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# Infant Warming Clinical Paper Summaries

## SNAP-II and SNAPPE-II: Simplified Newborn Illness Severity and Mortality Risk Scores.

Richardson D, Corcoran J, Escobar G, Lee S.  
 J Pediatr 2001;138(1):92-100.

**AIM:** The physiology-based Score for Neonatal Acute Physiology, SNAP, and Score for Neonatal Acute Physiology with Perinatal Extension, SNAPPE, have been extensively used in Neonatal Intensive Care Units and validated to predict risk of in-hospital morbidity and mortality. Although these scores are valid they are cumbersome. This paper aimed to derive and validate simplified versions of these scores SNAP-II (6 parameters) and SNAPPE-II (the same 6 parameters for SNAP-II and an additional 3 potent perinatal mortality risk parameters).

**METHOD:** Data was gathered from 30 sites with different populations in California, New England (USA) and Canada during the mid 1990s. The total number of newborns was 25 429.

**RESULTS:** The SNAP-II and SNAPPE-II were developed and validated. Clinical factors used to assess SNAPPE-II are given in the following table.

Variable	SNAPPE-II points
MBP 20 - 29mmHg	9
MBP < 20mmHg	19
Lowest Temperature 35.0 - 35.6°C	8
Lowest Temperature < 35.0°C	15
PO <sub>2</sub> /FiO <sub>2</sub> ratio 1.0 – 2.49	5
PO <sub>2</sub> /FiO <sub>2</sub> ratio 0.3 – 0.99	16
PO <sub>2</sub> /FiO <sub>2</sub> ratio < 0.3	28
Lowest serum pH 7.10 - 7.19	7
Lowest serum pH < 7.10	16
Multiple Seizures	19
Urine Output 0.1-0.9 ml/kg/h	5
Urine Output < 0.1 mL/kg/h	18
Birth weight 750 – 999 g*	10
Birth weight < 750 g*	17
Small for Gestational Age*	12
Apgar score at 5 minutes < 7*	18

\* Parameters not used to determine SNAP-II

The SNAPPE-II score is a good predictor of in-hospital infant mortality with an overall *P* value for goodness of fit of 0.90 across all cohorts. The shaded boxes in the table underline the importance of day one temperature.

### TAKE HOME POINTS:

- Risk due to the lowest (not mean) temperature < 35 °C on day one is similar to the risk associated with a birth weight of <750 g (highlighted blue in table).
- Risk due to the lowest temperature 35.0 - 35.6 °C on day one is similar to the risk associated with a birth weight of 750 - 999 g (highlighted yellow in table).
- Day one temperature has a significant effect on outcome.

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## The EPICure study: outcomes to discharge from hospital for infants born at the threshold of viability.

Costeloe K, Hennessy E, Gibson AT, Marlow N, Wilkinson AR.  
Pediatrics. 2000 ;106 (4):659-71

**AIM:** To evaluate the outcome (survival and complications until discharge) for all infants born before 26 weeks of gestation in the United Kingdom and the Republic of Ireland.

**METHOD:** A Prospective observational study of all births from 20 to 25 weeks of gestation, between 1 March 1995 and 31 December 1995.

**RESULTS:** A total of 4004 births were recorded and 811 infants were admitted to intensive care. Of those admitted to intensive care, 40% had a temperature below 35 °C. Overall survival was 39% (n = 314). Factors independently associated with death were: hypothermia, male sex, no reported chorioamnionitis, no antenatal steroids, persistent bradycardia at 5 minutes, and high Clinical Risk Index for Babies (CRIB) score. Of the survivors, 17% had parenchymal cysts and/or hydrocephalus, 14% received treatment for retinopathy of prematurity (ROP), and 51% needed supplementary oxygen at the expected date of delivery. Failure to administer antenatal steroids and postnatal transfer for intensive care within 24 hours of birth were predictive of major scan abnormality; lower gestation was predictive of severe ROP, while being born to a black mother was protective. Factors predicting oxygen dependency were: neonatal hypothermia, being of lower gestation, male sex, tocolysis, low maternal age, a high CRIB score, and surfactant therapy. There was no difference in survival between institutions when divided into quintiles based on their numbers of extremely preterm births or admissions

**CONCLUSIONS:** This study provides outcome data for this geographically defined cohort; survival and neonatal morbidity are consistent with previous data from the United Kingdom and facilitate comparison with other geographically based data.

### TAKE HOME POINTS:

- 40% of infants admitted to intensive care had an admission temperature less than 35 °C.
- Hypothermia was associated with death
- Hypothermia was predictive of oxygen dependency

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## **PROJECT 27/28 - An Enquiry into quality of care and its effect on the survival of babies born at 27–28 weeks.**

The Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI). 2003

Jain A, Fleming P.

Arch Dis Child Fetal Neonatal Ed 2004;89(1):F14-6.

**AIM:** Project 27/28 was a two-year project undertaken between 1998 – 2000. The aim was to identify patterns of practice or service that may have contributed to the deaths of premature infants born at 27-28 weeks gestation in England, Wales and Northern Ireland, and to make recommendations based on the information for future practice.

**METHOD:** There were 3522 infants included. Of these, 88% were alive at day 28. Panel enquiries and epidemiological information were used as a basis for recommendations. Enquires were held on 366 deaths and a random sample of 395 surviving babies.

**RESULTS:** An association between death and hypothermia on admission to the neonatal unit, and also between death and poor thermal care was demonstrated. On admission, 73% of babies who died and 59% of babies who survived had a temperature below the recommended standard (36.0 °C). This took an average of approximately 2 hours to correct, an unexpectedly long period of time. Early temperature control can be improved by occlusive wrap. The panels considered that there had been substandard early thermal care in over a third of babies, and this was associated with death.

Three aspects of substandard care were notably more frequent in babies that died:

- 1) Allowing temperature to fall
- 2) Lack of monitoring
- 3) Hypothermia consequent to transfer difficulties

### **ENQUIRY RECOMMENDATIONS:**

- Continuous recording of temperature is necessary for infants requiring intensive care.
- Efforts should be made to normalise the temperature of hypothermic infants
- All labour ward and neonatal staff should be trained in the thermal care of infants at resuscitation.

### **TAKE HOME POINTS:**

- 66% of babies admitted to the neonatal unit had a temperature below the recommended standard of 36°C.
- Hypothermia on admission to the neonatal unit and poor thermal care were shown to be associated with death.
- Occlusion wrapping in the delivery room improves early temperature control in babies <28 weeks gestation.
- Aspects of substandard care that were notably more frequent in babies that died were: temperature fall, lack of monitoring, and hypothermia arising from transfer difficulties.

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## Effect of Polyethylene Occlusive Skin Wrapping on Heat Loss in Very Low Birth Weight Infants at Delivery: A Randomized Trial

Vohra S, Frent G, Campbell V, Abbott M, Whyte R.  
Journal of Pediatrics 1999; 134(5):547-51.

**AIM:** To investigate the effect of polyethylene wrap applied immediately (without drying) at birth on rectal temperature measured at nursery admission.

**METHOD:** A randomized clinical trial was conducted to compare the effects of wrapping with occlusive polyethylene or not wrapping infants born at <31 weeks' gestation. Sixty-two consecutive infants, stratified by gestation age, were randomly allocated to resuscitation with or without wrap. Infants allocated to the wrap stratum were placed in wrap under the radiant warmer without prior drying. Infants allocated to the non-wrap group were routinely dried under the radiant warmer according to relevant conventional guidelines current at the time. Wraps were removed upon admission to nursery. Rectal temperature was measured using a calibrated digital thermometer.

**RESULTS:** Of the 62 infants enrolled, 59 infants completed the study. Younger and smaller infants were more dependent on the wrapping than older infants for maintaining a higher rectal temperature. In the <28 weeks gestation stratum, wrapped infants had a mean admission temperature 1.9 °C ( $P < 0.001$ ) higher than non-wrapped infants. In the 28 – 31 week gestation age stratum, infants were more able to maintain temperature on their own, and the difference in mean temperature reduced to 0.17 °C ( $P = 0.47$ ). Five deaths were recorded in the study, all from the non-wrap group, with a mean temperature of 35.1 °C versus 36.5 °C for the survivors.

**DISCUSSION:** Occlusive wrap reduces convective and evaporative heat loss more effectively than conventional drying and exposure, when both methods are applied under radiant heat.

No adverse events i.e. hyperthermia, infection, skin maceration or interference with resuscitation were attributable to the use of the wrap.

The care provided to the wrapped and non-wrapped groups was identical following admission to the NICU. Therefore, the differences in outcome were attributable to the care, including temperature stability, provided in the delivery room.

### TAKE HOME POINTS:

- Wrapped infants < 28 weeks gestation had a mean admission temperature 1.9 °C higher than non-wrapped infants.
- Wrapping very low birth weight or premature infants with occlusive polyethylene at birth reduces postnatal temperature fall.
- Postnatal temperature fall prior to admission to NICU may increase mortality.
- The intervention is cheap, practical, effective, and does not interfere with current resuscitation practice.

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## Heat Loss Prevention (HeLP) in the Delivery Room: A Randomized controlled trial of Polyethylene Occlusive Skin Wrapping in Very Preterm Infants

Vohra S, Roberts RS, Zhang B, Janes M, Schmidt B  
J Pediatr 2004;145(6):750-3.

**AIM:** To determine if occlusive polyethylene skin wrap prevents heat loss after delivery of very preterm infants better than conventional drying, and to see if any benefit is sustained after the wrap is removed.

**METHOD:** Infants were randomised to either a wrapped group, or a non-wrapped (control) group. Both groups were stabilised under radiant warmers. The non-wrapped group was dried completely according to the International Guidelines for Neonatal Resuscitation. For the wrapped group, a polyethylene bag (20 cm x 50 cm) was opened under the radiant warmer and the infant placed on it immediately after birth. The infant was wrapped from the shoulders down and only the head was dried. Rectal temperatures were measured both on admission to the NICU immediately after the wrap was removed, and again one hour later.

**RESULTS:** Fifty five infants were randomised to either the wrapped (28 infants) or non-wrapped (27 infants) group. Two infants, one from each group, died in the delivery room, and 13 infants died (6 wrapped and 7 non-wrapped) following admission to the NICU. Infants in the wrapped group had a statistically significant higher mean temperature (36.5 °C, SD. 0.8°C) than infants (35.6 °C, SD. 1.3 °C) in the non-wrapped group (P=0.002). Mean rectal temperatures one hour later were similar in both groups (wrapped: 36.6 °C, SD. 0.7 °C; non-wrapped: 36.4 °C, SD. 0.9 °C; P=0.4).

The smallest and most immature infants are most in need of special thermal protection at birth and are likely to benefit the most from occlusive wrap.

The wrap procedure was well accepted by the neonatal staff and did not interfere with resuscitation.

### TAKE HOME POINTS:

- The rectal temperature of infants wrapped in occlusive wrap was 0.9 °C higher than non-wrapped infants.
- Wrapping very preterm infants with polyethylene occlusive wrap at delivery prevents, rather than delays, heat loss.
- Birth weight is an important determinant of admission temperature with the most immature infants most likely to benefit from occlusive wrap
- The wrap procedure was well accepted by staff and did not interfere with resuscitation

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## Optimal Thermal Management for Low Birth Weight Infants Nursed Under High Powered Radiant Warmers

Malin S, Baumgart S.  
Pediatrics 1987;79(1):47-54.

**AIM:** To determine the optimal servo-control set point for skin temperature of low birth weight infants nursed on open beds under high power radiant warmers.

**METHOD:** Eighteen low birth weight infants\* were servo-controlled at 35.5 °C, 36.5 °C and 37.5 °C for three periods of 90 minutes each after thermal equilibrium was established. Continuous measurements were made of oxygen consumption, skin, deep rectal and environmental temperature, and behaviour.

\* study weight  $1.25 \pm 0.05$  kg [mean  $\pm$  SEM], mean gestation at birth  $30.7 \pm 0.5$  weeks

**RESULTS:** For the infants at 35.5 °C the oxygen consumption was found to be significantly higher than when they were controlled at 36.5 °C. Increasing the servo-control temperature to 37.5 °C produced no further significant decrease in oxygen consumption. At 35.5 °C there was evidence of peripheral vasoconstriction due to cold stress, whereas increasing servo-control temperature appeared to stimulate peripheral vasodilation, which in turn increased heart rate.

The gradient between core (rectal) and peripheral (heel) skin temperature diminished significantly as the servo-control temperature was increased.

There was no change in respiratory rates at the different servo-control temperatures, although heart rate did increase for the 35.5 °C to 36.5 °C to 37.5 °C set points.

An abdominal skin servo-control temperature of around 36.5 °C was confirmed as physiologically optimal for prevention of cold stress.

### TAKE HOME POINTS:

- Maintenance of body temperature within a narrow range (known as the neutral thermal environment) is essential for survival and growth of a premature newborn infant.
- Control within the neutral thermal environment results in minimal resting metabolic expenditure and oxygen consumption for the infant to maintain normal body temperature and maximal growth rate.
- Radiant warmers provide an effective alternative to the incubator for the maintenance of body temperature at minimum metabolic rate in the low birth weight premature infant.



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**NOTE:** These clinical paper summaries were written by the Neonatal Group of Fisher & Paykel Healthcare. Reviews such as this are provided free of charge to assist clinicians in caring for their patients. It is recommended that the time be taken to review the paper in full.