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Analysis of the Impact of Selected Anesthetic Agents on Neurobehavioral State of a Newborn

Analiza wpływu wybranych czynników anestezjologicznych na stan neurobehawioralny noworodka

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Abstract

Introduction. An increasing percentage of children are born through C-sections. Both mother and child are exposed to potential obstetric, anesthesia and neonatal complications. Hypoxia associated with obstetric or anesthetic complications can lead to fetal hypoxia, and induce adaptation difficulties in the postpartum period or permanent developmental disorders. Knowledge of issues related to the perioperative care of the mother and child will minimize complications and provide high-quality care.
Aim. The aim of the study was to analyze the impact of opioids in analgesia and hypotension during C-section on neonatal neurobehavioral state.
Material and Methods. The study involved 102 mothers and their babies born by C-section. The study was approved by the Bioethics Committee of PUM. The inclusion criterion was the lack of systemic diseases in the mother and the gestational age over 36 weeks. All mothers were subarachnoidally anesthetized for the labor. Newborns after two days of life were assessed by NBAS (Neonatal Behavioral Assessment Scale).
Results. Neonatal reflexes in the study group were normal. Newborns of mothers who were added fentanyl to anesthesia, did not differ in behavior from the others ($p>0.05$). After adding Morphini Sulfas 0.1% Spinal to anesthesia there were observed statistically significant differences in the behavior of newborns, compared to infants whose mothers did not receive it, in terms of sound stimulus habituation ($p=0.04$) in favor of those whose mothers received MF Spinal intrathecally. Children of mothers anaesthetized without the addition of MF Spinal presented higher self-calming abilities than the others ($p=0.03$). The ability of calming down differed infants of mothers whose blood pressure declined during anesthesia ($p=0.04$).
Conclusions. Subarachnoid anesthesia with opioid supplementation for C-section as well as an anesthesia-related decrease in blood pressure slightly affected neurobehavioral state of infants born by C-section comparing to those whose mothers had not received opioids intraspinally and had not experienced a blood pressure decrease. **(JNNN 2016;5(3):92–98)**
Key Words: neurobehavioral state, subarachnoid anesthesia, opioids

Streszczenie

Wstęp. Drogą cięcia cesarskiego rodzi się coraz większy odsetek dzieci. Niezależnie od przyczyn, z jakich zostało wykonane, zarówno matka, jak i dziecko narażeni są na potencjalne powikłania położnicze, anestezjologiczne, neonatologiczne. Niedotlenienie związane z powikłaniami położniczymi, czy anestezjologicznymi może prowadzić do niedotlenienia dziecka płodowego, a tym samym wpłynąć na trudności adaptacyjne w okresie poporodowym czy trwałe zaburzenia rozwojowe. Znajomość zagadnień związanych z opieką okołooperacyjną nad matką i dzieckiem pozwoli na minimalizację powikłań i zapewnienie wysokiej jakości opieki.
Cel. Celem badań była analiza wpływu podaży opioidów w analgezji oraz obniżenia ciśnienia tętniczego podczas cięcia cesarskiego na stan neurobehawioralny noworodka.

Materiał i metody. Badaniem objęto 102 pary noworodków i ich matek, które urodziły przez cięcie cesarskie. Na badanie uzyskano zgodę Komisji Bioetycznej PUM. Kryterium włączenia stanowił brak chorób układowych u matek oraz wiek ciążowy powyżej 36 tygodnia ciąży. Wszystkie matki znieczulane były do porodu podpajęczynówkowo. Szczegóły dotyczące znieczulenia uzyskano z karty znieczulenia. Noworodki po ukończeniu 2 doby życia zostały ocenione skalą NBAS (Neonatal Behavioural Assessment Scale) zgodnie z zasadami przeprowadzenia badania.
Wyniki. Odruchy noworodkowe w badanej grupie były prawidłowe. Stan neurobehawioralny w większości badanych pozycji nie wykazywał różnic między badanymi. Noworodki matek, którym do leków znieczulenia dodano Fentanyl, nie różniły się zachowaniem od pozostałych (p>0,05). Po dodaniu Morphini Sulfas 0,1% Spinal do znieczulenia przewodowego zaobserwowano istotne statystycznie różnice w zachowaniu noworodków w porównaniu do dzieci, których matki jej nie otrzymały w zakresie habituacji bodźca dźwiękowego (p=0,04) na korzyść tych, których matki otrzymały dokanałowo MF Spinal. Dzieci matek znieczulanych bez dodatku MF Spinal prezentowały samouspokajanie się na wyższym poziomie od pozostałych (p=0,03). Umiejętność uspokajania się różniła noworodki matek, u których obniżyło się ciśnienie tętnicze podczas znieczulenia (p=0,04).
Wnioski. Opieka nad matką i dzieckiem powinna być zindywidualizowana w oparciu o potrzeby matki i dziecka wynikające z samopoczucia matki i stanu neurobehawioralnego dziecka. **(PNN 2016;5(3):92–98)**
Słowa kluczowe: stan neurobehawioralny, znieczulenie podpajęczynówkowe, opioidy

Introduction

More than one-third of all the labors around the world are resolved by C-section being either elective or emergency procedure due to the health state of the mother or the baby. Hypoxia that occurs during surgical labor is associated mostly with sympathetic blockade after administration of regional anesthesia, as well as in conjunction with aortocaval compression syndrome resulting from positioning the mother in labor on her back [1].

Pharmacological agents administered to the mother during anesthesia can reach fetus and influence the postnatal state of the child [1–3]. The welfare of fetus is possible with normal uterine-placental flows. Hemodynamic disturbances in the mother, together with a decrease of blood pressure below 90 mmHg result in temporary hypoxia of the child [1].

Non-physiological way of coming into the world involving a C-section reduces in children born this way experiences associated with the passage through the birth canal that may affect neonatal neurobehavioral state. Neurobehavioral state is a reflection of the process of adapting to states outside the womb [4–7]. Abnormalities in musculoskeletal system concerning muscle tone can affect the efficiency of lactation, growth and motoric development [5,8]. In addition, the somatic aspects of child development should be an important element of a comprehensive health assessment [8]. Assessment of the neurobehavioral state using Brazelton method according to NBAS (Neonatal Behavioral Assessment Scale) includes 53 items evaluating neonatal reflexes (18 items), habituation, social interactions, musculoskeletal system, organization and regulation of states, the response of autonomic nervous system on stimulation of the child. Additional scoring (7 items) is a qualitative summary of the study. Thanks to the assessment, information on the strengths of the newborn is obtained, and at the same time postpartum screening exposes deficits in adapting to states outside the womb. The result of assessment allows to determine the areas and directions of stimulating development [4].

The aim of the study was to analyze the impact of opioids administered in C-section analgesia and hypotension during surgery on neurobehavioral state of newborn.

Material and Methods

Project of the study was approved by the Bioethics Commission (BN-001/108/08) and the mothers agreed on newborn assessment using Brazelton method. The study included women and their newborns (n=102), who were delivered by C-section in the Obstetrics Department of Teaching Hospital No. 2 in Szczecin. The inclusion criterion was the lack of systemic diseases and birth of babies after 36 weeks of gestation (Avg.=39 GW, gestation week; Me=39 GW). Maternal age was 18–41 years (Avg.=30.12; Me=29). Anesthesia card was used to determine the course of anesthesia and drugs administration. All patients were anesthetized regionally, subarachnoidally by means of Pencil Point — 25G or 26G needle, with the use of Marcaine Spinal Haevy 0.5%. Ephedrinum Hydrochloricum administration during anesthesia followed in the event of sympathetic blockade and blood pressure reduction. Analgesia was amplified by intrathecal administration of Fentanyl (FNT; dose of 100 μg) or Morphini Sulfas 0.1% Spinal (MF Spinal) at a dose of 200 μg. Neurobehavioral state of a newborn was assessed after two days of life for the child in accordance with the requirements of the NBAS with the consent and in the presence of mothers or parents, in a quiet, warm, darkened room, between feedings [4].

U Mann–Whitney test was used for statistical analysis. Values of p≤0.05 were considered significant, difference was statistically significant.

Results

Neonatal reflexes triggered during the NBAS assessment included: Plantar Grasp; Babinski; Ankle Tonus; Rooting; Sucking; Glabella; Passive Resist.-Legs; Passive Resist.-Arms; Palmar Grasp; Placing; Standing; Walking; Crawling; Incurvation; Tonic Dev. Head/Eyes' Nystagmus; TNR; Moro. Physiological reflex was assigned to 0, pathological reflex to 1. Newborns presented proper neonatal reflexes (Me=0). Few of the children (n=3) had lower scores in terms of individual elements of the assessment of reflexes. The average score was 0.13 points, standard deviation (SD=0.49).

Neurobehavioral state of infants born by caesarean section depending on the application MF Spinal as intensification of analgesic activity of anesthesia is shown in Table 1. Age of the mothers, newborns and their birth weight did not differ significantly (p>0.05). There was also no difference between infants in NBAS assessment

Table 1. Results of Mann–Whitney test of neurobehavioral state of newborns depending on the use of Morphini Sulfas 0.1% Spinal for anesthesia

Parameter	Subarachnoid anesthesia								Z	p
	w/o MF Spinal				MF Spinal					
	n	Average	Median	SD	n	Average	Median	SD		
1	2	3	4	5	6	7	8	9	10	11
Age of the mother	71	29.81	29	5.84	37	30.72	29	4.62	-0.83	0.40
Age of the child (GW)	71	39.01	39	1.51	37	38.97	39	1.16	0.78	0.43
Weight of the child	71	3390.63	3480	551.98	37	3610.27	3570	821.35	-1.30	0.19
Dose of ephedrine (mg)	71	6.97	5	7.72	37	11.35	10	10.18	0.648	0.03
NBAS	Habituation									
Response Dec.-Light	62	6	6	1.88	31	5.96	6	1.92	0.03	0.97
Response Dec.-Rattle	62	5.53	6	1.86	31	6.06	7	2.27	-1.88	0.05
Response Dec.-Bell	59	6	6	1.69	30	6.66	7	1.68	-1.96	0.04
Response Dec.-Foot	57	6.07	6	2.12	25	5.96	6	2.09	0.28	0.77
NBAS	Orientation									
Animate Visual	66	2.95	3	1.32	35	3.05	3	1.28	-0.52	0.60
Animate Visual-Auditory	66	3.59	3	1.30	35	3.65	3	1.76	-0.13	0.89
Inanimate Visual	69	3.34	3	1.45	35	3.4	3	1.47	-0.14	0.88
Inanimate Visual-Auditory	69	3.95	4	1.47	35	4.08	4	1.54	-0.31	0.74
Animate Auditory	71	4.26	4	1.38	37	4.16	4	1.59	0.55	0.58
Inanimate Auditory	71	4.90	5	1.44	37	5.10	5	1.46	-0.55	0.57
Alertness	71	4.61	5	1.24	37	4.64	5	1.05	-0.23	0.81
NBAS	Motor System									
General Tone	71	5	5	0.53	37	4.94	5	0.46	0.67	0.50
Motor Maturity	71	4.70	5	1.18	37	4.48	4	1.017	0.95	0.33
Pull-to-Sit	71	3.47	3	1.79	37	3.72	4	1.69	-0.71	0.47
Defensive	71	4.90	5	1.86	37	5.70	6	1.83	-2.01	0.04
Activity Level	71	4.36	4	0.83	37	4.54	5	0.93	-1.14	0.25
NBAS	State Organization									
Peak of Excitement	71	4.60	5	0.81	37	4.78	4	1.25	-0.12	0.89
Rapidity of Build-up	71	4.39	4	1.58	37	4.08	4	2	1.17	0.24
Irritability	70	3.74	4	1.13	37	3.97	4	1.44	-0.51	0.60
Lability of State	70	3.52	4	0.845	37	3.35	3	0.91	1.12	0.26

Table 1. Continued

1	2	3	4	5	6	7	8	9	10	11
NBAS					State Regulation					
Cuddliness	71	5.16	5	1.30	37	5.37	6	1.23	-1.04	0.29
Consolability	71	5.33	6	1.20	37	5.18	6	1.56	0.15	0.87
Self-Quieting	71	3.71	3	1.53	37	3.02	3	1.48	2.16	0.03
Hand-to-Mouth	71	3.33	3	1.85	37	3.10	2	1.89	0.68	0.49
NBAS					Autonomic System					
Tremulousness	71	1.87	1	1.68	37	1.75	1	1.51	0.22	0.82
Startles	71	1.80	2	0.95	37	2.08	2	1.01	-1.50	0.13
Lability of Skin Color	71	4.76	5	1.03	37	4.86	5	0.58	0.04	0.96
NBAS					Smiles					
Number of smiles	71	1.26	1	1.40	37	1.21	1	1.08	-0.31	0.75
NBAS					Supplementary Items					
Quality of Alertness	71	4.94	5	1.50	37	4.94	5	1.64	-0.13	0.89
Cost of Attention	71	5.32	5	1.30	37	5.45	6	1.36	-0.52	0.59
Examiner Facilitation	71	5.81	6	1.00	37	5.64	6	1.03	0.74	0.45
General Irritability	71	6.04	6	1.52	37	5.75	6	1.80	0.71	0.47
Robustness/Endurance	71	5.54	6	1.22	37	5.83	6	1.14	-1.11	0.26
State Regulation	71	5.53	6	1.19	37	5.86	6	0.88	-1.29	0.19
E's Emotional Resp.	71	6.25	6	1.28	37	6.08	6	1.44	0.53	0.59

Z — Mann–Whitney test, p — level of significance

Table 2. Results of the Mann–Whitney test for the neurobehavioral state of newborns depending on the occurrence of decrease in blood pressure during anesthesia

Parameter	Subarachnoid anesthesia						Z	p
	decrease in blood pressure n=76			no decrease in blood pressure n=32				
	Average	Median	SD	Average	Median	SD		
1	2	3	4	5	6	7	8	9
Age of the mother	29.88	29	5.60	30.71	31	5.11	0.61	0.54
Age of the child (GW)	39.01	39	1.39	38.96	39	1.42	-0.14	0.88
Weight of the child	3484.40	3495	679.71	3421.87	3500	623.43	0.44	0.65
Dose of ephedrine (mg)	11.97	10	8.32	32	0.15	0.88	-7.23	<0.00001
NBAS				Habituation				
Response Dec. -Light	5.87	6	1.98	6.32	7	1.63	0.94	0.34
Response Dec. -Rattle	5.76	7	2.14	5.58	6	1.72	-0.86	0.38
Response Dec. -Bell	6.16	7	1.82	6.35	6	1.44	0.14	0.88
Response Dec. -Foot	6.03	6	2.018	6.03	6	2.30	0.18	0.85
NBAS				Orientation				
Animate Visual	3.05	3	1.34	2.82	3	1.22	-0.93	0.34
Animate Visual-Auditory	3.70	3	1.53	3.37	3	1.29	-0.83	0.40
Inanimate Visual	3.52	3	1.49	3	3	1.31	-1.47	0.13
Inanimate Visual-Auditory	4.09	4	1.50	3.77	4	1.47	-0.89	0.36
Animate Auditory	4.34	4	1.51	3.96	4	1.28	-1.14	0.25

Table 2. Continued

1	2	3	4	5	6	7	8	9
Inanimate Auditory	5.07	5	1.52	4.71	5	1.22	-0.86	0.38
Alertness	4.67	5	1.17	4.53	4	1.21	-0.39	0.69
NBAS				Motor System				
General Tone	4.97	5	0.46	5	5	0.62	0.52	0.60
Motor Maturity	4.59	4	1.13	4.71	5	1.14	0.65	0.51
Pull-to-Sit	3.69	3.5	1.75	3.25	2	1.75	-1.28	0.19
Defensive	5.40	5.5	1.74	4.62	5	2.10	-1.65	0.09
Activity Level	4.42	4	0.85	4.43	4.5	0.91	0.22	0.81
NBAS				State Organization				
Peak of Excitement	4.60	4	0.99	4.81	5	0.96	1.46	0.14
Rapidity of Build-up	4.09	4	1.77	4.75	4	1.58	1.97	0.04
Irritability	3.89	4	1.29	3.65	4	1.15	-0.73	0.46
Lability of State	3.39	3	0.84	3.64	4	0.91	1.60	0.10
NBAS				State Regulation				
Cuddliness	5.30	6	1.27	5.09	5	1.30	-0.72	0.46
Consolability	5.46	6	1.22	4.87	5.5	1.49	-1.98	0.04
Self-Quieting	3.51	3	1.47	3.40	3	1.72	-0.58	0.55
Hand-to-Mouth	3.44	3	1.90	2.81	2	1.71	-1.69	0.09
NBAS				Autonomic System				
Tremulousness	1.94	1.94	1.74	1.56	1	1.29	-1.00	0.31
Startles	1.94	1.94	0.99	1.78	2	0.94	-0.82	0.41
Lability of Skin Color	4.78	4.78	0.82	4.81	5	1.09	0.86	0.38
NBAS				Smiles				
Number of smiles	1.18	1	1.22	1.40	1	1.45	0.58	0.55
NBAS				Supplementary Items				
Quality of Alertness	5	5	1.56	4.68	5	1.49	-1.13	0.25
Cost of Attention	5.48	6	1.32	5.09	4.5	1.30	-1.41	0.15
Examiner Facilitation	5.80	6	1.05	5.65	6	0.90	-0.95	0.34
General Irritability	6.02	6.5	1.63	5.75	5	1.60	-0.90	0.36
Robustness/Endurance	5.72	6	1.20	5.46	5.5	1.19	-1.07	0.28
State Regulation	5.64	6	1.10	5.65	6	1.12	0.13	0.88
E's Emotional Resp.	6.18	6	1.42	6.21	6	1.12	-0.28	0.77

Z — Mann–Whitney test, p — level of significance

in the area of social interaction, states organization, autonomic nervous system response to stimulation, in terms of the number of smiles observed during the examination and additional scoring (p>0.05). There were statistically significant differences in habituation of children associated with the phasing out unpleasant acoustic stimulus — bell ring (p=0.04) in favor of those whose mothers received MF Spinal intrathecally. These children faster ignored the irritating stimulus, and also presented a more mature defensive reflexes in response to covering their eyes and partially nose (p=0.04). While children of the mothers anesthetized without the addition of MF Spinal presented self-calming at a higher level, unlike the others, which was statistically significant (p=0.03). The course of anesthesia with hypotension required administration of higher dose of Ephedrinum Hydrochloricum (Avg.=11.35 mg) to mothers anesthetized with the addition of MF Spinal, which differed the anesthetized women (p=0.03) (Table 1).

Mann–Whitney test was used to assess relationships between the neurobehavioral states of newborns, and the intrathecal administration of FNT to strengthen the

analgesic effect of anesthesia. There were no differences between infants in terms of neurobehavioral state, maternal age, body weight. The results were not statistically significant (p>0.05).

In the greater part of anesthetized for cesarean section women (n=76) there occurred a sympathetic blockade with hypotension. Both these women as well as their children did not differ from each other in a statistically significant way with respect to age, maturity of children and their body weight (p>0.05). Neurobehavioral state in terms of states organization: agitation speed of children of mothers who experienced decreased blood pressure, was better, because infants were more resistant to sensory stimulation (p=0.04). Also, the ability to calm down from the area of states regulation differed the newborns for the benefit of better adaptation to stressful situations in favor of children of mothers who have decreased blood pressure during anesthesia (p=0.04) (Table 2).

Discussion

The optimal choice of method of anesthesia is important not only for the comfort of the mother, but also for the welfare of her child. Rapid correction of hemodynamic disturbances affects the maintenance of normal uterine flows affecting postnatal state of child. Mother lying in the supine position can cause the onset of the aortocaval compression syndrome resulting in decreased blood pressure and strengthening of changes relating to the performance of anesthetic drugs [1,2].

Cohen studied a group of 40 women perineurally anesthetized for cesarean section with the addition of intrathecally administered morphine. In the control group, a double-blind trial was used to assess the safety of block anesthesia with morphine in terms of maternal competence and behavior of the mothers in the postoperative period [9].

Neurobehavioral state of children assessed according to NBAS, and Apgar score did not indicate differences between examined children, as there was no difference in the assessment of the differences between the behavior of their mothers (p>0.05). The authors explain that they were not able to discover the differences in the quality of interactive behavior, because almost all women presented involvement in care. They believe that the applied method was not sensitive enough to accept the thesis that analgesia did not affect the mother-child relationship [9]. Examining Szczecin newborns using Brazelton method we obtained detailed information on the neurobehavioral state depending on the administration of pharmaceuticals or occurrence of hypotension associated with block anesthesia or aortocaval compression syndrome. Data on the functioning of the newborns in adaptation period in the new environment of life are valuable because they can serve planning of individual care for mother and child. For example, poorer coping with stress may require parental education in the field of maneuvers calming the child, allowing the child to develop self-regulation of behavior. The presence of parents during NBAS test allows observation of the entire range of behavior of a child involving the states of sleep and wakefulness. Brazelton, as well as Beal, Britt and Meyers indicate the advantages and opportunities related to NBAS assessment for parents, and above all as a screening test for children from risk groups [4–6]. Children born by C-section belong to a risk group due to the possibility of occurrence of postnatal complications of a different nature during surgery affecting their condition. Enning draws attention to the lack or very low stimulation of the limbic system, skin receptors of children who have not passed through the birth canal of the mother, and have not experienced neurohormonal stimulation associated with uterine contractions [10]. The scope of the phenomenon requires a planned action, states Ennig, which would allow midwives/nurses and parents in optimal for the development of children way to exercise care of them [10].

C-section is also connected with frequent occurrence of lack of skin-to-skin contact after delivery or its delays, as compared to children born physiologically, where the contact is common. Researchers including Gathwala analyzed the impact of early contact on the behavior of a newborn with the help of NBAS scale and direct observation during feeding. Mothers after physiological childbirth showed greater activity against women giving birth by C-section. Newborns are physiologically more active in social interactions, physically, they laughed more often and cried less. No differences were observed in states organization [11]. Similar results were obtained by Pilch, Rudnicki, Safranow in the analysis of neurobehavioral state of newborns in different modules of delivery in favor of those physiologically born, which probably influenced the functioning of mother-child-father triad [12].

Randomized test of Thomas, Robinson, Redfern, Hughes and Boys showed significantly higher compared to the physiological module administration of ephedrine related to the specificity of subarachnoid anesthesia [13]. Among subarachnoidally anesthetized women from Szczecin, up to 76 (70.5%) experienced a reduction in blood pressure and received Ephedrinum Hydrochloricum (Avg.=11.3 mg). Uterine flow disorders associated with decreased blood pressure in conjunction with central and peripheral action of drug balancing hypotension may affect the metabolism of fetus, particularly at high doses, as stated by Cooper, Lee, Mercier [2,3,14, 15]. Safety of anesthesia and minimized anesthetic complications (including vomiting, headaches) and

obstetrical may be achieved, based on the choice of technology, equipment and experience of the person performing the procedure [13,15].

Conclusions

1. The addition of opioid drugs to subarachnoid anesthesia to a small extent affects the neurobehavioral state of newborns whose mothers received it when compared to infants born to mothers anesthetized without opioids.
2. Reduction of blood pressure during subarachnoid anesthesia to a small extent affects the neurobehavioral state of newborns whose mothers experienced it, compared to children of mothers with normal blood pressure.

Implications for Nursing Practice

1. Support mothers after C-section and enable them early contact with the child (including skin-to-skin) to provide tactile, visual and auditory stimulation by the primary caregivers, which stimulates cognitive development of children and supports the creation of bonds.
2. Introduce NBAS scale to nursing/midwifery practice in order to identify, in hospital conditions, troublesome children in the area of care, so called "shouting babies", breastfeeding and after difficult labor (including treatment) and outline course of action.
3. Care for the mother and child should be individualized based on the needs of the mother and child resulting from the Mother and the child's behavior.

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