

## ORIGINAL ARTICLE

## Newborn mortality in 2007 and 2008 in a tertiary-level care center

Luis Alberto Fernández-Carrocerá, Erika Corral-Kassian, Silvia Romero-Maldonado, Enrique Segura-Cervantes, Elsa Moreno-Verduzco, Graciela Hernández-Peláez, Margarita Concepción Ruiz-Huerta, Ema Barla-Muñoz, Armando Serrano-Nada, and Mónica Aguinaga-Ríos

## ABSTRACT

**Background.** Mortality is a sensitive and specific indicator for determining the health status of a country in order to implement improvement strategies. It is the result of biological, social, economic and health factors. We undertook this study to determine general neonatal mortality and its relationship with weight and gestational age at a third-level health institution from 2007 to 2008.

**Methods.** We analyzed all patients >22 weeks of gestational age from the perinatal mortality service. Statistical analysis was done using measures of central tendency and dispersion for quantitative variables and  $\chi^2$ , percentage and frequency for qualitative variables; odds ratios were calculated with significance level  $\leq 0.05$ .

**Results.** The mortality rate for 2007 was 17.7 per 1000 live births, and for 2008 it was 19.7 per 1000 live births. When we compared both years, we did not find an increased risk for weight and gestational age. Malformations occupied the highest causes of death.

**Conclusions.** For years 2007 and 2008, mortality rates were 17.7 and 19.7 per 1000 live births, respectively, and the main cause of deaths was cardiac malformations.

**Key words:** neonatal mortality, mortality rates, risk.

## INTRODUCTION

Neonatal mortality is a sensitive and specific indicator that allows us to determine the health status of a country and to propose strategies for improvement. It results from a complex chain of determinants such as biological, socioeconomic and health factors.<sup>1</sup> During the past decade, advances in ventilation management along with progress of obstetrical management and intensive therapy have enabled a reduction in neonatal mortality. In 1996 the World Health Organization (WHO) estimated that there were ~7.6 million perinatal deaths, of which 4.3 million were late fetal deaths and 3.4 million were in early neonates.<sup>2</sup>

In Mexico, the Instituto Mexicano del Seguro Social (IMSS) reported a mortality rate of 19.6/1000 births from 1974 to 1976, which by 2005 decreased to 14.4/1000 newborns.<sup>3</sup> Statistically significant differences have been reported in studies that relate young maternal age, lower educational level and short interpregnancy period with an increased mortality. However, it is known that the most predictive factors are that relate to the newborn, more than maternal risk factors.<sup>4,5</sup>

According to global reports and also reports from Mexico, the main causes of death in newborns include the following: sepsis (59%), intraventricular hemorrhage (20%) and persistent pulmonary hypertension of the newborn (6%).<sup>6</sup> However, the National Institute of Perinatology (INPer) reported in 2005 that the main causes of death were birth defects in 34% of cases and immature births in 28%.<sup>7</sup>

Likewise, for neonatal mortality, the most important associated risk factor is birth weight <1500 g.<sup>6,8,9</sup> As mentioned, another factor is sepsis; mortality with early-onset sepsis is more common than that of late-onset sepsis.<sup>7,10</sup> Congenital defects are the major diseases as causes of mortality; heart disease is mentioned in first place (51%), neural tube defects (NTDs) (8%) and chromosomal ab-

Subdirección de Neonatología, Instituto Nacional de Perinatología Isidro Espinosa de los Reyes, México D.F., México

*Correspondence:* Dr. Luis Alberto Fernández Carrocera  
Subdirección de Neonatología  
Instituto Nacional de Perinatología Isidro Espinosa de los Reyes  
México, D.F., México  
E-mail: fcarrocera@yahoo.com.mx

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normalities (3%).<sup>11</sup> Some maternal pathologies such as preeclampsia or eclampsia have been associated with neonatal mortality in up to 15% of cases.<sup>12-14</sup> Other less common pathologies such as inborn errors of metabolism have been reported to represent 6% of the cases.<sup>15</sup>

Worldwide, mortality rates may vary from 2.3/1000 births for a city in the U.S. to 22.9/1000 births in Peru and up to 133/1000 of live births in Bangladesh. For Mexico, recent figures from INPer (institution focusing on high-risk pregnancies) report 20/1000 of live births.<sup>5,16-23</sup>

In addition to these figures, there are other factors such as geographic location, race, per capita income or level of health care services. We should also consider what type of patients are included in the database because if we exclude malformations incompatible with life, very low gestational ages, newborns who die during the first hours of life, etc., the rates will have important variations that must be considered when analyzing studies regarding mortality.<sup>1</sup>

The aim of this study was to determine the overall neonatal mortality rate according to weight and gestational age and the causes of death at a Mexican tertiary-care institution during 2007 and 2008.

## PATIENTS AND METHODS

This was an observational, retrospective and analytical study that included all cases of newborns who died in 2007 and 2008. Cases were reviewed by the Committee on Perinatal and Neonatal Mortality (CoMoPer). This committee had the objective of analyzing neonatal deaths that occur at INPer in cases of newborns  $\geq 22$  weeks of gestational age, as well as to identify the cause of death. The committee meets weekly and consists of a president, secretary and committee members. Committee members represent different specialties such as neonatologists, obstetricians, infectious disease specialists, geneticists, and pathologists. We included newborns who died at  $\geq 22$  weeks of gestation (WG). We excluded patients who did not have complete clinical records as well as those cases with an incomplete postmortem study or an absent or incomplete anatomopathological study of placenta.

Variables analyzed were a) demographic information: maternal age in years, marital status, occupation, education, b) perinatal background: number of pregnancies, maternal pathology during pregnancy, premature rupture of amniotic membranes, c) information relating to the

newborn: weight (g), gestational age (WG), Apgar at 1 and 5 min, cause of death [primary disease, according to the International Disease Classification (IDC)].

For the results analysis, we used measures of central tendency and dispersion (for quantitative variables) and frequency, percentage,  $\chi^2$  and significance OR level with  $p < 0.05$  (for qualitative variables). The program for the database format was designed in PHP for web pages. Data analysis was performed with SPSS v.10.0 for Windows.

## RESULTS

Mortality rate for 2007 was 17.7/1000 live births (93/5242) and for 2008 it was 19.7/1000 live births (102/5155). Maternal age ranged from 16 to 30 years for both years of the study. The main occupation of the mothers was homemaker (79 vs. 83%, respectively). The percentage of mothers with professional studies was 1% for 2007 and 7% for 2008. With regard to marital status, cohabitation was predominant (35 vs. 28%, respectively). The first pregnancy (GI) for 2007 ranked first with 46% and between GII and GIII in 2008 with 41%. Gestational age of onset of prenatal care was after 28 WG with no statistically significant differences between 2007 and 2008 ( $\chi^2 = 0.47$ ).

Maternal pathologies were different. The first ones for both years were as follows: urinary tract infections, preeclampsia, cervicovaginitis, diabetes and chronic hypertension. Only cervicovaginitis was statistically significant for the year 2007 ( $\chi^2 = 0.04$ ). In 2007, premature rupture of membranes represented 24% and in 2008 it was 33%. Of the neonatal deaths,  $>85\%$  were unique products for both years. There were no gender-related differences.

Apgar scores at 1 and 5 min demonstrated no statistically significant differences when comparing both years. Mortality rates according to weight are presented in Table 1. The rates for the  $<750$  g,  $<1000$  g,

$<1500$  g offered no differences according to odds ratios (Table 2). Mortality rates according to gestational age are presented in Table 3.

There were also no differences in risk rates for the  $<27$  WG,  $<31$  WG and  $<35$  WG (Table 4).

Malformations occupied the highest percentage of causes of death for both 2007 and 2008 with 33 and 41%, respectively. Cardiac malformations were statistically significant for 2008 ( $p = 0.01$ ). For other conditions, there were no differences (Table 5).

**Table 1.** Mortality rates and odds ratios according to weight ranges (2007-2008)

Weight (g)	NB 2007	2007 n (%)	Rate × 1000 LB	NB 2008	2008 n (%)	Rate × 1000 LB	OR (95% CI)
<499	5	2 (2.1)	400	8	2 (2)	250	2.0 (0.18-22.05)
500-749	26	13 (14)	500	26	16 (15.6)	615	0.62 (0.20-1.88)
750-999	48	7 (7.5)	145	43	11 (10.7)	255	0.49 (0.17-1.42)
1000-1249	87	8 (8.6)	91.9	79	9 (8.8)	113.9	0.78 (0.28-2.15)
1250-1499	93	8 (8.6)	86	94	6 (5.9)	63.8	1.36 (0.45-4.09)
1500-1749	132	8 (8.6)	53	135	7 (6.9)	51.8	1.02 (0.34-3.00)
1750-1999	198	6 (6.4)	30.3	175	13 (12.7)	74.2	0.38 (0.14-1.04)
>2000	4653	41 (45)	8.8	4595	38 (37.2)	8.2	1.06 (0.67-1.64)
Total	5242	93 (100)	17.7	5155	102 (100)	19.7	

n, number of cases; NB, newborns; LB, live births.

**Table 2.** Comparison of mortality rates and odds ratios according to weight (2007 and 2008)

Weight (g)	2007	*Rate 2007	2008	*Rate 2008	OR (95% CI)
<750	15/93 (16%)	483.8	18/102 (17%)	529.4	0.89 (0.42-1.90)
<1000	22/93 (23%)	278.4	29/102 (28%)	376.6	0.77 (0.40-1.48)
<1500	38/93 (40%)	177.6	45/102 (43%)	176.0	0.87 (0.49-1.54)

\*Rate × 1000 newborns. For 2007, total deaths were 93; for 2008 total deaths were 102.

**Table 3.** Mortality rates and odds ratios according to WG (2007-2008)

WG	LB 2007	2007 n (%)	Rate × 1000 LB	NB 2008	2008 n (%)	Rate × 1000 NB	OR (95% CI)
22-24	7	4 (4.3)	571.4	12	3 (2.9)	250	4.0 (0.54-29.1)
25-26	28	11 (11.8)	392.8	28	6 (5.8)	214	2.37 (0.72-7.71)
27-28	58	4 (4.3)	68.9	48	11 (10.7)	229	0.24 (0.07-0.84)
29-30	88	8 (8.6)	90.9	79	12 (11.7)	151.8	0.55 (0.21-1.44)
31-32	146	5 (5.3)	34.2	164	10 (9.8)	60.9	0.54 (0.18-1.63)
33-34	310	10 (10.7)	32.2	253	7 (6.8)	27.6	1.17 (0.43-3.12)
35-36	602	6 (6.4)	9.9	639	12 (11.7)	18.7	2.14 (0.80-5.75)
37-38	2071	16 (17.2)	7.7	2081	11 (10.7)	5.2	0.46 (0.67-3.16)
≥39	1932	4 (4.3)	2.0	1851	7(6.8)	3.8	0.54 (0.15-1.87)
Total	5242	93 (100)	17.7	5155	102 (100)	19.7	

WG, weeks of gestation; NB, newborns; n, number of cases; LB, live births.

**Table 4.** Comparison of mortality rates and odds ratios according to different gestational ages (2007-2008)

WG	2007	*Rate 2007	2008	*Rate 2008	OR (95% CI)
<27	15/35 (8%)	428	9/40 (16%)	225	2.58 (0.95-7.01)
<31	27/181 (29%)	149	32/167 (31%)	191	0.73 (0.42-1.29)
<35	42/637 (45%)	65.9	49/584 (48%)	83.9	0.77 (0.50-1.18)

WG, weeks of gestation.

\*Rate  $\times$  1000 live births.**Table 5.** Causes of death

Causes	2007 n (%)	2008 n (%)	$\chi^2$
Cardiac malformations	3 (3.2)	16 (15.6)	0.01
Multiple malformations	14 (15.0)	15 (14.7)	0.61
Pulmonary hyperplasia	12 (12.9)	11 (10.7)	0.81
Sepsis	8 (8.6)	11 (10.7)	0.45
Shock	4 (4.3)	9 (8.8)	0.12
Extreme immaturity	6 (6.4)	9 (8.8)	0.37
Necrotizing enterocolitis	1 (1.0)	4 (3.9)	0.08
Disseminated intravascular coagulation	0 (0)	4 (3.9)	-
Hydrocephaly	2 (2.1)	4 (3.9)	0.25
Perinatal asphyxia	5 (5.3)	4 (3.9)	0.88
Fetal hydrops	2 (2.1)	3 (2.9)	0.42
Trisomy	2 (2.1)	2 (1.9)	0.68
Fetal-fetal transfusion	2 (2.1)	2 (1.9)	0.68
Respiratory difficulty syndrome	1 (1.1)	1 (0.9)	0.51
Unknown	21 (22.5)	2 (1.9)	<0.001
Others (bronchospiration, inborn errors of metabolism, BPD, ARI)	12 (12.9)	5 (4.9)	0.08
Total	93 (100)	102 (100)	

Of the etiologies grouped together, each one was a single case. n, number of cases; BPD, bronchopulmonary dysplasia; ARI, acute renal insufficiency.

## DISCUSSION

Neonatal mortality rates are sensitive and specific indicators used to determine the health status of the population, for planning healthcare services and for evaluating the quality of the health care system, primarily in assessing the effectiveness of care provided during pregnancy, childbirth and the neonatal period.<sup>16</sup>

It is noteworthy to observe that during the past 20 years, neonatal mortality rates have declined throughout Europe due to improvement in social conditions and in medical care.<sup>16,23</sup> In analyzing the results of this study, we observed a lower rate for the year 2007, although not significant (17.7 vs. 19.7  $\times$  1000 live births). Upon comparing with the rate of Chiapas (one of the Mexican states with the highest marginalized population), the latter turns out to be four times higher (63.5). In Brazil<sup>24</sup> and Peru<sup>5</sup> there have also been reports of higher rates (27 and 23, respectively). In some countries in Asia such as Pakistan and Bangladesh, higher mortality rates<sup>18,22</sup> are found; however, in economically developed countries such as Spain, the rates have dropped considerably to 2.1/1000 live births.<sup>16</sup> Maternal age for both 2007 and 2008 was similar, between 16 and 30 years. This is the most common reproductive age period as observed also by other authors.<sup>4,25,26</sup>

In relation to mother's level of education, this was very low. Only 1% of mothers in 2007 and 6.8% in 2008 managed to complete professional studies and the highest percentage of schooling for both years was secondary school. This factor is a known neonatal mortality risk. As the level of education increases, the risk of neonatal death decreases. In the state of Chiapas, when the mother is illiterate, neonatal mortality risk increases 2.3 times.<sup>4,18,27</sup>

Prenatal visits for both years barely reached 50%. It is known that appropriate and timely prenatal care reduces mortality risk.<sup>4-6,18,25,27</sup> Maternal pathologies associated with neonatal death are preeclampsia, infections (chorioamnionitis, urinary tract infection, cervicovaginitis) and chronic hypertension, which in most cases causes prematurity with a high probability of death at a lower gestational age and weight.<sup>6,12-14,24</sup>

In relation to neonatal variables, some articles documented low Apgar scores, especially at 5 min, as an increased mortality risk; nevertheless, this was not a significant factor in either of the 2 years of our study.<sup>5,8,26</sup>

The organic status of the newborn, such as prematurity, influences mortality as well as weight and gestational age. In the study, despite the fact that some differences existed, although not significant, in the rates according to weight and gestational age, it is noteworthy that factors such as <750 g birth weight and gestational ages  $\leq 28$  WG are those that had the highest impact on mortality compared with higher birth weights and older gestational ages. These indicators are frequently referred to in various publications.<sup>6-9,17,24,27,28</sup>

It is pertinent to highlight that the leading causes of death found were major malformations incompatible with life for both years of the study; these elevated figures are possibly because the center where the study took place is a reference center for high-risk maternal and neonatal care. Spain refers to a percentage close to 30%;<sup>28</sup> however, other countries such as Brazil report 3.3%<sup>29</sup> and Pakistan reports 4%.<sup>18</sup> These are outrageously low numbers, possibly due to significant underreporting. Malformations are followed by infections, asphyxia and respiratory distress syndrome, mixed shock and extreme immaturity, among others, which are constantly referred to in various articles.<sup>6,10,16,30</sup>

The strengths of this study are in accordance with a weekly institutional perinatal and neonatal standards and procedures committee composed of a variety of specialists. Regarding the weaknesses, we can mention the lag in the analysis of the cases (up to 1 year) mainly due to the delay of anatomopathological analysis.

In conclusion, the most important factors affecting neonatal mortality are birth weight and gestational age. It should be recommended not to disregard known risk factors such as socioeconomic status, maternal educational level, prenatal care, diseases of pregnancy and, above all, to improve reinforcing healthcare services and continuing with neonatal resuscitation programs.

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