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Original Article

Characterization, Risk Factor and Outcome of Neonates Admitted to Neonatal Intensive Care Units at Sohag University Hospitals

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Abstract

Background: Due to the increased risk of death and morbidity for neonates admitted to the neonatal intensive care unit (NICU), admission to the NICU is a significant determinant of neonatal outcomes. Admission to the neonatal intensive care unit (NICU) may be necessary in some cases due to certain symptoms or risk factors. Babies who are born prematurely or for obvious medical reasons, such severe abnormalities or very low birth weight, are admitted to the neonatal intensive care unit (NICU) ahead of schedule.

Objective: Our study aims to document the number, disease pattern, severity of illness and different therapeutic modalities of neonates admitted to NICUs and to determine survival status, incidence rate and predictors of neonatal death among neonates admitted to neonatal intensive care units of Sohag University Hospitals.

Methods: A Hospital- based prospective cohort study lasted for one year from June, 2023 to June 2024 included 392 neonates presented to Neonatal Intensive Care Units in Pediatric Department in Sohag University Hospitals, Sohag, Egypt. The data was collected from the studied participants through full personal and medical history, general and systemic examination, laboratory and radiological examination, severity of illness was determined by Apgar score, MSNS or SNAP Π (Score for Neonatal Acute Physiology Π) and Downes score.

Results: The studied cases divided according to outcome into improved cases included 258 cases (65.82%) and died cases included 134 cases (34.18%). Regarding demographic characteristics, the mean age of the studied cases was 3.64 ± 5.36 days. We found that there was significant difference between improved cases and died cases according to transport mode and duration of admission. Assessment of maternal related factors, the was significant association between increase percentage of chronic disease and improved neonates due to increase frequency of antenatal follow up. Asking for gestational disease, there was significant difference between improved cases and died cases according to presence of gestational diabetes, anemia, PROM with antibiotic and premature rupture of membrane without antibiotic intake.

Relation between neonatal related factors and outcome of cases, there was significant relation between increase of weight and gestational age with improved cases. Regarding vital events, there was significant association between mortality rate with bradycardia, abnormal respiratory rate, abnormal blood pressure, hyperglycemia and decrease oxygen saturation. We assessed neonatal mortality risk using APGAR, Sarnat, MSNS, SNAP II and Down score. It was found that there was significant increase in APGAR, MSNS score among improved cases in comparison to died cases. Regarding Sarnat, SNAP II score and Downes score, improvement of cases significantly associated with low score.

Conclusion: Newborn mortality was seen in one-third of the hospitalized patients, according to our analysis. The health of the mother, the infant, and the surroundings were all associated with higher rates of mortality. There is a strong association between sepsis and neonatal mortality, and APGAR and SNAP II scores may be used to predict this outcome.

Keywords: Outcome of neonates, outcome of neonatal intensive care units
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Introduction

The neonatal period refers to the time between the moment of birth and the first 28 days of life. It is further divided into three stages: very early birth (birth to less than 24 hours), early birth (24 hours to less than 7 days), and late or final neonatal phase (from 7 days to 28 days)· [(1)] This period is characterized by rapid physical and mental development, along with the emergence from the gestational sac. This is the most perilous era for humanity, characterized by an exceptionally high incidence of preventable fatalities and diseases· [(2)] The incidence of newborn illness serves as a valuable metric for assessing the accessibility, utilization, and efficacy of mother and child health care services· [(3)] It fluctuates geographically and temporally, even within the same area· [(4)] Data about admission and death trends among hospitalized newborns should accurately represent the primary etiologies of diseases and the level of care administered to neonates within a certain region· [(5)] To enhance newborn care with improved outcomes and less severe morbidities, early identification of risk factors is essential for directing suitable therapies towards the most frequent and curable neonatal conditions. To attain this objective, it is essential to analyze the trends in neonatal admissions· [(6)]

Neonatal illness severity grading systems are widely used in neonatal critical care units. They provide standardized comparisons of performance across other facilities, since the recorded mortality may be corrected for the illness severity of admitted neonates. Additionally, they provide prognostic information to the parents of infants receiving treatment in the facilities. They also facilitate the identification of patterns in outcomes across time· [(7)] Numerous scoring systems include factors necessitating assessments such as pH, PO2/FiO2 ratio, and base excess, which are challenging to acquire in resource-limited environments· [(8)]

To assess the performance of specialised newborn care units and facilitate the early referral of infants with more severe conditions to better-equipped centres, a proper illness severity score system is necessary. This research was conducted to assess the Modified Sick newborn Score (MSNS), an innovative newborn illness severity metric intended for resource-constrained environments· [(7)] The SNAP II (Score for Neonatal Acute Physiology II) and SNAPPE II (Score for Neonatal Acute Physiology with Perinatal Extension II) scoring systems have been validated in extensive studies and demonstrated efficacy as predictors of mortality in neonates within neonatal intensive care units (NICU)· [(9)] Our study aims to document the number, disease pattern, severity of illness and different therapeutic modalities of neonates admitted to NICUs and to determine survival status, incidence rate and predictors of neonatal death among neonates admitted to neonatal intensive care units of Sohag University Hospitals.

Methods

A Hospital- based prospective cohort study lasted for one year from June, 2023 to June 2024 included 392 neonates presented to Neonatal Intensive Care Units in Pediatric Department in Sohag University Hospitals, Sohag, Egypt. The enrolled cases fulfilled the following eligibility criteria: Inclusion criteria were all neonates were admitted in Neonatal Intensive Care Units (NICU) including preterm, term and post term neonates while exclusion criteria were failure to obtain consent, neonates needed preparation for advanced interventions not available in our unit like cardiac operations and required peritoneal dialysis and neonates with traumatic injury.

The data was collected from the studied participants through full medical history (Name, age, sex, date of birth, type of delivery, gestational age, risk factors in mother and/or baby before during and after delivery, number in family, consanguinity), Complete examination included general examination (weight, Height, Head circumference), systemic examination (Chest, heart and abdomen), laboratory: complete blood count, C-reactive protein, cultures (blood, sputum, urine, CSF), serum urea and creatinine, serum electrolytes, liver function, coagulation profile, imaging (Chest x-ray, erect abdominal x-ray, abdominal ultrasonography, CT brain, MRI brain), Severity of illness was determined by Apgar score, MSNS or SNAP Π (Score for Neonatal Acute Physiology Π) and Downes score.

The APGAR scoring system is a comprehensive screening tool which should be used to assess newborns at birth. The Apgar score comprises 5 components: (1) color; (2) heart rate; (3) reflexes; (4) muscle tone; and (5) respiration. Each of these components is given a score of 0, 1, or 2. [(10)]

The Sarnat score is a clinical tool used to assess the severity of neonatal encephalopathy. [(11)] **Modified Sick Neonatal Score (MSNS):** Score 0 implied the worst and score 2 the best possible clinical setting for each of the parameter. [(7)]

Score for Neonatal Acute Physiology (SNAP Π): SNAP-II incorporated six physiological parameters: lowest temperature, urine output (mL/kg/hr), mean blood pressure, multiple seizures, lowest pH, and the ratio of partial oxygen pressure to inspired oxygen. [(12)] **Downes score:** The Downes score is a neonatal examination scoring tool frequently used to guide initiation of CPAP. [(13)]

Ethical consideration:

Ethical approval was obtained from the medical research Ethics Committee of Sohag University Hospitals. Informed written consents were obtained from the legal guardians after a clear explanation of the purpose of the study. Moreover, no personal identifiers were used on data collection questionnaires. The recorded data wasn't be accessed by a third person except the principal investigator and was kept secure.

Statistical analysis

Statistical package of Social science (SPSS) version 27.0 was used for data entry and analysis. Qualitative data are expressed as frequencies and percentages. Quantitative data are expressed as mean, standard deviation, range (Minimum-Maximum) for normal distributed data and median (IQR) for non- normally distributed data. The normality of data distribution was tested using Kolmogrov-Sminrov test. Chi-square test was used to compare groups of qualitative data. Independent T-test was used to compare means between two groups of independent variables of normally distributed quantitative data. Mann-Whitney test was used to compare groups of non-parametric quantitative data. Graphs are presented by Microsoft Excel. Regression analyses were conducted to predict factors affecting outcome that were found to be significant associated in the univariate analyses. Adjusted P-value <0.05 was considered to be statistically significant.

Results

We enrolled 392 neonates who were divided according to outcome into improved cases included 258 cases (65.82%) and died cases included 134 cases (34.18%).

Table (1): Socio-demographic characteristics of the studied cases

Variable	Summary statistics (n=392)			P-value
	Improved (n=258) No. (%)	Died (n=134) No. (%)	Total (392) No. (%)	
Age (days)				
Median (IQR)	1 (1-3)	1 (1-6)	1 (1-3.75)	0.3
Residence				
Rural	126 (76%)	62 (33%)	188 (100%)	0.62
Urban	132 (64.7%)	72 (35.3%)	204 (100%)	
Consanguinity				
Positive	108 (63.5%)	62 (36.5%)	170 (100%)	0.4
Negative	150 (67.6%)	72 (32.4%)	222 (100%)	
Transport mode				
Ambulance	198 (62.7%)	118 (37.3%)	316 (100%)	0.007
Parents	60 (78.9%)	16 (21.1%)	76 (100%)	
Transport duration				
<2 hours	232 (64.8%)	126 (35.2%)	358 (100%)	0.2
>2 hours	26 (76.5%)	8 (23.5%)	34 (100%)	
Duration of admission (days)				
Mean ± SD	21.16 ± 15.25	10.08 ± 6.75	17.37 ± 14	<0.001
Median (IQR)	18 (10-30)	8 (5-15)	14 (7-22)	

Table (1) shows that the mean age of the studied cases is 3.64 ± 5.36 days. There is significant difference between improved cases and died cases according to transport mode and duration of admission (P-value < 0.05). It was found among those were transported by ambulance, 62.7% improved and 37.3% died and among those were transported by their parents, 78.9% of them improved and 21.1% of them died. Also, improved cases show significant increase in duration of admission in comparison to died cases (21.16 ± 15.25 and 10.08 ± 6.75) days.

Table (2) Comparison between improved cases and died cases according to maternal related factors and gestational disease

Variable		Summary statistics (n=392)		P-value
		Improved (n=258)	Died (n=134)	
Maternal related factors				
Chronic disease	Diabetes mellitus	26 (76.5%)	8 (23.5%)	0.06
	Hypertension	14 (43.8%)	18 (56.3%)	0.006
	Thyroid	12 (75%)	4 (25%)	0.43
	Heart disease	18 (81.8%)	4 (18.2%)	0.1
Mode of delivery	Cesarean section	206 (64.8%)	112 (35.2%)	0.37
	Normal vaginal delivery	52 (70.3%)	22 (29.7%)	
Gestational disease				
Yes		224 (65.1%)	120 (34.9%)	0.31
Diabetes		32 (80%)	8 (20%)	0.04
Preeclampsia and Eclampsia		74 (66.1%)	38 (33.9%)	0.94
Anemia		16 (47.1%)	18 (52.9%)	0.02
Thrombocytopenia		6 (60%)	4 (40%)	0.69
Placenta previa		30 (75%)	10 (25%)	0.19
Polyhydramnios		6 (60%)	4 (40%)	0.69
Oligohydramnios		2 (50%)	2 (50%)	0.5
PROM with antibiotic		28 (82.4%)	6 (17.6%)	0.03
PROM without antibiotic		38 (50%)	38 (50%)	0.001

Table (2) described that there was significant difference between improved cases and died cases according to presence of chronic hypertension, gestational diabetes, anemia, PROM with antibiotic and PROM without antibiotic (P-value < 0.05). On the other hand, there is insignificant relation between improvement of cases and presence of chronic diabetes mellitus, thyroid disease, heart disease, preeclampsia and eclampsia, thrombocytopenia, placenta previa, polyhydramnios, oligohydramnios (P-value > 0.05).

Table (3) Distribution of neonatal related factors among the studied cases according to outcome

Neonatal related factors	Summary statistics (n=392)			P-value
	Improved (n=258) No. (%)	Died (n=134) No. (%)	Total (392) No. (%)	
Sex				
Male	140 (66.7%)	70 (33.3%)	210 (100%)	0.7
Female	118 (64.8%)	64 (35.2%)	182 (100%)	
Weight (kg)				
Mean ± SD.	2.29 ± 0.72	1.99 ± 0.73	2.19 ± 0.73	<0.001
Median (IQR)	2.3 (1.8 – 2.8)	1.9 (1.3-2.7)	2.2 (1.66-2.7)	
Gestational age (weeks)				
Mean ± SD.	35.73 ± 2.87	34.73 ± 3.45	35.39 ± 3.11	0.006
Median (IQR)	36 (34-38)	34 (33-38)	35.5 (33-38)	
Sepsis	132 (53.7%)	114 (46.3%)	246 (100%)	<0.001
Congenital anomaly	84 (63.6%)	50 (36.4%)	132 (100%)	0.34
Frequent apnea	6 (15.8%)	32 (84.2%)	38 (100%)	<0.001
Convulsion	18 (50%)	18 (50%)	36 (100%)	0.03

Table (3) shows that there is significant increase in weight of improved cases in comparison to died cases (2.29 ± 0.72 and 1.99 ± 0.73) kg. Also, improved cases show significant increase in gestational age in comparison to died cases (35.73 ± 2.87 and 34.73 ± 3.45) weeks. Among cases with sepsis, 53.7% of them improved and 46.3% of them died. Among cases with frequent apnea, 15.8% of them improved and 84.2% of them died. Among cases with convulsion, half of cases improved and half of cases died. However, there is insignificant relation between outcome and sex and presence of anomaly.

Table (4) Relation between outcome and clinical data of the studied cases assessed on admission

Clinical data	Summary statistics (n=392)		P-value
	Improved (n=258)	Died (n=134)	
Heart rate			
Normal	192 (70.6%)	80 (29.4%)	0.003
Bradycardia	0 (0%)	0 (0%)	
Tachycardia	66 (55%)	54 (45%)	
Blood pressure			
Normal	244 (66.7%)	122 (33.3%)	0.04
Hypotension	10 (45.5%)	12 (54.5%)	
Hypertension	4 (100%)	0 (0%)	
Respiratory rate			
Normal	50 (56.8%)	38 (43.2%)	0.004
Bradypnea	26 (52%)	24 (48%)	
Tachypnea	182 (71.7%)	72 (28.3%)	
Temperature			
Normal	130 (67.7%)	62 (32.3%)	0.63
Hypothermia	120 (64.5%)	66 (35.5%)	
Hyperthermia	8 (57.1%)	6 (42.9%)	
RBS			
Normal	230 (66.5%)	116 (33.5%)	0.67
Hypoglycemia	26 (61.9%)	16 (38.1%)	
Hyperglycemia	2 (50%)	2 (50%)	
UOP			
Normal	236 (65.2%)	126 (34.8%)	0.36
Oliguria	22 (73.3%)	8 (26.7%)	
Polyurea	0 (0%)	0 (0%)	
Feeding			
NPO	200 (60.6%)	130 (39.4%)	<0.001
Feeding	58 (93.5%)	4 (6.5%)	

Table (4) shows that there is significant difference between outcomes of cases and heart rat, blood pressure, respiratory rate and feeding (P-value < 0.05). However, there is insignificant difference between outcomes of cases and temperature, RBS and UOP (P-value > 0.05). Regarding heart rate, among those with normal rate we found that 70.6% improved and 29.4% died. And among those with tachycardia, 55% of them improved and 45% died. Regarding blood pressure, among those with normal level we found 66.7% of them improved and 33.3% died. Moreover, among those with normal respiratory rate, 56.8% of them improved and 43.2% died while among those with bradycardia, 52% improved and 48% died. On the other hand, among those with tachypnea, 71.7% improved and 28.3% died. Regarding feeding, among those with NPO, 60.6% of them improved and 39.4% died.

Table (5) Distribution of the studied cases according to gestational disease

Indications of admission	Summary statistics (n=392)	
	No.	**%**
Respiratory distress syndrome	188	48
Congenital heart disease	50	12.8
Poor suckling	42	10.7
Jaundice	40	10.2
Frequent apnea	38	9.7
HEI	36	9.2
Convulsions	36	9.2
Transient tachypnea of newborn	34	8.7
Necrotizing enterocolitis	34	8.7
Tracheosophegeal fistula	24	6.1
PPHN	22	5.6
Aspiration pneumonia	18	4.6
Congenital pneumonia	16	4.1
Intestinal obstruction	16	4.1
Hydrocephalus	16	4.1
Hypoglycemia	12	3.1
Pneumothorax	8	2
Meningocele	8	2
Choanal atresia	6	1.5
Meconium aspiration syndrome	6	1.5
Hirschsprung disease	6	1.5
Hematemesis	6	1.5
Polycystic kidney	6	1.5
Hydroureter & hydronephrosis	6	1.5
Anuria	6	1.5
Collodion baby	6	1.5
Abdominal mass	4	1
Imperforate anus	4	1
Irreducible inguinal hernia	4	1
Gastroenteritis	2	0.5
Eventration of diaphragm	2	0.5
Sacrococcygeal mass	2	0.5
Hepatosplenomegaly	2	0.5
Omphalocele	2	0.5
Congenital diaphragmatic hernia	2	0.5
Superficial skin abscess	2	0.5
Lobar emphysema	2	0.5

Table (5) shows that the highest frequent indication of admission is respiratory distress (48%) followed by CHD (12.8%) then poor suckling (10.7%) and jaundice (10.2%). The least frequent indications of admission are gastroenteritis, eventration of diaphragm, sacrococcygeal mass, HSM, omphalocele, congenital diaphragmatic hernia, abscess and lobar emphysema which are equals (0.05%).

Table (6) Comparison between outcomes and the studied scores among the studied cases

Scores	Summary statistics (n=392)			P-value
	Improved (n=258)	Died (n=134)	Total (392)	
APGAR Score				
Mean ± SD.	9.88 ± 0.38	8.97 ± 1.25	9.59 ± 0.88	<0.001
Median (IQR)	10 (10 – 10)	9 (8-10)	10 (10-10)	
Sarnat score				
0	224 (73.7%)	80 (26.3%)	304 (100%)	<0.001
1	22 (42.3%)	30 (57.7%)	52 (100%)	
2	10 (35.7%)	18 (64.3%)	28 (100%)	
3	2 (25%)	6 (75%)	8 (100%)	
MSNS				
Mean ± SD.	11.34 ± 2.89	9.2 ± 2.27	10.61 ± 2.88	<0.001
Median (IQR)	11 (9.75-14)	9 (7-11)	11 (9-13)	
SNAP II				
Mean ± SD.	16.58 ± 9.75	39.42 ± 17.5	24.38 ± 16.86	<0.001
Median (IQR)	16 (9.25-24)	41 (24-50)	20 (16-35)	
Down score				
Mean ± SD.	1.61 ± 0.5	2.34 ± 0.7	1.86 ± 0.67	<0.001
Median (IQR)	2 (1-2)	2 (2-3)	2 (1-2)	
Grades **1**	102 (83.6%)	20 (16.4%)	122 (100%)	<0.001
2	154 (75.5%)	50 (24.5%)	204 (100%)	
3	2 (3%)	64 (97%)	66 (100%)	

Table (6) showed that there was significant increase in APGAR score among improved cases in comparison to died cases (9.88 ± 0.38 and 8.97 ± 1.25). Regarding Sarnat score, among those with score 0, 73.7% of them improved and 26.3% of them died and among cases with score 1 we found that 42.3% of cases improved and 57.7% died. Among cases with score 2, we found that 35.7% improved and 64.3% died. Regarding MSNS score, improved cases scored significantly higher that died cases (11.34 ± 2.89 and 9.2 ± 2.27). However, improved cases scored significantly lower score of SNAP II in comparison to died cases (16.58 ± 9.75 and 39.42 ± 17.5). Regarding Down score, improved cases scored significantly lower than died cases (1.61 ± 0.5 and 2.34 ± 0.7).

Table (7) Logistic regression to predict risk factor for death among the studied cases

Variable	Adjusted odds ratio (95% CI)	P-value
Sepsis	0.12 (0.04: 0.33)	< 0.001
APGAR	0.29 (0.14: 0.59)	<0.001
SNAP II	1.1 (1.06: 1.14)	<0.001

Table (7) shows that sepsis, APGAR and SNAP II show significant association with death of cases with odd's ratio of 0.12, 0.29 and 1.1 (P-value < 0.05).

Discussion

The neonatal period is the essential era of human life including the first 28 days post-birth, characterized by the most rapid and substantial physiological changes as the baby acclimatizes to extrauterine existence. The admission rate of newborns to the critical care unit rises in direct correlation with heightened exposure to different disease agents. [14]

Admission to the neonatal intensive care unit (NICU) is a critical factor influencing neonatal outcomes, since neonates in the NICU have heightened risks of death and morbidity. Numerous indicators and risk factors exist for NICU admission. Premature infants are at significant risk for NICU admission and may need mechanical breathing and thermoregulation. [15]

The World Health Organization asserts that the infant mortality rate serves as a crucial metric for evaluating the efficacy of healthcare in a nation or area. It also aids in assessing the different elements that interact to enable the admission of newborns to critical care units. This element encompasses the environmental conditions and socioeconomic level of the individuals within the target group. The decline in the infant mortality rate signifies an enhancement in socioeconomic conditions and an overall advancement in healthcare delivery and service quality. Comprehension of the factors contributing to newborn mortality and fluctuations in mortality rates is crucial for prenatal counselling, decision-making, quality assurance, and enhancement of management practices. [16]

The current hospital- based prospective cohort was conducted at Neonatal Intensive Care Units (NICUs) in Pediatric Department in Sohag University (old and new) Hospitals on 392 neonates from June, 2023 to June 2024 with the aim to document the number, disease pattern, severity of illness and different therapeutic modalities of neonates admitted to NICUs and to determine survival status, incidence rate and predictor scores of neonatal deaths.

The primary indications of adverse outcomes in our research were sepsis, low Apgar scores, and elevated SNAP II scores. Concerning case outcomes, there were 258 better patients (65.82%) and 134 deceased cases (34.18%). Our findings aligned with those of Hedstrom et al., who reported that 77.6% of individuals were alive at release, whereas 22.4% were deceased at discharge. [17]

Our findings closely aligned with those of Agrawal et al., who reported that two-thirds (64.4%) of neonates were successfully discharged, 14.7% died, 14.2% left against medical advice (LAMA), 3.8% were discharged at guardian request (DOPR), and 2.9% were referred to a higher centre after stabilization. [18]

Our findings aligned with those of Al-Ghamdi et al., who reported that 77.7% of hospitalised newborn patients were released home, while 9.7% were discharged against medical recommendation, 2% were transferred to another hospital, and 10.6% of the neonates died after admission. [19]

Our research shown that improved patients exhibit a considerable increase in the length of admission compared to deceased cases (21.16 ± 15.25 days vs 10.08 ± 6.75 days). This aligns with the findings of Agrawal et al., who revealed that an extended period of NICU stay was substantially correlated with improved outcomes in neonates [18]. This might be understood as throughout the early neonatal period, the infant continues to adjust to life outside the uterus, concentrating on stabilizing respiratory and circulatory functioning. The period also includes the control of metabolism and temperature and it is a time of heightened sensitivity, when the danger of infections and other consequences is substantial.

In a study undertaken by the global health organization, more than half of the nearly 7.5 million newborn fatalities in the globe occur in the first four weeks following delivery. With additional research of numbers, they noticed that majority of these fatalities occurred in the developing countries, most certainly owing to the poor levels of treatment. In developing nations, the infant death rate is six times higher than in industrialized ones, but in the least developed countries, it is sometimes eight times more. In wealthy countries such as the United States, there is enhanced access to NICU facilities where ill newborns may undergo surfactant treatment and receive prenatal corticosteroids, hence improving their survival prospects. [16]

In terms of consanguinity history, 170 instances indicated positive consanguinity, showing a statistically insignificant correlation with the result. Our findings partially align with those of AL-Ghamdi et al., who indicated that adverse outcomes, excluding prematurity and low birth weight, were observed in consanguineous marriages across all studied pregnancies, with a prevalence exceeding 50%. Furthermore, the majority of neonatal and infant fatalities are predominantly linked to consanguineous unions. Perinatal, newborn, and neonatal death rates were documented at 62%, 60.3%, and 57.9%, respectively. [19]

Our findings did not align with those of Medcalf et al., who demonstrated that overall consanguinity in the perinatal and mortality categories was considerably less than 0.05. [20] This may be attributed to a broad belief that postnatal morbidity and death rates are heightened in the offspring of consanguineous unions. Estimates of the overall detrimental effects of consanguinity have been highly variable and often seem implausibly elevated, largely due to insufficient control for significant non-genetic factors that are known to affect childhood health, such as maternal age and education, birth order, and birth intervals. [21]

Our analysis indicated that 316 instances were taken by ambulance, whereas 76 cases were transported by parents. This mirrored the results of Hedstrom et al., who indicated that 53.4% of patients were conveyed by automobile or ambulance, 40.2% by motorbike, and 6.4% by bicycle or foot. [17] This could be explained as most of cases reported to be transmitted by parents were less likely to have severe illness like neonatal jaundice or superficial skin abscess.

The present research evaluated maternal risk variables, revealing that 318 instances were born by caesarean section and 74 cases were delivered vaginally, with no statistically significant correlation to the outcomes, and all deliveries occurred in a hospital setting. Most neonates delivered by normal vaginal delivery do not need NICU admission and are thus not included in our analysis, however there is a significant incidence of admission among those delivered by caesarean section.

Our findings did not align with those of Hedstrom et al., who indicated that the distribution of cases by type of birth attendant was as follows: doctor (30.9%), midwife (57.7%), traditional birth attendant (7.5%), and family or other (3.9%). The modes of delivery were distributed as follows: vaginal (68.1%), Caesarean section (31.9%), and singleton (77.2%). [17] The disparity may be attributed to the contrasting socioeconomic level and health knowledge between Egypt and Uganda.

In accordance with the findings of Al-Ghamdi et al., caesarean section delivery was identified as the predominant delivery factor (53.87%), followed by resuscitation in the delivery room (53.58%) and a low Apgar score after 1 minute (31.23%). Conversely, nuchal cord and vaginal delivery with obstetric complications were the least significant delivery factors for neonatal admission to the NICU, accounting for (3.15%) and (0.86%), respectively. [19]

The evaluation of the correlation between outcomes and gestational diseases in our research indicated that the incidence of antepartum hemorrhage, such as placenta previa, was greater among improved patients (75%) compared to deceased cases (25%). This is elucidated by the regular surveillance of women with a history of prenatal hemorrhage in the obstetric unit, effective management of bleeding episodes, and the use of corticosteroids to expedite fetal lung maturation if delivery is necessitated prior to 36 weeks of gestation.

Our results concurred with those of Mwangi et al., who demonstrated that the incidence of antepartum hemorrhage was much greater among survivors (64.3%) than among deceased patients (35.7%). The results were corroborated by our calculations, as improved patients exhibited almost three times the prenatal follow-up compared to deceased cases and got enhanced treatment that mitigated problems associated with gestational disorders such as low birth weight, respiratory distress syndrome, and intrauterine fetal demise. [22]

Our research demonstrated a substantial reduction in the proportion of deceased neonates (17.6%) compared to improved cases (82.4%) among moms with a history of PROM who received antibiotics. This may be elucidated as moms who got therapy had enhanced outcomes. Our findings were congruent with those of Akbarian Rad et al., who reported a newborn death rate of 5.35%. [23]

Our research demonstrated a substantial rise in the proportion of deceased cases among those with anemia (52.9%) compared to those who improved (47.1%). Our findings concurred with those of Parks et al., who demonstrated that fetal and neonatal mortality was linked to severe anemia, which was further elucidated by the association of severe maternal anemia with low birth weight (<2500 and <1500 g), preterm delivery, and postpartum hemorrhage. [24] Our results concurred with those of Edelson et al., who demonstrated that newborn fatalities were more prevalent in the anemia cohort . [25]

Our research indicated a substantial rise in infant mortality (56.3%) associated with maternal chronic hypertension, in contrast to an improvement rate of 43.8% among mothers without hypertension. Our findings concurred with those of Gilbert et al., who determined that infant mortality was elevated among women with chronic hypertension relative to their non-chronic hypertensive counterparts, with an odds ratio (95% CI) of [2.3, (2.0, 2.7)]. [26]

Evaluation of neonatal factors revealed that the weight of improved cases was greater than that of deceased cases (2.29 ± 0.72 kg vs. 1.99 ± 0.73 kg). The mean gestational age of the subjects was 35.39 ± 3.11 weeks, with improved cases demonstrating a statistically significant increase in gestational age compared to deceased cases (35.73 ± 2.87 weeks vs. 34.73 ± 3.45 weeks). Nevertheless, there was a negligible correlation between the result and gender. Low birth weight newborns are at an increased risk of early problems, including respiratory distress syndrome and infections, owing to their undeveloped immune systems. The interplay of these elements often leads to prolonged hospitalizations and heightened medical interventions. Our results aligned with those of Mwangi et al., who reported no significant correlation between gender and outcomes in the NICU among the examined neonates. [22]

Our results were corroborated by the explanation in the research by Ashour et al., which indicated that infants delivered at low gestational age are at elevated risk of respiratory distress syndrome owing to pulmonary surfactant deficit and are susceptible to hospital admission and respiratory-related mortality. Furthermore, premature infants were susceptible to viral illnesses, hypothermia, and ultimately mortality. [27] Consistent with the findings of Andegiorgish et al., there exists a substantial correlation between short gestational age (< 37 weeks) and elevated death rates. [28]

Our investigation indicated that among patients presenting with hypothermia, 64.5% exhibited improvement, whereas 35.5% succumbed, with statistical insignificance seen. The majority of our hypothermia patients were promptly and appropriately handled based on their etiology, using either incubator rewarming or radiant warmers for preterm newborns.

Our findings did not align with those of Phoya et al., who demonstrated that 72% of deceased patients had hypothermia, in contrast to all improved cases, and proposed that newborn hypothermia upon arrival to the neonatal unit is a significant predictor of death. [29] Conversely, Babaei's research determined that the comparison of mortality rates in hypothermic and normothermic neonates (5.8% vs 1.9%, p<0.001) indicated a significant correlation between hypothermia and neonatal mortality. [30]

Our analysis revealed that the most prevalent reasons for hospitalization were respiratory distress (48%), followed by congenital heart disease (12.8%), inadequate suckling (10.7%), and jaundice (10.2%). The least common reasons for hospitalization were gastroenteritis, diaphragmatic eventration, sacrococcygeal mass, hepatosplenomegaly, omphalocele, congenital diaphragmatic hernia, superficial skin abscess, and lobar emphysema, each accounting for 0.05%. Our results concurred with those of Al-Ghamdi et al., who reported that 49.28% of newborn patients were admitted to the NICU due to respiratory distress syndrome. Additional factors include low birth weight and prematurity, accounting for 43.27% and 39.83% of neonatal admissions to the NICU, respectively. Neonatal seizures and birth asphyxia contribute to 4.30%, while meconium aspiration syndrome accounts for 0.86% of NICU admissions. [19] In contrast to the data of Andegiogrish et al. who indicated that sepsis was the largest (35.5%) reason of hospitalization, followed by RDS (15.4%), and neonatal asphyxia (10%). Thirty three percent of admitted newborns were LBW [28]. The disparity may be attributed to inadequate implementation of infection control measures during delivery and post-natal care for neonates in Ethiopia.

The evaluation of mortality risk using the MSNS score indicated that improved patients had a considerably higher score than deceased cases (11.34 ± 2.89 vs 9.2 ± 2.27). This aligned with the results of Mansoor et al., who reported that the mean (SD) MSNS score for deceased individuals was 8.22 (2.96), while for those discharged, it was 13.4 (2.14), with statistically significant differences seen. Deceased neonates had markedly reduced MSNS scores. The correlation of specific MSNS parameters with outcomes revealed that lower scores in each parameter were strongly linked to death [31]. Moreover, our findings aligned with those of Meshram et al., who demonstrated that the total MSNS for deceased newborns was statistically substantially lower (mean ± standard deviation) at 7.93 ± 2.70, in contrast to living neonates, which was 12.02 ± 1.84, with statistical significance. [32]

Our analysis indicated that deceased individuals had a substantially higher SNAP II score compared to improved cases (39.42 ± 17.5 vs 16.58 ± 9.75). Moreover, our research evaluated outcomes using the Apgar score, which indicated a substantial reduction in the Apgar score among deceased patients compared to improved cases (8.97 ± 1.25 and 9.88 ± 0.38). The research by Harsha and Archana indicated that the SNAPPE-II score was elevated in deceased newborns compared to those who survived. [33]

Our results were congruent with those of Kadivar et al., who demonstrated that Apgar scores at 5 minutes (P=0.001) and SNAP-PE II (P=0.04) were strongly associated with the death rate. [34] Our findings concurred with those of Mu et al., who demonstrated that a low Apgar score at 5 minutes was significantly correlated with infant death (adjusted RR 126.50, 95% CI 107.35–149.06). [35]

Our research shown that a Downes score of ≥ 3 correlates with a 97% death rate, whereas a score of 1 is linked to an 83.6% survival rate, indicating that a higher score is strongly connected with increased mortality. This aligns with Yuniati et al., who demonstrated that a Downes score of ≥ 4 at delivery and at 2 and 6 hours correlated with decreased survival rates compared to a Downes score of < 4 (67.7%, 60.5%, and 52.7%). [36]

Strengths of the study included large sample size, multicenter units as we included NICUs at old and new Sohag university hospitals and assessment of cases using multiple scores included APGAR score, Sarnat, MSNS, SNAP II and Downes scores.

Limitations of the study included cross sectional design of the study and absence of control group.

Conclusion

Newborn mortality was seen in one-third of the hospitalized patients, according to our analysis. The health of the mother, the infant, and the surroundings were all associated with higher rates of mortality. There is a strong association between sepsis and neonatal mortality, and APGAR and SNAP II scores may be used to predict this outcome.

Recommendations
Further studies should be done with assessment of different lines of management and comparison of control group. Furthermore, training of residents how to apply APGAR and SNAP II scores on admitted neonates.

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