

The Effect of Birth Hour on Neonatal Morbidity and Mortality in Very-Low Birth Weight Infants in a Teaching Hospital

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What is already known on this topic?

- With the increase in preterm birth rates over the past 2 decades, the high mortality and morbidity rates of preterm infants, especially very-low-birth weight (VLBW) neonates, have become one of the major challenges, especially in developing countries.
- Findings on factors affecting mortality and morbidity rates of these newborns, such as timing of birth (working hours and after-hours care), have been mixed.

What this study adds on this topic?

- This study found that the hour of birth did not affect the mortality rate, IVH, or need for prolonged mechanical ventilation in VLBW newborns at our hospital. However, APGAR at the fifth minute was significantly lower in neonates born during after-hours care than in neonates born during working hours, although this did not result in a noticeable difference in the final outcome.

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ABSTRACT

Objective: With the increase in the preterm birth rate, the factors influencing mortality and morbidity in very-low-birth weight neonates have gained importance in recent years. The results of available studies on the influence of birth hour on the mortality and morbidity rates of preterm infants are contradictory. Moreover, no study on this topic has been conducted in our region.

Materials and Methods: This retrospective cohort study was conducted on 127 very-low-birth weight newborns based on birth hour. The newborns were divided into 2 groups, the first born during working hours (7:00 AM to 11:59 PM) and the second born during after-hours care (12-6:59 AM). Mortality and major diseases were compared using Statistical Package for the Social Sciences by Fisher's exact tests, Pearson's chi-squared test, and independent *t*-tests. The statistical significance level for all analyses was set at $P < .05$ and the CI at 95%.

Results: Based on the results of this study in terms of neonatal mortality and major morbidities such as intraventricular hemorrhage and the need for prolonged mechanical ventilation, no significant difference was found between the 2 groups, but the difference in appearance, pulse, grimace, activity, respiration (APGAR) score at the fifth minute was statistically significant and was lower at the working hours.

Conclusion: The results of the study may be due to appropriate allocation of resources, assignment of tasks, and professionalism of care in our study area. Further study is needed to determine the differences in clinical care processes that cause these results.

Keywords: After-hours care, infant, low birth weight, infant mortality, neonatal morbidity

INTRODUCTION

With the increase in the preterm birth rate over the past 2 decades,¹⁻³ the high mortality and morbidity rate of preterm infants, especially very-low-birth weight (VLBW) neonates, has become one of the major challenges, especially in developing countries. In the United States, this mortality rate has been reported to be 15%, while in our country, it is 29.1%.⁴⁻⁷ According to recent studies, infant mortality is directly related to prematurity and low birth weight.⁸

The initial care of these newborns, such as appropriate resuscitation and timely administration of surfactant, which has a great impact on reducing the mortality rate, is influenced by various factors such as the timing of birth. The mental and physical exhaustion of the staff,⁹ the lower number of nurses caring for the newborns during this period,¹⁰ the poorer access to paraclinical facilities could be causes of these deaths.^{11,12} The results of epidemiologic studies toward the end of the 20th century raised concerns about the influence of the timing of birth of VLBW newborns on mortality and morbidity rates.¹³ In subsequent years, despite adjustment for risk

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factors,^{14,15} similarly variable results on mortality rates and serious adverse events such as increased risk of intraventricular hemorrhage (IVH)¹⁶ have been reported. However, recent study results from different countries have not yielded similar results and do not confirm the existence of such differences.^{17,18}

Considering these contradictory results, we attempted to evaluate the correlation between postpartum delivery and mortality rates and morbidities such as IVH, low APGAR score, and the need for mechanical ventilation of VLBW newborns in our hospital to determine the necessary measures to be taken in their management system.

MATERIALS AND METHODS

Design

This retrospective cohort study was conducted between March 2018 and March 2022 at Firoozabadi Teaching Hospital in Tehran-Iran after approval by the Research Ethics Committee of Iran University of Medical Sciences (IR.IUMS. REC.1401.933).

Participants

The clinical cases of all neonates with birth weight less than 1500 g without severe congenital anomalies admitted to our neonatal intensive care unit were divided into 2 groups: the first group born during working hours between 7:00 AM and 11:59 PM, and the second group born during after-hours care between 12:00 AM and 6:59 AM.

During this time, staffing and access to paraclinical facilities are limited.

Infant information was obtained from clinical records (permission to use the information was obtained from the infants' parents) and entered into the data collection checklist.

Neonates in both groups were compared in terms of death before discharge, need for prolonged mechanical ventilation (more than 72 hours), IVH, APGAR score, and other underlying variables, including sex, birth weight, intrauterine growth restriction (IUGR), gestational age, route of delivery, maternal age, nationality, prolonged premature rupture of membranes (PROM), and, finally, underlying maternal diseases.

Statistical Analysis

Statistical analysis was conducted using Statistical Package for the Social Sciences version 20.0 (IBM Corp., Armonk, NY, USA). For normal distributed data, we used independent *t*-test. For categorical variables, Fisher's exact test and Pearson's chi-squared test were used. The level of statistical significance for all of the analysis was set at $P < .05$, and CI was set at 95%.

RESULTS

Of 127 VLBW neonates born in the period of this study in our hospital, 95 neonates were born during working hours and 32 were born during after-hours care, of which 48 and 13 out of them were expired, respectively. So there was not any substantive difference in mortality rates ($P = .33$) (Figure 1).

Demographic Characteristics

Demographic findings of these neonates including maternal age and nationality, sex, birth weight, gestational age, and route of delivery did not show significant statistical difference between 2 groups (Table 1).

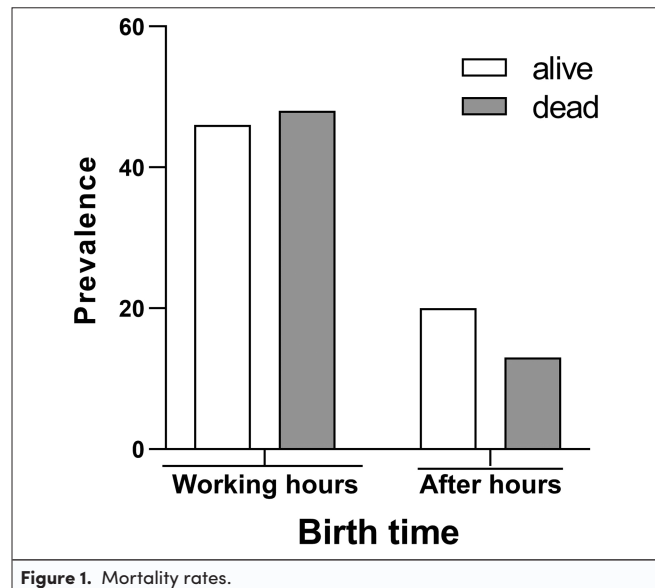


Figure 1. Mortality rates.

Major Neonatal Morbidities

Comparing the fifth minute APGAR score of these neonates, the mean of APGAR score in neonates born in the morning shift was significantly less than neonates born during after-hours care ($P = .04$) (Table 2).

Out of 95 neonates born during working hours, 66 needed prolonged mechanical ventilation which did not have any significant difference compared to neonates born in after-hours care ($P = .34$) (Table 2).

Table 1. Demographic Characteristics

Variables	Working Hours, n = 95 (74.8)	After-Hours Care, n = 32 (25.2)	P
Male*	50 (53)	18 (56)	.72
Weight** (g)	1169 ± 266	1194 ± 230	.31
Mother age** (years)	28.4 ± 6	30.9 ± 5.6	.12
Gestation age** (weeks)	29.2 ± 3.1	29.8 ± 3.9	.69
Cesarean section*	67 (70.5)	22 (68.7)	.84
Native citizen*	39 (41)	13 (40)	.96

Data are presented as mean ± SD or n (%).

*Pearson chi-square test. **Independent *t*-test.

Table 2. Major Neonatal Morbidities

Variables	Working Hours, n = 95 (74.8)	After-Hours Care, n = 32 (25.2)	P
APGAR score, median (IQR)			
1 minutes*	6 (3-6)	7 (5-7)	.05
5 minutes*	8 (5-8)	9 (7-9)	.04
IUGR**	11 (12)	3 (10)	.73
Ventilation applied**	66 (69.5)	25 (78)	.34
PROM >18 hours***	3 (3.2)	3 (9.3)	.16
IVH**	39 (41)	17 (53.1)	.23

IUGR, PROM. Data are presented as mean ± SD or number (%).

IUGR, intrauterine growth restriction; IQR, interquartile range; PROM, premature rupture of membranes.

*Independent *t*-test. **Pearson chi-square test. ***Fisher's exact test

Table 3. Brain Sonography Analysis

		Without IVH	IVH Grade 1	IVH Grade 2	IVH Grade 3	IVH Grade 4	Total
Time	Working hours	56	19	4	7	9	95
	After-hours	15	13	2	0	2	32
Total		71	32	6	7	11	127

IVH, intraventricular hemorrhage.

Table 4. Maternal Diseases Analysis

		Healthy	DM	PIH	Other Diseases	DM+PIH	DM+Other Diseases	PIH+Other Diseases	Total
Time	Working hours	59	1	19	11	3	1	1	95
	After-hours	24	0	4	4	0	0	0	32
Total		83	1	23	15	3	1	1	127

DM, diabetes mellitus; PIH, pregnancy-induced hypertension.

No substantive difference was noticed while assessing the IUGR prevalence rate ($P = .73$) and prolonged PROM between 2 groups ($P = .16$) (Table 2).

Results from brain sonography analysis during the first week of birth revealed 56 cases of IVH with varying degrees (Table 3); however, with no statistical difference between 2 study groups ($P = .23$) (Table 2).

Again, no substantive was difference noticed between 2 groups in terms of maternal diseases [diabetes mellitus (DM), pregnancy-induced hypertension (PIH), etc.] ($P = .93$) (Table 4).

DISCUSSION

In this study, conducted on 127 VLBW newborns over a 4-year period in a teaching hospital in Tehran, Iran, neonatal mortality and morbidity rates were examined both during working hours and after-hours care.

In a study conducted by Paccaud et al¹³ on more than 220 000 newborns in Switzerland, the results of which were published in 1988, the difference between mortality rates during working hours and after-hours care was striking, and this difference was more pronounced in the late evening than in the early morning hours. Although this difference was also evident in the mortality rate of low birth weight neonates (LBW) (less than 2500 g), a separate analysis conducted for VLBW found no significant difference based on the hour of birth, which is also consistent with our current study. However, according to the investigator, interpretation of this result should be made with caution given the small number of study cases.

In another retrospective study conducted in 2005 by Gould et al¹⁴ on more than 3 million newborns based on the hour of birth, neonatal mortality rates were found to be substantially higher in the early hours of the night shift as well as in the last hours of the night compared with births in the morning shift. This difference in VLBW neonates was similar to other neonates, which is not consistent with our study. The fact that other probable causes mentioned in their study, such as maternal age and nationality and, most importantly, different levels of hospitalization, were not considered in our study may justify this difference. To investigate staff fatigue as an important risk factor for neonatal outcomes after birth, the investigators conducted

2 different studies, the first involving the early hours of the night shift (7:00 PM to 1:00 AM) and the second involving the late hours of the night shift (1:00 AM to 7:00 AM), and the unsubstantiated difference between the 2 study groups reduced the possibility of personal fatigue as an important risk factor in neonatal care, which is similar to our results.

Previous studies found conflicting results in APGAR score depending on the hour of birth, whereas in the study by Eze et al,¹⁸ no significant difference was found in APGAR score of newborns born in the morning, night, or weekend. Lee et al¹⁵ related the difference in APGAR score to the severity of the newborn's medical condition and the availability of specialists. In contrast, Abdel-Latif et al¹⁹ attributed this difference to the likelihood of more unplanned births at these times. In our study, the difference in APGAR score at the fifth minute between neonates born during working hours and after-hours care was significant, but the mortality rate and the rate of severe complications such as IVH and the need for prolonged mechanical ventilation did not show significant differences between the 2 groups, which may be due to better care of neonates with unstable underlying conditions in our hospital.

In another study conducted in this area by Lee et al,¹⁵ neonates born under 32 weeks during the night shift had a 60% higher mortality rate compared with a comparison group born during the morning shift. Apart from other factors reducing mortality rates, the presence of fellows and attending neonatologists was responsible for a 40% reduction in mortality rates. Given the 24-hour presence of attending physicians in our hospital, this may explain our study results.

In the 2021 study by Yang et al¹⁷ to investigate the mortality and morbidity of extremely low birth weight (ELBW) newborns born at 23–24 weeks of gestation, hospitals providing care services were divided into 2 groups [mortality rate (MR) > 50% & MR < 50%]. The mortality rate of the first group (MR < 50%) did not show any significant difference depending on the working hours but was significant in the second group (MR > 50%). The concordance of our study with group 1 of these above-mentioned hospitals may be due to the similar conditions in the treatment of our newborns.

In a study conducted by Jensen and Lorch¹⁶ on more than 47 000 VLBW newborns in California and Pennsylvania, researchers

reported higher mortality, IVH, retinopathy of prematurity (ROP), and bronchopulmonary dysplasia (BPD) in newborns during follow-up. In contrast to our study, neonates born during follow-up had lower weight and gestational age, were mostly male, and had a higher prevalence of prolonged PROM and maternal underlying diseases, which may account for the difference in the 2 studies.

In the study conducted by Abdel-Latif et al¹⁹ on 8654 neonates with a gestational age of less than 32 weeks admitted to 10 neonatal intensive care units (NICUs), it was found that despite the fact that 65% of these neonates were admitted to NICUs during after-hours care, the investigators did not observe any difference in mortality and morbidity rates between them and neonates admitted during working hours, which is consistent with our findings.

The relatively small number of cases and the limitation of the study to a single hospital limit the generalizability of the study results, and conducting similar studies in hospitals in our region is necessary to make more appropriate decisions.

CONCLUSION

In this study, we found no difference in mortality and severe morbidity except for the 5-minute APGAR score of VLBW newborns born in our teaching hospital during working hours or after-hours care. This may be due to appropriate distribution of resources, assignment of tasks, and professionalism of care in our study areas. Further research is needed to determine the differences in clinical care processes that lead to these outcomes.

As a take-home message, depending on conditions at individual hospitals, delivery outside of hours does not necessarily mean a worse prognosis for babies.

Ethics Committee Approval: This study was approved by the Research Ethics Committee of Iran University of Medical Sciences (IR.IUMS. REC.1401.9333).

Informed Consent: Only infants whose parents provided written informed consent forms allowing the authors to use the information from their files for research purposes were included in the study. These forms were obtained and present in their clinical records.

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