

The background of the slide is a vertical gradient, transitioning from a light orange at the top to a light blue at the bottom. In the center, there is a large, faint white circle. Superimposed on this circle are several thin white lines that radiate outwards, resembling the tick marks on a clock face. The word "Thermoregulation" is written in a bold, black, sans-serif font, centered horizontally and partially overlaid by the white circle and its radiating lines.

# Thermoregulation

Weigh  $< 1,500$  g. Without the use of incubators, the likelihood of death was close to 100%, especially if the rectal temperature dropped to  $< 32^{\circ}\text{C}$  .



Homeotherms

Energy & O<sub>2</sub>

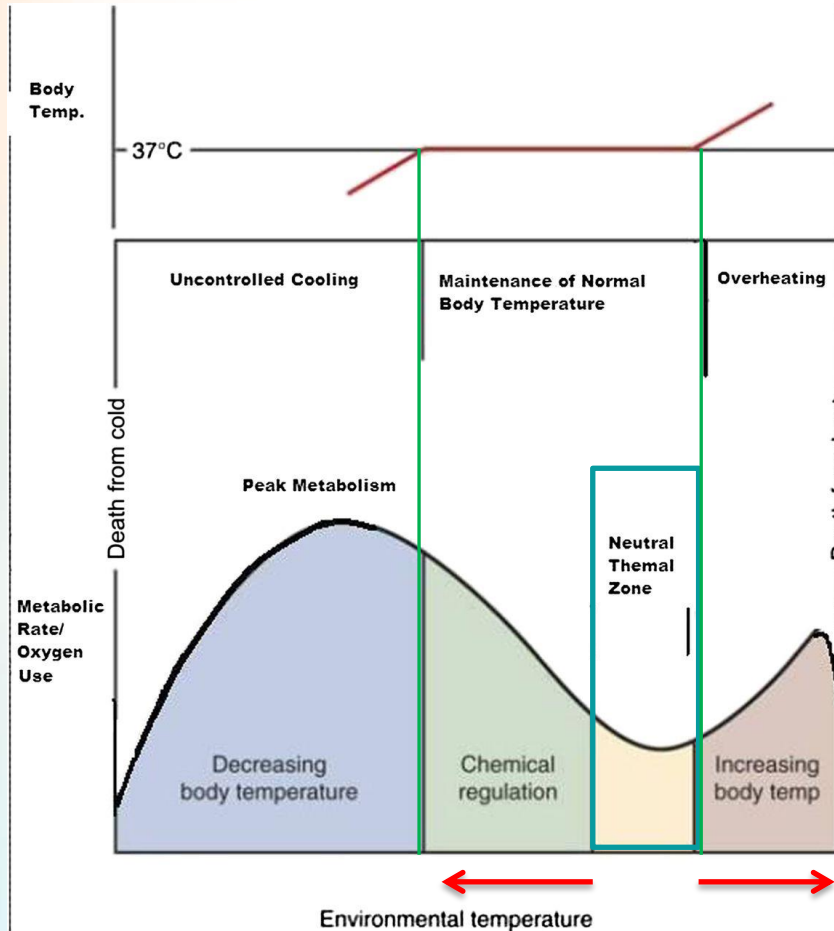


Poikilotherms

# Neutral Thermal Environment

- Conditions under which oxygen consumption is minimal even as body temperature is maintained in the normal range
- Range of temperature over which metabolic demands are minimal.

# Neutral thermal environment: effects of heat and cooling on metabolic rate and body temperature.



Steven A. Ringer Neoreviews 2013;14:e161-e167

TABLE  
6-1

## NEUTRAL THERMAL ENVIRONMENTAL TEMPERATURES

AGE AND WEIGHT	STARTING TEMPERATURE (°C)	RANGE OF TEMPERATURE (°C)	AGE AND WEIGHT	STARTING TEMPERATURE (°C)	RANGE OF TEMPERATURE (°C)
0-6 hr			>72-96 hr		
Under 1200 g	35.0	34.0-35.4	Under 1200 g	34.0	34.0-35.0
1200-1500 g	34.1	33.9-34.4	1200-1500 g	33.5	33.0-34.0
1501-2500 g	33.4	32.8-33.8	1501-2500 g	32.2	31.1-33.2
Over 2500 g (and >36 wk)	33.9	32.0-33.8	Over 2500 g (and >36 wk)	31.3	29.8-32.8
>6-12 hr			>4-12 days		
Under 1200 g	35.0	34.0-35.4	Under 1500 g	33.5	33.0-34.0
1200-1500 g	34.0	33.5-34.4	1501-2500 g	32.1	31.0-33.2
1501-2500 g	33.1	32.2-33.8	Over 2500 g (and >36 wk)		
Over 2500 g (and >36 wk)	32.8	31.4-33.8	4-5 days	31.0	29.5-32.6
>12-24 hr			5-6 days	30.9	29.4-32.3
Under 1200 g	34.0	34.0-35.4	6-8 days	30.6	29.0-32.2
1200-1500 g	33.8	33.3-34.3	8-10 days	30.3	29.0-31.8
1501-2500 g	32.8	31.8-33.8	10-12 days	30.1	29.0-31.4
Over 2500 g (and >36 wk)	32.4	31.0-33.7	>12-14 days		
>24-36 hr			Under 1500 g	33.5	32.6-34.0
Under 1200 g	34.0	34.0-35.0	1501-2500 g	32.1	31.0-33.2
1200-1500 g	33.6	33.1-34.2	>2-3 wk		
1501-2500 g	32.6	31.6-33.6	Under 1500 g	33.1	32.2-34.0
Over 2500 g (and >36 wk)	32.1	30.7-33.5	1501-2500 g	31.7	30.5-33.0
>36-48 hr			>3-4 wk		
Under 1200 g	34.0	34.0-35.0	Under 1500 g	32.6	31.6-33.6
1200-1500 g	33.5	33.0-34.1	1501-2500 g	31.4	30.0-32.7
1501-2500 g	32.5	31.4-33.5	>4-5 wk		
Over 2500 g (and >36 wk)	31.9	30.5-33.3	Under 1500 g	32.0	31.2-33.0
>48-72 hr			1501-2500 g	30.9	29.5-32.2
Under 1200 g	34.0	34.0-35.0	>5-6 wk		
1200-1500 g	33.5	33.0-34.0	Under 1500 g	31.4	30.6-32.3
1501-2500 g	32.3	31.2-33.4	1501-2500 g	30.4	29.0-31.8
Over 2500 g (and >36 wk)	31.7	30.1-33.2			

# Body Temperature

Heat loss



Heat production

- Mechanisms of heat production
- By product of normal metabolism

Cerebral cortex

Hypothalamic regulatory center

Newborn

Nonshivering thermogenesis

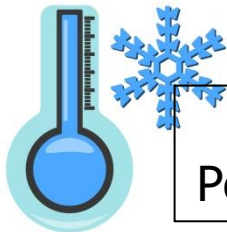
- Brown adipose tissue

Adult

Increase sympathetic activity

- Peripheral vasoconstriction
- Diminished sweating
- Shivering

This process can increase heat production



Skin

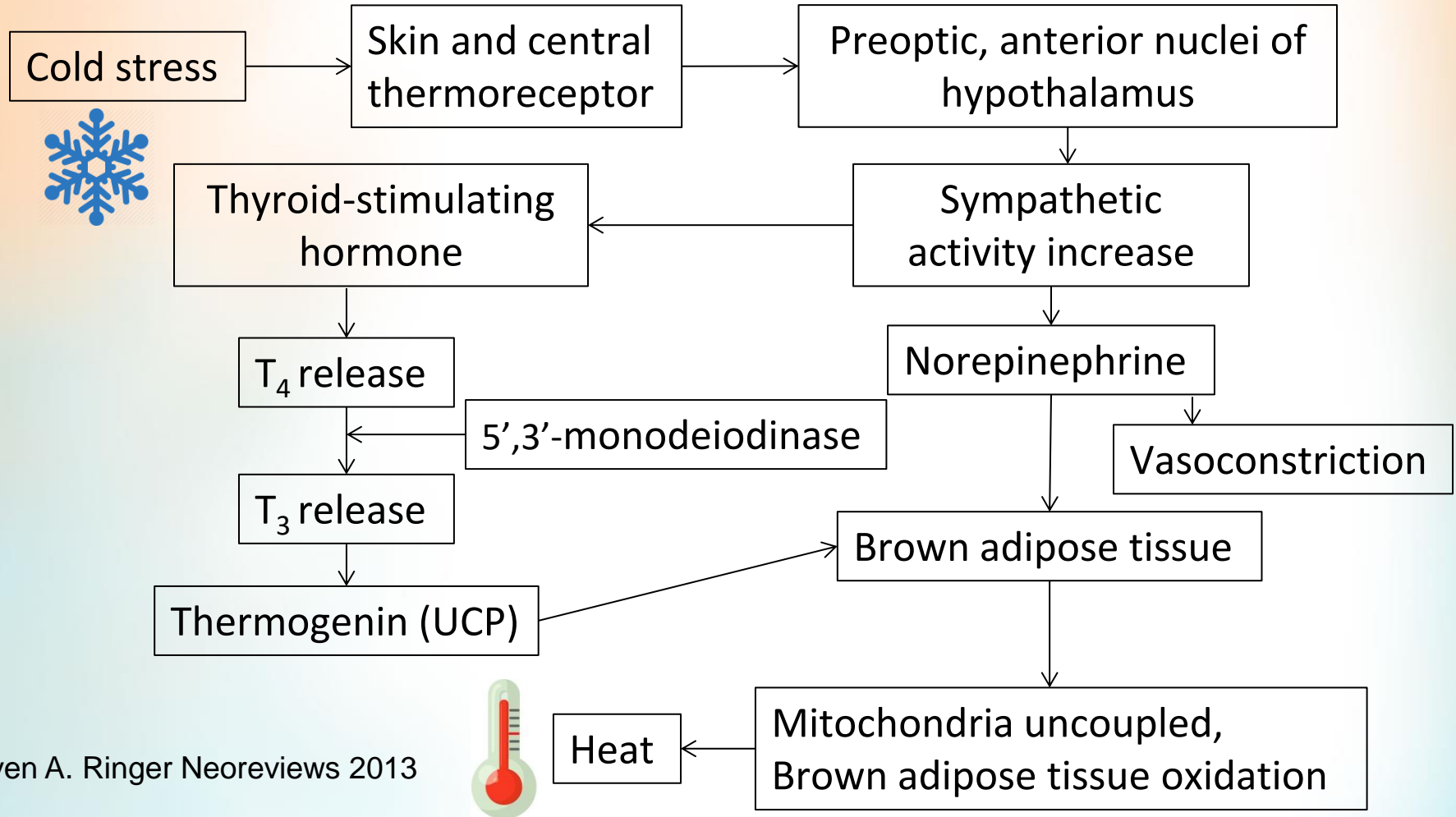
Peripheral thermal receptor



# Brown adipose tissue

- Specific heat-generating function
- Found in characteristic areas of the baby, such as interscapular, axillary, perirenal, and thoracic regions and between neck muscles
- Prominent in the fetus and newborn
- Increasing amounts found as gestation approaches term
- Metabolized, heat is produced that directly warms the blood and organs

# Nonshivering thermogenesis in newborn



# Heat loss

## Newborn

- Greater risks of heat loss
- Higher skin surface area to weight ratio
- Thinness of skin
- Diminished amount of subcutaneous fat

# Preterm Infant Susceptibility to Hypothermia

1. Large head and greater ratio of skin surface to body weight
2. Less subcutaneous fat and thinner skin with more transepidermal water losses
3. Decreased ability to maintain flexed posture
4. Less amount of brown fat and glycogen stores
5. Low levels of thermogenin and 5'3' monodeiodinase
6. Lower surge of thyrotropin
7. Greater likelihood of hypoxemia in preterm infants, which can impair brown fat metabolism

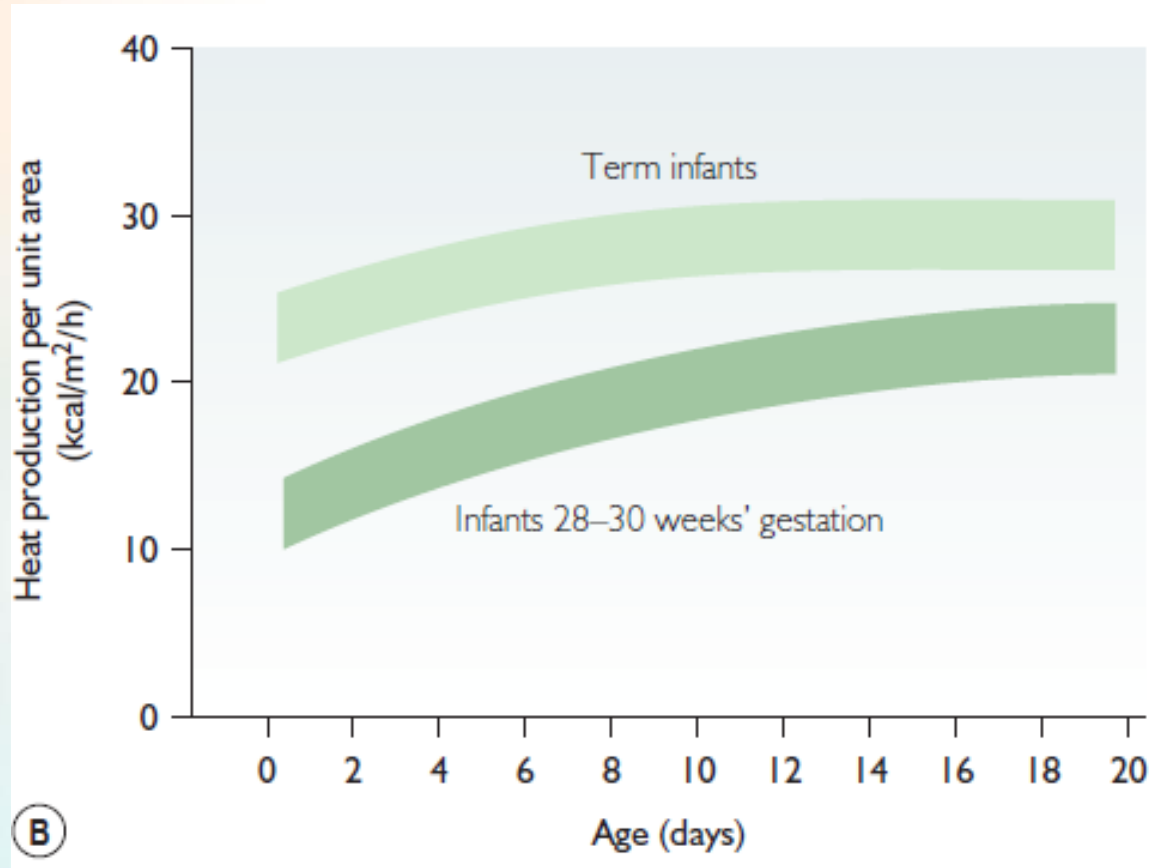
## Estimated Body Surface Area and Body Surface Area to Mass Ratio at Different Body Weights

Body Mass (kg)	BSA (m <sup>2</sup> )	BSA/Mass (m <sup>2</sup> /kg)
0.5	0.065	0.13
1	0.1	0.1
3.5	0.2	0.06
70	1.73	0.025

# Response to warm environment

- Physiologic
  - Sweating : absent in babies born at < 36 weeks' gestation but usually appears by about 2 weeks of age
  - Babies of opiate-abusing mothers have a well developed ability to sweat at any gestational age.
- Behavioral
  - less active, sleep more and lie in an extended, sunbathing posture

# Heat production



# Factors affecting a newborn infant's heat production

## HEAT PRODUCTION IS INCREASED

- Awake
- Active
- Postfeeding
- Rapid growth
- Neonatal thyrotoxicosis
- Left-to-right shunt
- Drugs (e.g. theophylline)

## HEAT PRODUCTION IS DECREASED

- Deep sleep
- Ill (e.g. asphyxia/hypoxia)
- Starvation
- Malnutrition
- Hypothyroidism
- Cyanotic cong heart disease
- Drugs (e.g. Caffeine)

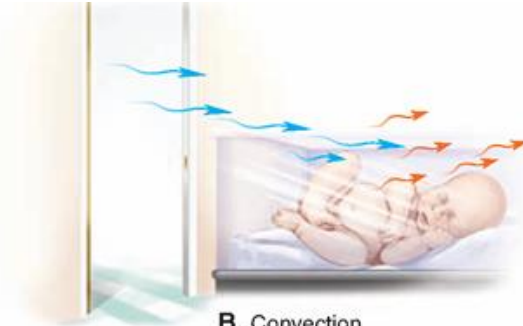


# Mechanism of heat loss

- Evaporation
- Conduction
- Radiation
- Convection



A. Conduction



B. Convection



C. Evaporation



D. Radiation

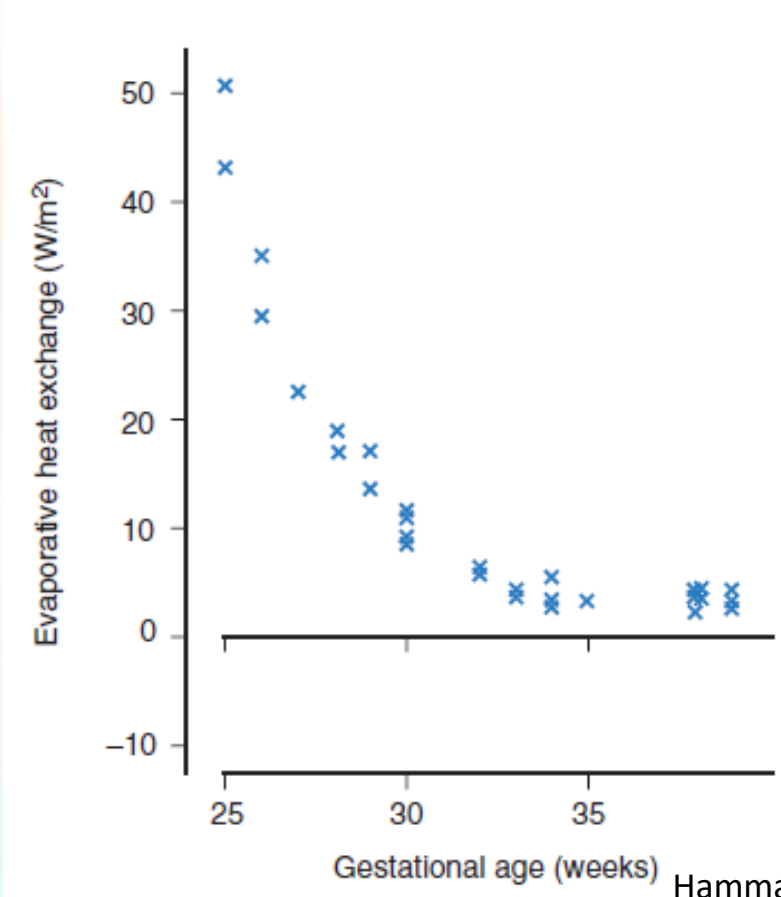
# Evaporative

- Water that evaporates from skin surface of infant
- Most common at the time of birth
- Baths represent a period of increased risk
- Low humidity environment
- Higher in premature



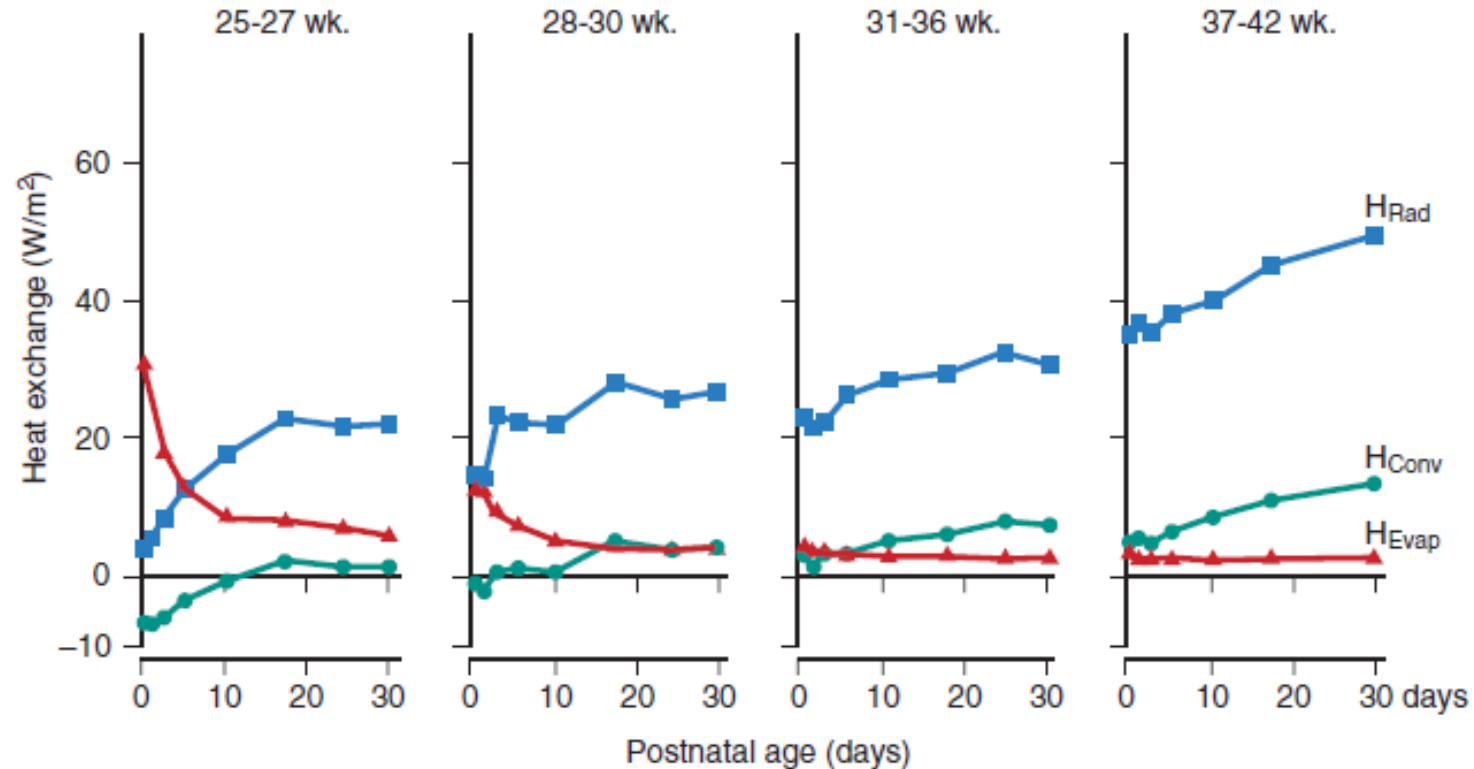
C. Evaporation

**Heat exchange through evaporation in relation to gestational age. Measurements from the first day of life during incubator care at an ambient humidity of 50%.**

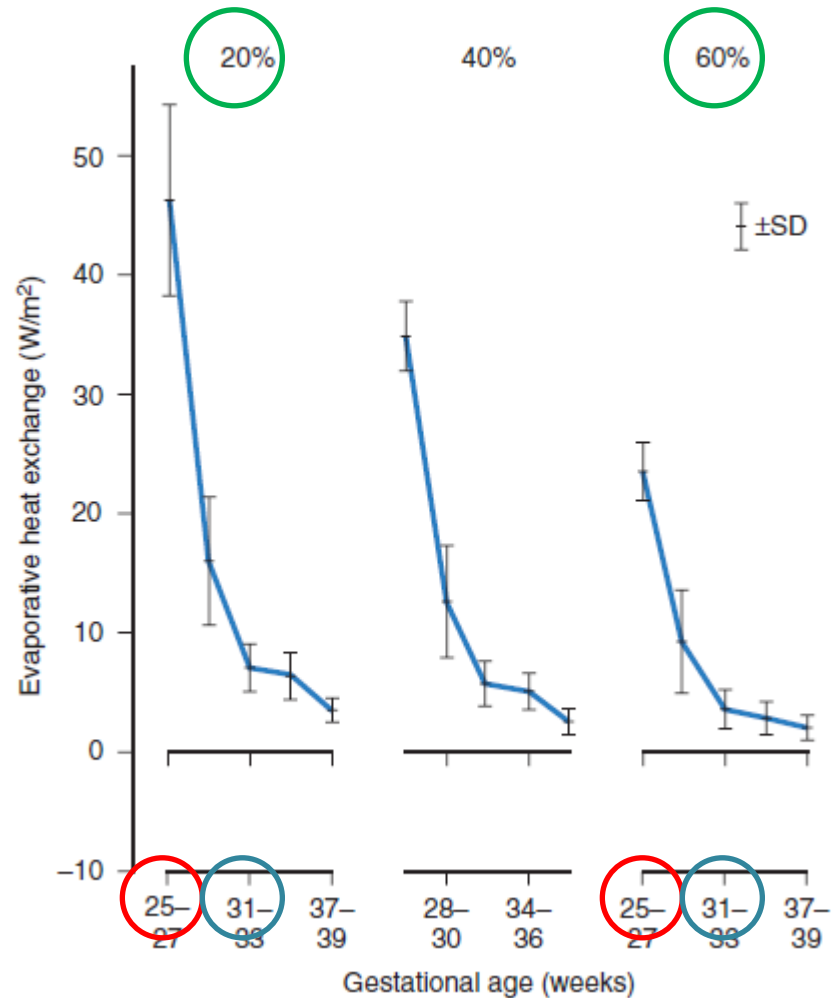


Hammarlund K, et al. *Acta Paediatr Scand.* 1982

# Heat exchange in relation to postnatal age in different gestational age groups



## Heat exchange through evaporation in relation to gestational age at different ambient relative humidity



# Evaporative Heat Loss in preterm infant

- Immature epidermal barrier with absence of a competent stratum corneum
- Less subcutaneous fat
- Increased surface area-to-body weight ratio
- Poor vasomotor control

# Prevention Strategies

- Keep the infant and clothing dry
- Dry the infant immediately after delivery
- Place preterm or small-for-gestational age infant in occlusive wrap/bag at delivery
- Delay bath until temperature is stable
- Place infant in an environment with 60% humidity

# Conductive

- Direct contact between infant and surrounding environment and objects
- Rate of loss is proportional to the temperature differential between the infant and the object



A. Conduction



# Prevention Strategies

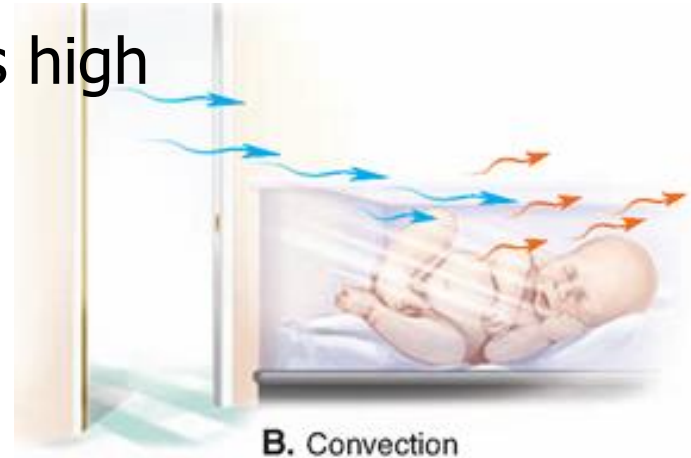
- Place a warm diaper or blanket between the infant and cold surfaces
- Place infant on prewarmed table at time of delivery
- Warm all objects that are in contact with the infant
- Hold infant skin to skin
- Use exothermic mattress



ตู้อบผ้า

# Convective

- Gradient between the temperature of skin of infant and movement of ambient air
- Infant moves through cold air after delivery, from the mother to a resuscitation table
- Heat loss is similar in term and preterm
- Heat loss increase when air velocity is high



# Prevention strategies

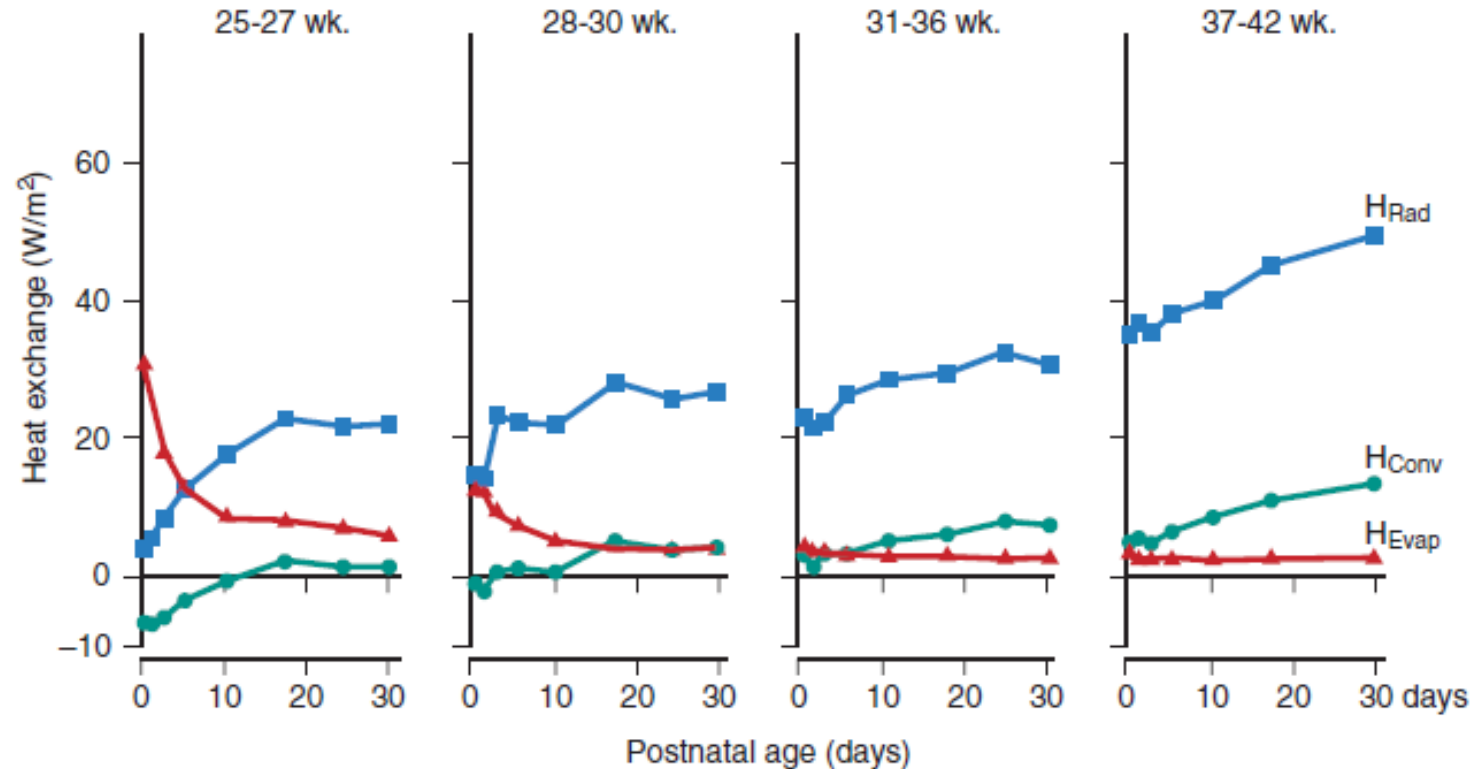
- Minimised by swaddling, using hats, warming oxygen and minimising draughts
- Place preterm infant in incubator
- Keep portholes of the incubator closed
- Warm all inspired air

# Radiation

- Gradient between skin of infant and surrounding surfaces not touching infant
- Infant is near a cold window
- Major route in preterm infants  $> 28$  weeks' gestation and term infant



# Heat exchange in relation to postnatal age in different gestational age groups



# Prevention strategies

- Avoid placement of incubators or bassinets near cold windows or air conditioners
- Place a hat on the infant's head
- Place extremely preterm infant in bag or surround with plastic wrap
- Increase environmental temperature
- Use double-walled incubators

# Respiratory loss of heat

- Combined processes of evaporation and convection
- Heat loss related to
  - Air temperature
  - Humidity
  - Rate of breathing

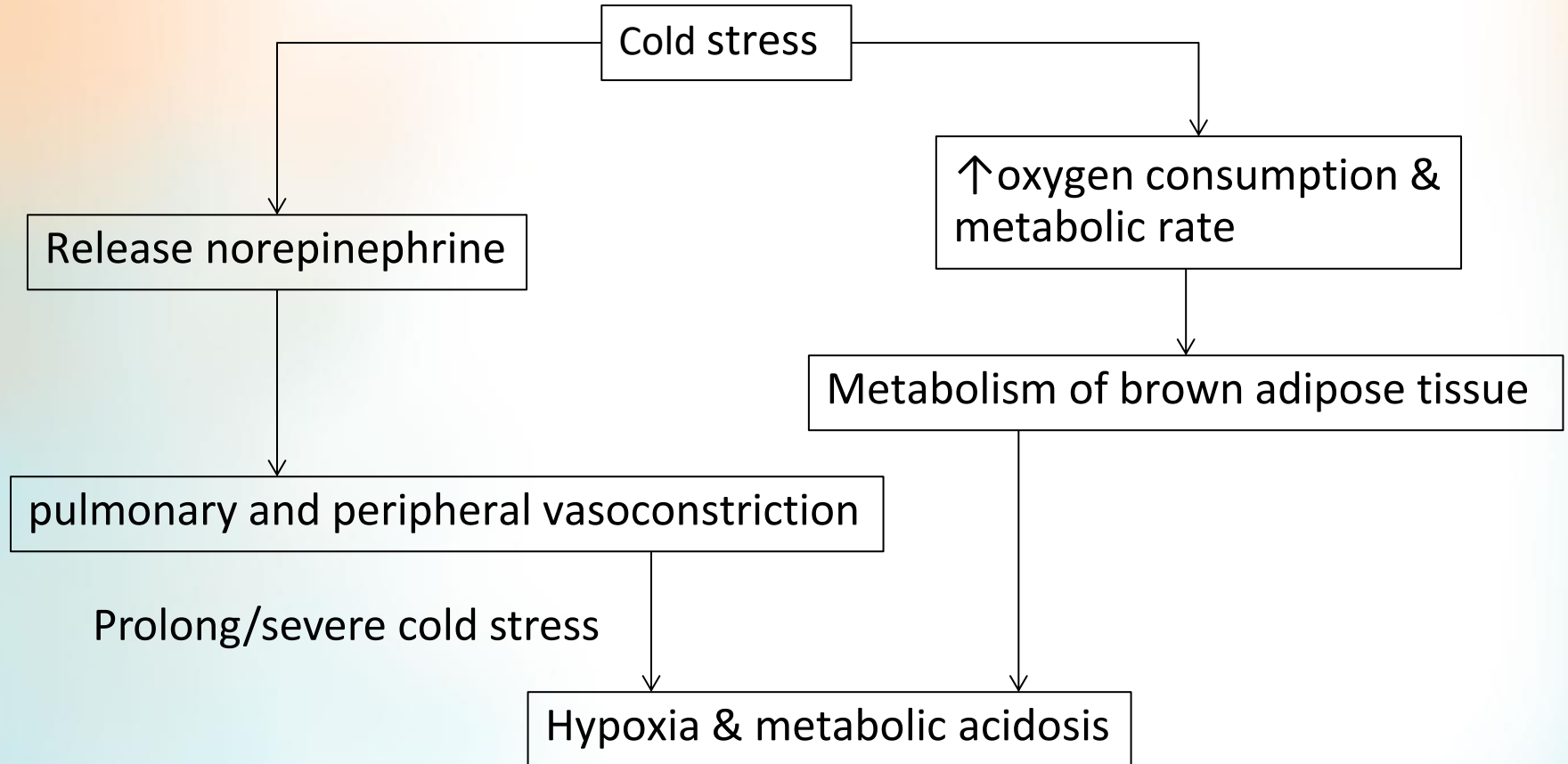


# Respiratory loss of heat

- Use of warmed and humidified (saturated at  $\geq 37.0^{\circ}\text{C}$ ) gas will reduce respiratory loss of water and heat to a minimum



# Effect of hypothermia



# Clinical of hypothermia

- Lethargic with limited movement
- Feed poorly
- Cold when touched
- Bright red skin
- Respiratory rate and the heart rate slow
- Hypoglycemia
- Metabolic acidosis
- Hypoxemia

# Clinical of hypothermia

In severe case

- Peripheral and facial edema
- Sclerema or subcutaneous fat necrosis
- Organ dysfunction including
  - Acute renal failure
  - Coagulopathy
  - Persistent pulmonary hypertension
  - Intraventricular hemorrhage

# **Measurement of temperature**

# Body temperature

## WHO

- Normal range : 36.5-37.5 °C
- Mild hypothermia : 36-36.5 °C
- Moderate hypothermia : 32-36 °C
- Severe hypothermia : < 32 °C

AAP : normal temperature 36.5-37.4 °C

NICE guideline defines normal newborn axillary temperature as 'around 37°C

# Measurement of temperature

- Rectal
- Axilla
  - Should be used, except during therapeutic hypothermia
  - Generally lower than rectal temperature by about 0.5°C
- AAP guidelines recommend adopting a similar normal range, 36.5–37.4°C

# Rectal measurement

- At birth or admission to ward

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Gold standard</li><li>• Closely approx. core temp</li><li>• Not affected by ambient temp</li><li>• Not limited by age</li></ul>	<ul style="list-style-type: none"><li>• Time consuming</li><li>• Risk of perforation</li><li>• Lag in core temperature change</li></ul>



# Axilla measurement

- Should be used, except during therapeutic hypothermia

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Safe</li><li>• Easily accessible</li><li>• Comfortable</li><li>• As accurate as rectal temperature</li><li>• Minimal cross infection</li></ul>	<ul style="list-style-type: none"><li>• Take longer to achieved depending on thermometer used</li><li>• Sweat can cause temperature lower than core temperature</li></ul>

- AAP guidelines recommend adopting a similar normal range, 36.5–37.4°C

# Skin measurement

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Comfortable</li><li>• Steady and continuous</li><li>• Automatic response to temperature changes</li></ul>	<ul style="list-style-type: none"><li>• Fragile skin</li><li>• Error if probe is loss</li></ul>

# Temperature probe



## เวลาที่ใช้วัดอุณหภูมิแกนกลางทารกโดยใช้ปรอทแก้วเพื่อให้ได้ค่าที่น่าเชื่อถือ

Position for measure		Depth	Placement time (min)
Rectal	Preterm	2.5 cm	3
	Term	3 cm	3
Axilla	Preterm	กลางรักแร้จับ แขนแนบชิดลำตัว	5
	Term		8

# **Maintenance of Thermal Stability in the Delivery Room**

# Delivery room

- WHO recommendations that the delivery site should be warmed to 25°C
- Dry with warm blankets
- Placed in
  - Preheated radiant warmer
  - Incubator
  - mother's chest and cover with a light blanket.



## ORIGINAL ARTICLE

# Hypothermia in very low birth weight infants: distribution, risk factors and outcomes

**SS Miller<sup>1</sup>, HC Lee<sup>2</sup> and JB Gould<sup>1</sup>**

*<sup>1</sup>Department of Pediatrics, Division of Neonatal and Developmental Medicine, Stanford University, Palo Alto, CA, USA and*

*<sup>2</sup>Department of Pediatrics, Division of Neonatology, University of California, San Francisco, CA, USA*

**Journal of Perinatology (2011) 31, S49–S56**

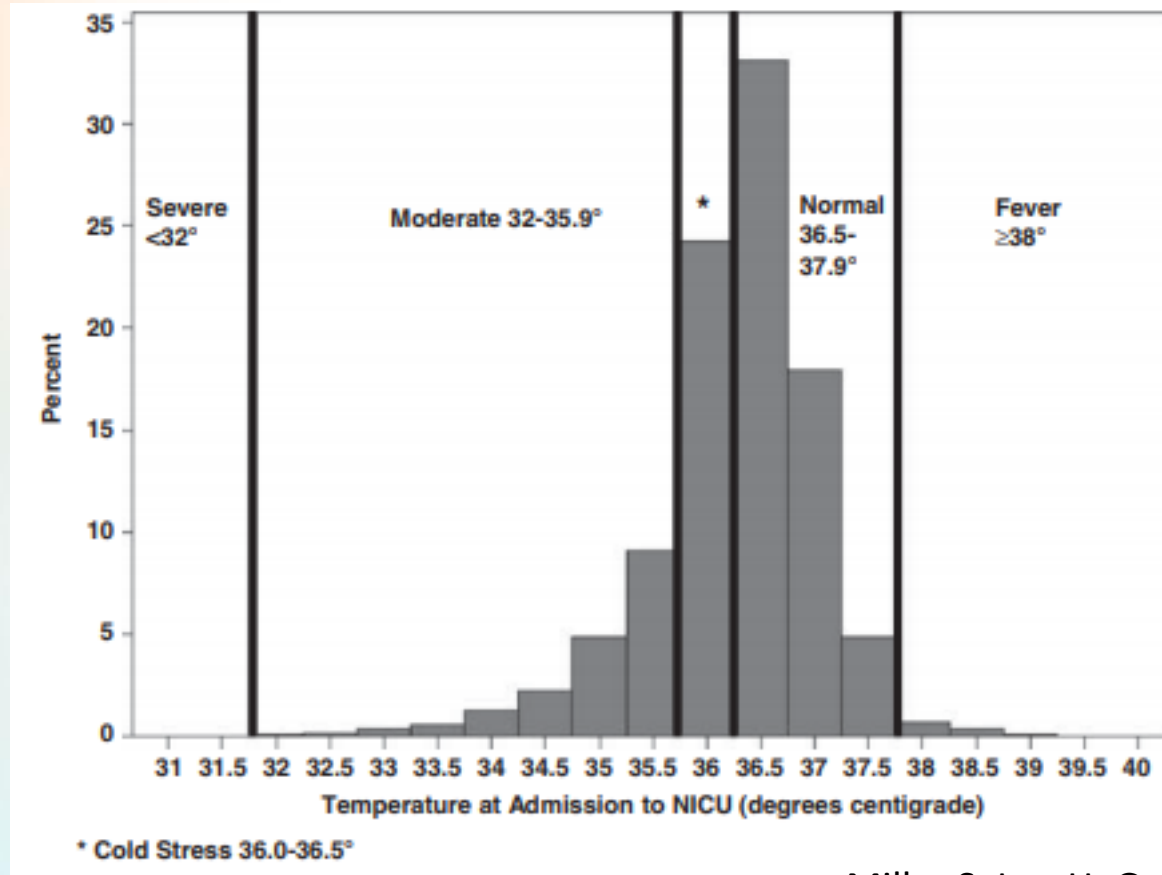
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[www.nature.com/jp](http://www.nature.com/jp)





# Admission temperatures from the delivery room for 8782 very low birth weight infants born in California neonatal intensive care units



**Table A1** Admission temperature for infants <32 weeks gestational age with birth weight <1500 g by gestational age

<i>Gestational age (weeks)</i>	<i>N</i>	<i>Mean BW (s.d.)</i>	<i>Mean temp (s.d.)</i>	<i>Range</i>
23	263	606 (90)	35.3 (1.3)	31.0–38.4
24	572	672 (103)	35.8 (1.2)	26.1–39.0
25	732	762 (128)	36.1 (0.9)	32.8–39.5
26	820	876 (160)	36.3 (0.8)	32.2–39.2
27	993	978 (180)	36.3 (0.7)	32.3–39.1
28	1120	1097 (204)	36.4 (0.8)	27.0–39.2
29	1311	1195 (198)	36.4 (0.7)	26.1–38.6
30	1022	1245 (185)	36.4 (0.7)	33.4–39.1
31	413	1295 (169)	36.3 (0.6)	33.0–37.9
32	235	1310 (149)	36.3 (0.6)	34.8–38.0

Abbreviation: BW, birth weight.

**Table A2** Admission temperature for infants <32 weeks gestational age with birth weight <1500 g by birth weight

<i>Birth weight (g)</i>	<i>N</i>	<i>Mean GA (s.d.)</i>	<i>Mean temp (s.d.)</i>	<i>Range</i>
400–499	87	24.7 (1.7)	35.4 (1.3)	32.0–39.1
500–599	343	24.5 (1.6)	35.6 (1.1)	31.7–38.3
600–699	622	25.0 (1.8)	35.8 (1.1)	30.5–39.0
700–799	793	25.7 (1.8)	36.1 (1.0)	26.1–39.5
800–899	800	26.6 (1.8)	36.3 (0.7)	33.1–38.5
900–999	792	27.4 (1.8)	36.2 (0.7)	32.9–39.0
1000–1099	905	28.2 (1.9)	36.4 (0.8)	26.7–39.2
1100–1199	973	29.1 (1.9)	36.4 (0.7)	33.2–38.6
1200–1299	1076	29.8 (1.9)	36.4 (0.7)	27.0–39.1
1300–1399	1159	30.4 (1.9)	36.4 (0.6)	33.5–38.4
1400–1499	1232	31.1 (1.9)	36.4 (0.7)	26.1–39.6

Abbreviation: GA, gestational age.

## Risk factor for WHO criteria of mod/severe hypothermia, cold stress

	Mod/severe (95% CI)	Cold stress (95% CI)
Delivery mode (cesarean vs vaginal)	1.2 (1.0-1.4)	1.3(1.1-1.5) ↑
Spontaneous labor	0.8 (0.7-0.9)	0.9 (0.8-1) ↓
Prolonged rupture of membrane	0.7 (0.6-0.9)	0.8 (0.7-0.9) ↓
Antenatal steroid	0.7 (0.6-0.8)	0.9 (0.8-1.0) ↓
Maternal hypertension	1.1 (1.0-1.1)	NS
1 min Apgar score (0-6 vs 7-10)	1.1 (1.0-1.3)	1.1 (1.0-1.3)
5 min Apgar score (0-6 vs 7-10)	1.5 (1.3-1.7)	NS
Resuscitation (none vs any in delivery room)	NS	0.8 (0.7-0.9)

## Neonatal outcome evaluated according to WHO criteria for hypothermia

	Normal (%) (N = 2233)	Cold stress (%) (N= 2639)	Mod/severe(%) (N= 3740)	P-value
Stage 3 Or 4 ROP	6.5	6.5	11.2	<0.0001
NEC	7.3	7.2	8.8	0.11
Sepsis (early)	2.4	2.0	2.3	0.11
Sepsis (late)	11.4	10.9	15	<0.0002
Oxygen at 36 wks	8.4	6.5	7.0	<0.0001
IVH	6.8	7.0	13.0	<0.0001
Death	6.7	8.5	17	<0.0001
Death + IVH 3-4	11.1	12.3	22.8	<0.0001

# Prevention

## TransWarmer exothermic mattress



## Polyethylene wrap



## Woolen cap



# Polyethylene wrap



- ↓ Conduction
- ↓ Convection
- ↓ Evaporation

- ↓ Heat loss esp. preterm
- ↓ Hypothermia 1-2 h after NICU admission

# HEAT LOSS PREVENTION (HELP) IN THE DELIVERY ROOM: A RANDOMIZED CONTROLLED TRIAL OF POLYETHYLENE OCCLUSIVE SKIN WRAPPING IN VERY PRETERM INFANTS

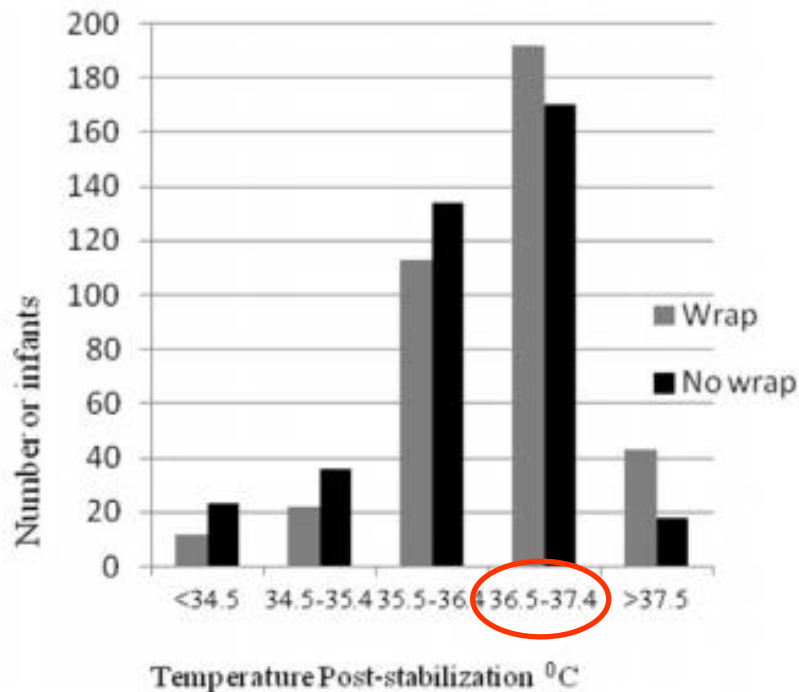
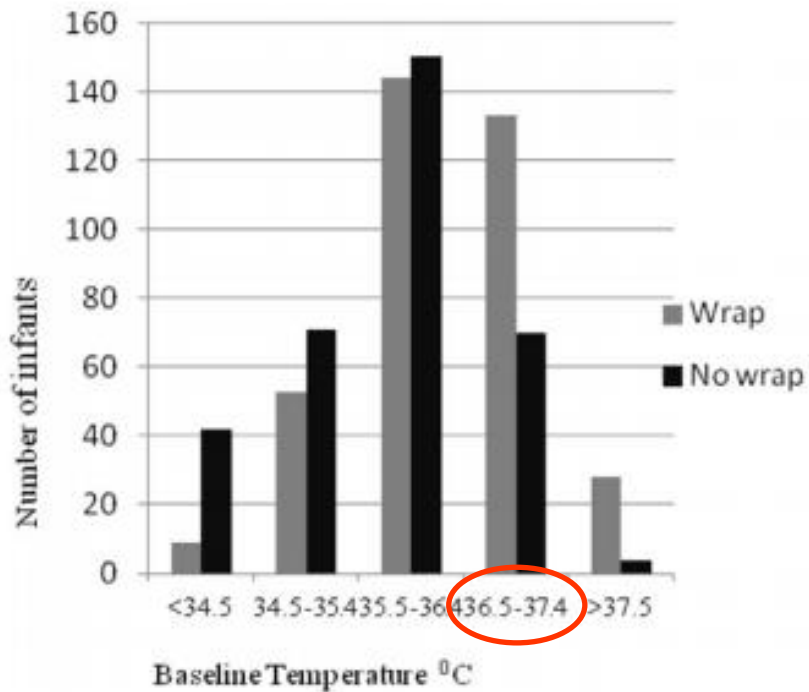
SUNITA VOHRA, MD, MSc, ROBIN S. ROBERTS, MSc, BO ZHANG, MPH, MARIANNE JANES, MHSc, AND BARBARA SCHMIDT, MD, MSc

**Table II. Outcomes**

	Wrap group (n = 27)	Control group (n = 26)	P value
<b>Primary outcome, rectal temperature (°C)</b>			
At NICU admission, mean ± SD	36.5 ± 0.8	35.6 ± 1.3	0.002
One hour after NICU admission, mean ± SD	36.6 ± 0.7	36.4 ± 0.9	0.4
<b>Secondary outcomes</b>			
Death, n (%) <sup>*</sup>	7 (25.0)	8 (29.6)	0.8
APGAR score at 1 min			
Median	6	6	0.6
Interquartile range	2 – 6	3–6	
APGAR score at 5 min			
Median	7	7	0.9
Interquartile range	6 – 8	7–8	
Blood gas pH, mean ± SD	7.32 ± 0.12	7.36 ± 0.12	0.3
Bicarbonate (mmol/L), mean ± SD	20.5 ± 4.0	19.5 ± 2.8	0.3
Glucose (mmol/L), mean ± SD	2.5 ± 1.1	2.8 ± 1.8	0.5

<sup>\*</sup>Death rate was calculated on the basis of 28 infants in the wrap group and 27 infants in the control group.

# Randomized Trial of Occlusive Wrap for Heat Loss Prevention in Preterm Infants







3\_12\_neoreviews\_videocorner.mp4

# Woolen cap



Brain :

- High oxygen consumption
- 12% of body weight
- 20% of total body surface are
- High vascularity

Increase heat loss

# Current NCPR 2015 recommendation

- Increase the temperature in the room
- Preheat the radiant warmer well before the time of birth
- Place a hat on the baby's head
- For babies born at < 32 weeks' gestation

Thermal  
mattress  
placed  
under a  
blanket on the  
radiant warmer



Polyethylene  
plastic bag  
Drying the  
baby is not  
necessary

# Transport from the Delivery Room to the NICU

- Radiant warmer or incubator should be used for transport.
- Transport incubator



# นวัตกรรมผ้าอ้อมอุ่น

พ.ต.ท.หญิง ธีรวรรณ ใจจักร์



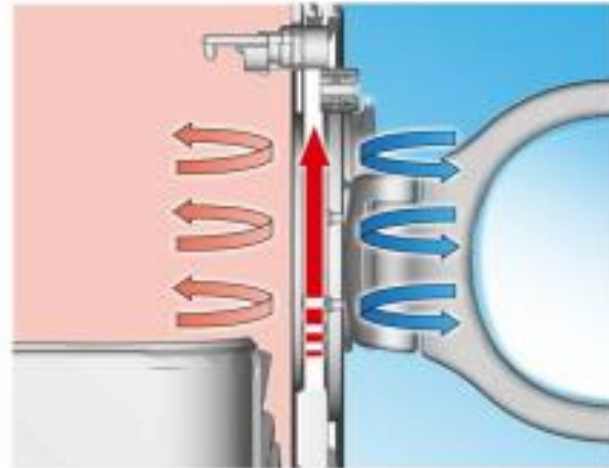
# **Maintenance of Thermal Stability in the NICU**

- Environment temperature
  - In incubator : 25-26 °C
  - In crib : 27-28 °C
- All windows and doors should be close



# Incubator care

- Get the newborn into the closed incubator as quickly as is feasible
- Double wall incubator





# Mode of incubator

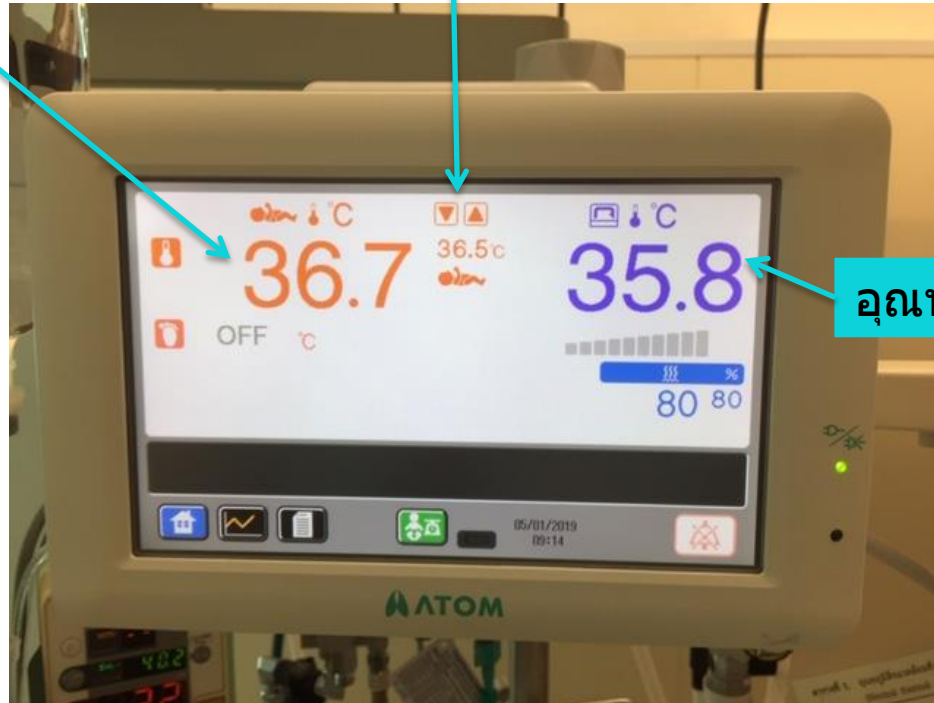
- Skin Servo control
  - Heater output is controlled by the newborn infant's skin temperature
- Air servo control
  - Air temperature is set to a desired level and maintained by thermostat

# Skin servo control

อุณหภูมิผิวหนังที่ตั้งไว้

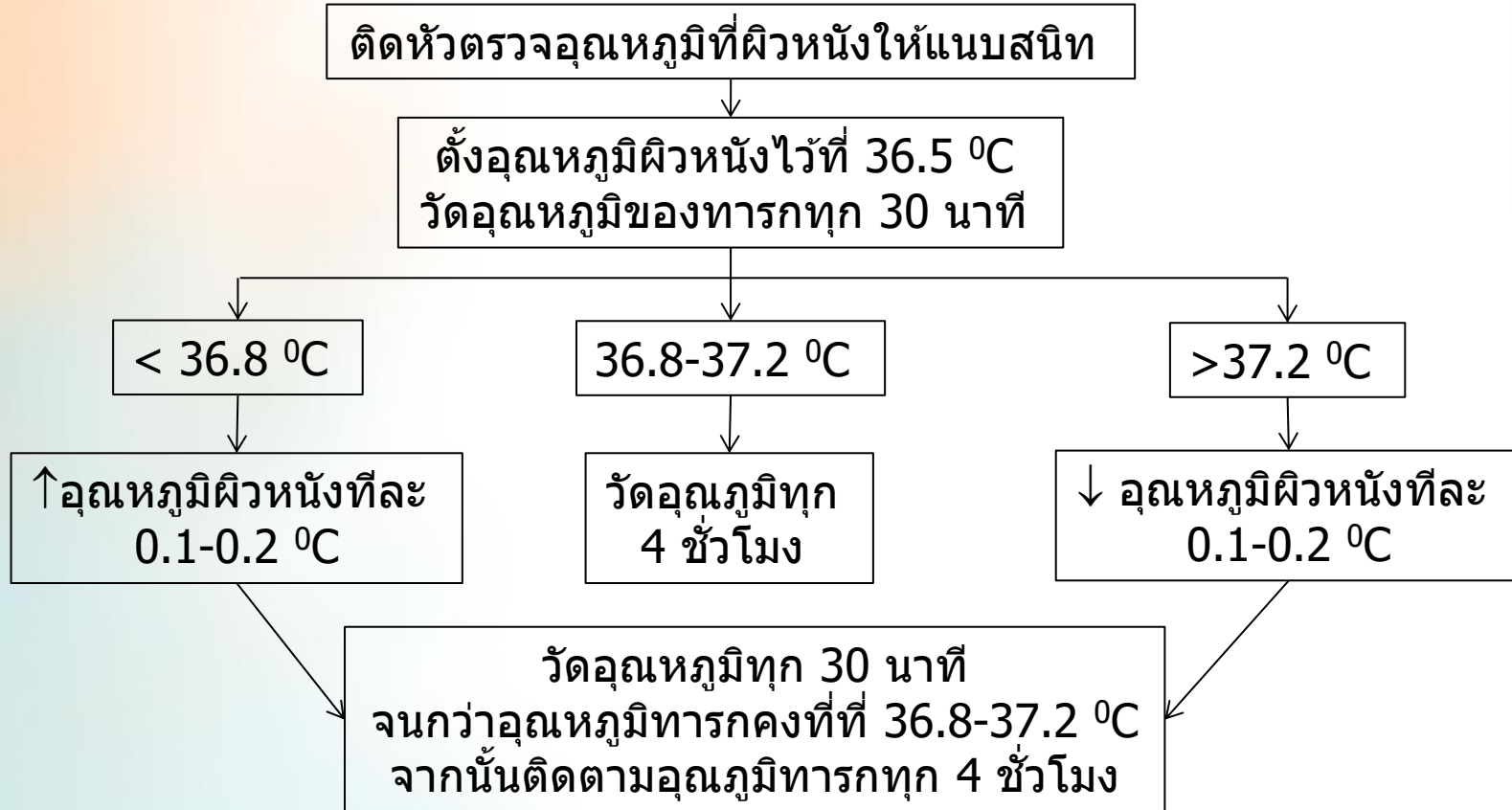
อุณหภูมิผิวหนังของทารก

Temperature probe ติดที่ผิวหนังทารก



อุณหภูมิภายในตัว

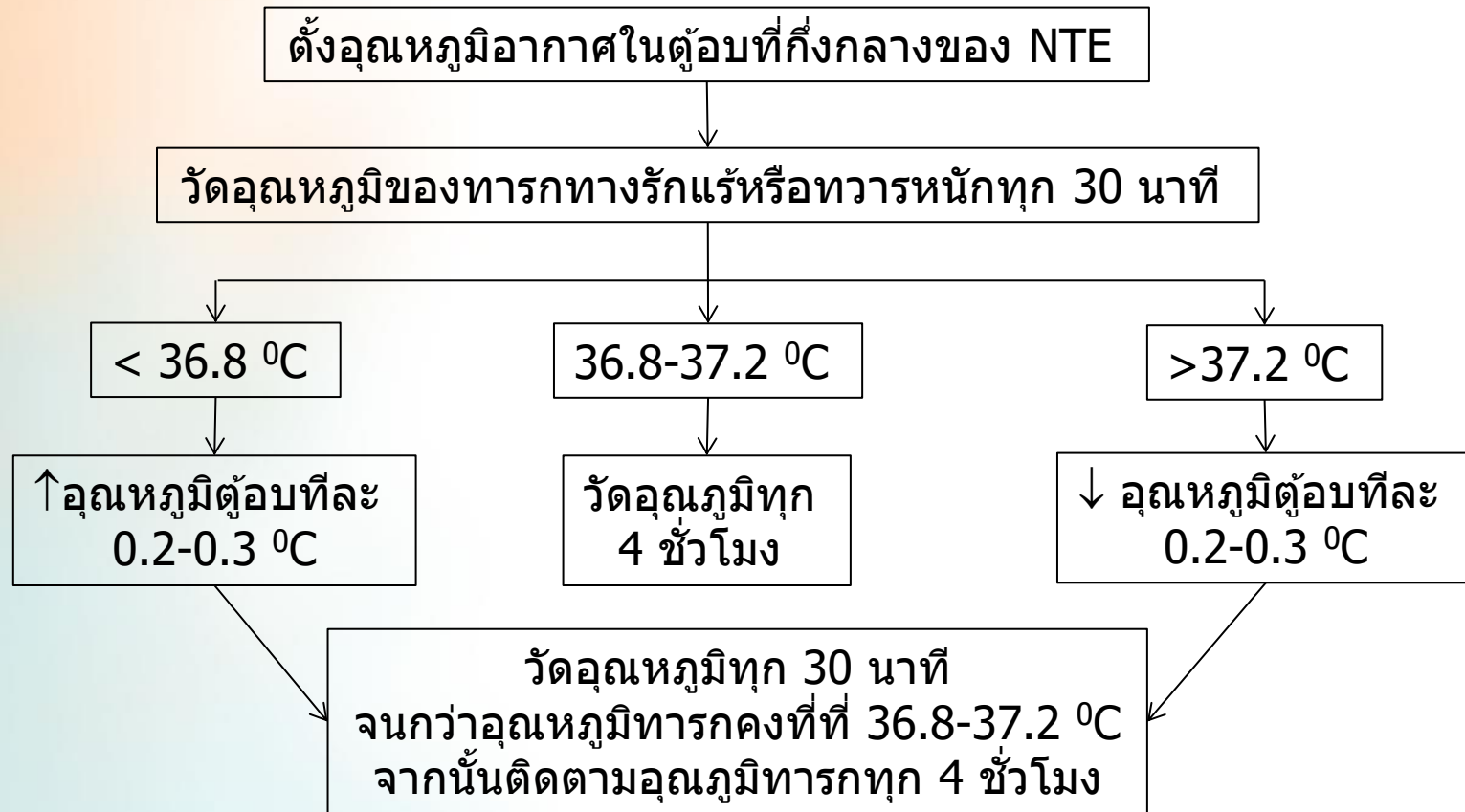
# วิธีตั้งอุณหภูมิรูปแบบ skin servo control



## **Suggested abdominal skin temperature settings for infants nursed under radiant warmers or in servo mode incubators**

<b>Birthweight (kg)</b>	<b>Abdominal skin temperature (°C)</b>
<1.0	36.9
1.0-1.5	36.7
1.5-2.0	36.5
2.0-2.5	36.3
>2.5	36

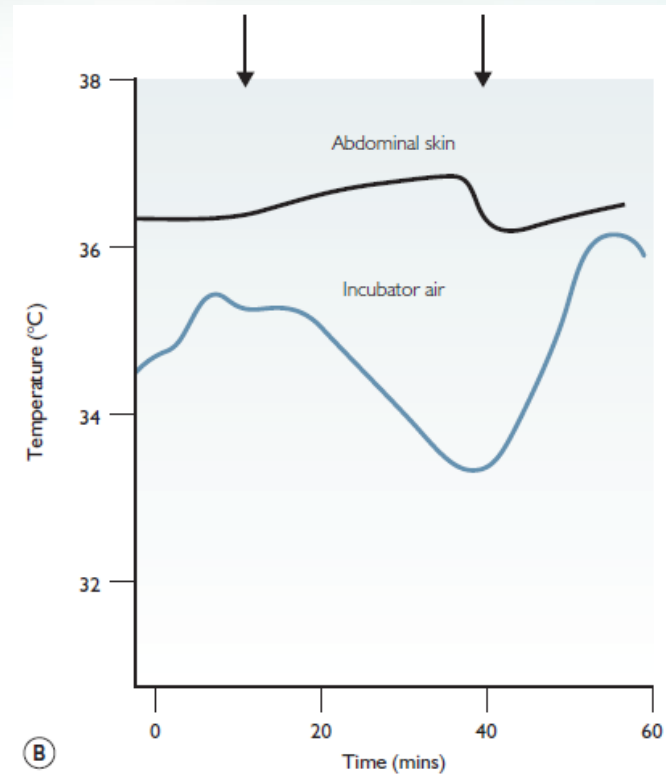
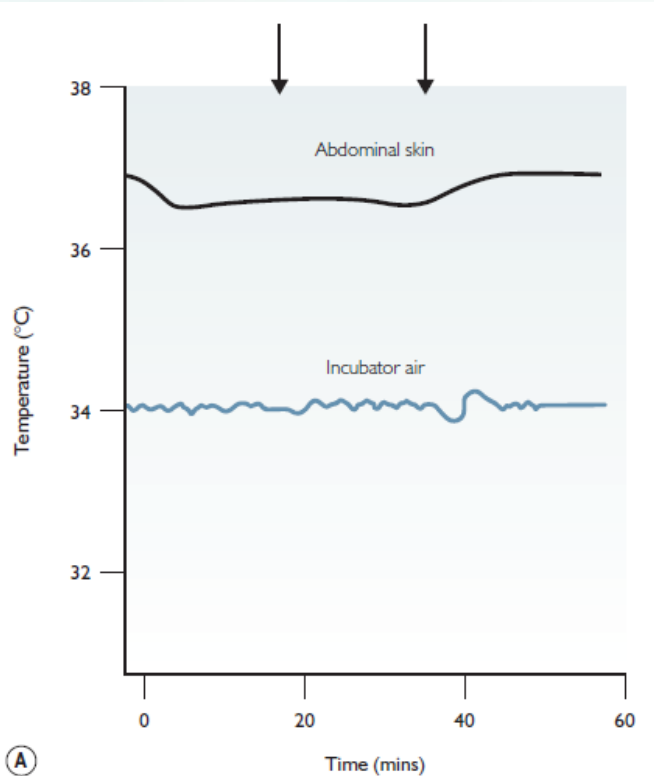
# วิธีตั้งอุณหภูมิรูปแบบ air servo control



# Monitor

- อุณหภูมิแกนกลางของทารก
- อุณหภูมิอากาศในตู้อบ
- อุณหภูมิที่ตั้งไว้
- อุณหภูมิห้อง

# Fluctuations in incubator air temperature when used (A) in air mode and (B) in servo mode.



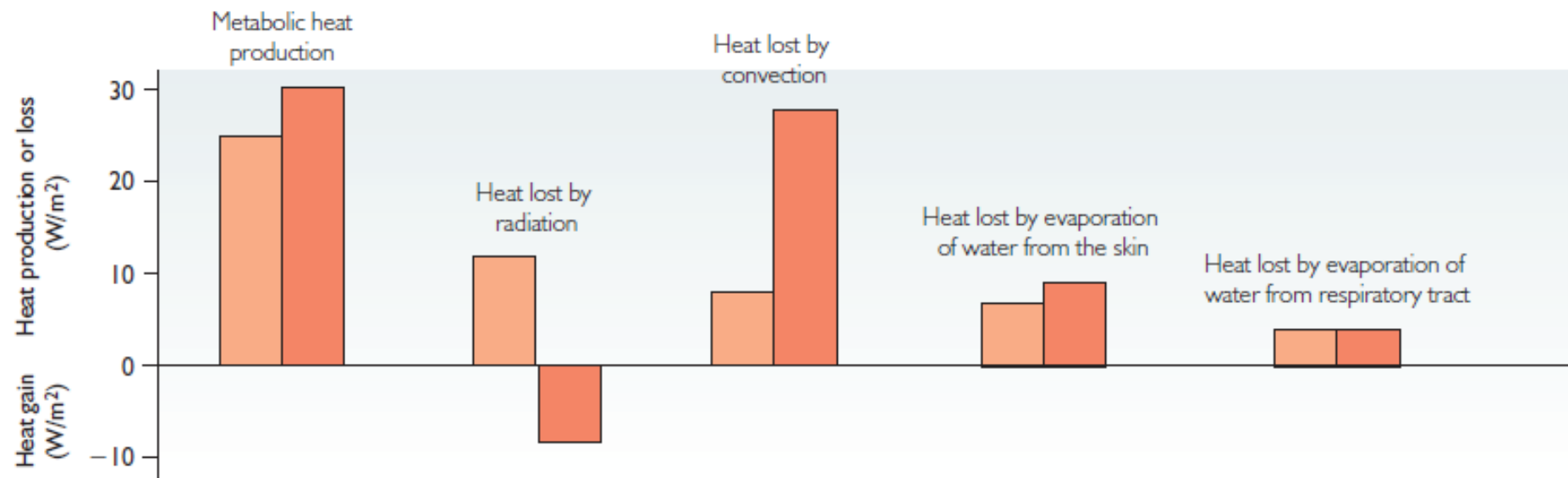


Fig. 15.4 Heat production, losses and gains of 11 preterm infants (mean birthweight 1.58 kg, gestation 32 weeks, age 7 days) nursed naked in an incubator (lighter bars) and under a radiant warmer (darker bars) in presumed neutral thermal conditions. (Redrawn from Wheldon and Rutter (1982).)



# Incubator

- Skin servo control is preferable to air temperature control esp. in LBW infant
- Cochrane review reported that skin servo control mode reduces neonatal death compared with air temperature control at 89.2°F (31.8°C)

# Temperature probe placement



- Place on the infant's upper abdomen, usually midway between xiphoid process and umbilicus.
- Avoid areas of brown fat such as the interscapular region, the axilla, or neck

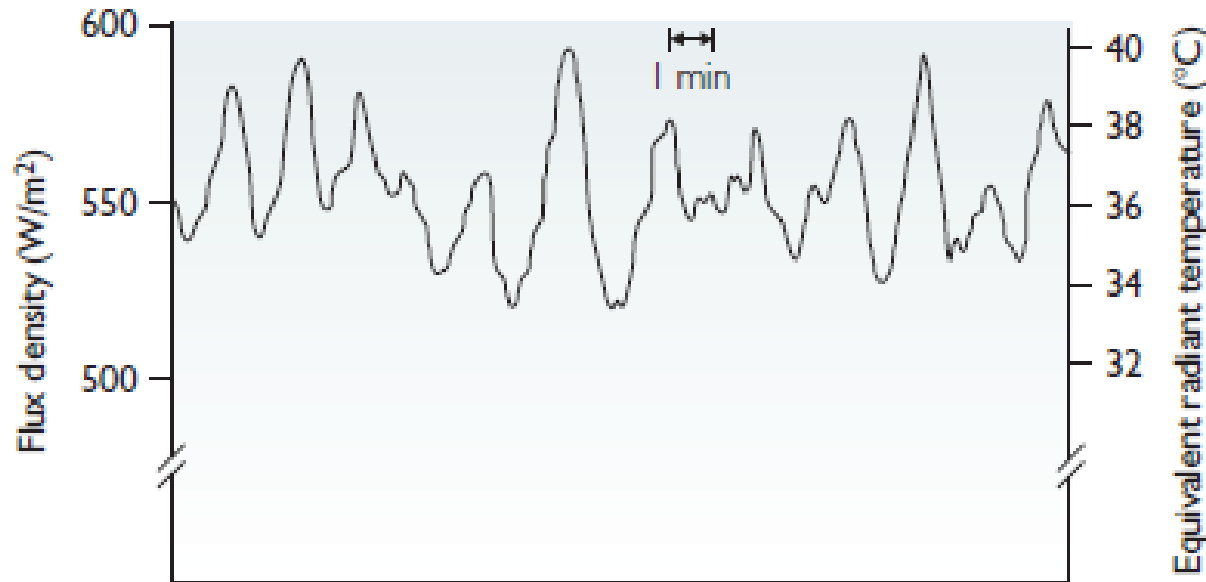
# Care under radiant warmer

- Prevent radiation heat loss
- Allow large evaporative and convective heat losses



# Care under radiant warmer

- The baby is exposed to cool, dry, draughty air and a markedly fluctuating radiant heat source



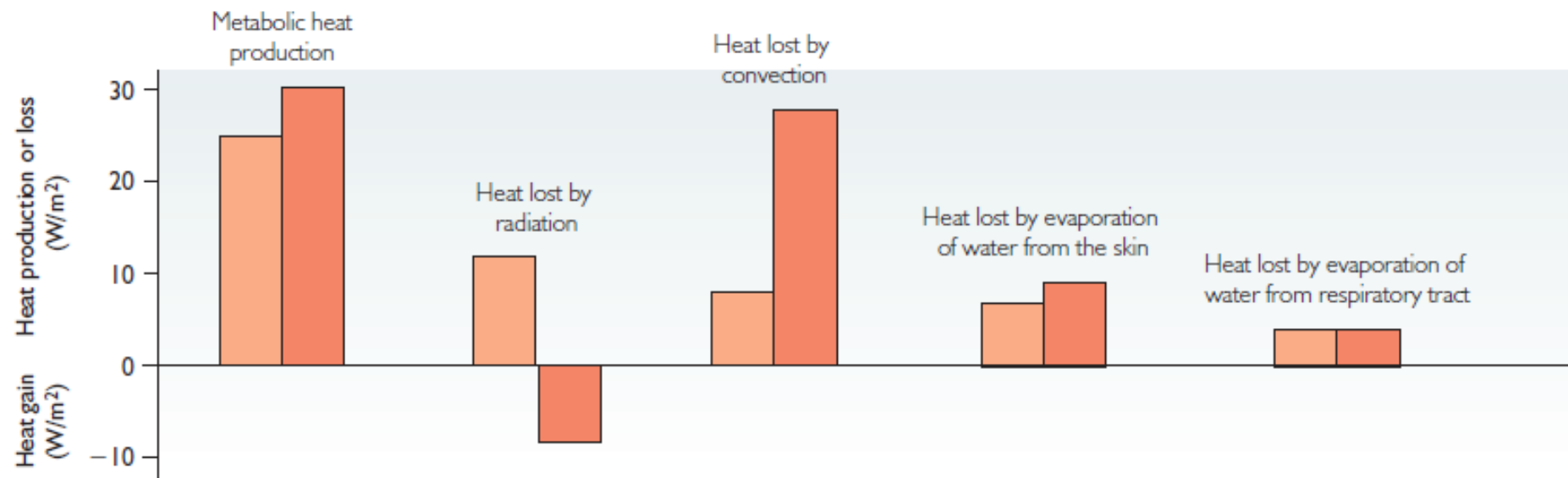


Fig. 15.4 Heat production, losses and gains of 11 preterm infants (mean birthweight 1.58 kg, gestation 32 weeks, age 7 days) nursed naked in an incubator (lighter bars) and under a radiant warmer (darker bars) in presumed neutral thermal conditions. (Redrawn from Wheldon and Rutter (1982).)

# Care under radiant warmer

- Fluctuating , asymmetrical thermal environment compared with the constant temperature provided by an incubator
- Higher resting levels of oxygen consumption
- Advantage
  - keeping a newborn infant warm particular in the **first 24 hours** after delivery, when considerable handling and practical procedures are necessary

# วิธีตั้งอุณหภูมิของ radiant warmer



- Manual control : ผู้ดูแลปรับตั้งค่า heat power เอง ซึ่งเป็นขีดสเกล หรือบอกเป็นเปอร์เซ็นต์



- Skin servo control : ตั้งอุณหภูมิผิวหนังทารกเหมือนการใช้ incubator
- วัดอุณหภูมิทารกทุก 30 นาที หากคงที่ แล้วจึงติดตามตามปกติทุก 4 ชั่วโมง

# Multifunction incubator (hybrid incubator-radiant warmer)



Incubator mode



Warmer mode



# ข้อควรระวังในการใช้หัวตรวจอุณหภูมิผิวหนัง (skin probe)

- ติดหัวตรวจด้านที่เป็นโลหะให้แนบสนิทกับทารก
- หากติดหัวตรวจไม่แน่น อุณหภูมิที่วัดได้จะต่ำกว่าอุณหภูมิจริงของผิวหนัง เครื่องเพิ่มความร้อนมากขึ้น ทารกมีอุณหภูมิกายสูงผิดปกติ
- ทารกเกิดก่อนกำหนด ควรติดแผ่น semipermeable membrane (Tegaderm) บนผิวหนังก่อนติด skin probe เพื่อเป็นการป้องกันผิวหนังหลุดลอกเวลาดึงแถบกาออก

# ข้อควรระวังในการใช้หัวตรวจอุณหภูมิผิวหนัง (skin probe)



- ทารกนอนหงาย ติดหัวตรวจอุณหภูมิที่บริเวณหน้าท้อง



- ทารกนอนคว่ำ ติดหัวตรวจอุณหภูมิที่บริเวณแผ่นหลังใต้สะบัก

# ข้อควรระวังในการใช้หัวตรวจอุณหภูมิผิวหนัง (skin probe)

- หลีกเลี่ยงการติดที่ปุ่มกระดูก หรือบริเวณที่ถูกผ้าอ้อมคลุมทับ
- ปิดทับหัวตรวจด้วยแผ่นสะท้อนความร้อนในกรณีที่ทารกนอนอยู่ใต้เครื่องให้ความอบอุ่น

# Skin-to-skin care

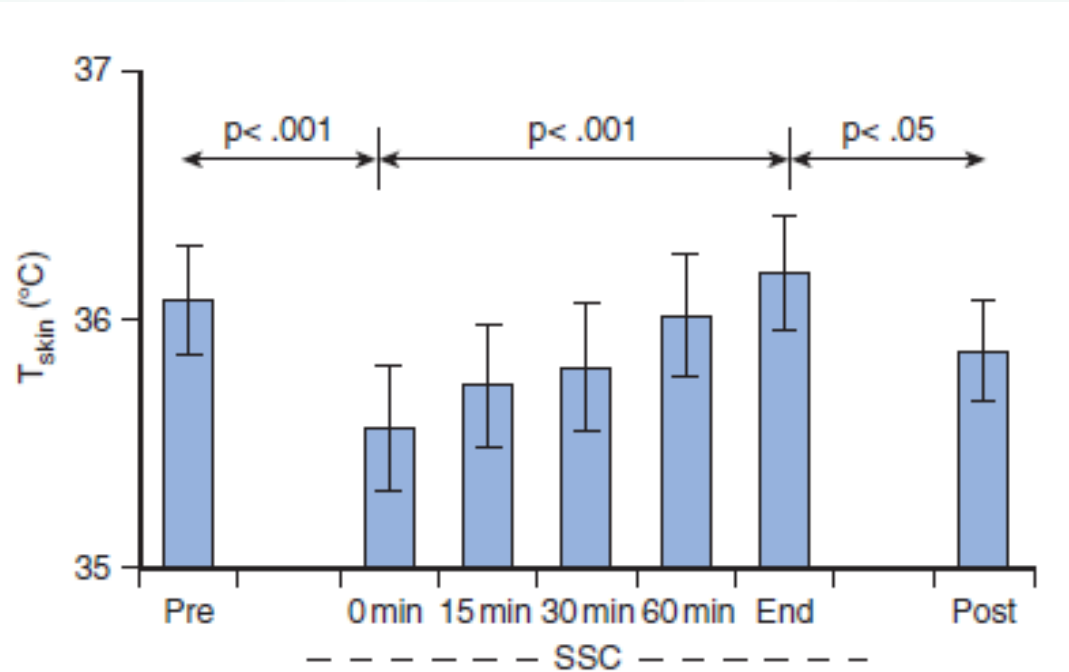
- Enables conductive heat gain through the skin-to-skin contact
- ↑ Mother –infant bonding
- ↑ Breastfeeding rate

# Skin-to-skin care



Cochrane demonstrated a statistically significant reduction in the risk of mortality, sepsis, and hypothermia with the use of skin-to-skin contact

## Skin temperatures ( $T_{\text{skin}}$ ) in a group of extremely (GA 22-26 wk) preterm infants during early (1st week) skin-to-skin care(SSC).



# Suggested Modes of Care in Infants of Different Gestational and Postnatal Ages

Infant Group	At Birth	Week 1	Weeks 2 to 4
<28 weeks	Radiant warmer Plastic bag Hot/humid gas	Incubator with $\geq 70\%$ RH Radiant warmer with plastic wrap SSC (end of first week)	Incubator with 50% RH Radiant warmer SSC
28-31 weeks	Radiant warmer	Radiant warmer Incubator SSC	Radiant warmer SSC Heated mattress
32-35 weeks	SSC Radiant warmer	SSC Heated mattress	SSC Cot
>36 weeks	SSC Radiant warmer	SSC Cot	

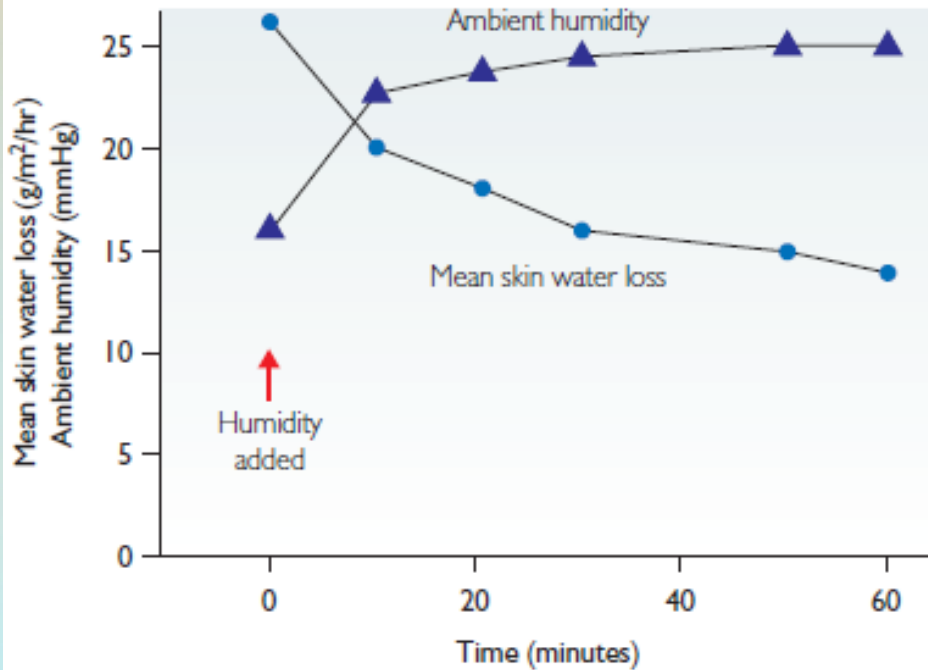
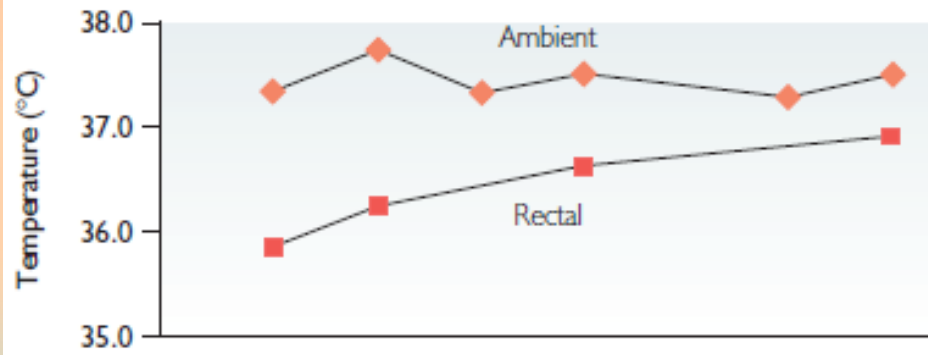
RH, Relative humidity; SSC, skin-to-skin care.

# Humidity

- Humidification is an effective way of reducing evaporative heat loss
- Recommended for babies below 30 weeks' gestation in the first week of life







The effect of humidifying an incubator

# Humidity

- Use of humidity  $> 70\%$  during first week of age followed by 50-60% in the subsequent weeks can reduce insensible water loss and minimize weight loss.

# การป้องกันอุณหภูมิภายตํ่าขณะทำหัตถการ

- UAC , UVC, PICC ,LP
- ย้ายทารกออกจากตู้อบเพื่อทำหัตถการภายใต้เครื่องให้ความอบอุ่นแบบแผ่รังสี
- ในกรณีทำหัตถการไม่นาน เช่น การใส่ท่อหลอดลมคอ สามารถทำในตู้อบได้ แต่ให้ตั้งค่าเป็น air servo control เพื่อควบคุมให้อุณหภูมิในตู้อบคงที่
- เมื่อเลื่อนเบาะในตู้ออกเพื่อทำหัตถการ ให้นำเครื่องให้ความอบอุ่นแบบแผ่รังสีแบบเคลื่อนที่ (mobile radiant warmer) มาให้ความอบอุ่นแทน

# A Randomized Controlled Trial of Plastic Drape for Prevention of Hypothermia during Umbilical Catheterization

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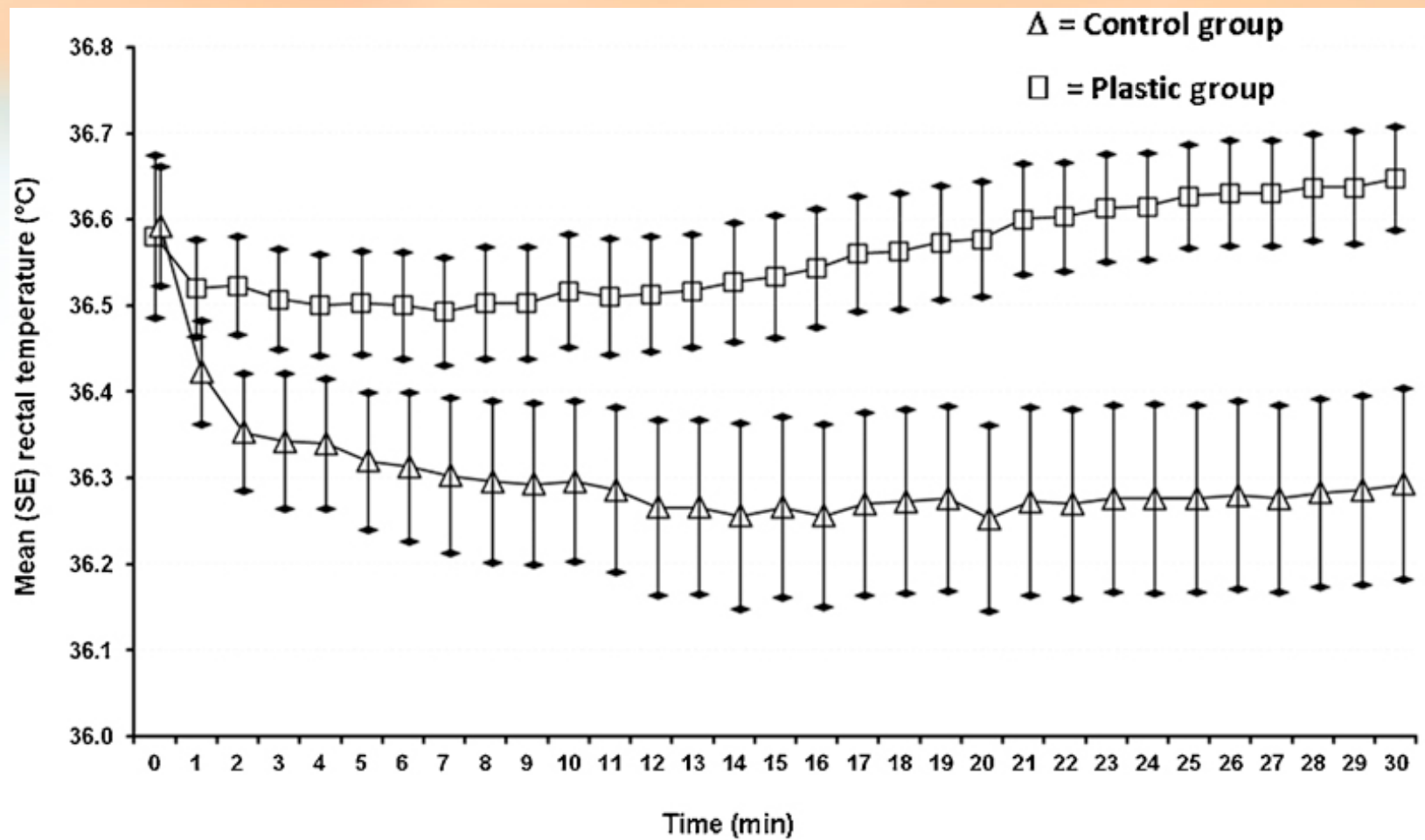
**Address for correspondence** Pracha Nuntnarumit, MD, Department of Pediatrics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand, 10400 (e-mail: pracha.nun@mahidol.ac.th).

Am J Perinatol 2013;30:839–842.



**VS**





## Recommendation for newborns < 32 weeks' gestation

- Maintain delivery room temperature >73.4°F (23°C)
- Prepare equipment in anticipation of delivery: Radiant warmer, plastic wrap, caps, warm blankets, thermostable gel mattress
- After birth, place preterm infant in a plastic bag/wrap without drying, and place a cap on the infant's head; term infants can be dried and placed skin to skin.

## **Recommendation for newborns < 32 weeks' gestation**

- Apply temperature probe to the skin and select servo control with target temperature at 98.6°F (37°C)
- Use warm blankets during transportation
- Use warm humidified air and warm boluses for resuscitation
- Closely monitor temperature until admission to NICU
- Postpone bath



# Interventions for Neonatal Hypothermia

Preterm infant develops hypothermia after a bath

- Drying the infant well, especially the head and neck areas
- Cover the infant's head with a cap and then dress the infant.

# Interventions for Neonatal Hypothermia

If a premature infant needs to be rewarmed

- Closely monitored vital sign every 15 to 30 minutes
- BP, HR and cardiac rhythm, RR and effort, oxygen saturations, acid-base balance, and blood glucose levels
- Active rewarming : bradycardia or arrhythmia  
hypotension
- Rewarm slowly by approximately 0.5°C per hour.

# Transfer from Incubator to Open Crib

- Infant continues to have stable temperatures at an incubator temperature of 29°C,
- Weight at least 1,700-1,800 g
- Consistent weight gain for at least 5 days
- Some center
  - switch to the air-control mode before weaning
  - challenge the clothed infant

# Hyperthermia

# Hyperthermia

- Core temperature  $> 37.5^{\circ}\text{C}$
- Occurs because of environmental factors leading to overheating

# Effects of Hyperthermia

## Risk factors

- Maternal fever occurs during labor and delivery
- Environmental
- Dehydration
- Result in neurologic injury and an increased risk of seizures.

# Clinical of hyperthermia

- Lethargy
- Irritability
- Apnea
- Dehydration
- Peripheral vasodilation and flushing
- tachycardia
- Tachypnea
- Poor feeding



**Thank you**