



*Topic Expert Group: Care procedures*

**Temperature management in newborn infants**

van Leeuwen M, Frauenfelder O, Oude-Reimer M, Camba F, Ceccatelli M, Hanks-Drielsma I, Kalbér A, Kühn T, Silva E

*Target group*

Newborn infants and parents

*User group*

Healthcare professionals, neonatal units, hospitals, and health services

*Statement of Standard*

Environmental management of temperature and humidity is necessary to optimise the management of newborn infants.

*Rationale*

Normal axillary temperature is defined to be between 36.5 and 37.5 degrees Celsius by international bodies. (1,2) Variation of body temperature from normal is more common in preterm and ill infants. The optimal environmental temperature is termed the thermo-neutral temperature, as defined as the temperature at which metabolic requirements of the infant are minimal. (3) Different studies have shown that low body temperatures in newborn infants are associated with mortality, increased risk of illness and delayed growth. (4–6) Similarly, high body temperature is associated with adverse outcomes, particularly in infants following hypoxia ischemia and very preterm infants. (7,8)

The physiological and behavioural responses of preterm infants to hot or cold environments are less developed than in term infants. Reduced bodyweight-body surface ratio can result in higher heat loss. Preterm infants can also have high trans-epidermal water losses through evaporation because of their thin porous skin. High evaporative water loss causes high energy expenditure due to skin cooling, increasing neonatal morbidity. (3) In addition, preterm and ill infants may be exposed during procedures to insert central catheters, endo-tracheal intubation and resuscitation, which cause fluctuation in body temperature.

*Benefits*

*Short-term benefits*

- Reduced risk of hypothermia (9)
- Reduced risk of hyperthermia (7,9)
- Minimises trans-epidermal water loss (10)
- Improved comfort and reduced physiologic instability and stress (11)
- Stabilised body temperature by skin-to-skin care (12,13)

*Long-term benefits*

- Improved developmental outcomes (4–6)



### *Components of the standard*

<b>Component</b>	<b>Grading of evidence</b>	<b>Indicator of meeting the standard</b>
<b>For parents and family</b>		
1. Parents are informed by healthcare professionals about the ideal body temperature and importance of temperature management. (14)	A (High quality) B (High quality)	Patient information sheet
2. Parents are invited to measure their infant's temperature. (14,15)	A (High quality) B (High quality)	Patient information sheet, parent feedback
3. Skin-to-skin care is provided as soon as possible. (3,12,13) (see TEG Infant- and family-centred developmental care)	A (High quality) B (High quality)	Audit report, parent feedback, patient information sheet
<b>For healthcare professionals</b>		
4. A unit guideline on temperature management is adhered to by all healthcare professionals. (3,16)	A (High quality) B (High quality)	Guideline
5. Training on temperature measurement, management including incubator settings for the best thermal environment, the importance of maintaining normothermia in the newborn infant, and the risks of hypothermia and hyperthermia, is attended by all responsible healthcare professionals. (3–6,9,17–21)	A (High quality) B (High quality)	Training documentation
<b>For neonatal unit</b>		
6. A unit guideline on temperature management is available and regularly updated. (3,16)	A (High quality) B (High quality)	Guideline
7. Appropriate facilities for temperature management are available. (5,17,22–24)	A (Moderate quality) B (High quality)	Audit report, guideline
<b>For hospital</b>		
8. Training on temperature management is ensured. (3–6,9,17–21)	A (High quality) B (High quality)	Training documentation
9. Appropriate facilities for neonatal temperature management are provided. (5,17,22–24)	A (Moderate quality) B (High quality)	Audit report, guideline



For health service		
10. Rates of hypo- and hyperthermia are monitored. (25)	A (High quality) B (High quality)	Audit report

*Where to go – further development of care*

Further development	Grading of evidence
For parents and family N/A	
For healthcare professionals N/A	
For neonatal unit N/A	
For hospital N/A	
For health service	
<ul style="list-style-type: none"> <li>Contribute to benchmarking strategies to monitor temperature control in different settings, e.g. postnatal ward or transfer. (25)</li> </ul>	A (High quality) B (High quality)

*Getting started*

Initial steps
For parents and family
<ul style="list-style-type: none"> <li>Parents are verbally informed by healthcare professionals about the ideal body temperature and importance of temperature management.</li> <li>Parents are encouraged to measure their infant's temperature and contribute to thermal management.</li> </ul>
For health care professionals
<ul style="list-style-type: none"> <li>Attend training on temperature measurement, management including incubator settings for the best thermal environment, the importance of maintaining normothermia in the newborn infant, and the risks of hypothermia and hyperthermia.</li> </ul>
For neonatal unit
<ul style="list-style-type: none"> <li>Develop and implement a unit guideline on temperature management.</li> <li>Develop information material on the ideal body temperature and importance of temperature management for parents.</li> </ul>
For hospital
<ul style="list-style-type: none"> <li>Support healthcare professionals to participate in training on temperature management.</li> </ul>
For health service
<ul style="list-style-type: none"> <li>Develop benchmarking of admission temperatures.</li> </ul>



### *Description*

Preterm infants and very low birthweight infants are prone to rapid heat loss through mechanisms of conduction, evaporation, radiation and convection. Low body temperature is directly related to higher mortality and morbidity rates. (4,8,18) A very preterm infant's admission temperature is inversely related to in-hospital mortality, with a 28% increase in the mortality rate per every 1 °C of decrease in the admission temperature. Low temperature on admission increases the rate of oxygen consumption, causes pulmonary and systemic vasoconstriction, and is associated with worsening of respiratory distress, metabolic acidosis, hypoglycaemia, coagulation disorder, and increases the risk of late sepsis and peri-intraventricular haemorrhage. (26,27)

Careful temperature management should be a standard in delivery-rooms, during transport and in the NICU.

### *Delivery room*

In preparation for the transition process or resuscitation of a preterm infant, the temperature in the delivery room should be increased to 23°C–25°C for term infants, and should be >28°C for infants <28 weeks of gestation. (2,16,28,29) For infants born before 32 weeks' of gestation, the neonatal team should take steps to prevent cooling by 1) placing a thermal mattress under the newborn infant, 2) using plastic wrap or a bag to cover the infant without drying, and 3) placing a hat immediately after delivery. (27,30,31) For infants who require respiratory support gases should be heated and humidified. The target axillary temperature in a newborn infant during resuscitation is between 36.5°C and 37.5°C. (6,28) Hyperthermia (>38°C) should be avoided due to increased risk of RDS, neonatal seizures, cerebral palsy and early death. (32–35) Admission temperature should be regularly audited.

### *Transport*

The transport of the newborn infant from delivery-room to the NICU needs to be safe and controlled. Very preterm infants should be transferred in a suitable transport incubator, pre-heated to 37°C, if it is not possible to effect the transfer skin-to-skin with mother or father.

### *NICU*

Room temperature in the NICU should be maintained >23°C. Incubator temperature is dependent on the infant's size and age. Each unit should have strict protocols for the management of environmental incubator temperature and the use of humidity to reduce evaporative water loss, that are regularly audited. Skin-to-skin care is used whenever possible (see TEG Infant- and family-centred developmental care) and care should be taken to avoid thermal stress during bathing. (see TEG Care procedures)

### *Source*

1. Interprofessional Education and Research Committee of the Champlain Maternal Newborn Regional Program (CMNRP). Newborn Thermoregulation Self Learning Module [Internet]. 2013 [cited 2018 Jun 12]. Available from: [http://www.cmnrp.ca/uploads/documents/Newborn\\_Thermoregulation\\_SLM\\_2013\\_06.pdf](http://www.cmnrp.ca/uploads/documents/Newborn_Thermoregulation_SLM_2013_06.pdf)



2. World Health Organization. Thermal protection of the newborn: a practical guide [Internet]. WHO. [cited 2018 Jun 12]. Available from: [http://www.who.int/maternal\\_child\\_adolescent/documents/ws42097th/en/](http://www.who.int/maternal_child_adolescent/documents/ws42097th/en/)
3. Baumgart S. Iatrogenic hyperthermia and hypothermia in the neonate. *Clin Perinatol*. 2008 Mar;35(1):183–197, ix–x.
4. de Almeida MFB, Guinsburg R, Sancho GA, Rosa IRM, Lamy ZC, Martinez FE, et al. Hypothermia and early neonatal mortality in preterm infants. *J Pediatr*. 2014 Feb;164(2):271–275.e1.
5. Russo A, McCready M, Torres L, Theuriere C, Venturini S, Spaight M, et al. Reducing hypothermia in preterm infants following delivery. *Pediatrics*. 2014 Apr;133(4):e1055-1062.
6. Bobby PD, Cabral J, Cianella J, Matias S, Kelley E, Bowman D. Reducing the Incidence of Hypothermia in Preterm Neonates: A Community Hospital Experience. *Obstet Gynecol*. 2014 May;123:139S.
7. Agourram B, Bach V, Tourneux P, Krim G, Delanaud S, Libert J-P. Why wrapping premature neonates to prevent hypothermia can predispose to overheating. *J Appl Physiol Bethesda Md* 1985. 2010 Jun;108(6):1674–81.
8. Laptook AR, Watkinson M. Temperature management in the delivery room. *Semin Fetal Neonatal Med*. 2008 Dec;13(6):383–91.
9. Sherman TI, Greenspan JS, St Clair N, Touch SM, Shaffer TH. Optimizing the neonatal thermal environment. *Neonatal Netw NN*. 2006 Aug;25(4):251–60.
10. Sinclair L, Crisp J, Sinn J. Variability in incubator humidity practices in the management of preterm infants. *J Paediatr Child Health*. 2009 Sep;45(9):535–40.
11. Hoffman K, Bromster T, Hakansson S, van den Berg J. Monitoring of pain and stress in an infant with asphyxia during induced hypothermia: a case report. *Adv Neonatal Care Off J Natl Assoc Neonatal Nurses*. 2013 Aug;13(4):252–61.
12. Hubbard JM, Gattman KR. Parent-Infant Skin-to-Skin Contact Following Birth: History, Benefits, and Challenges. *Neonatal Netw NN*. 2017 Mar 1;36(2):89–97.
13. Moore ER, Anderson GC, Bergman N, Dowswell T. Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database Syst Rev*. 2012 May 16;(5):CD003519.
14. Davidson J, Aslakson R, Long A, et. al. Guidelines for Family-Centered Care in the Neonatal, Pediatric, and Adult ICU. *Crit Care Med*. 2017;45(1):103–28.
15. Flacking R, Lehtonen L, Thomson G, Axelin A, Ahlqvist S, Moran VH, et al. Closeness and separation in neonatal intensive care: *Closeness and separation*. *Acta Paediatr*. 2012 Oct;101(10):1032–7.
16. Wyllie J, Bruinenberg J, Roehr CC, Rüdiger M, Trevisanuto D, Urlesberger B. European Resuscitation Council Guidelines for Resuscitation 2015 Section 7. Resuscitation and support of transition of babies at birth. *Resuscitation*. 2015;95:249–63.
17. Harer MW, Vergales B, Cady T, Early A, Chisholm C, Swanson JR. Implementation of a multidisciplinary guideline improves preterm infant admission temperatures. *J Perinatol Off J Calif Perinat Assoc*. 2017 Nov;37(11):1242–7.
18. Miller SS, Lee HC, Gould JB. Hypothermia in very low birth weight infants: distribution, risk factors and outcomes. *J Perinatol Off J Calif Perinat Assoc*. 2011 Apr;31 Suppl 1:S49-56.



19. New K, Flenady V, Davies MW. Transfer of preterm infants from incubator to open cot at lower versus higher body weight. *Cochrane Database Syst Rev*. 2011 Sep 7;(9):CD004214.
20. Whyte RK. Neonatal management and safe discharge of late and moderate preterm infants. *Semin Fetal Neonatal Med*. 2012 Jun;17(3):153–8.
21. Fraguera A, Matlalcuatzi FD, Ramos ÁM. Mathematical modelling of thermoregulation processes for premature infants in closed convectively heated incubators. *Comput Biol Med*. 2015 Feb;57:159–72.
22. Joseph RA, Derstine S, Killian M. Ideal Site for Skin Temperature Probe Placement on Infants in the NICU: A Review of Literature. *Adv Neonatal Care Off J Natl Assoc Neonatal Nurses*. 2017 Apr;17(2):114–22.
23. Sim MA, Leow SY, Hao Y, Yeo CL. A practical comparison of temporal artery thermometry and axillary thermometry in neonates under different environments. *J Paediatr Child Health*. 2016 Apr;52(4):391–6.
24. Uslu S, Ozdemir H, Bulbul A, Comert S, Bolat F, Can E, et al. A comparison of different methods of temperature measurements in sick newborns. *J Trop Pediatr*. 2011 Dec;57(6):418–23.
25. National Neonatal Audit Programme (NNAP) | RCPCH [Internet]. [cited 2018 May 25]. Available from: <https://www.rcpch.ac.uk/work-we-do/quality-improvement-patient-safety/national-neonatal-audit-programme-nnap>
26. Caldas JP de S, Millen F de C, Camargo JF de, Castro PAC, Camilo AL da F, Marba STM. Effectiveness of a measure program to prevent admission hypothermia in very low-birth weight preterm infants. *J Pediatr (Rio J)*. 2017 Sep 6;
27. Pinheiro JMB, Boynton S, Furdon SA, Dugan R, Reu-Donlon C. Use of chemical warming packs during delivery room resuscitation is associated with decreased rates of hypothermia in very low-birth-weight neonates. *Adv Neonatal Care Off J Natl Assoc Neonatal Nurses*. 2011 Oct;11(5):357–62.
28. Perlman JM, Wyllie J, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, et al. Part 7: Neonatal Resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (Reprint). *Pediatrics*. 2015 Nov;136 Suppl 2:S120-166.
29. Kent AL, Williams J. Increasing ambient operating theatre temperature and wrapping in polyethylene improves admission temperature in premature infants. *J Paediatr Child Health*. 2008 Jun;44(6):325–31.
30. Fawcett K. Preventing admission hypothermia in very low birth weight neonates. *Neonatal Netw NN*. 2014 Jun;33(3):143–9.
31. McCall EM, Alderdice FA, Halliday HL, Jenkins JG, Vohra S. Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants. *Cochrane Database Syst Rev*. 2008 Jan 23;(1):CD004210.
32. Lieberman E, Eichenwald E, Mathur G, Richardson D, Heffner L, Cohen A. Intrapartum fever and unexplained seizures in term infants. *Pediatrics*. 2000 Nov;106(5):983–8.
33. Grether JK, Nelson KB. Maternal infection and cerebral palsy in infants of normal birth weight. *JAMA*. 1997 Jul 16;278(3):207–11.
34. Coimbra C, Boris-Möller F, Drake M, Wieloch T. Diminished neuronal damage in the rat brain by late treatment with the antipyretic drug dipyron or cooling following cerebral ischemia. *Acta Neuropathol (Berl)*. 1996 Nov;92(5):447–53.



35. Dietrich WD, Alonso O, Halley M, Busto R. Delayed posttraumatic brain hyperthermia worsens outcome after fluid percussion brain injury: a light and electron microscopic study in rats. *Neurosurgery*. 1996 Mar;38(3):533–541; discussion 541.

First edition, November 2018

*Lifecycle*

5 years/next revision: 2023

*Recommended citation*

EFCNI, van Leeuwen M, Frauenfelder O et al., European Standards of Care for Newborn Health: Temperature management in newborn infants. 2018.