

# Providers' compliance with practice guidelines of prenatal and neonatal care to reduce neonatal mortality: 2004 versus 2012

## *Adesão dos profissionais de saúde a práticas pré-e neonatais de redução da mortalidade neonatal: 2004 versus 2012*

Renata Jaccottet Freitas<sup>I</sup>, Tiago Neuenfeld Munhoz<sup>I</sup>, Iná da Silva dos Santos<sup>I</sup>, Flávio Sérgio Chiuchetta<sup>I</sup>, Fernando Barros<sup>II</sup>, Aline Coletto<sup>III</sup>, Alicia Matijasevich<sup>IV</sup>

**ABSTRACT:** *Objective:* To evaluate providers' compliance with practice guidelines of prenatal and neonatal care in order to reduce neonatal mortality. *Methods:* Uncontrolled before-and-after study designed to evaluate changes that occurred between 2004 and 2012, after the interventions proposed by the Municipality Committee of Research on Child Deaths, Foetal and Maternal Death (COMAI) on the frequency of the process indicators for perinatal assistance improvement. A total of 254 patients were studied in 2004 and 259 patients in 2012. *Results:* During the study period, there was an increase of 65% in the use of prenatal corticosteroids among pregnant women in preterm labor with gestational age of  $\leq 34$  weeks (rate of use of 38.0 and 62.8% in 2004 and 2012, respectively;  $p < 0.001$ ), 35% of increase in the use of surfactant among newborns with  $\leq 34$  weeks of gestational age (41.3 and 55.6% in 2004 and 2012, respectively;  $p = 0.025$ ) and a reduction of 16% in the prevalence of hypothermia (70.8 and 59.4% in 2004 and 2012, respectively;  $p = 0.009$ ) at the neonatal intensive care unit admission. *Conclusions:* Prenatal and neonatal care practices improved between 2004 and 2012. At the end of the study period, rates of use of antenatal steroids and surfactant were lower than figures reported internationally. Similarly, the frequency of hypothermia at the neonatal intensive care unit admission was higher than the occurrence observed in developed countries.

**Keywords:** Adrenal cortex hormones. Epidemiology. Infant, newborn. Infant, premature. Cardiopulmonary resuscitation. Infant mortality.

<sup>I</sup>Postgraduate Program in Epidemiology, *Universidade Federal de Pelotas* – Pelotas (RS), Brazil.

<sup>II</sup>Postgraduate Program in Health and Behavior, *Universidade Católica de Pelotas* – Pelotas (RS), Brazil.

<sup>III</sup>School of Medicine, *Universidade Católica de Pelotas* – Pelotas (RS), Brazil.

<sup>IV</sup>Department of Preventive Medicine, School of Medicine, *Universidade de São Paulo* – São Paulo (SP), Brazil.

**Corresponding author:** Tiago Neuenfeld Munhoz. Programa de Pós-graduação em Epidemiologia, Universidade Federal de Pelotas, CEP: 96020-220, Pelotas, RS, Brasil. E-mail: tyagomunhoz@hotmail.com

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**RESUMO:** *Objetivo:* Avaliar a adesão dos profissionais de saúde a práticas de assistência pré-natal e neonatal para reduzir a mortalidade neonatal. *Métodos:* Estudo não controlado, do tipo antes-e-depois, que avaliou a mudança ocorrida entre os anos 2004 e 2012, após as intervenções propostas pelo Comitê Municipal de Investigação de Óbitos Infantis, Fetais e de Morte Materna (COMAI) na cidade de Pelotas, Rio Grande do Sul, na frequência de indicadores de processo de melhoria na assistência perinatal. Foram estudados 254 pacientes no ano de 2004 e 259 no ano de 2012. *Resultados:* Foi observado aumento de 65% na frequência do uso de corticoide pré-natal entre gestantes em trabalho de parto prematuro com idade gestacional  $\leq 34$  semanas (frequência de uso de 38,0 e 62,8% em 2004 e 2012, respectivamente;  $p < 0,001$ ) e de 35% no uso de surfactante entre recém-nascidos  $\leq 34$  semanas de idade gestacional (41,3 e 55,6% em 2004 e 2012, respectivamente;  $p = 0,025$ ), assim como uma redução de 16% na presença de hipotermia (70,8 e 59,4% em 2004 e 2012, respectivamente;  $p = 0,009$ ) na admissão à unidade de terapia intensiva neonatal. *Conclusão:* Houve melhora em algumas das práticas de assistência pré-natal e neonatal. Ao final do período estudado, as frequências de uso de corticoide pré-natal e de surfactante foram menores do que as relatadas internacionalmente. No mesmo sentido, a frequência de hipotermia na admissão à unidade de terapia intensiva neonatal foi maior do que a observada em países desenvolvidos.

*Palavras-chave:* Corticosteroides. Epidemiologia. Recém-nascido. Prematuro. Ressuscitação cardiopulmonar. Mortalidade infantil.

## INTRODUCTION

The fourth objective of the Millennium Development Goals is to reduce mortality of children aged under 5 years by two-thirds by 2015, compared to the levels of 1990. In Brazil, there has been a marked reduction in mortality in children aged under 5 years in the last three decades, with a reduction of 77% of deaths in this age group, overcoming the fourth goal of the millennium three years before the deadline<sup>1</sup>.

In middle and high income countries, most deaths occur in the neonatal period, and of those, more than half in the early neonatal period. The main causes of neonatal deaths are premature birth, birth asphyxia, respiratory problems, and infections<sup>2,3</sup>. The effective resuscitation of the newborn in the delivery room is one of the neonatal care practices that contributed to reduce deaths caused by suffocation<sup>4</sup>. A set of techniques — some as simple as maintaining body temperature of the newborn, and others more complex and requiring appropriate instruments, such as intubation — are part of the measures included in the newborn resuscitation process, which should be initiated in succession and following well-established guidelines<sup>5</sup>.

Two other practices that contribute to the increased survival of newborns, especially premature infants, are the use of prenatal corticosteroids and the administration of surfactant. Respiratory distress syndrome (RDS) secondary to surfactant deficiency is a common complication of prematurity and a major cause of early mortality and sequelae in the medium and long term<sup>6,7</sup>.

After careful evaluation of the child deaths in the 2004 birth cohort of Pelotas<sup>8</sup>, que which signaled stagnation of the infant mortality rate in relation to births in 1993 in that city<sup>9</sup>, the Municipality Committee of Research on Child Deaths, Foetal and Maternal Death

(COMAI) identified several problems in the care of pregnant women and newborn children, the most important being: low use of prenatal corticosteroids in pregnant women with preterm labor; low use of surfactant in the care of infants with gestational age of  $\leq 34$  weeks; and high frequency of hypothermia in newborns admitted to intensive care units (ICUs). As a result of this assessment, some recommendations were introduced in the period between 2005 and 2012 to improve care practices for pregnant women and newborns in order to reduce infant mortality in the city.

This study aimed to assess the adherence of health professionals to the recommendations proposed by COMAI by comparing the results of four indicators between 2004 and 2012, before and after, respectively, the implementation of a set of interventions promoted by COMAI in the city of Pelotas, Rio Grande do Sul.

## METHODS

### CHARACTERISTICS OF THE CITY WHERE RESEARCH WAS CARRIED OUT AND STUDY DESIGN

The city of Pelotas is located in southern Brazil. It is a medium-sized city with 329,173 inhabitants and 205 inhabitants per km<sup>2</sup>, according to the Brazilian 2010 Demographic Census. Its population is predominantly urban (93.3%) and over 99% of births occur in any of the five city hospitals.

An uncontrolled before-and-after study was conducted, which evaluated the change occurred between 2004 and 2012 (before and after, respectively, implementation of the interventions proposed by COMAI), according to the frequency of the following process indicators<sup>10</sup>: use of prenatal corticosteroids, use of surfactant in premature newborns, presence of a pediatrician in the delivery room, and frequency of hypothermia in newborns on arrival to the ICU. Inclusion criteria for patients in each period were live birth in a city hospital and being admitted to the ICU at birth (Teaching Hospital of Universidade Federal de Pelotas and University Hospital São Francisco de Paula of Universidade Católica de Pelotas). Infants with any gestational age were included, and those with congenital malformations were excluded.

To study the indicators in 2004, the 2004 birth cohort data from Pelotas were used<sup>11</sup>. This study identified 4,231 live births in the city of Pelotas in the period from January 1 to December 31, 2004 (< 1% loss). Of these, 254 (82 newborns with gestational age  $\leq 34$  weeks) were admitted to the neonatal ICU at birth and were included in this study.

To study the indicators in 2012, all infants born to mothers from the city of Pelotas, that had to be hospitalized at birth in both neonatal intensive care units (NICUs) of the city mentioned above, between January 1 and December 31, 2012 ( $n = 275$ ) were identified. Of these, 259 newborns were selected with complete records (117 infants with gestational age of  $\leq 34$  weeks).

In 2004 and 2012, hospital records of admissions were evaluated, and the information was collected through a standardized instrument.

## OUTCOMES

The outcome variables were frequency of prenatal corticosteroid administration to pregnant women in preterm labor with gestational age of  $\leq 34$  weeks (at least 1 dose); surfactant use (defined as the administration of at least 1 dose of surfactant to newborns with gestational age of  $\leq 34$  weeks); presence of hypothermia (defined as axillary temperature  $< 36^{\circ}\text{C}$  on admission to the NICU) and the presence of a pediatrician in the delivery room (defined as care by a pediatrician to newborn at the time of birth).

Secondary outcomes considered were number of corticosteroid doses, number of surfactant doses, age at first surfactant dose, and axillary temperature on arrival in the NICU.

## INTERVENTION

The most important intervention measures agreed between COMAI and the professionals of the care network included:

1. inspections carried out by the Pediatrics Society of Rio Grande do Sul in both of the city's NICUs in 2005. The presence and quantity of equipment and human resources were verified. The care routines of and the availability of diagnostic services were also evaluated, according to Decree No. 11 of January 5, 2005, "Common requirements for the qualification of the Neonatal and Pediatric Intensive Care Unit"<sup>12</sup>;
2. neonatal resuscitation courses were carried out, according to the norms of the Brazilian Pediatrics Society, in the University Hospitals for all pediatricians who performed in the delivery room, including pediatric residents; and
3. measures were introduced to prevent hypothermia in newborns at admission in neonatal ICU, including encouraging the use of transport incubators in hospitals and in the Mobile Emergency Service (SAMU) for transportation between hospitals, as well as heating the delivery room at  $26^{\circ}\text{C}$  and the use of plastic bags for wrapping preterm infants.

## OTHER VARIABLES

Maternal variables were education; skin color; maternal age; number of prenatal consultations; smoking during pregnancy, defined as the consumption of at least one cigarette per day in any trimester of pregnancy; type of delivery; and hospital of birth.

Newborn variables were sex, birth weight, gestational age assessed by the date of last menstrual period, and Apgar at the first and fifth minutes of life.

## STATISTICAL ANALYSIS

Initially, descriptive analyses of the variables of interest were performed for each year studied, 2004 and 2012. Descriptive analysis included frequency distributions calculated for dichotomous outcomes and measures of central tendency and dispersion for continuous outcomes. For the outcomes related to the administration of corticosteroids and surfactant, only information for infants with gestational age of  $\leq 34$  weeks was analyzed. Statistical tests were based on the  $\chi^2$  test. For continuous outcomes, Student's *t* test was used. All analyses were performed using the statistical software Stata® version 12.1.

## ETHICAL ASPECTS

The study protocol was approved by the Research and Ethics Committee of the School of Medicine of Universidade Federal de Pelotas, the University Hospital São Francisco de Paula (Universidade Católica de Pelotas) and the Teaching Hospital of Universidade Federal de Pelotas.

## RESULTS

After inspections were conducted in the two NICUs in the city of Pelotas in 2005, the late use of surfactant was found (it was administered after six hours of life in most cases), as well as the lack of, in one neonatal ICU, a routine doctor (neonatologist who is in the hospital daily and defines the techniques and behaviors). These issues were discussed in COMAI and communicated to the respective units. The two coordinators of the neonatal ICU of the city were COMAI participants, which enabled all COMAI recommendations to be transmitted to the respective services.

Table 1 shows the characteristics of mothers and newborns hospitalized in NICU after birth, in 2004 and 2012. The infants who were hospitalized in 2012 were children of mothers with higher education, who went to less prenatal consultations, more frequently delivered by cesarean section, with lower gestational age and lower Apgar in the first minute of life than those who were hospitalized in 2004.

Table 2 shows the frequency of the outcomes studied in neonates who were hospitalized in neonatal intensive care after birth, in 2004 and 2012. The proportion of pregnant women who received prenatal corticosteroids, as well as the frequency of administration of surfactant to newborns, were higher in 2012 compared to 2004. The average age (in hours) of administration of the first dose of surfactant decreased between 2004 and 2012. In 2004, 15% of infants received surfactant in the first hour of life; in 2012, this proportion was of 85% (data not shown in Table 2). The proportion of newborns

with hypothermia on arrival at the neonatal ICU decreased during the study period. Of the newborn group with weight between 501 and 1,500 g, 65% and 50 were hospitalized with axillary temperature below 36°C in 2004 and 2012, respectively (data not shown in Table 2).

Table 1. Characteristics of mothers and newborns hospitalized in a neonatal intensive care unit after birth, 2004 and 2012, Pelotas, Rio Grande do Sul.

Variables	2004	2012	p-value <sup>a</sup>
	n (%)	n (%)	
<b>Maternal variables</b>			
Maternal education (years)			
0 to 4	47 (19.0)	12 (5.9)	< 0.001
5 to 8	121 (48.8)	91 (44.8)	
≥ 9	80 (32.3)	100 (49.3)	
White skin color	178/254 (70.1)	166/222 (74.8)	0.254
Maternal age (years)			
< 20	61 (24.0)	40 (17.8)	0.245
20 to 34	151 (59.5)	146 (64.9)	
≥ 35	42 (16.5)	39 (17.3)	
Number of prenatal consultations			
0	10 (4.2)	15 (6.7)	< 0.001
1 to 3	40 (16.7)	42 (18.8)	
4 to 8	124 (51.7)	141 (62.9)	
≥ 9	66 (27.5)	26 (11.6)	
Smoking during pregnancy	175/254 (68.9)	152/213 (71.4)	0.563
Cesarean delivery	152/254 (59.8)	162/230 (70.4)	0.015
<b>Newborn variables</b>			
Hospital of birth			
Beneficência Portuguesa	6 (2.4)	1 (0.4)	0,075
Santa Casa	21 (8.3)	17 (7.2)	
Hospital de Clínicas	140 (55.1)	114 (48.3)	
Teaching Hospital, Universidade Federal de Pelotas	78 (30.7)	96 (40.7)	
Piltcher	5 (2.0)	7 (3.0)	
Homebirth	4 (1.6)	1 (0.4)	

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Tabela 1. Continuation

Variables	2004	2012	p-value <sup>a</sup>
	n (%)	n (%)	
Male sex	146/254 (57.5)	135/225 (60.0)	0.576
Low weight at birth	158/251 (62.9)	165/239 (69.0)	0.155
Gestational age in weeks			
< 28	21 (8.6)	22 (9.3)	< 0.001
28 to 33	61 (25.1)	95 (40.1)	
34 to 36	79 (32.5)	68 (28.7)	
37 to 41	72 (29.6)	52 (21.9)	
42 or more	10 (4.1)	–	
Apgar < 7 at the first minute of life	114/246 (46.3)	140/238 (58.8)	0.006
Apgar < 7 at the fifth minute of life	190/246 (77.2)	192/237 (81.0)	0.308

<sup>a</sup> $\chi^2$  test.

Table 2. Frequency of the indicators studied in the newborn that hospitalized in neonatal intensive care unit after birth, 2004 and 2012, Pelotas, Rio Grande do Sul.

Variables	2004	2012	p-value <sup>a</sup>
	n (%)	n (%)	
Antenatal corticosteroids administration <sup>b</sup>	41/108 (38.0)	86/137 (62.8)	< 0.001
Number of antenatal corticosteroid doses <sup>b</sup>			
1	6 (24.0)	16 (19.1)	0.753
2	19 (76.0)	67 (79.8)	
3	0 (0)	1 (1.2)	
Surfactant administration <sup>b</sup>	45/109 (41.3)	80/144 (55.6)	0.025
Number of surfactant doses <sup>b</sup>			
1	33 (76.7)	63 (88.7)	0.089
2	10 (23.3)	8 (11.3)	
Age (hours) at first dose of surfactant (mean, SD)	2.7 (2.2)	1.3 (0.9)	0.001 <sup>c</sup>
Hypothermia on admission to NICU	167/236 (70.8)	142/239 (59.4)	0.009
Axillary temperature on admission to the NICU (mean, SD)	36.0 (0.7)	36.1 (0.8)	0.017 <sup>c</sup>
Presence of pediatrician in the delivery room	236/253 (93.3)	226/233 (97.0)	0.083

<sup>a</sup> $\chi^2$  test; <sup>b</sup> analysis conducted only in infants with gestational age  $\leq$  34 weeks; <sup>c</sup> Student's; SD: standard deviation; NICU: neonatal intensive care units.

## DISCUSSION

Improvements were observed in prenatal and neonatal care practices between the years of 2004 and 2012 in the city of Pelotas, Rio Grande do Sul. The use of corticosteroids administered to pregnant women at risk of preterm delivery increased by 65%. The use of pulmonary surfactant administered to premature newborns with RDS increased by 35% in the period, in addition to the evidence of earlier use in 2012. The frequency of infants with hypothermia on admission to NICU was reduced by about 20%, with a slight increase in the average temperature at admittance to the unit. No differences were observed for the presence of a pediatrician in the delivery room, which was already high in 2004 (93.7%), and the number of corticosteroids and surfactant doses administered.

An increase was observed in preterm newborns admitted in neonatal ICUs in the city (66.2 and 78.1% in 2004 and 2012, respectively). The prematurity estimates in Brazil in the period 2000 to 2011 were fairly stable, with a slight upward trend, which does not explain the increase observed in the study<sup>13</sup>. On the other hand, there was also an increase in the frequency of less than three prenatal visits among mothers of children hospitalized in NICU in the city for the period. Several authors have shown that neonatal mortality, the prevalence of low birth weight, and prematurity are related to inadequate care for pregnant women<sup>14</sup>.

The use of prenatal corticosteroids induces lung maturity and decreases the frequency of necrotizing enterocolitis and intraventricular hemorrhage, contributing to reduce neonatal mortality and sequelae in newborns<sup>6</sup>. Studies by the Vermont Oxford Network in newborns with weight at birth between 501 and 1,500 g reported increased frequency of use of prenatal corticosteroids from 24% in 1991<sup>15</sup> to 76% in 2008<sup>16,17</sup>. In this study, a considerable increase was observed in the frequency of use of prenatal corticosteroids in infants in this weight range, although without reaching the values given in international studies (45 and 67% in 2004 and 2012, respectively; data not shown). In Brazil, a study conducted by the Brazilian Neonatal Research Network, with data from hospital admissions from June 2004 to May 2005, found the use of prenatal corticosteroids in 54% of infants with gestational age of 26–34 weeks<sup>18</sup>. The results of this study show that although there was a significant increase in the prenatal use of corticosteroids, this proportion is even lower than that observed mainly in international studies. This simple practice is safe, effective, inexpensive, and has the proven capability to reduce neonatal mortality, and should be used universally among pregnant women at risk of preterm birth and gestational age of  $\leq 34$  weeks.

Scientific evidence of the beneficial effects of reported that surfactant administration in the first two hours of life reduced the risk of bronchopulmonary dysplasia (BPD) or death at 28 days. Clinical trials conducted recently showed that infants who used positive end-expiratory pressure (early PEEP) also showed a reduced risk of BPD and of mortality at 28 days<sup>20</sup>. Horbar et al.<sup>21</sup> reported that 77% of infants weighing between 401 and 1,500 g and with gestational age between 23 and 29 weeks received surfactant in 1998, increasing this use to 80% in 2000. The authors also reported a decrease in mean age at the time of administration of the first dose of surfactant, which went from 60 to 42 minutes during the study



period<sup>21</sup>. In this study, the use of surfactant in this gestational age range for the year 2004 was 72%. In Brazil, a study by Almeida et al.<sup>18</sup> between June 2004 and May 2005, with data from the Brazilian Neonatal Research Network, reported that 62% of infants with gestational age between 23 and 33 weeks received surfactant. In this study, the frequency of use of surfactant in 2004 was 52%.

Currently, it is questionable whether the use of surfactant is better than less invasive alveolar recruitment techniques established at an early stage to reduce neonatal mortality and BPD. Clinical trials conducted more recently have shown that infants with gestational age between 25 and 28 weeks who used positive end-expiratory pressure (PEEP) early had lower frequency of intubation, fewer mechanical ventilation days, as well as reduced use of oxygen and decrease in mortality at 28 days compared with those who received treatment with surfactant<sup>22</sup>. These results are important, especially if we consider the material and technical resources that are required to perform intubation and maintain mechanical ventilation. Intubation at birth is not a simple procedure and should be avoided where possible, as the clinical deterioration of newborns is frequent after several ineffective attempts<sup>23</sup>.

Maintaining the temperature of newborns between 36.5 and 37.4°C, especially in premature infants, is a practice that should be applied at birth<sup>24</sup>. Several studies have found that procedures such as maintaining the delivery room temperature at a minimum of 26°C, drying the newborn, removing wet fields, wrapping the newborn in a pre-heated blanket and using radiant warmers or incubators for transportation to the NICU were effective to maintain the newborn's temperature higher and hence decrease the frequency of hypothermia<sup>24,25</sup>. A study conducted by the Vermont Oxford Network reported that 28% of infants weighing 501–1,500 g were hospitalized with a body temperature below 36°C<sup>16</sup>. In this study, 65.3 and 50.0% of infants in this weight range were hospitalized with axillary temperature below 36°C, respectively, in 2004 and 2012. A study by Ventura et al.<sup>26</sup> found hypothermia in 66% of newborns admitted to the NICU. In this study, the frequency of hypothermia was 71% in 2004 and 59% in 2012. As shown, simple procedures to prevent hypothermia can contribute to improving infant mortality rates in NICUs.

Evidence shows that newborn care in the delivery room by trained health professionals can reduce neonatal mortality between 20 and 30%. When resuscitation techniques are performed, an additional reduction between 5 and 20% can be achieved — a decrease by 45% in deaths from neonatal asphyxia<sup>27</sup>. The need for resuscitation of the newborn at birth increases with gestational age and lower birth weight<sup>17,18</sup>. In the delivery room, it is essential that a professional trained to resuscitate the newborn when necessary is present, and that they remain present throughout the entire duration of care<sup>28</sup>. In this study, it was shown that since 2004, nearly all newborns had the presence of a pediatrician in the delivery room.

In short, improvements were observed in prenatal and neonatal care practices in the city during the study period. However, it cannot be said that these differences are directly or exclusively a result of recommendations made by COMAI. The design of the study does not rule out that the observed improvements in the care of newborns and pregnant women are due to secular trends in pre- and neonatal care practices. It is known, however,

the period did not see the incorporation of new technologies and/or protocols that could be responsible for improving the quality of maternal and child care in the county. Another limitation of the study refers to the impossibility of knowing the actual number of women who should have received corticosteroids or the number of newborns who had the need to receive surfactant. Although the use of these practices has increased in the period, it is possible that mothers and babies in need of care have not received them. The main strengths of this study are the low data loss and the introduction of a set of measures to improve the care which involved internationally recognized validity procedures.

## CONCLUSION

The results of this study provide evidence of improvements in prenatal and neonatal care practices between 2004 and 2012. However, the frequency of use of prenatal corticosteroids and surfactant administration are still less than optimal. Similarly, the frequency of hypothermia in newborns at admission to the NICU is still high. These results indicate the importance of regular and systematic assessment of the result of interventions with proven effectiveness. Despite advances in perinatal care, there is still a long way to go in the search for quality in prenatal and neonatal care.

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