

after hospital discharge. The median time from hospital discharge to readmission was 30 days (IQR 7-45). The median time from hospital discharge to mortality was 30 days (IQR 14-45).

Clinician Impression and Hospital Readmission

Nearly three quarters of patients were perceived to have 0% risk of readmission within 60 days (Table 2). Clinician assigned probability of readmission was associated with readmission (P<0.001; Table 2). However, among the 187 neonates and young children who were readmitted, 80.7% (n=151) were perceived to have 0% risk of readmission.

Overall, clinician impression had poor discriminatory value in identifying neonates and young children at risk of readmission (AUC 0.46, 95% CI 0.43 to 0.49) (Table 3). Among medical officers, clinician impression had fair discriminatory value in identifying children at risk of readmission (AUC 0.67, 95% CI 0.55 to 0.79); this group was better at identifying patients at risk of readmission than interns/residents and consultants/specialists.

By clinician type, medical officer clinician impression had poor discriminatory value in identifying neonates (Supplemental Table 1) but fair discriminatory value in identifying infants and children at risk for readmission (Supplemental Table 2). In site-specific analyses, clinician impression was poor in identifying neonates and young children at risk of readmission at both sites (Supplemental Table 3). Regardless of the time from hospital discharge to readmission, clinician impression had poor discrimination in identifying neonates and young children at risk for readmission (Supplemental Table 4).

Clinician Impression and Post-Discharge Mortality

Most (97.2%, n=3,746) patients were assigned 0% risk of post-discharge mortality (Table 4). Clinician assigned probability of post-discharge mortality was associated with the outcome (P=0.002; Table 4). Among the 120 neonates and young children who died within 60 days of hospital discharge, 90.8% (n=109) were estimated to have a 0% probability of post-discharge mortality.

Overall, clinician impression had poor discriminatory value in identifying neonates and young children at risk post-discharge mortality (AUC 0.53, 95% CI 0.50 to 0.55) and did not vary substantially among interns/residents, specialist/consultants, or medical officers (Table 5). Clinician impression had poor discriminatory value in identifying post-discharge mortality among neonates (Supplemental Table 5) and infants and children (Supplemental Table 6). When analyzed by site, clinician impression in both Tanzania and Liberia had poor discriminatory value in identifying neonates and young children at risk of post-discharge mortality (Supplemental Table 7). Clinician impression had poor discriminatory value regardless of the time to post-discharge mortality (Supplemental Table 8).

Reason for Perceived Risk of Hospital Readmission and Post-Discharge Mortality

Patients for whom clinicians attributed inability to pay for treatment as the reason for readmission had 4.76 times the odds readmission (95% CI 1.31 to 17.25, P=0.02) compared to

those with no perceived risk (Table 6). Patients whose clinician cited "other" reasons to be at risk had lower odds of readmission compared to those whose clinician did not believe they were at risk for readmission (OR 0.24, 95% CI 0.09 to 0.66, *P*=0.005). Patients for whom clinicians attributed inability to pay for treatment as the reason for potential post-discharge mortality had 5.53 times the odds of post-discharge mortality (95% CI 1.22 to 25.10, *P*=0.03).

Discussion

Among nearly 3,900 neonates and young children discharged from referral hospitals in Dar es Salaam, Tanzania and Monrovia, Liberia, clinician impression had poor discriminatory value for identifying those at risk of unplanned hospital readmissions and post-discharge mortality. Medical officer clinician impression at both sites had fair discriminatory value in identifying young children at risk of readmission. Clinician perception of inability to pay for treatment was associated with readmission and post-discharge mortality.

The poor discriminatory value among clinicians in identifying neonates and young children at risk of readmission and post-discharge mortality differs from findings in studies in high-income settings that assessed the diagnosis of acute coronary syndrome and sinusitis in adults,[18,19] the presence of pneumonia[20] or the development of severe pneumonia among children,[13] or the presence of appendicitis among children.[21] This difference is likely multifactorial in nature and may consist of differences in available diagnostic and prognostic resources. Prior studies suggest that laboratory capabilities in resource-limited settings are inadequate,[22–24] leading to dependence on clinical exam findings to make diagnoses and determine prognosis,[25] which may hinder the accuracy of clinician impression in identifying neonates and young children at risk of untoward post-discharge outcomes. Moreover, clinicians may not consider key factors in the home (e.g., access to healthcare facilities and maternal health) that may contribute to post-discharge outcomes.

Clinician impression had poor discriminatory value in identifying neonates and young children at risk for readmission or post-discharge mortality regardless of the time from discharge to either event. Prior studies of clinician impression assessed outcomes within hours or days[13,18,19] and not up to 60 days. Several clinical prediction rules for post-discharge mortality have been developed but none have been validated or implemented in sub-Saharan Africa.[6,9,10] Thus, the current state of prognostic determination after discharge depends on clinician impression. Clinical decision aids to identify at-risk neonates and young children that perform well outside the population of derivation are urgently needed. Such clinical decision aids should include commonly collected variables and may include biomarkers to add precision to risk stratification to identify neonates and young children at risk of post-discharge morbidity and mortality.[26–28]

Clinician impression among medical officers had fair discriminatory value in identifying young children at risk of readmission. This may be due to the combination of more clinical experience than interns/residents and more time spent with patients than consultants/specialists who often spend less time directly with patients and more time supervising clinical care. Prior studies conducted in high-income settings demonstrate that clinician impression of less experienced clinicians may have less discriminatory value than that of more experienced clinicians.[13]

Our examination of reasons for estimated outcomes suggested that clinician perception of inability to pay for future treatment was associated with higher risk of readmission and post-discharge mortality. Young children from lower socioeconomic status have poorer overall health outcomes compared to young children from higher socioeconomic households in sub-Saharan Africa.[29–31] This is particularly relevant in the post-discharge period during which the financial burden of care seeking may influence the ability for a family to seek additional clinical care after a potentially costly hospital admission.

Limitations

Clinician impression is multifactorial and depends on clinical training as well as available laboratory, radiological, and clinical data that may not have been available to all discharging clinicians. We did not assess the availability of these in our analysis. We did not include nurses or clinical officers in our study, which is a limitation as these groups may have good insight into potential adverse outcomes after discharge. We could not account for the potential role that variations in the quality of clinical care provided to patients may have had in readmissions or post-discharge mortality.

Conclusions

Clinician impression had poor discriminatory value in identifying neonates and young children at risk of unplanned hospital readmission and post-discharge mortality at two referral hospitals in Dar es Salaam, Tanzania and Monrovia, Liberia. Validated and objective clinical decision aids to assist clinicians in the identification of young children at risk of readmission and post-discharge mortality may facilitate the identification of those at greatest risk.

Author Contributions: CAR, RK, RCI, AS, EG, HKM, CRS, MN, KPM, and CD conceptualized and designed the study. CAR, RCI, JK, AS, EG, CRS, KPM, and CD oversaw data collection and verified the underlying data. CAR and AM verified the underlying data. AM conducted the statistical analyses. CAR wrote the first draft of the manuscript. CAR, RK, RCI, JK, Y-JC, AS, EG, HKM, CRS, AM, MN, CRM, CGW, RFB, KPM, and CD interpreted the data, reviewed, and provided input to the final draft. CAR had final responsibility for the decision to submit for publication.

Competing Interests: The authors have no relevant competing interests to declare.

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Figure 1. Flow diagram for included neonates and children aged 1-59 months discharged from the neonatal wards and pediatric wards in Dar es Salaam, Tanzania and Monrovia, Liberia

Table 1. Characteristics of neonates and young children included in the evaluation of clinician impression on predicting 60-day hospital readmission or post-discharge mortality

Patient Characteristics	Overall Population, (N=3,896) n (%)	Readmitted to Hospital 60 Days After Hospital Discharge, (N=187) n (%)	Died 60 Days After Hospital Discharge, (N=120) n (%)
Discharged from Neonatal Ward[1]	2,173 (55.8)	80 (3.6)	61 (2.8)
Age in days at discharge, median (IQR)	2 (1, 7)	4 (2, 13)	2 (0, 10)
Discharged from Pediatrics Ward	1,723 (44.2)	107 (6.2)	59 (3.4)
Age in months for pediatric patients aged 1-59 months, median (IQR)[2]	12 (5, 24)	8 (4, 18)	8 (4, 21)
Sex[3]			
Male	2,198 (56.4)	109 (5.0)	74 (3.4)
Female	1,691 (43.4)	78 (4.6)	46 (2.7)
Country			
Tanzania	1,997 (51.3)	140 (7.0)	63 (3.2)
Liberia	1,899 (48.7)	47 (2.5)	57 (3.0)
Disposition from the Hospital			
Discharge	3,775 (96.8)	186 (4.9)	106 (2.8)
Left against medical advice	119 (3.1)	1 (0.8)	14 (11.8)
Transfer to another facility	2 (0.05)	0 (0.0)	0 (0.0)

[1]24 neonates had missing age.
[2]31 young children had missing age.
[3]7 participants did not have a documented sex.

Table 2. Association of discharging clinicians' predicted probability and unplanned 60-day hospital readmission among neonates and young children

	Total, n (%) (N=3,896)	Readmitted 60 Days After Hospital Discharge, n (%) (N=187)	*P* Value[1]
Clinician predicted probability			<0.001
0%	2,838 (94.1)	151 (5.1)	
1-5%	9 (100)	0 (0.0)	
6-20%	26 (89.7)	3 (10.3)	
21-40%	736 (97.8)	16 (2.2)	
41-60%	38 (92.7)	3 (7.3)	
61-80%	237 (95.9)	10 (4.1)	
81-99%	11 (73.3)	4 (26.7)	

[1]By Chi square test to assess independence of clinician predicted probability and likelihood of hospital readmission.
Note: There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 3. Test characteristics for clinician predicted probability of unplanned,60-day hospital readmission among all enrolled neonates and young children aged 1-59 months overall and by clinician type

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=3,895)[1]					0.46 (0.43, 0.49)
≤5	19.3 (13.9, 25.1)	72.5 (71.0, 73.8)	3.4 (2.5, 4.4)	94.7 (94.3, 95.1)	
≤20	19.3 (13.9, 25.1)	72.7 (71.3, 74.1)	3.4 (2.5, 4.5)	94.7 (94.4, 95.1)	
≤40	17.7 (12.3, 23.5)	73.7 (72.3, 75.1)	3.3 (2.4, 4.3)	94.7 (94.3, 95.0)	
≤60	16.0 (11.2, 21.9)	74.3 (72.9, 75.7)	3.0 (2.1, 4.1)	94.6 (94.3, 94.9)	
≤80	7.5 (4.2, 11.8)	93.7 (92.9, 94.4)	5.6 (3.1, 8.7)	95.3 (95.1, 95.5)	
≤99	2.1 (0.5, 4.3)	99.8 (99.7, 99.9)	36.4 (9.1, 66.7)	95.3 (95.2, 95.4)	
Consultant/Specialist (N=175)					0.41 (0.28, 0.55)
≤5	16.7 (0, 50.0)	69.2 (62.1, 75.8)	1.9 (0.0, 5.7)	95.8 (94.7, 97.6)	
≤20	16.7 (0, 50.0)	69.8 (62.7, 76.3)	1.9 (0, 5.9)	95.9 (94.7, 97.6)	
≤40	16.7 (0, 50.0)	73.4 (66.3, 79.9)	2.1 (0, 6.7)	96.1 (95.0, 97.7)	
≤60	0.0 (0.0, 0.0)	75.2 (68.6, 81.1)	0.0 (0.0, 0.0)	95.5 (95.1, 95.8)	
≤80	0.0 (0.0, 0.0)	85.2 (79.9, 90.5)	0.0 (0.0, 0.0)	96.0 (95.7, 96.2)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	NA	96.6 (96.6, 96.6)	
Intern/Resident (N=3,502)					0.44 (0.41, 0.47)
≤5	14.9 (9.9, 20.5)	72.4 (70.8, 73.9)	2.5 (1.7, 3.5)	94.6 (94.3, 95.0)	
≤20	14.9 (9.9, 20.5)	72.5 (70.9, 74.0)	2.5 (1.7, 3.5)	94.6 (94.3, 95.0)	
≤40	14.9 (9.9, 20.5)	73.2 (71.6, 74.7)	2.6 (1.7, 3.6)	94.7 (94.4, 95.1)	
≤60	13.6 (8.7, 19.3)	73.5 (71.9, 75.0)	2.4 (1.6, 3.4)	94.6 (94.3, 94.9)	
≤80	5.6 (2.5, 9.3)	94.1 (93.3, 94.9)	4.3 (1.9, 7.3)	95.4 (95.2, 95.6)	
≤99	1.2 (0.0, 3.1)	99.9 (99.8, 100)	40.0 (0.0, 100)	95.5 (95.4, 95.5)	
Medical Officer (N=217)					0.67 (0.55, 0.79)
≤5	55.0 (30.0, 75.0)	76.1 (70.1, 81.7)	18.9 (11.6, 26.5)	94.3 (91.6, 96.9)	
≤20	55.0 (30.0, 75.0)	78.7 (72.6, 84.3)	20.7 (12.7, 29.4)	94.5 (91.9, 96.9)	
≤40	40.0 (20.0, 60.0)	82.2 (76.6, 87.3)	18.4 (9.4, 28.9)	93.1 (90.8, 95.5)	
≤60	40.0 (20.0, 60.0)	86.8 (81.7, 91.4)	23.5 (12.1, 36.4)	93.4 (91.3, 95.7)	
≤80	25.0 (9.8, 45.0)	93.9 (90.4, 96.9)	29.4 (10.5, 50.0)	92.5 (90.9, 94.4)	
≤99	10.0 (0.0, 25.0)	97.9 (95.9, 99.5)	33.3 (0.0, 80.0)	91.5 (90.6, 92.8)	

[1]There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 4. Association of discharging clinicians' predicted probability and all-cause,60-day post-discharge mortality among neonates and young children

	Total, n (%) (N=3,896)	Died 60 Days After Hospital Discharge, n (%) (N=120)	*P* Value[1]
Clinician predicted probability			0.002
0%	3,746 (97.2)	109 (2.8)	
1-5%	10 (100)	0 (0.0)	
6-20%	9 (81.8)	2 (18.2)	
21-40%	13 (86.7)	2 (13.3)	
41-60%	95 (95.0)	5 (5.0)	
61-80%	21 (95.5)	1 (4.5)	
81-99%	2 (66.7)	1 (33.3)	

[1]By Chi square test to assess independence of clinician predicted probability and likelihood of hospital readmission.

Table 5. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality among all enrolled neonates and young children aged 1-59 months by clinician type

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=3,895)[1]					0.53 (0.50, 0.55)
≤5	9.2 (4.2, 15.0)	96.3 (95.7, 96.9)	7.3 (3.5, 11.9)	97.1 (96.9, 97.3)	
≤20	9.2 (4.2, 15.0)	96.6 (95.9, 97.2)	7.7 (3.8, 12.7)	97.1 (96.9, 97.3)	
≤40	7.5 (3.3, 12.5)	96.7 (96.2, 97.3)	6.8 (2.9, 11.6)	97.1 (96.9, 97.2)	
≤60	5.8 (1.7, 10.8)	97.1 (96.5, 97.6)	5.8 (1.9, 10.5)	97.0 (96.9, 97.2)	
≤80	1.7 (0.0, 4.2)	99.4 (99.2, 99.7)	8.3 (0.0, 22.7)	96.9 (96.9, 97.0)	
≤99	0.8 (0.0, 2.5)	99.9 (99.9, 100)	50.0 (0.0, 100)	96.9 (96.9, 96.9)	
Specialist or Consultant (N=175)					0.49 (0.48, 0.50)
≤5	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤20	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤40	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤60	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤80	0.0 (0.0, 0.0)	98.8 (97.0, 100)	0.0 (0.0, 0.0)	95.9 (95.9, 96.0)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	-	96.0 (96.0, 96.0)	
Intern/Resident (N=3,502)					0.53 (0.50, 0.56)
≤5	8.8 (3.9, 14.7)	97.1 (96.5, 97.6)	8.3 (3.7, 13.8)	97.3 (97.1, 97.4)	
≤20	8.8 (3.9, 14.7)	97.2 (96.6, 97.7)	8.5 (3.8, 14.2)	97.3 (97.1, 97.4)	
≤40	6.9 (2.9, 12.7)	97.2 (96.6, 97.7)	6.8 (2.7, 12.0)	97.2 (97.1, 97.4)	
≤60	5.8 (1.9, 10.8)	97.2 (96.7, 97.8)	5.9 (1.9, 11.0)	97.2 (97.1, 97.3)	
≤80	1.9 (0.0, 4.9)	99.6 (99.4, 99.8)	11.8 (0.0, 30.8)	97.1 (97.1, 97.2)	
≤99	0.9 (0.0, 2.9)	99.9 (99.9, 100.0)	50.0 (0.0, 100.8)	97.1 (97.1, 97.2)	
Medical Officer (N=218)					0.51 (0.38, 0.64)
≤5	18.2 (0.0, 45.5)	82.6 (77.8, 87.9)	5.0 (0, 12.2)	94.9 (93.8, 96.5)	
≤20	18.2 (0.0, 45.5)	85.9 (81.2, 90.3)	6.1 (0, 14.8)	95.1 (94.1, 96.7)	
≤40	18.2 (0.0, 45.5)	88.9 (84.5, 92.8)	7.7 (0, 18.7)	95.3 (94.2, 96.8)	
≤60	9.1 (0.0, 27.3)	93.7 (90.3, 96.6)	6.7 (0, 23.1)	95.1 (94.5, 96.1)	
≤80	0.0 (0.0, 0.0)	97.6 (95.2, 99.5)	0.0 (0.0, 0.0)	94.8 (94.7, 94.9)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	-	94.9 (94.9, 94.9)	

[1]There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 6. Reasons for perceived risk of hospital readmission and post-discharge mortality

Clinician Cited Reason for Outcome	Hospital Readmission, n (%)	No Hospital Readmission, n (%)	Odds Ratio (95% Confidence Interval)	*P* value[1]
No risk	148 (79.1)	2584 (69.7)	*Referent*	--
Clinician perceived inability to pay for treatment	3 (1.6)	11 (0.3)	4.76 (1.31, 17.25)	0.02
Clinician perceived social concerns	3 (1.6)	70 (1.9)	0.75 (0.23, 2.41)	0.63
Clinician perceived progression of illness	29 (15.5)	754 (20.3)	0.67 (0.45, 1.01)	0.05
Other[2]	4 (2.1)	290 (7.8)	0.24 (0.09, 0.66)	0.005
Clinician Cited Reason for Outcome	**Died Within 60 Days, n (%)**	**Did not Die Within 60 Days, n (%)**	**Odds Ratio (95% Confidence Interval)**	***P* value[1]**
No risk	80 (66.7)	2652 (70.2)	*Referent*	--
Clinician perceived inability to pay for treatment	2 (1.7)	12 (0.3)	5.53 (1.22, 25.10)	0.03
Clinician perceived social concerns	1 (0.8)	72 (1.9)	0.46 (0.06, 3.36)	0.44
Clinician perceived progression of illness	29 (24.2)	754 (20.0)	1.28 (0.83, 1.97)	0.27
Other[2]	8 (6.7)	286 (7.6)	0.93 (0.44, 1.94)	0.84

[1]Calculated using ordinal logistic regression analyses to assess whether the perceived reason for risk was associated with the participant's perceived likelihood of the outcomes.
[2]Included concerns about caregiver understanding, general clinician impression, and patient with history of recurrent illness.

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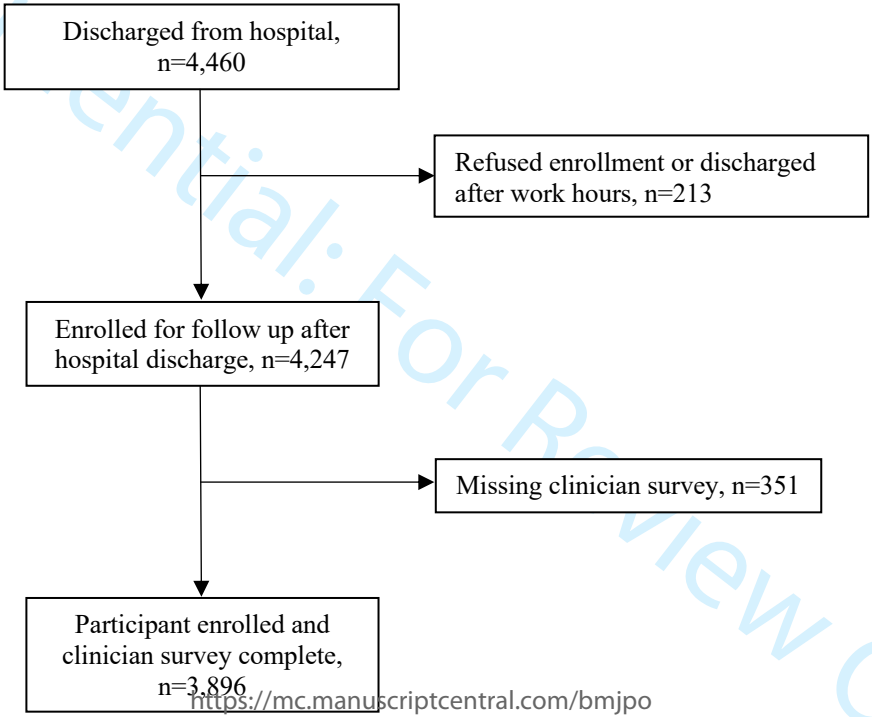

Supplemental Table 1. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission for neonates at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=2,173)					0.41 (0.38, 0.46)
≤5	8.75 (3.75, 15)	73.77 (71.91, 75.68)	1.25 (0.51, 2.19)	95.48 (95.19, 95.81)	
≤20	8.75 (3.75, 15)	73.87 (72, 75.73)	1.25 (0.51, 2.19)	95.48 (95.19, 95.81)	
≤40	8.75 (3.75, 15)	74.34 (72.48, 76.21)	1.28 (0.52, 2.23)	95.51 (95.23, 95.84)	
≤60	7.5 (2.5, 13.75)	74.58 (72.72, 76.4)	1.1 (0.36, 2.04)	95.46 (95.2, 95.78)	
≤80	2.5 (0, 6.25)	94.84 (93.88, 95.8)	1.75 (0, 4.47)	96.21 (96.11, 96.36)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.32 (96.32, 96.32)	
Interns/Residents (N=2,076)					0.41 (0.38, 0.44)
≤5	7.79 (2.6, 14.29)	73.69 (71.68, 75.54)	1.12 (0.37, 2.03)	95.39 (95.11, 95.72)	
≤20	7.79 (2.6, 14.29)	73.74 (71.74, 75.59)	1.12 (0.37, 2.04)	95.4 (95.12, 95.73)	
≤40	7.79 (2.6, 14.29)	74.09 (72.09, 75.94)	1.14 (0.37, 2.07)	95.42 (95.14, 95.74)	
≤60	7.79 (2.6, 14.29)	74.29 (72.34, 76.14)	1.15 (0.38, 2.08)	95.43 (95.15, 95.76)	
≤80	2.6 (0, 6.49)	95.15 (94.15, 96.05)	1.96 (0, 4.85)	96.2 (96.09, 96.35)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.29 (96.29, 96.29)	
Specialist or Consultant (N=66)					0.53 (0.13, 0.93)
≤5	50 (0, 100)	65.62 (53.12, 76.56)	4.35 (0, 10.53)	97.67 (94.87, 100)	
≤20	50 (0, 100)	67.19 (54.69, 79.69)	4.55 (0, 11.11)	97.73 (95.12, 100)	
≤40	50 (0, 100)	71.88 (60.94, 82.81)	5.26 (0, 12.5)	97.87 (95.45, 100)	
≤60	0 (0, 0)	73.44 (62.5, 84.38)	0 (0, 0)	95.92 (95.24, 96.43)	
≤80	0 (0, 0)	82.81 (73.44, 92.19)	0 (0, 0)	96.36 (95.92, 96.72)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.97 (96.97, 96.97)	
Medical Officer (N=30)					0.50 (NA, NA)
≤5	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤20	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤40	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤60	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤80	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	

Supplemental Table 2. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission for young children aged 1-59 months at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=1,722)					0.49 (0.45, 0.54)
≤5	27.1 (18.69, 35.51)	70.77 (68.54, 73)	5.77 (4.09, 7.57)	93.6 (92.9, 94.33)	
≤20	27.1 (18.69, 35.51)	71.21 (68.98, 73.44)	5.85 (4.14, 7.69)	93.64 (92.95, 94.36)	
≤40	24.3 (15.89, 32.71)	72.76 (70.65, 74.86)	5.51 (3.81, 7.4)	93.53 (92.9, 94.23)	
≤60	22.43 (14.95, 30.84)	73.87 (71.7, 75.98)	5.34 (3.59, 7.35)	93.48 (92.88, 94.19)	
≤80	11.21 (5.61, 17.76)	92.26 (90.84, 93.44)	8.63 (4.32, 13.71)	94 (93.63, 94.45)	
≤99	3.74 (0.93, 7.48)	99.57 (99.26, 99.88)	35.71 (10, 66.67)	93.98 (93.81, 94.21)	
Interns/Residents (N=1,426)					0.46 (0.42, 0.51)
≤5	21.43 (13.1, 30.95)	70.57 (68.18, 73.03)	4.32 (2.7, 6.11)	93.47 (92.81, 94.2)	
≤20	21.43 (13.1, 30.95)	70.72 (68.33, 73.1)	4.35 (2.71, 6.13)	93.48 (92.82, 94.22)	
≤40	21.43 (13.1, 30.95)	71.83 (69.45, 74.14)	4.51 (2.81, 6.35)	93.58 (92.93, 94.29)	
≤60	19.05 (10.71, 27.38)	72.35 (69.97, 74.67)	4.08 (2.45, 5.93)	93.43 (92.83, 94.12)	
≤80	8.33 (3.57, 14.29)	92.55 (91.06, 93.96)	6.25 (2.48, 11.2)	94.14 (93.83, 94.54)	
≤99	2.38 (0, 5.95)	99.78 (99.48, 100)	40 (0, 100)	94.23 (94.09, 94.43)	
Specialist or Consultant (N=109)					0.36 (0.31, 0.40)
≤5	0 (0, 0)	71.43 (62.86, 80)	0 (0, 0)	94.94 (94.29, 95.45)	
≤20	0 (0, 0)	71.43 (62.86, 80)	0 (0, 0)	94.94 (94.29, 95.45)	
≤40	0 (0, 0)	74.29 (65.71, 82.86)	0 (0, 0)	95.12 (94.52, 95.6)	
≤60	0 (0, 0)	76.19 (67.62, 83.81)	0 (0, 0)	95.24 (94.67, 95.65)	
≤80	0 (0, 0)	86.67 (79.98, 92.38)	0 (0, 0)	95.79 (95.45, 96.04)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.33 (96.33, 96.33)	
Medical Officer (N=187)					0.67 (0.54, 0.80)
≤5	57.89 (36.84, 78.95)	72.02 (64.88, 79.17)	19.2 (12.07, 26.32)	93.85 (90.76, 96.85)	
≤20	57.89 (36.84, 78.95)	75 (67.86, 81.55)	20.93 (13.46, 28.85)	94.07 (91.11, 96.95)	
≤40	42.11 (21.05, 63.16)	79.17 (72.62, 85.12)	18.75 (9.37, 28.57)	92.36 (89.61, 95.17)	
≤60	42.11 (21.05, 63.16)	84.52 (78.57, 89.88)	23.68 (12.12, 36)	92.86 (90.26, 95.42)	
≤80	26.32 (10.53, 47.37)	92.86 (88.69, 96.43)	30 (10.53, 50)	91.76 (89.88, 93.98)	
≤99	10.53 (0, 26.32)	97.62 (95.24, 99.4)	33.33 (0, 80)	90.61 (89.56, 92.18)	

Supplemental Table 3. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission among all participants by study site

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
Tanzania					
All Clinicians (N=1,996)					0.53 (0.51, 0.56)
≤5	10.71 (6.43, 15.71)	95.64 (94.67, 96.5)	15.56 (9.2, 22.64)	93.42 (93.1, 93.78)	
≤20	10.71 (6.43, 15.71)	96.07 (95.15, 96.93)	17.05 (10.23, 24.76)	93.44 (93.13, 93.81)	
≤40	8.57 (4.29, 13.57)	97.04 (96.23, 97.79)	17.81 (9.86, 27.59)	93.36 (93.08, 93.7)	
≤60	7.14 (3.57, 11.43)	97.79 (97.09, 98.38)	19.61 (9.76, 30.77)	93.32 (93.06, 93.62)	
≤80	4.29 (1.43, 7.86)	99.14 (98.71, 99.52)	26.92 (9.52, 47.62)	93.2 (93.01, 93.46)	
≤99	2.86 (0.71, 5.71)	99.68 (99.41, 99.89)	40 (10, 72.73)	93.15 (93, 93.35)	
Liberia					
All Clinicians (N=1,899)					0.52 (0.43, 0.60)
≤5	55.32 (40.43, 70.21)	50.76 (48.49, 53.08)	2.77 (2.04, 3.47)	97.81 (97.1, 98.5)	
≤20	55.32 (40.43, 70.21)	50.7 (48.49, 52.97)	2.77 (2.04, 3.47)	97.81 (97.1, 98.49)	
≤40	55.32 (40.43, 70.21)	49.78 (47.52, 52.11)	2.72 (2.01, 3.42)	97.77 (97.04, 98.46)	
≤60	57.45 (42.55, 70.21)	49.24 (47.03, 51.62)	2.8 (2.09, 3.47)	97.86 (97.13, 98.55)	
≤80	82.98 (72.34, 93.62)	11.77 (10.37, 13.23)	2.34 (2.02, 2.61)	96.51 (94.09, 98.6)	
≤99	100 (100, 100)	0.05 (0, 0.16)	2.48 (2.47, 2.48)	100 (100, 100)	

Supplemental Table 4. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission among all participants by time to unplanned hospital readmission

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
Day 7					0.49 (0.42, 0.56)
≤5	23.4 (10.64, 36.17)	72.77 (71.34, 74.22)	1.03 (0.49, 1.62)	98.72 (98.54, 98.95)	
≤20	23.4 (10.64, 36.17)	73 (71.57, 74.45)	1.04 (0.5, 1.64)	98.73 (98.54, 98.95)	
≤40	23.4 (10.64, 36.17)	74.01 (72.61, 75.39)	1.08 (0.51, 1.7)	98.75 (98.56, 98.96)	
≤60	23.4 (10.64, 36.17)	74.66 (73.28, 76.09)	1.1 (0.53, 1.74)	98.76 (98.57, 98.97)	
≤80	12.77 (4.26, 23.4)	93.69 (92.96, 94.49)	2.38 (0.78, 4.35)	98.87 (98.76, 99.01)	
≤99	4.26 (0, 10.64)	99.77 (99.58, 99.9)	16.67 (0, 46.15)	98.84 (98.79, 98.92)	
Day 14					0.45 (0.41, 0.50)
≤5	17.28 (9.88, 25.93)	72.68 (71.24, 74.07)	1.31 (0.75, 1.95)	97.63 (97.43, 97.87)	
≤20	17.28 (9.88, 25.93)	72.92 (71.47, 74.28)	1.32 (0.75, 1.97)	97.64 (97.43, 97.88)	
≤40	16.05 (8.64, 23.46)	73.89 (72.47, 75.25)	1.28 (0.69, 1.89)	97.64 (97.43, 97.86)	
≤60	16.05 (8.64, 23.46)	74.57 (73.13, 75.91)	1.31 (0.71, 1.94)	97.66 (97.46, 97.88)	
≤80	7.41 (2.47, 13.58)	93.68 (92.87, 94.47)	2.38 (0.8, 4.43)	97.94 (97.83, 98.08)	
≤99	2.47 (0, 6.17)	99.76 (99.61, 99.9)	16.67 (0, 44.44)	97.97 (97.91, 98.04)	
Day 30					0.46 (0.42, 0.49)
≤5	18.64 (11.86, 25.42)	72.57 (71.06, 73.95)	2.06 (1.34, 2.87)	96.61 (96.34, 96.91)	
≤20	18.64 (11.86, 25.42)	72.82 (71.33, 74.21)	2.08 (1.35, 2.9)	96.62 (96.35, 96.92)	
≤40	16.95 (10.17, 23.73)	73.79 (72.31, 75.17)	1.97 (1.23, 2.74)	96.6 (96.33, 96.87)	
≤60	15.25 (9.32, 22.03)	74.42 (72.97, 75.8)	1.81 (1.1, 2.62)	96.56 (96.31, 96.83)	
≤80	6.78 (2.54, 11.86)	93.65 (92.82, 94.39)	3.15 (1.24, 5.53)	96.98 (96.85, 97.14)	
≤99	1.69 (0, 4.24)	99.76 (99.6, 99.89)	16.67 (0, 44.44)	97.01 (96.96, 97.09)	
Day 45					0.46 (0.43, 0.49)
≤5	18.67 (12.67, 24.67)	72.52 (71.13, 73.91)	2.64 (1.84, 3.51)	95.7 (95.39, 96.02)	
≤20	18.67 (12.67, 24.67)	72.76 (71.35, 74.15)	2.66 (1.85, 3.54)	95.71 (95.41, 96.03)	
≤40	16.67 (11.33, 22.67)	73.72 (72.26, 75.09)	2.47 (1.69, 3.33)	95.66 (95.38, 95.97)	
≤60	15.33 (10, 21.33)	74.34 (72.92, 75.73)	2.33 (1.56, 3.19)	95.63 (95.37, 95.92)	
≤80	7.33 (3.33, 11.33)	93.67 (92.87, 94.45)	4.4 (2.21, 7.17)	96.19 (96.04, 96.37)	
≤99	2.67 (0.67, 5.35)	99.81 (99.68, 99.95)	35.71 (9.09, 66.67)	96.24 (96.16, 96.35)	

Supplemental Table 5. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality for neonates at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=2,173)					0.52 (0.49, 0.55)
≤5	6.56 (1.64, 13.11)	96.97 (96.21, 97.73)	5.71 (1.41, 12.09)	97.29 (97.15, 97.48)	
≤20	6.56 (1.64, 13.11)	96.97 (96.21, 97.73)	5.71 (1.41, 12.09)	97.29 (97.15, 97.48)	
≤40	6.56 (1.64, 13.11)	96.97 (96.21, 97.73)	5.71 (1.41, 12.09)	97.29 (97.15, 97.48)	
≤60	4.92 (0, 11.48)	97.02 (96.21, 97.77)	4.35 (0, 9.86)	97.24 (97.11, 97.42)	
≤80	1.64 (0, 4.92)	99.62 (99.34, 99.86)	10 (0, 36.36)	97.23 (97.18, 97.32)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	97.19 (97.19, 97.19)	
Interns/Residents (N=2,076)					0.52 (0.49, 0.55)
≤5	7.14 (1.79, 14.29)	96.93 (96.14, 97.67)	5.95 (1.43, 11.94)	97.41 (97.26, 97.62)	
≤20	7.14 (1.79, 14.29)	96.93 (96.14, 97.67)	5.95 (1.43, 11.94)	97.41 (97.26, 97.62)	
≤40	7.14 (1.79, 14.29)	96.93 (96.14, 97.67)	5.95 (1.43, 11.94)	97.41 (97.26, 97.62)	
≤60	5.36 (0, 12.5)	96.98 (96.19, 97.72)	4.62 (0, 10.17)	97.36 (97.22, 97.55)	
≤80	1.79 (0, 5.36)	99.65 (99.36, 99.9)	11.11 (0, 42.86)	97.34 (97.29, 97.44)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	97.3 (97.3, 97.3)	
Specialist or Consultant (N=66)					0.48 (0.46, 0.51)
≤5	0 (0, 0)	96.77 (91.94, 100)	0 (0, 0)	93.75 (93.44, 93.94)	
≤20	0 (0, 0)	96.77 (91.94, 100)	0 (0, 0)	93.75 (93.44, 93.94)	
≤40	0 (0, 0)	96.77 (91.94, 100)	0 (0, 0)	93.75 (93.44, 93.94)	
≤60	0 (0, 0)	96.77 (91.94, 100)	0 (0, 0)	93.75 (93.44, 93.94)	
≤80	0 (0, 0)	98.39 (95.16, 100)	0 (0, 0)	93.85 (93.65, 93.94)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	93.94 (93.94, 93.94)	
Medical Officer (N=30)[1]					0.50 (NA, NA)
≤5	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤20	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤40	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤60	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤80	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	

[1]All medical officers reported a perceived probability of 0% for neonates.

Supplemental Table 6. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality for young children aged 1-59 months at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
All Clinicians (N=1,723)					0.54 (0.49, 0.58)
≤5	11.86 (5.08, 20.34)	95.49 (94.53, 96.45)	8.43 (3.23, 14.77)	96.83 (96.56, 97.14)	
≤20	11.86 (5.08, 20.34)	96.09 (95.19, 97.06)	9.59 (3.66, 16.67)	96.85 (96.59, 97.16)	
≤40	8.47 (1.69, 16.95)	96.51 (95.61, 97.42)	7.84 (1.75, 14.82)	96.75 (96.52, 97.03)	
≤60	6.78 (1.69, 13.56)	97.12 (96.27, 97.96)	7.55 (1.79, 15.69)	96.7 (96.52, 96.95)	
≤80	1.69 (0, 5.08)	99.22 (98.74, 99.58)	6.25 (0, 25)	96.6 (96.54, 96.73)	
≤99	1.69 (0, 5.08)	99.94 (99.82, 100)	50 (0, 100)	96.63 (96.57, 96.74)	
Interns/Residents (N=1,426)					0.54 (0.50, 0.59)
≤5	10.87 (2.17, 19.57)	97.32 (96.38, 98.19)	11.63 (2.78, 21.95)	97.03 (96.76, 97.33)	
≤20	10.87 (2.17, 19.57)	97.54 (96.67, 98.33)	12.5 (3.03, 23.68)	97.04 (96.77, 97.34)	
≤40	6.52 (0, 15.22)	97.61 (96.74, 98.41)	8.11 (0, 18.18)	96.9 (96.7, 97.17)	
≤60	6.52 (0, 15.22)	97.61 (96.74, 98.41)	8.11 (0, 18.18)	96.9 (96.7, 97.17)	
≤80	2.17 (0, 6.52)	99.49 (99.06, 99.86)	11.11 (0, 42.86)	96.82 (96.75, 96.97)	
≤99	2.17 (0, 6.52)	99.93 (99.78, 100)	50 (0, 100)	96.84 (96.77, 96.98)	
Specialist or Consultant (N=109)					0.49 (0.48, 0.50)
≤5	0 (0, 0)	98.11 (95.28, 100)	0 (0, 0)	97.2 (97.12, 97.25)	
≤20	0 (0, 0)	98.11 (95.28, 100)	0 (0, 0)	97.2 (97.12, 97.25)	
≤40	0 (0, 0)	98.11 (95.28, 100)	0 (0, 0)	97.2 (97.12, 97.25)	
≤60	0 (0, 0)	98.11 (95.28, 100)	0 (0, 0)	97.2 (97.12, 97.25)	
≤80	0 (0, 0)	99.06 (97.17, 100)	0 (0, 0)	97.22 (97.17, 97.25)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	97.25 (97.25, 97.25)	
Medical Officer (N=188)					0.50 (0.36, 0.64)
≤5	20 (0, 50)	79.78 (73.6, 85.39)	5.13 (0, 12.12)	94.63 (93.24, 96.55)	
≤20	20 (0, 50)	83.71 (78.09, 88.76)	6.25 (0, 15)	94.87 (93.59, 96.71)	
≤40	20 (0, 50)	87.08 (82.02, 91.57)	7.69 (0, 19.05)	95.06 (93.83, 96.84)	
≤60	10 (0, 30)	92.7 (88.76, 96.07)	6.67 (0, 23.08)	94.8 (94.12, 96.02)	
≤80	0 (0, 0)	97.19 (94.38, 99.44)	0 (0, 0)	94.54 (94.38, 94.65)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	94.68 (94.68, 94.68)	

Supplemental Table 7. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality among all participants by study site

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
Tanzania					
All Clinicians (N=1,997)					0.53 (0.50, 0.56)
≤5	7.94 (1.59, 15.87)	97.88 (97.21, 98.5)	10.62 (2.63, 20.46)	97.02 (96.83, 97.27)	
≤20	7.94 (1.59, 15.87)	98.4 (97.83, 98.91)	13.51 (3.57, 25.93)	97.04 (96.85, 97.28)	
≤40	6.35 (1.59, 12.7)	98.76 (98.24, 99.22)	13.64 (3.45, 28.12)	97 (96.85, 97.21)	
≤60	4.76 (0, 11.11)	99.28 (98.91, 99.64)	16.67 (0, 37.51)	96.97 (96.82, 97.16)	
≤80	1.59 (0, 4.76)	99.69 (99.43, 99.9)	12.5 (0, 50)	96.88 (96.83, 96.99)	
≤99	1.59 (0, 4.76)	99.95 (99.84, 100)	50 (0, 100)	96.89 (96.84, 96.99)	
Liberia					
All Clinicians (N=1,899)					0.53 (0.49, 0.57)
≤5	7.94 (1.59, 15.87)	97.88 (97.21, 98.5)	10.62 (2.63, 20.46)	97.02 (96.83, 97.27)	
≤20	7.94 (1.59, 15.87)	98.4 (97.83, 98.91)	13.51 (3.57, 25.93)	97.04 (96.85, 97.28)	
≤40	6.35 (1.59, 12.7)	98.76 (98.24, 99.22)	13.64 (3.45, 28.12)	97 (96.85, 97.21)	
≤60	4.76 (0, 11.11)	99.28 (98.91, 99.64)	16.67 (0, 37.51)	96.97 (96.82, 97.16)	
≤80	1.59 (0, 4.76)	99.69 (99.43, 99.9)	12.5 (0, 50)	96.88 (96.83, 96.99)	
≤99	1.59 (0, 4.76)	99.95 (99.84, 100)	50 (0, 100)	96.89 (96.84, 96.99)	

Supplemental Table 8. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality among all patients by time to post-discharge mortality

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve (95% CI)
Day 7					0.57 (0.48, 0.67)
≤5	17.65 (0, 35.29)	96.21 (95.59, 96.78)	1.97 (0, 4.29)	99.63 (99.55, 99.71)	
≤20	17.65 (0, 35.29)	96.47 (95.88, 97.01)	2.11 (0, 4.58)	99.63 (99.55, 99.71)	
≤40	17.65 (0, 35.29)	96.7 (96.13, 97.24)	2.26 (0, 4.92)	99.63 (99.55, 99.71)	
≤60	17.65 (0, 35.29)	97.04 (96.49, 97.55)	2.52 (0, 5.5)	99.63 (99.55, 99.71)	
≤80	5.88 (0, 17.65)	99.43 (99.2, 99.66)	4.17 (0, 14.29)	99.59 (99.56, 99.64)	
≤99	0 (0, 0)	99.95 (99.87, 100)	0 (0, 0)	99.56 (99.56, 99.56)	
Day 14					0.55 (0.49, 0.60)
≤5	13.16 (2.63, 23.68)	96.24 (95.62, 96.81)	3.23 (0.7, 6.3)	99.12 (99.01, 99.23)	
≤20	13.16 (2.63, 23.68)	96.5 (95.93, 97.05)	3.45 (0.75, 6.78)	99.12 (99.02, 99.23)	
≤40	13.16 (2.63, 23.68)	96.73 (96.16, 97.25)	3.7 (0.81, 7.26)	99.12 (99.02, 99.23)	
≤60	7.89 (0, 18.42)	97.02 (96.47, 97.54)	2.42 (0, 5.51)	99.07 (99, 99.17)	
≤80	2.63 (0, 7.89)	99.43 (99.2, 99.66)	4 (0, 14.29)	99.04 (99.02, 99.1)	
≤99	0 (0, 0)	99.95 (99.87, 100)	0 (0, 0)	99.02 (99.02, 99.02)	
Day 30					0.53 (0.49, 0.57)
≤5	9.52 (3.17, 17.46)	96.24 (95.64, 96.82)	3.95 (1.29, 7.24)	98.48 (98.37, 98.61)	
≤20	9.52 (3.17, 17.46)	96.5 (95.9, 97.08)	4.23 (1.39, 7.76)	98.48 (98.37, 98.61)	
≤40	9.52 (3.17, 17.46)	96.74 (96.16, 97.29)	4.51 (1.48, 8.33)	98.49 (98.38, 98.62)	
≤60	6.35 (1.59, 12.7)	97.03 (96.45, 97.55)	3.28 (0.79, 6.96)	98.44 (98.36, 98.55)	
≤80	3.17 (0, 7.94)	99.45 (99.22, 99.69)	8.33 (0, 21.74)	98.42 (98.37, 98.5)	
≤99	1.59 (0, 4.76)	99.97 (99.92, 100)	50 (0, 100)	98.41 (98.38, 98.46)	
Day 45					0.52 (0.50, 0.55)
≤5	8.6 (3.23, 13.98)	96.27 (95.66, 96.87)	5.26 (2.17, 8.86)	97.73 (97.61, 97.87)	
≤20	8.6 (3.23, 13.98)	96.53 (95.9, 97.11)	5.63 (2.36, 9.45)	97.74 (97.61, 97.87)	
≤40	8.6 (3.23, 13.98)	96.77 (96.13, 97.32)	6.02 (2.5, 10.17)	97.74 (97.62, 97.88)	
≤60	6.45 (2.15, 11.83)	97.05 (96.48, 97.56)	4.96 (1.64, 9.26)	97.69 (97.59, 97.83)	
≤80	2.15 (0, 5.38)	99.45 (99.21, 99.66)	8.33 (0, 22.22)	97.65 (97.6, 97.73)	
≤99	1.08 (0, 3.23)	99.97 (99.92, 100)	50 (0, 100)	97.64 (97.61, 97.69)	

Appendix Survey. Survey that clinicians filled out near the time of discharge for each enrolled neonate or young child in Dar es Salaam, Tanzania and Monrovia, Liberia

Provider Discharge Survey

Date of Data Collection _____
DD/MM/YYYY

Patient's FIRST name _____

Patient's LAST name _____

Patient's SEX:
- Male
- Female

Participant's Hospital Identifier (Unique number assigned to each patient) _____

Discharging provider year of training:
- Intern
- First year resident
- Second year resident
- Third year resident
- Specialist
- Consultant
- Medical officer
- Other. Please describe. _____

In your estimation, is the patient who was discharged at risk of any of the following?
- Re-admission to the hospital within 60 days
- Death in the next 60 days
- None of the above

If yes to any of the above, how likely is that outcome?
- 0%
- 1-5%
- 6-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%

If yes, why do you think the patient is at risk of any of the above outcomes?
- Progression of illness
- Social concerns
- Inability to pay for future medical
- Other. Please describe. _____

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Predictive Value of Clinician Impression for Readmission and Post-Discharge Mortality among Neonates and Young Children in Dar es Salaam, Tanzania and Monrovia, Liberia

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Data Sharing Agreement

Data may be made available upon reasonable request to the corresponding author.

Ethics Approval

The study received ethical clearance from the Tanzania National Institute of Medical Research (#NIMR/HQ/R8a/Vol.IX/3494), the Muhimbili University of Health and Allied Sciences Research and Ethics Committee (#307/323/01), the John F. Kennedy Medical Center Institutional Review Board (#08062019), the Boston Children's Hospital Institutional Review Board (#P00033242), and the use of de-identified data was exempted from review by the Emory University Institutional Review Board (no number provided for exempted studies).

Transparency Declaration

This manuscript is an honest and accurate account of the study being reported. No aspects of this study have been omitted or withheld.

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Abstract

Background: There are no validated clinical decision aids to identify neonates and young children at risk of hospital readmission or post-discharge mortality in sub-Saharan Africa, leaving the decision to discharge a child to a clinician's impression. Our objective was to determine the precision of clinician impression to identify neonates and young children at risk for readmission and post-discharge mortality.

Methods: We conducted a survey study nested in a prospective observational cohort of neonates and children aged 1-59 months followed 60 days after hospital discharge from Muhimbili National Hospital in Dar es Salaam, Tanzania or John F. Kennedy Medical Center in Monrovia, Liberia. Clinicians who discharged each enrolled patient were surveyed to determine their perceived probability of the patient's risk of 60-day hospital readmission or post-discharge mortality. We calculated the area under the precision-recall curve (AUPRC) to determine the precision of clinician impression for both outcomes.

Results: Of 4,247 discharged patients, 3,896 (91.7%) had available clinician surveys and 3,847 (98.7%) had 60-day outcomes available: 187 (4.8%) were readmitted and 120 (3.1%) died within 60 days of hospital discharge. Clinician impression had poor precision in identifying neonates and young children at risk of hospital readmission (AUPRC 0.06, 95% CI 0.04 to 0.08) and post-discharge mortality (AUC 0.05, 95% CI 0.03 to 0.08). Patients for whom clinicians attributed inability to pay for future medical treatment as the reason for risk for unplanned hospital readmission had 4.76 times the odds hospital readmission (95% CI 1.31 to 17.25, P=0.02).

Conclusions: Given the poor precision of clinician impression alone to identify neonates and young children at risk of hospital readmission and post-discharge mortality, validated clinical decision aids are needed to aid in the identification of young children at risk for these outcomes.

What is already known on this topic?

- In parts of sub-Saharan Africa, hospital readmissions and post-discharge mortality rates are estimated to range from 1 to 18% within months of hospital discharge
- There are no validated clinical decision aids to accurately identify neonates, infants, and young children at risk of hospital readmission or post-discharge mortality in sub-Saharan Africa

What this study adds?

- Clinician impression alone had poor precision in identifying neonates, infants, and children at risk of hospital readmission within 60 days of hospital discharge
- Clinician impression also did not accurately identify neonates, infants, and children at risk of 60-day post-discharge mortality

How this study might affect practice?

- Clinician impression alone is not sufficient to accurately identify neonates, infants, and children at risk of hospital readmission or post-discharge mortality
- Validated and objective clinical decision aids are urgently needed to better identify neonates, infants, and children at risk of hospital readmission and post-discharge mortality

Introduction

Mortality rates among children aged <5 years in sub-Saharan Africa are 74 per 1,000 live births, which is the highest in the world and is 14 times higher than rates in Europe and North America.[1] The time after an inpatient hospital admission is particularly vulnerable in the life of a child in sub-Saharan Africa. Recent studies suggest that readmissions occur in 8-18% of young children and as much as 1-20% of young children die within six months after hospital discharge.[2-5] Childhood mortality rates in the period immediately after hospitalization for an illness (i.e., the post-discharge period) approximate and may even outpace rates of mortality during hospitalization.[5,6]

Although clinical prediction rules for all-cause hospital readmissions among children in settings like the United States have been developed that include variables such as prior healthcare utilization and markers of illness severity,[7] to our knowledge, there are currently no clinical prediction rules for hospital readmissions among children in sub-Saharan Africa, where readmissions are common. Differences in healthcare access and disease prevalence in the United States and sub-Saharan Africa necessitate the creation of clinical prediction rules catered to settings in sub-Saharan Africa. Clinical prediction rules have been developed to identify both young children and those aged <15 years at risk of post-discharge mortality in some settings in sub-Saharan Africa.[5,8,9] However, these clinical prediction rules lack external validation and thus are not widely used in clinical practice. Given the absence of validated risk assessment tools to identify young children at risk of readmission and post-discharge mortality in sub-Saharan Africa, the decision to safely discharge a young child from a hospital is often driven by clinical judgement.

Clinician impression relies on a clinician's ability to recognize pattens that may be associated with severe disease or an adverse outcome.[10] However, the accuracy of clinician impression to predict outcomes, such as severe disease from infections, among children has varied in previous studies conducted in high-income settings.[11-13] In a survey of 39 providers in Kenya, clinicians under-estimated the overall incidence of post-discharge mortality among children.[14] However, that study did not assess clinician impression of post-discharge mortality for individual patients and, to our knowledge, that has not been studied previously.

Given the absence of validated prognostic tools for hospital readmission and post-discharge mortality among children in sub-Saharan Africa, our primary objective was to determine the precision of treating clinicians' clinical impression to identify neonates and young children at risk for hospital readmission and post-discharge mortality in Dar es Salaam, Tanzania and Monrovia, Liberia. Our secondary objective was to evaluate factors associated with accuracy of treating clinicians' clinical impression to identify neonates and young children at risk for hospital readmission and post-discharge mortality.

Methods

Study Design

We conducted a survey nested in a prospective observational cohort study of pediatric patients discharged from Muhimbili National Hospital in Dar es Salaam, Tanzania and John F. Kennedy Medical Center in Monrovia, Liberia from October 2019 to January 2022. Details of our study protocol have been published previously.[15] Besides differences in estimated and actual enrollment, there were no deviations from that protocol. Neonates and young children aged 1-59 months were enrolled at discharge from the neonatal or pediatric wards at each facility. Follow-up consisted of caregivers receiving phone calls up to 60 days after hospital discharge. Caregivers provided written consent for participation in Tanzania and oral consent in Liberia because of cultural preference and low rates of caregiver literacy.

Patient and public involvement statement

The development of the research question was informed by the disease burden of readmission and post-discharge mortality among children in sub-Saharan Africa. Patients were not involved in the design, recruitment, or conduct of the study, nor were they advisers in this study. Results of this study will be made publicly available through publication.

Study Setting

This study was conducted at two large, national referral hospitals supported by each country's Ministry of Health. They are in urban areas in their respective countries. Muhimbili National Hospital has a catchment of approximately 6 million people and John F. Kennedy Medical Center has a catchment of approximately 1.5 million people. Both hospitals are training hospitals for pediatric residents who are completing their specialty training.

Study Populations

Neonates and young children discharged from the wards were consecutively enrolled. Neonates and young children who died during initial hospitalization were excluded. Neonates and young children whose caregivers did not have telephones for follow up or those who declined enrollment were excluded.

Surveyed clinicians included consultants/specialists, interns/residents, or medical officers. Consultants/specialists were certified pediatricians or pediatric specialists who completed medical school, residency, and subspecialty training (for specialists). Interns/residents had completed medical school and were completing residency training in pediatrics. Medical officers received three years of clinical training prior to providing clinical care to patients.

Study Procedures

After obtaining informed consent from caregivers, trained research coordinators at each site approached the clinician who discharged each enrolled patient, obtained consent, and asked them to complete a survey near the time of the patient's hospital discharge. This survey modeled previous surveys that assessed clinician impression[12] and was developed through an iterative process by the research team with multiple opportunities to each investigator to refine the content. The survey was also reviewed by an expert in survey design (i.e., a survey

methodologist) to ensure question clarity and appropriate response types (Appendix Survey). This survey was designed to allow clinician respondents to describe their perceived probability that each patient would experience both outcomes. Responses were recorded on standardized, electronic case report forms in electronic tablets using SQL (Tanzania) and KoboToolbox (Liberia).

Measurement and Outcomes

The exposure variable was the impression of the discharging clinician of the patient's risk of: 1) unplanned hospital readmission within 60 days of hospital discharge or 2) all-cause, 60-day post-discharge mortality. Aligned with previous studies,[12] probabilities of perceived risk of readmission or post-discharge mortality included categorical options of 0%, 1-5%, 6-20%, 21-40%, 41-60%, 61-80%, 81-99%, and 100%. This survey also assessed discharging clinicians' perceptions of why readmission or post-discharge mortality were possible for those who were identified as at-risk for each outcome. Surveyed clinicians were familiar with the patients' clinical history and laboratory results during hospital admission. To assess for outcomes, phone calls to patients' caregivers were made by research staff at 7, 14, 30, 45, and 60 days after hospital discharge. Outcomes were determined as reported by caregivers to research staff.

Statistical Analyses

The association of the discharging clinicians' predicted probability of readmission or post-discharge mortality and proportion of patients at each clinician-estimated risk threshold (e.g., 0%, 1-5%, etc.) who were readmitted or died was compared using Chi-square or Fisher's exact testing (P<0.05 for significance).[12] We calculated sensitivity, specificity, positive predictive value, and negative predictive value of treating clinician's impression at each percent risk threshold using caregiver-reported readmission or post-discharge mortality as the reference standards. We determined the precision of clinician impression for identifying patients at risk of readmission or post-discharge mortality by calculating the area under the precision-recall curve (AUPRC) which is useful for evaluating binary classifiers in imbalanced datasets.[16] 95% confidence intervals (95% CI) for the AUPRC were calculated through 5-fold cross-validation. We compared AUPRC and corresponding 95% CIs to baseline chance of the outcome occurring in that group. A 95% CI higher than baseline chance indicated better precision than random chance.

We conducted sub-analyses by the discharged patient's age group (i.e., neonate or young child), clinician experience level (i.e., consultant/specialist, intern/resident, or medical officer), site, and time to outcome. We conducted binary logistic regression analyses to assess whether the perceived reason for risk for each outcome was associated with the patient's likelihood of each outcome. Additionally, we conducted binary logistic regression analyses to assess whether the clinician probability for each outcome was associated with the patient's likelihood of each outcome after adjusting for clinician type, patient age at discharge (months), whether the discharge diagnosis was infectious or not, and duration of hospitalization (days). Due to small sample sizes in the non-0% clinician probability categories, we reduced the categorization of perceived risk to 0%, 1-20%, 21-60%, and 61-99%. The clinician cited reason for the outcome was also considered in the model but was removed due to collinearity as assessed by the variance

inflation factor. All tests were two-sided tests and used a 0.05 significance level. AUPRC analyses were conducted through the precrec package in R.[17] All analyses were performed in R Version 4.1.3 (R Foundation for Statistical Computing, Vienna, Austria) and SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

There were 4,460 discharged patients, 4,247 (95.2%) enrolled, and 3,896 (91.7%) had complete clinician surveys (Figure 1). Enrollment was approximately equal between the two sites (Tanzania n=1,997, 51.3%, Liberia n=1,899, 48.7%) (Table 1). There were 2,173 (55.8%) neonates and 1,723 (44.2%) young children who had clinician surveys available.

Sixty-day outcomes were available for 3,847 (98.7%) enrolled patients. The median age of enrolled neonates was 2 days (interquartile range [IQR] 1-7) and 12 months (IQR 5-24) for infants and children. The most common discharge diagnoses among neonates were sepsis (29.7%, n=609), prematurity (28.8%, n=591), and birth asphyxia (15.8%, n=323). Among infants and children, pneumonia (12.1%, n=223), diarrheal disease (10.1%, n=186), and malaria (7.2%, n=133) were most common.

There were 187 (4.8%) patients readmitted and 120 (3.1%) died within 60 days of discharge. There were 80 (3.6%) neonates who were readmitted and 61 (2.8%) died within 60 days of hospital discharge. Among infants and children, 107 (6.2%) were readmitted and 59 (3.4%) died after hospital discharge. The median time from hospital discharge to readmission was 30 days (IQR 7-45). The median time from hospital discharge to mortality was 30 days (IQR 14-45).

Clinician Impression and Hospital Readmission

Nearly three quarters of patients were perceived to have 0% risk of readmission within 60 days (Table 2). Patients who were readmitted were more likely to have a perceived risk of readmission of 0% than those who were not readmitted (81% vs. 72%, $P<0.001$; Table 2). Among the 187 neonates and young children who were readmitted, 80.7% (n=151) were perceived to have 0% risk of readmission.

Overall, clinician impression had poor precision in identifying neonates and young children at risk of readmission (AUPRC 0.06, 95% CI 0.04 to 0.08) (Table 3). Among medical officers, clinician impression had greater precision in identifying children at risk of readmission (AUPRC 0.23, 95% CI 0.17 to 0.34); this group was marginally better at identifying patients at risk of readmission than interns/residents and consultants/specialists.

By clinician type, medical officer clinician impression had poor precision in identifying neonates (Supplemental Table 1) but greater precision when identifying infants and children at risk for readmission (Supplemental Table 2). In site-specific analyses, clinician impression was imprecise when identifying neonates and young children at risk of readmission in Tanzania (AUPRC 0.11, 95% CI 0.07 to 0.15, chance: 0.07) and Liberia (AUPRC 0.03, 95% CI 0.02 to 0.04, chance: 0.02). Regardless of the time from hospital discharge to readmission, clinician

impression had poor precision in identifying neonates and young children at risk for readmission (Supplemental Table 3).

Clinician Impression and Post-Discharge Mortality

Most (96.1%, n=3,746) patients were assigned 0% risk of post-discharge mortality (Table 4). Patients who died within 60 days of discharge were more likely to have a perceived risk of 0% than patients who survived (96% vs. 90.8%, *P*=0.002; Table 4). Among the 120 neonates and young children who died within 60 days of hospital discharge, 90.8% (n=109) were estimated to have a 0% probability of post-discharge mortality.

Overall, clinician impression had poor precision in identifying neonates and young children at risk post-discharge mortality (AUPRC 0.05, 95% CI 0.03 to 0.08) and did not vary substantially among interns/residents, specialist/consultants, or medical officers (Table 5). Clinician impression had poor precision in identifying post-discharge mortality among neonates (AUPRC 0.04, 95% CI 0.03 to 0.06, chance: 0.03) and infants and children (AUPRC 0.06, 95 % CI 0.03 to 0.10, chance: 0.03). When analyzed by site, clinician impression in both Tanzania (AUPRC 0.08, 95% CI 0.03 to 0.13, chance: 0.03) and Liberia (AUPRC 0.04, 95% CI 0.03 to 0.06, chance: 0.04) had poor precision in identifying neonates and young children at risk of post-discharge mortality. Clinician impression had poor precision regardless of the time to post-discharge mortality (Supplemental Table 4).

Reason for Perceived Risk of Hospital Readmission and Post-Discharge Mortality

Patients for whom clinicians attributed inability to pay for treatment as the reason for readmission had 4.76 times the odds readmission (95% CI 1.31 to 17.25, *P*=0.02) compared to those with no perceived risk (Table 6). Patients whose clinician cited "other" reasons to be at risk had lower odds of readmission compared to those whose clinician did not believe they were at risk for readmission (OR 0.24, 95% CI 0.09 to 0.66, *P*=0.005). Patients for whom clinicians attributed inability to pay for treatment as the reason for potential post-discharge mortality had 5.53 times the odds of post-discharge mortality (95% CI 1.22 to 25.10, *P*=0.03).

In multivariable analyses, patients whom clinicians estimated to be at moderate risk for hospital readmission (i.e., 21-60%) were at decreased odds of hospital readmission (aOR 0.45, 95% CI 0.26 to 0.74, *P*=0.003) (Table 7). No other factors were independently associated with either hospital readmission or post-discharge mortality.

Discussion

Among nearly 3,900 neonates and young children discharged from referral hospitals in Dar es Salaam, Tanzania and Monrovia, Liberia, clinician impression had poor precision for identifying those at risk of unplanned hospital readmissions and post-discharge mortality. Medical officer clinician impression at both sites had slightly greater precision in identifying young children at risk of readmission. Clinician perception of inability to pay for treatment was associated with readmission and post-discharge mortality.

The poor precision of clinician impression in identifying neonates and young children at risk of readmission and post-discharge mortality differs from findings in studies in high-income settings that assessed the diagnosis of acute coronary syndrome and sinusitis in adults,[18,19] the presence of pneumonia[20] or the development of severe pneumonia among children,[12] or the presence of appendicitis among children.[21] This difference is likely multifactorial in nature and may consist of differences in available diagnostic and prognostic resources. Prior studies suggest that laboratory capabilities in resource-limited settings are inadequate,[22-24] leading to dependence on clinical exam findings to make diagnoses and determine prognosis,[25] which may hinder the accuracy of clinician impression to identify neonates and young children at risk of untoward post-discharge outcomes. Moreover, clinicians may not consider key factors in the home (e.g., access to healthcare facilities and maternal health) that may contribute to post-discharge outcomes. Additionally, clinician impression had poor precision in identifying neonates and young children at risk for readmission or post-discharge mortality regardless of the time from discharge to either event. Prior studies of clinician impression assessed outcomes within hours or days[12,18,19] and not up to 60 days, which may contribute to the difference in our results compared to prior studies assessing clinician impression in prognostication of outcomes.

Clinician impression among medical officers had fair precision in identifying young children at risk of readmission. This may be due to the combination of more clinical experience than interns/residents and more time spent with patients than consultants/specialists who often spend less time directly with patients and more time supervising clinical care. Prior studies conducted in high-income settings demonstrate that clinician impression of less experienced clinicians may have less discriminatory value than that of more experienced clinicians.[12]

Several clinical prediction rules for post-discharge mortality have been developed among young children aged 2-23 months in several countries in sub-Saharan Africa and South Asia, 6 months-5 years in Uganda, and all children aged <15 years in Mozambique.[5,8,9] These clinical prediction rules include variables such as clinical diagnoses and anthropometry to assign weighted points to included variables to assess an individual patient's risk for post-discharge mortality up to six months after discharge. However, none of these have focused specifically on neonates and none have been externally validated, which is a necessary step to assess discriminatory value prior to clinical use. Thus, the current state of prognostic determination for young children after discharge in sub-Saharan Africa depends on clinician impression and, given its poor precision demonstrated in our study, validated clinical prediction rules to identify neonates and young children at risk of post-discharge mortality are urgently needed. Such clinical decision aids should include commonly collected variables and may include biomarkers to add precision to risk stratification to identify neonates and young children at risk of post-discharge morbidity and mortality.[26-28]

Our examination of reasons for estimated outcomes suggested that clinician perception of inability to pay for future treatment was associated with higher risk of readmission and post-discharge mortality. Young children from lower socioeconomic status have poorer overall health outcomes compared to young children from higher socioeconomic households in sub-Saharan Africa.[29-31] This is particularly relevant in the post-discharge period during which the

financial burden of care seeking may influence the ability for a family to seek additional clinical care after a potentially costly hospital admission.

Limitations

Clinician impression is multifactorial and depends on clinical training as well as available laboratory, radiological, and clinical data that may not have been available to all discharging clinicians. We did not assess the availability of these in our analysis. We did not include nurses or clinical officers in our study, which is a limitation as these groups may have good insight into potential adverse outcomes after discharge. We could not account for the potential role that variations in the quality of clinical care provided to patients may have had in readmissions or post-discharge mortality.

Conclusions

Clinician impression had poor precision in identifying neonates and young children at risk of unplanned hospital readmission and post-discharge mortality at two referral hospitals in Dar es Salaam, Tanzania and Monrovia, Liberia. Validated and objective clinical decision aids to assist clinicians in the identification of young children at risk of readmission and post-discharge mortality may facilitate the identification of those at greatest risk.

Author Contributions: CAR, RK, RCI, AS, EG, HKM, CRS, MN, KPM, and CD conceptualized and designed the study. CAR, RCI, JK, AS, EG, CRS, KPM, and CD oversaw data collection and verified the underlying data. CAR and AM verified the underlying data. AM conducted the statistical analyses. CAR wrote the first draft of the manuscript. CAR, RK, RCI, JK, Y-JC, AS, EG, HKM, CRS, AM, MN, CRM, CGW, RFB, KPM, and CD interpreted the data, reviewed, and provided input to the final draft. CAR had final responsibility for the decision to submit for publication.
Competing Interests: The authors have no relevant competing interests to declare.
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Figure 1. Flow diagram for included neonates and children aged 1-59 months discharged from the neonatal wards and pediatric wards in Dar es Salaam, Tanzania and Monrovia, Liberia

Table 1. Characteristics of neonates and young children included in the evaluation of clinician impression on predicting 60-day hospital readmission or post-discharge mortality

Patient Characteristics	Overall Population, (N=3,896) n (%)	Readmitted to Hospital 60 Days After Hospital Discharge, (N=187) n (%)	Died 60 Days After Hospital Discharge, (N=120) n (%)
Discharged from Neonatal Ward[1]	2,173 (55.8)	80 (3.6)	61 (2.8)
Age in days at discharge, median (IQR)	2 (1, 7)	4 (2, 13)	2 (0, 10)
Discharged from Pediatrics Ward	1,723 (44.2)	107 (6.2)	59 (3.4)
Age in months for pediatric patients aged 1-59 months, median (IQR)[2]	12 (5, 24)	8 (4, 18)	8 (4, 21)
Sex[3]			
Male	2,198 (56.4)	109 (5.0)	74 (3.4)
Female	1,691 (43.4)	78 (4.6)	46 (2.7)
Country			
Tanzania	1,997 (51.3)	140 (7.0)	63 (3.2)
Liberia	1,899 (48.7)	47 (2.5)	57 (3.0)
Disposition from the Hospital			
Discharge	3,775 (96.8)	186 (4.9)	106 (2.8)
Left against medical advice	119 (3.1)	1 (0.8)	14 (11.8)
Transfer to another facility	2 (0.05)	0 (0.0)	0 (0.0)

[1]24 neonates had missing age.
[2]31 young children had missing age.
[3]7 participants did not have a documented sex.

Table 2. Association of discharging clinicians' predicted probability and unplanned 60-day hospital readmission among neonates and young children

	Total, n (%) (N=3,896)	Not Readmitted 60 Days After Hospital Discharge, n (%) (N=3,709)	Readmitted 60 Days After Hospital Discharge, n (%) (N=187)	*P* Value[1]
Clinician predicted probability				<0.001
0%	2,838 (72.8)	2,687 (72.4)	151 (80.7)	
1-5%	9 (0.2)	9 (0.2)	0 (0.0)	
6-20%	26 (0.7)	23 (0.6)	3 (1.6)	
21-40%	736 (18.9)	720 (19.4)	16 (8.6)	
41-60%	38 (1.0)	35 (0.9)	3 (1.6)	
61-80%	237 (6.1)	227 (6.1)	10 (5.3)	
81-99%	11 (0.3)	7 (0.2)	4 (2.1)	

[1]By Fisher's exact test to assess independence of clinician predicted probability and likelihood of hospital readmission.
Note: There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 3. Test characteristics for clinician predicted probability of unplanned,60-day hospital readmission among all enrolled neonates and young children aged 1-59 months overall and by clinician type

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
All Clinicians (N=3,895)[1]					0.06 (0.04, 0.08), chance=0.05
≤5	19.3 (13.9, 25.1)	72.5 (71.0, 73.8)	3.4 (2.5, 4.4)	94.7 (94.3, 95.1)	
≤20	19.3 (13.9, 25.1)	72.7 (71.3, 74.1)	3.4 (2.5, 4.5)	94.7 (94.4, 95.1)	
≤40	17.7 (12.3, 23.5)	73.7 (72.3, 75.1)	3.3 (2.4, 4.3)	94.7 (94.3, 95.0)	
≤60	16.0 (11.2, 21.9)	74.3 (72.9, 75.7)	3.0 (2.1, 4.1)	94.6 (94.3, 94.9)	
≤80	7.5 (4.2, 11.8)	93.7 (92.9, 94.4)	5.6 (3.1, 8.7)	95.3 (95.1, 95.5)	
≤99	2.1 (0.5, 4.3)	99.8 (99.7, 99.9)	36.4 (9.1, 66.7)	95.3 (95.2, 95.4)	
Consultant/Specialist (N=175)					0.05 (0.02, 0.08), chance=0.03
≤5	16.7 (0, 50.0)	69.2 (62.1, 75.8)	1.9 (0.0, 5.7)	95.8 (94.7, 97.6)	
≤20	16.7 (0, 50.0)	69.8 (62.7, 76.3)	1.9 (0, 5.9)	95.9 (94.7, 97.6)	
≤40	16.7 (0, 50.0)	73.4 (66.3, 79.9)	2.1 (0, 6.7)	96.1 (95.0, 97.7)	
≤60	0.0 (0.0, 0.0)	75.2 (68.6, 81.1)	0.0 (0.0, 0.0)	95.5 (95.1, 95.8)	
≤80	0.0 (0.0, 0.0)	85.2 (79.9, 90.5)	0.0 (0.0, 0.0)	96.0 (95.7, 96.2)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	NA	96.6 (96.6, 96.6)	
Intern/Resident (N=3,502)					0.06 (0.03, 0.08), chance=0.05
≤5	14.9 (9.9, 20.5)	72.4 (70.8, 73.9)	2.5 (1.7, 3.5)	94.6 (94.3, 95.0)	
≤20	14.9 (9.9, 20.5)	72.5 (70.9, 74.0)	2.5 (1.7, 3.5)	94.6 (94.3, 95.0)	
≤40	14.9 (9.9, 20.5)	73.2 (71.6, 74.7)	2.6 (1.7, 3.6)	94.7 (94.4, 95.1)	
≤60	13.6 (8.7, 19.3)	73.5 (71.9, 75.0)	2.4 (1.6, 3.4)	94.6 (94.3, 94.9)	
≤80	5.6 (2.5, 9.3)	94.1 (93.3, 94.9)	4.3 (1.9, 7.3)	95.4 (95.2, 95.6)	
≤99	1.2 (0.0, 3.1)	99.9 (99.8, 100)	40.0 (0.0, 100)	95.5 (95.4, 95.5)	
Medical Officer (N=217)					0.23 (0.17, 0.34), chance=0.09
≤5	55.0 (30.0, 75.0)	76.1 (70.1, 81.7)	18.9 (11.6, 26.5)	94.3 (91.6, 96.9)	
≤20	55.0 (30.0, 75.0)	78.7 (72.6, 84.3)	20.7 (12.7, 29.4)	94.5 (91.9, 96.9)	
≤40	40.0 (20.0, 60.0)	82.2 (76.6, 87.3)	18.4 (9.4, 28.9)	93.1 (90.8, 95.5)	
≤60	40.0 (20.0, 60.0)	86.8 (81.7, 91.4)	23.5 (12.1, 36.4)	93.4 (91.3, 95.7)	
≤80	25.0 (9.8, 45.0)	93.9 (90.4, 96.9)	29.4 (10.5, 50.0)	92.5 (90.9, 94.4)	
≤99	10.0 (0.0, 25.0)	97.9 (95.9, 99.5)	33.3 (0.0, 80.0)	91.5 (90.6, 92.8)	

[1]There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 4. Association of discharging clinicians' predicted probability and all-cause,60-day post-discharge mortality among neonates and young children

	Total, n (%) (N=3,896)	Did not Die 60 Days After Hospital Discharge, n (%) (N=3,776)	Died 60 Days After Hospital Discharge, n (%) (N=120)	*P* Value[1]
Clinician predicted probability				0.002
0%	3,746 (96.1)	3,637 (96.3)	109 (90.8)	
1-5%	10 (0.3)	10 (0.3)	0 (0.0)	
6-20%	9 (0.2)	7 (0.2)	2 (1.7)	
21-40%	13 (0.3)	11 (0.3)	2 (1.7)	
41-60%	95 (2.4)	90 (2.4)	5 (4.2)	
61-80%	21 (0.5)	20 (0.5)	1 (0.8)	
81-99%	2 (0.1)	1 (0.03)	1 (0.8)	

[1]By Fisher's exact test to assess independence of clinician predicted probability and likelihood of hospital readmission.

Table 5. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality among all enrolled neonates and young children aged 1-59 months by clinician type

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
All Clinicians (N=3,895)[1]					0.05 (0.03, 0.08), chance=0.03
≤5	9.2 (4.2, 15.0)	96.3 (95.7, 96.9)	7.3 (3.5, 11.9)	97.1 (96.9, 97.3)	
≤20	9.2 (4.2, 15.0)	96.6 (95.9, 97.2)	7.7 (3.8, 12.7)	97.1 (96.9, 97.3)	
≤40	7.5 (3.3, 12.5)	96.7 (96.2, 97.3)	6.8 (2.9, 11.6)	97.1 (96.9, 97.2)	
≤60	5.8 (1.7, 10.8)	97.1 (96.5, 97.6)	5.8 (1.9, 10.5)	97.0 (96.9, 97.2)	
≤80	1.7 (0.0, 4.2)	99.4 (99.2, 99.7)	8.3 (0.0, 22.7)	96.9 (96.9, 97.0)	
≤99	0.8 (0.0, 2.5)	99.9 (99.9, 100)	50.0 (0.0, 100)	96.9 (96.9, 96.9)	
Specialist or Consultant (N=175)					0.05 (0.02, 0.07), chance=0.04
≤5	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤20	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤40	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤60	0.0 (0.0, 0.0)	97.6 (95.2, 99.4)	0.0 (0.0, 0.0)	95.9 (95.8, 95.9)	
≤80	0.0 (0.0, 0.0)	98.8 (97.0, 100)	0.0 (0.0, 0.0)	95.9 (95.9, 96.0)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	-	96.0 (96.0, 96.0)	
Intern/Resident (N=3,502)					0.05 (0.02, 0.08), chance=0.03
≤5	8.8 (3.9, 14.7)	97.1 (96.5, 97.6)	8.3 (3.7, 13.8)	97.3 (97.1, 97.4)	
≤20	8.8 (3.9, 14.7)	97.2 (96.6, 97.7)	8.5 (3.8, 14.2)	97.3 (97.1, 97.4)	
≤40	6.9 (2.9, 12.7)	97.2 (96.6, 97.7)	6.8 (2.7, 12.0)	97.2 (97.1, 97.4)	
≤60	5.8 (1.9, 10.8)	97.2 (96.7, 97.8)	5.9 (1.9, 11.0)	97.2 (97.1, 97.3)	
≤80	1.9 (0.0, 4.9)	99.6 (99.4, 99.8)	11.8 (0.0, 30.8)	97.1 (97.1, 97.2)	
≤99	0.9 (0.0, 2.9)	99.9 (99.9, 100.0)	50.0 (0.0, 100.8)	97.1 (97.1, 97.2)	
Medical Officer (N=218)					0.05 (0.03, 0.08), chance=0.05
≤5	18.2 (0.0, 45.5)	82.6 (77.8, 87.9)	5.0 (0, 12.2)	94.9 (93.8, 96.5)	
≤20	18.2 (0.0, 45.5)	85.9 (81.2, 90.3)	6.1 (0, 14.8)	95.1 (94.1, 96.7)	
≤40	18.2 (0.0, 45.5)	88.9 (84.5, 92.8)	7.7 (0, 18.7)	95.3 (94.2, 96.8)	
≤60	9.1 (0.0, 27.3)	93.7 (90.3, 96.6)	6.7 (0, 23.1)	95.1 (94.5, 96.1)	
≤80	0.0 (0.0, 0.0)	97.6 (95.2, 99.5)	0.0 (0.0, 0.0)	94.8 (94.7, 94.9)	
≤99	0.0 (0.0, 0.0)	100 (100, 100)	-	94.9 (94.9, 94.9)	

[1]There was 1 respondent who estimated that the discharged child was at risk of hospital readmission but did not assign a proportion.

Table 6. Reasons for perceived risk of hospital readmission and post-discharge mortality

Clinician Cited Reason for Outcome	No Hospital Readmission, n (%)	Hospital Readmission, n (%)	Odds Ratio (95% Confidence Interval)	*P* value
No risk	2,584 (69.7)	148 (79.1)	*Referent*	--
Clinician perceived inability to pay for treatment	11 (0.3)	3 (1.6)	4.76 (1.31, 17.25)	0.02
Clinician perceived social concerns	70 (1.9)	3 (1.6)	0.75 (0.23, 2.41)	0.63
Clinician perceived progression of illness	754 (20.3)	29 (15.5)	0.67 (0.45, 1.01)	0.05
Other[1]	290 (7.8)	4 (2.1)	0.24 (0.09, 0.66)	0.005
Clinician Cited Reason for Outcome	**Did not Die Within 60 Days, n (%)**	**Died Within 60 Days, n (%)**	**Odds Ratio (95% Confidence Interval)**	***P* value**
No risk	2,652 (70.2)	80 (66.7)	*Referent*	--
Clinician perceived inability to pay for treatment	12 (0.3)	2 (1.7)	5.53 (1.22, 25.10)	0.03
Clinician perceived social concerns	72 (1.9)	1 (0.8)	0.46 (0.06, 3.36)	0.44
Clinician perceived progression of illness	754 (20.0)	29 (24.2)	1.28 (0.83, 1.97)	0.27
Other[1]	286 (7.6)	8 (6.7)	0.93 (0.44, 1.94)	0.84

[1]Included concerns about caregiver understanding, general clinician impression, and patient with history of recurrent illness.

Table 7. Multivariable regression model for all-cause 60-day hospital readmission and post-discharge mortality among young children discharged in Dar es Salaam, Tanzania and Monrovia, Liberia

Characteristics	No Hospital Readmission, n (%), N=3,709	Hospital Readmission, n (%), N=187	Adjusted Odds Ratio (95% CI), N=3,426	*P* value
Perceived risk				
0%	2,687 (72%)	151 (81%)	*Referent*	--
1-20%	44 (1.2%)	3 (1.6%)	0.96 (0.23, 2.77)	0.95
21-60%	743 (20%)	19 (10%)	0.45 (0.26, 0.74)	0.003
61-99%	234 (6.3%)	14 (7.5%)	1.08 (0.57, 1.90)	0.79
Discharge Provider Type				
Intern/Resident	3,341 (90%)	161 (86%)	*Referent*	--
Specialist or Consultant	169 (4.6%)	6 (3.2%)	0.78 (0.30, 1.65)	0.55
Medical Officer	198 (5.3%)	20 (11%)	2.07 (1.21, 3.39)	0.01
Patient Age at Discharge, months	1 (0, 10)	3 (1, 11)	1.00 (0.98, 1.01)	0.45
Discharge Diagnosis				
Non-infectious	1,492 (40%)	87 (47%)	*Referent*	--
Infectious	2,217 (60%)	100 (53%)	0.86 (0.62, 1.19)	0.35
Duration of Hospitalization, days	7 (3, 13)	8 (3, 16)	1.002 (1.0001, 1.005)	0.04
Characteristics	**Did not Die Within 60 Days, n (%), N=3,776**	**Died Within 60 Days, n (%), N=120**	**Adjusted Odds Ratio (95% CI), N=3,426**	***P* value**
Perceived risk				
0%	3,637 (96%)	109 (91%)	*Referent*	--
1-20%	17 (0.5%)	2 (1.7%)	2.95 (0.44, 11.8)	0.18
21-60%	101 (2.7%)	7 (5.8%)	1.92 (0.73, 4.20)	0.14
61-99%	21 (0.6%)	2 (1.7%)	2.94 (0.46, 10.4)	0.15
Discharge Provider Type				
Intern/Resident	3,400 (90%)	102 (85%)	*Referent*	--
Specialist or Consultant	168 (4.5%)	7 (5.8%)	1.53 (0.63, 3.15)	0.29
Medical Officer	207 (5.5%)	11 (9.2%)	1.76 (0.82, 3.45)	0.12
Patient Age at Discharge, months	1 (0, 11)	1 (0, 7)	0.99 (0.97, 1.00)	0.13
Discharge Diagnosis				
Non-infectious	1,531 (41%)	48 (40%)	*Referent*	--
Infectious	2,245 (59%)	72 (60%)	0.95 (0.64, 1.42)	0.80
Duration of Hospitalization, days	7 (3, 13)	8 (3, 14)	1.00 (0.99, 1.00)	0.88

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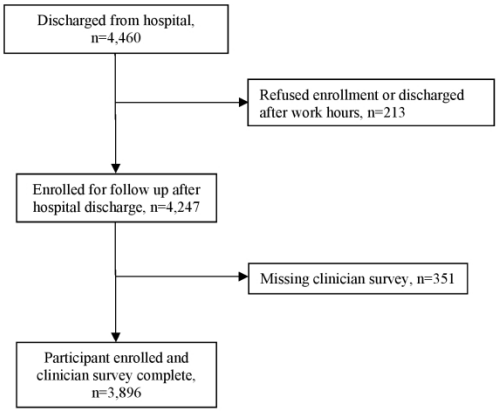

Figure 1. Flow diagram for included neonates and children aged 1-59 months discharged from the neonatal wards and pediatric wards in Dar es Salaam, Tanzania and Monrovia, Liberia

215x279mm (300 x 300 DPI)

Supplemental Table 1. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission for neonates at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
All Clinicians (N=2,173)					0.03 (0.02, 0.04), chance=0.04
≤5	8.75 (3.75, 15)	73.77 (71.91, 75.68)	1.25 (0.51, 2.19)	95.48 (95.19, 95.81)	
≤20	8.75 (3.75, 15)	73.87 (72, 75.73)	1.25 (0.51, 2.19)	95.48 (95.19, 95.81)	
≤40	8.75 (3.75, 15)	74.34 (72.48, 76.21)	1.28 (0.52, 2.23)	95.51 (95.23, 95.84)	
≤60	7.5 (2.5, 13.75)	74.58 (72.72, 76.4)	1.1 (0.36, 2.04)	95.46 (95.2, 95.78)	
≤80	2.5 (0, 6.25)	94.84 (93.88, 95.8)	1.75 (0, 4.47)	96.21 (96.11, 96.36)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.32 (96.32, 96.32)	
Interns/Residents (N=2,076)					0.03 (0.02, 0.04), chance=0.04
≤5	7.79 (2.6, 14.29)	73.69 (71.68, 75.54)	1.12 (0.37, 2.03)	95.39 (95.11, 95.72)	
≤20	7.79 (2.6, 14.29)	73.74 (71.74, 75.59)	1.12 (0.37, 2.04)	95.4 (95.12, 95.73)	
≤40	7.79 (2.6, 14.29)	74.09 (72.09, 75.94)	1.14 (0.37, 2.07)	95.42 (95.14, 95.74)	
≤60	7.79 (2.6, 14.29)	74.29 (72.34, 76.14)	1.15 (0.38, 2.08)	95.43 (95.15, 95.76)	
≤80	2.6 (0, 6.49)	95.15 (94.15, 96.05)	1.96 (0, 4.85)	96.2 (96.09, 96.35)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.29 (96.29, 96.29)	
Specialist or Consultant (N=66)					0.09 (0.01, 0.18) , chance=0.07
≤5	50 (0, 100)	65.62 (53.12, 76.56)	4.35 (0, 10.53)	97.67 (94.87, 100)	
≤20	50 (0, 100)	67.19 (54.69, 79.69)	4.55 (0, 11.11)	97.73 (95.12, 100)	
≤40	50 (0, 100)	71.88 (60.94, 82.81)	5.26 (0, 12.5)	97.87 (95.45, 100)	
≤60	0 (0, 0)	73.44 (62.5, 84.38)	0 (0, 0)	95.92 (95.24, 96.43)	
≤80	0 (0, 0)	82.81 (73.44, 92.19)	0 (0, 0)	96.36 (95.92, 96.72)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.97 (96.97, 96.97)	
Medical Officer (N=30)					0.03 (NA, NA), chance=0.04
≤5	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤20	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤40	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤60	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤80	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.67 (96.67, 96.67)	

Supplemental Table 2. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission for young children aged 1-59 months at both sites

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
All Clinicians (N=1,722)					0.09 (0.04, 0.14) , chance=0.06
≤5	27.1 (18.69, 35.51)	70.77 (68.54, 73)	5.77 (4.09, 7.57)	93.6 (92.9, 94.33)	
≤20	27.1 (18.69, 35.51)	71.21 (68.98, 73.44)	5.85 (4.14, 7.69)	93.64 (92.95, 94.36)	
≤40	24.3 (15.89, 32.71)	72.76 (70.65, 74.86)	5.51 (3.81, 7.4)	93.53 (92.9, 94.23)	
≤60	22.43 (14.95, 30.84)	73.87 (71.7, 75.98)	5.34 (3.59, 7.35)	93.48 (92.88, 94.19)	
≤80	11.21 (5.61, 17.76)	92.26 (90.84, 93.44)	8.63 (4.32, 13.71)	94 (93.63, 94.45)	
≤99	3.74 (0.93, 7.48)	99.57 (99.26, 99.88)	35.71 (10, 66.67)	93.98 (93.81, 94.21)	
Interns/Residents (N=1,426)					0.08 (0.04, 0.11), chance=0.06
≤5	21.43 (13.1, 30.95)	70.57 (68.18, 73.03)	4.32 (2.7, 6.11)	93.47 (92.81, 94.2)	
≤20	21.43 (13.1, 30.95)	70.72 (68.33, 73.1)	4.35 (2.71, 6.13)	93.48 (92.82, 94.22)	
≤40	21.43 (13.1, 30.95)	71.83 (69.45, 74.14)	4.51 (2.81, 6.35)	93.58 (92.93, 94.29)	
≤60	19.05 (10.71, 27.38)	72.35 (69.97, 74.67)	4.08 (2.45, 5.93)	93.43 (92.83, 94.12)	
≤80	8.33 (3.57, 14.29)	92.55 (91.06, 93.96)	6.25 (2.48, 11.2)	94.14 (93.83, 94.54)	
≤99	2.38 (0, 5.95)	99.78 (99.48, 100)	40 (0, 100)	94.23 (94.09, 94.43)	
Specialist or Consultant (N=109)					0.05 (0.02, 0.08), chance=0.06
≤5	0 (0, 0)	71.43 (62.86, 80)	0 (0, 0)	94.94 (94.29, 95.45)	
≤20	0 (0, 0)	71.43 (62.86, 80)	0 (0, 0)	94.94 (94.29, 95.45)	
≤40	0 (0, 0)	74.29 (65.71, 82.86)	0 (0, 0)	95.12 (94.52, 95.6)	
≤60	0 (0, 0)	76.19 (67.62, 83.81)	0 (0, 0)	95.24 (94.67, 95.65)	
≤80	0 (0, 0)	86.67 (79.98, 92.38)	0 (0, 0)	95.79 (95.45, 96.04)	
≤99	0 (0, 0)	100 (100, 100)	NA (NA, NA)	96.33 (96.33, 96.33)	
Medical Officer (N=187)					0.30 (0.18, 0.41), chance=0.10
≤5	57.89 (36.84, 78.95)	72.02 (64.88, 79.17)	19.2 (12.07, 26.32)	93.85 (90.76, 96.85)	
≤20	57.89 (36.84, 78.95)	75 (67.86, 81.55)	20.93 (13.46, 28.85)	94.07 (91.11, 96.95)	
≤40	42.11 (21.05, 63.16)	79.17 (72.62, 85.12)	18.75 (9.37, 28.57)	92.36 (89.61, 95.17)	
≤60	42.11 (21.05, 63.16)	84.52 (78.57, 89.88)	23.68 (12.12, 36)	92.86 (90.26, 95.42)	
≤80	26.32 (10.53, 47.37)	92.86 (88.69, 96.43)	30 (10.53, 50)	91.76 (89.88, 93.98)	
≤99	10.53 (0, 26.32)	97.62 (95.24, 99.4)	33.33 (0, 80)	90.61 (89.56, 92.18)	

Supplemental Table 3. Test characteristics for clinician predicted probability of all-cause, 60-day hospital readmission among all participants by time to unplanned hospital readmission

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
Day 7					0.03 (0.01, 0.05), chance=0.01
≤5	23.4 (10.64, 36.17)	72.77 (71.34, 74.22)	1.03 (0.49, 1.62)	98.72 (98.54, 98.95)	
≤20	23.4 (10.64, 36.17)	73 (71.57, 74.45)	1.04 (0.5, 1.64)	98.73 (98.54, 98.95)	
≤40	23.4 (10.64, 36.17)	74.01 (72.61, 75.39)	1.08 (0.51, 1.7)	98.75 (98.56, 98.96)	
≤60	23.4 (10.64, 36.17)	74.66 (73.28, 76.09)	1.1 (0.53, 1.74)	98.76 (98.57, 98.97)	
≤80	12.77 (4.26, 23.4)	93.69 (92.96, 94.49)	2.38 (0.78, 4.35)	98.87 (98.76, 99.01)	
≤99	4.26 (0, 10.64)	99.77 (99.58, 99.9)	16.67 (0, 46.15)	98.84 (98.79, 98.92)	
Day 14					0.03 (0.02, 0.04), chance=0.02
≤5	17.28 (9.88, 25.93)	72.68 (71.24, 74.07)	1.31 (0.75, 1.95)	97.63 (97.43, 97.87)	
≤20	17.28 (9.88, 25.93)	72.92 (71.47, 74.28)	1.32 (0.75, 1.97)	97.64 (97.43, 97.88)	
≤40	16.05 (8.64, 23.46)	73.89 (72.47, 75.25)	1.28 (0.69, 1.89)	97.64 (97.43, 97.86)	
≤60	16.05 (8.64, 23.46)	74.57 (73.13, 75.91)	1.31 (0.71, 1.94)	97.66 (97.46, 97.88)	
≤80	7.41 (2.47, 13.58)	93.68 (92.87, 94.47)	2.38 (0.8, 4.43)	97.94 (97.83, 98.08)	
≤99	2.47 (0, 6.17)	99.76 (99.61, 99.9)	16.67 (0, 44.44)	97.97 (97.91, 98.04)	
Day 30					0.03 (0.01, 0.06), chance=0.03
≤5	18.64 (11.86, 25.42)	72.57 (71.06, 73.95)	2.06 (1.34, 2.87)	96.61 (96.34, 96.91)	
≤20	18.64 (11.86, 25.42)	72.82 (71.33, 74.21)	2.08 (1.35, 2.9)	96.62 (96.35, 96.92)	
≤40	16.95 (10.17, 23.73)	73.79 (72.31, 75.17)	1.97 (1.23, 2.74)	96.6 (96.33, 96.87)	
≤60	15.25 (9.32, 22.03)	74.42 (72.97, 75.8)	1.81 (1.1, 2.62)	96.56 (96.31, 96.83)	
≤80	6.78 (2.54, 11.86)	93.65 (92.82, 94.39)	3.15 (1.24, 5.53)	96.98 (96.85, 97.14)	
≤99	1.69 (0, 4.24)	99.76 (99.6, 99.89)	16.67 (0, 44.44)	97.01 (96.96, 97.09)	
Day 45					0.05 (0.04, 0.06), chance=0.04
≤5	18.67 (12.67, 24.67)	72.52 (71.13, 73.91)	2.64 (1.84, 3.51)	95.7 (95.39, 96.02)	
≤20	18.67 (12.67, 24.67)	72.76 (71.35, 74.15)	2.66 (1.85, 3.54)	95.71 (95.41, 96.03)	
≤40	16.67 (11.33, 22.67)	73.72 (72.26, 75.09)	2.47 (1.69, 3.33)	95.66 (95.38, 95.97)	
≤60	15.33 (10, 21.33)	74.34 (72.92, 75.73)	2.33 (1.56, 3.19)	95.63 (95.37, 95.92)	
≤80	7.33 (3.33, 11.33)	93.67 (92.87, 94.45)	4.4 (2.21, 7.17)	96.19 (96.04, 96.37)	
≤99	2.67 (0.67, 5.35)	99.81 (99.68, 99.95)	35.71 (9.09, 66.67)	96.24 (96.16, 96.35)	

Supplemental Table 4. Test characteristics for clinician predicted probability of all-cause, 60-day post-discharge mortality among all patients by time to post-discharge mortality

Threshold %	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area under Precision-Recall Curve (95% CI)
Day 7					0.02 (0.001, 0.03), chance=0.004
≤5	17.65 (0, 35.29)	96.21 (95.59, 96.78)	1.97 (0, 4.29)	99.63 (99.55, 99.71)	
≤20	17.65 (0, 35.29)	96.47 (95.88, 97.01)	2.11 (0, 4.58)	99.63 (99.55, 99.71)	
≤40	17.65 (0, 35.29)	96.7 (96.13, 97.24)	2.26 (0, 4.92)	99.63 (99.55, 99.71)	
≤60	17.65 (0, 35.29)	97.04 (96.49, 97.55)	2.52 (0, 5.5)	99.63 (99.55, 99.71)	
≤80	5.88 (0, 17.65)	99.43 (99.2, 99.66)	4.17 (0, 14.29)	99.59 (99.56, 99.64)	
≤99	0 (0, 0)	99.95 (99.87, 100)	0 (0, 0)	99.56 (99.56, 99.56)	
Day 14					0.02 (0.005, 0.03), chance=0.01
≤5	13.16 (2.63, 23.68)	96.24 (95.62, 96.81)	3.23 (0.7, 6.3)	99.12 (99.01, 99.23)	
≤20	13.16 (2.63, 23.68)	96.5 (95.93, 97.05)	3.45 (0.75, 6.78)	99.12 (99.02, 99.23)	
≤40	13.16 (2.63, 23.68)	96.73 (96.16, 97.25)	3.7 (0.81, 7.26)	99.12 (99.02, 99.23)	
≤60	7.89 (0, 18.42)	97.02 (96.47, 97.54)	2.42 (0, 5.51)	99.07 (99, 99.17)	
≤80	2.63 (0, 7.89)	99.43 (99.2, 99.66)	4 (0, 14.29)	99.04 (99.02, 99.1)	
≤99	0 (0, 0)	99.95 (99.87, 100)	0 (0, 0)	99.02 (99.02, 99.02)	
Day 30					0.04 (0.01, 0.07), chance=0.02
≤5	9.52 (3.17, 17.46)	96.24 (95.64, 96.82)	3.95 (1.29, 7.24)	98.48 (98.37, 98.61)	
≤20	9.52 (3.17, 17.46)	96.5 (95.9, 97.08)	4.23 (1.39, 7.76)	98.48 (98.37, 98.61)	
≤40	9.52 (3.17, 17.46)	96.74 (96.16, 97.29)	4.51 (1.48, 8.33)	98.49 (98.38, 98.62)	
≤60	6.35 (1.59, 12.7)	97.03 (96.45, 97.55)	3.28 (0.79, 6.96)	98.44 (98.36, 98.55)	
≤80	3.17 (0, 7.94)	99.45 (99.22, 99.69)	8.33 (0, 21.74)	98.42 (98.37, 98.5)	
≤99	1.59 (0, 4.76)	99.97 (99.92, 100)	50 (0, 100)	98.41 (98.38, 98.46)	
Day 45					0.04 (0.02, 0.06), chance=0.02
≤5	8.6 (3.23, 13.98)	96.27 (95.66, 96.87)	5.26 (2.17, 8.86)	97.73 (97.61, 97.87)	
≤20	8.6 (3.23, 13.98)	96.53 (95.9, 97.11)	5.63 (2.36, 9.45)	97.74 (97.61, 97.87)	
≤40	8.6 (3.23, 13.98)	96.77 (96.13, 97.32)	6.02 (2.5, 10.17)	97.74 (97.62, 97.88)	
≤60	6.45 (2.15, 11.83)	97.05 (96.48, 97.56)	4.96 (1.64, 9.26)	97.69 (97.59, 97.83)	
≤80	2.15 (0, 5.38)	99.45 (99.21, 99.66)	8.33 (0, 22.22)	97.65 (97.6, 97.73)	
≤99	1.08 (0, 3.23)	99.97 (99.92, 100)	50 (0, 100)	97.64 (97.61, 97.69)	

Appendix Survey. Survey that clinicians filled out near the time of discharge for each enrolled neonate or young child in Dar es Salaam, Tanzania and Monrovia, Liberia

Provider Discharge Survey

Date of Data Collection _____
DD/MM/YYYY

Patient's FIRST name _____

Patient's LAST name _____

Patient's SEX:
- Male
- Female

Participant's Hospital Identifier (Unique number assigned to each patient) _____

Discharging provider year of training:
- Intern
- First year resident
- Second year resident
- Third year resident
- Specialist
- Consultant
- Medical officer
- Other. Please describe. _____

In your estimation, is the patient who was discharged at risk of any of the following?
- Re-admission to the hospital within 60 days
- Death in the next 60 days
- None of the above

If yes to any of the above, how likely is that outcome?
- 0%
- 1-5%
- 6-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%

If yes, why do you think the patient is at risk of any of the above outcomes?
- Progression of illness
- Social concerns
- Inability to pay for future medical
- Other. Please describe. _____