Midwifery 26 (2010) e37–e43

Contents lists available at ScienceDirect

Midwifery

journal homepage: www.elsevier.com/midw

Risk factors for neonatal transfers from the Sapopemba free-standing birth centre to a hospital in São Paulo, Brazil

Márcia Duarte Koiffman, MSc, CNM (Independent nurse-midwife), Camilla Alexsandra Schneck, MSc, CNM (PhD student), Maria Luiza Gonzalez Riesco, PhD, CNM (Professor), Isabel Cristina Bonadio, PhD, CNM (Professor)*

Escola de Enfermagem da Universidade de São Paulo, Departamento de Enfermagem Materno-Infantil e Psiquiátrica, 05403-000 Cerqueira César, São Paulo, SP, Brazil

ARTICLE INFO

Article history:
Received 7 November 2007
Received in revised form
13 January 2009
Accepted 14 February 2009

Keywords:
Birthing centres
Risk factors
Neonatal mortality
Case–control studies

ABSTRACT

Objective: to identify risk factors associated with neonatal transfers from a free-standing birth centre to a hospital.
Design: epidemiological case–control study.
Setting: midwifery-led free-standing birth centre in São Paulo, Brazil.
Participants: 96 newborns were selected from 2840 births between September 1998 and August 2005. Cases were defined as all newborns transferred from the birth centre to a hospital ($n = 32$), and controls were defined as newborns delivered at the same birth centre, during the same time period, and who had not been transferred to a hospital ($n = 64$).
Measurements and findings: data were collected from medical records available at the birth centre. Univariate and multivariate analyses were performed using logistic regression. The multivariate analysis included outcomes with $p < 0.25$, specifically: smoking during pregnancy, prenatal care appointments, labour complications, weight in relation to gestational age, and one-minute Apgar score. Of the foregoing outcomes, those that remained in the full regression model as a risk factor associated with neonatal transfer were: smoking during pregnancy [$p = 0.009$, odds ratio (OR) = 4.1, 95% confidence interval (CI) 1.03–16.33], labour complications ($p < 0.001$, OR = 5.5, 95% CI 1.06–28.26) and one-minute Apgar score $\leqslant 7$ ($p < 0.001$, OR = 7.8, 95% CI 1.62–37.03).
Key conclusions and implications for practice: smoking during pregnancy, labour complications and one-minute Apgar score $\leqslant 7$ were confirmed as risk factors for neonatal transfer from the birth centre to a hospital. The identified risk factors can help to improve institutional protocols and formulate hypotheses for other studies.

Introduction

Evaluations of health care in general, and of perinatal health in particular, demonstrate alarming results, particularly given the predominance of practices not based on scientific evidence of effectiveness or safety. This situation is even more serious in Latin-American countries, where a significant proportion of practices provided during pregnancy, childbirth and postnatal care are scientifically considered to be either ineffective or harmful (Bastos et al., 2007).

In Brazil, the care provided during birth in hospitals includes many practices not founded on scientific evidence, such as augmentation of labour, the performance of episiotomies, the absence of birth companions, and caesarean section rates that run as high as 93% in private hospitals and 33% in public Unified Health System (SUS) hospitals (Fonseca et al., 2008).

Efforts have been made to improve the quality of the birthing process, including better development of maternal and perinatal health outcomes, and the promotion of overall care for mothers and their families. One such movement to transform birth care in Brazil and other countries consists of performing births in a birth centre rather than a hospital.

In 1998, as part of the policy to improve the quality of maternal and perinatal care, the Brazilian Health Ministry founded regular birth centres (CPNs) as part of the SUS. The CPNs, which provide assistance during labour, can operate alongside hospitals or as free-standing models located within a one-hour drive from a reference hospital. The CPNs use a natural model that promotes physiological childbirth, and a given CPN's staff are co-ordinated by a nurse–midwife (Brasil Ministério da Saúde, 1999; Schneck and Riesco, 2006).

According to Stewart et al. (2005), a birth centre 'is an institution that offers care to women with a straightforward

* Corresponding author.
E-mail address: ibonadio@usp.br (I.C. Bonadio).

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doi:10.1016/j.midw.2009.02.004

pregnancy and where midwives take primary professional responsibility for care. During labour and birth, medical services, including obstetric, neonatal and anaesthetic care, are available should they be needed, but they may be at a separate site, or in a separate building, which may involve transfer by car or ambulance'.

In several countries, birth centres offer strategies to spare pregnant women from unnecessary intervention, with notable positive consequences for patients' health and their capacity to look after their newborns.

The care offered in birth centres attended by nurse–midwives remains a controversial issue in several cultures and countries, especially in Brazil. Most of the criticism is related to free-standing birth centres, i.e. the birth centres located within a one-hour drive from a reference hospital.

A Cochrane review addressing care offered by birth centres operating alongside hospitals, which analysed results from 8677 women in six studies, found lower intervention rates and higher patient satisfaction for birth centres compared with hospitals. There was no significant difference in neonatal mortality between the birth centres and hospitals (Hodnett et al., 2008).

Although there are few randomised controlled trials focusing on place of birth, pregnant women at low risk should not be discouraged from going to birth centres provided that the centres offer adequate assistance and the means for hospital transfer if required (Enkin et al., 2000).

A descriptive study carried out in the UK to evaluate the safety of a free-standing birth centre analysed 5468 patient records between 1995 and 2001. It showed an emergency caesarean section rate of 6%, and there were no maternal deaths or serious postpartum complications. The perinatal mortality rate was 4.2/1000 births. The authors concluded that the service offered by a free-standing birth centre is safe for pregnant women at low risk for complications or need for intervention, and that this model should be taken as an example to implement throughout the country (Reddy et al., 2004).

A retrospective cohort study that compared 3256 births at a birth centre operating alongside a hospital with 1,26,818 hospital births in Sweden between 1989 and 2000 showed that there was no significant difference in the general rates of perinatal mortality. However, it confirmed the results of a previous study held in the same place, which demonstrated a higher mortality rate among newborns of primiparous women compared with multiparous women. The authors emphasised the need for more studies concerning childbirth safety in birth centres in different contexts, and for the establishment of assistance protocols (Gottvall et al., 2004).

In many countries, birth centre experiences tend to be favourable with respect to maternal and perinatal outcomes, patient satisfaction, and low frequency of obstetric interventions (Rooks et al., 1989; Waldenström et al., 1997; David et al., 1999; Jackson et al., 2003; Hodnett et al., 2008). A systematic review conducted by Walsh and Downe (2004) did not find any randomised controlled trials comparing the care offered in free-standing midwifery-led birth centres with care offered in hospitals. The authors suggested that a series of well-designed studies should be performed to analyse the results regarding the care offered to low-risk pregnant women at birth centres and hospitals.

In Brazil, because of the international and national movement to change the traditional model of childbirth care, the first SUS-integrated birth centre – the Sapopemba Birth Centre (SBC) – was inaugurated in 1998.

In Brazil, few studies have been conducted to analyse the care provided at birth centres. Therefore, it is necessary to develop research that provides local evidence on the safety of childbirth and care provided in free-standing birth centres and those operating alongside hospitals. Maternal and neonatal transfers from free-standing birth centres to reference hospitals are important indicators of the quality of care offered in the delivery and birth care model (Fullerton et al., 1997; David et al., 2006). To study risk factors for neonatal transfers at the SBC, it would be useful to identify situations in which neonatal morbidity and mortality can be avoided. Such situations are indirect measures of the safety of the birth care model and include consideration of the location of the birth centre, the ability of the staff to manage complications, and the birth centre's interaction with reference hospitals for transfers.

Several studies regarding pregnancy and neonatal mortality have identified the following risk factors: age, parity, smoking, maternal education level, prematurity, low birth weight, care during pregnancy, labour, neonate's first days of life, and organisation of the assistance system (Winbo et al., 2001; Lansky et al., 2002; Mendes et al., 2006). However, the importance of the above factors may vary among pregnant women at low risk who give birth in a hospital or in another setting.

The results of the research may indicate important aspects for improvement of the birth care model in a free-standing birth centre in Brazil, supporting the drafting and design of protocols. They may also contribute to the consolidation of this care model within the SUS and its introduction to the private health system in Brazil.

The aim of this study was to identify risk factors associated with neonatal transfers at the SBC.

Methods

Design

This was an epidemiological case–control study. The design was appropriate for the study of rare events of low prevalence, such as neonatal transfers at the SBC. Between 1998 and 2005, 1.1% of the newborns were transferred to reference hospitals. This study was approved by the local ethics committee.

Setting

The SBC is a midwifery-led free-standing birth centre located in an urban area in the city of São Paulo. This service is available for pregnant women with a low risk of complications, as recommended by local primary care health units, which serve as non-emergency patients' first point of access to the Brazilian SUS. The SBC also accepts residents from other areas of the city who are attracted by the care model offered. Women who comply with the criteria established by the SBC's and Government's protocols are booked during or following the 37th week of pregnancy.

These women are monitored via periodic individual prenatal appointments. In addition to the clinical evaluation, the women and their birth companions receive information about the physiological labour process, signs and symptoms of the beginning of labour, birth positions, practices that favour development of labour, breast feeding and newborn care.

The aforementioned protocols include a gestational age between 37 and 42 weeks, a singleton gestation, a live fetus, a vertex presentation, no clinical or obstetric maternal complications, and normal biophysical fetal parameters.

When the service was launched, the neonatal transfer protocol routine included the following: an Apgar score $\leqslant 7$ in the first minute (without recovering in subsequent minutes), respiratory

discomfort, suspicion of serious congenital malformations, and other non-foreseeable pathological conditions or risks.

The SBC is properly equipped with supplemental oxygen, resuscitation equipment and an incubator for transportation to assist neonatal and maternal emergencies. All nurse–midwives receive periodic training to provide this emergency care.

The SBC team consists of nurse–midwives, auxiliary nurses and ambulance drivers. Maternal and neonatal transfers to hospitals are performed by ambulances that are available on site 24 hours per day, exclusively for this purpose. Since 2006, all transfers have been monitored by a nurse–midwife.

The transportation time to any one of the four reference hospitals is under one hour. All associated hospitals have neonatal intensive care units.

Participants

From its opening in September 1998 until August 2005, there were 2840 births at the SBC. All the newborns transferred to hospital during the above period were included in this study as cases. Two controls from the same period were selected for each case that arose at the SBC. Therefore, the total number of newborn participants was 96, comprised of 32 cases and 64 controls.

Cases and controls were matched according to the following criterion: one control birth just before and one control birth just after each case birth. This criterion was used to minimise bias regarding changes in midwife staff and reference hospitals during the study period, which may have affected decision making regarding newborn transfer to a reference hospital.

Data source and measurement of variables

Data were collected from the SBC medical records, which contain information of both the mother and the newborn infant. Although data were collected from a secondary source, all study variables were available in SBC medical records.

The study outcome was newborn transfer to a hospital. The predictors were maternal sociodemographic characteristics and obstetric history (age, education, marital status, employment status, how they were directed or recommended to the SBC, whether they were resident in an area covered by the SUS, smoking during pregnancy, parity and previous pregnancy outcomes), prenatal care, labour and obstetric conditions upon admission (prenatal appointments, SBC appointments, relationship between uterine height and gestational age according to the curve proposed by the Perinatal Latin-American Centre, cervical dilatation, condition of amniotic membranes, fetal auscultation and uterine contraction control per hour, oxytocin use, amniotic membrane rupture, cervical dilatation at amniotomy, condition of the perineum, and labour complications) and newborn characteristics (low birth weight, one-minute Apgar score and relationship between birth weight and gestational age, which was considered appropriate when birth weight was between 2500 and 4000 g and gestational age was between 37 and 42 weeks). All variables were analysed as categorical, including quantitative variables.

Statistical analysis

The association between the outcome and the predictors was analysed using χ^2 test. Subsequently, for the logistic analysis model, all variables with $p<0.25$ were selected. The forward stepwise selection procedure was used in the multiple regression model, and the variable was kept in the final model if $p<0.05$. The estimated risk measure was the odds ratio (OR), presented as crude OR (univariate analysis) and adjusted OR, with the 95% confidence interval (CI) (multivariate analysis). Modifiers or confounder effects were not analysed.

Findings

Ninety-six newborn infants took part in this case–control study (32 cases and 64 controls). The cases were all the newborns transferred from SBC to a reference hospital between September 1998 and August 2005.

Six of the transferred newborns died; three due to intrapartum asphyxia, two due to malformations that were not diagnosed

Table 1
Maternal sociodemographic characteristics and obstetric history.

Variable	Control		Case		Total		p (χ^2)
	n	(%)	n	(%)	n	(%)	
Age (years)							
14–19	17	(26.6)	9	(28.1)	26	(27.1)	0.793
20–29	38	(59.4)	17	(53.1)	55	(57.3)	
30–36	9	(14.1)	6	(18.8)	15	(15.6)	
Total	64	(100)	32	(100)	96	(100)	
Education (years)							
1–7	33	(51.6)	19	(59.4)	52	(54.2)	0.469
⩾8	31	(48.4)	13	(40.6)	44	(45.8)	
Total	64	(100)	32	(100)	96	(100)	
Marital status							
Partner	37	(57.8)	19	(59.4)	56	(58.3)	0.884
Single	27	(42.2)	13	(40.6)	40	(41.7)	
Total	64	(100)	32	(100)	96	(100)	
Employment status							
Unemployed	53	(82.8)	25	(78.1)	78	(81.3)	0.579
Employed	11	(17.2)	7	(21.9)	18	(18.8)	
Total	64	(100)	32	(100)	96	(100)	
Recommended to SBC from							
Primary care health unit	37	(57.8)	14	(43.8)	51	(53.1)	0.383
Former patients	21	(32.8)	15	(46.9)	36	(37.5)	
Other	6	(9.4)	3	(9.4)	9	(9.4)	
Total	64	(100)	32	(100)	96	(100)	
From area covered by the SUS							
Yes	48	(75.0)	20	(62.5)	68	(70.8)	0.204
No	16	(25.0)	12	(37.5)	28	(29.2)	
Total	64	(100)	32	(100)	96	(100)	
Smoked during pregnancy							
Yes	9	(14.1)	12	(37.5)	21	(21.9)	0.009
No	55	(85.9)	20	(62.5)	75	(78.1)	
Total	64	(100)	32	(100)	96	(100)	
Parity							
Nullipara	26	(40.6)	15	(46.9)	41	(42.7)	0.448
Primipara	16	(25.0)	10	(31.3)	26	(27.1)	
Multipara	22	(34.4)	7	(21.9)	29	(30.2)	
Total	64	(100)	32	(100)	96	(100)	
Previous pregnancy outcome							
Healthy infant	35	(92.1)	16	(94.1)	51	(92.7)	0.791
Stillbirth or neonatal death	3	(7.9)	1	(5.9)	4	(7.3)	
Total[a]	38	(100)	17	(100)	55	(100)	

SBC, Sapopemba Birth Centre.
[a] Nulliparous women excluded.

prenatally, and one due to complications resulting from milk aspiration while in the hospital.

Table 1 summarises maternal sociodemographic characteristics, prenatal care and obstetric history. Among these variables, those associated with transferring a newborn infant to a hospital from the SBC were smoking during pregnancy ($p = 0.009$) and having fewer than four prenatal care appointments ($p = 0.03$). None of the other factors were significantly related to the case or control subjects.

Obstetric conditions upon admission and labour care are presented in Table 2. Neonatal transfer was associated with labour complications ($p < 0.001$), with a rate of 37.5% among cases and 6.3% among controls.

Table 2
Prenatal care, labour and obstetric conditions upon admission to the Sapopemba Birth Centre (SBC).

Variable	Control		Case		Total		p (χ^2)
	n	(%)	n	(%)	n	(%)	
Prenatal appointments							
1–3	5	(8.1)	9	(28.1)	14	(14.9)	0.030
4–6	34	(54.8)	12	(37.5)	46	(48.9)	
⩾7	23	(37.1)	11	(34.4)	34	(36.2)	
Total[a]	62	(100)	32	(100)	94	(100)	
SBC appointments							
1	23	(35.9)	15	(46.9)	38	(39.6)	0.208
2	9	(14.1)	7	(21.9)	16	(16.7)	
⩾3	32	(50.0)	10	(31.3)	42	(43.8)	
Total	64	(100)	32	(100)	96	(100)	
Uterine height and gestational age							
Appropriate	45	(76.3)	19	(67.9)	64	(73.6)	0.406
Inappropriate	14	(23.7)	9	(32.1)	23	(26.4)	
Total[b]	59	(100)	28	(100)	87	(100)	
Dilatation upon admission (cm)							
0–4	30	(46.9)	13	(40.6)	43	(44.8)	0.837
5–9	30	(46.9)	17	(53.1)	47	(49.0)	
10	4	(6.3)	2	(6.3)	6	(6.3)	
Total	64	(100)	32	(100)	96	(100)	
Condition of amniotic membranes							
Intact	52	(81.3)	20	(62.5)	72	(75.0)	0.046
Ruptured	12	(18.8)	12	(37.5)	24	(25.0)	
Total	64	(100)	32	(100)	96	(100)	
Fetal auscultation (per hour)							
<1	19	(29.7)	6	(18.8)	25	(26.0)	0.250
⩾1	45	(70.3)	26	(81.3)	71	(74.0)	
Total	64	(100)	32	(100)	96	(100)	
Uterine contraction control (per hour)							
<1	30	(46.9)	11	(34.4)	41	(42.7)	0.243
⩾1	34	(53.1)	21	(65.6)	55	(57.3)	
Total	64	(100)	32	(100)	96	(100)	
Use of oxytocin							
No	42	(65.6)	20	(62.5)	62	(64.6)	0.763
Yes	22	(34.4)	12	(37.5)	34	(35.4)	
Total	64	(100)	32	(100)	96	(100)	
Rupture of amniotic membranes							
Artificial	37	(57.8)	15	(46.9)	52	(54.2)	0.311
Spontaneous	27	(42.2)	17	(53.1)	44	(45.8)	
Total	64	(100)	32	(100)	96	(100)	
Cervical dilatation at amniotomy (cm)							
0–5	5	(13.5)	3	(20.0)	8	(15.4)	0.766
6–8	19	(51.4)	8	(53.3)	27	(51.9)	
9–10	13	(35.1)	4	(26.7)	17	(32.7)	
Total[c]	37	(100)	15	(100)	52	(100)	
Condition of perineum							
Intact or laceration	41	(64.1)	20	(62.5)	61	(63.5)	0.881
Episiotomy	23	(35.9)	12	(37.5)	35	(36.5)	
Total	64	(100)	32	(100)	96	(100)	
Labour complications							
No	60	(93.8)	20	(62.5)	80	(83.3)	<0.001
Yes	4	(6.3)	12	(37.5)	16	(16.7)	
Total	64	(100)	32	(100)	96	(100)	

[a] Two without records.
[b] Nine without records.
[c] Women with spontaneous rupture of amniotic membranes were excluded.

Table 3
Newborn characteristics.

Variable	Control		Case		Total		p (χ^2)
	n	(%)	n	(%)	n	(%)	
Low birth weight							
No	63	(98.4)	29	(90.6)	92	(95.8)	0.071
Yes	1	(1.6)	3	(9.4)	4	(4.2)	
Total	64	(100)	32	(100)	96	(100)	
Birth weight and gestational age							
Appropriate	60	(98.4)	21	(75.0)	81	(91.0)	<0.001
Small or large	1	(1.6)	7	(25.0)	8	(9.0)	
Total[a]	61	(100)	28	(100)	89	(100)	
Apgar score at one minute							
0–7	3	(4.7)	16	(50.0)	19	(19.8)	<0.001
8–10	61	(95.3)	16	(50.0)	77	(80.2)	
Total	64	(100)	32	(100)	96	(100)	

[a] Seven without records.

Regarding newborn characteristics, neonatal transfer was associated with inappropriate weight in relation to gestational age ($p < 0.001$). A one-minute Apgar score ⩽7 was seen in 50% of the cases and in 4.7% of the controls ($p < 0.001$) (Table 3).

The logistic regression analysis is summarised in Table 4, which shows that the independent risk factors for neonatal transfer were smoking during pregnancy, labour complications and a one-minute Apgar score ⩽7.

Infants born to mothers who had smoked during pregnancy had a 4.1-fold greater risk of being transferred after birth. Infants born with labour complications had a 5.5-fold greater risk of being transferred after birth. Finally, the risk of transfer to a hospital was 7.8 times greater for infants with a one-minute Apgar score ⩽7.

Discussion

Identification of the risk factors and an adequate neonatal transfer system are directly related to the quality of care and safety in out-of-hospital births. Therefore, improvement of

Table 4
Results of univariate and multivariate analysis.

Variable	Univariate analysis		Multivariate analysis		
	OR (crude)	*p*	OR (adjusted)	95% CI	*p*
Smoked during pregnancy					
No	1.0	–	1.0	–	–
Yes	3.1	0.020	4.1	1.03–16.33	0.045
Prenatal appointments					
1–3	6.5	0.030			
4–6	0.9	0.856			
⩾7	1.0	–			
Labour complications					
No	1.0	–	1.0	–	–
Yes	7.5	0.002	5.5	1.06–28.26	0.042
Birth weight and gestational age					
Small	34.7	0.007			
Appropriate	1.0	–			
Large	10.1	0.044			
Apgar score at one minute					
0–7	15.4	<0.001	7.8	1.62–37.03	0.010
8–10	1.0	–	1.0	–	–

OR, odds ratio; CI, confidence interval.

admission protocols and compliance with these protocols, as well as improved knowledge of risk factors associated with neonatal transfer, could, in combination or separately, help to prevent morbidity and mortality at birth centres.

The present study showed that smoking during pregnancy was a risk factor for neonatal transfer from the SBC to a hospital based on univariate and multivariate analyses. The relationship between smoking and unfavourable perinatal results is well known, as are the harmful effects of nicotine on the fetus and the newborn. The literature is broad in terms of perinatal complications associated with smoking during pregnancy. The most prominent smoking-associated complication is intra-uterine growth restriction, which results in newborns that are small for their gestational age, and placental abruption (Winbo et al., 2001).

It is difficult to distinguish the association between smoking and other socio-economic risk factors for perinatal death. Among other risk behaviours, smoking while pregnant has been shown to be related to poverty, belonging to an ethnic minority, being a single parent, having an unplanned pregnancy, drinking alcohol, and using illicit drugs during pregnancy (Hogan and Park, 2000; Heaman and Chalmers, 2005; Steyn et al., 2006). A study conducted in Rio de Janeiro, Brazil between 1999 and 2001, including 10,027 postpartum women, showed that 13.3% of women smoked during pregnancy, and also showed that this frequency was lower (5.2%) among women who attended private hospitals (Leal et al., 2004).

The above results and those of the current study highlight the importance of further research on the subject of smoking during pregnancy within the context of free-standing birth centres. It is important to identify women who smoke during pregnancy since the association with other psychosocial and economic factors may contribute to unfavourable perinatal results. Taking this into consideration, smoking during pregnancy could be an effective starting point to track other conditions that may compromise the safety of free-standing births.

Quality prenatal care is also a significant protective factor against maternal and perinatal morbidity and mortality, and a lack of prenatal care is considered to be an important risk factor for neonatal mortality (Victora and Barros, 2001; Lansky et al., 2002). Attendance at fewer than six prenatal medical appointments was also a potential risk factor for neonatal mortality in a case–control study conducted in Caxias do Sul, Brazil between 2001 and 2002, which included 118 cases and 236 controls, as assessed by univariate analysis. However, in the multivariate analysis, the number of prenatal appointments did not remain in the model as a risk factor for neonatal mortality (Mendes et al., 2006).

Similarly, in the present study, a low number of prenatal appointments was associated with neonatal transfer according to univariate analysis, but not according to multiple regression analysis.

The provision of follow-up to pregnant women at the SBC at the end of their pregnancy, as well as prenatal appointments, may help to prevent complications during pregnancy that eventually compromise newborns' health.

There is a complex interaction between the risk factors for perinatal death and the quality of care provided during labour. Therefore, in addition to the traditional risk factors reported in the literature (sociodemographic characteristics, and maternal and newborn conditions), other aspects have to be considered. These other aspects concern the structure of maternity services and the care process, which include a number of non-evidence-based practices (Leal et al., 2004; Lansky et al., 2006).

Complications during labour and childbirth were risk factors for neonatal transfer in both the univariate analysis and the multivariate analysis. Labour complications are relevant to the care provided because their occurrence re-inforces the importance of careful surveillance for identification of the need for intrapartum transfers at the correct time to optimise conditions for a safe birth. This finding highlights the urgency for scientific studies focusing on maternal transfers and their outcomes, including the influence of perinatal conditions in transfers and outcomes.

A study conducted in several German birth centres investigated the reasons for intrapartum transfer, the stage of labour at the start of transportation, the medical diagnosis upon arrival at the hospital, labour progress and newborn conditions among 3060 women. The findings showed that nulliparous women transferred to reference hospitals during labour and their infants may represent a special high-risk group with respect to maternal and neonatal morbidity (David et al., 2006).

Studies such as this can offer a deeper analysis of the association between reasons for intrapartum transfer, outcomes for newborns whose mothers were transferred, and cases that could have been transferred during labour but, for some reason, were not.

Inappropriate birth weight in relation to gestational age was seen in more cases than controls according to the univariate analysis, but not according to the multiple regression analysis. The transfer of small or large newborns in relation to gestational age is not included in the SBC protocol transfer. In these cases, the need for transfer was, and continues to be, decided by the nurse–midwife according to the health of the newborn.

Apgar scores are used to evaluate birth conditions and are often included in studies examining childbirth care. In the present study, a one-minute Apgar score ⩽7 was associated with neonatal transfer in the multivariate analysis.

In a systematic Cochrane review, only one clinical trial performed with 114 women included the one-minute Apgar score as a study variable. The results showed an OR of 0.37 (95% CI 0.05–2.71) for scores <7 in the first minute, indicating that birth centres operating alongside hospitals are protective against occurrence of this event (Hodnett et al., 2008).

In the present study, the five-minute Apgar score was not included in the risk factor analysis because none of the controls showed scores ⩽7. All the newborns with this score were transferred.

It is known that the five-minute Apgar score is more important as a prognostic variable. The study by Hodnett et al. (2008) showed an OR of 1.19 (95% CI 0.53–2.66) for scores <7 at five minutes in two randomised controlled trials with 2028 women. According to Mendes et al. (2006), an Apgar score <7 was a risk factor for neonatal death (OR = 13.5, 95% CI 1.69–107.80).

In the present study, the 95% CIs suggest that the results are compatible with increased risk of neonatal transfer. The wide CIs reduce the statistical power and can be related to the sample size. However, this study was carried out with all the transferred newborns; to obtain a larger sample, it would be necessary to conduct this study including other similar birth centres, and these do not exist in São Paulo.

The potential sources of bias, such as selection, exposition and information, were controlled. As this was a case–control study in which the cases and controls came from the same clearly defined population, selection and exposition bias were minimised, which provided strength of association to the results. The quality of information was favoured by data collection from records prior to this study, without suffering from the influence of informants' memory or researchers' tasks (Rothman, 2002).

With regard to selection of the controls, the criterion of choosing those infants born immediately before and immediately after case births resulted in similar conditions between exposed and non-exposed subjects. However, under the influence of neonatal transfer, the nurse–midwives may have been less strict when filling out the neonatal transfer protocols for births subsequent to transfers. In childbirths following transfers, it is possible that newborns with less severe complications remained at the SBC. This event could have influenced the results in some way, minimising the risk factors for neonatal transfer.

Although the study was conducted in a health setting that attends to a very specific population, mainly represented by low-income families, results found at the SBC are suitable for generalisation to other similar environments because neonatal morbidity and mortality are of special interest among this population.

Limitations regarding the instability of reference hospitals during the study period do not compromise generalisability. Unfortunately, this is a common situation faced by various independent birth centres all over the world, and the results found in the study may contribute to the discussions of difficulties in neonatal transfers among out-of-hospital birth settings (Davis-Floyd, 2003).

Conclusion

The findings of the present study are consistent with the literature related to the proximal determinants in the causal chain of neonatal transfer. The variable control by multivariate analysis confirmed smoking during pregnancy, labour complications and a one-minute Apgar score ⩽7 as risk factors for neonatal transfer. Labour complications and a low Apgar score express the convergence among these factors that were studied as independent variables. Both are part of the causal chain in the event of neonatal transfer.

In this sense, intrapartum maternal transfer is an important aspect that can increase the quality and safety of the care offered by the SBC. Therefore, constant risk monitoring is required during labour and childbirth, and a well-functioning transfer system to a reference hospital is essential.

The risk factors associated with neonatal transfer identified in this study can help to improve institutional protocols and formulate hypotheses for other studies that could increase knowledge regarding these factors.

Aknowledgememts

This research was financed by a grant from the State of São Paulo Research Foundation (FAPESP). Brazil.

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