



ABSTRACTS COLLECTION

4th Congress of Joint European Neonatal Societies: Resuscitation

Pediatric Research (2021) 90:44–47; <https://doi.org/10.1038/s41390-021-01765-3>

Date: 14–18 September 2021

Location: Virtual Meeting

Sponsorship: Publication of this supplement was sponsored by MCA Events on behalf of the European Society of Paediatric Radiology (ESPR), Union of European Neonatal and Perinatal Societies (UENPS), European Foundation for the Care of Newborn Infants (EFCNI).

All content was reviewed and selected by the Scientific Committee and selected abstract reviewers, which held full responsibility for the abstract selections.

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ID 52. Impact of carbon dioxide on cerebral oxygenation and vital parameters in stable preterm and term neonates immediately after birth

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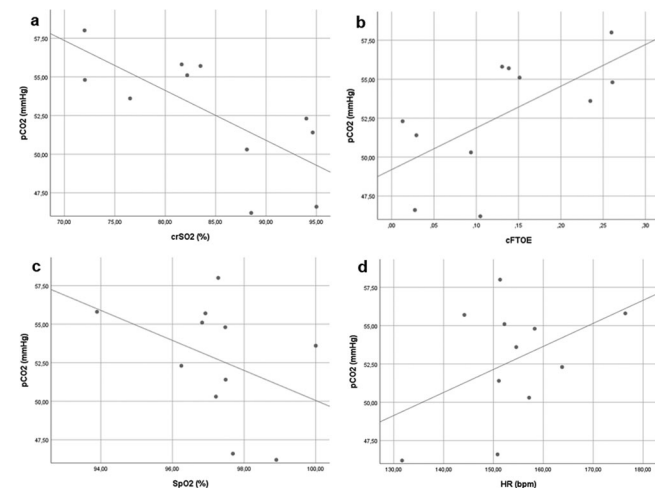
Background: Carbon dioxide (pCO₂) is one of the most potent mediators influencing cerebral auto-regulation and cerebral blood flow due to changes in the tone of cerebral vessels. The aim of the present study was to evaluate a potential correlation between pCO₂ and cerebral oxygen saturation (crSO₂), cerebral fractional tissue oxygen extraction (cFTOE) and cerebral tissue oxygen extraction (cTOE) measured with near-infrared spectroscopy (NIRS), and routine monitoring parameters [heart rate (HR), arterial oxygen saturation (SpO₂), mean arterial blood pressure (MABP) and rectal body temperature] 15 min after birth in preterm and term neonates with no need for medical support.

Methods: Secondary outcome parameters of prospective observational studies conducted between 2009 and 2018 at the Division of Neonatology Graz were analysed. Included were preterm and term neonates with NIRS monitoring during the first 15 min after birth and a blood gas analysis performed at discretion of the attending neonatologist between 14–18 minutes after birth. Excluded were neonates with respiratory and medical support. The NIRS measurements were performed with an INVOS monitor. cFTOE was calculated out of SpO₂ and crSO₂: cFTOE=(SpO₂-crSO₂)/SpO₂. The correlation between pCO₂ and NIRS parameters and clinical routine monitoring parameters in minute 15 after birth were calculated in preterm and term neonates.

Results: Eleven preterm neonates with a median(IQR) gestational age of 34.8 (32.7; 36.1) weeks were analysed. Median pCO₂ was 54.6 (49.0; 57.9) mmHg. In minute 15 after birth crSO₂ was 82.6 (74.3; 91.3)%, cFTOE 0.13 (0.06; 0.24), HR 152 (136; 167) bpm and SpO₂ 97.4 (95.2; 99.6)%. pCO₂ correlated significantly negatively with crSO₂ and positively with cFTOE and cTOE (Fig. 1a–d). Further, pCO₂ showed a trend towards positive correlation with HR and MABP and towards negative correlation with SpO₂.

84 term neonates with a median gestational age of 39.0 (38.5; 38.9) weeks were analysed. Median pCO₂ was 53.5 (51.7; 55.2) mmHg. In minute 15 after birth crSO₂ was 84.4 (80.8; 85.1)%, cFTOE 0.13 (0.12; 0.16), HR 155 (153; 163) bpm and SpO₂ 96.9 (95.8; 97.2)%. pCO₂ did not correlate with any parameter.

Conclusion: In preterm neonates higher pCO₂ values were associated with lower crSO₂ and higher cFTOE and cTOE values, whereas no association between pCO₂ and cerebral tissue oxygenation was observed in term neonates.



(ID 52) - Fig. 1a–d Correlations of blood gas pCO₂ and NIRS monitoring parameter (crSO₂ and cFTOE) and routine parameters (SpO₂ and HR) in 11 preterm neonates. None declared.

ID 69. Increased risk for cerebral hypoxia during immediate transition in healthy term neonates with prenatal tobacco exposure

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Background: Maternal tobacco smoking during pregnancy is a global issue and still prevalent. The impact of smoking on pregnancy related conditions and fetal and neonatal morbidities and mortalities are reported. The aim of the present study was to evaluate if healthy term neonates of mothers who had smoked during pregnancy differ in cerebral oxygen saturation (crSO₂) and cerebral fractional tissue oxygen extraction (cFTOE) measured with near-infrared spectroscopy (NIRS) during immediate postnatal transition from neonates of mothers who had not smoked during pregnancy.

Methods: Secondary outcome parameters of prospective observational NIRS studies conducted at the Division of Neonatology Graz were analyzed. Included were term neonates without medical support within the first 15 min after birth, when maternal information on their smoking behaviour during pregnancy were obtained. The NIRS measurements were performed with the INVOS 5100C monitor. Term neonates with prenatal tobacco exposure were stratified to the smoking group and those without prenatal tobacco exposure were stratified to the non-smoking group. The term neonates in the smoking group were matched according to gestational age (±1 week), birth weight (±100 g) and haematocrit value (±5%) to term neonates in the non-smoking group.

Results: 24 term neonates without medical support were included in the present analysis. 12 neonates were analyzed in smoking group with a median gestational age of 39.1 (38.8–39.3) weeks and birth weight of 3155 (2970–3472)g; and 12 neonates were analyzed in the non-smoking group with a gestational age of 39.1 (38.7–39.2) weeks and birth weight of 3134 (2963–3465)g. crSO₂ was significantly lower in the smoking group within the first five minutes after birth, whereby cFTOE was significantly higher in the smoking group. HR was also significantly higher in the smoking group in minute 3 after birth, compared to the non-smoking group. Afterwards, there were no significant differences in crSO₂, cFTOE, SpO₂ and HR between the two groups.

Conclusion: To conclude, in healthy term neonates with prenatal tobacco exposure lower crSO₂ and higher cFTOE were observed compared to neonates without within the first 5 min after birth. Risk for cerebral hypoxia is increased due maternal smoking during pregnancy. None declared.

ID 280. Fixed pressure devices (T-pieces) or hand driven pressure devices (BAGS) for resuscitation at birth: a systematic review and meta-analysis

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Background: Initial management of inadequate adaptation to extrauterine life relies on non-invasive respiratory support. Two types of devices are commonly available: fixed pressure devices (FP; T-pieces or ventilators) and hand driven pressure devices (HDP; eg self-inflating bags). There is no consensus about benefits that each option offers. However, some studies reported a higher incidence of pneumothorax since T-piece utilisation.

Methods: A systematic review and meta-analysis was carried out. Medline, Embase, Scopus and Cochrane Library of Trials were searched. Randomised, quasi-randomised studies and prospective cohorts comparing the use of the two types of devices in neonatal resuscitation were included.

Results: Eight (8) studies recruiting 3571 newborns were included: 4 RCTs, 2 qRCTs and 2 prospective cohorts. Mortality was decreased in FP group (OR 0.57 95% CI (0.47–0.69)–NNT 12.5). Several respiratory outcomes were also improved: intubation in the delivery room (OR 0.55 (0.39–0.79)–NNT 7), mechanical ventilation (OR 0.58 (0.42–0.80)–NNT 7) and its duration (SMD –0.16 (–0.29 to –0.03)), surfactant administration in premature infants (OR 0.67 (0.55–0.82)–NNT 30) and combined risk of mortality or bronchopulmonary dysplasia (RR 0.60 (0.50–0.71)–NNT 9). Decreases in mortality, intubation and mechanical ventilation rates remained when focusing on randomized studies (RR 0.62 (0.41–0.94), RR 0.61 (0.38–0.99) and RR 0.72 (0.53–0.98) respectively). Common morbidities of premature birth as patent ductus requiring treatment, intraventricular haemorrhage, retinopathy of premature and necrotizing enterocolitis were similar in the two groups. The risk of cystic periventricular leukomalacia decreased significantly with FP (OR 0.59 (0.41–0.85)–NNT 27). Finally, there wasn't any significant difference in pneumothorax rates between the two groups (OR 0.82 (0.44–1.52)).

Conclusion: Resuscitation at birth with fixed pressure devices increases its effectiveness, without increasing morbidity. Longer term benefits may include decreased mortality, mortality or bronchopulmonary dysplasia, and cystic periventricular leukomalacia.

Devices providing fixed pressures should therefore prevail for resuscitation at birth.

Other

No founding

Registration: PROSPERO 2020 CRD42020191685

None declared.

ID 324. Video analysis of thermal care for very preterm infants in the delivery room

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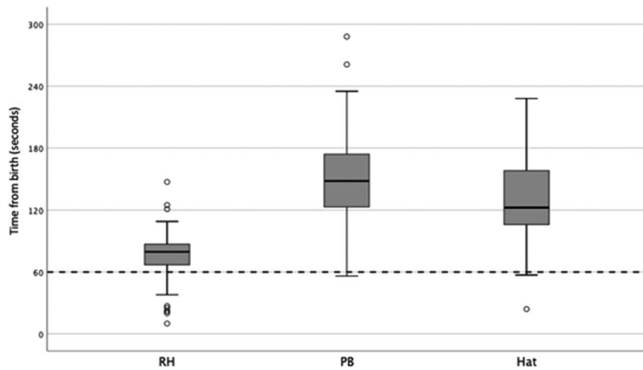
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Objective: Hypothermia is an independent risk factor for mortality in preterm infants. Neonatal resuscitation guidelines now recommend waiting for at least 1 minute after birth before cord clamping (CC) in uncompromised preterm infants. We aimed to observe and document the timing of warming interventions in the era of "delayed cord clamping".

Study design: We observed video room recordings of infants born <32 weeks' gestation at our hospital between September 2016–March 2020. We estimated time of CC based on the time of arrival to the resuscitation trolley. We determined the time from birth to placement under radiant heat, application of a hat and a polyethylene bag (PB). We report the proportion of infants in whom these tasks were completed within 60 s from (i) birth and (ii) arrival at the resuscitation trolley. We recorded the median time to perform each task.

Results: 108 videos were suitable for analysis (median [IQR] gestational age 27 [26–29] weeks and birthweight 1007 [780–1303] grams). Seventeen (15%) infants underwent CC <60 s after birth. Sixty seconds after birth; 17 (16%) infants were under radiant heat and 12 (11%) had a hat placed. Seventeen (15%) infants were placed in a PB prior to arrival at the resuscitation trolley. Most (n = 88, 98%) of the remainder were not in a PB by 60 s after birth. At 60 s after arrival at the resuscitation trolley; 74 (70%) had a hat placed and 100 (93%) were in a PB. The median time to perform all tasks from the time of birth was greater than that recommended by the guidelines.

Conclusion: Initial steps to preserve heat in newly born very preterm infants now takes more time to perform than guidelines recommend. Neonatal resuscitation guidelines should consider that an increased time to CC impacts the time to initiation of thermal care.



The horizontal dashed line shows the recommended time of 60 seconds to complete the task.

(ID 324) - Boxplot showing median (IQR) and outliers for time to complete tasks. RH: placement under radiant heat. PB: Placement in a polyethylene bag. Hat: placement of a hat. None declared.

ID 362. Resuscitation after cardiac arrest in a newborn piglet model of LPS induced sepsis; randomization to epinephrine versus placebo and the effects on ROSC and markers of CNS outcome

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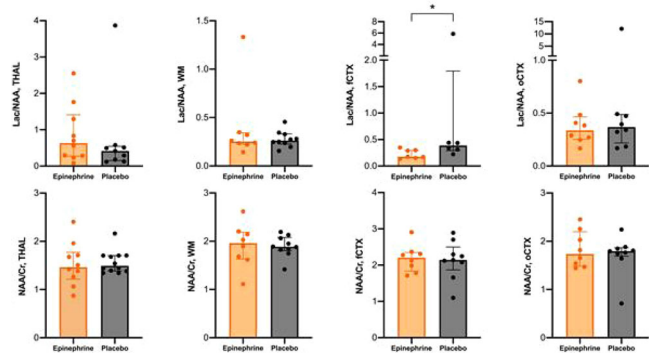
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Background: Most cardiac arrests (CA) in newborns are presumed of hypoxic origin, yet a number of preexisting conditions, e.g. sepsis, have been associated with high risk of requiring resuscitation. Epinephrine is part of the resuscitation guidelines; however, epinephrine may not be the optimal treatment in sepsis associated CA (SA-CA), as epinephrine and sepsis are both potential risk factors of adverse neurologic outcome. We aimed to investigate the effect of epinephrine vs. placebo on (1) return of spontaneous circulation (ROSC), (2) time-to-ROSC, and (3) markers of CNS outcome, in a piglet model of neonatal SA-CA.

Methods: Sepsis was induced in 30 newborn piglets by continuous infusion of lipopolysaccharide (LPS) from *Escherichia coli*. After 4 h of LPS infusion, hypoxia was induced by clamping the endotracheal tube until CA (mean arterial blood pressure <20 mmHg and heart rate <60 bpm). CPR was initiated 5 min after CA. The animals were randomized to either CPR + intravenous epinephrine or CPR + placebo (saline). The primary outcome was ROSC and secondary outcomes were time-to-ROSC and markers of CNS outcome measured by magnetic resonance imaging and -spectroscopy (MRI/MRS) 14 h after ROSC.

Results: We found no difference in ROSC (RR = 0.93 (95% CI: 0.70–1.18)) or time-to-ROSC between animals resuscitated with epinephrine compared to placebo. The Lac/NAA ratio in frontal cortex was significantly lower in animals that received epinephrine (median Lac/NAA ratio; epinephrine: 0.17 vs. placebo: 0.39; p = 0.02); though, all remaining MRS measures showed no difference between the two groups (Fig. 1). We found no difference between groups in MRI measures of cerebral edema, cerebral oxygenation, or cerebral perfusion.

Conclusion: Resuscitation with epinephrine compared to placebo did not affect ROSC or time-to-ROSC after neonatal SA-CA. Based on Lac/NAA ratio, the brain damage in frontal cortex was less severe in animals resuscitated with epinephrine. Remaining MRI/MRS biomarkers of brain damage showed no difference between groups. This study provides evidence that epinephrine is a safe treatment to apply during resuscitation with regards to CNS outcome. Yet, epinephrine was nonessential to achieve ROSC, and other therapies might prove more beneficial in neonatal SA-CA.



(ID 362) - Fig. 1. Magnetic resonance spectroscopy. NAA N-acetyl-aspartate, Cr creatine, THAL thalamus, WM white matter, fCTX frontal cortex, cCTX occipital cortex. Scatter plots with superimposed medians (IQR). *p < 0.05 epinephrine vs placebo. None declared.

ID 364. The association between admission temperature and adverse outcomes in premature infants with gestational age less than 32 weeks: systematic review and meta-analysis

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Background: Although it may sound simple and easy, to keep a newborn warm immediately after birth appears to be difficult and hypothermia occurs frequently. Occurrence of hypothermia, most often defined as a temperature <36°C, in the early postnatal period during this transition period in the first hours of their life. Hypothermia has been associated with adverse outcomes including hypoglycaemia, bronchopulmonary dysplasia, necrotising enterocolitis, intraventricular haemorrhage, and even death in some, but not all studies.

Methods: A systematic review and meta-analysis was performed considering the association between admission hypothermia upon arrival at the NICU and adverse outcomes in premature infants born <32 weeks. Outcomes of interest were mortality and neonatal morbidities. A random effects analysis was performed.

Results: After screening 7094 studies, 36 studies were analyzed full-text of which 18 studies were included in this review. In total n = 63,170 infants were included, varying from 50 to 9833 between studies.

All but two studies reported on mortality, ten studies reported on IVH, seven on sepsis, eight studies reported on NEC, six on BPD and six studies on ROP. One study reported on the combined outcome of BPD/IRDS and mortality.

Mortality data for hypothermia compared to normothermia could be extracted for 12/18 studies (67%) (n = 44,906). Hospital mortality was reported in five studies, early neonatal mortality in one study, both in one study and for five studies no definition of mortality was provided. Overall crude RR for mortality in the hypothermia group compared to normothermia was 1.85 (1.66–2.06) (12 studies) (Table 1). The majority of studies which presented adjusted effect measures used birthweight, gender, antenatal corticosteroids and 5 min Apgar score.

Studies for which both crude and adjusted effect estimates were provided or could be calculated showed lower effect estimates after adjustments in all nine studies (Table 1). For crude RR for neonatal morbidities see Table 1.

Conclusion: Hypothermia is associated with mortality in preterm infants in both crude and adjusted analysis. The strength of this association may be influenced by confounders, definitions of hypothermia and exclusion criteria.

Outcome	RR	95% CI	No. of studies
Overall crude mortality	1.851.66;	2.0612	
Crude mortality (hypothermia <36 °C)	2.001.77;	2.279	
Crude mortality (hypothermia <36.5 °C)	1.911.62;	2.257	
Pooled adjusted RR for mortality	1.221.08;	1.382	
Overall crude mortality OR	2.161.92;	2.4212	
Pooled adjusted OR for mortality	1.531.4;	1.68 7	
Crude RR for NEC	1.150.93;	1.426	
Crude RR for IVH	1.241.08;	1.437	
Crude RR for BPD	1.120.97;	1.296	
Crude RR for sepsis	1.181.06;	1.355	
Crude RR for ROP	1.471.35;	1.616	

(ID 364) - Table 1. Crude and adjusted risk ratio's for mortality and neonatal morbidities for admission hypothermia compared to normothermia. None declared.

ID 501. Delivery-associated intrauterine cord obstruction and delayed cord clamping affects blood gas values but not NEC sensitivity in preterm pigs

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Background: Hypoxia and ischemia from cord obstruction during delivery may negatively affect lung, brain and gut functions in preterm infants. Moreover, optimal cord clamping procedures may support postnatal adaptation. At cesarean section, it remains unclear if delayed cord clamping improves fetal-to-neonatal transition, relative to immediate clamping and umbilical cord milking. Using caesarean-delivered preterm pigs as models, we hypothesized that (1) preterm birth negatively affects adaptation to delivery-associated intrauterine cord and (2) delayed cord clamping improves vital signs and adaptation in preterm pigs, including later sensitivity to necrotizing enterocolitis (NEC).

Methods: Experiment 1: Piglets delivered by caesarean section at preterm (90% gestation, n = 41) or near-term (98% gestation, n = 51) were subjected to intrauterine cord obstruction (5–7 min), or immediate delivery with umbilical cord milking before cord transection. Experiment 2: Caesarean-delivered preterm piglets (90% gestation) were subjected to umbilical cord milking (n = 30) or delayed cord clamping (1 min, n = 34) before cord transection. Vital signs and blood gases were followed for 4 days of formula-feeding, predisposing to gut NEC lesions.

Results: Experiment 1: Intrauterine cord obstruction induced a mixed respiratory-metabolic acidosis in both preterm and near-term pigs just after birth (Table 1), which for surviving pigs normalized within few hours of life. The obstruction was less tolerated by preterm pigs, resulting in difficult resuscitation and higher mortality, relative to near-term pigs (88% mortality versus 13% mortality within 1 h). Experiment 2: Preterm pigs benefited from delayed cord clamping, as indicated by higher blood pH and lower pCO₂ in the first 24 h (no differences in saturation, heart rate, blood pressure, hematology). NEC incidence on day 4 was not affected by intrauterine cord obstruction in near-term pigs, nor by delayed cord clamping in preterm piglets.

Conclusion: Delivery-associated hypoxia/ischemia is less tolerated by preterm than near-term pigs. Following caesarean delivery, delayed cord clamping induced a moderate improvement in neonatal physiological adaptation in preterm pigs relative to cord milking. Immediate postnatal NEC sensitivity was not affected by birth hypoxia or cord clamping procedures, but longer-term effects on organ maturation remain to be determined. In perspective, preterm pigs is a relevant model to study the effects of delivery-associated complications on later morbidities.

		pH		pCO ₂ (mmHg)		Lactate (mmol/L)		NEC (%)Mortality (1 h)
		Birth	4 h	Birth	4 h	Birth	4 h	
Experiment 1	Preterm DICO (n = 24)	7.12 ± 0.08*	7.45 ± 0.04	99.7 ± 14.3*	46.2 ± 3.7 5.3 ± 1.4*	2.9 ± 0.9	—	88%
	Controls (n = 17)	7.30 ± 0.01	7.48 ± 0.06	72.7 ± 11.0	43.3 ± 6.0 3.4 ± 0.9 2.3 ± 0.9	—	—	47%
	Near-term DICO (n = 29)	7.16 ± 0.09*	7.39 ± 0.12	94.2 ± 15.1*	49.2 ± 7.3 5.2 ± 1.6*	2.8 ± 2.7	—	32%
	Controls (n = 22)	7.32 ± 0.03	7.38 ± 0.09	68.8 ± 3.5 49.7 ± 8.0	2.5 ± 0.3 3.4 ± 1.8	—	—	9%
Experiment 1		Baseline	4 h	Baseline	4 h	Baseline	4 h	NEC (%)Mortality (1 h)
	Preterm DCC (n = 34)	7.28 ± 0.09*	7.37 ± 0.09*	67.3 ± 11.3*	58.7 ± 10.9*	3.3 ± 1.0 2.1 ± 1.0	—	46% 3%
	Preterm UCM (n = 30)	7.20 ± 0.08	7.25 ± 0.15	74.2 ± 10.8	74.1 ± 17.7	4.5 ± 1.4 2.2 ± 1.0	—	57% 0%

All data presented as means with ± standard deviations. Birth, time of delivery; Baseline, 2 hours after delivery; 4 h, 4 hours after delivery; DICO, delivery-associated intrauterine cord obstruction; DCC, delayed cord clamping; UCM, umbilical cord milking; NEC, necrotizing

enterocolitis; n, numbers; *p < 0.05 compared to control in experiment 1, or UCM in experiment 2 at same time point; —, not recorded.

(ID 501) - Table 1. Differences in blood gases, NEC and neonatal mortality in Experiments 1 and 2
None declared.

ID 502. A randomised controlled study of low-dose, high-frequency simulation training for competence in neonatal resuscitation

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Background: Simulation training shows potential to increase competence in time-critical interventions such as positive pressure ventilation (PPV) of non-breathing newborns. The unpredictable need for neonatal resuscitation means many different healthcare personnel (HCP), potentially with very little real-life experience, may be required to initiate PPV until competent help arrives.

Method: A novel, high-fidelity newborn simulator, facilitating low-dose, high frequency training (LDHFT) in PPV and giving immediate performance feedback, was used in a randomised controlled study of the effect of simulation training in six different groups of HCPs commonly present at neonatal resuscitations.

187 HCPs were recruited and baseline competence was assessed in two simulations of differing difficulty (test 1). After a 3-h personalised education session, participants were tested again with the same two scenarios (test 2) and randomised to train twice a month, or as desired, over a 9-month period. Test 3 repeated the same two scenarios after 9 months of own-training.

Each test was observed by the same investigator and scored according to demonstration of knowledge (to a maximum of 10 points) and ventilation performance assessed objectively by the simulator (to a maximum of 30 points) giving a total of 40 points for each scenario.

Results: Mean score of both scenarios at test 1 was 31.2. Paediatricians scored significantly higher than all other groups except anaesthetists. Following the educational session, the mean score rose to 37.9 with no significant difference between HCP groups. 104 HCPs randomised to train as desired performed an average of 2.8 own-trainings, while 83 HCPs randomised to train twice a month performed an average of 8 trainings. Average score at test 3 was 36.3 with no significant difference according to randomisation or between HCP groups. Subgroup analysis comparing no training to 9 or more trainings shows a significant difference at test 3 in favour of LDHFT.

Conclusion: Study participation resulted in equivalent, high-scoring performance in all HCPs at tests 2 and 3. No difference at T3 according to randomisation may reflect protocol violation. Subgroup analysis shows clear benefit to LDHFT for some HCPs, including anaesthesia nurses and paediatric nursing assistants. PPV competence can be trained.



(ID 502) - Study participant performing PPV with neonatal heart rate displayed both on a monitor applied to the manikin and via the simulator App on a tablet device.

The author is a recipient of PhD funding from Laerdal Global Health Fund. The neonatal simulator is produced by Laerdal Medical.

ID 547. Positive pressure ventilation at birth using a disposable infant T-piece resuscitator (NEO-TEE®) versus a self-inflating bag—a randomized-controlled mannequin study

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Background: Where resources permit, a T-Piece resuscitator is recommended over a self-inflating bag (SIB) to provide positive pressure ventilation (PPV) in neonates at birth. In low-resource environments (e.g., out of hospital), SIBs are frequently used for bag-valve-mask ventilation in cases of neonatal emergencies. A disposable infant T-Piece resuscitator (Neo-Tee®) is a relatively new and cost-effective device that may allow PPV at birth with all advantages of a T-Piece resuscitator even in low-resource environments and could potentially be used by emergency physicians or paramedics in out-of-hospital settings. Therefore, we investigated whether there are differences in paramedics' ventilation quality during simulated PPV in neonates by using Neo-Tee® compared to a SIB.

Methods: Randomized-controlled mannequin study in 25 voluntary paramedics from the Austrian Red Cross were included. Prior participation, participants received training with both ventilation devices: (i) disposable infant T-Piece resuscitator (Neo-Tee® Mercury Medical, Clearwater, Florida, U.S.A.) [default settings: positive inspiratory pressure (PIP) of 25 cm H₂O, positive end-expiratory pressure (PEEP) of 5 cm H₂O, gas flow of 8l/min] and (ii) SIB (Ambu® Mark IV Baby, Ambu, Denmark) [PEEP valve at 5 cm H₂O, pressure-limiting valve at 40 cm H₂O, without manometer]. Participants were asked to deliver adequate PPV to a modified leak-free term

manikin (GM Instruments, U.K.) via face mask for 60 s with each device in a random order. PIP, PEEP, expiratory tidal volume (VTe), mask leak, and ventilation rate were recorded using a respiratory function monitor (SMART Resuscitation Mask Leak Trainer, GM Instruments, U.K.).

Results: A total of 2250 inflations were analyzed. The Neo-Tee® compared to the SIB resulted in a mean (SD) PIP and PEEP of 22.2 (16.0) versus 32.4 (11.7) cm H₂O ($p < 0.001$) and 2.7(0.8) versus 3.9(1.5) cm H₂O ($p = 0.001$), respectively. VTe was higher with the Neo-Tee® with 40.8 (13.3) versus 29.7 (8.9) mL with the SIB ($p = 0.001$). Mask leak was lower with the Neo-Tee®

compared to the SIB with 16 (24) versus 42 (26)% ($p < 0.001$), while ventilation rate was similar with 43 (11) versus 39 (10)min⁻¹ ($p = 0.032$).

Conclusion: During simulated PPV in neonates with Neo-Tee® delivered by paramedics, we found significantly lower PIP and significantly reduced mask leak, while VTe was significantly higher compared to bag-valve-mask ventilation. These findings suggest paramedics' PPV with Neo-Tee® is feasible and warrants studies in human patients.

None declared.