

Impact of Delivery Room Resuscitation Efforts on Admission Temperatures in Infants Born < 32 Weeks Gestation

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Abstract

Aim: This study aimed to determine how delivery room resuscitation efforts influence admission temperatures in premature infants born before 32 weeks gestation.

Methods: We retrospectively analyzed a cohort of premature infants born before 32 weeks gestation from January 2014 until December 2016. We compared the impact of resuscitation efforts performed in the delivery room on the admission temperature. Hypothermia was defined as a core temperature of less than 36.5°C on admission. The primary outcome was admission temperature in the Neonatal Intensive Care Unit. Secondary outcomes were Apgar scores in the first and fifth minute, pH on admission, respiratory distress syndrome requiring surfactant, persistent ductus arteriosus, necrotizing enterocolitis, late onset sepsis, kidney failure, intraventricular hemorrhage and death before hospital discharge. Exclusion criteria were inevitably lethal congenital malformations.

Results: We studied 147 infants born < 32 weeks gestation. In the delivery room, 66 (44.8%) of infants were given standard thermal care, 20 (13.6%) received standard care and continuous positive airway pressure (CPAP), 49 (33.3%) received standard care and IPPV, whereas 12 (8.1%) of infants received standard care and extensive resuscitation efforts (intubation and/or chest compressions and/or epinephrine). Patients receiving standard care and intermittent positive-pressure ventilation (IPPV) had significantly lower admission temperatures than those given standard care only (35.7°C vs. 36.2°C, $p < 0.02$). No correlation was found in infants receiving CPAP or extensive resuscitation efforts compared to those receiving standard thermal care only.

Conclusion: In our study, admission hypothermia was associated with IPPV in the delivery room. Application of CPAP or extensive resuscitation efforts in the delivery room did not influence admission temperatures.

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Introduction

Admission hypothermia is a common problem in preterm neonates and is reported in up to 78% of preterm neonates admitted to neonatal intensive care units (1). The World Health Organization classifies 36.0°C to 36.4°C as cold stress or mild hypothermia, 32.0°C to 35.9°C as moderate hypothermia, and lower than 32.0°C as severe hypothermia (2). Admission hypothermia is associated with increased mortality in premature neonates (3), higher rates of late onset sepsis (4), respiratory distress syndrome (5) and intraventricular hemorrhage (6). For this reason, multiple strategies for preventing admission hypothermia have been proposed: the use of polyethylene wraps, heated mattresses, chemical warming packs and humidified and heated respiratory gases (7, 8). Miller et al. (9) reported decreased odds of hypothermia following no resuscitative efforts with the conclusion that this is due to the fact that very low birth weight infants are healthier and better able to maintain normothermia. On the other hand, Lyu et al. (3) reported that resuscitation in the first 30 minutes after birth was associated with increased admission temperature. They speculate "that an infant requiring resuscitation is likely to be sicker and require more care, which should result in the care team ensuring that all practices are followed, including attending to body temperature" (3).

This study aimed to analyze the impact of delivery room resuscitation efforts on admission temperatures in infants born < 32 weeks of gestation as well as short-term outcomes of these infants.

Materials and Methods

This retrospective cohort study was performed at a single, referral level III NICU of University Hospital Osijek (Osijek, Croatia). The medical charts of all infants of gestational age at birth $\geq 22 + 0/7 - 31 + 6/7$ weeks born from January 2014 to December 2016 were retrospectively reviewed. Infants with major congenital anomalies were excluded. The study was

approved by University Hospital Osijek Ethical Board.

Standard thermal care was provided for all infants immediately after birth, and included placing the infant in polyethylene wrap under a radiant warmer. The infants were divided in four groups with regards to resuscitation efforts undertaken. Infants who received only standard thermal care were assigned to "None" group, those who received standard care and continuous positive airway pressure (CPAP) were assigned to "CPAP" group, if intermittent positive pressure ventilation (IPPV) was applied (bag mask or T – piece), infants were assigned to the "IPPV" group and if at any time extensive resuscitation efforts (chest compression and/or epinephrine and/or delivery room intubation) were performed, infants were assigned to "CEI" group. Outcomes were compared among groups.

Our NICU was next to the delivery room and the transport time was within 5 minutes. The first temperature on admission was measured by the rectal method and was recorded immediately after admission to the NICU. We collected data regarding intrapartum and demographic variables. Antenatal steroids were defined as any doses of corticosteroids given before delivery. Chorioamnionitis was defined upon pathohistological analysis of the placenta. A low Apgar score was defined as an Apgar score < 7.

The short-term outcome variables included: respiratory distress syndrome (RDS) that required surfactant therapy, necrotizing enterocolitis at Bell's stage \geq II, severe intraventricular hemorrhage (grades III or IV), patent ductus arteriosus requiring treatment, late onset sepsis, kidney failure and death before hospital discharge. Respiratory distress syndrome (RDS) was diagnosed by clinical and radiographic findings, and surfactant was delivered according to Croatian recommendations (10). Infants were diagnosed with sepsis if they had positive blood cultures for either bacteria or fungi. Severe intracranial hemorrhage was classified as IVH grade III – IV as classified by Papile et al. (11). Necrotizing

enterocolitis (NEC) was diagnosed in the presence of at least intestinal pneumatosis and/or portal venous gas (Bell's stage ≥ 2) (12). Kidney failure was diagnosed if the infant met the neonatal RIFLE criteria for kidney failure (13). Neonatal mortality was defined as infant death before hospital discharge.

Statistical analysis

Data are presented as arithmetic means, quartiles and standard deviations for continuous variables. Categorical variables were presented with frequency tables and cross tables. Due to the fact that variables were not normally distributed and some samples were small, nonparametric tests were used. For testing differences in distributions for two variables Mann-Whitney test was used and, in the case of three or more variables, Kruskal-Wallis ANOVA

was used. For testing dependence between two categorical variables, 2 and Fisher exact tests were used. For the purposes of our study, p value of < 0.02 was considered to be statistically significant. Statistical analyses were performed by using statistical software Statistica 13.3.

Results

During the 3-year period, 147 infants met the inclusion criteria for the study. The maternal and infant variables of the four groups are listed in Table 1. Compared to "None" group, the infants in the "IPPV" group had lower birth weight (925 vs. 1207g, $p < 0.02$), and were more often born via C section (89.8% vs. 66.1%, $p < 0.02$). Compared to the "None" group, the infants in the "CIE" group had lower birth weight (898 g vs. 1207g, $p < 0.02$), and were more often born following chorioamnionitis (96.1% vs. 46.9%, $p < 0.02$).

Table 1. Comparison of maternal and infant variables among groups

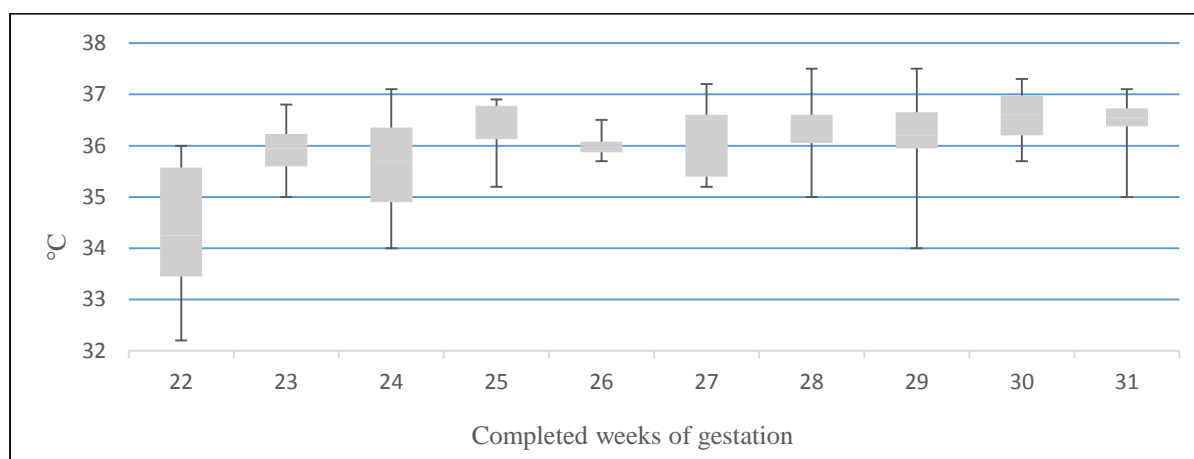
	"None" (N=66)	"CPAP" (N=20) ^a	"IPPV" (N=49)	p value ^b	"CIE" (N=12)	p value ^c
Gestational age (weeks), median (IQR)	29.5 (27.1 - 30.5)	29.6 (28.7 - 30.9)	27.5 (25.7 - 30.0)	NS	27.0 (24.9 - 28.5)	NS
Birth weight, (g) median (IQR)	1207 (872 – 1545)	1323 (966 – 1422)	925 (697 – 1186)	<0.02	898 (721 - 1138)	<0.02
Female	33 (50%)	7 (35%)	27 (55.1%)	NS	2 (16.6%)	NS
Chorioamnionitis	31 (46.9%)	6 (30%)	25 (51.1%)	NS	11 (91.6%)	<0.02
Maternal hypertension	14 (21.2%)	6 (30%)	10 (20.4%)	NS	0 (0%)	NS
C section	44 (66.1%)	17 (85.1%)	44 (89.8%)	<0.02	6 (50%)	NS
Antenatal steroids	42 (63.6%)	15 (75%)	35 (71.4%)	NS	4 (33.3%)	NS

^aNo statistically significant P value: "CPAP" group compared to "None" group

^b p value: "IPPV" group compared to "None" group

^c p value: "CIE" group compared to "None" group

The median admission temperature was 36.3 °C (IQR range 35.9 °C – 36.7 °C). Admission hypothermia was found in 61.2% of the study population. Fifty-seven (38.7%) infants were normothermic, 51 (34.6%) were mildly hypothermic and 39 (26.5%) infants were moderately hypothermic. There were no severely hypothermic infants. The highest admission temperature was found in premature infants with completed 30 weeks of gestation (36.5 °C) (Fig 1).

Fig 1. Admission temperatures (degrees centigrade) and gestational age

Compared to the "None" group, the "IPPV" group had lower admission temperatures (35.7 °C vs. 36.2 °C, $p < 0.02$). "CPAP" and "CIE" groups were not associated with higher rates of admission hypothermia compared to "None" group (Table

2). Compared to "None" group, infants in the "CPAP" group had fewer Apgar scores < 7 in the first (0%, vs. 30.3%, $p < 0.02$) and fifth minute (0% vs. 25.7%, $p < 0.02$) and lower mortality before discharge (0% vs. 18.1%, $p < 0.02$).

Table 2. Admission temperature and outcomes among groups

	"None" (N=66)	"CPAP" (N=20)	<i>p</i> value ^a	"IPPV" (N=49)	<i>p</i> value ^b	"CIE" (N=12)	<i>p</i> value ^c
Admission temperature, mean \pm SD (°C)	36.2 \pm 0.77	36.4 \pm 0.49	NS	35.9 \pm 0.69	<0.02	35.7 \pm 1.44	NS
1-min. Apgar score < 7	20 (30.3%)	0 (0%)	<0.02	31 (61.2%)	<0.02	11 (91.6%)	<0.02
5-min. Apgar score < 7	17 (25.7%)	0 (0%)	<0.02	26 (53.0%)	<0.02	9 (75%)	<0.02
pH on admission, mean \pm SD	7.24 \pm 0.1	7.24 \pm 0.9	NS	7.15 \pm 0.13	<0.02	7.1 \pm 0.16	<0.02
RDS requiring surfactant	51 (77.2%)	11 (55.0%)	NS	41 (83.6%)	NS	11 (91.6%)	NS
PDA	8 (12.1%)	1 (5%)	NS	4 (8.1%)	NS	4 (33.3%)	NS
NEC ≥ 2 grade	13 (19.7%)	3 (15%)	NS	10 (20.4%)	NS	7 (58.3%)	<0.02
LOS	28 (42.4%)	7 (35.0%)	NS	25 (51.0%)	NS	9 (75.0%)	NS
Kidney failure	7 (10.6%)	0 (0%)	NS	5 (10.2%)	NS	4 (33.3%)	NS
IVH \geq grade III	16 (24.2%)	3 (15%)	NS	15 (30.6%)	NS	4 (33.3%)	NS
Mortality before discharge	12 (18.1%)	0 (0%)	<0.02	19 (38.7%)	NS	7 (58.3%)	<0.02

IVH, intraventricular hemorrhage; NEC, necrotizing enterocolitis; PDA, patent ductus arteriosus; RDS, respiratory distress syndrome; LOS, late onset sepsis

^a*p* value in the "CPAP" group compared to "None" group

^b*p* value in the "IPPV" group compared to "None" group

^c*p* value in the "CIE" group compared to "None" group

Compared to "None" group, infants in the "IPPV" group had more Apgar scores < 7 in the first (61.2%, vs. 30.3%, $p < 0.02$) and fifth minute (53.0% vs. 25.7%, $p < 0.02$) and lower pH values (7.15 vs. 7.24) but did not have lower mortality and morbidity.

Compared to the "None" group, the "CIE" group had more Apgar scores < 7 in the first (91.6%, vs. 30.3%, $p < 0.02$) and fifth minute (75.0% vs. 25.7%, $p < 0.02$) and lower pH values (7.11 vs. 7.24). They also exhibited higher incidence of NEC grade ≥ 2 (58.3% vs. 19.7%, $p < 0.02$) and higher mortality before discharge (58.3% vs. 18.1%, $p < 0.02$).

Discussion

This study aimed to analyze the impact of delivery room resuscitation efforts on admission temperatures in infants born < 32 weeks of gestation as well as short-term outcomes in infants treated in a Croatian Neonatal Intensive Care Unit, using the WHO classifications of hypothermia: mild hypothermia, 36.0 to 36.4 °C; moderate hypothermia, 32.0 to 35.9 °C; and severe hypothermia, below 32 °C (2). Hypothermia rates in our cohort are similar to those reported in other studies (3, 14, 15).

In our study, lower admission temperatures were significantly associated with intermittent positive pressure ventilation (IPPV) but were not associated with application of continuous positive airway pressure (CPAP) or extensive resuscitation efforts which include delivery room intubation, epinephrine administration or chest compressions.

The finding that CPAP application in the delivery room does not lead to increased hypothermia is consistent with Miller et al., who speculate that very low birth weight are healthier and better able to maintain normothermia (9). This is also reflected in the finding that these infants had significantly better Apgar scores in the first and fifth minute and had a low mortality before discharge. Also, this is consistent with previous findings that delivery room application of CPAP is beneficial regarding outcomes in premature infants (16, 17).

On the other hand, the findings that extensive resuscitation efforts which include delivery room intubation, epinephrine administration or chest compressions do not lead (to a statistically significant extent) to lower rates of admission hypothermia are consistent with findings of Lyu et al. (3), who demonstrated that admission hypothermia is not associated with extensive resuscitation efforts despite the fact that these infants are sicker and in poor condition. This is consistent with our findings that infants who require extensive resuscitation efforts have significantly lower birth weights, lower Apgar scores and lower pH values on admission and have a high rate of death before discharge.

Compared to infants who received standard thermal delivery room care, infants who received IPPV in the delivery room had lower admission temperatures. We speculate that there are several factors leading to this. These infants had significantly lower birth weight than the group that received only standard thermal care, but, on the other hand, this did not influence admission temperature in the extensive resuscitation group.

We speculate that lower admission temperature in the IPPV group could be the result of ventilating these infants with unheated gases. Duration of resuscitation must also be taken into consideration. This is one of the limitations of our study: duration of delivery room resuscitation efforts is not taken into consideration because no accurate data is noted in the charts. Also, the temperature of the delivery room at the time of delivery is unknown and, just like in other institutions, these temperatures are known to be below the WHO-recommended 25°C (2).

The limitations of the study are small sample size and a low number of infants receiving extensive resuscitation efforts in the delivery room. The effect of delivery room resuscitation procedures on admission temperatures in premature infants will require further investigation.

Promising results in maintaining normothermia in premature infants were recently published by Pinheiro et al. (18) regarding the use of chemical warming packs in achieving above-average admission temperatures in neonates. Also, simple and inexpensive methods including preheating the delivery room in expectance of a premature birth have shown to reduce admission hypothermia rates (19).

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