Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants (Review)

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[Intervention Review]

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

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Editorial group: Cochrane Neonatal Group.
Publication status and date: New search for studies and content updated (conclusions changed), published in Issue 3, 2010.
Review content assessed as up-to-date: 7 February 2010.

Citation: McCall EM, Alderdice F, Halliday HL, Jenkins JG, Vohra S. Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants. *Cochrane Database of Systematic Reviews* 2010, Issue 3. Art. No.: CD004210. DOI: 10.1002/14651858.CD004210.pub4.

ABSTRACT

Background

Keeping vulnerable preterm infants warm is problematic even when recommended routine thermal care guidelines are followed in the delivery suite.

Objectives

To assess efficacy and safety of interventions designed for prevention of hypothermia in preterm and/or low birthweight infants applied within 10 minutes after birth in the delivery suite compared with routine thermal care.

Search strategy

We used the standard search strategy of the Cochrane Neonatal Review Group (CNRG). The review was updated in October 2009.

Selection criteria

Trials using randomised or quasi-randomised allocations to test a specific intervention designed to prevent hypothermia, (apart from 'routine' thermal care) applied within 10 minutes after birth in the delivery suite to infants of < 37 weeks' gestational age or birthweight $\leq$ 2500 g.

Data collection and analysis

We used the methods of the CNRG for data collection and analysis.

Main results

1) Barriers to heat loss [5 studies; plastic wrap or bag (3), plastic cap (1), stockinet cap (1)]:

Plastic wraps or bags were effective in reducing heat losses in infants < 28 weeks' gestation (4 studies, n = 223; WMD 0.68 °C; 95% CI 0.45, 0.91), but not in infants between 28 to 31 week's gestation. Plastic caps were effective in reducing heat losses in infants < 29 weeks' gestation (1 study, n = 64; MD 0.80 °C; 95% CI 0.41, 1.19). There was insufficient evidence to suggest that either plastic wraps

or plastic caps reduce the risk of death within hospital stay. There was no evidence of significant differences in other clinical outcomes for either the plastic wrap/bag or the plastic cap comparisons. Stockinet caps were not effective in reducing heat losses.

2) External heat sources [2 studies; skin-to-skin (1), transwarmer mattress (1)]:

Skin-to-skin care (SSC) was shown to be effective in reducing the risk of hypothermia when compared to conventional incubator care for infants (1 study, n = 31; RR 0.09; 95% CI 0.01, 0.64). The transwarmer mattress reduced the incidence of hypothermia on admission to NICU in VLBW infants (1 study, n = 24; RR 0.30; 95% CI 0.11, 0.83).

Authors' conclusions

Plastic wraps or bags, plastic caps, SSC and transwarmer mattresses all keep preterm infants warmer leading to higher temperatures on admission to neonatal units and less hypothermia. However, the small numbers of infants and studies and the absence of long-term follow-up mean that firm recommendations for clinical practice cannot be given.

PLAIN LANGUAGE SUMMARY

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

Preventing low body temperature at birth in premature and low birthweight infants may be important to survival and long-term outcome. Babies rely on external help to maintain body and skin temperature particularly in the first 12 hours of life. For vulnerable infants born prematurely or that are very small, abnormally low body temperature (hypothermia) is a world-wide issue across all climates and can lead to a variety of diseases and even death. Preventative action is taken by reducing heat loss and/or providing warmth using external heat sources. Precautionary steps routinely include a warm delivery room; drying the newborn immediately, especially the head; wrapping in pre-warmed dry blankets that cover the head; pre-warming surfaces and eliminating draughts. A review of seven studies involving 391 infants used additional preventative actions in the first 10 minutes of life to prevent problems with hypothermia. Results showed that the use of special plastic wraps or bags, plastic caps, heated mattresses and skin-to-skin contact kept the infants warmer than routine preventative action. Limitations included the small numbers of infants and studies included; variations in the methods and definitions of normal body temperature, routine care; and the use of different materials. Although this review confirmed that some of these measures are effective in preventing hypothermia, we do not yet know the long-term consequences of these interventions therefore the authors recommend that further research is carried out.

BACKGROUND

Keeping preterm infants sufficiently warm immediately after birth, especially during resuscitation, is problematic even when routine thermal care guidelines are followed. The newborn cannot shiver (Scopes 1963), and relies on interventions to protect it against exposure to cold. The ability to maintain an equilibrium between heat loss and heat gain (Bickmann 1992) despite variation in environmental temperatures is restricted during the first 12 hours of life (Smales 1978). After birth, deep body and skin temperature of the term newborn can drop at a rate of approximately 0.1 °C and 0.3 °C per minute respectively unless immediate action is taken (Adamsons 1965a). Although cold stress may be important for initiating breathing (Harned 1970) and induced cooling may help protect the brain of asphyxiated term newborns, prolonged exposure to cold should be avoided.

Description of the condition

Extended periods of cold stress can lead to harmful side effects, which include hypoglycaemia (Elliott 1957), respiratory distress (Pomerance 1974), hypoxia, metabolic acidosis (Gandy 1964), coagulation defects (Chadd 1972), delayed readjustment from fetal to newborn circulation (Stephenson 1970), acute renal failure, necrotizing enterocolitis, failure to increase weight or weight loss (Glass 1968) and in extreme cases death (Elliott 1957). Nayeri 2006 concluded that hypothermia at birth is one of the most significant risk factors causing death in newborn infants of all birthweights and gestational ages and particularly for vulnerable preterm infants (Costeloe 2000; CESDI 2003). Factors that increase the risk of hypothermia include prematurity, intrauterine growth retardation (Borse 1997; Hey 1975), asphyxia, certain congenital anomalies such as gastroschisis and damage to the central

nervous system (Bickmann 1992).

Rapid postnatal fall in body temperature is attributable to a combination of the physical characteristics of the infant (e.g. large surface area in relation to body weight and a thin layer of insulating fat) and environmental factors in the delivery suite. Extent of total heat loss and the four modes of heat exchange (conduction, convection, radiation and evaporation) are influenced by the ambient air temperature, pressure and relative humidity, and temperature of surrounding surfaces (Capobianco 1980; Thomas 1994). Increased rate of heat loss is mainly caused by evaporation of amniotic fluid from the skin surface (Hammarlund 1980) when the wet newborn moves from the warm environment of the uterus (Adamsons 1965a) into a cool, dry delivery suite.

In an attempt to maintain core body temperature within the normal range of 36.5 to 37.5 °C (skin temperature of 0.5 to 1.0 °C lower) (Hey 1970 ; Oliver 1965), the term infant responds mainly by production of heat from the breakdown of brown fat (Davis 1980) (non-shivering thermogenesis) (Stern 1970) and peripheral vasoconstriction. When skin temperature falls to 35 to 36 °C, non-shivering thermogenesis is initiated (Bruck 1961). The World Health Organisation classifies a core body temperature for newborns of 36 to 36.4 °C as mild hypothermia, 32 to 35.9 °C as moderate and < 32 °C as severe (WHO 1997). The preterm infant has the combined disadvantages of decreased fat for heat production and insulation, decreased glycogen stores, immature skin which increases water loss and poor vascular control. They experience even higher evaporative heat losses than term infants in the first day, especially at low ambient relative humidities (Hammarlund 1979). Five hundred and sixty calories of heat are lost for each millilitre of water which evaporates from the skin (Rutter 2000). Currently, there is no accepted formal definition of 'normal' temperatures for preterm infants and methods and accuracy of temperature measurement continue to be debated (Bailey 2000; Smith 2004).

The external (skin-environment) temperature gradient is pivotal in influencing the infant's response to cold (Adamsons 1965) and it is here that health professionals can intervene in the delivery suite to minimise the risk of hypothermia.

Standard care includes providing a warm delivery room at a minimum of 25 °C (although rarely achieved in practice) (WHO 1997), drying the infant thoroughly, immediately after birth (especially the head) (Bloom 1994), removing any wet blankets, wrapping in a prewarmed blanket, prewarming any contact surfaces, eliminating draughts and close proximity to outside walls (Capobianco 1980). If available, radiant warmers for resuscitation and stabilisation allow easy access and are effective in preventing heat losses, provided that the infant is immediately dried and placed under the prewarmed heater (Du 1969; Dahm 1972). Although the infant gains heat by radiation, there are increased potential losses through convection and evaporation and these losses are exacerbated if the infant is inadequately dried. Servocontrol is advantageous for the avoidance of overheating or underheating if absorption of heat is being obstructed by coverings. Watkinson 2006 suggested two reasons why conventional thermal care has failed to prevent hypothermia at birth: 1) current recommended techniques are inadequate and 2) thermal management awareness needs to be increased among personnel carrying out the resuscitation of newborns. The latter has also been highlighted in reviews of practice for care of very immature infants during resuscitation and transfer (Lyon 2006).

Description of the intervention

Studies to investigate the effectiveness of additional measures to reduce heat loss in the immediate postnatal period fall into two groups:

(1) barriers to heat loss;

(2) external heat sources.

Interventions in the first group focus mainly on reducing evaporative heat losses (LeBlanc 1991) and have included wraps and/or headcoverings made from a variety of materials (Chaput 1979; Coles 1979; Holzman 1985 ; Lang 2004). Baum 1968 tested a polyester suit lined with aluminum, known as the 'silver swaddler', designed to prevent hypothermia by reducing all modes of heat transfer to the environment. This was effective for infants with birthweights > 3000 g but, since the material is opaque, it is not practical during resuscitation. Transparent plastic coverings such as bubble wrap (Besch 1971) and single layer gowns (Hobbs 1975) are effective in the delivery suite for full-term healthy newborn infants and those with birthweights > 2000 g respectively and where the intervention was polyethylene wrap for infants of < 33 weeks' gestation (Lenclen 2002). Hoods or heat shields that are not in contact with the infant's body have also been used in conjunction with a radiant warmer or incubator (Baumgart 1981; Bell 1980). Barrier creams, waxes or protective films such as Aquaphor ® (Nopper 1996) have also been utilised to reduce heat losses in immature infants but are not normally applied within 10 minutes of birth.

Interventions in the second group have included heated mattresses (Almeida 2009) and as an alternative to radiant warmers, for a healthy term newborn skin-to-skin contact, (where the infant is thoroughly dried and placed on the mother's chest and abdomen with a light blanket around them), can reduce radiant and conductive heat loss and promote temperature stabilisation (Britton 1980; Christensson 1992). More recently, efforts to reduce the incidence of hypothermia on admission to neonatal units have included quality improvement initiatives using 'intervention bundles' such as staff education, consistent room air temperature, use of polyethylene bags and transfer in a warmed incubator (Kaplan 2009 ; Ho 2007).

All of these interventions have potential disadvantages; for example, Newton 2003 reported that significantly more infants (with gestational ages < 30 completed weeks) wrapped in polythene bags were hyperthermic (> 37 °C) when compared to unwrapped his-

torical controls. Brun 1997 noted that a chemical hot pack during resuscitation of a newborn infant resulted in third degree burns and recommended that these should not be used unless the peak temperature of the pack is < 44 °C.

How the intervention might work

Interventions should either decrease total heat losses or provide external heat without compromising accessibility during resuscitation and should have minimal side effects (such as hyperthermia, burns, maceration, or infection).

Why it is important to do this review

Neonatal hypothermia after birth is a world-wide issue (Costeloe 2000) across all climates (Christensson 1988; Johanson 1992; Tafari 1973; Laptook 2007; Kumar 2009) and, if prolonged, can lead to harm and in severe cases death. Silverman 1958 and Day 1964 showed that reducing heat losses in preterm infants in the first few days after birth increased survival rates. Knobel 2005 reported that chart review of 100 patients revealed that 93% of infants of < 1000 g birthweight had rectal temperature < 36.4°C on admission to neonatal intensive care. The Project 27/28 undertaken in England, Wales and Northern Ireland for a period of two years including all live born infants (n = 3522) with a gestation between $27^{0}$and 28^{6} weeks (CESDI 2003) stated that some component of early thermal care was inadequate in over a third of infants and this was associated with the infants who died. Early intervention in the delivery suite, particularly for the preterm infant undergoing resuscitation (Laptook 2008) is therefore of high priority if hypothermia is to be prevented. Soll 2008 re-emphasised the need to address and understand the consequences of poor thermal care for the newborn infant in order to improve clinical outcomes. This review focuses on individual interventions applied within 10 minutes after birth in the delivery suite and is limited to preterm and/or low birthweight infants since these are most susceptible to the adverse effects of hypothermia. Longer term thermal management and spatial or environmental strategies for increasing warming are beyond the scope of this review. This is an update of a Cochrane review first published in 2005 and previously updated in 2008.

OBJECTIVES

PRIMARY OBJECTIVE

To assess the efficacy and safety of interventions, designed for the prevention of hypothermia in preterm and/or low birthweight infants, and applied within 10 minutes after birth in the delivery suite, compared with routine thermal care.

Subgroup analyses to be carried out by intervention, by birthweight/gestational age and by developmental status of the country of study, to determine whether effectiveness varies according to:

The interventions applied:

Birthweight and gestational age within the following categories:

- birthweight (< 1500 g), (1500 g to 2500 g)

- gestational age (< 28 wk), (28 to 32 wk) and (33 to 37 wk)

The developmental status of the country in which the trial was conducted based upon the UNICEF classification of a developing country (UNICEF 2002).

However, the subgroups reported in the included studies were not compatible with those pre-specified. Therefore, post facto subgroup analyses based on reported gestational age and birthweight subcategories were carried out where appropriate within each comparison group.

SECONDARY OBJECTIVES

To assess effects on complications associated with preterm birth, hypothermia, and adverse outcomes.

METHODS

Criteria for considering studies for this review

Types of studies

All trials using randomised or quasi-randomised allocation to test a specific intervention designed to prevent hypothermia immediately after birth.

Types of participants

Preterm infants of < 37 weeks' gestational age (according to best obstetric estimate at time of delivery) or low birthweight infants of ≤ 2500 g, where the intervention to prevent hypothermia is applied within 10 minutes after birth in the delivery suite. Both appropriate and small-for-gestational age infants were eligible.
Exclusions: Infants with major congenital malformations, especially abdominal wall defects.

Types of interventions

Any intervention applied within 10 minutes after birth in the delivery suite apart from ROUTINE THERMAL CARE, which was defined as any of the following routine practices: providing a warm delivery suite at a minimum of 25 °C (rarely achieved in practice), drying the infant immediately after birth, removing

any wet blankets and wrapping in a pre-warmed blanket, pre-warming any contact surfaces, avoiding draughts and, in developed countries, the use of radiant warmers or incubators. The control intervention comprised any elements of routine thermal care.
The interventions studied were to include:

(1) Barriers to heat loss applied to any part of the body of the preterm and/or low birthweight infant within 10 minutes after birth in the delivery suite

- Coverings such as transparent plastic wraps and bags made of low density polyethylene (LDPE) or linear low density polyethylene (LLDPE) or polyvinylidene chloride (PVDC)
- Semi-permeable membranes such as Opsite® or Tegaderm®
- Other additional swaddling materials or wraps (excluding delivery room blankets) such as the 'silver swaddler'.

(2) External heat sources (non-routine) initiated within 10 minutes after birth in the delivery suite

- Skin-to-skin care
- Heated/gel/chemical mattresses.

Types of outcome measures

Primary outcomes

The temperature of the infant taken on admission to the Neonatal Intensive Care Unit (NICU) or up to two hours after birth. Temperature was assessed as both continuous and dichotomous variables.
Rectal, axillary, oral or tympanic temperature measurements were accepted as equivalent core body temperature and abdominal skin temperature was accepted for skin temperature. Where both core temperature and skin temperature were recorded core temperature took priority. Where multiple temperatures were recorded (i.e. within different time frames up to two hours after birth) the lowest temperature recorded took priority.
A core body temperature of < 36.5 °C or a skin temperature of < 36 °C indicated the presence of hypothermia within the control and intervention groups.
For hypothermia, core body temperature and skin temperature subgroupings as defined by WHO 1997 were used to determine three levels of severity:

- mild hypothermia or cold stress: core body temperature 36 to 36.4 °C or skin temperature of 35.5 to 35.9 °C;
- moderate hypothermia: core body temperature 32 to 35.9 °C or skin temperature of 31.5 to 35.4 °C;
- severe hypothermia: core body temperature of < 32 °C or skin temperature < 31.5 °C.

Secondary outcomes

These were categorised as (1) morbidity and (2) adverse outcomes due to the intervention.

(1) Morbidity

- hypoglycaemia (defined by a blood glucose level of < 2.0 mmol/L within two hours of birth);
- respiratory distress syndrome (RDS) (defined by clinical signs of grunting, flaring, retractions, cyanosis in room air, tachypnoea and a radiological picture of reticulogranular mottling and air bronchogram);
- surfactant given at any time;
- intubation in delivery room;
- requirement for ventilation and duration of ventilation (days);
- length of stay (days);
- mortality: death within seven days, death within 28 days and/or death during hospital stay;
- Severe metabolic acidosis as defined by pH < 7.20 and/or base deficit > 10 mmol/L within the first three days of life;
- intraventricular haemorrhage (defined according to the criteria of Papile et al from head ultrasound performed before 14 days of life) (Lee 2000; Papile 1978);
- patent ductus arteriosus (defined by clinical diagnosis plus treatment with indomethacin or surgical ligation or both) (Lee 2000);
- chronic lung disease (defined by oxygen dependency at 36 weeks' postmenstrual age for an infant who was born at ≤ 32 weeks' gestation) (Lee 2000; Shennan 1988);
- necrotizing enterocolitis [defined according to the criteria of Bell et al (Bell 1978) stage 2 or higher and classified as medical (clinical symptoms and signs plus evidence of pneumatosis on abdominal radiographs) or surgical (histological evidence of NEC on surgical specimen of intestine)] (Lee 2000);
- acute renal failure [defined by a serum creatinine level of more than 1.5 mg/dL (Stapleton 1987) and oliguria (urine output < 1 ml/kg/hr)].

(2) Adverse outcomes due to the intervention

- hyperthermia (defined by an admission temperature to NICU or within two hours of birth of ≥ 38 °C);
- burns within three days of birth;
- maceration within three days of birth;
- skin or systemic infection secondary to intervention within the first week of birth (defined by a culture of pathogenic bacteria from normally sterile body tissue or fluid);
- antibiotic course of five days or more started within the first seven days of birth;
- interference with resuscitation and other practices (e.g. UV catheter placement for fluid replacement, chest tube insertion);
- fluid problems such as dehydration or fluid overload, electrolyte imbalance such as hypernatraemia (serum sodium > 150 mmol/L) or hyponatraemia (serum sodium < 130 mmol/L);
- any other unexplained adverse outcome attributed to the intervention within seven days of birth;

- negative psychological outcomes (perception of care by parents).

Search methods for identification of studies

The standard search strategy of the Cochrane Collaboration was used (Clarke 2002).

Electronic searches

We searched the following electronic databases: the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 4, 2009), the Database of Abstracts of Reviews of Effects (DARE 1994 to October 2009), MEDLINE (1950 to October 2009), CINAHL (1982 to October 2009), EMBASE (1974 to October 2009), conference/symposia proceedings using ZETOC (1993 to October 2009) and ISI proceedings (1990 to October 2009). In addition, OCLC WorldCat (October 2009) was searched and identified articles were cross referenced. No language restrictions were imposed. The MEDLINE search strategy is detailed below and similar search strategies were devised using appropriate terminology for each electronic database.

1. plastic barrier*.ab,ti.
2. polyethylene*.ab,ti.
3. (bubble wrap* or bubble-wrap* or bubblewrap*).ab,ti.
4. (clingfilm* or cling film* or cling-film*).ab,ti.
5. (plasticwrap* or plastic-wrap* or plastic wrap*).ab,ti.
6. exp Polyethylenes/
7. exp Polyvinyls/
8. (polyvinyl* or poly-vinyl*).ab,ti.
9. (low density polyethylene* or low-density polyethylene*).ab,ti.
10. (gladwrap* or glad wrap* or glad-wrap*).ab,ti.
11. (polybag* or poly bag* or poly-bag*).ab,ti.
12. (saranwrap* or saran-wrap* or saran wrap*).ab,ti.
13. transparent baby bag*.ab,ti.
14. baby bag*.ab,ti.
15. (headwrap* or polyester headwrap*).ti,ab.
16. silver swaddling*.ti,ab.
17. (silver and swaddling*).ti,ab.
18. swaddling*.ti,ab.
19. exp Incubators, Infant/
20. radiant warmer*.ti,ab.
21. exp Membranes, Artificial/
22. (semi-permeable membrane* or semipermeable membrane*).ti,ab.
23. exp POLYURETHANES/
24. polyurethane*.ti,ab.
25. kangaroo care*.ti,ab.
26. skin to skin contact*.ti,ab.
27. heat* mattress*.ti,ab.
28. chemical gel mattress*.ti,ab.
29. gel mattress*.ti,ab.
30. chemical mattress*.ti,ab.
31. head hood*.ti,ab.
32. head insulation*.ti,ab.
33. swaddl*.ti,ab.
34. plastic bag*.ti,ab.
35. early suck*.ti,ab.
36. Breast Feeding/
37. (breast feed* or breastfeed*).ti,ab.
38. skin-to-skin.ti,ab.
39. suckl*.ti,ab.
40. bath*.ti,ab.
41. radiant heater*.ti,ab.
42. radiant heat lamp*.ti,ab.
43. (mother* adj5 (bab* or infant*) adj5 (contact* or hold*)).ti,ab.
44. heated bed*.ti,ab.
45. resuscitat*.ti,ab.
46. exp RESUSCITATION/
47. (intervention* or procedure* or method*).ti,ab.
48. exp Infant, Low Birth Weight/
49. ((birth* or bab* or infant) and (premature or pre-mature or preterm or pre-term or low weight or low birth weight or very low birth weight or VLBW or LBW)).ab,ti.
50. Infant, Newborn/
51. Body Temperature Regulation/ or Body Temperature/
52. HYPOTHERMIA/
53. (hypothermia or cold stress or heat loss or temperature regulation or body temperature).ab,ti.
54. temperature drop*.ti,ab.
55. heat loss.ti,ab.
56. or/1-47
57. or/48-50
58. or/51-55
59. 56 and 57 and 58

Searching other resources

We searched for cross references from included articles.

Data collection and analysis

We followed the standard method of The Cochrane Collaboration for conducting a systematic review as described in The Cochrane Reviewers' Handbook (Clarke 2002).

Selection of studies

The search strategy was designed and electronic databases searched in association with the Medical Faculty Librarians, Queen's University Belfast. At least three review authors independently assessed the full list of titles and abstracts for eligibility and the full texts of those considered to be relevant were retrieved. Reasons for exclu-

sion of studies were clearly stated by each review author. Formal translation of studies was not required.

Data extraction and management

The review authors separately extracted, assessed and coded all data for each study using a form that was designed specifically for this review. Any standard error of the mean was replaced by the corresponding standard deviation. Any disagreement was resolved by discussion.

Assessment of risk of bias in included studies

At least three independent review authors assessed those studies that fulfilled the criteria for inclusion for quality and risk of bias and extracted data using prepared proformas. Methodological quality and risk of bias was judged according to: (1) blinding of randomisation, (2) blinding of intervention, (3) completeness of follow-up and (4) blinding of outcome measurement. There was complete agreement among team members. Additional information was sought from investigators for four included trials (Vohra 2004a; Vohra 1999; Knobel 2005; Trevisanuto 2009b). Review authors were not blinded to authors or to institution. In two papers, a team member was also an author of a selected trial so that team member was excluded from the study appraisal process. The information retrieved is detailed in the Table of "Characteristics of included studies".

In addition, the following issues were evaluated and entered into the Risk of Bias Table:

1) Sequence generation (checking for possible selection bias). Was the allocation sequence adequately generated?

For each included study, we catagorized the method used to generate the allocation sequence as:

- adequate (any truly random process e.g. random number table; computer random number generator);
- inadequate (any non random process e.g. odd or even date of birth; hospital or clinic record number);
- unclear.

(2) Allocation concealment (checking for possible selection bias). Was allocation adequately concealed?

For each included study, we catagorized the method used to conceal the allocation sequence as:

- adequate (e.g. telephone or central randomization; consecutively numbered sealed opaque envelopes);
- inadequate (open random allocation; unsealed or non-opaque envelopes, alternation; date of birth);
- unclear.

(3) Blinding (checking for possible performance bias). Blinding of participants, personnel and outcome assessors: Was knowledge of the allocated intervention adequately prevented during the study? At study entry? At the time of outcome assessment?

For each included study, we catagorized the methods used to blind study participants and personnel from knowledge of which intervention a participant received. Blinding was assessed separately for different outcomes or classes of outcomes. We catagorized the methods as:

- adequate, inadequate or unclear for participants;
- adequate, inadequate or unclear for personnel;
- adequate, inadequate or unclear for outcome assessors.

In some situations there may be partial blinding e.g. where outcomes are self-reported by unblinded participants but they are recorded by blinded personnel without knowledge of group assignment. Where needed "partial" was added to the list of options for assessing quality of blinding.

(4) Incomplete outcome data (checking for possible attrition bias through withdrawals, dropouts, protocol deviations). Were incomplete outcome data adequately addressed?

For each included study and for each outcome, we described the completeness of data including attrition and exclusions from the analysis. We noted whether attrition and exclusions were reported, the numbers included in the analysis at each stage (compared with the total randomized participants), reasons for attrition or exclusion where reported, and whether missing data were balanced across groups or were related to outcomes. Where sufficient information was reported or supplied by the trial authors, we re-included missing data in the analyses. We catagorized the methods as:

- adequate (< 20% missing data);
- inadequate ($\geq$ 20% missing data):
- unclear.

(5) Selective reporting bias. Are reports of the study free of suggestion of selective outcome reporting?

For each included study, we described how we investigated the possibility of selective outcome reporting bias and what we found. We assessed the methods as:

- adequate (where it is clear that all of the study's pre-specified outcomes and all expected outcomes of interest to the review have been reported);
- inadequate (where not all the study's pre-specified outcomes have been reported; one or more reported primary outcomes were not pre-specified; outcomes of interest are reported incompletely and so cannot be used; study fails to include results of a key outcome that would have been expected to have been reported);
- unclear.

(6) Other sources of bias. Was the study apparently free of other problems that could put it at a high risk of bias?

For each included study, we described any important concerns we had about other possible sources of bias (for example, whether there was a potential source of bias related to the specific study design or whether the trial was stopped early due to some data-dependent process). We assessed whether each study was free of other problems that could put it at risk of bias as: yes; no; or unclear.

If needed, we planned to explore the impact of the level of bias through undertaking sensitivity analyses.

Measures of treatment effect

Relative risk (RR) and 95% confidence limits were calculated for dichotomous outcomes. From the risk difference (RD), the number needed to treat (NNT) or the number needed to harm (NNH) and 95% confidence limits were calculated. Mean differences (MD) and 95% confidence limits were calculated for continuous outcomes.

Assessment of heterogeneity

We estimated the treatment effects of individual trials and examined heterogeneity between trials by inspecting the forest plots and quantifying the impact of heterogeneity using the I^2 statistic. If we detected statistical heterogeneity, we explored the possible causes (for example, differences in study quality, participants, intervention regimens, or outcome assessments) using *post hoc* sub group analyses.

Assessment of reporting biases

Where heterogeneity was identified, subgroup analyses were carried out for gestational age and birthweight. Had there been sufficient studies, sensitivity analyses would have provided valuable information on the role of variations in methodological quality, definitions of hypothermia, type of patient group and intervention.

Data synthesis

Meta-analysis was performed using Review Manager software (RevMan 5) supplied by the Cochrane Collaboration. For estimates of typical relative risk and risk difference, we used the Mantel-Haenszel method. For measured quantities, we used the inverse variance method. All meta-analyses were done using the fixed effect model.

Subgroup analysis and investigation of heterogeneity

Subgroup analyses to be carried out by intervention, by birthweight/gestational age and by developmental status of the country of study, to determine whether effectiveness varies according to:
The interventions applied:
Birthweight and gestational age within the following categories:
- birthweight (< 1500 g), (1500 g to 2500 g)
- gestational age (< 28 wk), (28 to 32 wk) and (33 to 37 wk)
The developmental status of the country in which the trial was conducted based upon the UNICEF classification of a developing country (UNICEF 2002).
However, the subgroups reported in the included studies were not compatible with those pre-specified. Therefore, *post facto* subgroup analyses based on reported gestational age and birthweight subcategories were carried out where appropriate within each comparison group.

Sensitivity analysis

Had there been more studies, the influence of the trial quality on the findings of the review would have been explored by conducting a sensitivity analysis of adequate versus unclear versus inadequate allocation concealment as outlined in The Cochrane Reviewers' Handbook (Clarke 2002).

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification; Characteristics of ongoing studies.
One hundred and sixty studies potentially eligible for inclusion in our review were identified. Of these, ninety-eight were randomised or quasi-randomised controlled studies and sixty-two were non-randomised studies. On assessment, eight studies were identified as fulfilling all of our criteria for inclusion. Ninety randomised or quasi randomised studies did not fulfill our criteria for inclusion and are detailed in the Table of "Characteristics of excluded studies". One randomised study is awaiting classification pending further details from the authors (Punnahitananda 2008). This study is detailed in the Table of "Characteristics of studies awaiting classification". We decided not to include in the Table of "Characteristics of excluded studies" non-randomised studies. Further details of these non-randomised trials can be obtained from the authors on request. In all, seven studies involving 400 randomised infants were included in this review: two theses (Brennan 1996; Roberts 1981), four published papers (Bergman 2004; Vohra 1999; Vohra 2004a; Knobel 2005) and one manuscript accepted for publication by the Journal of Pediatrics (Trevisanuto 2009b) and also available as a conference proceeding abstract.
Five studies compared barriers to heat loss to no barriers (Roberts 1981; Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b) and two studies compared external heat sources (non-routine) to no external heat sources (Bergman 2004; Brennan 1996). There were three comparison groups within the barriers to heat loss category : plastic wrap or bag versus routine care, plastic cap versus routine care (Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b) and stockinet cap versus routine care (Roberts 1981). There were also two comparison groups within the external heat source category: skin-to-skin care versus routine care (Bergman 2004) and transwarmer mattress versus routine care (Brennan 1996).
All interventions were applied immediately after birth in the delivery suite. Participants were categorised by gestational age (all preterm) in five studies and by birthweight (all low birthweight) in two studies. One study was conducted in a developing country, (South Africa) (Bergman 2004), and all other studies took

place in developed countries (USA: Brennan 1996; Roberts 1981; Knobel 2005 , Canada: Vohra 1999; Vohra 2004a and Italy Trevisanuto 2009b). Routine external heat sources were utilised as part of care (control group and/or intervention group) in all studies : servo controlled incubator (Bergman 2004), radiant warmer (Brennan 1996; Vohra 1999; Vohra 2004a), warmer table (Knobel 2005) and radiant warmer ± transport incubator (Roberts 1981; Trevisanuto 2009b). The main outcome measure (temperature of the infant on admission to NICU or up to 2 hours after birth) was reported as a continuous variable in six studies and as a dichotomous variable only in one study (Bergman 2004). Six studies reported core body temperature (rectal:3, axillary:3) and in one study skin temperature was reported. In addition, four studies also provided dichotomous data pertaining to incidence of hypothermia in the intervention and control groups. Definitions of hypothermia were not consistent across studies. There was limited reporting of pre-specified secondary outcomes.

SUMMARY DESCRIPTIONS OF INDIVIDUAL STUDIES

Further details for each study are given in the Table of "Characteristics of included studies."

BARRIERS TO HEAT LOSS

Roberts 1981

Participants

Forty inborn infants of 32 to 36 completed weeks' gestation born between 7 am to 5 pm on weekdays were included in this single centre study conducted at Parkland Memorial Hospital in Dallas, Texas, USA. Infants were excluded from the study if they were not appropriate for gestational age, had an Apgar score < 7 at 5 minutes, signs of central nervous system defect, developed sepsis or where the maternal temperature > 37.8 °C during labour.

Intervention Stockinet cap (CAP) - sterile headpiece made of stockinet that covers the forehead, the ears, underneath the occipital bone and all the area above this plane.

CAP group (n = 17): infants received a stockinet cap after delivery as soon as possible after being dried under a radiant warmer.

Control group (n = 23): infants received the same treatment as the intervention group but did not receive a stockinet cap.

All infants weighing < 2500 g were transported to the nursery in a transport incubator.

Outcomes

Core body temperature (axillary °C) was measured within 10 minutes of admission to the neonatal unit. The amount of heat lost from the time the axillary temperature was taken in the delivery room until the temperature was taken in the neonatal unit was also reported.

Vohra 1999

Participants

Sixty-two inborn infants of < 32 completed weeks' gestation, where the neonatal resuscitation team were present, were included in this single centre study conducted at the Grace Hospital (later the IWK Grace Health Centre) in Halifax, Nova Scotia, Canada. Infants were excluded from the study if they had major congenital anomalies with open lesions and where the infant was considered "previable" by the attending Obstetrician.

Intervention Polyethylene bag (WRAP) - 20cm x 50cm manufactured by Eastern Paper, a Division of EPC Industries.

WRAP group (n = 27): a transparent polyethylene bag was opened at resuscitation under a radiant warmer and the infant was placed on it from the shoulders down. Only the head of the infant was dried; the body was wrapped without drying.

Control group (n = 32): infants were managed with the protocol described by the Neonatal Resuscitation Program. Infants were routinely dried under the radiant warmer.

All infants were transferred to NICU in incubators.

Outcomes

Core body temperature (rectal °C) was measured on removal of the bag/wrap on admission to the neonatal unit. Incidence of mortality, hyperthermia, infection, skin maceration and interference with resuscitation were also reported.

Vohra 2004a

Participants

Fifty-five inborn infants of < 28 completed weeks' gestation, where the neonatal resuscitation team were present, were included in this single centre study conducted at McMaster University Medical Center in Hamilton, Ontario, Canada. Infants were excluded from the study if they had major congenital anomalies that were not covered by the skin and blistering skin conditions.

Intervention Polyethylene wrap (WRAP) - 20cm X 50cm manufactured by Eastern Paper, a Division of EPC Industries.

WRAP group (n = 26): infants were placed on polyethylene, wrapped from the neck down, only the head was dried and stabilised under a radiant warmer.

Control group (n = 27): infants were dried completely according to the International Guidelines for Neonatal Resuscitation and stabilised under a radiant warmer.

All infants were carried by one member of the neonatal team from the delivery room to the neonatal unit and placed in a single walled incubator with 60 percent humidity.

Outcomes

Core body temperature (rectal °C) on removal of the bag/wrap on admission to the neonatal unit, core body temperature (rectal °C) 1 hour later and incidence of mortality from all causes were reported. Secondary outcome measures have been updated as reported in the publication of the full manuscript (Vohra 2004a): Apgar score at 1 minute, Apgar score at 5 minutes, blood gas pH, Bicarbonate (mmol/L), Glucose mmol/L, hyperthermia (rectal °C > 37.5) and interference with resuscitation.

Knobel 2005

Participants

Eighty-eight infants of < 29 completed weeks' gestation were included in this single centre study conducted at Pitt County Memorial Hospital, Greenville, NC, USA. Infants were excluded from

the study if they had congenital anomalies with open lesions, meconium staining of the amniotic fluid or if they were considered previable or subsequent assessment indicated that the infant was ≥ 29 completed weeks' gestation.

Intervention Polyurethane bag (WRAP) - 19" X 18" sterile isolation transport bag DeRoyal REF30-5510.

WRAP group (n = 41): infants were placed immediately into a polyurethane bag, on a radiant warmer bed, while still wet, up to their necks. The head and face were dried and infants were resuscitated according to the guidelines for Neonatal Resuscitation.

Control group (n = 47): infants were resuscitated according to these guidelines without the bags.

All infants were taken to the neonatal unit on a warmer table, (with the heat off) with warm blankets on top of the infant.

Outcomes

Core body temperature (rectal°C) and incidence of hypothermia (rectal °C < 36.4) on admission to the neonatal unit, incidence of mortality, major brain injury, duration of oxygen therapy and hospitalisation, incidence of hyperthermia and interference with assessment or resuscitative interventions.

Trevisanuto 2009b

Participants

Ninety-six infants of < 29 completed weeks' gestation were included in this single centre study conducted at the Pediatric Department, Medical School, University of Padua, Azienda Ospedakiera di Padova, Padua, Italy. Infants were excluded if they had congenital anomalies with open lesions (e.g. gastroschisis, meningomyelocele) and if the delivery was not attended by the neonatal team.

Intervention Polyethylene cap (CAP) - (Degusto Dolomiti, Belluno, Italy)

CAP group (n = 32): polyethylene caps were placed on the radiant warmer bed prior to delivery. The heads of the infants were covered with a polyethylene cap immediately after birth; only the head was dried.

Active comparator group (n = 32): polyethylene bags (Vedovato SNC, Camposampiero, Padova, Italy, isolation transport bag 35 cm by 40 cm) were placed on the radiant warmer bed prior to delivery. The infants were placed into the bag while still wet, up to the neck; only the head was dried.

Control group (n = 32): the infants were placed in pre-warmed towels after drying, according to International Guidelines for Neonatal Resuscitation. All infants were stabilised in the delivery room under radiant warmers and a transport incubator was used to transfer all infants from delivery room into the NICU where they were then placed in a double walled incubator and at this point, the cap or the wrap were removed.

Outcomes

Core body temperature (axillary °C) and incidence of hypothermia (axillary temperature < 36.4°C) on admission to the neonatal unit (immediately after cap and wrap removal) and again one hour later, incidence of: mortality prior to hospital discharge, major brain injury and requirement for endotracheal intubation at birth, Apgar scores, blood gas analysis and serum glucose concentration on NICU admission.

EXTERNAL HEAT SOURCES (NON-ROUTINE)

Bergman 2004

Participants

Thirty-five inborn infants delivered, (excluding caesarean sections), having a birthweight between 1200 and 2199 g were included in this study conducted at two secondary level referral hospitals (Mowbray Maternity Hospital and Karl Brenar Hospital) in Cape Town, South Africa. Infants were excluded from the study if they had a birthweight below 1200 g or above 2199 g, an Apgar score below six at five minutes, congenital malformations detected at birth or where the mother was too severely ill to be able to look after herself or the infant, was known to have a positive HIV status or had given up the infant for adoption.

Intervention: Skin-to-skin care (SSC)

All infants were delivered onto a theatre cloth on the mother's abdomen/chest, dried, assessed, then placed on the mother's naked chest and covered with double layered cotton cloth. The bed was then placed in the semi-Fowlers position.

SSC group (n = 18): the infant remained in skin-to-skin contact, was secured to the mother's chest, hips and arms were flexed and placed in a 'frog' position.

Control group (n = 13): the infant was immediately transferred to a pre-warmed servo-controlled closed incubator which remained with the mother in the delivery ward for the first hour. A cap, booties and heat shield were applied if the infant skin temperature fell below 36 °C.

Outcomes

Infant stability was measured in terms of a set of pre-defined physiological parameters. Observations for heart rate, oxygen saturation and body temperature (skin °C) were recorded at five minute intervals in the first half hour, then 15 minute intervals. Continuous observations for apnoea and signs of respiratory distress, and blood sugar were measured at one, three and six hours.

Brennan 1996

Participants

Twenty-four inborn infants having a birthweight ≤ 1500 g were included in this single centre study conducted at Shands Hospital located in north-central Florida, USA. Infants were excluded from the study where the maternal temperature at delivery was > 38.0 °C, the infant had an obvious neural tube defect, an omphalocoele, gastroschisis, extrophy of the bladder, cloacal exstrophy, any other open lesion that would cause greater than normal heat loss at delivery, sacral teratoma, or any other lesion that would prevent the infant from being positioned and evaluated in the normal manner.

Intervention: Transwarmer Infant Transport Mattress (TM) manufactured by Prism Technologies, San Antonio, Texas. These are filled with a gel of sodium acetate, water and thickeners. Once activated they heat to approximately 40 °C for two hours.

TM group (n = 12): the mattress was activated and placed on the

radiant warmer surface with blankets on top of it when delivery was imminent. The newborn infant was immediately placed on the blankets and dried. Blankets were removed and the infant was then placed directly onto the warming mattress.

Control group (n = 12): infants received the same care as the intervention group but without the warming mattress.

Both groups were evaluated and resuscitated according to the Neonatal Resuscitation Program and transported to the neonatal unit on the radiant warmer surface. The infants in the intervention group remained on the mattress until the admission temperatures were taken.

Outcomes

Core body temperature (axillary °C) was measured as soon as possible after arrival at the neonatal unit. Incidence of interference with resuscitation was also monitored. Individual patient data was reported in this study.

Risk of bias in included studies

BARRIERS TO HEAT LOSS

The generation of allocation sequence was adequate (computer randomisation or lot drawing) in four studies and unclear in one. Allocation concealment was adequate in four studies using varying degrees of sealed/opaque/double enclosed envelopes and in one study the method was unclear. However, two studies Vohra 2004a and Trevisanuto 2009b used computer generated random sequence balanced in blocks of four and six subjects respectively. There is some potential for inadequate allocation concealment, therefore, selection bias cannot be ruled out. No attempt was reported in any of the studies to blind participants or care givers to the intervention. However, lack of blinding is often not feasible for non-pharmacological interventions Boutron 2008. The majority of outcome measures were objective and so were less likely to be biased than subjective outcome measures. The primary outcome (temperature of the infant on admission to NICU or up to two hours after birth) was measured using digital thermometers in all studies. No studies reported any attempt to blind the outcome assessors or data analysis team to the intervention, therefore, potential biases cannot be ruled out.

Follow-up was complete in three studies. In the remaining two studies Vohra 1999 (3 of 62 or 5%) and Vohra 2004a (2 of 55 or 4%) of infants randomised were lost to follow-up. Reasons for loss to follow-up were reported adequately in each study. There was insufficient information to assess whether these studies were free from selective reporting.

Other potential bias for barriers to heat loss:

In two studies, Knobel 2005 and Vohra 1999 the authors attempted to allay fears of potential confounding factors (other biases) by statistically adjusting for this and found that the main conclusions remained unchanged.

The Knobel 2005 study attempted to maintain delivery suite temperature at 26°C for all preterm deliveries, but actual temperatures ranged from 18.9 °C to 31.1 °C. On post hoc analysis warmer delivery suite temperatures were associated with higher admission temperatures, but only the subgroup of infants who were both delivered in warm rooms and placed in plastic bags had a mean temperature > 36.4 °C. There was, however, no significant differences between intervention and control group for mean delivery room temperature. After controlling for delivery suite temperature the mean admission temperature to NICU in the intervention group was still 0.6 °C higher than controls.

There was some imbalance in birthweight between study groups in Vohra 1999. However the birthweight adjusted difference in mean rectal temperature of 1.54°C for the smaller group remained significant. For infants < 28 completed weeks birthweight (g) was mean (914) SD (163) for the plastic wrap group and mean (742) SD (206) for the non-wrap group, therefore, results could be potentially biased towards the wrap group since the non-wrap group were smaller and, therefore, more vulnerable to heat loss.

The Trevisanuto 2009b study reported that delivery to admission time was significantly shorter in the control group than in the plastic wrap group. This measure could be an indicator of potentially how unwell an infant is and to see if the team behaved differently towards intervention infants than control infants. If the plastic wrap infants took longer to get to the NICU and therefore these infants had a greater chance of being chilled then the plastic wrap measured estimate of treatment effect is likely to be a conservative one. Trevisanuto 2009b also reported that delivery suite temperature was not monitored throughout the study. Standard environmental temperature of delivery suites within the institution was reported to be 24°C. The authors felt that this may have negatively influenced the findings of the study.

The Roberts 1981 study reported some imbalance in mean delivery suite axillary temperatures for infants < 2000 g between study groups. Analysis of covariance showed that the delivery suite axillary temperature had a significant effect on the infant axillary temperature on admission to the NICU. When the two groups were statistically equalised with respect to delivery suite axillary temperature there were no significant differences betwen the two interventions.

EXTERNAL HEAT SOURCES (NON-ROUTINE)

The generation of allocation sequence was adequate (computer randomisation or lot drawing) in both studies, however, the method of allocation concealment for each study was unclear. No attempt was reported in any of the studies to blind participants or care givers to the intervention. However, lack of blinding is often not feasible for non-pharmacological interventions Boutron 2008. The majority of outcome measures were objective and so were less likely to be biased than subjective outcome measures. The primary outcome (temperature of the infant on admission to NICU or up to two hours after birth) was measured using a digital thermometer in Brennan 1996 and a dedicated and regularly calibrated monitor (Dash 3000) in Bergman 2004. Follow-up was complete in one study. In the remaining study Bergman 2004 (4 of

35 or 11%) of infants randomised were lost to follow-up. Reasons for loss to follow-up were adequately reported. Only one study Bergman 2004 reported any attempt to blind the outcome assessors to the intervention where the principal investigator and data analysis team were blinded. There was insufficient information to assess whether these studies were free of selective reporting.

Other potenial bias for external heat sources:

For the Bergman 2004 study there was a potential for selection bias since the assigned research nurse was unavailable for 99 potentially eligible mother-infant dyads. The aetiology of these infants may have differed from those studied. In addition, recruitment for this study was terminated based on significant results after an interim analysis was conducted.

In all, no studies in either category fulfilled all the methodological quality criteria. Risk of bias across studies is condidered to be low to moderate. Further details for each study are given in the Table of "Characteristics of included studies."

Effects of interventions

RESULTS OF META-ANALYSES

Seven studies were identified which fulfilled our criteria for inclusion giving a total of 400 infants randomised and 391 infants completing the studies. Five studies compared barriers to heat loss to no barriers giving a total of 341 infants randomised and 336 infants completing the studies (Roberts 1981; Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b). Two studies compared external heat sources (non-routine) to no external heat sources giving a total of 59 infants randomised and 55 infants completing the studies (Brennan 1996; Bergman 2004). There were three comparisons within the barriers to heat loss category: plastic wrap or bag versus routine care (Vohra 1999; Knobel 2005; Vohra 2004a), plastic cap versus routine care (Trevisanuto 2009b) and stockinet cap versus routine care (Roberts 1981). There were also two comparisons group within the external heat source category: skin-to-skin care versus routine care (Bergman 2004) and transwarmer mattress versus routine care (Brennan 1996). There were insufficient studies to carry out subgroup analysis according to developmental status of the country.

BARRIERS TO HEAT LOSS

PLASTIC WRAP VERSUS ROUTINE CARE (COMPARISON 1):

Primary outcomes

Core body temperature (°C) of the infant taken on admission to NICU or up to 2 hours after birth (Outcome 1.1):

Four studies comprising 264 infants (Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b) reported core body temperature (rectal °C or axillary °C) on admission to NICU. Each individual study showed a significant effect in favour of the intervention (plastic wrap) group for infants with a gestational age < 28 completed weeks. Although the infants in the Knobel 2005 and Trevisanuto 2009b studies had a gestational age < 29 completed weeks, these infants were included in the < 28 completed week subgroup for meta-analysis and are referred to as such in the text unless all the included studies participants were of < 29 completed weeks' gestational age.

Overall

For infants with a gestational age < 32 completed weeks, a statistically significant difference was shown in core body temperature on admission to NICU favouring the intervention (plastic wrap) group when compared to those who received routine care immediately after birth in the delivery suite (four studies, n = 264; WMD 0.57°C 95% CI 0.37, 0.77).

However, the overall test for homogeneity and for the subgroup of infants with a gestational age < 28 completed weeks failed with an I^2 value of 75%. We note the most likely reason for this failure is the contribution of the small Vohra 1999 study for the subgroup of infants < 28 completed weeks which gives rise to a 95% CI range somewhat outside the range suggested by the other studies. Rather than excluding this study purely on statistical grounds the possible reasons for this heterogeneity are explored in the discussion section of this review. The outcomes reported below suggest that the heterogeneity issue has been dealt with by dividing the population into the two gestational age subgroups: < 28 completed weeks and 28 to 31 completed weeks.

Outcome 1.1.1: For infants with a gestational age < 28 completed weeks a statistically significant difference was shown in core body temperature on admission to NICU favouring the intervention (plastic wrap) group when compared to those who received routine care immediately after birth in the delivery suite (four studies, n = 223; WMD 0.68 °C; 95% CI 0.45, 0.91).

Outcome 1.1.2: For infants with a gestational age of 28 to 31 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for core body temperature on admission to NICU (one study, n = 41; MD 0.17 °C; 95% CI -0.27, 0.61).

Core body temperature taken 1 hour after initial admission temperature to the NICU was taken (Outcome 1.2):

This outcome was reported in one small study (Vohra 2004a) in terms of core body temperature (rectal °C) one hour after the initial admission temperature was taken and in an additional study in terms of core body temperature (axillary °C) (Trevisanuto 2009b). This was not pre-defined at review protocol stage. The reason stated for collection of this outcome measure was to ascertain whether the intervention (plastic wrap) prevented rather than delayed the postnatal fall in body temperature immediately after birth.

Outcome 1.2.1 For infants with a gestational age < 28 completed weeks a statistically significant difference in the effect was shown for core body temperature one hour after the initial admission temperature to NICU was taken favouring the intervention (plastic wrap) group when compared to those who received routine care immediately after birth in the delivery suite (two studies, n= 117; WMD 0.40 °C; 95% CI 0.16, 0.65). The test for homogeneity

passed with an I^2 value of 20%.

Hypothermia on admission to NICU (core body temperature < 36.5 °C or skin temperature < 36 °C) (Outcome 1.3):

Outcome 1.3.1 Knobel 2005 and Trevisanuto 2009b in addition to reporting core body temperature on admission to NICU as a continuous variable, also provided data in a dichotomous format in terms of incidence of hypothermia in intervention and control groups (plastic wrap and routine care). Hypothermia was defined in both studies as a core body temperature (rectal or axillary) < 36.4 °C on admission to NICU. For infants of gestational age < 29 completed weeks, plastic wrap significantly reduces the risk of hypothermia on admission to NICU (two studies, n = 152; RR 0.66, 95% CI 0.51, 0.84; RD -0.27; 95% CI -0.41, -0.13).

This finding is consistent with those for the outcome measure 01.01.01. Four infants would need to be wrapped in plastic in order to prevent one infant from becoming hypothermic (NNT 4, 95% CI 2 to 8).

Secondary outcomes

Mortality (death prior to hospital discharge) (Outcome 1.4):

Four studies (Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b) reported this outcome in terms of death within hospital stay. Mortality figures for the Vohra 2004a study included two infants who died in the delivery suite. The test for homogeneity passed with an I^2 value of 0%.

Outcome 1.4.1: For infants with a gestational age < 28 completed weeks the results of the meta-analysis are in the direction in favour of the intervention group (plastic wrap). However, this is being influenced by the (Vohra 1999) study with five events in the control group and showing borderline significance. Overall there is insufficient evidence to suggest that plastic wrap reduces the risk of death within hospital stay for this group of infants (four studies, n = 225; RR 0.66; 95% CI 0.35, 1.24; RD -0.06 ; 95% CI -0.15, 0.03).

Outcome 1.4.2: For infants with a gestational age of 28 to 31 completed weeks there were no deaths within hospital stay in either group. Data were provided from one study Vohra 1999 (n = 41 infants).

Major brain injury (defined as sonographic evidence of intraventricular haemorrhage with ventricular dilatation, parenchymal haemorrhagic infarction or periventricular leukomalacia) (Outcome 1.5):

This outcome was reported in two studies (Knobel 2005; Trevisanuto 2009b) but it was not pre-defined at review protocol stage.

Outcome 1.5.1: For infants of gestational age < 29 completed weeks there was no evidence of a difference in risk of major brain injury (two studies, n = 152; RR 1.10; 95% CI 0.41, 2.98; RD 0.01; 95% CI -0.08, 0.10). The test for homogeneity passed with an I^2 value=0%.

Duration of oxygen therapy (days) (Outcome 1.6):

This outcome was reported in one study (Knobel 2005) but it was not pre-defined at review protocol stage.

Outcome 1.6.1: For infants of gestational age < 29 completed weeks there were no ststistically significant differences between the two interventions (plastic wrap and routine care) for duration of oxygen therapy (one study, n = 88; MD -6.51 days; 95% CI -23.30, 10.28).

Duration of hospitalisation (days) (Outcome 1.7):

This outcome was reported in one study (Knobel 2005).

Outcome 1.7.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for duration of hospitalisation (one study, n = 88; MD -5.49 days; 95% CI -19.93, 8.95).

Apgar score at one minute (Outcome 1.8):

This outcome was reported as a median value with interquartile ranges in Vohra 2004a and as a mean value with SD in Trevisanuto 2009b but it was not pre-defined at review protocol stage.

Outcome 1.8.1: For infants of gestational age < 28 completed weeks, median Apgar scores at one minute were comparable in the intervention and control group (one study, n = 53; P = 0.6).

Apgar score at one minute (Outcome 1.9):

Outcome 1.9.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for Apgar scores at one minute (one study, n = 64; MD 0.20; 95% CI -0.83, 1.23).

Apgar score at five minutes (Outcome 1.10):

This outcome was reported as a median value with interquartile ranges in (Vohra 2004a) and as a mean value with SD in Trevisanuto 2009b but it was not pre-defined at review protocol stage.

Outcome 1.10.1: For infants of gestational age < 28 completed weeks, median Apgar scores were comparable in the intervention and control group (one study, n = 53; P = 0.9).

Apgar score at five minutes (Outcome 1.11):

Outcome 1.11.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for Apgar score at five minutes (one study,n=64; MD 0.40; 95% CI -0.19, 0.99).

First blood gas pH (Outcome 1.12):

This outcome was reported in two studies (Vohra 2004a; Trevisanuto 2009b). This was not pre-specified at review protocol stage.

Outcome 1.12.1: For infants of gestational age < 28 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for first blood gas pH (two studies, n = 117; MD 0.01 ; 95% CI -0.02, 0.04). The test for homogeneity failed with an I^2 value of 70%. Since pH is on a logarithmic scale it would be more appropriate to measure this outcome as a median value and range or interquartile range (IQR) or to avoid its use as a continuous variable such as that pre-specificed at review protocol stage: severe metabolic acidosis as defined by pH < 7.20 and/or base deficit > 10 mmol/L within the first three days of life.

Bicarbonate (mmol/L) (Outcome 1.13):
This outcome was reported in two studies (Vohra 2004a; Trevisanuto 2009b). This was not pre-specified at review protocol stage.
Outcome 1.13.1: For infants of gestational age < 28 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for bicarbonate (two studies, n = 117; WMD 0.31 mmol/L; 95% CI -0.72, 1.35).
First serum glucose concentration (mmol/L) (Outcome 1.14):
This outcome was reported in two studies (Vohra 2004a; Trevisanuto 2009b). This was not our pre-specified definition of hypoglycaemia at review protocol stage.
Outcome 1.14.1: For infants of gestational age < 28 completed weeks there were no statistically significant differences between the two interventions (plastic wrap and routine care) for first serum glucose concentration (two studies, n = 117; WMD 0.01 mmol/L; 95% CI , -0.36, 0.39).
Intubation in delivery room (Outcome 1.15):
This outcome was reported in one study (Trevisanuto 2009b).
Outcome 1.15.1: For infants of gestational age < 29 completed weeks, there was no evidence of a difference in risk of intubation in delivery room (one study, n = 64; RR 1.00; 95% CI 0.63, 1.58; RD 0.00; 95% CI -0.24, 0.24).
Other secondary outcomes
The following secondary outcome measures were not reported (as pre-defined at review protocol stage) for any of the included studies for this comparison group: hypoglycaemia, respiratory distress syndrome, surfactant given at any time, requirement for ventilation, duration of ventilation, severe metabolic acidosis, intraventricular haemorrhage, patent ductus arteriosus, chronic lung disease, necrotising enterocolitis, acute renal failure, burns, antibiotics or negative psychological outcomes.
Adverse occurrences
There were no occurrences of adverse events attributable to the intervention (i.e. hyperthermia, infection, skin maceration or interference with resuscitation) for infants in the intervention and control groups in the Vohra 1999 study. Knobel 2005 reported that one participant in the intervention group was hyperthermic with a rectal admission temperature of 38.3°C; the delivery room environmental temperature was 26.7 °C. Knobel 2005 also reported that the clear, pliable polyurethane bag did not interfere with either assessment (visualization, auscultation, palpation) or resuscitative interventions. Vohra 2004a reported that the wrap procedure was accepted by the neonatal staff and did not interfere with resuscitation in the delivery room. Two infants in the intervention group (Vohra 2004a) were reported to have a rectal temperature on admission above 37.5 °C. Two infants in the plastic wrap group (active comparator) (Trevisanuto 2009b) were reported to have an axillary admission temperature > 37.5 °C (37.6 °C and 38 °C respectively).
Hyperthermia on admission to NICU: core body temperature > 37.5°C (Outcome 1.16):
A clear definition of hyperthermia was reported in only one study (Vohra 2004a). This was not the pre-specified definition of hyperthermia at review protocol stage.
Outcome 1.16.1: For infants of gestational age < 28 completed weeks, there was no significant difference in risk of hyperthermia between those infants who received plastic wrap and those who received routine care (one study, n = 53; RR 4.82, 95% CI 0.24, 95.88; RD 0.07; 95% CI -0.04, 0.19).
PLASTIC CAP VERSUS ROUTINE CARE (COMPARISON 2):
Primary outcomes
Core body temperature (°C) of the infant taken on admission to NICU or up to 2 hours after birth (Outcome 2.1):
One study Trevisanuto 2009b reported core body temperature (axillary ° C) on admission to NICU.
Outcome 2.1.1: For infants with a gestational age < 29 completed weeks a statistically significant difference in the effect was shown for core body temperature on admission to NICU favouring the intervention (plastic cap) group when compared to those who received routine care immediately after birth in the delivery suite (one study, n = 64; MD 0.80 95% CI 0.41, 1.19).
Core body temperature taken 1 hour after initial admission temperature to the NICU was taken (Outcome 2.2):
This outcome was reported in one study in terms of core body temperature (axillary °C) (Trevisanuto 2009b). This was not pre-defined at review protocol stage.
Outcome 2.2.1: For infants with a gestational age < 29 completed weeks a statistically significant difference in the effect was shown for core body temperature taken one hour after initial admission temperature to the NICU was taken favouring the intervention (plastic cap) group when compared to those who received routine care immediately after birth in the delivery suite (one study, n = 64; MD 0.80 95% CI 0.46, 1.14).
Hypothermia on admission to NICU (core body temperature < 36.5 °C or skin temperature < 36 °C) (Outcome 2.3):
Trevisanuto 2009b in addition to reporting core body temperature on admission to NICU as a continuous variable, also provided data in a dichotomous format in terms of incidence of hypothermia in intervention and control groups (plastic cap and routine care). Hypothermia was defined as a core body temperature (axillary) < 36.4 °C on admission to NICU.
Outcome 2.3.1: For infants of gestational age < 29 completed weeks, plastic cap significantly reduces the risk of hypothermia on admission to NICU (one study, n = 64; RR 0.48, 95% CI 0.32, 0.73; RD -0.47; 95% CI -0.67, -0.27).

This finding is consistent with those for the outcome measure 02.01.01. Two infants would need to wear a plastic cap in order to prevent one infant from becoming hypothermic (NNT 2, 95% CI 2 to 4).
Mortality (death prior to hospital discharge) (Outcome 2.4):
Trevisanuto 2009b reported this outcome in terms of death within

hospital stay.

Outcome 2.4.1: For infants of gestational age < 29 completed weeks there is insufficient evidence to suggest that plastic cap reduces the risk of death within hospital stay for this group of infants (one study, n = 64; RR 1.50; 95% CI 0.27, 8.38; RD 0.03; 95% CI -0.10, 0.16).

Major brain injury (defined as sonographic evidence of intraventricular haemorrhage with ventricular dilatation, parenchymal haemorrhagic infarction or periventricular leukomalacia) (Outcome 2.5):

This outcome was reported in one study (Trevisanuto 2009b) but it was not pre-defined at review protocol stage.

Outcome 2.5.1: For infants of gestational age < 29 completed weeks there was no evidence of a difference in risk of major brain injury (one study, n = 64; RR 1.50; 95% CI 0.27, 8.38; RD 0.03 ; 95% CI -0.10, 0.16).

Apgar score at one minute (Outcome 2.6):

This outcome was reported as a mean value with SD in Trevisanuto 2009b but it was not pre-defined at review protocol stage.

Outcome 2.6.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic cap and routine care) for Apgar scores at one minute (one study, n=64;MD 0.80; 95% CI -0.21, 1.81).

Apgar score at five minutes (Outcome 2.7):

This outcome was reported as a mean value with SD in Trevisanuto 2009b but it was not pre-defined at review protocol stage.

Outcome 2.7.1: For infants of gestational age < 29 completed weeks a statistically significant difference in the effect was shown for Apgar score at five minutes favouring the intervention (plastic cap) group when compared to those who received routine care immediately after birth in the delivery suite (one study, n=64; MD 0.70 95% CI 0.08, 1.32).

First blood gas pH (Outcome 02.08):

This outcome was reported in one study (Trevisanuto 2009b). This was not pre-specified at review protocol stage.

Outcome 02.08.01: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic cap and routine care) for first blood gas pH (one study, n = 64; MD 0.01 ; 95% CI -0.03 0.05). Since pH is on a logarithmic scale it would be more appropriate to measure this outcome as a median value and range or interquartile range (IQR) or to avoid its use as a continuous variable such as that pre-specificed at review protocol stage: severe metabolic acidosis as defined by pH < 7.20 and/or base deficit > 10 mmol/L within the first three days of life.

Bicarbonate (mmol/L) (Outcome 2.9):

This outcome was reported in one study (Trevisanuto 2009b).

Outcome 2.9.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic cap and routine care) for bicarbonate (one study, n = 64; MD 1.00 mmol/L; 95% CI -0.25, 2.25).

First serum glucose concentration (mmol/L) (Outcome 2.10):

This outcome was reported in one study (Trevisanuto 2009b). This was not our pre-specified definition of hypoglycaemia at review protocol stage.

Outcome 2.10.1: For infants of gestational age < 29 completed weeks there were no statistically significant differences between the two interventions (plastic cap and routine care) for first serum glucose concentration (one study, n = 64; MD 0.10 mmol/L; 95% CI, -0.42, 0.62).

Intubation in delivery room (Outcome 2.11):

This outcome was reported in one study (Trevisanuto 2009b).

Outcome 2.11.1: For infants of gestational age < 29 completed weeks, there was no evidence of a difference in risk of intubation in delivery room (one study, n = 64; RR 0.82; 95% CI 0.49,1.37 ; RD -0.09; 95% CI -0.34, 0.15).

Other secondary outcomes

The following secondary outcome measures (as pre-defined at review protocol stage) were not reported for this comparison group: hypoglycaemia, respiratory distress syndrome, surfactant given at any time, requirement for ventilation, duration of ventilation, severe metabolic acidosis, intraventricular haemorrhage, patent ductus arteriosus, chronic lung disease, necrotizing enterocolitis or acute renal failure.

Adverse occurrences

The following adverse outcome measures (as pre-defined at review protocol stage) were not reported for this comparison group: hyperthermia, burns, infection, antibiotics, skin maceration, interference with resuscitation or negative psychological outcomes for infants in the intervention and control group.

STOCKINET CAP VERSUS ROUTINE CARE (COMPARISON 3):

Primary outcomes

Core body temperature (°C) on admission to NICU or up to 2 hours after birth (Outcome 3.1):

Roberts 1981 reported core body temperature (axillary °C) on admission to NICU in a study of 40 infants. This study reported figures for all infants with a gestational age 32 to 36 completed weeks, and also for the subgroup of infants < 2000 g birthweight. We have tried to disaggregate the data using the information available, in order to obtain data for the subgroup of infants weighing 2000 g or more at birth. These subgroup analyses by birthweight class were not pre-specified in the protocol for this review.

Overall:

The I^2 value of 65.8% indicates that there is a moderate degree of heterogeneity of effect across these two birthweight subgroups. Overall, the results show no statistically significant difference in the effects of the two interventions (stockinet cap versus routine care) on core body temperature on admission to NICU (one study, n = 40; MD 0.15 °C; 95% CI -0.18, 0.48).

Outcome 3.1.1: For infants with a birthweight < 2000 g a borderline statistically significant difference was shown in core body

temperature on admission to NICU favouring the intervention (stockinet cap) group when compared to those who received routine care (one study, n = 10; MD 0.70 °C; 95% CI -0.01, 1.41).

Outcome 3.1.2: For infants with a birthweight ≥ 2000 g there were no statistically significant differences between the two interventions (stockinet cap versus routine care) for core body temperature on admission to NICU (one study, n = 30; MD 0.00 °C; 95% CI -0.37, 0.37).

Hypothermia on admission to NICU (core body temperature < 36.5 °C or a skin temperature < 36 °C) (Outcome 3.2):

Outcome 3.2.1: Roberts 1981, in addition to reporting core body temperature on admission to NICU as a continuous variable, also provided data in a dichotomous format in terms of incidence of hypothermia in both groups (stockinet cap and routine care). Hypothermia was defined in this study as a core body temperature (axillary) < 36 °C on admission to the NICU. For infants with a gestational age 32 to 36 completed weeks (birthweight range 1360 to 2965 g), there was no significant difference in risk of hypothermia (as defined by the study) between those infants who received stockinet cap and those who received routine care (one study, n = 40; RR 0.90; 95% CI 0.48, 1.71; RD -0.05; 95% CI -0.36, 0.26).

Secondary outcomes

The following secondary outcome measures (as pre-defined at review protocol stage) were not reported for this comparison group: hypoglycaemia, respiratory distress syndrome, surfactant given at any time, intubation in delivery room, requirement for ventilation, duration of ventilation, length of stay, mortality, severe metabolic acidosis, intraventricular haemorrhage, patent ductus arteriosus, chronic lung disease, necrotizing enterocolitis, acute renal failure and adverse events due to the intervention (hyperthermia, burns, maceration, skin or systemic infection, antibiotics, interference with resuscitation and other practices, fluid problems, negative psychological outcomes).

EXTERNAL HEAT SOURCES (NON-ROUTINE)

SKIN-TO-SKIN CARE VERSUS ROUTINE CARE (COMPARISON 4):

Primary outcomes

Hypothermia (skin temperature < 35.5 °C for two consecutive recordings) (Outcome 4.1):

Bergman 2004 reported this outcome in terms of skin temperature remaining below 35.5 °C for two consecutive readings (five minute intervals for the first hour, thereafter 15 minute intervals during the six hour observation period). This outcome was not pre-specified at review protocol stage.

Outcome 4.1.1: For infants with a birthweight between 1200 and 2199 g evidence suggests that skin-to-skin contact significantly reduces the risk of hypothermia (as defined by the study) within 6 hours of birth when compared to conventional incubator care (one study, n = 31; RR 0.09; 95% CI 0.01, 0.64; RD -0.56; 95% CI -0.84, -0.27). Two infants would need to receive skin-to-skin contact in order to prevent one infant from becoming hypothermic (NNT 2, 95% CI 1 to 4).

Secondary outcomes

Hypoglycaemia (blood glucose < 2.6 mmol/L) (Outcome 4.2):

Bergman 2004 reported this outcome which was confirmed by laboratory estimation within the 6 hour observation period where blood glucose was measured by heel prick at one, three and six hours. This was not the pre-specified definition of hypoglycaemia at review protocol stage.

Outcome 4.2.1: For infants with a birthweight between 1200 and 2199 g there is no significant difference in risk of hypoglycaemia (as defined by the study) between those infants who received skin-to-skin contact and those who received conventional incubator care (one study, n = 31; RR 0.24; 95% CI 0.03, 2.06; RD -0.18; 95% CI -0.43, 0.08).

Other secondary outcomes

This study reported the following additional outcome measures: heart rate below 100, or above 180 beats per minute for two consecutive recordings, apnoea longer than 20 s, oxygen saturation below 87% for two consecutive recordings despite supplementation with nasal prong oxygen, FiO_2 up to 0.60 and CPAP up to 5 cm water, and overall data (transfers to NICU, exceeded parameters, mean SCRIP score within first 6 hours and number of perfect scores, mean SCRIP score in the sixth hour and number of perfect scores).

The following secondary outcome measures (as pre-defined at review protocol stage) were not reported for this comparison group: respiratory distress syndrome, surfactant given at any time, intubation in delivery room, requirement for ventilation, duration of ventilation, length of stay, mortality, severe metabolic acidosis, intraventricular haemorrhage, patent ductus arteriosus, chronic lung disease, necrotizing enterocolitis or acute renal failure.

Adverse occurrences

Bergman 2004 reported that "there were no adverse events related to the intervention".

TRANSWARMER (SODIUM ACETATE) MATTRESS VERSUS ROUTINE CARE (COMPARISON 5):

Primary outcomes

Core body temperature (°C) on admission to NICU or up to two hours after birth (Outcome 5.1):

Brennan 1996 reported core body temperature (axillary °C) on admission to NICU in a study of 24 infants.

Outcome 5.1.1: For infants with a birthweight ≤ 1500 g a statistically significant difference in effect was shown for core body temperature on admission to NICU favouring the intervention (transwarmer mattress) group when compared to those who received routine care immediately after birth in the delivery suite (one study, n = 24; MD 1.60 °C; 95% CI 0.83, 2.37).

Hypothermia on admission to NICU (core body temperature < 36.5°C or skin temperature < 36°C) (Outcome 5.2):

Brennan 1996 in addition to reporting core body temperature on admission to NICU as a continuous variable, also provided data

in a dichotomous format in terms of incidence of hypothermia in the intervention and control groups (transwarmer mattress and routine care). Hypothermia was defined in this study as a core body temperature (axillary °C) < 36.5 on admission to NICU.

Outcome 5.2.1: For infants with a birthweight ≤ 1500 g evidence suggests that the transwarmer mattress significantly reduces the risk of hypothermia on admission to NICU (one study, n = 24; RR 0.30 95% CI 0.11, 0.83; RD -0.58; 95% CI -0.91, -0.26). Two infants would need to receive a sodium acetate mattress in order to prevent one infant from becoming hypothermic (NNT 2, 95% CI 1 to 4).

Secondary outcomes

The following secondary outcome measures (as pre-defined at review protocol stage) were not reported for this comparison group: hypoglycaemia, respiratory distress syndrome, surfactant given at any time, intubation in delivery room, requirement for ventilation, duration of ventilation, length of stay, mortality, severe metabolic acidosis, intraventricular haemorrhage, patent ductus arteriosus, chronic lung disease, necrotizing enterocolitis, acute renal failure, hyperthermia, burns, maceration, skin or systemic infection, antibiotics, fluid problems or negative psychological outcomes.

Adverse occurrences

Brennan 1996 reported that the intervention did not at any time interfere with the care of the infants.

DISCUSSION

Hypothermia (body temperature below normal) on admission to neonatal units is a problem world-wide across all climates, particularly for small infants and those born too early. Early intervention in the delivery room is vital. This review focused on individual interventions to prevent hypothermia applied immediately at birth apart from 'routine' care in comparison to 'routine care' only. The studies fell into two major groups: barriers to prevent heat losses and additional external heat sources. The strengths of the review lie in the fact that a comprehensive literature search was undertaken encompassing both published and unpublished studies. In addition, strict inclusion criteria were adhered to ensuring that the review was focused on interventions that were applied within the first 10 minutes after birth for preterm and/or low birthweight infants as opposed to bigger infants or long-term thermal management. Limitations of the review were dictated by the number and size of the relevant studies and by the lack of reported data for the pre-specified secondary outcomes.

Seven studies were identified which fulfilled our criteria for inclusion giving a total of 400 infants randomised and 391 infants completing the studies. Five studies compared barriers to heat loss to no barriers (Roberts 1981; Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b) and two studies compared external heat sources (non-routine) to no external heat sources (Brennan 1996; Bergman 2004). There were three comparisons within the barriers to heat loss category: plastic wraps or bags versus routine care (Vohra 1999; Vohra 2004a; Knobel 2005), plastic cap versus routine care (Trevisanuto 2009b) and stockinet cap versus routine care (Roberts 1981). There were also two comparisons within the external heat source category: skin-to-skin care versus routine care (Bergman 2004) and transwarmer (sodium acetate) mattress versus routine care (Brennan 1996). Each technique was successful to a greater or lesser degree in increasing temperature on admission to NICU.

Barriers to heat loss

Plastic wraps or bags were effective in reducing heat losses for the younger group of infants with gestational ages of < 28 completed weeks. The results showed that there was a high level of heterogeneity within this subgroup of infants. Possible causes may lie within the variations in methods used in the four studies (Vohra 1999; Vohra 2004a; Knobel 2005; Trevisanuto 2009b). The authors of these studies were contacted and potential differences were explored. In both the Vohra 1999 and Vohra 2004a studies the study sample represented all preterm infants within the eligible gestational age range born at the institution. The intervention consisted of a polyethylene bag which was cut into a wrap, only the head of the infant was dried, the body was wrapped from the neck down, a radiant warmer was used, and no parental consent was sought although institutional consent was given. No attempt was made to change standard delivery room temperatures during the studies. Infants were transferred to the NICU in incubators in the first study (Vohra 1999) and in the arms of one of the neonatal team in the second (Vohra 2004a). In the Trevisanuto 2009b study where possible, parental consent was obtained before delivery; the remaining parents received a parent information form after initial stabilisation of their baby. The intervention was also polyethylene bags and the infants were also placed into the bag while still wet up to their necks and only the head was dried and a radiant warmer was used. No attempt was made to change standard delivery room temperatures during the study. Infants were also transferred to the NICU in a transport incubator.

In contrast, in Knobel 2005, the study sample excluded infants for whom no consent was given (and who might have been smaller or more ill and thus more prone to heat loss); and the intervention consisted of polyurethane bag with a drawstring, and the body was wrapped from the neck down while still wet. Attempts to control delivery room temperatures (Knobel 2005), as recommended by the World Health Organisation, failed and resulted in a wide spread of delivery room temperatures during the study period. Infants were transferred to the NICU down a very long, draughty hallway on an open warmer with its heat off with warm blankets over the infants. All four studies followed the NRP protocol and exclusion criteria were similar. An additional point of interest was

the reported imbalance of birthweight between study groups in the Vohra 1999 study. The birthweight-adjusted difference in rectal temperatures for infants with a gestational age of < 28 completed weeks remained significant but decreased from 1.90 °C, SD(0.43 °C) to 1.54 °C, SD(0.42 °C).

There was limited reporting of pre-specified secondary outcomes for this group of studies. There was insufficient evidence to suggest that plastic barriers reduce the risk of death within hospital stay for the younger infants and no deaths were reported for the older group of infants. Similarly, there was no evidence of a significant difference in major brain injury, mean duration of oxygen therapy or hospitalisation, for infants with a gestational age < 29 completed weeks (Knobel 2005) nor median Apgar score at one and five minutes, first serum glucose concentrations, first blood pH, bicarbonate and hyperthermia for infants < 28 completed weeks gestational age (Vohra 2004a; Trevisanuto 2009b) mean Apgar score at one minute and five minutes and intubation in delivery room for infants with a gestational age < 29 completed weeks (Trevisanuto 2009b).

Plastic caps were also effective in reducing heat losses for the younger group of infants with gestational ages of < 29 completed weeks. There was limited reporting of pre-specified secondary outcomes for this comparison group. There was insufficient evidence to suggest that plastic caps reduce the risk of death within hospital stay and there was no significant difference in major brain injury, Apgar score at one minute, first blood pH, bicarbonate and intubation in delivery room. However, a statistically significant difference in effect was shown for Apgar at five minutes favouring the plastic cap group when compared to those who received routine care immediately after birth in the delivery suite.

Where the barrier to heat loss was stockinet caps, a borderline statistically significant difference in temperature on admission to NICU in favour of the intervention group was shown for those infants with a birthweight < 2000 g but no difference for those infants ≥ 2000 g. This finding is consistent with those reported by Greer 1988 in which various head coverings were compared under radiant warmers for infants > 2500 g. Where head coverings were applied within one minute of birth, results showed that infants wearing 'stockinettes' had lower mean core body temperatures at 5, 15 and 30 minutes after delivery than either the hatless group or the group wearing an insulated fabric bonnet. As a result, 'stockinettes' were not recommended for use in conjunction with a radiant warmer.

External heat sources (non-routine)

Skin-to-skin care was shown to be effective in reducing the risk of hypothermia when compared to conventional incubator care for infants with a birthweight between 1200 and 2199 g and the transwarmer mattress significantly kept infants ≤ 1500 g warmer and reduced the incidence of hypothermia on admission to NICU. There was no evidence that skin-to-skin care reduced the risk of hypoglycaemia. There was limited reporting of secondary outcomes.

Overall

Despite the variations in interventions applied, definitions of 'routine care', definitions of hypothermia and groups of infants included, across all studies there is a similar pattern emerging showing that infants in the intervention group are significantly warmer (or show a non-significant trend in that direction) when compared to infants receiving 'routine care'. There is also an indication from these studies that the effect is greater in the lightest and most immature infants. Babies of < 28 weeks or those weighing ≤ 1500 g appeared to derive most benefit from interventions in the delivery suite to prevent hypothermia. These are also the infants most likely to suffer from the adverse effects of hypothermia and in whom further studies should be undertaken.

There was limited reporting of pre-specified secondary outcomes across all studies. In the Vohra 1999 study, there were no occurrences of adverse events attributable to the intervention (i.e. hyperthermia infection, skin maceration or interference with resuscitation) for infants in the intervention and control groups. Knobel 2005 reported that one participant in the intervention group was hyperthermic with a rectal admission temperature of 38.3°C; the delivery room environmental temperature was 26.7 °C and Trevisanuto 2009b reported two infants in the plastic wrap group with axillary admission temperatures of 37.6 °C and 38 °C respectively. Knobel 2005 also reported that the clear, pliable polyurethane bag did not interfere with either assessment (visualization, auscultation, palpation) or resuscitative interventions. Vohra 2004a reported that the wrap procedure was accepted by the neonatal staff and did not interfere with resuscitation in the delivery room. Two infants in the intervention group (Vohra 2004a) were reported to have a rectal temperature on admission above 37.5 °C. Bergman 2004 reported that "there were no adverse events related to the intervention" and Brennan 1996 stated that the intervention did not at any time interfere with the care of the infants.

Knobel 2005a in a national survey of newborn intensive care units reported that twenty percent of responding level three neonatal intensive care units used occlusive material instead of drying preterm infants in the delivery room. They also found that only one of the one-hundred and twenty-five responding neonatal intensive care units reported any adverse effects from using wrap or bags in the delivery room. This unit reported that a single infant was hyperthermic on admission to the neonatal intensive care unit but did not report the actual infant temperature.

More recently, the International Liaison Committee on Resuscitation (ILCOR) consensus statement recommends that plastic bags or plastic wrapping under radiant heat be considered as standard techniques to maintain temperature (ILCOR 2006). National and

international agencies responsible for the development of neonatal resuscitation guidelines have a challenging role when research evidence is emerging, but long-term safety data are not yet available. While the interventions studied in this review offer some short-term benefit regarding heat loss prevention in vulnerable preterm and/or low birthweight infants, their effect on morbidity, mortality and their long-term safety remain unknown. We recommend these additional data are sought, before these interventions are recommended for routine use. Therefore, monitoring (for both benefits and for risks of potential adverse events) should continue in neonatal units where such interventions are adopted as routine practice since wide variation in clinical practice has been reported (Knobel 2005a). In addition, Clarification on 'normal' temperatures for these populations of infants is alo essential as is better data correlating axillary versus rectal versus other temperatures.

Paradoxically hypothermia is more of a problem in the developing world where climates are generally warmer (Kumar 2009). Only one of the included studies was conducted in a developing country, South Africa (Bergman 2004). Although South Africa is classified as developing, the units participating in this study carried out in Cape Town provided secondary level care for inborn babies and is therefore not truly representative of the developing world. The plastic wraps utilised in the ongoing Heat Loss Prevention study Vohra 2004 cost approximately 157 Canadian Dollars for 5000 wraps which when calculated per infant is approximately three cents therefore these may be an affordable option for preterm infants in low resource settings.

Further studies are needed of interventions such as plastic bag wrapping for infants under 30 weeks' gestation with adequate sample size to assess both short-term and long-term neurodevelopmental outcomes. Such a multicentre study (HeLP) is currently underway in partnership with the Vermont Oxford Network (n = 1600). The primary study outcome is all cause mortality while secondary outcomes include neurodevelopmental status at 18 months corrected age and safety data. This study will yield important prospective data on 'normal' temperatures in this population, including correlationg axillary and rectal temperature.

AUTHORS' CONCLUSIONS

Implications for practice

Health professionals strive to minimise risk of cold stress for newborn infants immediately after birth by adhering to practice guidelines such as: providing a warm delivery room at a minimum of 25 °C (although this is difficult to achieve in practice), drying the infant, removing any wet blankets and wrapping in a prewarmed blanket, prewarming any contact surfaces, avoiding draughts and in developed countries, using radiant warmers or incubators. Despite this hypothermia remains a world-wide problem, especially for small infants and those born too early (Costeloe 2000). Any additional intervention designed for prevention of hypothermia in very preterm and/or low birthweight infants, and applied within 10 minutes after birth in the delivery suite, compared with routine thermal care may be beneficial in practice. The interventions in this review (plastic wraps and bags, plastic caps, skin-to-skin contact, and transwarmer mattresses) keep infants warmer and lead to higher temperatures on admission to the NICU and to decreased incidence of hypothermia. As hypothermia increases the risk of morbidity and mortality in preterm infants, consideration should be given to using these interventions in the delivery suite. However, given the small numbers of infants and the small numbers of studies in this review and the fact that no long-term data on follow-up are available, firm recommendations for clinical practice cannot be given at this time.

Implications for research

Due to the small numbers and size of trials in this review there is a need conduct high quality randomised controlled trials where the specifically designed intervention to prevent hypothermia is applied within the first few minutes after birth in the delivery suite. These studies should be large enough to look at long-term neurodevelopmental outcomes and could also include economic evaluations to assess feasibility for use in poorer countries where cost is a fundamental concern. We report in the Table of "Characteristics of ongoing studies" that a large multicentre randomised controlled trial of heat loss prevention (HeLP) in the delivery room commenced in September 2004 (Vohra 2004). This trial will include infants < 28 weeks' gestational age, the intervention will be polyethylene skin wrap and the study will look at mortality as its primary outcome. Eighteen-month neurodevelopmental follow-up is also planned.

ACKNOWLEDGEMENTS

Mr Diarmuid Kennedy, Ms Angela Thompson and Ms Alex McIlroy, Faculty Librarians - Medicine and Health Sciences, Queen's University Medical Library, Mulhouse Building, Belfast, BT12 6DP.

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The Cochrane Neonatal Review Group has been funded in part with Federal funds from the Eunice Kennedy Shriver National

Institute of Child Health and Human Development National Institutes of Health, Department of Health and Human Services, USA, under Contract No. HHSN267200603418C.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Bergman 2004

Methods	Randomised. Multicentre (2). Blinding of randomisation: unclear. Generation of allocation sequence: adequate, (computer minimisation method). Allocation concealment: unclear, ("... a computer minimisation method determined allocation in a concealed manner" , ".. second hospital... minimisation factors and subsequent allocation by the computer were exchanged by mobile telephone, with no delays") . Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: yes, after the pilot phase, the principal investigator and data analyses team were blinded. A statistician, blinded to the allocation, performed the statistical analyses. Complete follow-up: no, (31 of 35 infants randomised completed the study, one infant was excluded after 2 hours when the mother required a caesarean section for a second twin, three further infants 'bailed out' within the first 3 hr requiring additional respiratory support and moved to neonatal intensive care). Room temperature, maternal temperature and incubator temperature were recorded. Ethical approval was obtained. Informed consent.
Participants	Infants delivered with a birthweight 1200 to 2199 g. Thirty-five infants randomised: intervention group (n = 21), control group (n =14), 31 completed study: intervention group (n = 18), control group (n =13). Setting: South Africa. Exclusion criteria: Mother: 1) delivered outside the unit, 2) had a caesarean section, 3) too severely ill to be able to look after themselves or their infants, 4) known to have positive HIV status, 5) giving their babies up for adoption. Infant: 1) birthweight below 1200 g or above 2199 g, 2) Apgar score below 6 at 5 min, 3) congenital malformations detected at birth. Intervention group (skin-to-skin care) characteristics: Mothers: gravidity mean (1.9), parity mean (1.8), race African (8), race Coloured (12), smoking in pregnancy (7), alcohol use(6), opiate in labour (9), Oxytocin in labour (3), hypertension (3), antepartum steroids (5). Infants: male (12), resuscitation (4), birthweight (g) mean (1813) SD(260), gestational age (wks) mean (34.2) SD(1.9), appropriate for GA (13), small for GA (7). Control group (conventional care) characteristics: Mothers: gravidity mean (1.9), parity mean (1.6), race African (4), race Coloured (10), smoking in pregnancy (4), alcohol use (2), opiate in labour (6), Oxytocin in labour (1), hypertension (1), antepartum steroids (3). Infants: male: (7), resuscitation baby (1), birthweight (g) mean (1866) SD(258), gestational age (wks) mean (35.3) SD(1.9), appropriate for GA (10), small for GA (5).

Bergman 2004 (*Continued*)

Interventions	SKIN-TO-SKIN CARE All infants were delivered onto a theatre cloth on the mother's abdomen/chest , dried gently and assessed. They were then placed naked on the mother's naked chest and covered with double layered cotton cloth. The bed was placed in semi-Fowlers position. Intervention group: The infant remained in skin-to-skin contact, was secured to the mother's chest, the hips were flexed and placed in a 'frog position', arms also flexed. Control group: The infant was immediately transferred to a prewarmed servocontrolled closed incubator which remained with the mother in delivery ward for the first hour. If the infant temperature was < 36 °C, a cap and booties were applied along with a heat shield placed over the infant. If this was insufficient a sheet of plastic was framed over the foot end of the heat shield and the outlet of the warm air funnelled over the infant.
Outcomes	Infant stability in terms of a set of predetermined physiological parameters. Observations for heart rate, respiratory rate, oxygen saturation and temperature were recorded at 5 minute intervals in the first hour, then 15 minute intervals. Continuous observations for apnoea and signs of respiratory distress, blood sugar measured at 1, 3 and 6hr. Primary Outcomes: 1) neonatal intensive care admissions 2) number of exceeded parameters 3) composite stabilization score (SCRIP) (1-6h) 4) composite stabilization score (SCRIP) (6th h). Secondary outcomes: 1) skin temperature degrees centigrade remaining below 35.5 °C for 2 consecutive readings 2) heart rate below 100 or above 180 beats per minutes for 2 consecutive readings 3) apnoea longer than 20 seconds 4) oxygen saturation below 87% for 2 consecutive recordings, despite supplementation with nasal prong oxygen, FiO2 up to 0.6 and CPAP up to 5cm water 5) blood glucose below 2.6 mmol/L reading confirmed by laboratory.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer minimisation method.
Allocation concealment?	Unclear	Quote: "a computer minimisation method determined allocation in a concealed manner", "second hospital ... minimisation factors and subsequent allocation by the computer were exchanged by mobile telephone, with no delays".

Bergman 2004 (*Continued*)

Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: yes, after the pilot phase, the principal investigator and data analyses team were blinded. A statistician, blinded to the allocation, performed the statistical analyses.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: no Thirty - one of 35 infants randomised completed the study, one infant was excluded after 2 hours when the mother required a caesarean section for a second twin, three further infants 'bailed out' within the first 3 hrs requiring additional respiratory support and moved to neonatal intensive care.
Free of selective reporting?	Unclear	Unclear.
Free of other bias?	No	Quote: "The possibility of selection bias exsists: many prematurely born infants delivered unexpectedly (without a nurse researcher available), and the aetiology of such premature delivery may differ from those studied". Recruitment for this study was terminated after interim analysis was carried out, based on significant results.

Brennan 1996

Methods	Randomised. Single centre. Blinding of randomisation: unclear. Generation of allocation sequence: adequate, (lot drawing - pulling cards from an envelope in which 24 cards had been placed. Equal numbers of cards had either 'mattress' or 'no mattress' written on them). Allocation concealment: unclear. Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no. Complete follow-up: yes, all 24 infants randomised completed the study. Gestational age, birthweight, and the time temperature taken after birth were recorded. The proposal for the study underwent a full review by the Institutional Review Board of the University of Florida, Health Science Centre. Informed consent.

Brennan 1996 (*Continued*)

Participants	Infants delivered with a birthweight ≤ 1500 g. Twenty - four infants randomised: intervention group (n = 12), control group (n = 12). Setting: USA. Exclusion criteria: 1) the maternal temperature at delivery was greater than 38.0 °C 2) the infant had an obvious neural tube defect 3) the infant had an omphalocele, gastroschisis, exstrophy of the bladder, cloacal exstrophy, or any other open lesion than would cause greater than normal heat loss at delivery, 4) the infant had a sacral teratoma, or any other lesion that would prevent the infant from being positioned and evaluated in the normal manner. All infants characteristics: gestational age range (wks) 24 to 32, birthweight range (g) 531 to 1498. Intervention group (transwarmer mattress) characteristics: gestational age (wks) mean (27.8), birthweight (g) mean (1033). Control group characteristics: gestational age (wks) mean (27.3), birthweight (g) mean (1027).
Interventions	TRANSWARMER INFANT TRANSPORT MATTRESS (Prism Technologies, San Antonio, Texas). These mattresses are filled with a gel of sodium acetate, water and thickeners. Once activated they heat to approximately 40 degrees centigrade for 2 hours. Intervention group: The NICU nurse activated the mattress when delivery was imminent and placed it on the radiant warmer surface with blankets on top of it and the newborn infant was immediately placed on the blankets, dried and the blankets removed, then placed directly onto the warming mattress. Control group: Infants received the same care as the intervention group but without the warming mattress. Both groups were evaluated and resuscitated according to the Neonatal Resuscitation Program and transported to NICU on the radiant warmer surface. The infants in the intervention group remained on the mattress until the admission temperatures were taken in the NICU.
Outcomes	Primary outcomes: 1) core body temperature °C (axillary) was measured using the IVAC 2080A Temp Plus 11 (IVAC, San Diego, California) as soon as possible after arrival at NICU. Secondary outcomes: 1) interference to resuscitation.
Notes	Individual patient data was reported in this study therefore dichotomous data for hypothermia on admission to NICU for the control and intervention group was calculated.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Generation of allocation sequence: adequate, (lot drawing - pulling cards from an envelope in which 24 cards had been

Brennan 1996 (*Continued*)

		placed. Equal numbers of cards had either 'mattress' or 'no mattress' written on them) .
Allocation concealment?	Unclear	Unclear.
Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: yes, all 24 infants randomised completed the study.
Free of other bias?	Yes	

Knobel 2005

Methods	Randomised. Single centre. Blinding of randomisation: yes. Generation of allocation sequence: unclear. Allocation concealment : adequate, (opaque envelopes). Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no. Complete follow-up: yes, all 88 infants randomised completed the study. Delivery to admission time was also recorded. Parental consent was sought if the mother was expected to deliver before completing 29 weeks' gestation.
Participants	Infants delivered with a gestational age < 29 completed weeks. Eighty - eight infants randomised: intervention group (n = 41), control group (n = 47). Setting: USA. Exclusion criteria: 1)congenital anomalies with open lesions (e.g. gastroschisis, meningomyelocele), 2) resuscitation not undertaken because of previability, 3) meconium staining of amniotic fluid, 4) subsequent assessment indicated that infant had a gestational age ≥ 29 completed weeks. Intervention group (Polyurethane bag) characteristics: birthweight (g) mean (918) SD (259), gestational age (wks) mean (26.5), SD (1.4). Control group (conventional care) characteristics: birthweight (g) mean (850) SD (253) , gestational age (wks) mean (26.1) SD (1.4).
Interventions	POLYURETHANE BAG - measured 19" x 18" DeRoyal REF30-5510 Intervention group: Infants were placed immediately into a polyurethane bag, while still wet, up to their necks and resuscitated according to the guidelines for Neonatal Resuscitation. Control group: Controls were resuscitated according to these guidelines without bags. Both groups were taken to the neonatal intensive care unit on a warmer table, (with the

	heat off) with warm blankets on top of the infant.
Outcomes	Primary outcome: 1) core body temperature °C (rectal) on admission to the NICU. 2) hypothermia on admission to the NICU defined by a core body temperature (rectal) < 36.4 °C. Secondary outcomes: 1) mortality 2) major brain injury 3) duration of oxygen therapy 4) duration of hospitalisation 5) hyperthermia 6) interference with assessment and resuscitation.
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Unclear.
Allocation concealment?	Yes	Opaque envelopes.
Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: yes, all 88 infants randomised completed the study.
Free of other bias?	No	This study attempted to maintain delivery suite temperature at 26°C for all preterm deliveries, but actual temperatures ranged from 18.9 to 31.1°C. On post hoc analysis warmer delivery suite temperatures were associated with higher admission temperatures, but only the subgroup of infants who were both delivered in warm rooms and place in plastic bag had a mean temperature > 36.4 °C. There was however no significant differences between intervention and control group for mean delivery room temperature. After controlling for delivery suite temperature the mean admission temperature in the intervention group was still 0.6 °C higher than controls.

Roberts 1981

Methods	Randomised. Single centre. Stratified randomisation by gestational age 32 to 34 and 35 to 36 completed weeks' gestation. Blinding of randomisation: unclear. Generation of allocation sequence: adequate, (lot drawing - index cards were utilised to pre-arranged randomisation - random number tables). Allocation concealment: unclear. Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no Complete follow-up: yes, all 40 infants randomised completed the study. Delivery room, transport incubator, highest maternal temperatures, birthweight, gestational age, method of delivery, time elapsed from birth to onset of drying and time elapsed from birth to arrival in nursery were recorded. Informed consent.
Participants	Infants delivered from 7am until 5 pm Monday through Friday with a gestational age of 32 to 36 completed weeks. Forty infants randomised: intervention group (n = 17), control group (n = 23). Setting: USA. Criteria for exclusion: 1) infant not appropriate birthweight for gestational age, 2) Apgar score @ 5 min < 7, 3) signs of central nervous system defect, 4) infant dropped from study on development of sepsis, 5) maternal temperature ≥ 37.8 °C, 6) delivered outside of delivery room. Intervention group (stockinet cap) characteristics: male (4), female (13), white (6), black (5), Mexican - American (6), vaginal delivery (15), caesarean section (2), gestational age (wks) (32 to 34 (5), 35 to 36 (12)), gestational age (wks) mean (34.9), birthweight (g) range (1420 to 2890), birthweight (g) mean (2253.4), Apgar score @ 5 min equal to 9 (16), infants transported in incubator (7), highest maternal temperature (degrees centigrade) range (36.6 to 37.7) mean (37.1). Control group (conventional care) characteristics: male (12), female (11), white (8), black (13), Mexican - American (2), vaginal delivery (18), caesarean section (5), gestational age (wks) (32 to 34 (4), 35 to 36 (19)), gestational age (wks) mean (35.2), birthweight (g) range (1360 to 2965), birthweight (g) mean (2276.8), Apgar score @ 5 min equal to 9 (22), infants transported in incubator (12), temperature (°C) transport incubator range (33 to 37) mean (35.2), highest maternal temperature (°C) range (36.2 to 37.8) mean (37.2).
Interventions	STOCKINET CAP - a sterile headpiece made of stockinet (a material used to protect skin under orthopedic casts) which covers the forehead, the ears, underneath the occipital bone, and all the area above this plane. Intervention group: Infants received a stockinet cap after delivery as soon as possible after being dried under a radiant warmer. Control group: Infants received the same treatment as the intervention group but did not receive a stockinet cap. All infants weighing < 2500 g were transported to the nursery in a transport incubator.

Roberts 1981 (*Continued*)

Outcomes	Primary outcomes: 1) core body temperature °C (axillary) within 10 minutes of admission to NICU (IVAC electric thermometer Model 821) Core body temperatures °C (axillary) in the delivery room were also recorded to enable calculation of the "amount of heat lost from the time the axillary temperature was taken in the delivery room until the axillary temperature was taken in the nursery". Secondary outcomes: None reported.
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Lot drawing - index cards were utilised to pre-arranged randomisation - random number tables.
Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: yes, all 40 infants randomised completed the study.
Free of other bias?	No	For infants < 2000 g the mean delivery suite temperatures were different for the intervention and control groups.

Trevisanuto 2009b

Methods	Randomised. Single centre. Blinding of randomisation: adequate. Generation of allocation sequence: adequate (computer-generated, randomisation sequence balanced in blocks of six subjects). Allocation concealment: adequate (double-enclosed, opaque, sealed and sequentially numbered envelopes). Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no. Complete follow-up: yes, all 96 infants randomised completed the study. This study was approved by the Azienda Ospedaliera - Padova Research Ethics Comittee. Mothers axillary temperature was recorded 30 minutes within delivery. Delivery suite temperature was not monitored throughout the study. Delivery suite temperature is normally 24° C. Time from delivery to NICU admission (minutes) was recorded. Where possible, parental consent was obtained before delivery; the remaining parents received a parent information form after initial stabilisation of the infant.
Participants	Inborn infants with a gestational age of < 29 completed weeks. 96 infants randomised: intervention group (n = 32), active comparator (n = 32), control group (n = 32). Setting: Italy Exclusion criteria: 1) infants with congenital anomalies with open lesions (e.g. gastroschisis, meningomyelocele) 2) infants whose delivery was not attended by the neonatal team Intervention group (polyethylene cap) characteristics: Mothers: ethnicity white (31), ethnicity black (1), age (years) mean (32) SD (7), antenatal steroids (31), temperature (°C) mean (36.4) SD (0.4), vaginal delivery (7), caesarean section (25). Infants: gestational age (wks) mean (26.1) SD (1.4), birthweight (g) mean (834) SD (246), female (18), multiple birth (5). Active comparator (polyethylene bag) characteristics: Mothers: ethnicity white (30), ethnicity black (2), age (years) mean (33) SD (5), antenatal steroids (30), temperature (°C) mean (36.4) SD (0.5), vaginal delivery (8), caesarean section (24). Infants: gestational age (wks) mean (25.8) SD (1.5), birthweight (g) mean (800) SD (223), female (19), multiple birth (6). Control group (conventional care) characteristics: Mothers: ethnicity white (32), ethnicity black (0), age (years) mean (32) SD (4), antenatal steroids (30), temperature (°C) mean (36.4) SD (0.6), vaginal delivery (8), caesarean section (24) Infants: gestational age (wks) mean (26.3) SD (1.0), birthweight (g) mean (813) SD (225), female (16), multiple birth (7).
Interventions	POLYETHYLENE CAPS (Degusto Dolomiti, Belluno, Italy). Intervention group: Polyethylene caps were placed on the radiant warmer bed prior to delivery. The head of the infant was covered with a polyethylene cap immediately after birth; only the head was dried. Active comparator group:

	Polyethylene bags (Vedovato SNC, Camposampiero, Padova, Italy, isolation transport bag 35cm by 40 cm) were placed on the radiant warmer bed prior to delivery. The infants were placed into the bag while still wet, up to the neck; only the head was dried. Control group: The infants were placed in pre-warmed towels after drying, according to International Guidelines for Neonatal Resuscitation. All infants were stabilised in the delivery room under radiant warmers (Babytherm® 8004/8010, Drager Medizintechnik GmbH, Lubeck, Germany). A transport incubator (MOG® 500, Ginevri, Tecnologie Biomediche, Cecchina, Roma, Italy) was used to transfer all infants from delivery room into the NICU; where they were placed in a double walled incubator at 35°C temperature and 70% humidity (Drager Medical AG& Co. KGaA, Lubeck, Germany. At this point, the cap or the wrap were removed.
Outcomes	Primary outcomes: 1) core body temperature °C (axillary) was measured with a digital thermometer (Terumo® Digital Clinical Thermometer C202, Terumo Corporation, Tokio, Japan) on admission to the NICU (immediately after cap and wrap removal) and again one hour later. 2) hypothermia, defined as axillary temperature less than 36.4°C, on NICU admission was also evaluated. Secondary outcomes: 1) mortality prior to hospital discharge 2) presence of major brain injury 3) trachael intubation at birth 4) Apgar scores 5) blood gas analysis 6) serum glucose concentration on NICU admission.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated, randomisation sequence balanced in blocks of six subjects.
Allocation concealment?	Yes	Double-enclosed, opaque, sealed and sequentially numbered envelopes.
Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measure: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: yes, all 96 infants randomised completed the study.

Free of other bias?	No	Delivery to admission time was significantly shorter in the control group than in the plastic wrap group. Delivery room temperature was not monitored. Standard environmental temperature of delivery suite is 24°C.

Vohra 1999

Methods	Randomised. Single centre. Prognostic stratification was by gestational age 23 to 27 and 28 to 31 completed weeks' gestation. Blinding of randomisation: yes. Generation of allocation sequence: adequate, (computer generated random sequence). Allocation concealment: adequate, (double-enclosed, opaque, sealed, and sequentially numbered envelopes). Blinding of intervention: participants: no/unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no. Complete follow-up: no, (59 of 62 infants randomised completed the study, 1 infant was excluded as no rectal temperature was recorded, two infants were excluded due to an imperforate anus). Delivery room, nursery temperatures and other potential confounding variables, (birthweight, maternal temperature, illnesses, medications, length of second stage of labour, length of time to arrival at nursery) were recorded. Ethics approval was obtained. No informed consent. Institutional consent was given.
Participants	Infants delivered with a gestational age of less than 32 completed weeks. Sixty-two infants randomised: 59 completed study, intervention group (n = 27), control group (n = 32). Setting: Canada. Exclusion criteria: 1) major congenital anomalies with open lesions, 2) infants whom the attending obstetrician considered "previable". Intervention group (polyethylene wrap) characteristics < 28 wks: birthweight (g) mean (914) SD (163), gestational age (wk) mean (26.1) SD (1.4) Apgar score @ 1min mean (5.0) SD (3.0), Apgar score @ 5 min mean (6.7) SD (1.7), ruptured membranes (min) mean (186) SD (471), length 2nd stage (min) mean (26) SD (55). Control group (conventional care) characteristics < 28 wks: birthweight (g) mean (742) SD (206), gestational age (wks) mean (25.7) SD (1.5), Apgar score @ 1 min mean (4.3) SD (2.1), Apgar score @ 5 min mean (7.1) SD (1.4), ruptured membranes (min) mean (10) SD (21), length 2nd stage (min) (18) SD (24). Intervention group (polyethylene wrap) characteristics ≥ 28 wks: birthweight (g) mean (1251) SD (282), gestational age (wk) mean (29.6) SD (1.1) Apgar score @ 1min mean (6.5) SD (1.8), Apgar score @ 5 min mean (8.5) SD (1.1), ruptured membranes (min) mean (105) SD (310), length 2nd stage (min) mean (15) SD (25).

Vohra 1999 (*Continued*)

	Control group (conventional care) characteristics ≥ 28 wks: birthweight (g) mean (1265) SD (206), gestational age (wks) mean (29.4) SD (1.5), Apgar score @ 1 min mean (6.0) SD (2.1), Apgar score @ 5 min mean (8.0) SD (1.4), ruptured membranes (min) mean (108) SD (21), length 2nd stage (min) (13) SD (24).
Interventions	POLYETHYLENE BAG - measured 20 cm x 50 cm and was manufactured by Eastern Paper, a Division of EPC Industries. Intervention group: A transparent polyethylene bag was opened at resuscitation under a radiant warmer and the infant was placed on it from the shoulders down. Only the head of the infant was dried; the body was wrapped without drying. Control group: Controls were managed with the protocol described by the Neonatal Resuscitation Program. Infants were routinely dried under the radiant warmer. Infants were transferred to the neonatal unit in an incubator.
Outcomes	Primary outcome: 1) core body temperature °C (rectal) was measured with a digital rectal thermometer on removal of the bag/wrap on admission to NICU. Secondary outcomes: 1) mortality 2) hyperthermia 3) infection 4) skin maceration 5) interference with resuscitation.
Notes	Forty-two infants who met the inclusion criteria were not enrolled in the study reasons were as follows: still birth (1), 34 wks gestational age (2), failure to reach delivery in time (8), failure of staff to pick up envelope on the way to the delivery room (31). The non-enrolled infants did not differ significantly from those in the study population.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Computer generated random sequence.
Allocation concealment?	Yes	Double-enclosed, opaque, sealed and sequentially numbered envelopes.
Blinding? All outcomes	No	Blinding of participants: no/unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: no, (59 of 62 infants randomised completed the study, one infant was excluded as no rectal temperature was recorded, two infants were excluded due to an imperforate anus.

Vohra 1999 (*Continued*)

Free of other bias?	No	There was some imbalance in birthweight between study groups. For infants < 28 completed weeks' gestational age birthweight was 914 g; SD 163 for the plastic wrap group and 742 g: SD 206 for the non wrap group.

Vohra 2004a

Methods	Randomised. Single centre. Blinding of randomisation: yes. Generation of allocation sequence: adequate, (computer generated random sequence balanced in blocks of 4 subjects). Concealment of allocation: adequate, (double enclosed, opaque, sealed and sequentially numbered envelopes). Blinding of intervention: participants: no/ unfeasible, care givers: no/unfeasible. Blinding of outcome measurement: no. Complete follow-up: no, (53 of 55 infants randomised completed the study, 2 infants died in the delivery room). Multiple eligible births were separately randomised. Institutional consent was given.
Participants	Infants delivered with a gestational age less than 28 completed weeks where the birth was attended by the neonatal team. 55 infants randomised: intervention group (n = 28), control group (n = 27), 53 completed study: intervention group (n = 26), control group (n = 27). Setting: Canada. Exclusion criteria: 1) neonatal team did not attend the delivery, 2) major congenital anomalies that were not covered by skin e.g. gastroschisis, meningomyelocele, 3) blistering skin conditions. Intervention group (polyethylene wrap) characteristics: female (14), birthweight (g) mean (858) SD (199), gestational age (wks) mean (26) SD (1.5). Control group (conventional care) characteristics: female (13), birthweight (g) mean (825) SD (270), gestational age (wks) mean (26) SD (1.4).
Interventions	POLYETHYLENE WRAP - measured 20 cm x 50 cm and was manufactured by Eastern Paper, a Division of EPC Industries LTD. Intervention group: Infant placed on polyethylene, wrapped from the neck down, only the head was dried, stabilised under radiant warmer. Control group: Control infants were dried completely according to the International Guidelines for Neonatal Resuscitation and stabilised under a radiant warmer. All infants were carried by one member of the neonatal team from the delivery suite to the neonatal unit and placed in a single walled incubator with 60 percent humidity.

Vohra 2004a (*Continued*)

Outcomes	Primary outcomes: 1) core body temperature °C (rectal) on admission to NICU following removal of wrap. Secondary outcomes: 1) core body temperature °C (rectal) taken one hour later. 2) mortality - death before discharge. Further secondary outcomes are reported for Apgar scores, blood gas pH, Bicarbonate (mmol/L), Glucose (mmol/L), hyperthermia and interference with resuscitation.
Notes	One hundred and seventeen infants were screened for the study. Twenty-one were excluded for the following reasons: neonatal team did not attend the delivery (13), parents refused to participate (5), and presence of congenital malformations (3). Baseline characteristics of excluded infants and their mothers were not different from those included in the study.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Computer generated random sequence balanced in blocks of four subjects.
Allocation concealment?	Yes	Double enclosed, opaque, sealed and sequentially numbered envelopes.
Blinding? All outcomes	No	Blinding of participants: no/ unfeasible. Blinding of care givers: no/unfeasible. Blinding of outcome measurement: no.
Incomplete outcome data addressed? All outcomes	Yes	Complete follow-up: no, (53 of 55 infants randomised completed the study, two infants died in the delivery room).
Free of other bias?	Yes	

Characteristics of excluded studies *[ordered by study ID]*

Ammari 2009	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Anderson 2003	No thermal outcome measures were reported.
Andrade 2005	No thermal outcome measures were reported. Query re: randomisation.
Baum 1968	Participants had a birthweight greater ≥ 6 lb.
Bell 1983	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.

(*Continued*)

Bergstrom 2005	Participants were normal infants, mean gestational age at delivery : 38 wks (Intervention group), 38.4 wks control group. Intervention not strictly for the prevention of hypothermia immediately at birth.
Besch 1971	Participants had a birthweight > 2000 g.
Bier 1996	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Boo 2007	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were normal term infants undergoing phototherapy.
Brice 1981	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Bystrova 2003	Participants had a birthweight > 2500 g.
Bystrova 2007	Participants were term.
Carfoot 2005	Participants were term.
Cattaneo 1998	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Chaput 1979	Participants had a birthweight > 2000 g.
Charpak 1997	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. No thermal outcome measures were reported.
Cheah 2000	Participants were term.
Christensson 1992	Participants were term.
Christensson 1995	Participants were term.
Christensson 1996	Participants were term delivered by caesarean section.
Christensson 1998	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Chwo 1999	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite but on the day following birth.
Chwo 2002	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite but on the day following birth.
Coles 1979	Participants were term.
Dahm 1972	Participants were term.
Daniel 2004	Unable to obtain a copy of the abstract.

(*Continued*)

Dannaway 2009	This study compared two interventions applied after delivery: warming mattress (sodium acetate warming blanket) to polyethylene wrap. This comparison is not within the scope of this review.
Darmstadt 2007	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Darmstadt 2008	Primary outcome measure was rate of nosocomial infection. Hypothermia was reported as a morbidity among neonates who died.
Day 1964	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Dodd 2003	No thermal outcome measures were reported.
Erlandsson 2007	Participants were term delivered by caesarean section. No thermal outcome measures were reported.
Fallis 2006	Participants were term. Intervention was maternal warming during caesarean section.
Fardig 1980	Participants were term.
Ferber 2004	Participants were term. Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. No thermal outcome measures were reported.
Gray 2004	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were at least 3 days old.
Green-Abate 1994	Intervention was not applied immediately at birth (within 10 mins) in delivery suite. Participants were less than 1 week old.
Greer 1988	Participants were term and had a birthweight > 2500 g.
Grover 1994	Participants were term and the intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were aged 11 to 95 days.
Gulezian 1980	Insufficient information - unable to obtain a copy of the abstract.
Harrison 2004	Insufficient information - unable to obtain a copy of the abstract.
Hellin Martinez 2000	Participants were term.
Hobbs 1975	Participants were term.
Holzman 1985	Participants were term.
Horn 2002	Query if participants were term as infants were delivered by elective caesarean section. The author was contacted for verification. Intervention was active warming during caesarean section.
Huang 2002	Participants had a birthweight ≥ 2500 g.

(*Continued*)

Huang 2006	Participants were term. Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Johanson 1992	Participants were term with a mean gestational age 39.1 weeks. Randomised controlled intervention study compared to a prospective observational study.
Kadam 2005	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. (Verified by author).
Kaushal 2005	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Kumar 2008	This cluster-randomised controlled efficacy trial looked at three community-based interventions which are outside the scope of this review.
Legault 1993	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were aged 1 week or more.
Ludington-Hoe 1994	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants in intervention group averaged 18 days old and control participants averaged 13 days old.
Ludington-Hoe 2000	Participants had a postnatal age of 6 to 53 days on enrolment to the study therefore the intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Ludington-Hoe 2004	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Marks 1985	Participants had a gestational age of 36 plus or minus one week. Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were aged 14 to 68 days.
Mathew 2008	This study compared vinyl bag (Vi-Drape) to thermal mattress (Transwarmer). Both groups underwent drying of the head and placement of a stocking cap. This comparison is not within the scope of this review.
Mazurek 1999	Participants were term.
Medves 2004	Participants were term.
Meyer 2001	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Intervention applied on arrival at NICU.
Meyer 2007	This study compared plastic wrap plus radiant warmer to plastic wrap plus incubator for transport to NICU. All infants were wrapped under a radiant warmer at birth but it is unlikely that assignment to incubator or radiant warmer took place within 10 minutes of birth for all infants. This comparison is not within the scope of this review.
Miles 2006	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. No thermal outcome measures were reported.

(*Continued*)

Monterosso 1999	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were at least one week of age at time of study.
Moore 2007	Participants were term. No thermal outcome measures were reported.
Nopper 1996	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants enrolled within the first 96 hours after birth.
Nuntnarumit 2004	This study compared plastic wrap and plastic bag to plastic wrap only. Plastic wrap only was not considered to be 'routine care' as pre-specified in the review inclusion criteria.
Omene 1978	Participants were term.
Pattinson 2005	Intervention was an educational package (with/without facilitation visits) on the implementation of kangaroo mother care.
Punthmatharith 2001	Thermal outcome measures were not reported.
Raman 1992	Participants were term.
Ramanathan 2001	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Thermal outcome measures were not reported.
Rao 2008	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Roberts 2000	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were born at 30 or more weeks' gestation or corrected age.
Rojas 2001	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Thermal outcome measures were not reported.
Ruiz 1998	Intervention not applied immediately at birth (within 10 mins) in the delivery suite. Thermal outcome measures were not reported.
Sankaranarayanan2005	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Sarman 1989	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Sarman 1992	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants were 3 to 32 days of age during the study.
Short 1998	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Participants day of life 32.9 plus or minus 15.9 days.
Sloan 1994	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. No thermal outcome measures were reported.

(*Continued*)

Syfrett 1993	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Trevisanuto 2009a	Participants were mainly term infants delivered by caesarean section. Primary outcome measure was the time elapsed from the cord clamping to the positioning of the infant under the radiant warmer for infants managed with the 'cicogna' system and those who received standard care.
Tsogt 2005	Participants were term. Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Vaidya 2005	Participants were term. Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. No thermal outcomes were measured.
van den Bosch 1990	Participants were term.
van den Bosch 1996	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite. Intervention applied after 48 hours in the NICU.
Villalon 1992	Participants were full term.
Worku 2005	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Yeh 1980	Intervention was not applied immediately at birth (within 10 mins) in the delivery suite.
Yokoyama 2009	Participants were term infants delivered by elective cesarean section.

Characteristics of studies awaiting assessment *[ordered by study ID]*

Punnahitananda 2008

Methods	Randomised. Single centre. Blinding of randomisation: need further information. Generation of allocation sequence: need further information. Allocation concealment: need further information. Blinding of intervention: need further information. Blinding of outcome measurement: need further information. Complete follow-up: no, 130 infants randomised, 122 completed the study, need further information.
Participants	Inborn infants of 34 weeks' gestation or less. 130 infants randomised, 122 completed the study: intervention group (n = 61), control group (n = 61). Setting: Thailand. Exclusion criteria: need further information. Infant characteristics: need further information.
Interventions	POLYETHYLENE PLASTIC WRAP/BAG. Intervention group: Infants were placed in polyethylene plastic bags immediately after birth in delivery room, leaving only the head

	uncovered and were kept in plastic bags for three hours. Any resuscitation treatment was carried out with the bags covering the bodies. Control group: Infants were dried and resuscitated per standard protocol before transferred to nursery. All infants were stabilised under radiant warmers.
Outcomes	Primary outcomes: 1) core body temperature degrees centigrade (rectal) on admission to the nursery and hourly there after for three hours using a digital thermometer. 2) hypothermia on admission to the nursery and during the three hour study period (definition of hypothermia not given).
Notes	Unable to contact author. Further information required for: definition of hypothermia and incidence, data for rectal temperature on admission to nursery for infants of 31-34 weeks' gestation and information regarding the methodological quality.

Characteristics of ongoing studies *[ordered by study ID]*

Vohra 2004

Trial name or title	Multicentred randomised controlled trial of heat loss prevention (HeLP) in the delivery room.
Methods	The randomised controlled trial (RCT) is a two-intervention, parallel design with a 24 month accrual period. Preterm infants meeting the eligibility criteria will be randomly assigned within three gestational age strata (less than 24 weeks, 24+0 to 25+6 weeks gestation, and 26+0 to 27+6 weeks gestation) to either the occlusive skin wrap group or the standard of care (non-wrap) group.
Participants	Infants less than 28 weeks' gestation.
Interventions	Polyethylene occlusive skin wrap applied immediately following birth in the delivery suite.
Outcomes	Mortality, axillary temperature, rectal temperature (in some) and clinically important variables including: APGAR scores, incidence of acidosis, hypotension, hypoglycaemia, seizures, patent ductus arterious, respiratory distress syndrome/chronic lung disease, necrotizing enterocolitis, intraventricular haemorrhage. Also length of stay and cause of death.
Starting date	Infant enrolments began in December 2004.
Contact information	Sunita Vohra MD FRCPC MSc Director CARE Program for Integrative Health and Healing Director PedCAM Research and Education Network Professor, Department of Pediatrics, Faculty of Medicine and School of Public Health University of Alberta, Edmonton AB, Canada. Email: svohra@ualberta.ca
Notes	This multicentre trial will involve 40 centres, Canada, US and UK, all part of the Vermont-Oxford Network. This study has received funding from the Canadian Institute of Health Research (CIHR).Forty-five centers

Vohra 2004 (*Continued*)

	are currently involved in this study.

DATA AND ANALYSES

Comparison 1. Plastic wrap versus routine care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth	4	264	Mean Difference (IV, Fixed, 95% CI)	0.57 [0.37, 0.77]
1.1 < 28 completed weeks' gestational age	4	223	Mean Difference (IV, Fixed, 95% CI)	0.68 [0.45, 0.91]
1.2 28 to 31 completed weeks' gestational age	1	41	Mean Difference (IV, Fixed, 95% CI)	0.17 [-0.27, 0.61]
2 Core body temperature (°C) 1 hour after the initial admission temperature to the NICU was taken	2	117	Mean Difference (IV, Fixed, 95% CI)	0.40 [0.16, 0.65]
2.1 < 28 completed weeks' gestational age	2	117	Mean Difference (IV, Fixed, 95% CI)	0.40 [0.16, 0.65]
3 Hypothermia on admission to NICU: core body temperature < 36.5°C or skin temperature < 36°C	2	152	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.51, 0.84]
3.1 < 28 completed weeks' gestational age	2	152	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.51, 0.84]
4 Death within hospital stay	4	266	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.35, 1.24]
4.1 < 28 completed weeks' gestational age	4	225	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.35, 1.24]
4.2 28 to 31 completed weeks' gestational age	1	41	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
5 Major brain injury	2	152	Risk Ratio (M-H, Fixed, 95% CI)	1.10 [0.41, 2.98]
5.1 < 28 completed weeks' gestational age	2	152	Risk Ratio (M-H, Fixed, 95% CI)	1.10 [0.41, 2.98]
6 Duration of oxygen therapy (days)	1	88	Mean Difference (IV, Fixed, 95% CI)	-6.51 [-23.30, 10.28]
6.1 < 28 completed weeks' gestational age	1	88	Mean Difference (IV, Fixed, 95% CI)	-6.51 [-23.30, 10.28]
7 Duration of hospitalisation (days)	1	88	Mean Difference (IV, Fixed, 95% CI)	-5.49 [-19.93, 8.95]
7.1 < 28 completed weeks' gestational age	1	88	Mean Difference (IV, Fixed, 95% CI)	-5.49 [-19.93, 8.95]
8 Apgar at 1 minute			Other data	No numeric data
8.1 < 28 completed weeks' gestational age			Other data	No numeric data
9 Apgar at 1 minute	1	64	Mean Difference (IV, Fixed, 95% CI)	0.20 [-0.83, 1.23]
9.1 < 28 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.20 [-0.83, 1.23]
10 Apgar at 5 minutes			Other data	No numeric data

10.1 < 28 completed weeks' gestational age			Other data	No numeric data
11 Apgar at 5 minutes	1	64	Mean Difference (IV, Fixed, 95% CI)	0.40 [-0.19, 0.99]
11.1 < 28 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.40 [-0.19, 0.99]
12 First blood gas pH	2	117	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.02, 0.04]
12.1 < 28 completed weeks' gestational age	2	117	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.02, 0.04]
13 Bicarbonate (mmol/L)	2	117	Mean Difference (IV, Fixed, 95% CI)	0.31 [-0.72, 1.35]
13.1 < 28 completed weeks' gestational age	2	117	Mean Difference (IV, Fixed, 95% CI)	0.31 [-0.72, 1.35]
14 First serum glucose concentration (mmol/L)	2	117	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.36, 0.39]
14.1 < 28 completed weeks' gestational age	2	117	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.36, 0.39]
15 Intubation in delivery room	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.63, 1.58]
15.1 < 28 completed weeks' gestational age	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.63, 1.58]
16 Hyperthermia on admission to NICU: core body temperature > 37.5°C	1	53	Risk Ratio (M-H, Fixed, 95% CI)	4.82 [0.24, 95.88]
16.1 < 28 completed weeks' gestational age	1	53	Risk Ratio (M-H, Fixed, 95% CI)	4.82 [0.24, 95.88]

Comparison 2. Plastic cap versus routine care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [0.41, 1.19]
1.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [0.41, 1.19]
2 Core body temperature (°C) 1 hour after the initial admission temperature to the NICU was taken	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [0.46, 1.14]
2.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [0.46, 1.14]
3 Hypothermia on admission to NICU: core body temperature < 36.4 °C	1	64	Risk Ratio (M-H, Fixed, 95% CI)	0.48 [0.32, 0.73]
3.1 < 29 completed weeks' gestational age	1	64	Risk Ratio (M-H, Fixed, 95% CI)	0.48 [0.32, 0.73]
4 Death within hospital stay	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.5 [0.27, 8.38]
4.1 < 29 completed weeks' gestational age	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.5 [0.27, 8.38]
5 Major brain injury	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.5 [0.27, 8.38]

5.1 < 29 completed weeks' gestational age	1	64	Risk Ratio (M-H, Fixed, 95% CI)	1.5 [0.27, 8.38]
6 Apgar score at 1 minute	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [-0.21, 1.81]
6.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.80 [-0.21, 1.81]
7 Apgar score at 5 minutes	1	64	Mean Difference (IV, Fixed, 95% CI)	0.70 [0.08, 1.32]
7.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.70 [0.08, 1.32]
8 First blood gas pH	1	64	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.03, 0.05]
8.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.03, 0.05]
9 Bicarbonate (mmol/L)	1	64	Mean Difference (IV, Fixed, 95% CI)	1.0 [-0.25, 2.25]
9.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	1.0 [-0.25, 2.25]
10 First serum glucose concentration (mmol/L)	1	64	Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.42, 0.62]
10.1 < 29 completed weeks' gestational age	1	64	Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.42, 0.62]
11 Intubation in delivery room	1	64	Risk Ratio (M-H, Fixed, 95% CI)	0.82 [0.49, 1.37]
11.1 < 28 completed weeks' gestational age	1	64	Risk Ratio (M-H, Fixed, 95% CI)	0.82 [0.49, 1.37]

Comparison 3. Stockinet cap versus routine care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth	1	40	Mean Difference (IV, Fixed, 95% CI)	0.15 [-0.18, 0.48]
1.1 < 2000 g birthweight	1	10	Mean Difference (IV, Fixed, 95% CI)	0.70 [-0.01, 1.41]
1.2 > or = 2000 g birthweight	1	30	Mean Difference (IV, Fixed, 95% CI)	Not estimable
2 Hypothermia on admission to NICU: core body temperature < 36.5°C or skin temperature < 36°C	1	40	Risk Ratio (M-H, Fixed, 95% CI)	0.90 [0.48, 1.71]
2.1 32 to 36 completed weeks' gestational age	1	40	Risk Ratio (M-H, Fixed, 95% CI)	0.90 [0.48, 1.71]

Comparison 4. Skin-to-skin care versus routine care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hypothermia: skin temperature < 35.5°C for 2 consecutive recordings	1	31	Risk Ratio (M-H, Fixed, 95% CI)	0.09 [0.01, 0.64]
1.1 1200 g to 2199 g birthweight	1	31	Risk Ratio (M-H, Fixed, 95% CI)	0.09 [0.01, 0.64]
2 Hypoglycaemia: blood glucose level < 2.6 mmol/L	1	31	Risk Ratio (M-H, Fixed, 95% CI)	0.24 [0.03, 2.06]
2.1 1200 g to 2199 g birthweight	1	31	Risk Ratio (M-H, Fixed, 95% CI)	0.24 [0.03, 2.06]

Comparison 5. Transwarmer mattress versus routine care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth	1	24	Mean Difference (IV, Fixed, 95% CI)	1.60 [0.83, 2.37]
1.1 < or = 1500 g birthweight	1	24	Mean Difference (IV, Fixed, 95% CI)	1.60 [0.83, 2.37]
2 Hypothermia on admission to NICU: core body temperature < 36.5 °C or skin temperature < 36°C	1	24	Risk Ratio (M-H, Fixed, 95% CI)	0.3 [0.11, 0.83]
2.1 < or = 1500 g birthweight	1	24	Risk Ratio (M-H, Fixed, 95% CI)	0.3 [0.11, 0.83]

Analysis 1.1. Comparison 1 Plastic wrap versus routine care, Outcome 1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 1 Core body temperature (C) on admission to NICU or up to 2 hours after birth

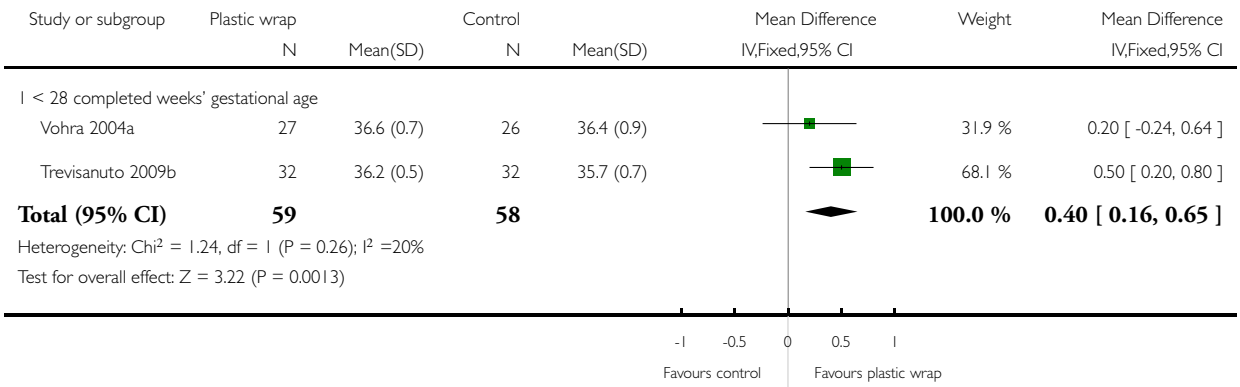
Study or subgroup	Plastic wrap N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 < 28 completed weeks' gestational age							
Vohra 1999	8	36.94 (0.56)	10	35.04 (1.08)		6.8 %	1.90 [1.13, 2.67]
Vohra 2004a	27	36.5 (0.8)	26	35.6 (1.3)		11.9 %	0.90 [0.32, 1.48]
Knobel 2005	41	36.5 (0.79)	47	36 (0.79)		37.0 %	0.50 [0.17, 0.83]
Trevisanuto 2009b	32	35.8 (0.9)	32	35.3 (0.8)		23.3 %	0.50 [0.08, 0.92]
Subtotal (95% CI)	**108**		**115**			**79.0 %**	**0.68 [0.45, 0.91]**
Heterogeneity: Chi^2 = 11.95, df = 3 (P = 0.01); I^2 =75%							
Test for overall effect: Z = 5.89 (P < 0.00001)							
2 28 to 31 completed weeks' gestational age							
Vohra 1999	19	36.69 (0.55)	22	36.52 (0.87)		21.0 %	0.17 [-0.27, 0.61]
Subtotal (95% CI)	**19**		**22**			**21.0 %**	**0.17 [-0.27, 0.61]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.76 (P = 0.45)							
Total (95% CI)	**127**		**137**			**100.0 %**	**0.57 [0.37, 0.77]**
Heterogeneity: Chi^2 = 16.04, df = 4 (P = 0.003); I^2 =75%							
Test for overall effect: Z = 5.58 (P < 0.00001)							
Test for subgroup differences: Chi^2 = 4.09, df = 1 (P = 0.04), I^2 =76%							

Analysis 1.2. Comparison 1 Plastic wrap versus routine care, Outcome 2 Core body temperature (°C) 1 hour after the initial admission temperature to the NICU was taken.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 2 Core body temperature (C) 1 hour after the initial admission temperature to the NICU was taken

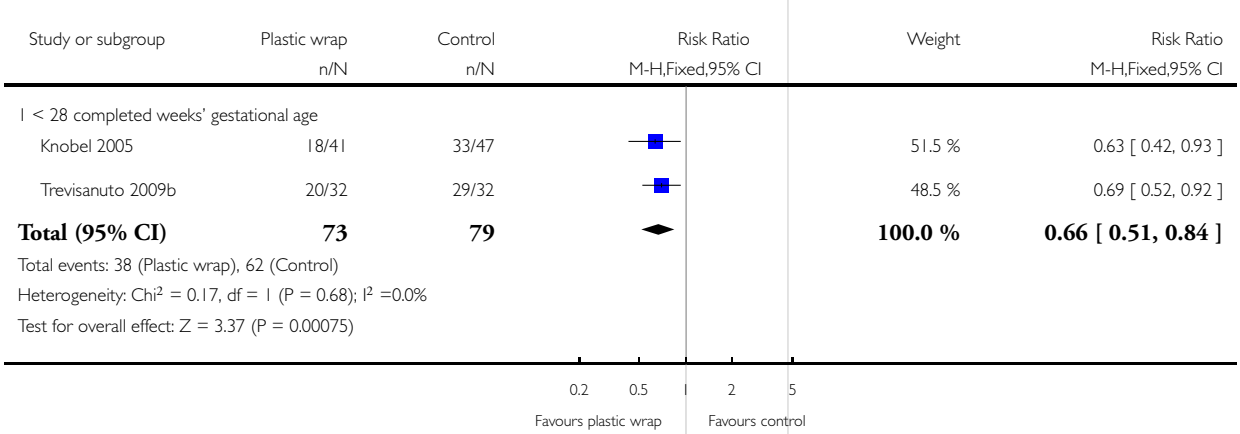


Analysis 1.3. Comparison 1 Plastic wrap versus routine care, Outcome 3 Hypothermia on admission to NICU: core body temperature < 36.5°C or skin temperature < 36°C.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 3 Hypothermia on admission to NICU: core body temperature < 36.5C or skin temperature < 36C

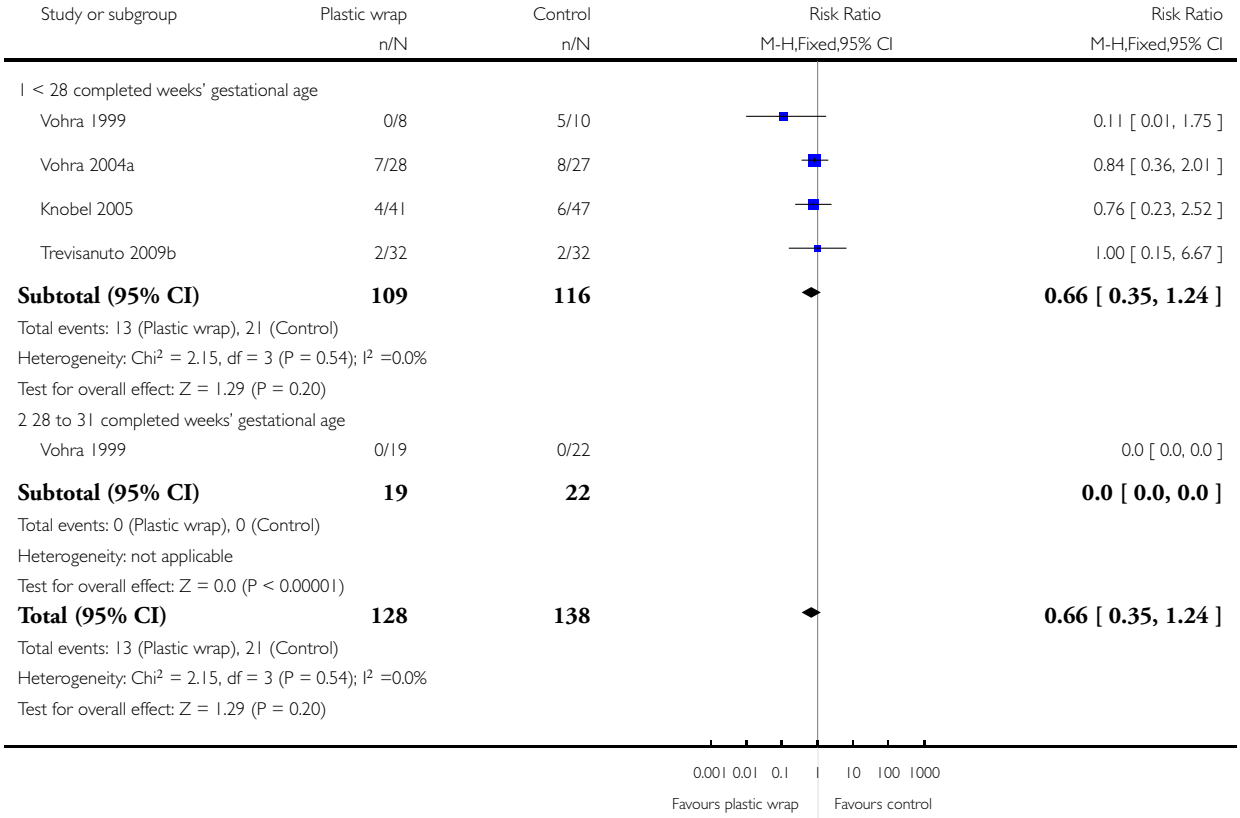


Analysis 1.4. Comparison 1 Plastic wrap versus routine care, Outcome 4 Death within hospital stay.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 4 Death within hospital stay

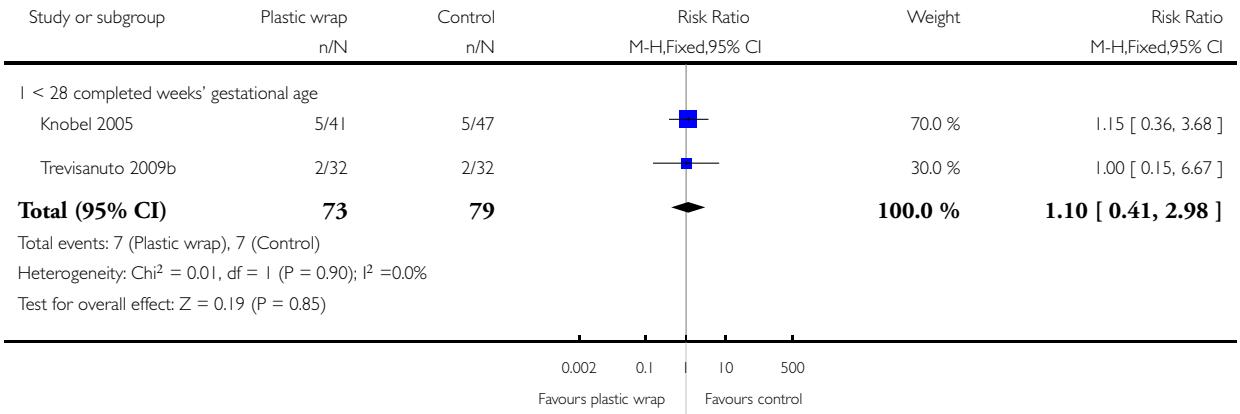


Analysis 1.5. Comparison 1 Plastic wrap versus routine care, Outcome 5 Major brain injury.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 5 Major brain injury

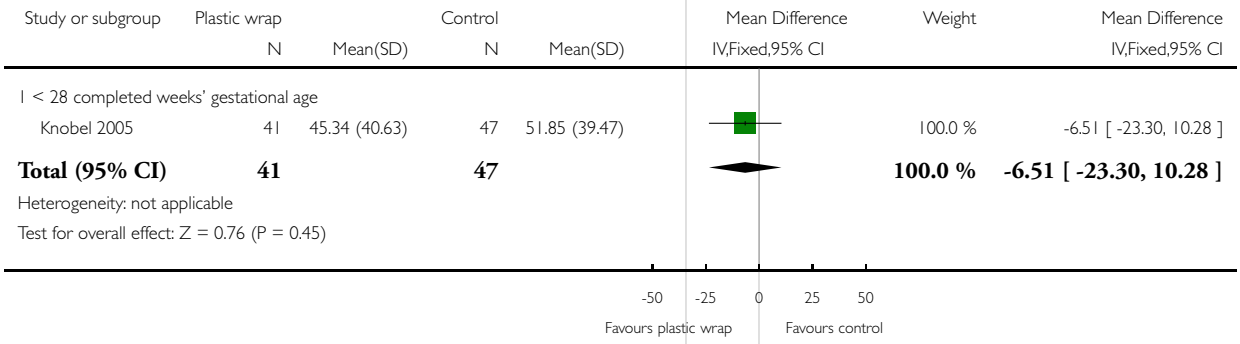


Analysis 1.6. Comparison 1 Plastic wrap versus routine care, Outcome 6 Duration of oxygen therapy (days).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 6 Duration of oxygen therapy (days)

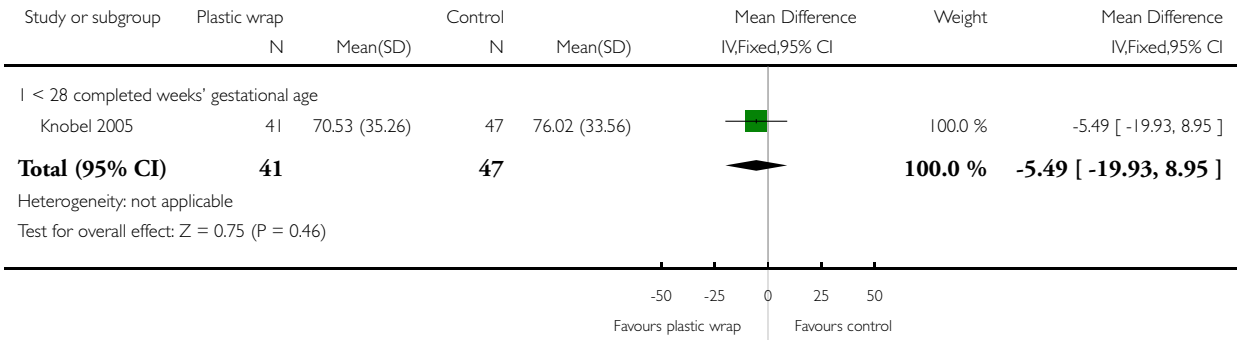


Analysis 1.7. Comparison 1 Plastic wrap versus routine care, Outcome 7 Duration of hospitalisation (days).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 7 Duration of hospitalisation (days)



Analysis 1.8. Comparison 1 Plastic wrap versus routine care, Outcome 8 Apgar at 1 minute.

Apgar at 1 minute

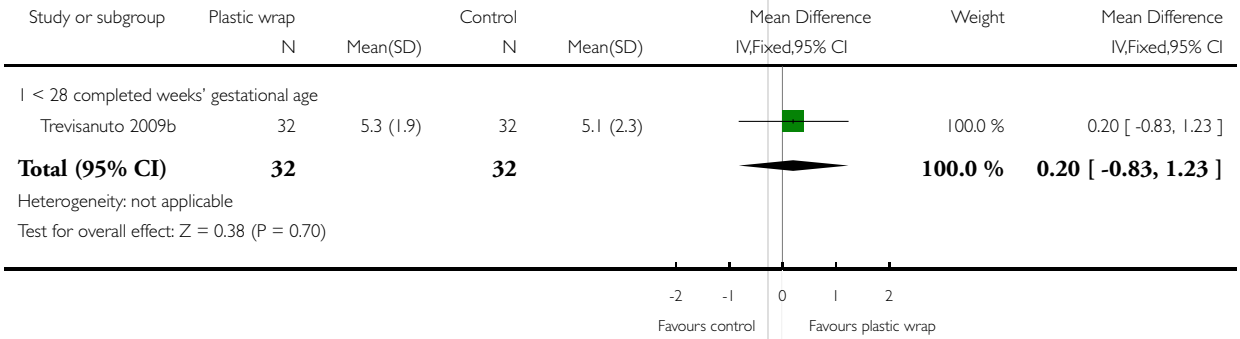
< 28 completed weeks' gestational age					
Vohra 2004a	Intervention	27	6	2 - 6	0.6
Vohra 2004a	Control	26	6	3 - 6	

Analysis 1.9. Comparison 1 Plastic wrap versus routine care, Outcome 9 Apgar at 1 minute.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 9 Apgar at 1 minute



Analysis 1.10. Comparison 1 Plastic wrap versus routine care, Outcome 10 Apgar at 5 minutes.

Apgar at 5 minutes

< 28 completed weeks' gestational age					
Vohra 2004a	Intervention	27	7	6 - 8	0.9
Vohra 2004a	Control	26	7	7 - 8	0.9

Analysis 1.11. Comparison 1 Plastic wrap versus routine care, Outcome 11 Apgar at 5 minutes.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 11 Apgar at 5 minutes

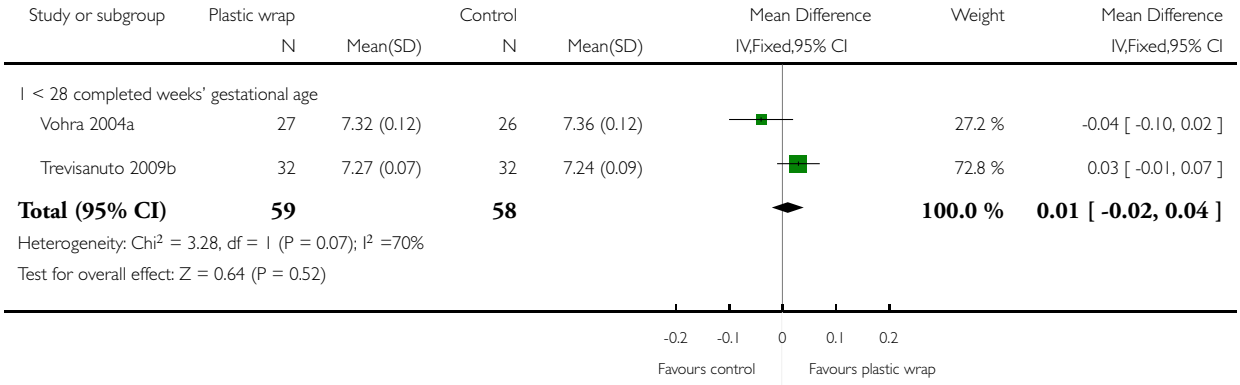
Study or subgroup	Plastic wrap N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 < 28 completed weeks' gestational age							
Trevisanuto 2009b	32	7.8 (0.8)	32	7.4 (1.5)		100.0 %	0.40 [-0.19, 0.99]
Total (95% CI)	**32**		**32**			**100.0 %**	**0.40 [-0.19, 0.99]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.33 (P = 0.18)							

Analysis 1.12. Comparison 1 Plastic wrap versus routine care, Outcome 12 First blood gas pH.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 12 First blood gas pH

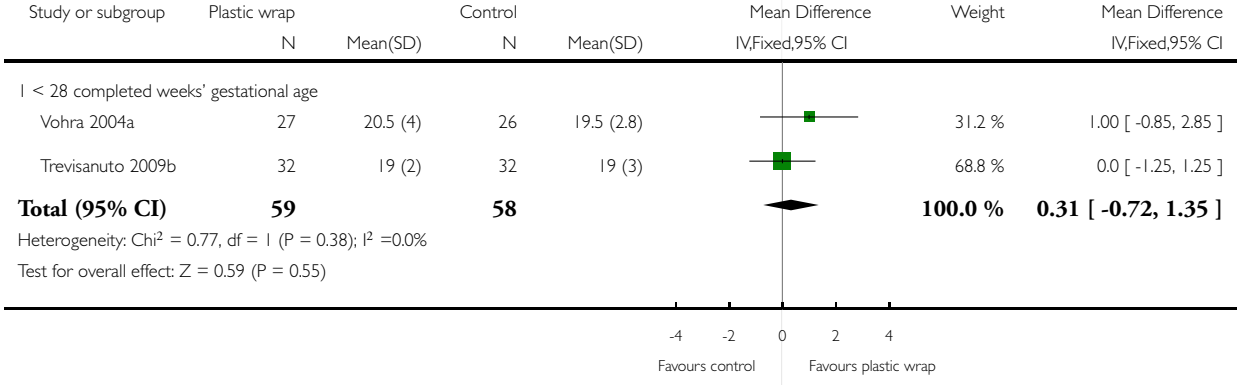


Analysis 1.13. Comparison 1 Plastic wrap versus routine care, Outcome 13 Bicarbonate (mmol/L).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 13 Bicarbonate (mmol/L)

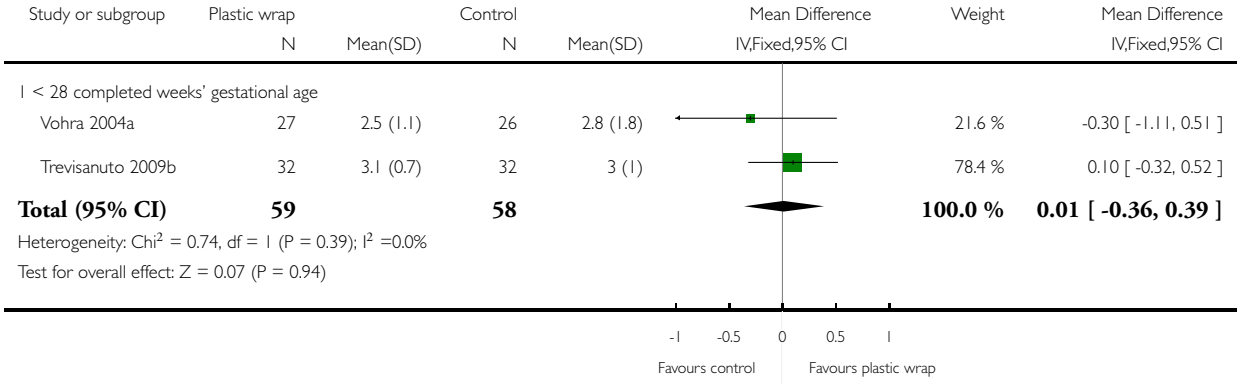


Analysis 1.14. Comparison 1 Plastic wrap versus routine care, Outcome 14 First serum glucose concentration (mmol/L).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 14 First serum glucose concentration (mmol/L)

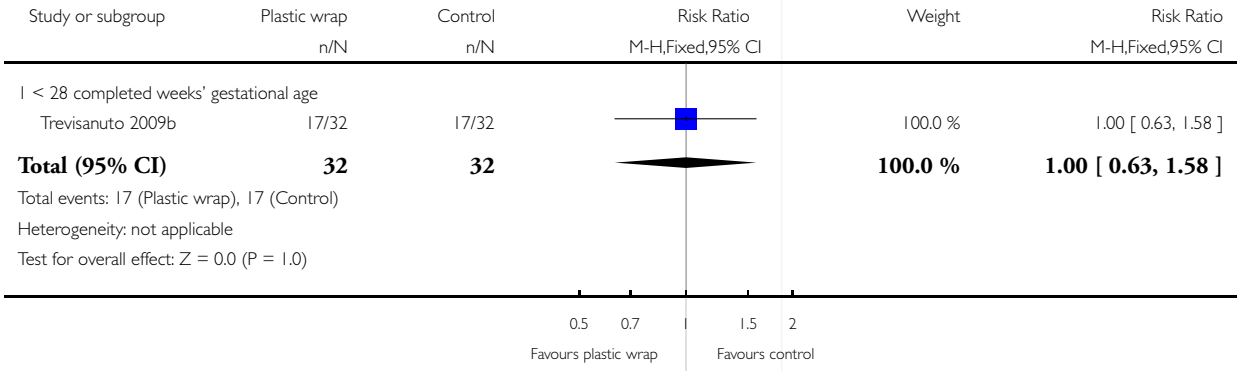


Analysis 1.15. Comparison 1 Plastic wrap versus routine care, Outcome 15 Intubation in delivery room.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 15 Intubation in delivery room

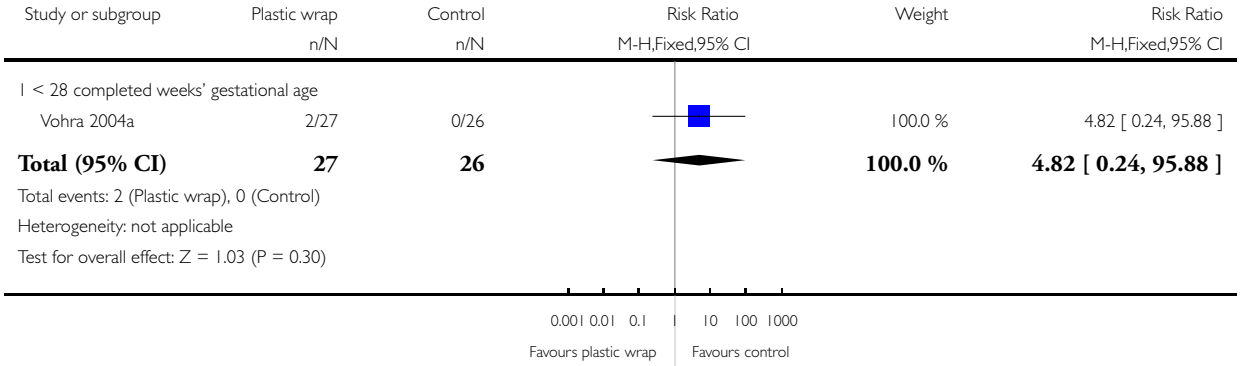


Analysis 1.16. Comparison 1 Plastic wrap versus routine care, Outcome 16 Hyperthermia on admission to NICU: core body temperature > 37.5°C.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 1 Plastic wrap versus routine care

Outcome: 16 Hyperthermia on admission to NICU: core body temperature > 37.5C

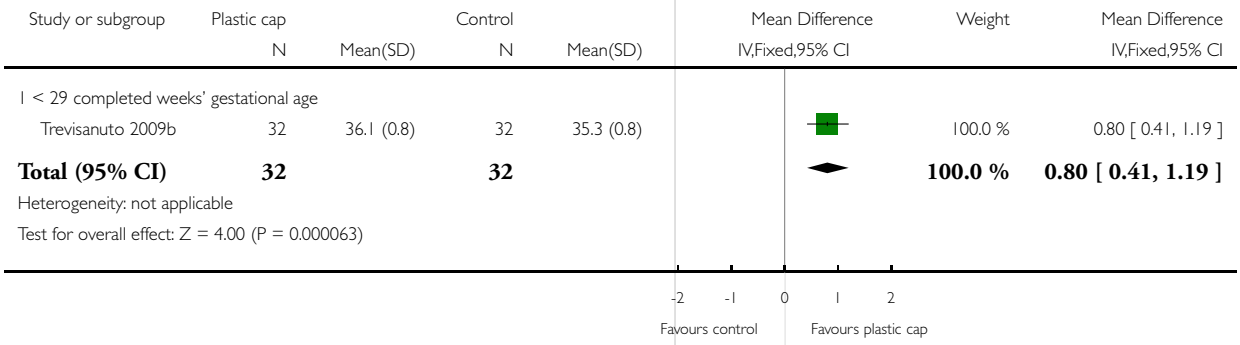


Analysis 2.1. Comparison 2 Plastic cap versus routine care, Outcome 1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 1 Core body temperature (C) on admission to NICU or up to 2 hours after birth

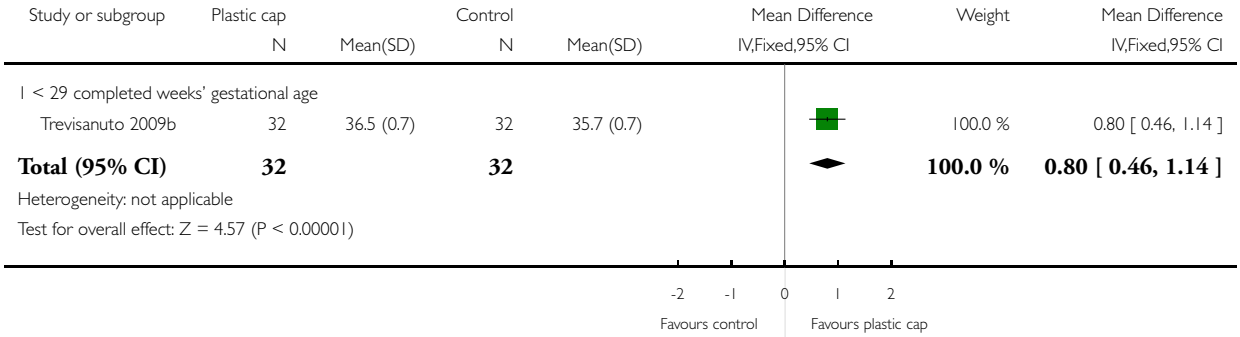


Analysis 2.2. Comparison 2 Plastic cap versus routine care, Outcome 2 Core body temperature (°C) 1 hour after the initial admission temperature to the NICU was taken.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 2 Core body temperature (C) 1 hour after the initial admission temperature to the NICU was taken

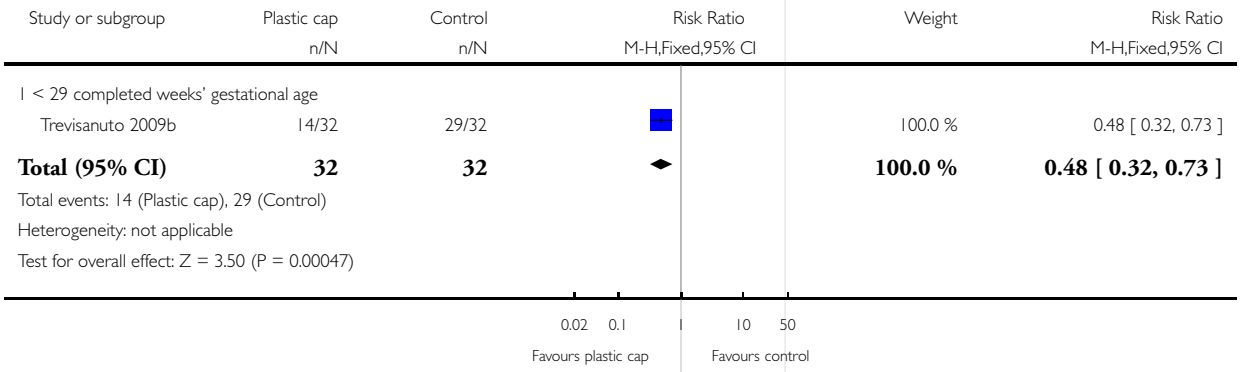


Analysis 2.3. Comparison 2 Plastic cap versus routine care, Outcome 3 Hypothermia on admission to NICU: core body temperature < 36.4 °C.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 3 Hypothermia on admission to NICU: core body temperature < 36.4 C

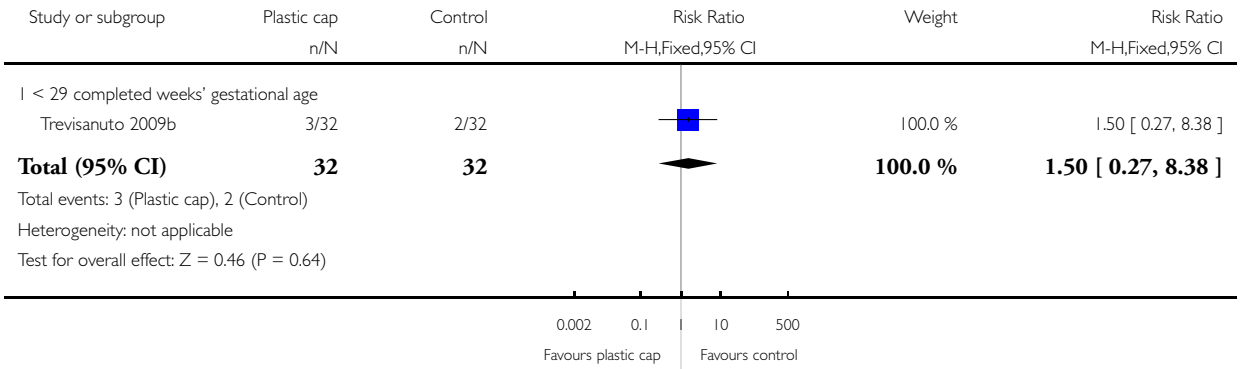


Analysis 2.4. Comparison 2 Plastic cap versus routine care, Outcome 4 Death within hospital stay.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 4 Death within hospital stay

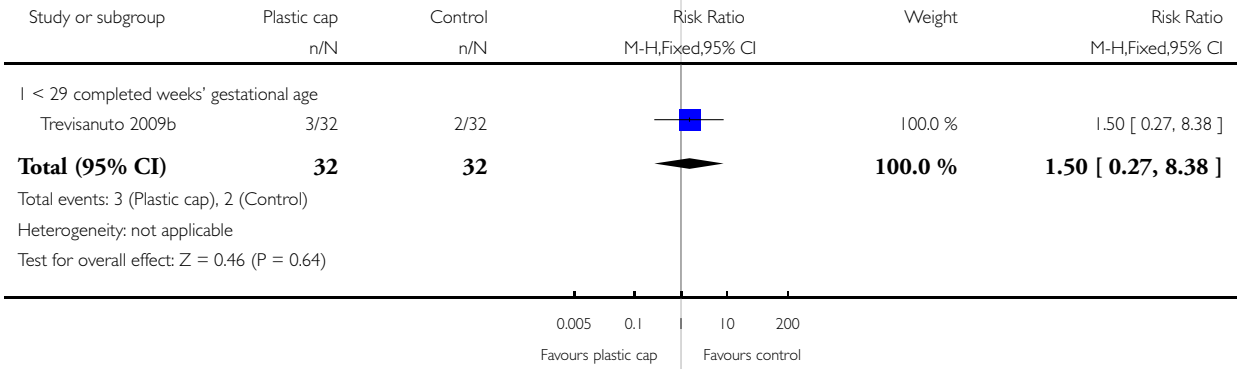


Analysis 2.5. Comparison 2 Plastic cap versus routine care, Outcome 5 Major brain injury.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 5 Major brain injury

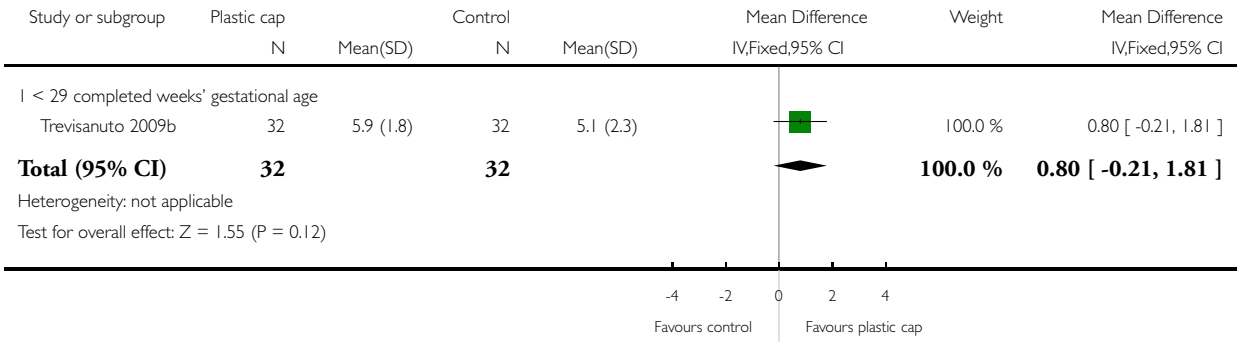


Analysis 2.6. Comparison 2 Plastic cap versus routine care, Outcome 6 Apgar score at 1 minute.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 6 Apgar score at 1 minute

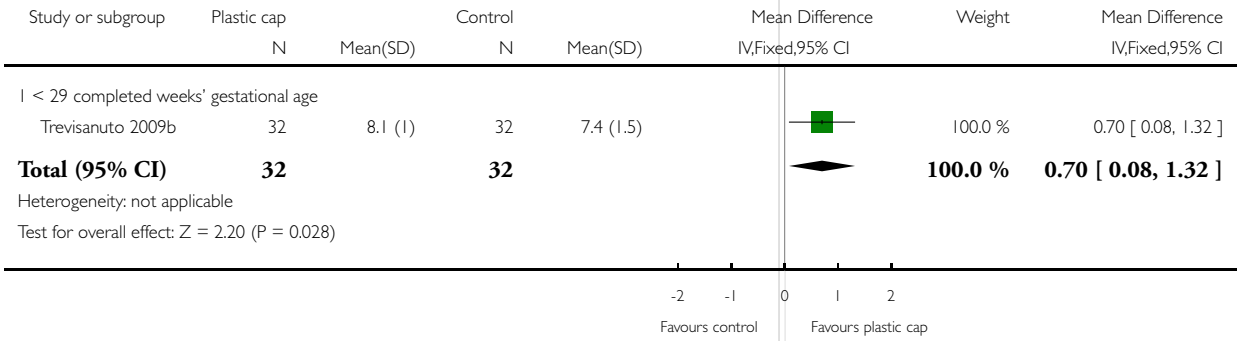


Analysis 2.7. Comparison 2 Plastic cap versus routine care, Outcome 7 Apgar score at 5 minutes.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 7 Apgar score at 5 minutes

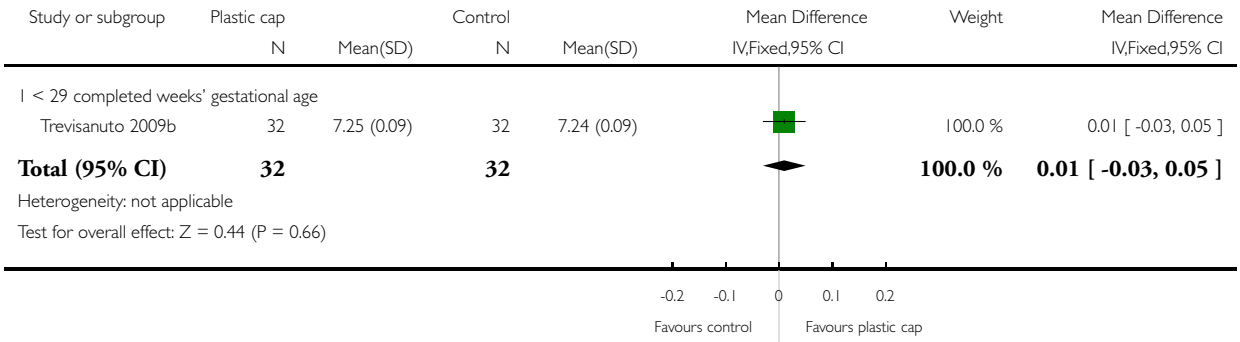


Analysis 2.8. Comparison 2 Plastic cap versus routine care, Outcome 8 First blood gas pH.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 8 First blood gas pH

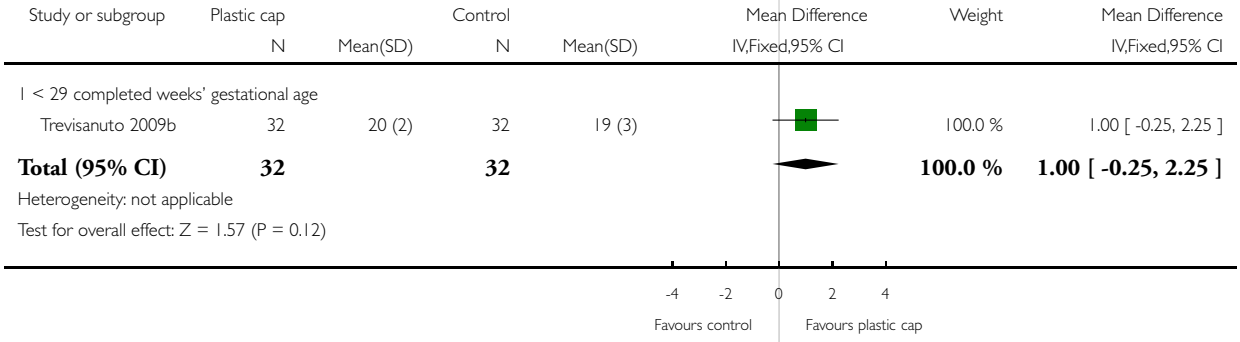


Analysis 2.9. Comparison 2 Plastic cap versus routine care, Outcome 9 Bicarbonate (mmol/L).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 9 Bicarbonate (mmol/L)

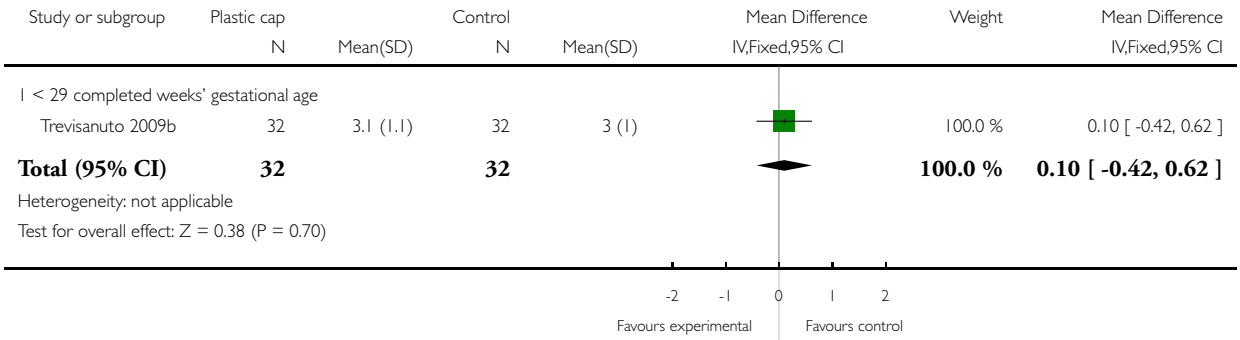


Analysis 2.10. Comparison 2 Plastic cap versus routine care, Outcome 10 First serum glucose concentration (mmol/L).

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 10 First serum glucose concentration (mmol/L)

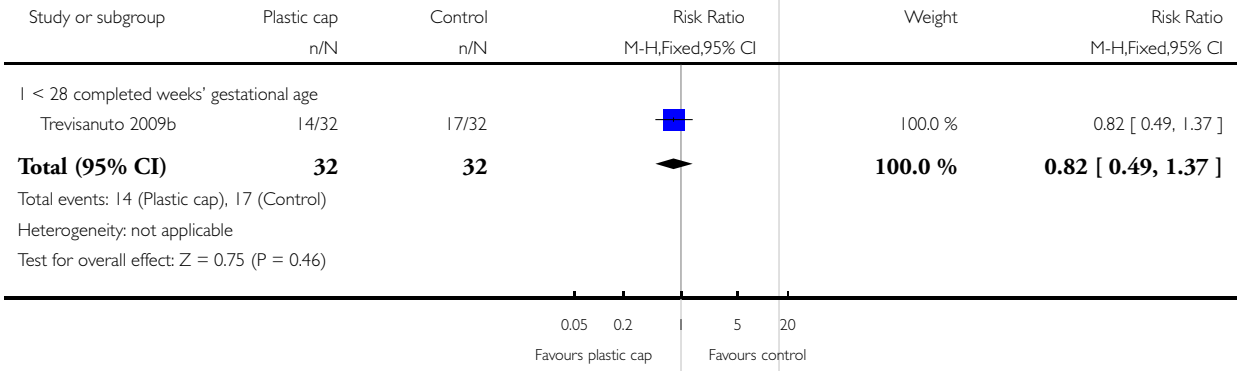


Analysis 2.11. Comparison 2 Plastic cap versus routine care, Outcome 11 Intubation in delivery room.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 2 Plastic cap versus routine care

Outcome: 11 Intubation in delivery room

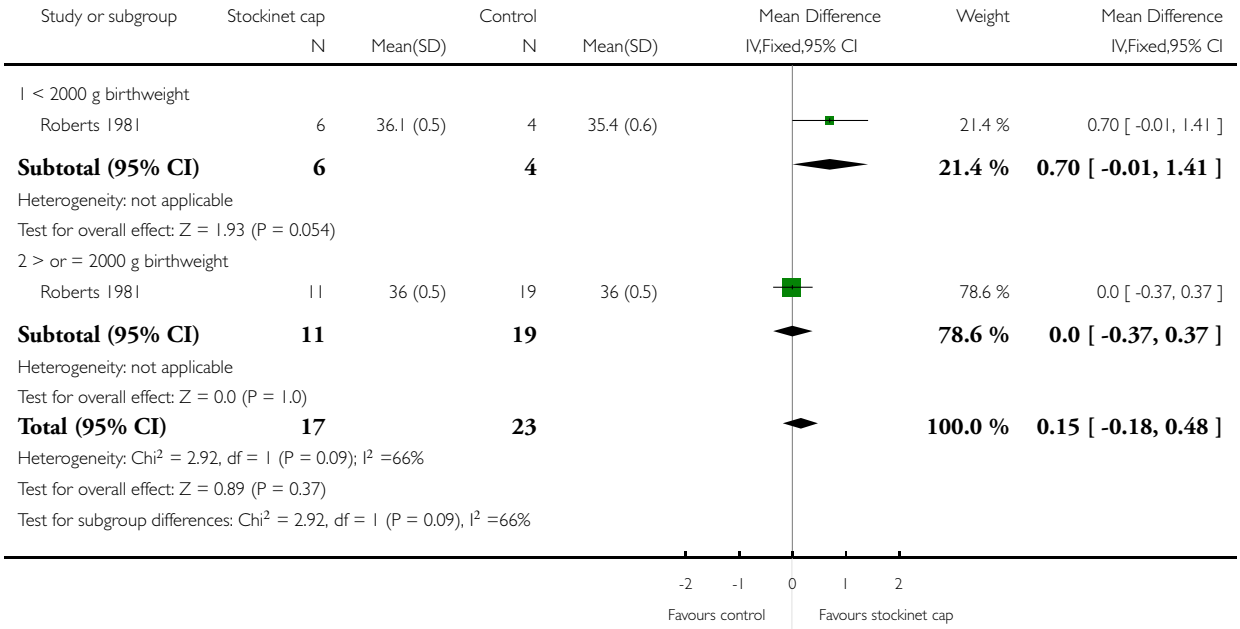


Analysis 3.1. Comparison 3 Stockinet cap versus routine care, Outcome 1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 3 Stockinet cap versus routine care

Outcome: 1 Core body temperature (C) on admission to NICU or up to 2 hours after birth

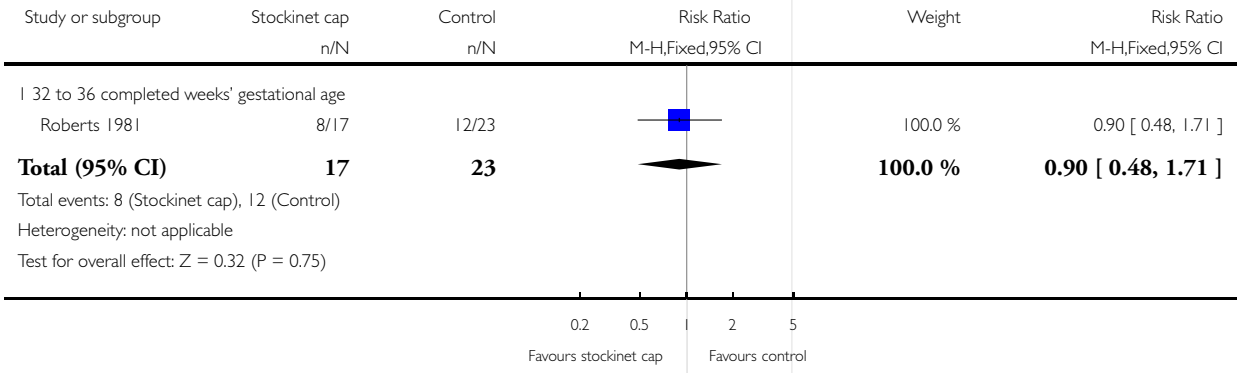


Analysis 3.2. Comparison 3 Stockinet cap versus routine care, Outcome 2 Hypothermia on admission to NICU: core body temperature < 36.5°C or skin temperature < 36°C.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 3 Stockinet cap versus routine care

Outcome: 2 Hypothermia on admission to NICU: core body temperature < 36.5C or skin temperature < 36C



Analysis 4.1. Comparison 4 Skin-to-skin care versus routine care, Outcome 1 Hypothermia: skin temperature < 35.5°C for 2 consecutive recordings.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 4 Skin-to-skin care versus routine care

Outcome: 1 Hypothermia: skin temperature < 35.5C for 2 consecutive recordings

Study or subgroup	Skin-to-skin n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 1200 g to 2199 g birthweight					
Bergman 2004	1/18	8/13		100.0 %	0.09 [0.01, 0.64]
Total (95% CI)	**18**	**13**		**100.0 %**	**0.09 [0.01, 0.64]**
Total events: 1 (Skin-to-skin), 8 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.41 (P = 0.016)					

Analysis 4.2. Comparison 4 Skin-to-skin care versus routine care, Outcome 2 Hypoglycaemia: blood glucose level < 2.6 mmol/L.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 4 Skin-to-skin care versus routine care

Outcome: 2 Hypoglycaemia: blood glucose level < 2.6 mmol/L

Study or subgroup	Skin-to-skin n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 1200 g to 2199 g birthweight					
Bergman 2004	1/18	3/13		100.0 %	0.24 [0.03, 2.06]
Total (95% CI)	**18**	**13**		**100.0 %**	**0.24 [0.03, 2.06]**
Total events: 1 (Skin-to-skin), 3 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.30 (P = 0.19)					

Analysis 5.1. Comparison 5 Transwarmer mattress versus routine care, Outcome 1 Core body temperature (°C) on admission to NICU or up to 2 hours after birth.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 5 Transwarmer mattress versus routine care

Outcome: 1 Core body temperature (C) on admission to NICU or up to 2 hours after birth

Study or subgroup	Mattress N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 < or = 1500 g birthweight							
Brennan 1996	12	36.6 (0.58)	12	35 (1.24)		100.0 %	1.60 [0.83, 2.37]
Total (95% CI)	**12**		**12**			**100.0 %**	**1.60 [0.83, 2.37]**
Heterogeneity: not applicable							
Test for overall effect: Z = 4.05 (P = 0.000051)							

Analysis 5.2. Comparison 5 Transwarmer mattress versus routine care, Outcome 2 Hypothermia on admission to NICU: core body temperature < 36.5 °C or skin temperature < 36°C.

Review: Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants

Comparison: 5 Transwarmer mattress versus routine care

Outcome: 2 Hypothermia on admission to NICU: core body temperature < 36.5 C or skin temperature < 36C

Study or subgroup	Mattress n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 < or = 1500 g birthweight					
Brennan 1996	3/12	10/12		100.0 %	0.30 [0.11, 0.83]
Total (95% CI)	**12**	**12**		**100.0 %**	**0.30 [0.11, 0.83]**
Total events: 3 (Mattress), 10 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.33 (P = 0.020)					

WHAT'S NEW

Last assessed as up-to-date: 7 February 2010.

10 February 2010	New search has been performed	This updates the review "Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants" published in The Cochrane Database of Systematic Reviews, Issue 1, 2008 (McCall 2008). One additional eligible study has been included. Data are included in the plastic wrap versus routine care comparison group and a new comparison group 'Plastic cap versus routine care' has been added.
10 February 2010	New citation required and conclusions have changed	New citation. Conclusions not changed.

HISTORY

Protocol first published: Issue 2, 2003

Review first published: Issue 1, 2005

3 July 2008	Amended	Converted to new review format.
13 September 2007	New search has been performed	This review updates the existing review of "Interventions to prevent hypothermia at birth in preterm and/or low birthweight babies", published in The Cochrane Library, Issue 1, 2005 (McCall 2005). Literature searches were updated to July week 4, 2007. No additional studies fulfilled the criteria for inclusion in this review. Secondary outcome measures for Vohra 2004a were updated as a result of publication of the full manuscript. There were no changes to the reviewer's conclusions nor to implications for practice or research.
13 September 2007	New citation required but conclusions have not changed	Substantive amendment.

CONTRIBUTIONS OF AUTHORS

The review was conceived by the Northern Ireland Neonatal Intensive Care Outcomes Research and Evaluation Group (NICORE).

The review was co-ordinated and the manuscript prepared in RevMan5 by the contact reviewer (EC). The search strategy was designed by EC and the QUB Medical Faculty Librarian. The data extraction proforma was drafted by EC and edited by FA, HH, JJ and SV.

FA, HH, JJ, SV and EC screened abstracts and papers against the inclusion criteria, appraised the quality and extracted the data. Entry onto RevMan was carried out by EC.

HH, JJ and SV provided clinical input at all stages of the review process. FA and HH also provided methodological input.

All reviewers were involved equally in the development of the content of the final manuscript.

DECLARATIONS OF INTEREST

SV is principal investigator on two studies that met the review eligibility criteria. This team member was excluded from the study appraisal process for these studies.

SV is also co-leading the current multicentre HeLP study.

SOURCES OF SUPPORT

Internal sources

- Northern Ireland Neonatal Outcomes Research and Evaluation Group (NICORE), UK.

External sources

- Research & Development Office - Northern Ireland, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Infant, Low Birth Weight; Hypothermia [*prevention & control]; Infant, Newborn; Infant, Premature; Infant, Premature, Diseases [*prevention & control]; Perinatal Care [methods]; Randomized Controlled Trials as Topic

MeSH check words

Humans