2024 VON Grand Rounds Date: 08/14/2024

Planners: Roger Soll MD; Denise Zayack RN, MPH

Speaker(s): Roger Soll MD, Danielle Ehret MD, Erika Edwards PhD, Elizabeth Foglia MD, MA, MSCE

Purpose Statement/Goal of this Activity: The 2024 VON Grand Rounds webinar series will provide evidence reviews, a summary of the current practice guidelines, a synthesis of the application of evidence in real work practice settings and will be supported by discussion and question and answer opportunities with expert faculty

The following have relevant financial relationships with ineligible companies (all have been mitigated):
All other speakers/planners/CMIE reviewers do not have ay relevant financial relationships.

This activity did not receive any support for ineligible companies (grants or in-kind).

All recommendations involving clinical medicine made during this talk were based on evidence that is accepted within the profession of medicine as adequate justification for their indication and contradictions in the care of patients.

In support of improving patient care, this activity ahs been planned and implemented by The Robert Larner College of Medicine at the University of Vermont and Vermont Oxford Network. The University of Vermont is jointly accredited by the Accreditation Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialling Center (ANCC), to provide continuing education for the healthcare team.

The University of Vermont designates this live activity for a maximum of 1.0 *AMA PRA Category 1 Credit(s)™*. Physicians should claim only the credit commensurate with the extend of their participation in the activity.

This program has been reviewed and is acceptable for up to 1.0 Nursing Contact Hours.

This activity was planned by and for the healthcare team, and learners will receive 1 Interprofessional Continuing Education (IPCE) credit for learning and change.

1

VON Grand Rounds

Evidence to Practice: Preventing Hypothermia

August 14th, 2024

VON Vermont Oxford NETWORK

2

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Moderators

Roger F. Soll, MD
H. Wallace Professor of Neonatology, University of Vermont
Coordinating Editor, Cochrane Neonatal
Director, VON Institute for Evidence Based Practice, Vermont Oxford Network

Danielle Ehret, MD, MPH
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Chief Medical Officer, Director, Global Health, Vermont Oxford Network

3

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Discussants

Elizabeth Foglia, MD, MA, MSCE
Associate Professor of Pediatrics
Perelman School of Medicine at the University of Pennsylvania

Erika Edwards PhD
Research Professor
University of Vermont
Chief Scientific Officer,
Vermont Oxford Network

4

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5

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Evidence to Practice: Preventing Hypothermia

Disclosures

Danielle Ehret MD, MPH is the Director of Global Health and Chief Medical Officer at Vermont Oxford Network (VON) and receives salary support to UVM for non-clinical time dedicated to her leadership roles.

Elizabeth Foglia, MD, MSCE has received consulting fees from Chiesi USA who have also funded a grant to her institution. She is a member of the International Liaison Committee on Resuscitation (ILCOR) Neonatal Life Support Task Force and also the NRP Steering Committee. Previously, Dr. Foglia has consulted with Medtronic.

Erika Edwards, PhD is the Chief Scientific Officer at VON.

Roger F. Soll, MD is the H. Wallace Professor of Neonatology at the Larner College of Medicine at the University of Vermont, Vice President of the Vermont Oxford Network, Director of the VON Institute for Evidence Based Practice, and Coordinating Editor of Cochrane Neonatal. He is a consultant with the International Liaison Committee on Resuscitation (ILCOR).

No other relevant financial issues to disclose

6

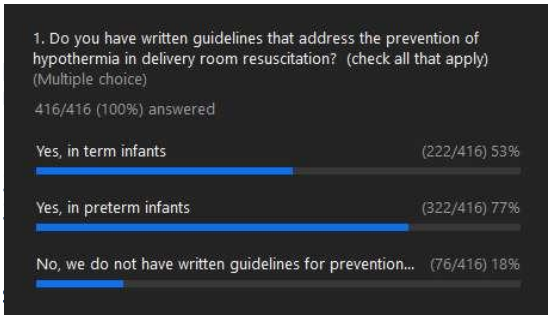
How to Participate in Today's Webinar

- Chat questions and comments to "Everyone" during the presentations and discussion.
- Respond to Zoom poll questions posed during the session. Select your answer(s) and click "Submit". Please do not respond to polls via Chat.

7

Poll Question

Guidelines



8

Evidence to Practice: Preventing Hypothermia

Roger F. Soll, MD
H. Wallace Professor of Neonatology, University of Vermont
Coordinating Editor, Cochrane Neonatal
Director, VON Institute for Evidence Based Practice, Vermont Oxford Network

9

Evidence to Practice: Preventing Hypothermia

Evidence synthesis for informed decisions and better health: prevention of hypothermia in preterm infants.

1. What are our goals?
2. Does preventing hypothermia make a difference?

10

Thermoregulation in preterm infants

Impact

Abnormal temperature is common among very preterm infants after birth and is an independent risk factor for mortality.

The current guidelines recommend a combination of interventions to prevent heat loss after birth.

Despite this, abnormal temperature is still a problem, across all climates and economies.

Dunne and colleagues. Thermoregulation for very preterm infants in the delivery room: a narrative review. *Pediatr Res* 95, 1448–1454 (2024). https://doi.org/10.1038/s41390-023-02902-w

11

NeoReviews™

Thermoregulation: Advances in Preterm Infants.

Smita Roychoudhury, Kamran Yusuf.

Neoreviews December 2017; 18 (12): e692–e702.

https://doi.org/10.1542/neo.18-12-e692

12

Thermoregulation in preterm infants

Newborns must undergo many adaptations after delivery to adjust to extrauterine life.

One of the paramount adjustments is the need to rapidly increase body temperature and strive to accommodate to an environment colder than that of the prenatal milieu.

The temperature of a fetus is slightly above the maternal temperature but within a few minutes after birth, the neonatal core temperature begins to fall.

Keeping newborns warm, especially preterm infants, can be challenging.

Smita Roychoudhury, Kamran Yusuf; Thermoregulation: Advances in Preterm Infants. *Neoreviews* December 2017; 18 (12): e692–e702. https://doi.org/10.1542/neo.18-12-e692

13

Thermoregulation in preterm infants

Thermoregulation in the Context of Preterm Infants

Compared with term infants, preterm infants are at higher risk for hypothermia because of several unique characteristics:

Preterm infants can only maintain core temperatures in a narrow range of environmental temperatures.

They have a greater ratio of skin surface to body weight leading to more radiant heat loss and eventually, more insensible losses.

Thermogenesis is compromised; brown fat may not be well-developed until 26 to 30 weeks of gestation.

Smita Roychoudhury, Kamran Yusuf; Thermoregulation: Advances in Preterm Infants. *Neoreviews* December 2017; 18 (12): e692–e702. https://doi.org/10.1542/neo.18-12-e692

14

Thermoregulation in preterm infants

Hypothermia and the history of modern neonatology

Silverman, a pioneer in the field of modern neonatology, observed significant mortality among low-birthweight infants who were hypothermic on admission to the nursery and in the first few days after birth.

They noted a striking improvement in survival rates if infants were cared for in warm environments, especially in the first 5 days after birth.

Silverman, W. A., Fertig, J. W. & Berger, A. P. The influence of the thermal environment upon the survival of newly born premature infants. Pediatrics 22, 876–886 (1958).

15

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How do we define hypothermia?

Clinical condition	Body temperature	
Hyperthermia	Greater than 37.5° C	Measured with a digital, mercury, or contactless thermometer (axillary, rectal, or other defined site) on admission to a postnatal ward or neonatal unit; or if admission temperature not reported, temperature measured between 30 to 60 minutes of age
Normothermia	**36.5° C to 37.5° C**	
Cold stress	36.0° C to 36.4° C 96.8°F to 97.5°F	
Moderate hypothermia	32.0° C to 35.9° C 89.6°F to 96.6°F	
Severe hypothermia	Less than 32° C	

World Health Organization. Thermal protection of the newborn: a practical guide. 1997. Accessed February 8, 2021. https://apps.who.int/iris/bitstream/handle/10665/63986/WHO_RHT_MSM_97.2.pdf

16

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Admission temperature of low birth weight infants: predictors and associated morbidities.

Laptook AR, Salhab W, Bhaskar B; Neonatal Research Network.

Pediatrics. 2007 Mar;119(3):e643-9. doi: 10.1542/peds.2006-0943.

Available at:
www.pediatrics.org/cgi/content/full/119/3/e643[PubMed]

17

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Admission temperature of low birth weight infants: predictors and associated morbidities.

Background: There is a paucity of information on the maintenance of body temperature at birth for low birth weight infants.

Objectives: We examined the distribution of temperatures in low birth weight infants on admission to the NICUs in the Neonatal Research Network centers and determined whether admission temperature was associated with antepartum and birth variables and selected morbidities and mortality.

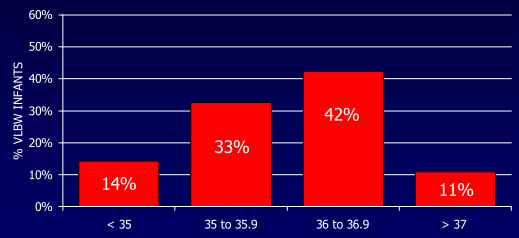
Methods: Infants without major congenital anomalies born during 2002 and 2003 with birth weights of 401 to 1499 g who were admitted directly from the delivery room to the NICU were included.

Bivariate associations between antepartum/birth variables and admission temperature and selected morbidities/mortality and admission temperature were examined, followed by multivariable linear or logistic regressions to detect independent associations.

Laptook and colleagues. Admission temperature of low birth weight infants: predictors and associated morbidities. Pediatrics. 2007 Mar;119(3):e643-9. doi: 10.1542/peds.2006-0943.

18

Distribution of temperatures in low birth weight infants on admission to the NICUs in the Neonatal Research Network 2002 to 2003



5277 study infants and the mean (+/-SD) birth weight and gestational age were 1036 +/- 286 g and 28 +/- 3 weeks, respectively.

19

American Academy of Pediatrics
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Admission temperature of low birth weight infants: predictors and associated morbidities.

Results:

On adjusted analyses, admission temperature was inversely related to mortality (28% increase per 1 degrees C decrease) and late-onset sepsis (11% increase per 1 degrees C decrease) but not to intraventricular hemorrhage, necrotizing enterocolitis, or duration of conventional ventilation.

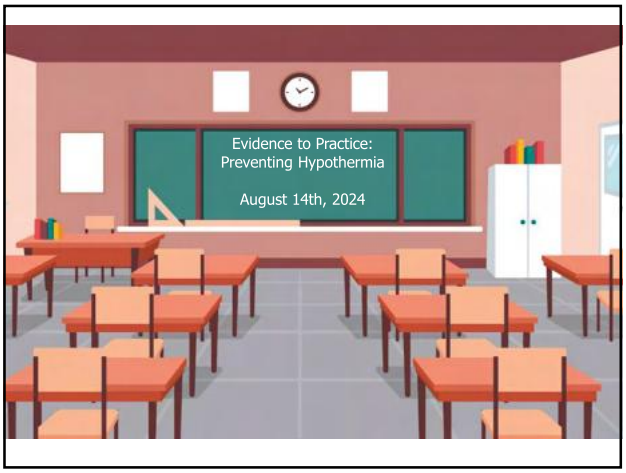
Conclusions:

Preventing decreases in temperature at birth among low birth weight infants remains a challenge.

Whether the admission temperature is part of the casual path or a marker of mortality needs additional study.

Laptook and colleagues. Admission temperature of low birth weight infants: predictors and associated morbidities. Pediatrics. 2007 Mar;119(3):e643-9. doi: 10.1542/peds.2006-0943.

20



21

Evidence to Practice: Preventing Hypothermia

Mechanisms of heat loss

22

Mechanisms of heat loss: evaporation

Evaporation is one of the main ways in which a baby can lose heat when it is born.

Water loss occurs through the skin or respiratory tract.

Preterm infants are especially at risk of heat loss through evaporation as their immature skin loses water more easily, and their high respiratory rates cause more water loss on their breath.

At birth, a baby is wet and there is a dramatic temperature drop between the intrauterine and extrauterine environments.

There is a linear relationship between the ambient humidity and the evaporation rate, with higher evaporation rates at lower levels of humidity.

Evaporative losses can be enormous and may total up to 200 kcal/kg per minute!

https://www.efcni.org/2020_10_14_Thermoregulation_Factsheet_english-1.pdf (efcni.org)

23

Mechanisms of heat loss: convection

Heat is transferred by convection when air currents carry heat away from the body surface.

Convective heat loss occurs at birth when the baby is exposed to the draft from open doors or air conditioning units.

Raised sides on cots, incubators and warmers can help prevent convection currents.

https://www.efcni.org/2020_10_14_Thermoregulation_Factsheet_english-1.pdf (efcni.org)

24

Mechanisms of heat loss: conduction

Conductive heat loss occurs when heat is lost from the baby coming into direct contact with a cold surface or object, for example, wrapping in a cold blanket.

Pre-warming surfaces and fluids will minimize conductive heat losses while caring for a preterm baby.

https://www.efcni.org/2020_10_14_Thermoregulation_Factsheet_english-1.pdf (efcni.org)

25

Mechanisms of heat loss: radiation

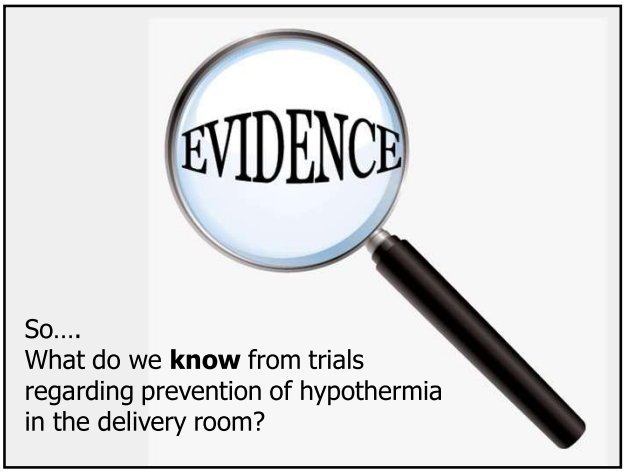
All body surfaces emit heat energy in the form of electromagnetic waves, which is called radiant heat loss.

A baby may lose heat due to a cold wall or window located nearby.

Likewise, a preterm baby can be warmed by an overhead warmer.

https://www.efcni.org/2020_10_14_Thermoregulation_Factsheet_english-1.pdf (efcni.org)

26



So....
What do we **know** from trials regarding prevention of hypothermia in the delivery room?

27

Pediatric RESEARCH

Thermoregulation for very preterm infants in the delivery room: a narrative review.

Dunne, E.A., O'Donnell, C.P.F., Nakstad, B. *et al.*

Pediatr Res (2024). https://doi.org/10.1038/s41390-023-02902-w

Dunne and colleagues. Thermoregulation for very preterm infants in the delivery room: a narrative review. *Pediatr Res* (2024). https://doi.org/10.1038/s41390-023-02902-w

28

ILCOR Treatment Recommendations 2023

Dawson, JA, Ramaswamy, VV, de Almeida, MF, Trang, J, Trevisanuto, D, Nakwa, F, Kamlin, C, Weiner, G, Wyckoff, MH, Liley, HG; International Liaison Committee on Resuscitation Neonatal Life Support Task Force.

Maintaining normal temperature immediately after birth in preterm infants: NLS 5101 TF SR.

29

ILCOR Treatment Recommendations 2023

PICOST

Population: Preterm infants (< 34 weeks' gestation at birth)

Intervention: Any of the following: increased room temperature ≥ 23.0° C, thermal mattress, plastic bag or wrap, hat, heating and humidification of gases used for resuscitation, radiant warmer (with or without servo control), early monitoring of temperature, warm bags of fluid, swaddling, skin-to-skin care with mother, or combinations of these interventions

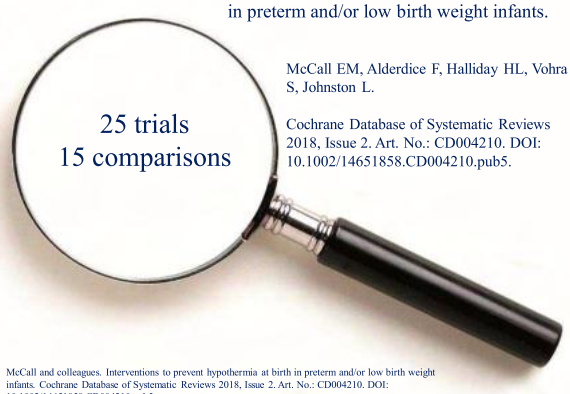
Comparators: Drying alone or with use of a plastic bag or wrap, or comparisons between interventions

Outcomes:
- Critical: Survival to hospital discharge
- Important: Rate of normothermia; moderate hypothermia; cold stress; hyperthermia; body temperature; response to resuscitation (need for assisted ventilation, highest Fio2); major morbidity, including bronchopulmonary dysplasia, intraventricular hemorrhage (all grades), and severe (critical); necrotizing enterocolitis; respiratory distress syndrome; and late-onset sepsis

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

30

Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants.



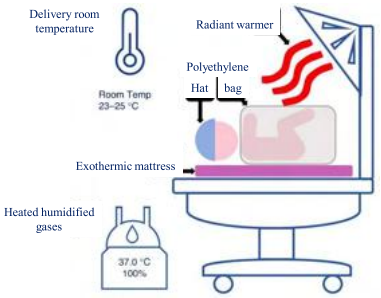
McCall EM, Alderdice F, Halliday HL, Vohra S, Johnston L.

Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

McCall and colleagues. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

31

Interventions to improve thermoregulation for very preterm infants in the delivery room



Dunne and colleagues. Thermoregulation for very preterm infants in the delivery room: a narrative review. *Pediatr Res* (2024). https://doi.org/10.1038/s41390-023-02902-w

32

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Evidence to Practice: Preventing Hypothermia

External heat sources:

- Delivery room temperature
- Radiant heat
- Thermal mattress
- Skin to skin care
- Heated humidified gases

33

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Preventing Hypothermia
Delivery room temperature

Delivery rooms are usually kept at a temperature that is comfortable for the delivering mother and for the attending staff.

However, this practice will clearly increase heat loss in infants due to both conduction and convection.

Cold delivery rooms (delivery rooms maintained at a temperature < 26°C) have been associated with colder admission temperatures in the NICU for ELBW infants (Knobel 2005).

Raising delivery room temperature may be one of the most direct ways that hypothermia and cold stress can be addressed.

34

Maintaining a Neutral Thermal Environment

The neutral thermal environment (NTE) has been defined as the environmental condition where the infants' temperature is maintained so that metabolic demands are at a minimum (minimal oxygen and energy expenditure).

It is not a fixed range of temperatures but instead, varies with the age of the newborn, as well as gestational age and birth weight.

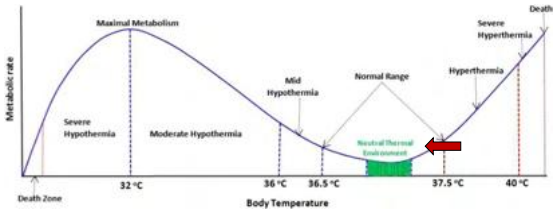
The NTE is best achieved when infants can maintain a core temperature at rest between 36.5°C and 37.5°C.

When environmental temperatures fall below the NTE, metabolic demands increase. This then leads to increased oxygen consumption. If this cascade continues, compensatory mechanisms are exhausted and eventually, the infant's temperature begins to decrease.

Smita Roychoudhury, Kamran Yusuf; Thermoregulation: Advances in Preterm Infants. *Neoreviews* December 2017; 18 (12): e692–e702. https://doi.org/10.1542/neo.18-12-e692

35

Maintaining a Neutral Thermal Environment



Baghel, Devesh & Sinha, Shobha & Dewangan, Satish. (2020). Numerical analysis of heat transfer under a radiant warmer. Heat Transfer. 49. 10.1002/htj.21728.

36

Increased room temperature ≥ 23.0° C versus lower room temperature for birth of newborn infants born at < 34 weeks' gestation

Dawson and colleagues.

https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

37

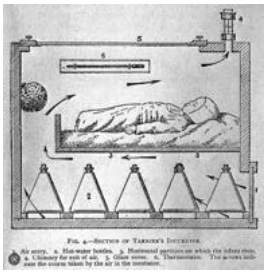
Increased room temperature ≥ 23.0° C versus lower room temperature for birth of newborn infants born at < 34 weeks' gestation

Comparison	Studies/ Infants	Certainty	Results
Operating room temperature 20° C vs 23° C	1 study 22 infants	Very low	Improved body temperatures and reduced rates of hypothermia
Higher (24° C–26° C) vs lower (20° C–23° C) DR temperature	1 study 91 infants	Very Low	Increased body temperature on admission (MD, 0.5° C higher [95% CI, 0.15–0.85 higher]) Reduced moderate hypothermia (RR, 0.51 [95% CI, 0.32–0.80]; RD, 337 fewer infants per 1000 were hypothermic [95% CI, 467–137 fewer infants])
Higher (25° C–28° C) vs lower (20° C) operating room temperature	1 cohort study 253 infants	Very low	Hypothermia less common when operating room temperatures were higher (RR, 0.69 [95% CI, 0.51–0.94])
DR temperature <25° C vs higher temperature	1 retrospective observational study 1764 infants	Very low	DR temperature <25° C independently associated with risk of hypothermia (aOR, 1.44 [95% CI, 1.10–1.88])
High (34° C) vs lower (28° C) ambient temperature	1 observational study 202 infants	Very low	Higher admission temperatures (MD, 0.4° C higher [95% CI, 0.24–0.5 higher]) Increased risk of hyperthermia (RR, 11.48 [95% CI, 1.54–85.54]; RD, 115 more infants were hyperthermic per 1000 [95% CI, 6–929 more infants])

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

38

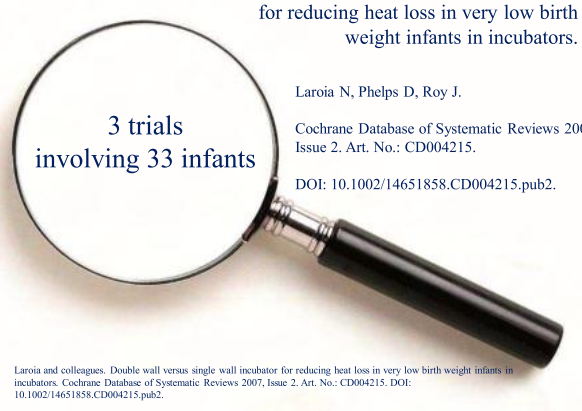
Incubators and radiant warmers



The incubator has revolutionized the management of hypothermia, significantly reducing neonatal mortality and morbidity.

39

Double wall versus single wall incubator for reducing heat loss in very low birth weight infants in incubators.



Laroia N, Phelps D, Roy J.

Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No.: CD004215.

DOI: 10.1002/14651858.CD004215.pub2.

Laroia and colleagues. Double wall versus single wall incubator for reducing heat loss in very low birth weight infants in incubators. Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No.: CD004215. DOI: 10.1002/14651858.CD004215.pub2.

40

Double wall versus single wall incubator for reducing heat loss in very low birth weight infants

Objectives: To assess the effects of double walled incubator versus a single wall incubator on insensible water loss, rate of oxygen consumption, episodes of hypothermia, time to regain birth weight, duration of hospitalization and infant mortality in premature infants.

Selection criteria: Only studies using random or quasi-random methods of allocation were considered for this review.

Main results: Three studies met the criteria.

Double wall incubators have the advantage of decreasing heat loss, decreasing heat production and decreasing radiant heat loss when compared to single wall incubators. There is also the advantage of reduced oxygen consumption. A minimal increase in conductive heat loss was noted when compared to single wall incubators.

All of these effects are small and do not support the proposition that double wall incubators have a beneficial effect on long-term outcomes including mortality or the duration of hospitalization.

Laroia and colleagues. Double wall versus single wall incubator for reducing heat loss in very low birth weight infants in incubators. Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No.: CD004215. DOI: 10.1002/14651858.CD004215.pub2.

41

Radiant warmers versus incubators for regulating body temperature in newborn infants.

Flenady V, Woodgate PG.

Cochrane Database of Systematic Reviews 2003, Issue 4. Art. No.: CD000435. DOI: 10.1002/14651858.CD000435.

Flenady and colleagues. Radiant warmers versus incubators for regulating body temperature in newborn infants. Cochrane Database of Systematic Reviews 2003, Issue 4. Art. No.: CD000435. DOI: 10.1002/14651858.CD000435.

42

Radiant warmers versus incubators for regulating body temperature in newborn infants

Objectives: To assess the effects of radiant warmers versus incubators on neonatal fluid and electrolyte balance, morbidity and mortality.

Selection criteria: Randomized or quasi-randomized trials in which radiant warmers were compared to incubators in a neonatal population.

Main results: Eight studies are included in this review; six employed a crossover design.

In the overall comparison of radiant warmers vs incubators, radiant warmers caused a statistically significant increase in insensible water loss (IWL) [WMD 0.94g/Kg/day (95% CI 0.47, 1.41)] and a trend towards increased oxygen consumption which was not statistically significant [WMD 0.27mL/kg/min (95% CI -0.09, 0.63)]. Due to small numbers, effects on important clinical outcomes could not be adequately assessed.

Authors' conclusions: Radiant warmers result in increased IWL compared to incubators. This needs to be taken into account when calculating daily fluid requirements. The results of this review do not provide sufficient evidence concerning effects on important outcomes to guide clinical practice.

Flenady and colleagues. Radiant warmers versus incubators for regulating body temperature in newborn infants. Cochrane Database of Systematic Reviews 2003, Issue 4. Art. No.: CD000435. DOI: 10.1002/14651858.CD000435.

43

Thermoregulation in preterm infants

Thermal mattress

44

Thermal mattress compared with no thermal mattress for newborn infants born at < 34 weeks' gestation

Dawson and colleagues.

https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

45

Thermal mattress compared with no thermal mattress for newborn infants born at <34 weeks' gestation

Outcome	Studies/ Infants	Certainty	Results
Survival (critical)	2 RCTs 174 infants	Low	RR 1.02 (0.98–1.06) 19 more infants surviving per 1000 (19 fewer to 56 more)
Normothermia on admission (important)	1 RCT 72 infants	Moderate	RR 0.53 (0.34–0.81) 363 fewer normothermic infants per 1000 (509 fewer to 147 fewer);
Mean body temperature (important)	2 RCTs 174 infants	Low	MD 0.46° C higher (0.22 higher to 0.69° C higher)
Hyperthermia (important)	2 RCTs 174 infants	Low	RR 2.77 (1.24–6.17) 126 more hyperthermic infants per 1000 (17 more to 369 more);
Hyperthermia (important)	4 observational study 703 infants	Moderate	RR 3.44 (1.91–6.20) 113 more hyperthermic infants per 1000 (42 more to 241 more);

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

46

ACTA PÆDIATRICA

Systematic review confirmed the benefits of early skin-to-skin contact but highlighted lack of studies on very and extremely preterm infants.

Gupta N, Deierl A, Hills E, Banerjee J.

Acta Paediatr. 2021 Aug;110(8):2310-2315. doi: 10.1111/apa.15913. Epub 2021 May 24. PMID: 33973279.

47

Systematic review confirmed the benefits of early skin-to-skin contact but highlighted lack of studies on very and extremely preterm infants

Results

We reviewed 30 studies that assessed the benefits of early SSC: 22 comprised term-born healthy infants and eight focused on preterm or ill infants. These included various gestational ages, birth methods and cultural backgrounds. The studies demonstrated that early SSC stabilized neonatal physiological parameters, promoted exclusive breastfeeding and supported bonding. Most of the data were from term and late preterm births.

Conclusion

This systematic review showed that early SSC could be beneficial. Further studies that focus on providing very and extremely preterm infants with SSC, and parental experiences, are needed to enable SSC to be adopted as routine practice.

Gupta and colleagues. Systematic review confirmed the benefits of early skin-to-skin contact but highlighted lack of studies on very and extremely preterm infants. Acta Paediatr. 2021 Aug;110(8):2310-2315. doi: 10.1111/apa.15913.

48

Heating and humidification of gases for resuscitation compared with no heating and humidification of gases for newborn infants born at < 34 weeks' gestation

Dawson and colleagues.

https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

49

Heating and humidification of gases for resuscitation compared with no heating and humidification of gases for newborn infants born at < 34 weeks' gestation

Outcome	Studies/ Infants	Certainty	Results
Survival (critical)	2 RCTs 476 infants	Very low	RR 1.00 (0.94–1.05) 0 fewer/more infants survived per 1000 (55 fewer to 56 more)
Normothermia on admission (important)	2 RCTs 476 infants	Very low	RR 1.23 (0.93–1.62) 108 more infants were normothermic per 1000 (33 fewer to 292 more)
Mean body temperature (important)	2 RCTs 476 infants	Moderate	MD 0.15°C higher (0.03°C higher to 0.26°C higher)
Moderate hypothermia	2 RCTs 476 infants	Low	RR 0.58 (0.36–0.94) 72 fewer hypothermic infants per 1000 (68 fewer to 7 fewer); NNTB, 14 infants
IVH above grade 2	2 RCTs 476 infants	Moderate	RR 0.39 (0.17–0.91) 50 fewer infants had IVH per 1000 (68 fewer to 7 fewer); NNTB, 42 infants

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

50

Vermont Oxford NETWORK

Evidence to Practice: Preventing Hypothermia

Interventions to prevent heat loss:

- Polyethylene bags
- Hats/head coverings

51

Vermont Oxford NETWORK

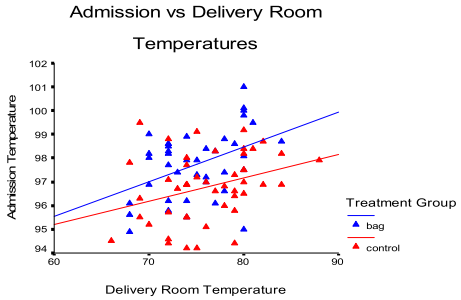
Evidence to Practice: Preventing Hypothermia

Placing or covering infants with an occlusive wrap immediately after birth will reduce the incidence of hypothermia and result in decreased morbidity and mortality.

52

53

Evidence to Practice: Preventing Hypothermia



Knobel and colleagues. Heat loss prevention for preterm infants in the delivery room. *Journal of Perinatology* 2005;25(5):304-8. [DOI: 10.1038/sj.jp.7211289]

54

The Journal of Pediatrics

Heat Loss Prevention (HeLP) Trial Study Group. Randomized trial of occlusive wrap for heat loss prevention in preterm infants.

Reilly MC, Vohra S, Rac VE, Dunn M, Ferrelli K, Kiss A, Vincer M, Wimmer J, Zayack D, Soll RF; Vermont Oxford Network

J Pediatr. 2015 Feb;166(2):262-8.e2.
doi: 10.1016/j.jpeds.2014.09.068. PMID: 25449224.

55

VON Vermont Oxford NETWORK

Heat Loss Prevention (HeLP)

BACKGROUND: Immediate postnatal hypothermia is associated with increased morbidity and mortality in preterm infants.

OBJECTIVE: To determine if the application of occlusive wrap immediately after birth will reduce mortality in preterm infants.

DESIGN/METHODS: Infants 24+0 to 27+6 weeks gestation were enrolled prior to delivery and randomly assigned to occlusive wrap or no wrap groups.

PRIMARY OUTCOME: All cause mortality at discharge or six months corrected age.

56

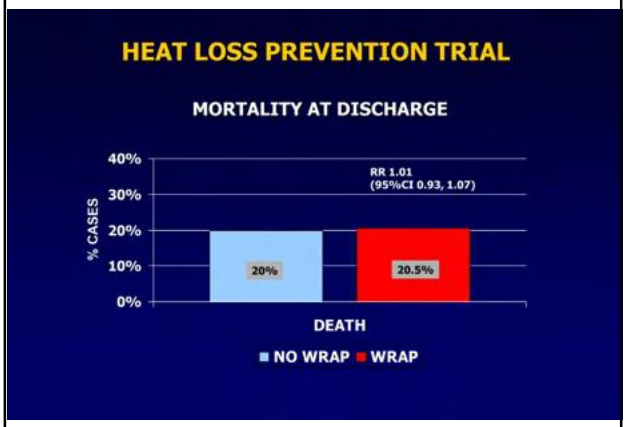
VON Vermont Oxford NETWORK

Heat Loss Prevention (HeLP)

RESULTS: 801 infants were enrolled. There were no differences in baseline population characteristics.

Infants in the wrap group had statistically significant higher baseline (36.3 wrap vs 35.7 no wrap) and post stabilization temperatures (36.6 vs 36.2) than non-wrapped infants.

57



58

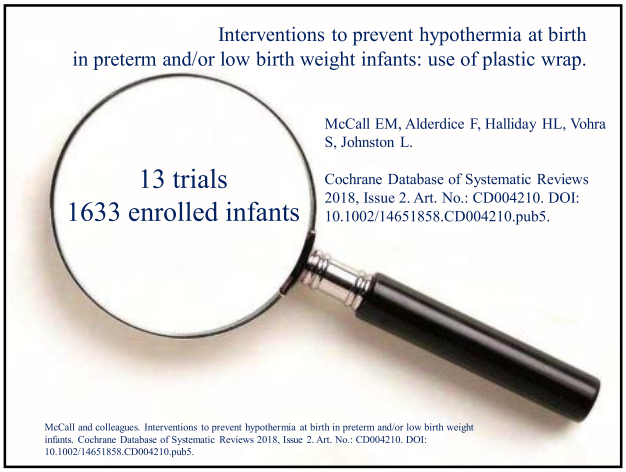
VON Vermont Oxford NETWORK

Heat Loss Prevention (HeLP)

CONCLUSION:

Application of occlusive wrap to very preterm infants immediately after birth reduces hypothermia but was not shown to reduce mortality or other selected complications of prematurity in this study.

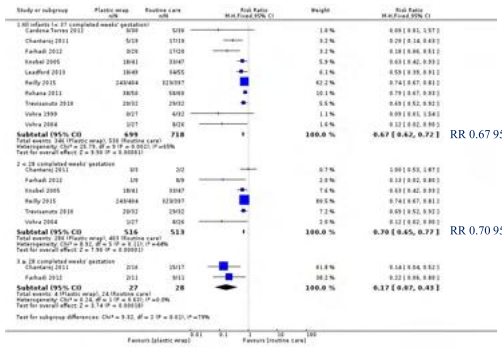
59



60

Plastic wrap or bag versus routine care

Hypothermia on admission to NICU (core body temperature < 36.5 or skin temperature < 36)



RR 0.67 95% 0.62 to 0.72)

RR 0.70 95% 0.65 to 0.77)

McCall and colleagues. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

61

Plastic wrap or bag versus routine care

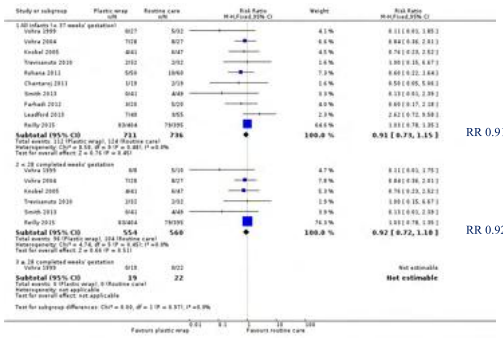
Outcome	Studies/ Infants	Results
Core body temperature on admission to the neonatal intensive care unit (NICU) or up to two hours after birth	13 RCTs 1633 infants	mean difference (MD) 0.58°C, 95% confidence interval (CI) 0.50 to 0.66
Hypothermia on admission to the NICU or up to two hours after birth	10 RCTs 1417 infants	risk ratio (RR) 0.67, 95% CI 0.62 to 0.72; risk reduction (RD) -0.25, 95% CI -0.29 to -0.20; number needed to treat for an additional beneficial outcome (NNTB) 4, 95% CI 4 to 5
Risk of hyperthermia on admission to the NICU or up to two hours after birth	12 RCTs 1523 infants	RR 3.91, 95% CI 2.05 to 7.44; RD 0.04, 95% CI 0.02 to 0.06; number needed to treat for an additional harmful outcome (NNTH) 25, 95% CI 17 to 50
Outside the normothermic range	5 RCTs 1048 infants	RR 0.75, 95% CI 0.69 to 0.81; RD -0.20, 95% CI -0.26 to -0.15; NNTH 5, 95% CI 4 to 7
Mortality (death within hospital stay or 6 months corrected age)	10 RCTs 1447 infants	RR 0.91 95% 0.73 to 1.15

McCall and colleagues. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

62

Plastic wrap or bag versus routine care

Mortality (death within hospital stay or 6 months corrected age)



RR 0.91 95% 0.73 to 1.15)

RR 0.92 95% 0.72 to 1.18)

McCall and colleagues. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

63

Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants

McCall and colleagues. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub5.

64

BMJ Journals

ADC Fetal & Neonatal edition

Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial

Dunne EA, Ni Chathasaigh CM, Geraghty LE, et al

Archives of Disease in Childhood - Fetal and Neonatal Edition 2024;109:317-321.

65

Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial

Objective Hypothermia on admission to the neonatal intensive care unit (NICU) is associated with an increased risk of death in preterm infants.

There are currently no evidence-based recommendations for thermal care before cord clamping (CC). We wished to determine whether placing very preterm infants in a polyethylene bag (PB) before CC, compared with after CC, results in more infants with a temperature in the normal range on NICU admission.

Design: Randomized controlled trial.

Setting: Tertiary maternity hospital.

Patients: Inborn infants < 32 weeks' gestational age (GA).

Interventions Infants were randomly assigned to have a PB placed before or after CC.

Dunne and colleagues. Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial. Archives of Disease in Childhood - Fetal and Neonatal Edition 2024;109:317-321.

66

Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial

Patient outcomes	BEFORE (n=99)	AFTER (n=98)	P value
Primary outcome			
Rectal admission temperature 36.5°C–37.5°C*	54 (55)	55 (56)	0.824
<28 weeks' GA†	19/38 (50)	21/39 (54)	0.736
28–31 +6 weeks' GA†	35/60 (58)	34/59 (58)	0.978
Secondary outcomes			
Admission rectal temperature (°C)†	36.6 (0.8)	36.7 (0.7)	0.330
Admission axillary temperature (°C)*	36.7 (0.8)	36.7 (0.7)	0.642
Admission rectal temperature<36.5°C†	34 (34)	33 (34)	0.880
Admission rectal temperature<36.0°C†	12 (12)	11 (11)	0.824
Admission rectal temperature<35.5°C†	3 (3)	3 (3)	1.00
Admission rectal temperature>37.5°C†	10 (10)	10 (10)	1.00
Intubated during hospital stay†	52 (53)	60 (61)	0.248
Surfactant during hospital stay†	49 (50)	52 (53)	0.721
Chronic lung disease†	11 (11)	15 (14)	0.4
Late onset sepsis†	7 (7)	10 (10)	0.748
Necrotising enterocolitis†	9 (9)	7 (7)	0.819
Abnormal cranial ultrasound†	9 (9)	8 (8)	0.894
Death before discharge†	17 (17)	18 (18)	0.852

Dunne and colleagues. Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial. Archives of Disease in Childhood - Fetal and Neonatal Edition 2024;109:317-321.

67

Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial

Conclusions

Placing a plastic bag before cord clamping did not increase the proportion of preterm infants with normal temperature on NICU admission. A large proportion of preterm infants had abnormal temperature. Further studies on thermoregulation before cord clamping are needed.

Dunne and colleagues. Polyethylene bags before cord clamping in very preterm infants: a randomised controlled trial. Archives of Disease in Childhood - Fetal and Neonatal Edition 2024;109:317-321.

68

Use of plastic cap compared with no cap for newborn infants born at < 34 weeks' gestation

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

69

Use of plastic cap compared with no cap for newborn infants born at < 34 weeks' gestation

Comparison	Studies/ Infants	Certainty	Results
Survival (critical)	1 RCT 64 infants	Moderate	RR 0.97 (0.84–1.12) 28 fewer infants survived per 1000 (150 fewer to 113 more infants)
Normothermia on admission (important)	1 RCT 64 infants	Moderate	RR 6.00 (1.96–18.38) 469 more normothermic infants per 1000 (90 more to 1629 more); NNTB, 2 infants
Mean body temperature (important)	1 RCT 64 infants	Moderate	MD, 0.8° C higher (0.41° C higher to 1.19° C higher)
Hypothermia or cold stress (important)	1 RCT 64 infants	Moderate	RR 0.48 (0.32–0.73) 471 fewer hypothermic or cold-stressed infants per 1000 (616 fewer to 245 fewer); NNTB, 2 infants

Dawson and colleagues. https://costr.ilcor.org/document/maintaining-normal-temperature-immediately-after-birth-in-preterm-infants-nls-5101-tf-sr

70

Can quality improvement initiatives impact on delivery room hypothermia?

71

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Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates.

Joaquim M.B. Pinheiro, Susan A. Furdon, Susan Boynton, Robin Dugan, Christine Reu-Donlon, Sharon Jensen.

Pediatrics January 2014; 133 (1): e218–e226. 10.1542/peds.2013-1293

72

American Academy of Pediatrics
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Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates.

BACKGROUND AND OBJECTIVE:

Hypothermia during delivery room stabilization of very low birth weight (VLBW) newborns is independently associated with mortality, yet it occurred frequently both in collaborative networks and at our institution. We aimed to attain admission temperatures in the target range of 36°C to 38°C in ≥ 90% of inborn VLBW neonates through implementation of a thermoregulation bundle.

METHODS:

This quality improvement project extended over 60 consecutive months, using sequential plan–do–check–act cycles. During the 14 baseline months, we standardized temperature measurements and developed the Operation Toasty Tot thermoregulation bundle (including consistent head and torso wrapping with plastic, warmed blankets, and a closed stabilization room). We introduced this bundle in month 15 and added servo-controlled, battery-powered radiant warmers for stabilization and transfer in month 21. We provided results and feedback to staff throughout, using simple graphics and control charts.

Pinheiro and colleagues. Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates. Pediatrics January 2014; 133 (1): e218–e226. 10.1542/peds.2013-1293

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Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates.

Type of Heat Loss	Common Causes	Primary Interventions Specified in Bundle
Conduction	Direct contact with cold bed surfaces	Turn on radiant warmer when delivery is anticipated to prewarm resuscitation bed.
		Make additional prewarmed blankets available for transfer.
Radiation	Large skin surface area exposed to cooler surroundings; blockage of radiant heat source	Turn warmer on early and close door to selectively warm the separate resuscitation room (when available).
		Lean back, do not block infant's access to heat.
		Set servo-controlled warmer to 37°C by 5 min of age (in phase 2).
Evaporation	Wet skin or nonocclusive wrappings; low humidity of ambient air or inspired gas	Rapidly blot off excess fluid and blood; no need to dry completely.
		Apply plastic wrap to head immediately.
		Apply stockinette hat over the plastic wrap.
		Apply plastic wrap around body of infant when <29 weeks' gestational age.
		Auscultate through undisturbed plastic wrap.
Convection	Cool air flowing over skin; cold gases flowing over mucous membranes	Increase temperature of stabilization room using warmer.
		Reduce air drafts by closing door, raising sides of warmer; keep all sides up and use additional blankets, with only face exposed, for transfer.
		Keep baby's skin covered with plastic wrap; add large blanket for transfer.
		Transfer to prewarmed, humidified incubator on admission (after temperature measured).

Pinheiro and colleagues. Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates. Pediatrics January 2014; 133 (1): e218–e226. 10.1542/peds.2013-1293

74

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Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates.

RESULTS:
There were 164 inborn VLBW babies before and 477 after bundle implementation.

Introduction and optimization of the bundle decreased the incidence of hypothermia, with rates remaining in the target range for the last 13 study months.

The incidence of temperatures >38°C was ~2% both before and after bundle implementation.

CONCLUSIONS:
This thermoregulation bundle resulted in sustained improvement in normothermia rates during delivery room stabilization of VLBW newborns. Our benchmark goal of ≥90% admission temperatures above 36°C was met without increasing hyperthermia rates.

Pinheiro and colleagues. Decreasing Hypothermia During Delivery Room Stabilization of Preterm Neonates. Pediatrics January 2014; 133 (1): e218–e226. 10.1542/peds.2013-1293

75

Thermoregulation in preterm infants

Hyperthermia

Hyperthermia is defined as a core temperature that is higher than 99.5°F (37.5°C).

Neonatal hyperthermia most often occurs because of environmental factors leading to overheating, rather than as a result of a disease process.

Hyperthermia can be as dangerous as hypothermia and can lead to increased metabolism, resulting in increased water loss and possibly increased mortality.

Smita Roychoudhury, Kamran Yusuf; Thermoregulation: Advances in Preterm Infants. *Neoreviews* December 2017; 18 (12): e692–e702. https://doi.org/10.1542/neo.18-12-e692

76

VON Vermont Oxford NETWORK

Discussants

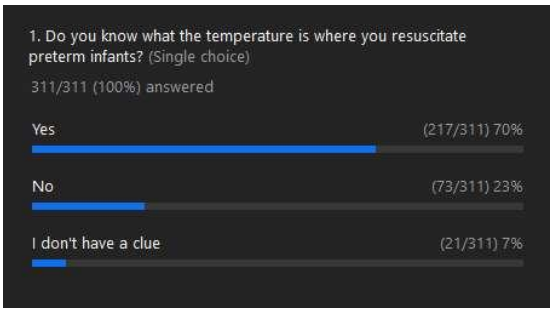
Elizabeth Foglia, MD, MA, MSCE
Associate Professor of Pediatrics
Perelman School of Medicine at the University of Pennsylvania

Erika Edwards PhD
Research Professor
University of Vermont
Chief Scientific Officer,
Vermont Oxford Network

77

VON Vermont Oxford NETWORK

Poll Question



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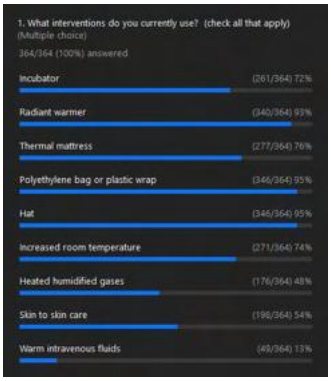
Poll Question



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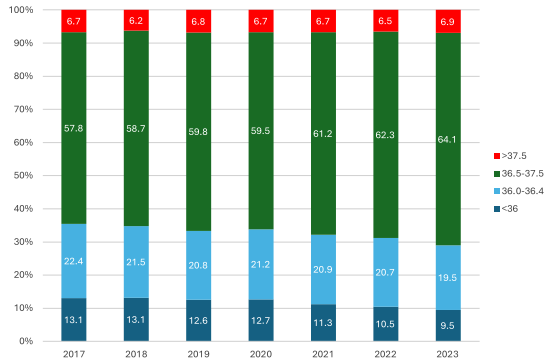
In 2023, 3 in 10 infants are cold upon admission to the NICU.



80

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Neonatal admission temperature in middle- and high-income countries.

Frade Garcia A, Edwards EM, de Andrade Lopes JM, Tooke L, Assenga E, Ehret DEY, Hansen A.

Pediatrics. 2023; 152 (3)e2023061607. doi: 10.1542/peds.2023-061607.

81

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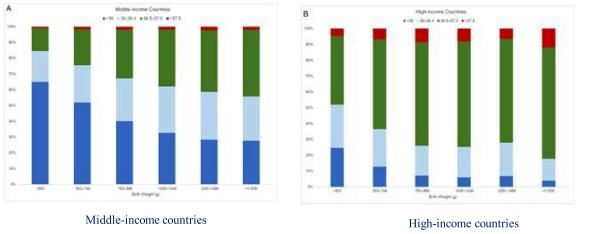
Neonatal admission temperature in middle- and high-income countries

Admission temperature by birth weight in MIC and HIC hospitals.



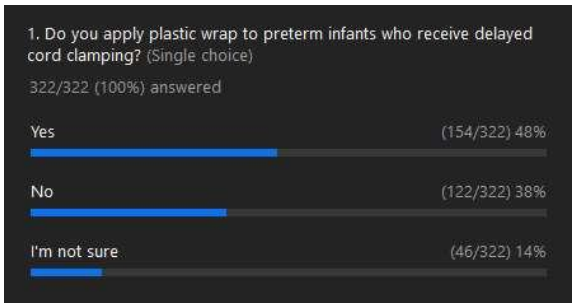
Middle-income countries

High-income countries

Frade Garcia A and colleagues. Neonatal admission temperature in middle- and high-income countries. Pediatrics. 2023;e2023061607. doi: 10.1542/peds.2023-061607.

82

Poll Question



83

Pierre Budin, "The Nursling"(1907) Lecture 1

"Thus, even without being exposed to the outside air, a weakling may die, if precautions are not taken to prevent the temperature of the room in which it is from falling too low…

Here, then, is a weakling whose temperature fell to 34°C., in spite of its having been placed in an incubator.

How far would it have fallen if this measure had not been taken?"

Neonatology on the Web (neonatology.net)

84

1. You can't improve what you don't measure

Patient Level

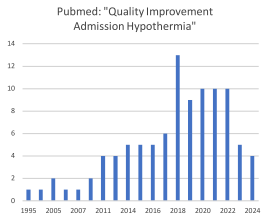
Measure *and respond* to patient temperature

- Obtain temperature every 15 minutes in resuscitation suite
- Once admitted to ICU, remove plastic wrap if admission temperature >98.5 F
  Check temperature every 30-60 minutes
- Remove head wrap if next temperature >98.5 F
- Remove exothermic mattress if next temperature > 98.5 F

HUP thermoregulation protocol

Unit Level

Monitor and track admission temperatures

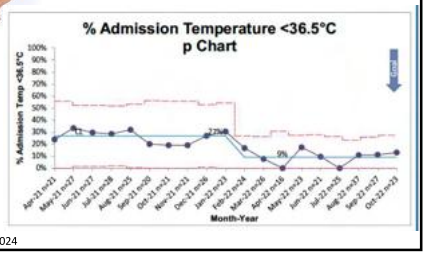


85

2. Other populations are at risk for hypothermia

Newborns with congenital anomalies:

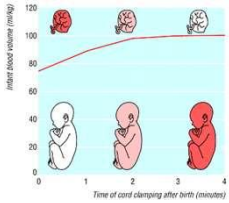
- 27% with admission temp < 36.5 C
  - Increased exposure to facilitate extensive resuscitation (ie: CDH)
  - Increased surface area (external defects)



Heimall L, Advances in Neonatal Care 2024

86

3. New approaches to newborn stabilization require new approaches to thermoregulation



Yao AC, *Lancet* 1969; 2:871-3

Delayed Cord Clamping

Katheria A, *Frontiers Pediatrics* 2018; 2:871-3

Physiologically-Based Cord Clamping

87

JAMA Network | Open.

Original Investigation | Pediatrics

Ventilatory Assistance Before Umbilical Cord Clamping in Extremely Preterm Infants
A Randomized Clinical Trial

Karen D. Fairchild, MD; Gina R. Petroni, PhD; Nikole E. Varhegyi, MS; Marya L. Strand, MD; Justin B. Josephsen, MD; Susan Niermeyer, MD; James S. Barry, MD; Jamie B. Warren, MD; Monica Rincon, MD; Jennifer L. Fang, MD; Sumesh P. Thomas, MBBS; Colm P. Travers, MD; Andrea F. Kane, MD; Waldemar A. Carlo, MD; Bobbi J. Byrne, MD; Mark A. Underwood, MD; Francis R. Poulain, MD; Brenda H. Law, MD; Terri E. Gorman, MD; Tina A. Leone, MD; Dorothy I. Bulas, MD; Monica Epelman, MD; Beth M. Kline-Fath, MD; Christian A. Chisholm, MD; John Kattwinkel, MD; for the VentFirst Consortium

P: 570 infants born 23 $^{0/7}$ – 28 $^{6/7}$ weeks' gestation

I: Ventilation before cord clamping at 120 sec

C: Delayed cord clamping at 30-60 sec

O: IVH (any) or death before 7 DOL

No significant difference between groups in primary outcome, mortality or major morbidities

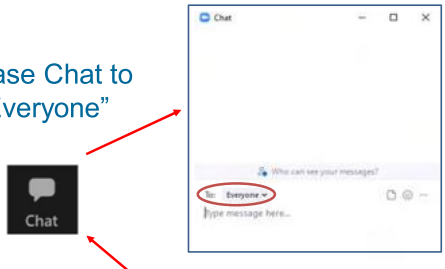
Increased risk of hypothermia (<36.5 C) in intervention group
RR 1.34 (1.02-1.76)

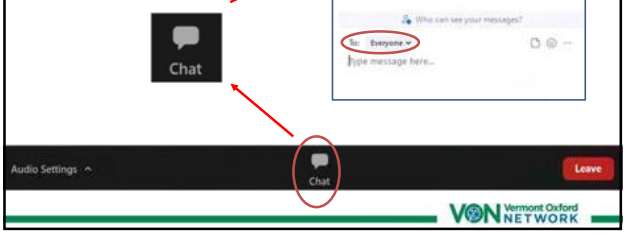
Fairchild KD. JAMA Netw Open. 2024

88

Questions? Comments? Ideas to Share?

Please Chat to "Everyone"





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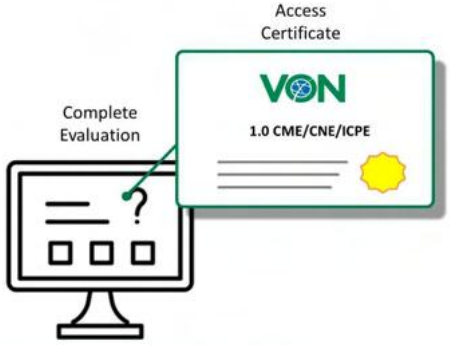
89

Continuing Education Credit



VON Vermont Oxford NETWORK

90

Future sessions

November 13th - Follow up and follow through

91

92