Admission Early Warning Score and Neonatal Outcome in a Resource-limited Settings

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Original Article

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Abstracts

Background: Neonatal mortality has remained a major public health concern in low- and middle-income countries. Early warning scoring (EWS) systems minimize hospital mortality by providing rapid and efficient care; however, their effectiveness in low- and middle-income countries is unknown.

Method: This study is a retrospective analysis of neonates admitted to the University College Hospital in Nigeria between January and December 2019. We evaluate the accuracy of significant modified early warning scores (sMEWS) in predicting neonatal in-hospital mortality and associated risk factors.

Results: The majority (254; 68.5%) of the 371 admitted newborns were late preterm to term, and 54.7% were males; 173 (48.7%) required resuscitation at admission in the emergency department (ED). One hundred and thirty-seven had sMEWS, which decreased to 22 (5.9%) 72 h post-admission. Univariable analysis shows that sMEWS at admission were associated with sepsis, perinatal asphyxia, and the necessity for resuscitation. Multivariable logistic regression indicated that outborns (adjusted odds ratio [AOR]: 2.218; 95% confidence interval [CI], 1.125–4.371), need for resuscitation at admission (AOR: 5.501; CI, 3.350–9.034) and persistence of sMEWS 72 h post-admission (AOR: 9.693; CI, 2.181–43.079), were associated with sMEWS. Significantly associated with excess mortality were sMEWS at admission (AOR: 3.530; CI, 1.721–7.240) and sMEWS 72 h post-admission (AOR: 5.931; CI, 5.944 –64.385).

Conclusions: The sMEWS performed moderately well as an EWS in a neonatal emergency unit. Excess mortality was associated with the need for resuscitation in the ED and the persistence of sMEWS 72 h post-admission.

Keywords

Early warning score, early warning signs, early warning system, neonate, in-hospital mortality, 72 h post-admission, Nigeria

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Introduction

Despite significant gains in child survival over the past three decades, neonatal mortality in sub-Saharan Africa appears to be lagging. Approximately half of all deaths in children under the age of 5 years, occur within the first 28 days of life due to preventable causes, with neonatal sepsis, perinatal asphyxia, and premature birth being the most prevalent.[1–4] The narrative is not different in Nigeria, where neonatal mortality ranks among the highest globally.[1–4] A number of factors contribute to the disproportionate distribution of poor neonatal outcomes in low- and middle-income countries.[5,6] Poverty, inadequate healthcare infrastructure, ineffective governance, and inefficient use of available resources are just a few examples.[1,5,7]

The neonatal period has been described as the most vulnerable period in a child's life, especially in resource-constrained settings.[8,9] The poor neonatal outcome observed in this setting could also be due to organ system immaturity and neonates' nonspecific response to the diverse pathological processes to which they are exposed, making diagnosis and management even more difficult. Poor prenatal care for pregnant women, with its attendant high prevalence of extremely small and very sick newborns delivered by a weakened healthcare delivery system, aggravates the challenges.[5,6] Furthermore, there is poor health-seeking behavior with hospital delivery rates as low as 6% in some sub-Saharan African countries.[10–12] It is therefore critical to ensure that, while actions are geared toward safe deliveries, those who make the effort to reach the health facilities receive the best possible

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care and are saved through patient-centered care as well as prompt and effective management.

An early warning system is an evidence-based intervention that has been found to improve survival, reduce morbidity, and ensure a safer healthcare delivery system in both adult and pediatric populations.[13–15] An early warning score (EWS) is a scoring guide used by medical services to quickly determine the severity of a patient's acute illness or risk for clinical deterioration in order to begin early intervention and management.[13–15] They are based on vital signs. An elevated score derived from the vital signs triggers a clinical pathway to alert healthcare providers and request necessary actions to prevent unexpected adverse events.[16] It entails assigning numbers to vital signs such as respiratory rate, oxygen saturation, temperature, blood pressure, pulse/heart rate, and level of consciousness.[16]

Although most physiologic changes in sick newborns at the early stages of illness are usually subtle, these changes frequently precede clinical deterioration, allowing room for targeted care.[16–18] EWS in neonates is extremely effective at detecting deviations from normal physiology as early as eight hours before the adverse event.[17,18] It has the potential to halt deterioration if treated promptly.[17,18] It is also useful for systematic and consistent patient monitoring in addition to being an important tool for the allocation of resources.

The potential benefits of implementing an early warning system include improved detection of clinical deterioration, timely interventions such as early medication administration or transfer to a higher level of care, and enhanced communication and coordination among healthcare providers. As a result, there is potential for enhanced efficacy and efficiency in the provision of healthcare services. Ultimately, there will be a reduction in the incidence of neonatal mortality and morbidity, coupled with an enhancement in the standard of care provided to newborns.

In resource-constrained settings, EWS is particularly useful where there are shortages of skilled healthcare providers, limited diagnostic and monitoring equipment, and a high patient load. By using an EWS, healthcare providers can prioritize care for newborns who are at the highest risk of clinical deterioration and ensure that resources are used efficiently.

The neonatal wards of the study center use non-color-coded charts for vital sign monitoring. Temperature, pulse, and respiration are tracked on a 4-hourly basis on an observation chart. The patient's oxygen saturation, activity changes, feed intolerance, abdominal distension, seizures, bowel movements, blood transfusions, feeding, weight, and other acute events are recorded on improvised sheets. When a patient's condition deteriorates, nurses and doctors use clinical judgment and a non-color-coded observation chart to create a triage system. As neonatal mortality remains unacceptably high despite the use of the nursing observation chart, there is a need to improve the current practice. Hence, it would be instructive to examine the usefulness of the EWS system as a predictor of neonatal outcome at admission and after stabilization (after 72 h).

We hypothesized that modified EWS (MEWS) of four or more can predict in-hospital mortality.

The objective of this study was to evaluate the accuracy of the significant MEWS (sMEWS) using retrospective data to predict in-hospital mortality. In addition, identify the risk factors that are associated with sMEWS.

Methods and Participants

Study Settings

This study was conducted at a tertiary hospital in southwestern Nigeria. The division provides acute care for nine subspecialties, including neonatal care.

Study Design

This was a retrospective analysis of data on neonatal admissions in the neonatal unit from January to December 2019. MEWS were generated from data extracted from the standard nursing observation charts. The observation charts were scored at the point of admission and 72 h post-admission. We referred to the MEWS of four or higher at the time of initial assessment as sMEWS at admission in order to examine the efficacy of triage and intervention at the time of admission. The second score was designated as sMEWS 72 h post-admission. It evaluates the effectiveness of acute care management care after 72 h of admission. The term "at admission" in our study refers to findings and actions carried out on the neonate at the point of entry into the Neonatal Emergency Unit.

At admission, data on temperature, heart rate, oxygen saturation, degree of consciousness, and respiratory rate were recorded by the nurses within 10 min of arrival while the doctors carried out a quick examination of the neonates for emergency signs. The observation data at admission were computed to generate the sMEWS at admission (Table 1) by the authors, similar to those published in the literature.[19,20] The sMEWS at admission were computed as scores for initial triage to identify critically ill neonates in need of immediate care and offer information on pending clinical deterioration and in-hospital mortality or survival. The sMEWS 72 h post-admission were generated using comparable data collected 72 h after hospital admission and assessed the impact of ongoing care and in-hospital mortality or survival 72 h post-admission. In line with the literature, we used a trigger score of four or more for the sMEWS at admission and sMEWS 72 h post-admission.[21–23]

Sample Size Estimation

The minimum sample size was estimated using an online sample size calculator (http://www.raosoft.com/samplesize.html). Using a notification level of 63% for pediatric EWS obtained from a study in Rwanda,[24] we obtained a minimum sample size of 352 at a 95% confidence level and a 5% margin of error.

Study Population

The study population comprised newborns admitted to the special care baby unit (SCBU) and outborn from the neonatal unit of the pediatric department.

Definition of Resuscitation

We used the blocks (A–D) in the flow charts of the 8th edition of the American Academy of Pediatrics/American Heart Association Neonatal Resuscitation Program to define the intensity of resuscitation[25] Resuscitation limited to clearing of the airway and bag and mask ventilation is referred to as minimal resuscitation, while babies who required chest compression and advanced airway with or without medication were said to have had extensive resuscitation.[25]

Definition of Sepsis

Neonatal sepsis was diagnosed based on clinical suspicion, elevated C-reactive protein, an abnormal complete blood count, and/or a positive isolated blood culture, as per national guidelines.[26]

Description of Research Tools and Data Collection

We adopted a MEWS system. The respiratory rate, oxygen saturation, heart rate, neurologic features (such as floppiness, unconsciousness, and seizures), and temperature were all recorded and scored based on the previously determined sMEWS cutoff point in Table 1.[18,20,27]

All five physiologic parameters were rated from 0 to 3, with the exception of temperature, which was rated 1 and 2 only. A score of 0 is normal and any score above 0 is abnormal, while the total score ranges from 0 to 14.[23] Individual patient scores were aggregated, and a cutoff value of four or more indicated the risk of deterioration, whereas patients with scores of less than four were considered clinically stable.[13,14,18,20,27] Because blood pressure is not a routine parameter measured in newborns, it was not included in our dataset for computing the MEWS. Two coauthors who are in-house physicians extracted all of the data from the case records of eligible participants, and a Senior Resident verified the data's accuracy.

Eligibility Criteria

Inclusion Criteria

1. All inborn neonates admitted to the newborn units of the hospital.
2. All outborn neonates referred from outlying hospitals within and outside the state.

Exclusion Criteria

1. Neonates with multiple congenital malformations.
2. Neonates who had a cardiopulmonary arrest on arrival.
3. Gestational age less than 20 weeks.
4. Newborns in the unit managed in the postnatal wards of the hospital.
5. Neonates with solely surgical conditions.
6. Neonates transferred out of the unit for further care.
7. Neonates managed in the neonatal unit but with an incomplete dataset.

Statistical Analysis

Data were analyzed using GraphPad Prism 9 (GraphPad Software, 2365 Northside Dr. Suite 560, San Diego, CA 92108, USA). Categorical data were described using percentages and frequencies. Continuous variables were presented using the arithmetic mean, SD, median, and interquartile range as appropriate. We determined factors that were associated with sMEWS at admission and MEWS 72 h post-admission and reported the associations as an odds ratio (OR) with a 95% confidence interval (CI). Variables related to sMEWS at admission and sMEWS 72 h post-admission on the

Table 1. Modified Early Warning Score Adopted from El Amouri et al[20].

Physiologic Parameters	3	2	1	0	1	2	3
Temperature		>38	37.5–38	36.5–37.4	35.5–36.4	<35.5	
Pulse rate		>190	150–189	91–149	71–90		<70
Respiration rate		>80	60–79	30–59	20–29		<20
Respiration pattern			Grunting	Regular			
Oxygen saturation	<90		90–94	>94	90–94		<90
Neurological signs	floppy		Jittery	Active	Irritable		Seizures

univariable analysis with p values less than 0.20 were added into the multivariable logistic regression, and the findings were provided as an adjusted OR (AOR) with a 95% CI. The performance of sMEWS at admission and sMEWS 72 h post-admission in predicting in-hospital mortality and cutoff values was determined using a receiver operator characteristic (ROC) and area under the curve. The level of statistical significance was set at $p < .05$.

Results

Sociodemographic Characteristics of Study Population

Of the 418 charts obtained from the hospital information system, 371 (88.8%) of the participants' charts had complete data for computing the sMEWSs. Details of the study participant's flow chart are presented in Figure 1. The mean age (SD) of the mothers was 30.3 (±5.3) years, and 94.3% were between the ages of 21 and 40. Two hundred and sixteen (58.2%) mothers were multiparous. Other details are shown in Table 2.

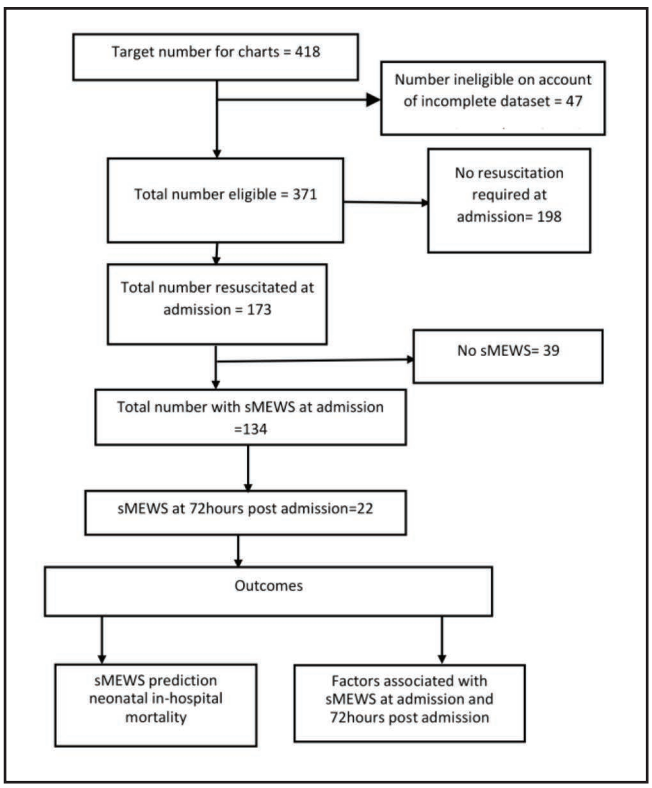

Figure 1. Study Participants Flow Chart of sMEWS and Neonatal Outcomes. sMEWS, significant modified early warning scores.

Clinical Characteristics of Study Participants and Outcomes

The median birth weight was 2.6 kg (range: 1–4.9 kg). The mean length and occipitofrontal circumference (SD) were 45 cm (±6.0) and 33.8 cm (±3.6), respectively. Two hundred and fifty-four (68.5%) infants were born late preterm to term, with a mean gestational age (SD) of 35.7 (±3.5) weeks. The median age at presentation was 48 h (interquartile range 24–168). On arrival at the newborn unit, nearly half of the newborns, 173 (46.6%), required resuscitation. Manual ventilation was required for 119 (32.1%) of these patients, while chest compression and advanced airway support were required for 54 (14.6%).

The overall mortality was 50/371 (13.5%). A total of 134 (36.1%) babies had significant EWS at admission (sMEWS at admission) and decreased to 22 (5.9%), 72 h post-admission (sMEWS post-admission; ≥72 h). Table 3 shows the details of the patient's clinical characteristics.

Factors Associated with sMEWS at Admission

On binary logistic regression, factors significantly associated with sMEWS at admission were the diagnosis of perinatal asphyxia with a crude OR of 2.117 (95% CI, 1.121–3.999), sepsis with a crude OR of 1.871 (95% CI, 1.132–3.092), and babies that needed resuscitation at admission with a crude OR of 6.231 (95% CI, 3.881–10.002). After adjusting for confounders, variables that were associated with sMEWS at admission included babies admitted into the outborn ward with an AOR of 2.218 (95% CI, 1.125–4.371), and infants who needed resuscitation at admission with AOR of 5.501 (95% CI, 3.350–9.034). However, babies admitted within ≥72h of life had reduced odds for sMEWS with AOR 0.281 (95% CI, 0.084–0.940), as shown in Table 4.

Factors Associated with sMEWS 72 h Post-admission

At 72 h, post-admission, the number of babies with sMEWS reduced to 22 (5.9%). Factors that were associated with sMEWS 72 h post-admission included the diagnosis of perinatal asphyxia with crude OR of 6.369 (95% CI, 1.369–29.185) and babies that were resuscitated at admissions with crude OR of 12.810 (95% CI, 2.949–55.561). However, after controlling for confounders, only babies that were resuscitated at admission were associated with sMEWS 72 h post-admission (AOR: 9.693; 95% CI, 2.181–43.079) (Table 5).

Association Between sMEWS and Outcomes of Death

On further analysis, the presence of sMEWS at admission had an increase in the odds of death by AOR of 3.530 (95% CI, 1.721–7.240); $p = .001$, whereas the identification of sMEWS 72 h post-admission increased the chances of death by AOR of 5.931 (95% CI, 5.944–64.385); $p = .001$.

Table 2. Sociodemographic Characteristics of the Study Population.

Variables	Frequency	Percentage (%)
Gestational age at Delivery		
>37 weeks	143	38.5
34–36 + 6 weeks	111	30.0
<34 weeks	104	28.0
Unspecified	13	3.5
Age at admission (h)		
<24	82	22.1
24–48	108	29.1
48–72	22	5.9
>72	159	42.9
Gender		
Male	203	54.7
Female	168	45.3
Wards		
Inborn	111	29.9
Outborn	260	70.1
Sources of referral		
Primary health	11	3
Public secondary hospital	228	61.5
Private hospital	102	27.5
Self/from home	30	8.1
	Maternal characteristics	
Maternal age		
<20	14	3.8
21–30	194	52.3
31–40	156	42
>40	7	1.9
Parity		
Primiparous	155	41.8
Multiparous	216	58.2

Table 3. Clinical Characteristic of Study Participants.

Clinical Characteristics	Frequencies *N* = 371	Percentage (%)
Resuscitation at presentation		
Not required	198	53.4
Resuscitation	173	46.6
Diagnosis		
Perinatal asphyxia	87	23.5
Prematurity	102	27.5
Significant neonatal jaundice	101	27.2
Others§	81	21.8
Co-infections		
Sepsis	268	72.2
No sepsis	103	27.8
Outcomes		
Alive	310	83.6
Death	50	13.5
Discharged against medical advice	11	3
sMEWS at admission		
Yes	134	36.1
No	237	63.9
MEWS 72 h post-admission		
Yes	22	5.9
No	349	94.1

Note: § = presumed sepsis (79,) congenital pneumonia, birth trauma, posterior urethral valves.

Abbreviation: sMEWS, significant modified early warning score.

ROC Curves for sMEWS at Admission and 72 h Post-admission

In predicting in-hospital mortality, the ROC curve for sMEWS at admission shows an area under the curve of 0.75 (95% CI, 0.70–0.79), with a sensitivity of 72.00% (95% CI, 57.50–83.80) and a specificity of 69.47% (95% CI, 64.10–74.50) as shown in Figure 2. The best criterion value for sMEWS at admission was a score >3 (Supplementary Table S1). For sMEWS post-admission (≥72 h) in predicting in-hospital mortality, the ROC shows an area under the curve of 0.76 (95% CI 0.72–0.80). The sensitivity was 88.00% (95% CI 75.70–95.50) and the specificity was 47.35% (95% CI, 41.80–53.00), as shown in Figure 2.

The criterion value for sMEWS 72 h post-admission was a score >0 (Supplementary Table S1).

On a comparative note, there was no significant difference in the areas under the curves with respect to the sMEWS at admission and the sMEWS 72 h post-admission (Figure 2), $p = .748$.

Discussion

A pre-implementation audit was conducted on neonatal wards with the purpose of establishing the efficacy of a standard nursing observation chart for tracking in-hospital mortality and its trigger and response system. The sMEWS identified infants at risk for in-hospital mortality and performed moderately as an EWS in a neonatal emergency unit. We found a diagnosis of perinatal asphyxia, neonatal sepsis, the need for resuscitation at admission, and admission into the outborn ward to be associated with having sMEWS. Persistence of sMEWS 72 h post-admission and need for resuscitation at admission carry an excess mortality risk compared to their counterparts. Our findings are corroborated by outcomes from research conducted in a neighboring nation, Ghana.[23] Preventive and proactive management is the standard of care for newborns.[4,17,18,20,28] A high index of suspicion is usually required to detect subtle changes indicative of clinical deterioration in this age group.[29–31] The computed sMEWSs, scores obtained from vital signs at admission, significantly predicted neonatal adverse outcomes. This clearly demonstrates the importance that should be assigned to point-of-entry vital signs and the presence of early warning signs in a neonate. It reflects how effectively this score can be used for triaging newborns while on admission for escalation of care. A standardized communication system based on a validated, evidence-based score would allow for more efficient use of manpower and resources, especially in low-resource settings with fewer experts.

EWS at the point of entry into the ward was found to identify critically ill babies and those at risk of deterioration up to 72-h post-stabilization. This observation is similar to one reported in an older population in an acute care setting.[19,32] Our report appears to be one of the few studies in which EWS at the neonatal emergency department predicted adverse neonatal outcomes in low-resource settings.[33]

The study highlights the importance of ongoing monitoring of hospitalized patients, as evidenced by the concordance between the predictive capabilities of the entry point EWS and the EWS obtained 72 h post-admission with respect to in-hospital mortality. The persistence of sMEWS calls for increased attention and care escalation for a better outcome. Furthermore, the absence of an EWS upon admission to the ward does not rule out the possibility of subsequent deterioration during the course of hospitalization. Hence the need for close monitoring beyond the point of admission. sMEWS has the advantage of being color coded with easy flagging of danger indications from vital signs when contrasted to the current

Table 4. Factors Associated with MEWS at Admission in Emergency Department.

Variables	Categories	sMEWS at Admissionn = 134 (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI), *p* Value
GA (weeks)	<34	45 (33.6)	1	1
	34< 37	37 (27.6)	0.656 (0.377–1.140)	0.750 (0.345–1.633), *p* = .469
	>37	48 (35.8)	0.662 (0.394–1.115)	0.813 (0.369–1.793), *p* = .435
	Unknown	4	0.583 (0.169–2.014)	0.435 (0.098–1.925), *p* =.435
Age (hours)	<24	33 (24.6)	1	1
	24–48	50 (37.3)	1.280 (0.716–2.289)	1.108 (0.573–2.146), *p* = .760
	49–72	5 (3.7)	0.437 (0.147–1.300)	0.281 (0.084–0.940), *p* = .039
	>72	46 (34.4)	0.604 (0.346–1.057)	0.609 (0.270–1.378), *p* = .234
Admitting ward	Inborn		1	1
	Outborn		1.415 (0.881–2.275)	2.218 (1.125–4.371), >*p* = .021
Gender	Male	71 (53.0)	1	
	Female	63 (47.0)	1.115 (0.729–1.707)	
Maternal age (years)	<20	6 (4.5)	1	
	21–30	76 (56.7)	0.859 (0.287–2.572)	
	31–40	48 (35.8)	0.593 (0.195–1.801)	
	41–50	4 (3.0)	1.778 (0.206–2.098)	
Diagnosis	Others	24 (17.9)	1	1
	Perinatal asphyxia	41 (30.6)	2.117 (1.121–3.999)	1.275 (0.583–2.790), *p* = .543
	Prematurity	42 (31.3)	1.662 (0.895–3.087)	1.402 (0.566–3.471), *p* = .465
	Significant Neonatal jaundice	27 (20.1)	0.867 (0.453–1.659)	1.413 (0.464–4.308), *p* = .543
Co-infections	No sepsis	27 (20.10	1	1
	Sepsis	107 (79.9)	1.871 (1.132–3.092)	1.526 (0.571–4.080), *p* = .399
Resuscitation	No	35 (26.1)	1	1
	Yes	99 (73.9)	6.231(3.881–10.002)	5.501 (3.350–9.034), *p* < .001

Abbreviations: CI, confidence interval; ED, emergency department; GA, gestational age; OR, odds ratio; sMEWS, significant modified early warning score.

study center's standard nursing record chart, which does not clearly demarcate or color code priority or emergency signs.

The low sensitivity of the sMEWS was observed in this study. This may be attributable to subjective assessments, the quality of health worker competencies in accurately documenting vital signs, individual interpretations of neurological signs, such as subtle seizures commonly observed during the neonatal period, level of consciousness, and other non-specific or atypical features of severe illness, such as sclerema, that do not align with the EWS parameters. In addition to inadequate communication, the limited clinical parameters included in the scoring system may also contribute to the low sensitivity observed, as patients with deteriorating conditions not reflected in the EWS parameters may be missed.

An effective screening tool should never miss a sick child. For effective resource allocation in locations where an early warning system is implemented, a higher area under the curve may be preferred. Incorporating contextual clinical risk

Table 5. Factors Associated with sMEWS 72 h Post-admission.

Variables	Categories	sMEWS 72 h Post-Admission, *n* = 22 (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI), *p* Value
GA (weeks)	<34	7 (31.8)	1	
	34< 37	7 (31.8)	0.933 (0.316–2.756)	
	>37	7 (31.8)	0.540 (0.242–2.099)	
	Unknown	1 (4.50	1.155 (0.131–10.210)	
Age (hours)	<24	6 (27.3)	1	
	24–48	10 (45.6)	1.293 (0.450–3.714)	
	49–72	0	0.000 (0.000)	
	>72	6 (27.3)	0.497 (0.155–1.592)	
Admitting ward	Inborn	7 (31.8)	1	
	Outborn	15 (68.2)	0.841 (0.360–2.296)	
Gender	Male	12 (54.5)	1	
	Female	10 (45.5)	1.007 (0.424–2.393)	
Maternal age (years)	> 40	1 (4.5)	1	1
	<20	0	0.000 (0.000),	0.000 (0.000), *p* = .998
	21–30	16 (72.7)	0.539 (0.061–4.761)	0.309 (0.030–3.182), *p* = .309
	31–40	5 (22.7)	0.199 (0.020–1.975)	0.140 (0.012–1.619), *p* = .116
Diagnosis	Others	2 (9.1)	1	1
	Perinatal asphyxia	12 (54.5)	6.369 (1.369–29.185)	5.044 (0.994–25.588), *p* = .051
	Prematurity	5 (22.7)	2.036 (0.385–10.778)	1.784 (0.312–10.203), *p* = .515
	significant neonatal jaundice	3 (13.6)	1.209 (0.197–7.415)	3.677 (0.352–38.410), *p* = .277
Co-infections	No sepsis	2 (9.1)	1	1
	Sepsis	20 (90.9)	4.073 (0.935–17.745),	3.790 (0.433–33.193), *p* = .229
Resuscitation	No	2 (9.1)	1	1
	Yes	20 (90.9)	12.810 (2.949–55.561),	9.693, (2.181–43.079), *p* = .003

Abbreviations: CI, confidence interval; GA, gestational age; OR, odds ratio; sMEWS, significant modified early warning score.

indicators for higher mortality, as proposed by Burns et al. should be considered in the development of an EWS system.[34] The current EWS heavily emphasizes vital signs as the primary criterion. Incorporating the leading risk factors for increased neonatal mortality, such as the presence of low birth weight (admission weight <2.5 kg) and the degree of prematurity at admission (delivery at a gestational age of <28 weeks), the need for extensive resuscitation (chest compression and advanced airway with or without medication) at admission, as well as the leading cause of mortality in a local setting, such as the presence of severe perinatal asphyxia, may enhance the sensitivity of the EWS system. Burns et al. made the aforementioned recommendation when they advocated for the incorporation of contextual clinical risk indicators for increased mortality into the development of an EWS system.[34] We hope that the experience from this pre-implementation study will inspire the development and validation of an enhanced early warning scoring system based on the identified risk factors in this study. It is imperative that healthcare professionals who attend to neonates in the emergency department possess the ability to administer prompt and efficient advanced resuscitation measures and undergo

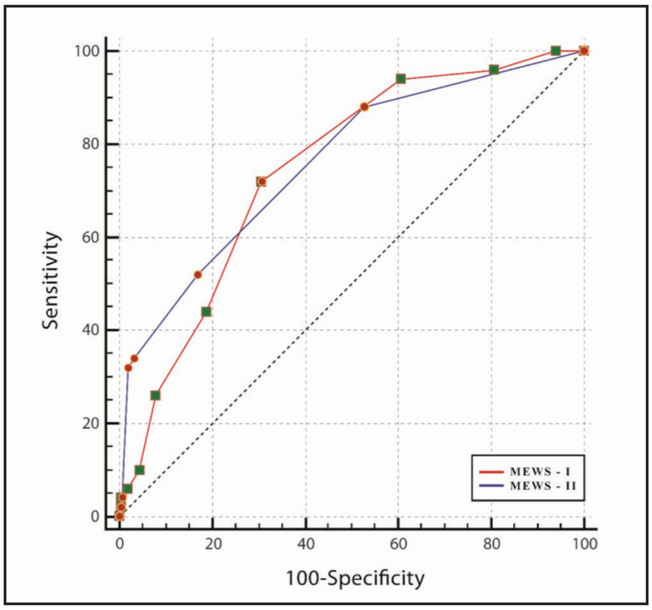

Figure 2. Receiver Operator Characteristic Curve for Modified Early Warning Scores at Admission (sMEWS-I) and Post-admission ≥72 h (sMEWSII).

periodic evaluations to ensure their competency. According to our report, it is justifiable to recommend that care for neonates exhibiting persistent sMEWS be escalated and that parents/carers be promptly counseled for neonatal intensive care.

Strength and Limitations

This study is not without its own limitations. Being a retrospective study with a relatively small sample size and a single-center design may limit the external validity of the study, although the findings are similar to the observed pooled effect sizes from a systematic review.[28]

Conclusions

The sMEWS identified infants at risk for in-hospital mortality and performed moderately as an EWS in a neonatal emergency unit. Excess mortality was associated with the need for resuscitation in the emergency department and the persistence of sMEWS 72 h post-admission.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Ethical Approval

The Chairman of the Medical Advisory Committee of University College Hospital, Ibadan gave approval for the retrospective study.

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Informed Consent

The participant has consented to the submission of the article to the journal.

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Supplementary Material

Supplemental material for this article is available online

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