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Original article

Incidence and the Underlying Factors of Neonatal Mortality in The University Hospital of Benha, Egypt

S.I. Abdel Hady[1], O.M. Abdel Haie[2], R. SH. Eldesouky[3*],M.G.Gabal[4]

[1,2&4] Department of Pediatrics, Faculty of Medicine, Benha University, Egypt,
[3] Department Community Medicine, Faculty of Medicine, Benha University, Egypt.

ABSTRACT

Background: Neonatal mortality is a reflection of the effectiveness of obstetric and neonatal services in any particular community. **Objectives**: This study aimed at determining the incidence of neonatal mortality among cases admitted to Benha University Hospital NICU for the year 2013 and to determine its underlying factors. **Material and methods**: All the neonates admitted in year 2013 were included in the study; an approval from research ethics committee in Benha faculty of medicine was obtained. Data were collected from the files of the neonates in the Archive. **Results**: Results showed that neonatal mortality in year 2013 was 30.6%.The main cause of death was mainly respiratory failure 55.6%, followed by septic shock20.6%, then heart failure 15.9% and lastly asphyxia 7.9%. Number of factors appeared to be significantly accompanied with neonatal mortality like respiratory distress, prematurity, birth weight and mechanical ventilation. **Conclusion**: Neonatal mortality is still a significant problem among cases admitted to Benha University Hospital NICU, needing our attention.

KEYWORDS: Incidence; Neonatal mortality; Underlying factors.

INTRODUCTION

The first four weeks of life (neonatal period) carries one of the highest risks of death of any four week period in the human life span [1]. Neonatal mortality is a reflection of the effectiveness of obstetric and neonatal services in any particular community. It contributes to about two thirds of infant mortality worldwide and most of these occur in the first week of life [2]. Neonatal death generally results from complications of preterm birth, birth asphyxia, trauma during birth, infection, or other specifically perspective perinatal causes [3].Premature birth (before 37 weeks of pregnancy) is the most common cause of neonatal death. Prematurity and its complications cause about 25% of neonatal death [4].

Though promising progress has been made towards achieving the Millennium Development Goal (MDG) through substantial reduction in under-five mortality, the decline in neonatal mortality remains stagnant, mainly in the middle and low-income countries [5].

Infant mortality rates are decreasing at a faster pace than neonatal mortality (NM), consequently, neonatal deaths will represent an increasing proportion of child deaths. One of the challenges that Egypt currently faces is how to reduce perinatal mortality (PM) and NM[6].

Objectives:

The objectives of this work were to measure the incidence rate of neonatal mortality among cases admitted to the neonatal intensive care units (NICU) in Benha University Hospital, and to determine the risk factors of this health problem.

MATERIALS AND METHODS

Technical design: A retrospective review of medical records of the neonates admitted to the NICU in Benha University Hospital during the year 2013 was conducted. The field work was carried out from February to April, 2014. The total sample of neonates was 420; we have

excluded 8 referred cases from the study, so the total studied sample was 412 neonates.

Ethical consideration: An approval from research ethics committee in Benha faculty of medicine was obtained.

Data collection: Data were collected from the files from the Archive, the investigator used to revise the files 3 days a week for 3 months. Data included maternal items as consanguinity, multiple pregnancy, and mode of delivery, premature rupture of membrane (PROM),maternal illness and maternal medications during pregnancy. Neonatal items included admission age, gestational age, sex, weight at admission, diagnosis, duration of stay, use of mechanical ventilation, outcome (survived, died) and cause of death.

Statistical analysis:

The collected data were tabulated and analyzed using SPSS version 16 software (Spss Inc, Chicago, ILL Company). Categorical data were presented as number and percentages while quantitative data were expressed as mean ± standard deviation and range. Chi square test (X^2) test was used as a test of significance. Odds Ratios (ORs) and the corresponding 95% CI were calculated when applicable. Binary logistic regression analysis was carried out to detect the predictors of neonatal mortality. Kaplan Meier curve was used to determine survival probability among the studied groups, Log Rank test was used to compare survival among the groups. The accepted level of significance in this work was stated at 0.05 (P <0.05 was considered significant).

RESULTS

Basic characters of the studied sample:

The results showed that 52.4% of the studied neonates were males while 47.6% were females, their mean age was 5 days ranging from 1-30 days, 80.6% of them were from urban areas and 41.7% have positive history of consanguinity, 23.3% of the studied neonates had mothers with history of multiple pregnancy, 19.4% of the mothers developed premature rupture of membrane (PROM), 51.5% of the studied neonates were preterm,70.4% of them were born by cesarean section (C.S), 35.4% had moderately low birth weight, 14.6% had very low birth weight (VLBW) and 4.4% of them had extremely low birth weight (ELBW). The main cause of admission among the studied sample was respiratory distress (50.5%). About 41% of the admitted neonates needed MV, while the mean duration of stay was 7.8 days with range 1-110 days (Table 1).

Table 1: Socio-demographic, Perinatal and admission data of the studied sample

Variable		Number (N=412)	Percentage (%)
Sex	Male	216	52.4
	Female	196	47.6
Residence	Rural	80	19.4
	Urban	332	80.6
Consanguinity	Positive	172	41.7
	Negative	240	58.3
Multiple pregnancy	Yes	96	23.3
	No	316	76.7
PROM	Yes	80	19.4
	No	332	80.6
Gestational age	< 37 w	212	51.5
	≥ 37 w	200	48.5
Mode of delivery	NVD	122	29.6
	C.S	290	70.4
Birth weight	ELBW	18	4.4
	VLBW	60	14.6
	MLBW	146	35.4
	NBW	188	45.6
Main cause of admission	RD	208	50.5
	Birth asphyxia	12	2.9
	Cong. Anomalies	26	6.3
	Infections	38	9.2
	IDM	8	1.9
	Others*	120	29.1
Use of MV	Yes	170	41.3
	No	242	58.7
	Mean ± SD	**Minimum**	**Maximum**

Admission age (days)	5.0 ± 6.1	1	30
Duration of stay (days)	7.8 ± 10.2	1	110

*Others : (Hyperbilirubinemia, bleeding)

Incidence rate and underlying factors of neonatal mortality:

This work demonstrated that 30.6% of the studied neonates died(Table 2), 54% of them died after the age of 7 days, while 46% died before this age. The main cause of death was respiratory failure affecting 55.6% of them. The results showed that there was a statistically significant association between sex, PROM, gestational age, birth weight, cause of admission and use of MV and neonatal mortality (P<0.05 for them all). Regarding sex, 57.1% of the non survivors were females compared to 43.4% of survivors (P=0.01, OR= 1.74 &95%CI= 1.14-2.66). Non survivors were about 2 times more likely to have mothers with history of PROM than survivors (OR= 2.2, 95% CI= 1.33-3.64, P=0.002).

Table 2: Incidence rate of neonatal mortality in Benha University NICU

Neonatal mortality	**Number (N=412)**	**Percentage (%)**
No (Survivors)	286	69.4
Yes (non survivors)	126	30.6

Regarding gestational age, non survivors were about 3 times more likely to be preterm than survivors (OR=2.73, 95%CI=1.75-4.3, P<0.001). Considering birth weight, non survivors were about ten times more likely to have ELBW&VLBW than survivors (OR=9.6, 95%CI= 5.5-16.7, P<0.001), also, non survivors were 14.3 folds to be mechanically ventilated than survivors (OR=14.3, 95%CI= 8.06-22.7, P<0.001). About 60% of non survivors were admitted mainly due to RD followed by infections (12.7%) compared with 46.2% and 7.7% of survivors respectively (P<0.001) (Table3).

Table 3: Underlying factors of neonatal mortality at Benha University Hospital

Variable		**Survivors (N= 286)**		**Non survivors (N= 126)**		**X^2& P**	**OR& 95%CI**
		No.	**%**	**No.**	**%**		
Sex	Male (R)	162	56.6	54	42.9	6.66& 0.01	1.74& 1.14-2.66
	Female	124	43.4	72	57.1		
Residence	Rural(R)	60	21.0	20	15.9	1.45& 0.23	1.41& 0.81-2.45
	Urban	226	79.0	106	84.1		
Consanguinity	Positive	120	42.0	52	41.3	0.017 & 0.89	1.03& 0.67-1.57
	Negative(R)	166	58.0	74	58.7		
Multiple pregnancy	Yes	74	25.9	22	17.5	3.46& 0.063	1.65& 0.97-2.8
	No(R)	212	74.1	104	82.5		
PROM	Yes	44	15.4	36	28.6	9.72& 0.002	2.2& 1.33-3.64
	No(R)	242	84.6	90	71.4		
Gestational age	< 37 w	126	44.1	86	68.3	20.5& <0.001	2.73& 1.75-4.3
	≥ 37 w(R)	160	55.9	40	31.7		
Mode of delivery	NVD(R)	81	28.3	41	32.5	0.75 & 0.39	0.82& 0.52-1.29
	C.S	205	71.7	85	67.5		
Birth weight	ELBW& VLBW	22	7.7	56	44.4	79.9& <0.001	9.6& 5.5-16.7
	MLBW& NBW(R)	264	92.3	70	55.6		
Main cause of Admission	RD	132	46.2	76	60.3	40.2 & <0.001	----------
	Birth asphyxia	4	1.4	8	6.3		
	Cong. anomalies	14	4.9	12	9.5		

	Infections	22	7.7	16	12.7		
	IDM	6	2.1	2	1.6		
	*Others	108	37.8	12	9.5		
Use of MV	Yes	68	23.8	102	81.0	118.0& <0.001	14.3& 8.06-22.7
	No (R)	218	76.2	24	19.0		

(R) → Reference category*Others →(Hyperbilirubinemia, bleeding)

Table 4:Binary logistic regression analysis for predictors of neonatal mortality

Variable	OR (Exp B)	95%CI	P
Sex (Female)	1.51	0.85-2.7	0.16
PROM (Yes)	1.54	0.71-3.33	0.27
Gestational age(< 37 w)	2.41	1.14-4.07	0.015
Birthweight(ELBW & VLBW)	6.4	3.02-13.6	<0.001
UseofMV(Yes)	11.1	5.81-21.2	<0.001
Causeofadmission (RD)	1.03	0.45-2.36	0.94

Binary logistic regression analysis was used to detect the significant predictors of neonatal mortality where all factors that found to be significantly associated with neonatal mortality were entered model, it was found that gestational age<37w, ELBW&VLBW, and use of mechanical ventilation are the significant predictors of neonatal mortality (Table 4).

Survival analysis using Kaplen Meier Curve revealed that the survival probability among preterm neonates (gestational age <37 w) was significantly lower than that of full term neonates (P=0.005) (Figure 1), also, the survival probabilities among neonates with ELBW & VLBW were significantly lower than that of MLBW & NBW (P<0.001) (Figure 2), moreover, the curve showed that mechanically ventilated neonates have significantly lower survival probability than those who were not mechanically ventilated (P<0.001) (Figure 3).

Figure 1: Kaplen Meier Curve showing the survival probability among the studied neonates according to gestational age

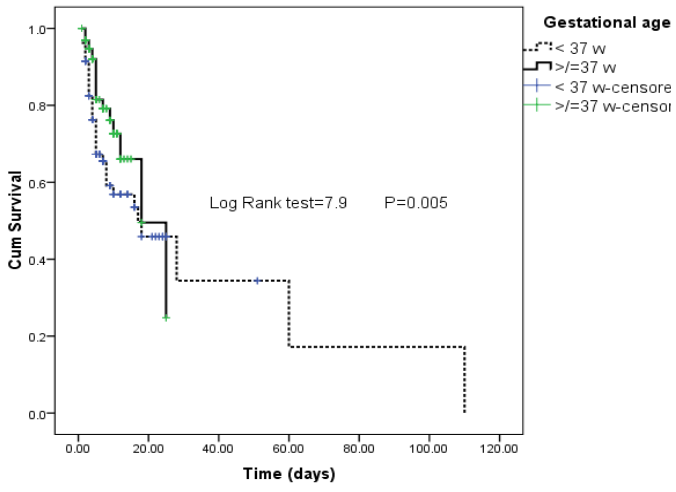


Figure 2: Kaplen Meier Curve showing the survival probability among the studied neonates according to birth weight

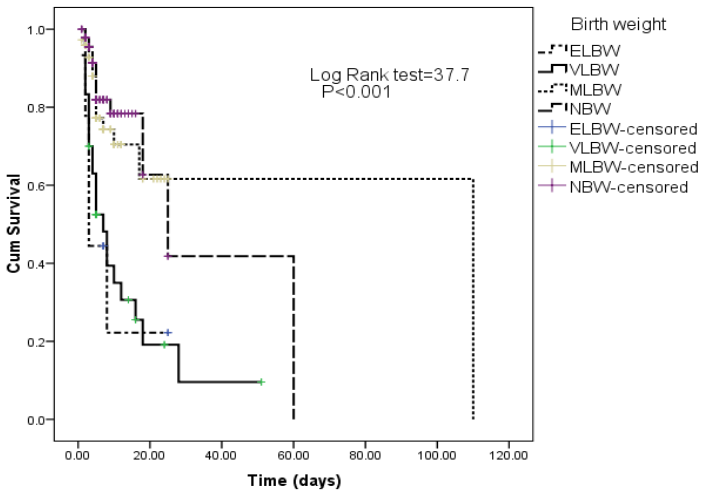
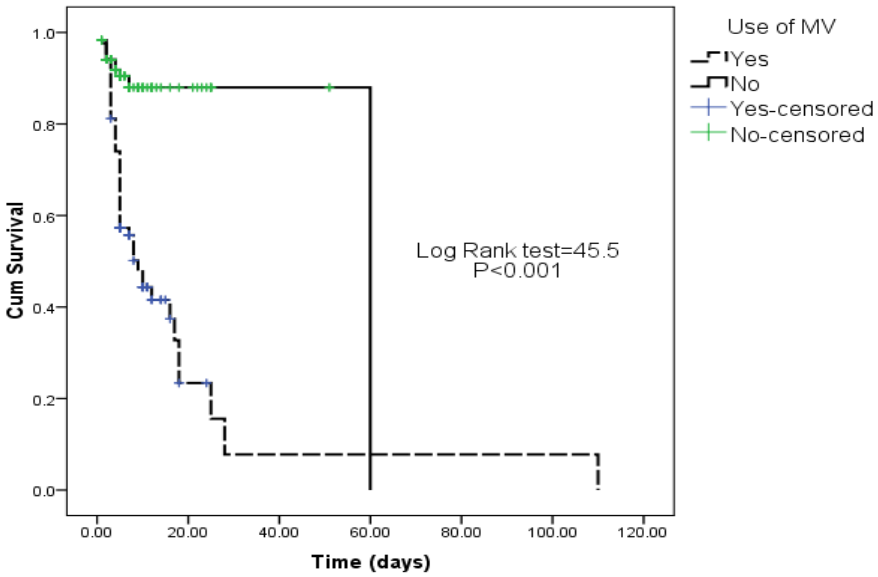


Figure 3: Kaplen Meier Curve showing the survival probability among the studied neonates according to use of mechanical ventilation



DISCUSSION

The estimation of about 130 million infants born each year worldwide,1 4 million die in the first 28 days of life. Three-quarters of neonatal deaths occur in the first week, and more than one-quarter occur in the first 24 hours. Neonatal deaths account for 40% of deaths under the age of 5 years worldwide.[7]. Many factors determine an individual baby`s chance of survival as, the gestational age at the time of birth, the baby weight, the presence or absence of congenital anomalies or malformation, the presence or absence of severe diseases especially infection [8].

On the basis of The Egypt National Perinatal/Neonatal Mortality Study 2000, PM (Perinatal Mortality) was mainly attributed to congenital anomalies, prematurity, asphyxia, and a considerable percentage of unknown causes. However, the main causes of neonatal death were prematurity, respiratory distress, infections, and unknown causes [9].

Chen and Wen [10]have argued that teenage mothers are more likely to have perinatal/neonatal deaths, preterm babies, babies with congenital anomalies, and babies with low birth weight. All these factors finally decrease the probability of survival of the babies.

In our study neonatal mortality rate was (30.6%) which was nearly equal to local Egyptian studies done in Alexendria by Monaet al. as their results were (38%) [11]. On the other hand our results differ from other studies done in foreign countries as in Nigeria by Omoigberale et al.[12]who reported that mortality was (25.5%) among neonates born inside their hospital and (64.2%) among neonates born outside their hospital. In comparison to Abdalatif et al.[13]who study "Neonatal Mortality Rate in SCBU at Gharian Teaching Hospital" the overall death rate was (4.75%) among the admitted neonates, this big difference may be due to selection criteria in the admitted cases or difference in the level of care in hospital. Neonatal mortality depends on the level of care in the hospital like in Ciaran et al. [14]study "mortality among very-low-birth-weight infants was lowest for deliveries that occurred in hospitals with NICUs that had both a high level of care and a high volume of such patients".

According to time of death we found that (54%) of deaths occurred after first week, while (46%) of deaths occurred in the first week of life. Our results differ from results reported by Oona et al. [15]. The difference that we have in our study may be due to difference in admission causes or acquired causes like sepsis during their stay in our NICU, as even medications taken inside the NICU may cause infection like Saiman et al.,[16]study who reported that "Exposure to more than two antibiotics, parenteral nutrition for >5 days, use of intravenous lipid emulsion for>7 days, exposure to an H2 blocker, length of stay of>7 days and assisted ventilation are associated with increased risk of infection".

Respiratory distress was the main cause of admission (50.5%) among our cases, similarly Abdalatif et al. [13]who found respiratory distress (40.96%) So respiratory distress seem to be the main cause of admission in many NICUs, and differ from study done by Elhasan et al.[17]conducted on a total of 1211 neonate showed that the major cause of admission were infection (24.8%), LBW (25.4%), and asphyxia (10.7%). Cause of death in our study was mainly (55.6)respiratory failure followed by septic shock (20.6)while being only (9.2%) from admitted cases and lastly from asphyxia(7.9%).Also, the study done by Patiletal. [18] reported that respiratory disorders related deaths were (49%), infection related deaths (32.1%),CNSrelateddeaths(25.6%)andcongenitalheartrelated deaths(20.9%).

So in many studies like ours the highest cause of death was respiratory failure or respiratory disorder related deaths. Comparing cause of death and cause of admission in our study, (88.6%) of the neonates died with respiratory failure were admitted due to respiratory distress, and (53.8%) of the neonates died with septic shock were 1st diagnosed as sepsis, also (80%) of the asphyxiated neonates were admitted as birth asphyxia, regarding heart failure it was distributed among all causes of admission as (40%) were from (Hyperbilirubinemia, bleeding, dehydration, hydrocephalus and IVH),20%were for respiratory distress, the same for congenital anomalies, and (10%) for both IDM &sepsis. Mortality rates in neonatal sepsis may be as high as 50% for infants haven't been treated. Infection is a major cause of mortality during the first month of life, contributing up to 13.15% of all neonatal deaths [19].

Of the annual 4 million neonatal deaths, 99% occur in developing countries, and an estimated 36% are attributed to infections [1]. In our study the mean value of admission age among non survivors was lower than that of survivors (4.92 days & 5.06 days respectively), while the mean value of duration of stay among non survivors was higher than that of survivors (8.42 days & 7.49 days respectively), but these differences were not statistically significant (P>0.05) for both. This may refers to the longer they stay the more they exposed to the risk of infection. According to socio-demographic data we found that most of our cases were males (52.4%).

This was opposite to another Egyptian study (Mona et al. [11]which reported that male ratio were (42.7%) less than female's ratio (57.3%). Of the dead neonates the majority (57.1%) were females. These results are matched with community based cross-sectional study done by Ayaz and Saleem. [20]On 565 neonates, who found that males were (57.7%) of non survivors, while females were (42.3%). The majority of our cases (80.6%) were from urban areas and the rest (19.4%) were from rural areas, in another Egyptian study by Mona et al. [11]where the ratio of urban areas was(58%) and rural areas were (42%). This high level of urban (80.6%) may be because Benha is a big city with many villages related to it, so bad recording of the address during admission may result in this difference. Negative consanguinity was found in (58.3%)and this has no statistical significance on neonatal mortality. While consanguinity doesn't affect neonatal mortality in this study significantly, the traditional pattern of consanguineous marriage in Islamic countries, including ours may influence the autosomal recessive conditions that increase neonatal morbidity and mortality [21].

PROM as a complication of pregnancy and as a risk of NM it represent only (19.4%) of the studied neonates, also PROM in our study was present in (28.6%) of the non survivors. Knowing that neonates with maternal history of PROM were (19.4%) of the admitted cases, when we compare these result to all neonates (survivors & non survivors), we found that they were more susceptible to death than living. As the main problem of PROM on the neonates is infection (sepsis) which may be a cause of death, as in many studies like Gerdes[22].Study who reported that "Once the membranes have been ruptured for >18 hours, the risk of sepsis in the neonate increases approximately 10-fold over baseline to a rate of 1% for proven and 2% for suspected sepsis" [22].

Mode of delivery has many consequences on neonates depending on its type, in our study the largest number of neonates were delivered by cesarean section "C.S" (70.4%). But in Mona et al., study, C.S was lower than normal vaginal delivery "NVD" as it represent only (35.3%) and NVD (64.7%) this difference may be due to the place of the sample [11]. The overall rate of dead neonates delivered by C.S was (63.5%) which was higher than the rate of dead neonates delivered by NVD (36.5%).These results are in accordance to the results of a survey done by Drif [23],the rate of C.S was (57.7%) among dead neonates, similarly in Mona et al .study where(54.5%) of dead neonates were born by C.S [11]. These results were against another Pakistan cross-sectional study done by Ayaz and Saleem. On 565 neonates; the majority of them were born by NVD (94.9%) [20].

Preterm neonates represent (51.5%) of our cases. In contrast to another study Abdalatif et al.[13]who reported that prematurity represent only (22.09%).We think that the cause of this difference than our study is due to the difference in locality and also according to the supplies of the NICU. There was a statistical significant relation between the gestational age at birth and neonatal mortality; these results are also in accordance with Dorling et al. [24]who reported a significantly decreased mortality rate with increasing gestational age at birth. Also mortality and morbidities had a strong GA-related trend with the lowest incidences consistently found between 38 and 40 weeks of gestation independent of delivery mode [25].

Regarding dead neonates the highest percent of them was VLBW (34.9%) and we found that the dead neonates are 10 times more likely to be ELBW&VLBW than MLBW&NBW. These results are in accordance to the study by Patil et al.[18], who reported that the mortality rate was higher among neonates less than 2.5 Kg, to reach (45.8%) in ELBW, (27.8%) in VLBW, and (26.4%) in LBW neonates admitted during the study duration from June 2007-May 2010, mortality related LBW (<2.5 Kg) in his study was (93.2%).These results agree with the study of Yasmin et al.[26],who reported that the mortality rate was higher among neonates less than 2.5 kg than among those more than 2.5 kg. Higher rates of sepsis are reported in developing countries; also low birth weight is associated with higher rate of sepsis [27].Oshikisaid that the risk of death increases 1.8 folds if birth weight decreases by 100 gm."[28].

As respiratory distress was important factor in neonatal admission, so use Continuous Positive Air Way Pressure (CPAP) and Mechanical Ventilation (MV) must be taken in consideration. In our study (41.3%)of the admitted neonates were on MV. In contrast to Abdalatif et al.[13]study they have very low percent (00.07%) of cases that were on M.V compared to other studies especially ours, this may be explained by difference in selection criteria during admission or different level of treatment. The use of mechanical ventilation in our study was associated with increase neonatal mortality with(81%) percent, in comparison to neonates weren't on mechanical ventilation, the mortality was(19%), this is highly significant meaning

that the non survivors is more likely to be on MV than survivors. These results correlate with those of Abdalatif et al. [13] who reported that the mortality rate among ventilated patients was (80%).Mechanical ventilation, while life-saving is also associated with iatrogenic complications which themselves are life-threatening like ventilation associated pneumonia, lung collapse, tension pneumothorax, hypotension and death[29].

From all this we can see that despite mechanical ventilation should enhance the chance of survival, we found that neonatal mortality was higher in cases have been on mechanical ventilation than whom haven't and this may be due to many factors as delayed decision of utilization of mechanical ventilation or bad technique and acquired complications. Although investigators observed decreased rates of mortality with assisted ventilation in larger infants who died of inadequate respiratory effort, premature infants still died of severe progressive lung disease and associated conditions [30]**.**So from all these results we found that the Predictors of neonatal mortality in our study were gestational age, birth weight and the use of mechanical ventilation(MV) as shown in binary logistic regression analysis table.

CONCLUSION

We conclude from our study that neonatal mortality is important public health problems in developing countries, Neonatal mortality in year 2013 was 30.6%, The main cause of death was mainly respiratory failure 55.6%, followed by septic shock20.6%, then heart failure 15.9% and lastly asphyxia 7.9%. Number of factors appeared to be significantly accompanied with neonatal mortality like respiratory distress, prematurity, birth weight and mechanical ventilation

Recommendations

Prevention of preterm labor and provide proper health care for preterm neonates as regarding safe delivery, proper resuscitation, thermal regulation, proper nutrition, immunization and follow up. We strongly recommended to improve the quality & quantity of man power with continuous supervision, training and improve facilities e.g. artificial ventilator support, surfactant administration for premature, strict hygiene and good Infection control program inside the NICU. Further and more detailed studies about neonatal mortality causes, incidence and prevention in different NICU allover Egypt should be done in the future.

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*Corresponding author: Dr.Rasha Shaker Eldesouky
E-Mail: RASHA.ALSAYED@fmed.bu.edu.eg