The Egyptian Journal of Hospital Medicine (April 2019) Vol. 75 (1), Page 1996-2006

Risk Factors for Neonatal Mortality in Neonatal Intensive Care Units in Tanta City

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ABSTRACT

Background: Neonatal period is the weakest period of life as it causes high rates of morbidity and mortality due to various diseases, especially in preterm infants and those with low birth weight. **Aim of the present study:** assessment of the risk factors and incidence of neonatal mortality in neonatal intensive care units in Tanta city.

Subjects and Methods: Multi-centric prospective Cohort study that was conduct in Neonatal Intensive Care Units in Tanta city (5 public centers and 10 private centers). The duration was 6 months from August 2017 to January 2018. **Results:** Incidence of neonatal mortality among the studied sample during a period of six months was 27.7%. The most common cause of neonatal deaths was prematurity (39.4%). Cesarean section was the highest maternal risk factors (64.3%) among the study sample. Positive consanguinity was found in 52% and had statistically significant on neonatal mortality. There was no statistically significant difference between survived and expired neonates, while gestational age and birth weight were statistically significant. Neonatal mortality was higher between lower gestational age and lower birth weight. **Conclusion:** Neonatal mortality rates were found to be significantly high in prematurity, low gestational age, low birth weight, cesarean section and positive consanguinity. Improvement of health care qualities is needed to control the preventable risk factors and decrease neonatal morality.

Keywords: Neonatal mortality, Neonatal intensive care units.

INTRODUCTION

The first four weeks of newborns carry the highest risk of death than any four-week period in a person's lifetime. Neonatal mortality is a reflection of the effectiveness of obstetrics and neonatal services in any given community. It contributes to about two-thirds of infant deaths worldwide and most of these occur in the first week of life [(1)]. Infants with long-term central catheterization and TPN, those who suffer from delayed initiation of enteral feeding and who have a prolonged period to reach full enteral feedings or to regain their birth weight are all at high risk of late-onset sepsis (LOS) [(2)].

PATIENTS AND METHODS

This Prospective Cohort study was carried out at Pediatric Department, Tanta University Hospital over 6 months [August 2017 to January 2018]. A total of 238 neonates (The least sample size needed was calculated by epi-info statistical program (version 7.2.1.0), using 90% estimated power and 95% confidence level.) were included in this study and were followed up till their death or discharge.

Collection of data: Data were obtained from:

1. **Review of maternal records which included the following**:

- Maternal age.
- Level of education, occupation of the parents, marital status, urban/rural residence, address and consanguinity.
- Medical history (*diabetes, hypertensive disease, hemorrhage, genito-urinary infection, preterm rupture of the membrane and postpartum complications*).
- History of antenatal care routine (*antenatal care visits, regular ultra sound, regular measuring blood pressure, taking routine vaccine, screening for TORCH infection and blood tests for blood group and rhesus factor*).
- Parity, health status of the other siblings and family history.

2. **Review of neonatal records which included the following:**

- Childbirth complications: pallor, cyanosis and jaundice.
- Newborn care: neonatal resuscitation and vital signs, neonatal parameters (appearance, anthropometric measurements and breast feeding).
- Neonatal sex, place, mode of delivery and gestational age.
- Neonatal complications: hyperthermia, hypothermia, hypoglycemia, and anemia and their management.
- Presence of congenital anomalies.
- Initial diagnosis (respiratory, cardiac, hematological, infectious, surgical, metabolic, neurological and miscellaneous), and final diagnosis (the same as primary diagnosis).
- Any investigation done during incubation.
- Any operation or procedure done during incubation.

All newborns were followed up for 28 days or until time of death if before 28 days. All deaths which occurred up to 28 days of life were considered as neonatal deaths. All details regarding dates of admission, length of stay, management, provided examination and investigation and

Received:6/1/2019
Accepted:25/1/2019

its results will be recorded. All neonatal deaths were reviewed to assign obstetric and final causes of death. The circumstances of the death were determined by reviewing hospital records. Mortality rates were calculated in both types of centers (public and private) according to the causes of death. Associated risk factors were mentioned to evaluate the associations between potential risk factors and neonatal death.

Ethical considerations:

- No risks for the subjects who share in this study.
- Any unexpected risks appeared during the course of the research were cleared to participants and the ethical committee on time.
- Written informed consent was obtained from all the parents of all subjects of the study.
- **The study was approved by the Ethics Committee of Faculty of Medicine, Tanta University.**
- Adequate provisions to maintain the privacy of participants and confidentiality of the data were as the following:

✓ We hided the name of patient in the research and put a code number to every patient's name and address that will be kept in a special file.

✓ We used the results of the research only in scientific aim and not to use it in any other aim.

Statistical analysis

In addition to the descriptive data, statistical analysis was done using IBM SPSS statistic version 20. Data were expressed as mean ± SD and analyzed using the **Chi square (x2) test** and the **Student's t-test** to assess the significance of difference in the levels between different parameters. $P < 0.05$ was accepted as significant. Coefficient (r) of two variables was also done by using **Pearson Correlation Coefficient (r)** with **P Value** Calculation.

RESULTS

Laboratory assessments of the measured parameters in the different submitted groups are presented in the following tables and figures:

Table (1): Maternal and neonatal characteristics of the studied neonates

Maternal characteristics	Number (N=238)	Percentage (%)	Neonatal characteristics	Number (N=238)	Percentage (%)
Maternal age			**Sex**		
< 20 years	8	3.4	Male	136	57.1
20 -30 years	176	73.9	Female	102	42.9
> 30 years	54	22.7			
Level of education			**Gestational age**		
Moderate	82	34.5	< 37 week	98	41.2
High	156	65.5	≥ 37 week	140	58.8
Residence			**Birth weight**		
Rural	108	45.4	< 2.5 kg	66	27.7
Urban	130	54.6	≥ 2.5 kg	172	72.3
Parity			**Neonatal Complications**		
Primipara	116	48.7	Yes	158	66.4
Multipara	122	51.3	No	80	33.6
Consanguinity			**Use of Ventilator**		
Yes	50	21.0	Yes	140	58.8
No	188	79.0	No	98	41.2
Family history			**Other siblings loss**		
Yes	22	9.2	Yes	44	18.5
No	216	90.8	No	194	81..5
Mode of delivery					
Caesarean section	153	64.3			
Normal	85	35.7			
History of antenatal care					
Yes	224	94.1			
No	14	5.9			
Medical or &Obstetric problems					
Yes	114	47.9			
No	124	52.1			

- Table (1) showed the characteristics of neonates and their mothers enrolled in the current study.

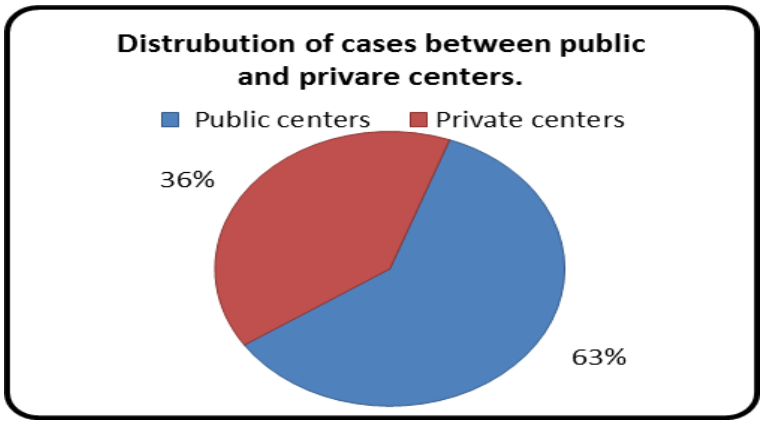

Figure (1): percent of cases between public and private centers.

- Figure (1) showed that percent of cases in public centers among the studied sample was 36% and percent of cases in private centers was 63%.

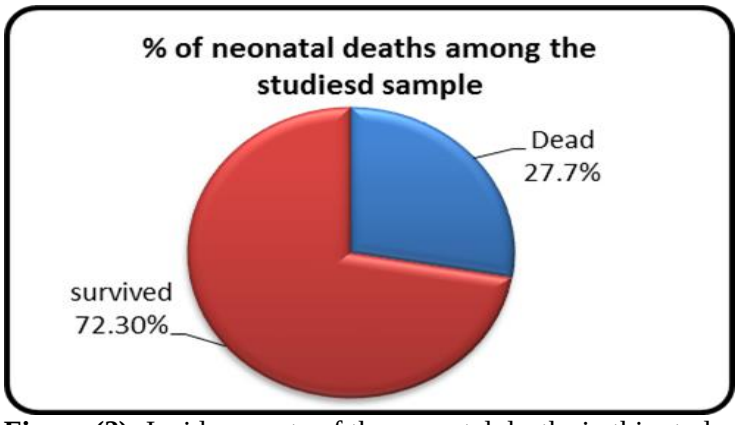

Figure (2): Incidence rate of the neonatal deaths in this study.

- Figure (2) showed that the incidence risk of neonatal mortality among the studied sample was 27.7 % and the percentage of the survived babies was 72.3 %.

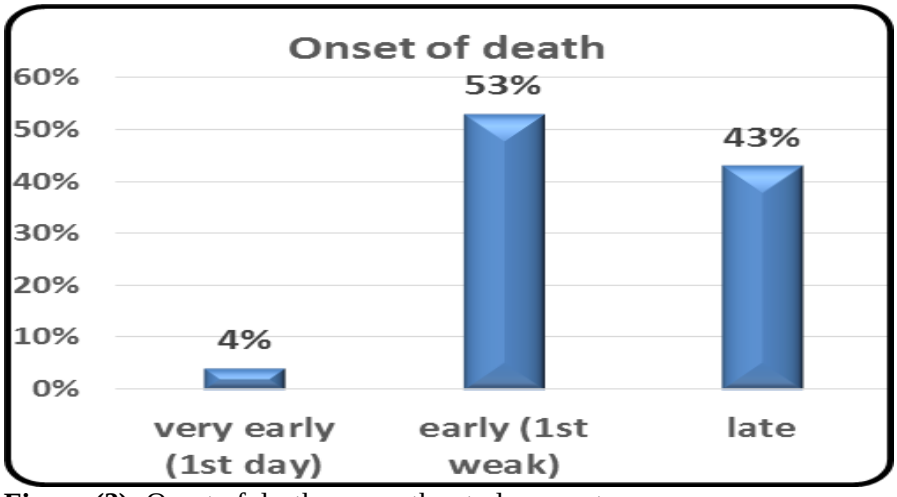

Figure (3): Onset of death among the study neonates.

- Figure (3) showed that very early onset of death was 4%, early onset of death was 53% and late onset of death was 43%.

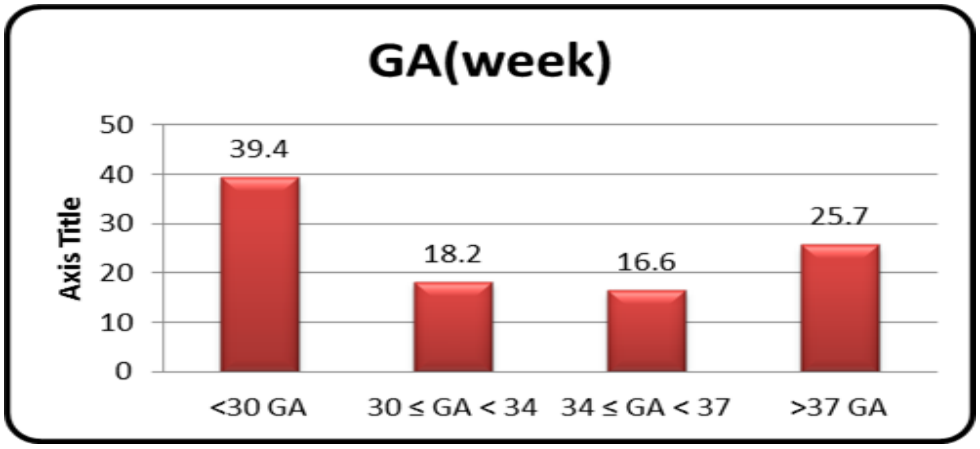

Figure (4): Mortality rates of the studied neonates among preterm and full term.

Figure (4) showed that the highest mortality rate was in preterm babies below 30 week (39.9%) followed by full term > 37 week (25.5%).

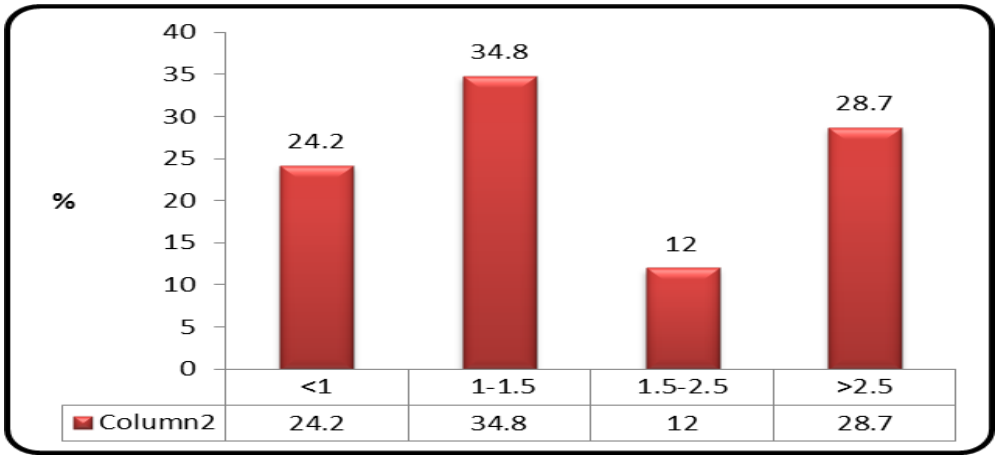

Figure (5): Mortality rates of the studied neonates among different birth weights.

- Figure (5) showed that the highest mortality rate was in babies whose weight between 1: 1.5 kg then whose weight > 2.5 kg.

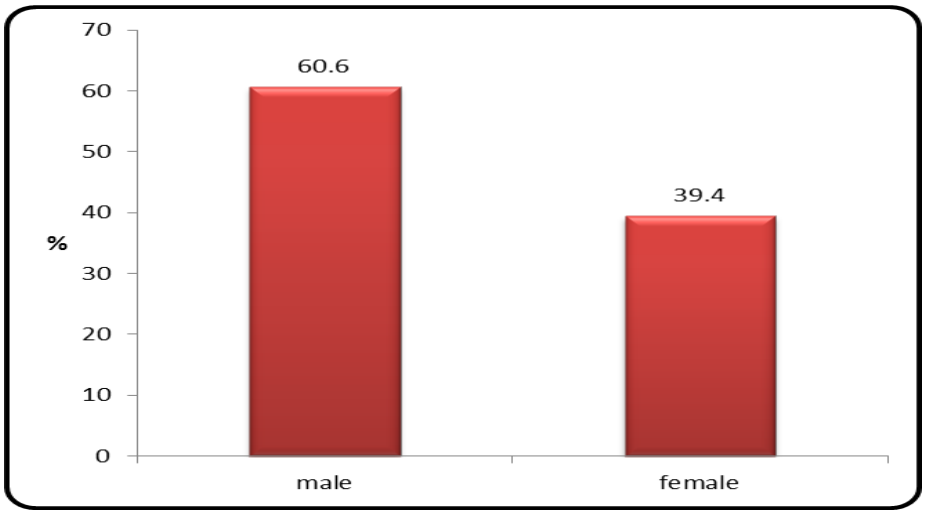

Figure (6): Sex distribution of mortality rates of the studied neonates.

- Figure (6) showed that mortality rate in males was more than females among the dead neonates.

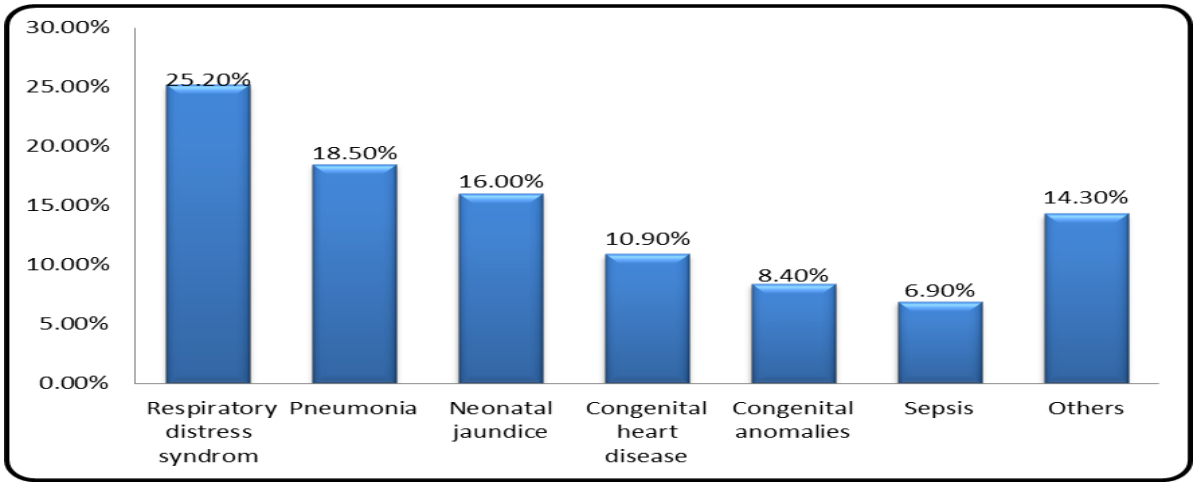

Figure (7): Causes of neonatal admissions among the study group.

- Figure (7) showed that causes of neonatal admissions among the study group the most common cause was RDS (25%), followed by pneumonia (18.5%), and sepsis in about 7% of the neonates.

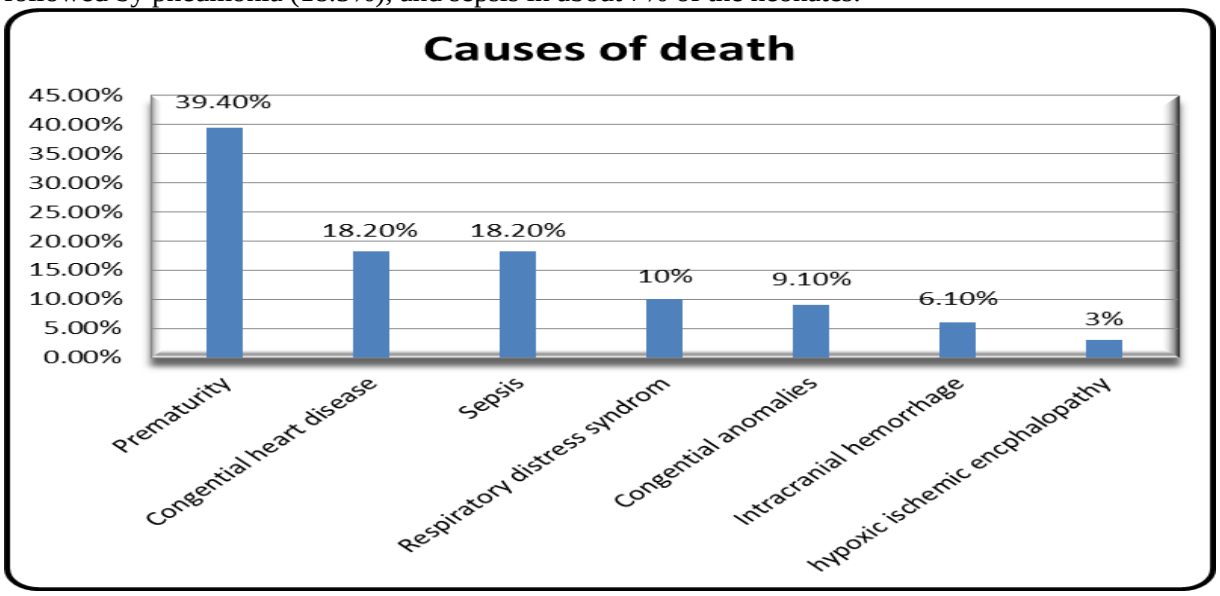

Figure (8): Causes of neonatal deaths among the study group.

Figure (8) showed that the most common cause was prematurity (39.4%) followed by both CHD and sepsis in 18.2% of neonatal deaths.

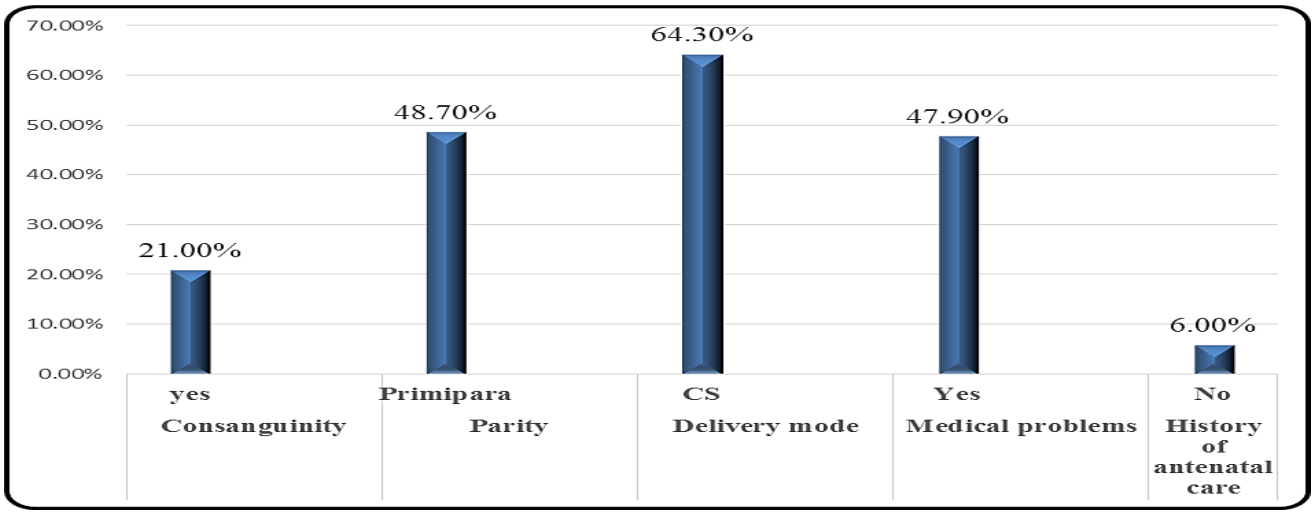

Figure (9): Maternal risk factors among the study sample.

- Figure (9) showed that CS (cesarean section) was the highest maternal risk factors among the study sample, followed by primipara in 48.7% and mothers with a history of medical problems in 47.9%.

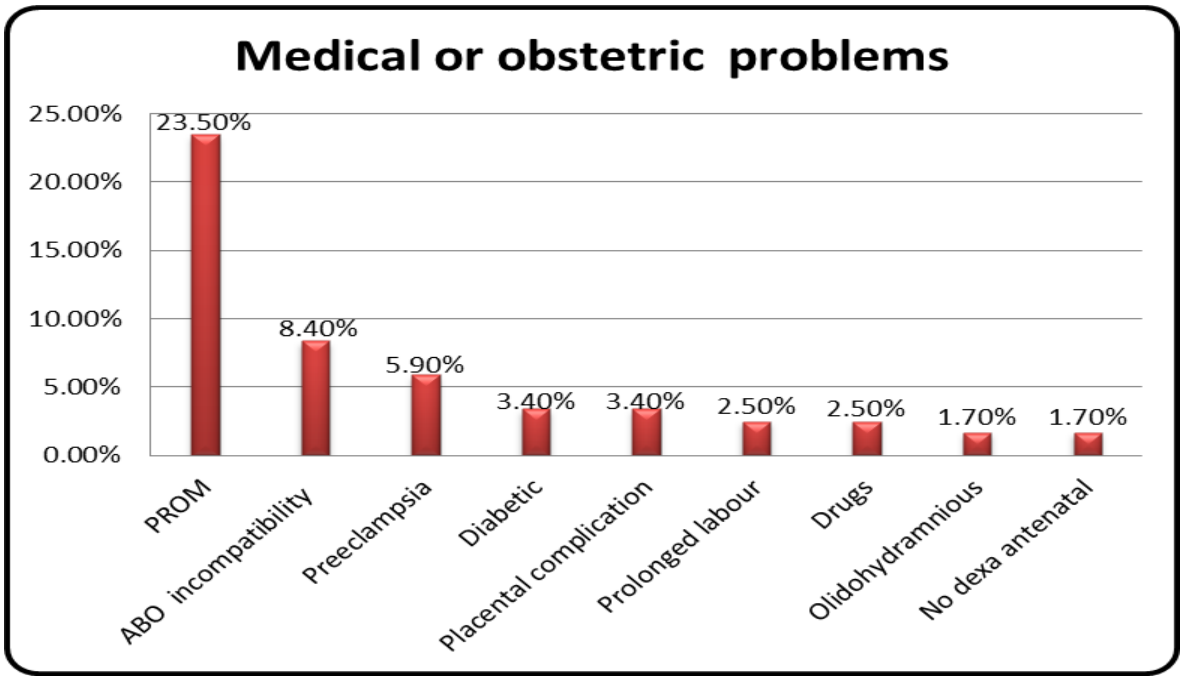

Figure (10): Medical or obstetric problems during pregnancy and labor.

Figure (10) showed that PROM (premature rupture of the membrane) was the highest maternal risk factors among the study sample, followed by ABO incompatibility and preeclampsia.

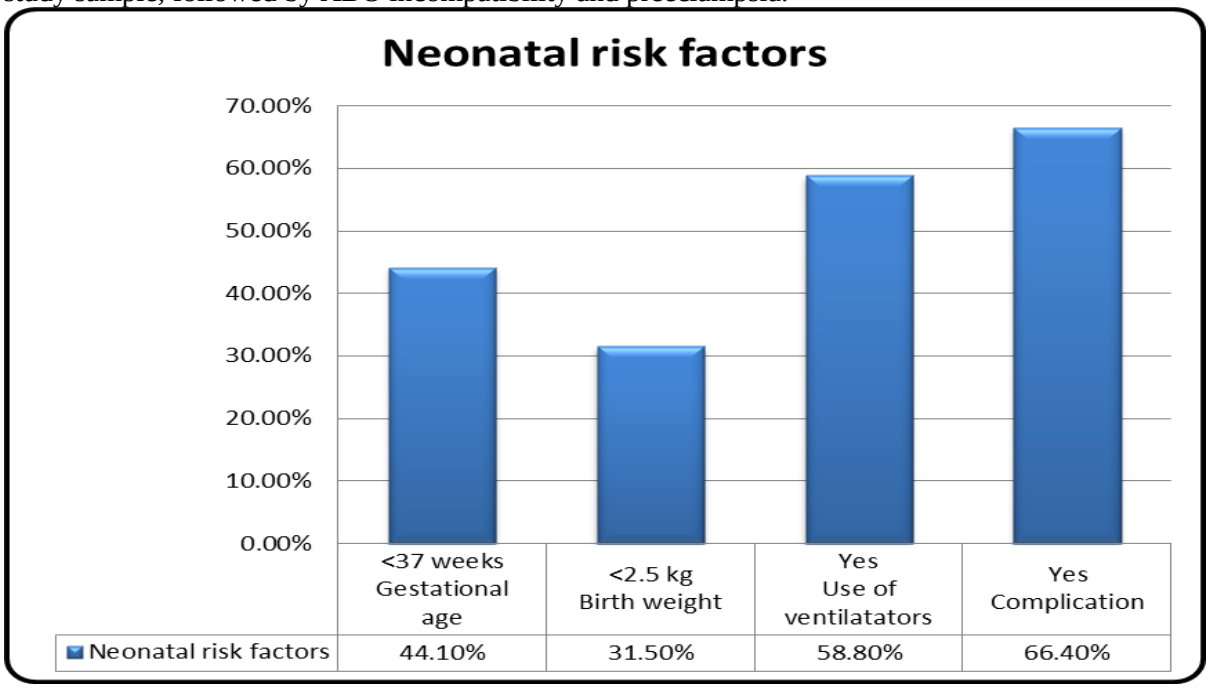

Figure (11): Comparing the mean of gestational age, birth weight and age at admission between dead and survived neonates among the study sample at Tanta NICUs.

- Figure (11) showed that neonates with complication carried high of mortality.

Table (2): Comparison between mean age of the mothers for both dead and survived neonates

Mean age of mothers	Neonatal outcome		Total mothers			
	Dead (N=66)	Survived (N=172)				
	Mean ± SD	Mean ± SD	Mean ± SD	Minimum-maximum	T test	P value
Maternal age	25 ± 4.96	27 ± 4.74	26.5 ± 4.87	17 – 38 yrs.	2.8	**0.006***

- Table (2) revealed that the mean age for mothers of the dead neonates were lower than mean age for mothers of survived neonates, they were (25 ± 4.46 & 27 ± 4.74) respectively with a statistically significant difference (P=0.006).

Table (3): Underlying neonatal factors for neonatal mortality among the studied sample

Neonatal characteristics		Neonatal outcome				X^2 test	Relative Risk (CI)
		Dead (N=66)		Survived (N=172)		P value	
		No	%	NO	%		
Sex	Male	40	29.4	96	70.6	X^2 =0.45	RR= 1.15 (0.76-1.76)
	Female	26	25.5	76	74.5	P<0.50	
Gestational age	<37 week	49	46.6	56	53.3	X^2 =19.02	RR= 2.5 (1.62-3.84)
	>37 week	17	12.7	116	87.2	P<0.001*	
Birth weight	<2.5 kg	47	62.7	28	37.3	X^2 =40.59	RR= 3.54 (2.38-5.26)
	>2.5 kg	19	11.6	144	88.3	P<0.001*	
Neonatal Complications	Yes	66	41.8	92	58.2	X^2=46.24	RR not applicable
	No	0	0.0	80	100.	P<0.001*	
Use of Ventilator	Yes	54	38.6	86	61.4	X^2=19.94	RR= 3.15 (1.78- 5.57)
	No	12	12.2	86	87.8	P<0.001*	
Other siblings#	yes	10	22.7	34	77.3	X^2 = 0.67	RR= 0.79 (0.44- 1.42)
	No	56	28.9	138	71.1	P<0.41	

 # Some of complications that happened during admission were pneumothorax, refusal of feedings , sepsis , convulsions , DIC , pulmonary hypertension , BPD , ICH and NEC .

- **Table (3) showed the following:**
  - Gestational ages, birth weight, having complication during admission, putting on mechanical ventilation in relation to the neonatal outcome of the cases were statistically significant as the (P value < 0.001).
  - It was found that 46.6% of neonates with gestational age < 37weeks died compared to only 12.7% of neonates >37week.
  - According to birth weight it was found that 62.7% of neonates < 2.5 kg died compared to only 11.6% of neonates > 2.5 kg.
  - It was found that 41.8% of neonates who had complications during admission died.
  - It was found that 38.6% of neonates who received MV died compared to only 12.2% who didn't.

Table (4): Comparing the mean of all laboratory parameters between dead and survived neonates among the study sample

Neonatal characteristics	Neonatal outcome				T test
	Dead (N=66)		Survived (N=172)		P value
	Mean	SD	Mean	SD	
HB	7.14	2.19	10.51	1.77	T test = 11.175 P<.001*
CRP	67.21	70.52	18.74	31.42	T test = 5.382, P< .001*
WBC	17939.39	20899.67	9941.86	8881.92	T test = 3.006 P< .004*
Platelets	62757.58	63249.46	122755.81	73539.73	T test = -5.848 P<.001*
Urea	44.90	14.73	35.37	13.82	T test = 4.678 P<.001*
ALT	65.00	47.43	49.92	29.52	T test = 2.410 P< .018*
AST	72.91	52.04	69.37	46.24	T test = .510 P< .611
Bilirubin	2.070	2.7393	4.085	5.7377	T test = -3.648 P=<.001*
Creatinine	1.56	1.159	.67	.583	T test = 5.956 P< .001*

- **Table (4) showed the following:**
  - As regards **Hb**, in relation to the neonatal outcome of cases, it was proved to be statistically significant as the (P value < 0.001). The mean among survived neonates was10.51 compared with mean of Dead 7.14.
  - As regards **CRP**, in relation to the neonatal outcome of cases, it was proved to be statistically significant as the (P value < 0.001). The mean among survived neonates was 18.74 compared to mean of Dead 67.21.
  - As regards **WBC**, in relation to the neonatal outcome of cases, it was proved to be statistically significant as the (P value = 0.004). The mean among survived neonates was 9941.86 compared to mean of dead 17939.39.
  - In regard to **platelets**, in relation to the neonatal outcome of cases, it was proved to be statistically significant as the (P value < 0.001). The mean among survived neonates was 122755.81 compared to mean of dead 62757.58.
  - As regards *urea* in relation to the Neonatal outcome of cases, it was proved to be statistically significant as the (P value < 0.001). The mean among survived neonates was 35.37 compared to mean of Dead 44.90.
  - Concerning **ALT** in relation to the neonatal outcome of cases, it was proved to be statistically significant as the (P value = 0.018). The mean among survived neonates was 49.92 % compared to mean of dead 65.
  - As regards **AST** distribution in relation to neonatal outcome of the studied patients (survived or dead) it was proved to be statistically non-significant (P value = 0.611) (> 0.05).
  - About *bilirubin* in relation to the neonatal outcome of cases, it was proved to be statistically significant as the P value < 0.001. The mean among survived neonates was 4.085 compared to mean of Dead 2.070.
  - As regards **Creatinine** in relation to the neonatal outcome of cases, it was proved to be statistically significant (P value <0.001). The mean among survived neonates was .67 compared to mean of dead 1.56.

Table (5): Binary logistic regression analysis for predictors of neonatal mortality

	OR EXP (B)	95% C.I. for EXP(B)		P value
		Lower	Upper	
Maternal age	0.947	0.872	0.193	0.193
Level of education (Moderate)	2.841	1.328	0.007	0.007
Consanguinity (Yes)	5.558	2.178	0.000	0.000
PROM (Yes)	1.282	0.544	0.570	0.570
Preeclampsia (Yes)	6.516	1.665	0.007	0.007
Use of Ventilator (Yes)	2.709	1.165	0.021	0.021
Gestational age (<37 week)	1.118	0.296	0.869	0.869
Birth weight (<2.5 kg)	6.994	1.642	0.009	0.009
Constant	0.139		0.099	0.099

- **Table (5) showed** binary logistic regression analysis 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 moderate

level of education, preeclampsia, consanguineous marriage, Low birth weight, and use of mechanical ventilation were the significant predictors of neonatal mortality.

Table (6): Binary logistic regression analysis for neonatal laboratory parameters as predictors of neonatal mortality

	OR EXP(B)	95% C.I. for EXP(B)		P value
		Lower	Upper	
HB	0.530	0.417	0.673	0.000
CRP	1.015	1.001	1.028	0.030
WBC	1.000	1.000	1.000	0.241
Platelet	1.000	1.000	1.000	0.810
Urea	1.017	0.984	1.052	0.307
Creatinine	1.979	1.184	3.306	0.009
ALT	1.012	0.990	1.034	0.275
Bilirubin	0.838	0.713	0.985	0.032
Constant	18.059			0.017

- **Table (6) showed** binary logistic regression analysis to detect the significant neonatal laboratory parameters as predictors of neonatal mortality, where all the parameters was found to be significantly associated with neonatal mortality and entered model. It was found that low level of Hb, high levels of creatinine, CRP and bilirubin were the significant predictors of neonatal mortality.

DISCUSSION

In developed countries, the primary cause of morbidity and mortality in the early neonatal period is congenital anomalies that are mainly non-preventable. However, in developing countries, infection, jaundice and birth asphyxia are usually predominate [(3)].

Neonatal deaths generally result from complications of preterm delivery, birth asphyxia, trauma during birth, infection, or other specifically perspective perinatal causes [(4)]. 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 [(5)].

The present study aimed to estimate incidence risk of neonatal mortality in NICUs in Tanta city and to assess risk factors for neonatal mortality in NICUs in Tanta city.

In this prospective cohort study, out of the total 238 neonates, (57.1%) were males and (42.9%) were females. Another Egyptian study by **Mona *et al.*** [(6)] was in contrast to the present study and reported that male ratio were (42.7%) that was less than female's ratio (57.3%).

The present study showed that, mortality rates of the studied neonates was high in the first week of life was (57%). This agrees with **Belizán *et al.*** [(7)] who aimed to determine neonatal mortality rates. They found that more than half of all deaths occurred within the first week of life. In addition, it agrees with **Ndawala** [(8)] who reported that 67 % of mortality occurred in the first week of life.

Preterm neonates represent 41.2% of the current study cases. In contrast, **Abdalatif and Ali** [(9)] reported that prematurity represent only (22.09%). The present study assumed that this difference may be due to the difference in locality and the supplies of the NICU. They also reported that most of the studied neonates delivered prematurely (56.5%).

Mode of delivery has many consequences on neonates depending on its type, in the current study the largest number of neonates were delivered by cesarean section (C.S) (64.3%). **Mona *et al.*** [(6)] study reported that C.S was lower than normal vaginal delivery (NVD) as it represented only (35.3%) and NVD (64.7%). This difference may be due to the place of the sample. These results were contradictory with Pakistan cross-sectional study done by **Ayaz and Saleem** [(10)] on 565 neonates; the majority of them were born by NVD (94.9%).

The majority of the present study cases (54.6%) were from urban areas and the rest were from rural areas, in another Egyptian study by **Mona *et al.*** [(6)], the ratio of urban areas was (58%) and rural areas were (42%).

The present study showed that, incidence risk of neonatal mortality among the studied sample during a period of 6 months was 27.7%. This was similar to **Shah *et al.*** [(11)] retrospective study that was conducted at level III neonatal NICU of a tertiary-care teaching hospital from January, 2012 to December, 2012. They studied the clinical profile, pattern of diseases and common causes of mortality and morbidity in neonates admitted to NICU, they found that the mortality was 20.2%. In addition, in agreement with **Abdel Hady *et al.*** [(12)] who reported that the incidence rate of neonatal mortality among cases admitted to the NICUs in Benha University Hospital was 30.6% of the studied neonates. In contrast to the present study, **Shrestha *et al.*** [(13)] who aimed to identify the indications for admission, complications, co-morbid

conditions and outcome of those neonates in terms of survival. They found that there were 33.3% survivors and 66.7% non-survivors. In comparison with the present study, results of **Abdalatif and Ali** [9] who studied "Neonatal Mortality Rate in SCBU at (Ghryan Teaching Hospital, Libya). The overall death rate was 4.75% among the admitted neonates.

The current study showed that most common cause of neonatal deaths among the study group was prematurity (39.4%). The mortality rate of NICUs varies but remains high in both developing and developed countries. Prematurity is a very common etiology of death, as well as low birth weight infants [14]. This could be attributed to the large number of preterm births.

Abdel Hady *et al.* [12] revealed that cause of death in their study was mainly (55.6%) respiratory failure followed by septic shock (20.6%) from admitted cases and lastly from asphyxia (7.9%). Also, **Patil *et al.*** [15] reported that respiratory disorders-related deaths were 49%, infection-related deaths were 32.1%, CNS-related deaths were 25.6% and congenital heart-related deaths were 20.9%.

The present study showed that, mortality rate in males was more than females among the studied neonates. The results agrees with a study in Nigeria [16] and another in Baghdad [17] in which male deaths was 58.3%, while female death was 41.7%, and male to female ratio was 1.4:1. Also **Ayaz and Saleem** [10] and **Hoque *et al.*** [18] found that mortality rate was higher in males as compared to females. In addition, **Abdel Hady *et al.*** [12] found that there was a statistically significant association between sex and neonatal mortality, 57.1% of the non survivors were females compared to 43.4% of survivors. In contrast, to the current study results, **Riyas *et al.*** [19] found that sex did not have a statistically significant association with the outcome. Higher male mortality may be explained due to gender differences in genetic and biological makeup. Moreover, male gender has a higher incidence of infection (sepsis), and respiratory distress syndrome than female children [20].

The current study showed positive consanguinity (52%) and had statistical significance on neonatal mortality; the traditional pattern of consanguineous marriage in Islamic countries, including ours may influence the autosomal recessive conditions that increase neonatal morbidity and mortality [21].

In the present study, gestational age was found to be a significant predictor of neonatal mortality. As regards birth weight in relation to the neonatal outcome, it was proved to be statistically significant. This proves the strong association between mortality rate in the NICUs with preterm births and low birth weight babies. The present study showed that, the highest mortality rate was in babies was weight from 1-1.5 kg than > 2.5 kg. This agreed with **Rego *et al.*** [22] who found that, low birth weight has been classically associated with neonatal death.

The current study showed that, the highest mortality rate was in preterm babies lower than 30 wks. This is in agreement with **Hornik *et al.*** study [23]. Also; **Arafa and Alshehri** [24] found that, mortality was seen in 29.8% of preterm babies as compared to 7.3% of term newborns. Concordantly, **Iqbal *et al.*** [25] found that birth weight was statistically significant lower among dead than survived neonates. These results were also in accordance with **Dorling *et al.*** [26] who reported a significantly decreased mortality rate with increasing gestational age at birth. The outcome was affected by the gestational age and birth weight of the neonate. Impact of low birth weight and prematurity on survival of neonates is known and reported as well [27].

In the present study and as regards admission age distribution in relation to neonatal outcome of the studied patients it was statistically non-significant (P value = 0.14). This disagreed with **Abdel Hady *et al.*** [12] who found that, the mean value of admission age among non survivors was lower than that of survivors (4.92 days and 5.06 days respectively).

In the present study, CS was among highest maternal risk factors (64.3%) among the study sample. These results are in agreement with the results of a survey done by **Drif** [28] where he showed that the rate of CS was (57.7%) among dead neonates. Similarly **Mona *et al.*** [6] showed that 54.5% of dead neonates were born by CS. In contrast to the present study, **Riyas *et al.*** [19] reported that the mode of delivery without statistically significant association with the neonatal outcome.

The limitations of our study were that not all admitted babies in all NICUs in Tanta city were enrolled in our study. We estimated neonatal mortality in 6 months duration only. Finally we calculated neonatal mortality rate in admitted neonates in NICUs, not neonatal deaths occurred before NICUs admission.

Conclusion the current study concluded that neonatal mortality is important public health problems in developing countries. Neonatal mortality was 27.7%, the main cause of death was prematurity (39.4%). Number of factors appeared to be significantly associated with neonatal mortality like positive consanguinity, lower gestational age, low birth weight and CS.

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