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A NEONATAL EARLY WARNING SYSTEM (NEWS) IN PORT MORESBY GENERAL HOSPITAL, SPECIAL CARE NURSERY

Running title: Use of Neonatal Early Warning System

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ABSTRACT:

The neonatal mortality rate in Papua New Guinea is high, estimated at 24 per 1000 live births. The neonatal case fatality rate in newborns in provincial and referral hospitals was 5.9% in 2021. Deteriorating newborns can be difficult to identify. This observational study investigated the feasibility of using a neonatal colour coded observation and response chart to identify neonates at risk of deterioration and to promptly escalate care in the Special Care Nursery of Port Moresby General Hospital. The chart was adapted from the Plymouth Hospital Neonatal Early Warning System chart, and was used to collect data over 8 weeks between 1st May and 30th June 2022. One hundred and fifty seven (157) neonates were observed over the 72 hours following admission to the Special Care Nursery. Neonates were grouped into those that had triggers (vital signs that fell in the red zone) and a stable group (who had no observations in the red zone). Of the 157 patients recruited 72 (45.9%) were stable, and 85 (54.1%) had triggers that should prompt a response. Forty seven (55.3%) of the neonates in the trigger group had appropriate interventions. Neonates with observations in the red zone (triggers) were more likely to die in the first 72 hours compared with those with no triggers. Most of the nurse responded positively to the introduction of the chart. Whilst the Neonatal Early warning System is a tool that can be used to identify neonates at risk of clinical deterioration, proper training of its use and knowledge of and appropriate escalation of care are necessary to ensure its benefit.

Keywords: Neonatal Early Warning System, Low Middle Income Countries

INTRODUCTION:

In 2020, globally there were about 2.4 million newborns who died before the 28th day of life. Neonatal deaths accounted for 47% of all under five deaths [1]. Most of these neonatal deaths are in low to middle income countries [LMIC]. Many deaths result from lack of basic quality care in the first days after birth.

Papua New Guinea (PNG) is a low to middle income country in the Western Pacific Region with an estimated population of 9.9 million people in 2021 [2]. In 2020, the World Health Organization (WHO) estimated the neonatal mortality rate in Papua New Guinea to be 22 per 1000 live births [1]. Trends overall in recent years have shown a steady decline, but this figure remains one of the highest in the Pacific. It is also considerably higher than the target of 12/1000 live births as suggested by the United Nations Sustainable Development Goals [3]. The 2021 Paediatric Annual Mortality and Morbidity report stated a hospital case fatality rate for neonates to be 5.9%. In the same report, recommendations were made to use color coded charts to help identify neonates at risk [4]. Paediatric early warning systems (PEWS) have been used for many years including those designed for use in LMICs [5] but there is limited information of Newborn Early Warning System (NEWS) even in high income countries. A small study from UK reported the importance of a NEWS for detecting early sepsis [6]. An international review published in 2017 found

only 4 published systems and these were primarily designed for term or near term infants in postnatal wards [7].

Although there is a color-coded chart formulated by the Paediatric Society of Papua New Guinea for use in children, there is none specifically tailored for use in neonates. There are no published studies in Papua New Guinea on the use of color-coded charts or track and trigger systems.

The aim of this study was to describe the use of a Neonatal Early Warning System adapted from the Plymouth Hospital Neonatal Early Warning System chart [8] in Port Moresby General Hospital (PMGH) Special Care Nursery (SCN). Our primary objective was to describe neonates who had vital signs in the trigger or red zone and to document the interventions applied and their outcomes at 72 hours. Our secondary objective was to assess the response of nursing staff to the use of the NEWS.

METHODOLOGY:

A descriptive observational study was conducted in PMGH, SCN during an eight-week period (1st May 2022 to 30th of June 2022). The color-coded NEWS chart was used to record vital signs (Figure 1). Observations in the red zone were triggers to initiate appropriate interventions such as administration of oxygen or increasing oxygen flow rate, adjusting positioning, initiation of intravenous

antimicrobial therapy or administration of anticonvulsants.

Prior to the study period, a presentation on how to use the Neonatal Early Warning System was given to the nursing staff in the SCN. This included discussion of the interventions required in the event of observations being in the red zone.

Neonates born at PMGH who were identified by the paediatric team on duty as needing admission to the nursery using the standard Special Care Nursery guidelines were included in the study. Babies born in hospitals other than PMGH, who were more than 72 hours old and who had been admitted prior to the study period were excluded, as well as babies who had structural congenital abnormalities of the respiratory and cardiovascular system.

A NEWS observation form was added to the admission charts. Routine vital observations were carried out at normal times as per SCN practice. Vital signs were taken using routine equipment and observations were recorded. A separate data collection form was used to gather the data.

Neonates were followed up for 72 hours following admission to the nursery, and their outcomes at this point were recorded. Characteristics of neonates with their admitting diagnoses were entered into Microsoft Excel 2019 spreadsheets.

The data were summarized using frequency tables and percentages for categorical

variables. Odds ratios and p-values were calculated using Open Epi Means and standard deviations for normally distributed continuous variables were calculated using Microsoft Excel 2019. The differences between the groups were assessed by Students unpaired t test. Differences were regarded as significant if the p-value was ≤ 0.05 .

Nurses were asked to provide feedback on the use of the NEWS chart after the end of the study period using a self- designed structured questionnaire incorporating a Likert Scale. Questions were grouped into 4 categories: usability of the form, monitoring and interpretation of abnormal vital signs, management of abnormal vital signs and communication.

RESULTS:

A total of 157 neonates were included in the study of whom, 85 (54.1%) had vital signs that fell in the red zone and formed the trigger group whilst 72 (45.9%) had vital signs within the acceptable range and formed the stable group. Each neonate was followed up for the first 72 hours of admission and their outcome recorded.

Details of the neonates in each group is shown in Table 1. The mean birth weights and gestational age in the two groups were similar, $p = 0.27$ and $p = 0.34$, respectively. There was a higher proportion of neonates born by Caesarean section in the stable group than the trigger group ($p = 0.01$).

Table 1. Baseline characteristics of neonates in each group

CHARACTERISTIC	STABLE: (n =72) N (%)	TRIGGER: (n = 85) N (%)
SEX		
Female	37 (51.4)	48 (56.5)
Male	35 (48.6)	37 (43.5)
GESTATIONAL AGE		
Less than 37/40	27 (37.5)	33 (38.8)
Greater than or equal to 37/40	45 (62.5)	52 (61.2)
Mean (standard deviation) gestational age in weeks	37.13 (3.02)	36.62 (3.59)
BIRTH WEIGHTS		
Less than 1 kg	4 (5.6)	6 (7.1)
1 kg to 2 kg	19 (26.4)	29 (34.1)
2 kg to 2.5 kg	12 (16.7)	12 (14.1)
More than 2.5 kg	37 (51.4)	38 (44.7)
Mean (standard deviation) birth weight in kg	2.51 (0.93)	2.33 (1.03)
DELIVERY MODES		
Normal vaginal delivery	55 (76.4)	77 (90.6)

Table 2. Diagnoses of the neonates in each group

DIAGNOSIS	STABLE GROUP (n=72) N (%)	TRIGGER GROUP (n=85) N (%)
Meconium aspiration syndrome	2 (2.8)	17 (20)
Prematurity with complications	7 (9.7)	22 (25.9)
Intrauterine growth restriction with complications	20 (27.8)	15 (17.7)
Neonatal sepsis (including meningitis and pneumonia)	25 (34.7)	25 (29.4)
Birth asphyxia - mild	8 (11.1)	
Birth asphyxia – severe *	1 (1.4)	6 (7.1)
Transient tachypnoea of the newborn	1 (1.4)	-
Subgaleal Haemorrhage	1 (1.4)	-
Jaundice	7 (9.7)	-

* With signs of hypoxic ischaemic encephalopathy

There were marked differences in the diagnosis of the two groups, with meconium aspiration syndrome (MAS), prematurity with complications and severe birth asphyxia accounting for 45 (53%) of the 85 neonates in the trigger group. The proportion of neonates with sepsis was similar in the groups ($p = 0.48$).

The incidence of observations in the red zone in the trigger group babies during the three 24 hour periods is shown in table 3.

Some babies had more than one physiological abnormality

Table 3. Abnormal observations in the trigger group over the first 72-hours N=85#

PHYSIOLOGICAL ABNORMALITIES	0-23 HOURS N (%)	24-47 HOURS N (%)	48-71 HOURS N (%)	TOTAL N (%)
Fever	24 (28.2)	16 (18.8)	11 (12.9)	51 (60)
Hypothermia	20 (23.5)	10 (11.8)	11(12.9)	41 (48.2)
Grunting	9 (10.6)	0	0	9 (10.6)
Tachypnoea	9 (10.6)	4 (4.7)	4 (4.7)	17 (20)
Bradypnoea	4 (4.7)	3 (3.5)	0	7 (8.2)
Spasticity / Convulsions	12 (14.1)	2 (2.4)	1 (1.2)	15 (17.6)
Floppy	3 (3.5)	1 (1.2)	0	4 (4.7)
Dusky / Cyanosis	31 (36.5)	10 (11.8)	3 (3.5)	44 (51.8)
Tachycardia	4 (4.7)	0	1 (1.2)	5 (5.9)
Bradycardia	1 (1.2)	1 (1.2)	0	2 (2.4)
Hypoglycemia	0	0	0	0
Hyperglycemia	2 (2.4)	0	0	(2.4)

Table 4. Outcomes of patients at 72 hours

OUTCOMES	STABLE GROUP (n=72) N(%)	TRIGGERS GROUP (n=85) N(%)
Still unstable after 72 hours	11 (15.3)	32 (37.7)
Rooming with mother	22 (30.6)	17 (20)
Transferred to post-natal ward	17 (23.6)	7 (8.2)
Died	7 (9.7)	27 (31.8))
Discharged	11 (15.3)	2 (2.4)
Absconded	1 (1.4)	0
Lost to follow up	3 (4.2)	

Cyanosis was the most common trigger in the first 24 hours. Both high and low temperatures in the trigger zones were recorded in all three time periods and fever was the most observed trigger overall. Only 47 (55.3%) of the 85 patients in the trigger group had an appropriate intervention carried out. The outcome of the neonates at 72 hours after admission is shown in Table 4.

Neonates with triggers were 4.3 (1.7-12.6) times more likely to die than those without ($p=0.001$).

Ten of the 27 babies who died in the trigger group had hypothermia for which adequate intervention was not initiated. The 7 babies who died in the stable group were extremely low

birth-weight and/or preterm and all died suddenly within 12 hours of admission. There was no significant difference in mortality in the neonates in the trigger group who did and who did not receive intervention (17/47 vs 10/38 $p = 0.46$).

Nursing staff responses to the introduction of the NEWS.

The responses of the 13 nursing staff with differing levels of training and experience in neonatal care (6 general nurses, 2 community health workers and 5 specialty nurses) who provided feedback are shown in Table 5. All but one gave positive responses.

Table 5. Nursing staff responses to the introduction of the NEWS (n=13) N (%)

USABILITY OF THE FORMS	STRONGLY DISAGREE	DISAGREE	AGREE	FULLY AGREED
I find the NEWS observation form user friendly	1 (7.7)		2 (15.4)	10 (76.9)
I find the NEWS observation form can help in identifying sick neonates quickly	1 (7.7)			12 (92.3)
I understand the color-coded lines			2 (15.4)	11 (84.6)
I find the forms and font size clear enough for A4 size	1			12
USAGE OF EQUIPMENT, AND UNDERSTANDING VITAL SIGNS				
I understand how to correctly use a digital thermometer to measure temperature				13
I understand how to correctly use a pulse oximeter to get oxygen saturation and pulse rate				13
I understand how to use a blood glucose machine to measure sugar levels	1			12
I understand how to measure the respiratory rate of neonates	1			12
I understand the normal ranges for each of the vital signs	1			12
I can easily attend to a neonate with fever	1			12
I can easily manage a neonate with hypothermia	1			12
MANAGEMENT OF A NEONATE WITH AN ABNORMAL VITAL SIGN				
I can easily manage a neonate with cyanosis and respiratory distress	1		2	10
I can easily manage a neonate that has an apnoeic attack	1			12
I know what to do immediately when a neonate is fitting				13
I know what to do when a neonate is not feeding properly	1		1	11
I can easily manage a child who has hypoglycemia	1		1	11
I can manage a neonate who has had a cardiorespiratory arrest	1		2	10
COMMUNICATION				
I feel I am able to discuss sick neonate with my senior colleagues easily			2	11
In an emergency, I am able to get through to the on-call resident easily from nursery			2	11
In an emergency, I am able to get through to the on-call medical officer easily from nursery			2	11
When needed I am able to get through to the on-call Specialist Paediatrician easily from nursery			3	10

DISCUSSION:

This study has shown that the NEWS can be used as a tool to aid in the diagnosis and management of neonates at high risk of mortality admitted to our SCN. It is likely that similar NEWS will be of benefit in situation similar to ours in which high tech monitoring and intervention is not available. Of the 13 nursing staff that participated in this study 12 (92.3%) found the chart easy to use. They were confident

in using the digital thermometers, pulse oximetry and blood glucose machines, and interpreting the abnormal values. However, our study found that whilst babies whose observations fell in the red zone of the chart were 4 times more likely to die than those with no triggers, only 47 (55.3%) of these 85 high risk babies received appropriate escalation of care. Ten (27.0%) of the 27 babies who died in the trigger group had hypothermia recorded for which no intervention was initiated.

Hypothermia is recognised as a major risk factor for neonatal mortality even in tropical climates [9]. Interventions such as administering oxygen and adjusting flow to maintain adequate oxygenation, correcting hypothermia, administration of intravenous appropriate antibiotics, maintaining normal blood glucose levels with intravenous dextrose or carefully administered nasogastric feeds and ensuring correct positioning are interventions that can and should be done in such settings as ours without highly technical and complex and expensive neonatal intensive care facilities. Similar scoring systems have been trialed and found effective in other similar settings [10].

Our study has demonstrated that NEWS is an important tool for improving quality of care for our neonates but that its introduction requires initial training of the SCN staff, encouragement and support for its use and regular assessment of its impact.

LIMITATIONS:

This study was conducted over a short time period. Further study should assess the use of NEWS over a prolonged period to determine sustainability.

Precise causes of death could not be determined but many deaths were thought to be unavoidable.

CONCLUSIONS:

Despite its limitations, this study has provided an insight on the use of a track and trigger system to escalate care on high risk neonates. It confirms that the use of a NEWS is feasible in our setting but maximizing its effect requires training, reinforcement, and regular assessment.

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Figure 1. Neonatal Monitoring and Response Chart

Derived from Plymouth NEWS: https://www.infantjournal.co.uk/pdf/inf_034_ris.pdf

NAME:		MR:	GA:	ADMISSION DATE:	
ADMISSION TIME:		DATE OF BIRTH:	BIRTHWEIGHT:	DIAGNOSIS:	
DATE					
TIME					
TEMPERATURE (°C)	>38.0				
	37.5-37.9				
	36.1-37.4				
	35.6-36.0				
	<35.5				
GRUNTING	>75				
	74-60				
	59-50				
	49-40				
	39-30				
	29-20				
	<20				
OR/IN	ACTIVE/FEEDING				
	JITTERY/IRRITABLE				
	SLOPPY/REGURGES				
C-COLOR (%O ₂)	PINK (>95%)				
	94-90%				
	DUSKY (<89%)				
HEART RATE (BEATS/MIN)	>190				
	189-180				
	179-170				
	169-160				
	159-150				
	149-140				
	139-130				
	129-120				
	119-110				
	109-100				
	99-90				
	89-80				
	79-70				
	69-60				
<60					
BLOOD SUGAR LEVELS (mmol/L)	>7.0				
	5.0-6.9				
	4.9-3.0				
	2.9-2.0				
<2.0					
SCORE	RED				
	YELLOW				
	WHITE				
ACTION TAKEN	REGULAR OBSERVATION				
	CALL SENIOR NURSING HELP/RMD				
	CALL MD/SMD				
REMARKS					