Radiant warmers versus incubators for regulating body temperature in newborn infants (Review)

Flenady V, Woodgate PG

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2009, Issue 4

http://www.thecochranelibrary.com

TABLE OF CONTENTS

[Intervention Review]

Radiant warmers versus incubators for regulating body temperature in newborn infants

Vicki Flenady[1], Paul G Woodgate[2]

[1]Mater Mother's Research Centre, Mater Health Services, Wooloongabba, Australia. [2]Dept of Neonatology, Mater Mothers' Hospital, South Brisbane, Australia

Contact address: Vicki Flenady, Mater Mother's Research Centre, Mater Health Services, Level 2 Quarters Building, Annerley Road, Wooloongabba, Queensland, 4102, Australia. vicki.flenady@mater.org.au. (Editorial group: Cochrane Neonatal Group.)

Cochrane Database of Systematic Reviews, Issue 4, 2009 (Status in this issue: *Unchanged*)

DOI: 10.1002/14651858.CD000435
This version first published online: 20 October 2003 in Issue 4, 2003.
Last assessed as up-to-date: 12 January 2005. (Help document - Dates and Statuses explained)

This record should be cited as: Flenady V, Woodgate PG. Radiant warmers versus incubators for regulating body temperature in newborn infants. *Cochrane Database of Systematic Reviews* 2003, Issue 4. Art. No.: CD000435. DOI: 10.1002/14651858.CD000435.

ABSTRACT

Background

The provision of a thermoneutral environment is an essential component of the immediate and longer term care of newborn infants. A variety of methods are currently employed including incubators and open-care systems, with or without modifications such as heat shields and plastic wrap. The system used must allow ready access to the infant but should also minimise alterations in the immediate environment.

Objectives

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

Search strategy

The standard search strategy of the Cochrane Neonatal Review Group was used. This included searches of electronic databases: Oxford Database of Perinatal Trials, Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2005), MEDLINE (1966 -2005), and CINAHL (1982-2005), previous reviews including cross references, abstracts, conferences, symposia proceedings, expert informants and journal hand searching mainly in the English language.

Selection criteria

Randomised or quasi-randomised trials in which radiant warmers were compared to incubators in a neonatal population.

Data collection and analysis

Independent data extraction and quality assessment of included trials was conducted by the authors. Data were analysed using relative risk (RR) and weighted mean difference (WMD). Results are presented with 95% confidence intervals. Meta-analysis was undertaken using a fixed effect model.

Main results

Eight studies are included in this review; six employed a crossover design. In the overall comparison of radiant warmers vs incubators, radiant warmers caused a statistically significant increase in insensible water loss (IWL) [WMD 0.94g/Kg/day (95% CI 0.47, 1.41)] and a trend towards increased oxygen consumption which was not statistically significant [WMD 0.27mL/kg/min (95% CI -0.09, 0.63)].

Due to small numbers, effects on important clinical outcomes could not be adequately assessed. A comparison of radiant warmers with heat shields vs incubators without heat shields showed a trend for increased IWL in the radiant warmer group, which was not statistically significant. No difference was shown in oxygen consumption.

Authors' conclusions

Radiant warmers result in increased IWL compared to incubators. This needs to be taken into account when calculating daily fluid requirements. The results of this review do not provide sufficient evidence concerning effects on important outcomes to guide clinical practice. Further randomised controlled trials are required to assess the effects of radiant warmers versus incubators in neonatal care on important short and long term outcomes, with particular attention to extremely low birthweight infants in the early neonatal period.

PLAIN LANGUAGE SUMMARY

Radiant warmers versus incubators for regulating body temperature in newborn infants

Not enough evidence to show the effects of radiant warmers versus incubators for regulating body temperature in newborn babies.

Low birthweight babies have a higher chance of survival if they are kept warm. Incubators have been used for some time to maintain body temperature. More recently, open cots with an overhead radiant warmer have also been used for babies needing intensive care.

The review of trials found that radiant warmers increase water loss in low birthweight babies in the newborn period when compared to incubators and that this water loss needs to be taken into account when daily fluid requirements are calculated. However, there was not enough information available for this review to enable assessment of other important effects of radiant warmers. Therefore, at the present time, it is not clear which method of maintaining body temperature is best for newborn babies - radiant warmers or incubators. More research is necessary.

BACKGROUND

An understanding of neonatal thermoregulation led to significant decreases in morbidity and mortality in neonates, especially sick preterm infants requiring intensive care. In a series of randomised trials published in the late 1950's and early 1960's Silverman and colleagues demonstrated improved survival of small infants nursed in warmer environments (Silverman 1957; Silverman 1958; Silverman 1963). Maintaining a thermoneutral environment in the case of very low birthweight infants is now routine practice in neonatal nurseries.

Since the first incubators were used, many advances in design have been made. Nursing in closed incubators was initially standard practice and provided reasonable control over the neonate's immediate environment. Subsequently, open care cots incorporating radiant warmers were introduced to provide easier access to the baby receiving intensive care (LeBlanc 1991; Sinclair 1992).

Evaporative heat and water losses may be higher in infants nursed under radiant warmers than in incubators. These effects are of major importance for the very preterm infant especially in the first week of life (LeBlanc 1991). In a study observing hand washing practices in neonatal intensive care, although no difference was shown in handwashing practice, neonates nursed under radiant warmers were shown to have twice as many nurse interactions (mostly non emergency) than neonates nursed in an incubator (Davenport 1992). This suggests neonates under radiant warmers may be exposed to frequent handling which has been shown to increase oxygen and energy consumption and cause bradycardic episodes (Long 1980; Gorski 1990; Hutchison 1994). Other noxious stimuli such as noise and light may be increased, possibly disrupting sleep patterns. However this exposure may have the advantage of providing the primary caregiver immediate unobstructed access and may also promote parent-infant attachment. These effects may have an impact on both short and long term outcomes.

Because of the sensitivity of sick neonates to alterations in their environment, the influence of different methods of controlling the environment on morbidity and mortality needs to be considered.

OBJECTIVES

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

Planned sub-group analyses :

With or without added humidification

With or without the use of additional methods eg heat shields, plastic wrap

Duration of treatment - from birth to two weeks of age

Preterm < 28 weeks gestation or birthweight <1000 gms

Preterm < 32 weeks gestation or birthweight <1500 gms

METHODS

Criteria for considering studies for this review

Types of studies

Randomised or quasi-randomised trials in which radiant warmers were compared to incubators.

Types of participants

Neonates nursed under radiant warmers vs incubators in neonatal nurseries.

Types of interventions

Radiant warmers
Incubators

Types of outcome measures

Primary:
Mortality
Oxygen consumption
Metabolic rate
Insensible water loss
Fluid and electrolyte balance
Patent ductus arteriosus
Time to regain birthweight
Bacterial colonisation
Infection
Necrotising enterocolitis*
Intraventricular haemorrhage (All grades)
Intraventricular haemorrhage (Grades 3 and 4)
Cerebral cystic lesions (Periventricular leukomalacia, porencephalic cysts)]
Chronic lung disease [infant receiving any respiratory support (supplemental oxygen or any form of assisted ventilation) for a chronic pulmonary disorder i) on the day they reached 36 weeks' post menstrual age; and ii) at 28 days postnatal age].
Secondary:
Length of hospital stay
Parent satisfaction
Staff satisfaction
Retinopathy of prematurity (All stages) *
Retinopathy of prematurity (Stages III and IV)*
Long term neurosensory impairment
NB: In the first update of this review, the reviewers changed the criteria for considering studies - Types of outcome measures - by adding three eligible outcomes (indicated by *).

Search methods for identification of studies

The standard search strategy of the Neonatal Review Group was used. Searches were made of the Oxford Database of Perinatal Trials, Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2005), MEDLINE (1966 -2005), and CINAHL (1982-2005). Text terms used included: incubator, isolette, radiant*, open warmer and MeSH term infant-newborn. The search strategy also included previous reviews including cross references, abstracts in conferences and symposia proceedings, journal hand searching in the English language.

Data collection and analysis

Standard methods of the Cochrane Collaboration were used as described in the Cochrane Handbook.
Quality assessment:
Included trials were assessed for blinding of randomization, blinding of intervention, completeness of follow-up, and blinding of outcome assessment. The authors independently undertook this assessment and assigned a rating of either Yes (Adequate), Can't Tell (Unclear), or No (Inadequate) for each. Differences were resolved by discussion.
Methods used to collect and synthesise data from included studies:
Each reviewer independently extracted data, then compared and resolved differences. Additional information concerning outcomes and method of randomisation was sought and received from the authors of three included trials (Bell 1980; Schnabel 1999; Meyer 2001).
For further details, please see table, Characteristics of included studies.
Three crossover studies employed more than one crossover (Bell 1979; Bell 1980; Marks 1986). (For details please see section, Description of studies). In the overall analysis, only one crossover (two exposures) were included from these studies as follows: infants nursed naked in radiant warmers and incubators in Bell 1979; radiant warmers and incubators without the use of heat shields in Bell 1980; and radiant warmers and incubators without phototherapy in Marks 1986.
Subgroup analyses were conducted to assess the effects of heat shields in each environment. Two trials were included in the comparisons on the use of heat shields (Bell 1980; Meyer 2001).
Categorical data were analysed with the use of relative risk (RR), and weighted mean differences (WMD) were used for outcome

data measured on a continuous scale. All outcomes were analysed with the use of 95% confidence intervals (CI). Meta-analysis was conducted using a fixed effect model.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Eight studies were included in this review. Six employed a crossover design (Darnall 1978; Bell 1979; Bell 1980; Marks 1980; LeBlanc 1982; Marks 1986) and two did not (Schnabel 1999; Meyer 2001). A further seven studies were identified. Six of these were excluded as neither random nor quasi-random allocation to the exposure was employed (Levison 1966; Wu 1974; Williams 1974; Jones 1976; Wheldon 1982; Kjartansson 1995) and one trial (Merenstein 1979) was excluded following correspondence with the author as data were not available in a format for inclusion in this review.

Participants in the included trials were similar. All studies enrolled preterm neonates (mean gestational ages 28-32 weeks, mean birthweights 1.1 - 1.6 kg across the trials). Darnall 1978 also included term neonates. The two more recent trials studied a less mature population (Schnabel 1999; Meyer 2001). The age at which the neonates were studied varied; however, the majority of infants were greater than seven days of age. One study enrolled infants shorty after birth on admission to the nursery (Meyer 2001). The duration of the exposure in the crossover trials ranged from one hour to three days (most were between one and three hours). Two non-crossover trials studied infants in the two environments for longer periods - one study from seven to 35 days of life (Schnabel 1999) and the other from admission to a weight of 1800g (Meyer 2001).

The number and types of exposures studied differed in the included crossover studies. Three crossover trials studied infants in each of the two environments (radiant warmers and incubators) without additional thermal measures (Darnall 1978; LeBlanc 1982; Marks 1980). Three trials reported additional exposures. One study (Bell 1979) assessed the effects of clothing and included three exposures: naked in incubators, naked in radiant warmers and clothed in incubators. Another (Marks 1980) studied infants in four environments: radiant warmers and incubators with and without phototherapy. Bell 1980 compared the effects of heat shields in the two environments (four exposures).

One non-crossover trial (Meyer 2001) assessed the use of heat shields with radiant warmers compared to incubators without heat shields.

Double-walled incubators were used in two trials (Schnabel 1999; Meyer 2001), while single-wall incubators were used in all six crossover trials. In all studies, attempts were made to achieve a thermal state associated with minimal resting oxygen consumption in each environment. Added humidification was mentioned in four trials (LeBlanc 1982; Marks 1986; Schnabel 1999; Meyer 2001). Five studies reported a relative humidity of approximately 30%. Two trials reported much higher relative humidity of 50 - 80% for both radiant warmer and incubator groups (LeBlanc 1982; Meyer 2001). The infant's temperature was maintained with the use of servo-control in the majority of the included trials.

The most frequently reported outcomes in the crossover trials were insensible water loss (three trials) and oxygen consumption (five trials). One crossover trial also reported weight gain, and skinfold fat gain (Marks 1986). The two non-crossover trials assessed temperature control, fluid and electrolyte balance, weight gain, major neonatal morbidity and mortality (Schnabel 1999; Meyer 2001). In these trials, the outcome of chronic lung disease was reported by different definitions: oxygen use at 28 days postnatal age (Schnabel 1999) and at 36 weeks corrected age (Meyer 2001). The reviewers decided due to small numbers of infants studied to report this outcome according to one definition only and chose the definition of oxygen use at 36 weeks' post menstrual age.

(For further details on included studies see table, Characteristics of Included Studies).

Risk of bias in included studies

Six of the eight included studies used a crossover design. Random allocation of the order of exposure was undertaken in four crossover studies (Bell 1979; Bell 1980; LeBlanc 1982; Marks 1986). Whether blinding of randomisation was undertaken is unknown. Quasi-random allocation was used in two studies (Darnall 1978; Marks 1980). A blinded method of random allocation was undertaken in the two non-crossover trials (Schnabel 1999; Meyer 2001). Meyer 2001 used a numbered card with the allocation concealed beneath an adhesive label; numbered cards were kept in a locked cupboard until the point of randomisation and Schnabel 1999 used sealed envelopes. Blinding of the intervention was not possible. Blinding of outcome measure was reported by one trial Schnabel 1999 following correspondence with the author. All neonates enrolled in the included studies were included in the analysis apart from Marks 1986 (four of the 17 enrolled infants were excluded due to illness), Schnabel 1999 (four of 34 excluded - one death and three transfers), and Meyer 2001 (one exclusion of 61 enrolled due to no parental consent).

Effects of interventions

The results of six crossover trials with a total of 66 infants and two non-crossover trials in 90 infants are included in this review.

Radiant warmers versus incubators

In the overall analysis comparing radiant warmers and incubators, a statistically significant increase in insensible water loss (IWL) was shown for neonates nursed under radiant warmers [WMD 0.94 g/kg/day, (95% CI 0.47, 1.41)] when compared to incubators. There was a trend towards increased oxygen consumption which was not statistically significant for infants nursed under radiant warmers [WMD 0.27 mL/kg/min (95% CI -0.09, 0.63)].
The results of one cross-over trial (Marks 1986) showed no difference in metabolic rate [MD 0.13 kcal/kg/h (95% CI -0.26, 0.52)]. However, this trial showed a statistically significant increase in skinfold fat gain for infants nursed under radiant warmers [MD 0.04 mm/d (95% CI 0.01, 0.07)]. No statistically significant difference was shown in weight gain over the study period [WMD 1.06 g/kg/d (95% CI -0.94, 3.06)] (Marks 1986; Meyer 2001) or time to regain birthweight [WMD 0.86 days (95% CI -1.49, 3.21)] (Meyer 2001; Schnabel 1999).

A non-statistically significant reduction in chronic lung disease (defined as oxygen use at 36 weeks postmenstrual age) [RR 0.20 (95% CI 0.01, 4.00)], and an increase in infants with serum sodium >150mmol/L which was also not statistically significant [RR 3.00 (95% CI 0.66, 13.69)], were shown for infants nursed under radiant warmers (data from one trial, Meyer 2001).
No differences were shown in the rates of other reported neonatal morbidities (infection, necrotising enterocolitis, patent ductus arteriosus, retinopathy of prematurity, intraventricular haemorrhage, cerebral cystic lesions, or death). However, due to the small numbers of infants studied, all measures of effect for these outcomes are imprecise.

Subgroup analyses by use of heat shields

1. Radiant warmers vs incubators - without the use of heat shields
In this comparison, as shown in the overall analysis, a statistically significant increase in insensible water loss (IWL) [WMD 0.94 g/kg/day (95% CI 0.47, 1.41)] and a trend towards increased oxygen consumption [WMD 0.27 mL/kg/min (95% CI -0.09, 0.63)] which was not statistically significant was shown for infants nursed under radiant warmers when compared to infants nursed in incubators without the use of heat shields. No statistically significant differences were shown for the outcomes of time to regain birthweight, infection, necrotising enterocolitis, patent ductus arteriosus, retinopathy of prematurity, cerebral cystic lesions, or neonatal death (data from one small trial of 34 infants, Schnabel 1999).
2. Radiant warmers with heat shields vs incubator without heat shields
This comparison showed a similar trend to that of the overall analysis for increased IWL in the radiant warmer group which was not statistically significant [WMD 1.00 g/kg/day (95% CI -0.10, 2.10)]. No difference was shown in the rate of oxygen consumption when radiant warmers with heat shields were compared to incubators [WMD -0.05 mL/kg/min (95% CI -0.84, 0.74)]. Data from one trial of sixty infants (Meyer 2001) showed non-statistically significant reductions for infants nursed under radiant warmers in chronic lung disease, necrotising enterocolitis and intraventricular haemorrhage (Grades 3 and 4), an increase in infants with retinopathy of prematurity and serum sodium > 150 mmol/L, and no difference between groups in time to regain birthweight or weight gain over the study period. However, due to the small numbers of infants studied, adequate assessment of these outcomes is not possible.
3. Radiant warmers without heat shields vs incubators with heat shields
Only two outcomes were able to be assessed in this comparison: IWL and oxygen consumption. A statistically significant increase in IWL [WMD 1.27 g/kg/day (95% CI 0.02, 2.52)] was shown for the infants nursed under radiant warmers. Oxygen consumption was not statistically significantly different [WMD -0.05 mL/kg/min (95% CI -0.89, 0.79).
4. Radiant warmers with heat shields vs incubators with heat shield
Once again, only two outcomes were able to be assessed in this comparison. A statistically significant increase in IWL for radiant warmers [WMD 1.24 g/kg/day (95% CI 0.30, 2.18)] and a trend towards a reduction in oxygen consumption was shown for the radiant warmer group [WMD -0.45 mL/kg/min (95% CI -1.33, 0.43)], again with no statistical significance.
Due to insufficient data, planned sub-group analyses by duration of treatment (birth to two weeks of age), added humidification and lower gestational age could not be conducted.

DISCUSSION

This review includes eight trials which assessed short term effects of radiant warmers vs incubators. A statistically significant increase was shown in IWL for the infants nursed under radiant warmers. The mean increase in IWL was 0.94 mL/kg/h or 22.6 mL/kg /day. This effect needs to be considered when calculating daily fluid requirements. A non significant trend for increased oxygen consumption in neonates nursed under radiant warmers was shown. The crossover design used by most studies included in this review has the limitation of being able to assess immediate effects of the intervention only. There is limited information available in this review on more meaningful clinically important outcomes, as only two trials did not use a cross-over design.

One trial (Marks 1986) reported no statistically significant differences in urine output, specific gravity and osmolality in low birthweight neonates aged 28 days (mean) nursed under radiant warmers compared to incubators for a three day period with similar fluid intake. Meyer 2001 reported an increase in the number of infants with serum sodium levels > 150 mmol/L in the radiant warmer group, although this was not statistically significant. Data from two trials showed no difference in weight gain over the study period in infants nursed under radiant warmers compared to those nursed in incubators (Marks 1986; Meyer 2001) and no differ-

ence in time to regain birthweight in two trials (Schnabel 1999; Meyer 2001). One trial also showed no difference in metabolic rate over a three day period although a statistically significant increase in skinfold fat gain was shown for infants nursed under radiant warmers was shown (Marks 1986).

The results of the two non-crossover trials in this review showed no difference in important clinical outcomes of major neonatal morbidity and mortality (Schnabel 1999; Meyer 2001) . However, Meyer 2001 reported an overall trend to less neonatal morbidity for infants under radiant warmers with heat shields when compared to infants in an incubator without heat shields and postulated that this may have been due to less hypothermia demonstrated in the immediate newborn period for infants nursed under radiant warmers. Due to small numbers of infants studied, it is not possible to adequately assess these effects.

The findings from the comparisons assessing the effects of heat shields come from one small crossover trial (Bell 1980) and one small non-crossover trial (Meyer 2001). In these comparisons there is a suggestion that the use of heat shields with radiant warmers may reduce oxygen consumption when compared to incubators; no differential effect was shown for IWL. There is some evidence to suggest that heat shields may diminish transmission of radiant heat to the infant's skin (Baumgart 1982). There is insufficient evidence in this review of the benefits and possible harm of heat shields to guide clinical practice. This review was unable to carry out the planned sub-group analyses limited to high risk infants of very short gestation or very low birth weight, or according to use (or not) of humidification. The effects of radiant warmers and incubators in the early newborn period, when infants (particularly those of extremely low birthweight) are most sensitive to environmental conditions, was unable to be assessed.

Further randomised controlled trials in which infants are allocated to radiant warmers or incubators in the period immediately following admission to the neonatal nursery are necessary. Specific issues to be addressed by further research include:

- important thermal and non thermal effects, ie neonatal mortality, neonatal morbidity including chronic lung disease, nosocomial infection, sleep disturbance and parental perceptions

- the effects in neonates less than seven days of age, particularly extremely low birthweight neonates

- the effects of extra measures to modify the environment, eg humidification, 'bubble plastic' and plastic heat shields

AUTHORS' CONCLUSIONS

Implications for practice

Radiant warmers result in an increased insensible water loss when compared to incubators. The results of this review do not provide sufficient evidence regarding clinically important effects to guide clinical practice.

Implications for research

Further randomised controlled trials are required to assess the effects of radiant warmers versus incubators in neonatal care with particular attention to the extremely low birthweight population in the early neonatal period.

ACKNOWLEDGEMENTS

The reviewers would like to thank Dr Merenstein, Dr Bell, Dr Myer and Karin Schnabel for providing additional information on their trials and also Prof David Henderson-Smart (Cochrane Neonatal Group Regional Coordinator, Australasia) for advice on this review and Zsuzsoka Kecskes for assistance with translation of an included trial.

We would also like to acknowledge Katie Welsh for assistance with literature searching and formatting the review.

REFERENCES

References to studies included in this review

Bell 1979 *{published data only}*
Bell EF, Neidich GA, Cashore WJ, Oh W. Combined effect of radiant warmer and phototherapy on insensible water loss in low-birthweight infants. *Journal of Pediatrics* 1979;**94**:810–3.

Bell 1980 *{published data only}*
Bell EF, Weinstein MR, Oh W. Heat balance in premature infants: Comparative effects of convectively heated incubator and radiant warmer, with and without plastic heat shield. *Journal of Pediatrics* 1980;**96**:460–5.

Darnall 1978 *{published data only}*
Darnall RA, Ariagno RL. Minimal oxygen consumption in infants cared for under overhead radiant warmers compared with conventional incubators. *Journal of Pediatrics* 1978;**93**:283–7.

LeBlanc 1982 *{published data only}*
LeBlanc M. Relative efficacy of an incubator and an open warmer in producing thermoneutrality for the small premature infant. *Pediatrics* 1982;**69**:439–45.

Marks 1980 *{published data only}*
Marks KH, Gunther RC, Rossi JA, Maisels MJ. Oxygen consumption and insensible water loss in premature infants under radiant heaters. *Pediatrics* 1980;**66**:228–32.

Marks 1986 *{published data only}*
Marks KH, Nardis EE, Momin MN. Energy metabolism and substrate utilization in low birth weight neonates under radiant warmers. *Pediatrics* 1986;**78**:465–72.

Meyer 2001 *{published data only}*
Myer MP, Payton MJ, Salmon A, Hutchinson C, de Klerk A. A clinical comparison of radiant warmer and incubator care for preterm infants from birth to 1800 grams. *Pediatrics* 2001;**108**:395–401.

Schnabel 1999 *{published data only}*
Schnable K. Incubator care versus "open care" in the warming bed for very small premature infants. *Kinderkrankenschwester* 1999;**18**: 195–200.

References to studies excluded from this review

Jones 1976 *{published data only}*
Jones RW, Rochefort MJ, Baum JD. Increased insensible water loss in newborn infants nursed under radiant heaters. *British Medical Journal* 1976;**2**:1347–50.

Kjartansson 1995 *{published data only}*
Kjartansson S, Arson S, Hammarlund K, Sjors G. Water loss from the skin of term and preterm infants under a radiant heater. *Pediatric Research* 1995;**37**:233–8.

Levison 1966 *{published data only}*
Levison H, Linsao L, Swyer PR. A comparison of infra-red and convective heating for newborn infants. *Lancet* 1966;**2**:1346–8.

Merenstein 1979 *{published data only}*
Merenstein G B, Koziol D F, Brown G L, Weisman LE. Radiant warmers vs incubators for neonatal care. *American Journal of Diseases of Children* 1979;**133**:857–8.

Wheldon 1982 *{published data only}*
Wheldon AE, Rutter N. The heat balance of small babies nursed in incubators and under radiant warmers. *Early Human Development* 1982;**6**:131–43.

Williams 1974 *{published data only}*
Williams PR, Oh W. Effects of radiant warmer on insensible water loss in newborn infants. *American Journal of Diseases of Children* 1974;**128**:511–4.

Wu 1974 *{published data only}*
Wu PYK, Hodgman JE. Insensible water loss in preterm infants: changes with postnatal development and non-ionizing radiant energy. *Pediatrics* 1974;**54**:704–12.

Additional references

Baumgart 1982
Baumgart S, Fox WW, Polin RA. Physiologic implications of two different heat shields for infants under radiant warmers. *Journal of Pediatrics* 1982;**100**:787–90.

Davenport 1992
Davenport SE. Frequency of hand washing by registered nurses caring for infants on radiant warmers and in incubators. *Neonatal Network* 1991;**11**:21–5.

Gorski 1990
Gorski PA, Huntington L, Lewkowicz DJ. Handling preterm infants in hospitals. *Clinics in Perinatology* 1990;**17**:103–12.

Hutchison 1994
Hutchison AA. Respiratory disorders of the neonate. *Current Opinion in Pediatrics* 1994;**6**:142–53.

LeBlanc 1991
LeBlanc MH. Thermoregulation: incubators, radiant warmers, artificial skins, and body hoods. *Clinics in Perinatology* 1991;**18**:403–21.

Long 1980
Long JG, Philip AGS, Lucey JF. Excessive handling as a cause of hypoxaemia. *Pediatrics* 1980;**65**:203–7.

Silverman 1957
Silverman WA. Blanc WA. Effect of humidity on survival of newly born premature infants. *Pediatrics* 1957;**20**:447.

Silverman 1958
Silverman WA, Fertig JW, Berger A. Influence of the thermal enviroment upon the survival of newly born premature infants. *Pediatrics* 1958;**22**:876–86.

Silverman 1963
Silverman WA, Agate FJ, Fertig JW. A sequential trial of the nonthermal effects of atmospheric humidity on survival of newborn infants of low birthweight. *Pediatrics* 1963;**31**:719–24.

Sinclair 1992
Sinclair JC. Management of the thermal environment. In: Sinclair JC, Bracken MB editor(s). *Effective Care of the Newborn Infant*. Oxford: Oxford University Press, 1992:40–55.

References to other published versions of this review

Flenady 1998
Flenady VJ, Woodgate PG. Radiant warmers versus incubators for regulating body temperature in newborn infants. *Cochrane Database of Systematic Reviews* 1998, Issue 1. [DOI: 10.1002/14651858.CD000435]

Flenady 2002
Flenady VJ, Woodgate PG. Radiant warmers versus incubators for regulating body temperature in newborn infants. *Cochrane Database of Systematic Reviews* 2002, Issue 2. [DOI: 10.1002/14651858.CD000435]

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Bell 1979

Methods	Blinding of randomization - can't tell Blinding of intervention -no Complete followup - yes Blinding of outcome measure -no
Participants	10 infants studied. Mean birthweight: 1.24 kgs, gestational age: 30 weeks, mean age at entry: 12 days, mean weight at entry: 1.15 kg
Interventions	Crossover design. Each infant was studied for a 2 hour period in four conditions with a one hour pause in between. 1. Incubator, no phototherapy 2. Radiant warmer, no phototherapy 3. Radiant warmer with low-dose phototherapy 4. Radiant warmer with high-dose phototherapy
Outcomes	Insensible water loss, heart rate, respiratory rate
Notes	Temperature control: servo controlled in both environments to maintain rectal temperature 36.8 - 37.1C. Infants were studied naked. Mean skin temperatures for both RW and INC groups - 36.4C Relative humidity: RW - 29.4%, INC - 26.4%. (p value <0.025)

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Bell 1980

Methods	Blinding of randomization - can't tell (coin toss) Blinding of intervention -no Complete followup - yes Blinding of outcome measure -no
Participants	8 infants studied. Mean birthweight: 1.57 kg, gestational age: 32 weeks, weight on study entry:1.47 kg, age when studied: 12.2 days
Interventions	Crossover design. Each infant was studied during four consecutive two-hour periods in four different conditions. 1. single wall incubator 2. incubator with heat shield 3. radiant warmer 4. radiant warmer with a heat shield

Bell 1980 (*Continued*)

Outcomes	Insensible water loss, oxygen consumption, heart rate, respiratory rate	
Notes	Temperature control: servo controlled to keep rectal temperature between 36.8 and 37C in all groups. Infants nursed naked. Mean skin temperature: RW - 36.9, INC - 37C Relative humidity: RW - 39%, INC - 31.4% (p value <0.01)	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Darnall 1978

Methods	Blinding of randomization - can't tell Blinding of intervention -no Complete followup - yes Blinding of outcome measure -no	
Participants	10 infants studied. Birthweight range: 820-3800 gm, gestational age range: 28 - 40 weeks. Age range when studied: 4 hrs - 30 days	
Interventions	Crossover design. Infants were studied from one to three hours in each of two environments. 1. incubator 2. radiant warmer	
Outcomes	Oxygen consumption, carbon dioxide production, skin temperature	
Notes	Temperature control: Servo control in both environments to maintain skin temperature 36.1 36.8C. Mean skin temperatures: RW - 36.4, INC - 36.5C Relative humidity or infant clothing in either environment was not mentioned	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	No	C - Inadequate

LeBlanc 1982

Methods	Random allocation not described "order randomised". Blinding of randomization - can't tell Blinding of intervention -no Complete followup - yes Blinding of outcome measure -no
Participants	Entry criteria: low birthweight, feeding and gaining weight 16 infants studied. Mean birthweight 1.212 kg, mean gestational age: 31 weeks, mean age when studied: 22 days
Interventions	Crossover design. Infants were studied on a single day in four environments . Two environments are reported in this publication - radiant warmer and incubator groups
Outcomes	Oxygen consumption, body temperature
Notes	Temperature control:servo controlled in both environments to maintain skin temperature 36C. Mean skin temperatures: RW - 35.99, INC - 36.04C (not significant). Infants were nursed naked Relative humidity: RW - 55.2%, INC (set at maximum humidification) - 75.9%. (p value <0.001)

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Marks 1980

Methods	Quasi-random allocation: "order alternated". Blinding of randomization - can't tell Blinding of intervention -no Complete followup - yes Blinding of outcome measure -no
Participants	Inclusion criteria: low birthweight 9 infants studied. Mean birthweight:1.812 kg, mean gestational age: 34 weeks, mean age when studied: 7 days
Interventions	Crossover design. Infants were studied for 2 consecutive three hour periods in a single wall incubator and under a radiant warmer
Outcomes	Heart rate, respiration rate, oxygen consumption, insensible water loss, carbon dioxide production
Notes	Temperature control: servo controlled to maintain skin temperature 36.5C. Infants were nursed naked. Mean skin temperatures: RW - 36.3, INC - 36.3C Relative humidity:RW - 30.6%, INC - 29.9% (not significant)

Marks 1980 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	No	C - Inadequate

Marks 1986

Methods	Blinding of randomization - can't tell Blinding of intervention -no Complete followup - no (4 infants out of 17 enrolled were excluded) Blinding of outcome measure -no
Participants	Inclusion criteria: in an incubator, gaining weight, tolerating three hourly gavage feeds, free of complicating disease 17 infants enrolled, 4 were excluded. Mean gestational age: 34 weeks, mean weight at study entry:1.395 kg, mean age at study entry: 28 days
Interventions	Crossover design. Infants were studied for a total of nine days in three different conditions (3 days in each) 1. Single-walled forced air incubator, infant naked 2. incubator, infant clothed 3. radiant warmer, infant naked
Outcomes	Heart rate, respiration rate, oxygen consumption, carbon dioxide production, metabolic rate, body temperature, dietary intake, growth, urine - volume, specific gravity, osmolality
Notes	Temperature control: RW - servo controlled to maintain skin temperature 36.5, INC - manual control "in the higher portion of the NTE". Infants nursed in diaper only Mean skin temperature: RW - 36.2, INC - 35.8C (p value 0.03) Relative humidity : RW - not stated, INC - "maintained at < 40%"

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Meyer 2001

Methods	Blinding of randomization - yes Blinding of intervention -no Complete followup - no (one post randomisation exclusion) Blinding of outcome measure - can't tell
Participants	61 preterm infants studied from admission to nursery up to 1800g. Inclusion criteria: <33 wks gestation. Exclusion criteria: Major congenital abnormality, congenital infections, outborn infants. Mean BW of study groups: 1182 and 1211 g. Mean GA of study groups: 28 and 29 wks
Interventions	Radiant warmer: Fisher and Paykel "Cosy Cot" with polythene "tent-like" cover to deliver humidification. Incubator: Air Shields double-walled (C550 or Isolette, Vickers Medical.) Temp control - Air servocontrol. Humidification via incubator mechanism.
Outcomes	Body temperatures, Weight gain, caloric intake, fluid intake. Major neonatal morbidity: infection, PDA, CLD, ROP, IVH, other major cerebral abnormalities. Mortality, use of phototherapy Unpublished data received from author for outcome: time to regain birthweight
Notes	Target body temp - Abdominal wall - 36.8 and axilla 36.8 to 37.3. All infants nursed in diapers and bonnets and booties after 1 week, incubator infants also wore woolen tops after 1 week. Added humidity (relative humidity 70-80%) for infants < 1250 (<1000 for 5 days , 1000-1249 for 3 days). Sample size calculation based on % time body temp <36 in the first week and weight gain.

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	Yes	A - Adequate

Schnabel 1999

Methods	Blinding of randomization - yes Blinding of intervention - no Complete followup - no (4 post randomisation exclusions) Blinding of outcome measure - yes

Schnabel 1999 (*Continued*)

Participants	34 preterm infants <1500 g at birth. Studied from 7 to 35 days of age. Mean BW in study groups 1125 and 894 g. Mean GA in study groups: 29 and 28 wks.
Interventions	Radiant warmer: Drager Babytherm 8010 or the Air Shield Open Care System or the Heinen-Lowenstein Open Care System. Skin temp control as well as the Heinen-Lowenstein open Care System. Incubator: Drager Isolette 8000 or Air Shields Incubator.
Outcomes	Bacterial colonisation of infant and cot, infection, body temperatures, intravenous fluid intake, weight gain, use of phototherapy, NEC, ROP, duration and mode of oxygen therapy.
Notes	Unpublished data received from the author for outcomes of neonatal death, ROP, IVH, cerebral cystic lesions, time to regain birthweight. Four babies lost to followup due to: death - 1, transfer to other unit - 3. Relative humidity : RW - not stated, INC - mean 55%(Unpublished information from the author)

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

RW = Radiant warmer
INC = Incubator
NTE = Neutral thermal environment
NEC= Necrotising enterocolitis
IVH= Intraventricular haemorrhage
CLD= Chronic lung disease
PDA= Patent ductus arteriosus
ROP= Retinopathy of prematurity
BW = Birthweight
GA = Gestational age

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

Jones 1976	Random allocation to exposure was conducted for a subgroup only.
Kjartansson 1995	Neither random or quasi-random allocation to study groups was performed.

(*Continued*)

Levison 1966	Neither random or quasi-random allocation to study groups was performed.
Merenstein 1979	Data were not available in a format for inclusion in this review.
Wheldon 1982	Neither random or quasi-random allocation to study groups was performed.
Williams 1974	Neither random or quasi-random allocation to study groups was performed.
Wu 1974	Neither random or quasi-random allocation to study groups was performed.

DATA AND ANALYSES

Comparison 1. Radiant warmers vs incubators

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Insensible water loss(mL/kg/h)	3	53	Mean Difference (IV, Fixed, 95% CI)	0.94 [0.47, 1.41]
2 Oxygen consumption(mL/kg/min)	5	111	Mean Difference (IV, Fixed, 95% CI)	0.27 [-0.09, 0.63]
3 Skinfold fat gain(mm/d)	1	26	Mean Difference (IV, Fixed, 95% CI)	0.04 [0.01, 0.07]
4 Metabolic rate(kcal/kg/h)	1	26	Mean Difference (IV, Fixed, 95% CI)	0.13 [-0.26, 0.52]
5 Weight gain(g/kg/d)	2	86	Mean Difference (IV, Fixed, 95% CI)	1.06 [-0.94, 3.06]
6 Time to regain birthweight (days)	2	90	Mean Difference (IV, Fixed, 95% CI)	0.86 [-1.49, 3.21]
7 Infection - suspected or proven	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.93 [0.66, 1.30]
8 Infection - positive blood culture	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.6 [0.16, 2.29]
9 Necrotising enterocolitis	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.78 [0.20, 3.00]
10 Patent ductus arteriosus	2	90	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.38, 2.62]
11 Retinopathy of prematurity- all stages	2	88	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.59, 1.59]
12 Retinopathy of prematurity - Stages III and IV	2	88	Risk Ratio (M-H, Fixed, 95% CI)	1.27 [0.28, 5.83]
13 Intraventricular haemorrhage - all grades	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.31, 1.91]
14 Intraventricular haemorrhage - Grades 3 and 4	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.87]
15 Cerebral cystic lesions	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.04, 3.08]
16 Chronic lung disease	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.2 [0.01, 4.00]
17 Neonatal death	2	94	Risk Ratio (M-H, Fixed, 95% CI)	0.27 [0.05, 1.59]
18 Serum sodium >150mmol/L	1	60	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.66, 13.69]

Comparison 2. Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Insensible water loss	3		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 Radiant warmers vs incubators - without the use of heat shields	3	53	Mean Difference (IV, Fixed, 95% CI)	0.94 [0.47, 1.41]
1.2 Radiant warmers with heat shields vs incubators without heat shields	1	14	Mean Difference (IV, Fixed, 95% CI)	1.0 [-0.10, 2.10]
1.3 Radiant warmers without heat shields vs incubators with heat shields	1	14	Mean Difference (IV, Fixed, 95% CI)	1.27 [0.02, 2.52]

1.4 Radiant warmers with heat shields vs incubators with heat shields	1	13	Mean Difference (IV, Fixed, 95% CI)	1.24 [0.30, 2.18]
2 Oxygen consumption (mL/kg/min)	5		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 Radiant warmers vs incubators - without the use of heat shields	5	111	Mean Difference (IV, Fixed, 95% CI)	0.27 [-0.09, 0.63]
2.2 Radiant warmers with heat shields vs incubators without heat shields	1	14	Mean Difference (IV, Fixed, 95% CI)	-0.05 [-0.84, 0.74]
2.3 Radiant warmers without heat shields vs incubators with heat shields	1	14	Mean Difference (IV, Fixed, 95% CI)	-0.05 [-0.89, 0.79]
2.4 Radiant warmers with heat shields vs incubators with heat shields	1	13	Mean Difference (IV, Fixed, 95% CI)	-0.45 [-1.33, 0.43]
3 Time to regain birthweight (days)	2	90	Mean Difference (IV, Fixed, 95% CI)	0.86 [-1.49, 3.21]
3.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Mean Difference (IV, Fixed, 95% CI)	-0.65 [-4.58, 3.28]
3.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Mean Difference (IV, Fixed, 95% CI)	1.70 [-1.24, 4.64]
4 Infection - suspected or proven	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.93 [0.66, 1.30]
4.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	0.73 [0.41, 1.28]
4.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	1.06 [0.69, 1.62]
5 Infection - positive blood culture	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.6 [0.16, 2.29]
5.1 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.6 [0.16, 2.29]
6 Necrotising enterocolitis	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.78 [0.20, 3.00]
6.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.35, 25.68]
6.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.14 [0.01, 2.65]
7 Patent ductus arteriosus	2	90	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.38, 2.62]
7.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	1.5 [0.29, 7.73]
7.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.8 [0.24, 2.69]

8 Retinopathy of prematurity - all stages	2	88	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.59, 1.59]
8.1 Radiant warmers vs incubators - without the use of heat shields	1	28	Risk Ratio (M-H, Fixed, 95% CI)	0.71 [0.44, 1.14]
8.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.55, 7.27]
9 Retinopathy of prematurity - Stages III and IV	2	88	Risk Ratio (M-H, Fixed, 95% CI)	1.27 [0.28, 5.83]
9.1 Radiant warmers vs incubators - without the use of heat shields	1	28	Risk Ratio (M-H, Fixed, 95% CI)	0.87 [0.14, 5.32]
9.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.13, 70.83]
10 Intraventricular haemorrhage - all grades	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.31, 1.91]
10.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.58]
10.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.86 [0.33, 2.25]
11 Intraventricular haemorrhage - Grades 3 and 4	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.87]
11.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
11.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.87]
12 Cerebral cystic lesions	2	90	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.04, 3.08]
12.1 Radiant warmers vs incubators - without the use of heat shields	1	30	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.58]
12.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.87]
13 Chronic lung disease	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.2 [0.01, 4.00]
13.1 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.2 [0.01, 4.00]
14 Neonatal death	2	94	Risk Ratio (M-H, Fixed, 95% CI)	0.27 [0.05, 1.59]
14.1 Radiant warmers vs incubators - without the use of heat shields	1	34	Risk Ratio (M-H, Fixed, 95% CI)	0.5 [0.05, 5.01]
14.2 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.14 [0.01, 2.65]
15 Serum sodium >150mmol/L	1	60	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.66, 13.69]

15.1 Radiant warmers with heat shields vs incubators without heat shields	1	60	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.66, 13.69]

Analysis 1.1. Comparison 1 Radiant warmers vs incubators, Outcome 1 Insensible water loss(mL/kg/h).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 1 Insensible water loss(mL/kg/h)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Bell 1979	10	2.43 (0.76)	10	1.58 (0.82)		45.1 %	0.85 [0.16, 1.54]
Bell 1980	7	3.4 (1.5)	8	2.37 (1.15)		11.6 %	1.03 [-0.34, 2.40]
Marks 1980	9	1.98 (0.75)	9	0.97 (0.78)		43.3 %	1.01 [0.30, 1.72]
Total (95% CI)	**26**		**27**			**100.0 %**	**0.94 [0.47, 1.41]**

Heterogeneity: Chi^2 = 0.12, df = 2 (P = 0.94); I^2 =0.0%

Test for overall effect: Z = 3.96 (P = 0.000075)

Analysis 1.2. Comparison 1 Radiant warmers vs incubators, Outcome 2 Oxygen consumption(mL/kg/min).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

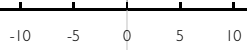
Comparison: 1 Radiant warmers vs incubators

Outcome: 2 Oxygen consumption(mL/kg/min)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Bell 1980	7	7.73 (0.52)	8	7.38 (0.93)		23.1 %	0.35 [-0.40, 1.10]
Darnall 1978	10	6.33 (1.8)	10	6.23 (1.69)		5.6 %	0.10 [-1.43, 1.63]
LeBlanc 1982	16	7.45 (1.76)	16	6.84 (1.48)		10.3 %	0.61 [-0.52, 1.74]
Marks 1980	9	5.77 (0.5)	9	5.54 (0.58)		52.1 %	0.23 [-0.27, 0.73]
Marks 1986	13	8.64 (1.3)	13	8.67 (1.8)		8.9 %	-0.03 [-1.24, 1.18]
Total (95% CI)	**55**		**56**			**100.0 %**	**0.27 [-0.09, 0.63]**

Heterogeneity: $Chi^2 = 0.70$, df = 4 (P = 0.95); $I^2 = 0.0\%$

Test for overall effect: Z = 1.45 (P = 0.15)



Analysis 1.3. Comparison 1 Radiant warmers vs incubators, Outcome 3 Skinfold fat gain(mm/d).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 3 Skinfold fat gain(mm/d)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Marks 1986	13	0.08 (0.05)	13	0.04 (0.04)		100.0 %	0.04 [0.01, 0.07]
Total (95% CI)	**13**		**13**			**100.0 %**	**0.04 [0.01, 0.07]**

Heterogeneity: not applicable

Test for overall effect: Z = 2.25 (P = 0.024)

Analysis 1.4. Comparison 1 Radiant warmers vs incubators, Outcome 4 Metabolic rate(kcal/kg/h).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 4 Metabolic rate(kcal/kg/h)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Marks 1986	13	2.64 (0.4)	13	2.51 (0.6)		100.0 %	0.13 [-0.26, 0.52]
Total (95% CI)	**13**		**13**			**100.0 %**	**0.13 [-0.26, 0.52]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.65 (P = 0.52)

Analysis 1.5. Comparison 1 Radiant warmers vs incubators, Outcome 5 Weight gain(g/kg/d).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 5 Weight gain(g/kg/d)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Marks 1986	13	18.2 (5.7)	13	17.3 (5.6)		21.2 %	0.90 [-3.44, 5.24]
Meyer 2001	30	17.1 (4.3)	30	16 (4.6)		78.8 %	1.10 [-1.15, 3.35]
Total (95% CI)	**43**		**43**			**100.0 %**	**1.06 [-0.94, 3.06]**

Heterogeneity: Chi^2 = 0.01, df = 1 (P = 0.94); I^2 =0.0%

Test for overall effect: Z = 1.04 (P = 0.30)

Analysis 1.6. Comparison 1 Radiant warmers vs incubators, Outcome 6 Time to regain birthweight (days).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 6 Time to regain birthweight (days)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Meyer 2001	30	14.1 (5.7)	30	12.4 (5.9)		64.1 %	1.70 [-1.24, 4.64]
Schnabel 1999	15	13.14 (6.54)	15	13.79 (4.17)		35.9 %	-0.65 [-4.58, 3.28]
Total (95% CI)	**45**		**45**			**100.0 %**	**0.86 [-1.49, 3.21]**

Heterogeneity: Chi² = 0.88, df = 1 (P = 0.35); I² =0.0%

Test for overall effect: Z = 0.71 (P = 0.47)

Analysis 1.7. Comparison 1 Radiant warmers vs incubators, Outcome 7 Infection - suspected or proven.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

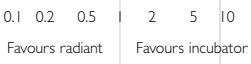
Outcome: 7 Infection - suspected or proven

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	18/30	17/30		60.7 %	1.06 [0.69, 1.62]
Schnabel 1999	8/15	11/15		39.3 %	0.73 [0.41, 1.28]
Total (95% CI)	**45**	**45**		**100.0 %**	**0.93 [0.66, 1.30]**

Total events: 26 (Radiant), 28 (Incubator)

Heterogeneity: Chi² = 1.08, df = 1 (P = 0.30); I² =8%

Test for overall effect: Z = 0.43 (P = 0.67)

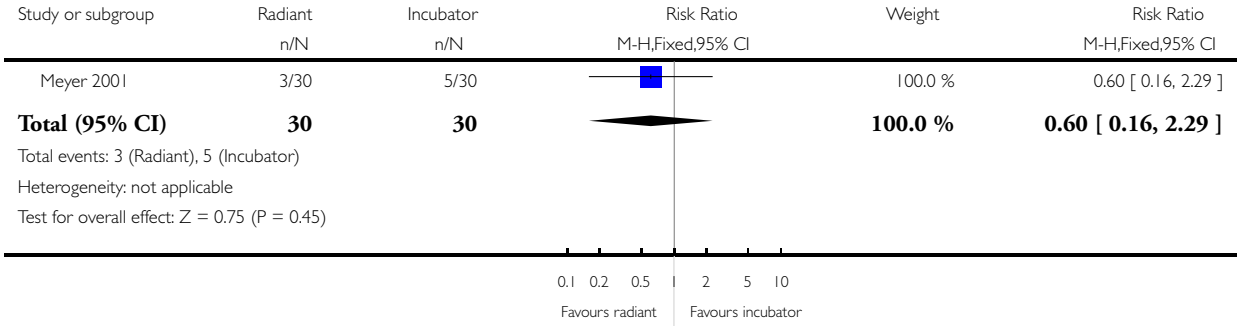


Analysis 1.8. Comparison 1 Radiant warmers vs incubators, Outcome 8 Infection - positive blood culture.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 8 Infection - positive blood culture

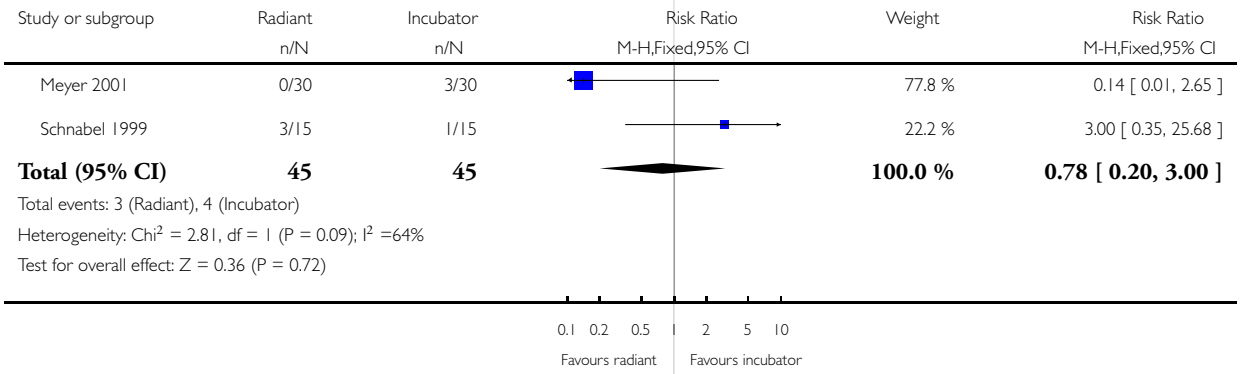


Analysis 1.9. Comparison 1 Radiant warmers vs incubators, Outcome 9 Necrotising enterocolitis.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 9 Necrotising enterocolitis



Analysis 1.10. Comparison 1 Radiant warmers vs incubators, Outcome 10 Patent ductus arteriosus.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 10 Patent ductus arteriosus

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	4/30	5/30		71.4 %	0.80 [0.24, 2.69]
Schnabel 1999	3/15	2/15		28.6 %	1.50 [0.29, 7.73]
Total (95% CI)	**45**	**45**		**100.0 %**	**1.00 [0.38, 2.62]**

Total events: 7 (Radiant), 7 (Incubator)

Heterogeneity: Chi^2 = 0.36, df = 1 (P = 0.55); I^2 =0.0%

Test for overall effect: Z = 0.0 (P = 1.0)

Analysis 1.11. Comparison 1 Radiant warmers vs incubators, Outcome 11 Retinopathy of prematurity- all stages.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

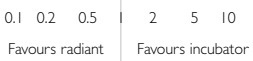
Outcome: 11 Retinopathy of prematurity- all stages

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	6/30	3/30		20.3 %	2.00 [0.55, 7.27]
Schnabel 1999	9/15	11/13		79.7 %	0.71 [0.44, 1.14]
Total (95% CI)	**45**	**43**		**100.0 %**	**0.97 [0.59, 1.59]**

Total events: 15 (Radiant), 14 (Incubator)

Heterogeneity: Chi^2 = 2.90, df = 1 (P = 0.09); I^2 =65%

Test for overall effect: Z = 0.12 (P = 0.91)



Analysis 1.12. Comparison 1 Radiant warmers vs incubators, Outcome 12 Retinopathy of prematurity - Stages III and IV.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 12 Retinopathy of prematurity - Stages III and IV

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	1/30	0/30		18.9 %	3.00 [0.13, 70.83]
Schnabel 1999	2/15	2/13		81.1 %	0.87 [0.14, 5.32]
Total (95% CI)	**45**	**43**		**100.0 %**	**1.27 [0.28, 5.83]**

Total events: 3 (Radiant), 2 (Incubator)

Heterogeneity: Chi^2 = 0.45, df = 1 (P = 0.50); I^2 =0.0%

Test for overall effect: Z = 0.31 (P = 0.76)

Analysis 1.13. Comparison 1 Radiant warmers vs incubators, Outcome 13 Intraventricular haemorrhage - all grades.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

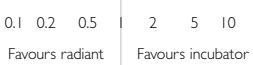
Outcome: 13 Intraventricular haemorrhage - all grades

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	6/30	7/30		82.4 %	0.86 [0.33, 2.25]
Schnabel 1999	0/15	1/15		17.6 %	0.33 [0.01, 7.58]
Total (95% CI)	**45**	**45**		**100.0 %**	**0.76 [0.31, 1.91]**

Total events: 6 (Radiant), 8 (Incubator)

Heterogeneity: Chi^2 = 0.32, df = 1 (P = 0.57); I^2 =0.0%

Test for overall effect: Z = 0.57 (P = 0.57)



Analysis 1.14. Comparison 1 Radiant warmers vs incubators, Outcome 14 Intraventricular haemorrhage - Grades 3 and 4.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 14 Intraventricular haemorrhage - Grades 3 and 4

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	0/30	1/30		0.33 [0.01, 7.87]
Schnabel 1999	0/15	0/15		0.0 [0.0, 0.0]
Total (95% CI)	**45**	**45**		**0.33 [0.01, 7.87]**

Total events: 0 (Radiant), 1 (Incubator)

Heterogeneity: Chi² = 0.0, df = 0 (P = 1.00); I² =0.0%

Test for overall effect: Z = 0.68 (P = 0.50)

Analysis 1.15. Comparison 1 Radiant warmers vs incubators, Outcome 15 Cerebral cystic lesions.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 15 Cerebral cystic lesions

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	0/30	1/30		50.0 %	0.33 [0.01, 7.87]
Schnabel 1999	0/15	1/15		50.0 %	0.33 [0.01, 7.58]
Total (95% CI)	**45**	**45**		**100.0 %**	**0.33 [0.04, 3.08]**

Total events: 0 (Radiant), 2 (Incubator)

Heterogeneity: Chi² = 0.0, df = 1 (P = 1.00); I² =0.0%

Test for overall effect: Z = 0.97 (P = 0.33)

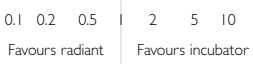
Analysis 1.16. Comparison 1 Radiant warmers vs incubators, Outcome 16 Chronic lung disease.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 16 Chronic lung disease

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	0/30	2/30		100.0 %	0.20 [0.01, 4.00]
Total (95% CI)	**30**	**30**		**100.0 %**	**0.20 [0.01, 4.00]**
Total events: 0 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.05 (P = 0.29)					



Analysis 1.17. Comparison 1 Radiant warmers vs incubators, Outcome 17 Neonatal death.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 17 Neonatal death

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	0/30	3/30		63.6 %	0.14 [0.01, 2.65]
Schnabel 1999	1/17	2/17		36.4 %	0.50 [0.05, 5.01]
Total (95% CI)	**47**	**47**		**100.0 %**	**0.27 [0.05, 1.59]**
Total events: 1 (Radiant), 5 (Incubator)					
Heterogeneity: Chi^2 = 0.45, df = 1 (P = 0.50); I^2 =0.0%					
Test for overall effect: Z = 1.45 (P = 0.15)					

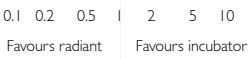
Analysis 1.18. Comparison 1 Radiant warmers vs incubators, Outcome 18 Serum sodium >150mmol/L.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 1 Radiant warmers vs incubators

Outcome: 18 Serum sodium >150mmol/L

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Meyer 2001	6/30	2/30		100.0 %	3.00 [0.66, 13.69]
Total (95% CI)	**30**	**30**		**100.0 %**	**3.00 [0.66, 13.69]**
Total events: 6 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.42 (P = 0.16)					



Analysis 2.1. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 1 Insensible water loss.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 1 Insensible water loss

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields							
Bell 1979	10	2.43 (0.76)	10	1.58 (0.82)		45.1 %	0.85 [0.16, 1.54]
Bell 1980	7	3.4 (1.5)	8	2.37 (1.15)		11.6 %	1.03 [-0.34, 2.40]
Marks 1980	9	1.98 (0.75)	9	0.97 (0.78)		43.3 %	1.01 [0.30, 1.72]
Subtotal (95% CI)	**26**		**27**			**100.0 %**	**0.94 [0.47, 1.41]**
Heterogeneity: Chi^2 = 0.12, df = 2 (P = 0.94); I^2 =0.0%							
Test for overall effect: Z = 3.96 (P = 0.000075)							
2 Radiant warmers with heat shields vs incubators without heat shields							
Bell 1980	6	3.37 (0.94)	8	2.37 (1.15)		100.0 %	1.00 [-0.10, 2.10]
Subtotal (95% CI)	**6**		**8**			**100.0 %**	**1.00 [-0.10, 2.10]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.79 (P = 0.074)							
3 Radiant warmers without heat shields vs incubators with heat shields							

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Bell 1980	7	3.4 (1.5)	7	2.13 (0.76)		100.0 %	1.27 [0.02, 2.52]
Subtotal (95% CI)	**7**		**7**			**100.0 %**	**1.27 [0.02, 2.52]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.00 (P = 0.046)							
4 Radiant warmers with heat shields vs incubators with heat shields							
Bell 1980	6	3.37 (0.94)	7	2.13 (0.76)		100.0 %	1.24 [0.30, 2.18]
Subtotal (95% CI)	**6**		**7**			**100.0 %**	**1.24 [0.30, 2.18]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.59 (P = 0.0097)							
Test for subgroup differences: Chi^2 = 0.48, df = 3 (P = 0.92), I^2 =0.0%							

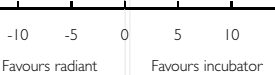
Analysis 2.2. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 2 Oxygen consumption (mL/kg/min).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 2 Oxygen consumption (mL/kg/min)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields							
Bell 1980	7	7.73 (0.52)	8	7.38 (0.93)		23.1 %	0.35 [-0.40, 1.10]
Darnall 1978	10	6.33 (1.8)	10	6.23 (1.69)		5.6 %	0.10 [-1.43, 1.63]
LeBlanc 1982	16	7.45 (1.76)	16	6.84 (1.48)		10.3 %	0.61 [-0.52, 1.74]
Marks 1980	9	5.77 (0.5)	9	5.54 (0.58)		52.1 %	0.23 [-0.27, 0.73]
Marks 1986	13	8.64 (1.3)	13	8.67 (1.8)		8.9 %	-0.03 [-1.24, 1.18]
Subtotal (95% CI)	**55**		**56**			**100.0 %**	**0.27 [-0.09, 0.63]**
Heterogeneity: Chi^2 = 0.70, df = 4 (P = 0.95); I^2 =0.0%							
Test for overall effect: Z = 1.45 (P = 0.15)							
2 Radiant warmers with heat shields vs incubators without heat shields							
Bell 1980	6	7.33 (0.58)	8	7.38 (0.93)		100.0 %	-0.05 [-0.84, 0.74]
Subtotal (95% CI)	**6**		**8**			**100.0 %**	**-0.05 [-0.84, 0.74]**



(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: not applicable							
Test for overall effect: Z = 0.12 (P = 0.90)							
3 Radiant warmers without heat shields vs incubators with heat shields							
Bell 1980	7	7.73 (0.52)	7	7.78 (1.01)		100.0 %	-0.05 [-0.89, 0.79]
Subtotal (95% CI)	**7**		**7**			**100.0 %**	**-0.05 [-0.89, 0.79]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.12 (P = 0.91)							
4 Radiant warmers with heat shields vs incubators with heat shields							
Bell 1980	6	7.33 (0.58)	7	7.78 (1.01)		100.0 %	-0.45 [-1.33, 0.43]
Subtotal (95% CI)	**6**		**7**			**100.0 %**	**-0.45 [-1.33, 0.43]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.00 (P = 0.32)							
Test for subgroup differences: Chi^2 = 2.57, df = 3 (P = 0.46), I^2 =0.0%							

Analysis 2.3. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 3 Time to regain birthweight (days).

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 3 Time to regain birthweight (days)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields							
Schnabel 1999	15	13.14 (6.54)	15	13.79 (4.17)		35.9 %	-0.65 [-4.58, 3.28]
Subtotal (95% CI)	**15**		**15**			**35.9 %**	**-0.65 [-4.58, 3.28]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.32 (P = 0.75)							
2 Radiant warmers with heat shields vs incubators without heat shields							
Meyer 2001	30	14.1 (5.7)	30	12.4 (5.9)		64.1 %	1.70 [-1.24, 4.64]
Subtotal (95% CI)	**30**		**30**			**64.1 %**	**1.70 [-1.24, 4.64]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.14 (P = 0.26)							
Total (95% CI)	**45**		**45**			**100.0 %**	**0.86 [-1.49, 3.21]**

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Radiant N	Mean(SD)	Incubator N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: Chi^2 = 0.88, df = 1 (P = 0.35); I^2 =0.0%							
Test for overall effect: Z = 0.71 (P = 0.47)							
Test for subgroup differences: Chi^2 = 0.88, df = 1 (P = 0.35), I^2 =0.0%							

Analysis 2.4. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 4 Infection - suspected or proven.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 4 Infection - suspected or proven

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields					
Schnabel 1999	8/15	11/15		39.3 %	0.73 [0.41, 1.28]
Subtotal (95% CI)	**15**	**15**		**39.3 %**	**0.73 [0.41, 1.28]**
Total events: 8 (Radiant), 11 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.11 (P = 0.27)					
2 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	18/30	17/30		60.7 %	1.06 [0.69, 1.62]
Subtotal (95% CI)	**30**	**30**		**60.7 %**	**1.06 [0.69, 1.62]**
Total events: 18 (Radiant), 17 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.26 (P = 0.79)					
Total (95% CI)	**45**	**45**		**100.0 %**	**0.93 [0.66, 1.30]**
Total events: 26 (Radiant), 28 (Incubator)					
Heterogeneity: Chi^2 = 1.08, df = 1 (P = 0.30); I^2 =8%					
Test for overall effect: Z = 0.43 (P = 0.67)					

Analysis 2.5. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 5 Infection - positive blood culture.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 5 Infection - positive blood culture

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	3/30	5/30		100.0 %	0.60 [0.16, 2.29]
Total (95% CI)	**30**	**30**		**100.0 %**	**0.60 [0.16, 2.29]**
Total events: 3 (Radiant), 5 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.75 (P = 0.45)					

Analysis 2.6. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 6 Necrotising enterocolitis.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

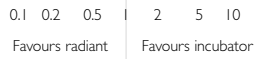
Outcome: 6 Necrotising enterocolitis

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields					
Schnabel 1999	3/15	1/15		22.2 %	3.00 [0.35, 25.68]
Subtotal (95% CI)	**15**	**15**		**22.2 %**	**3.00 [0.35, 25.68]**
Total events: 3 (Radiant), 1 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.00 (P = 0.32)					
2 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	0/30	3/30		77.8 %	0.14 [0.01, 2.65]
Subtotal (95% CI)	**30**	**30**		**77.8 %**	**0.14 [0.01, 2.65]**
Total events: 0 (Radiant), 3 (Incubator)					
Heterogeneity: not applicable					

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Test for overall effect: Z = 1.31 (P = 0.19)					
Total (95% CI)	**45**	**45**		**100.0 %**	**0.78 [0.20, 3.00]**
Total events: 3 (Radiant), 4 (Incubator)					
Heterogeneity: Chi^2 = 2.81, df = 1 (P = 0.09); I^2 =64%					
Test for overall effect: Z = 0.36 (P = 0.72)					



Analysis 2.7. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 7 Patent ductus arteriosus.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 7 Patent ductus arteriosus

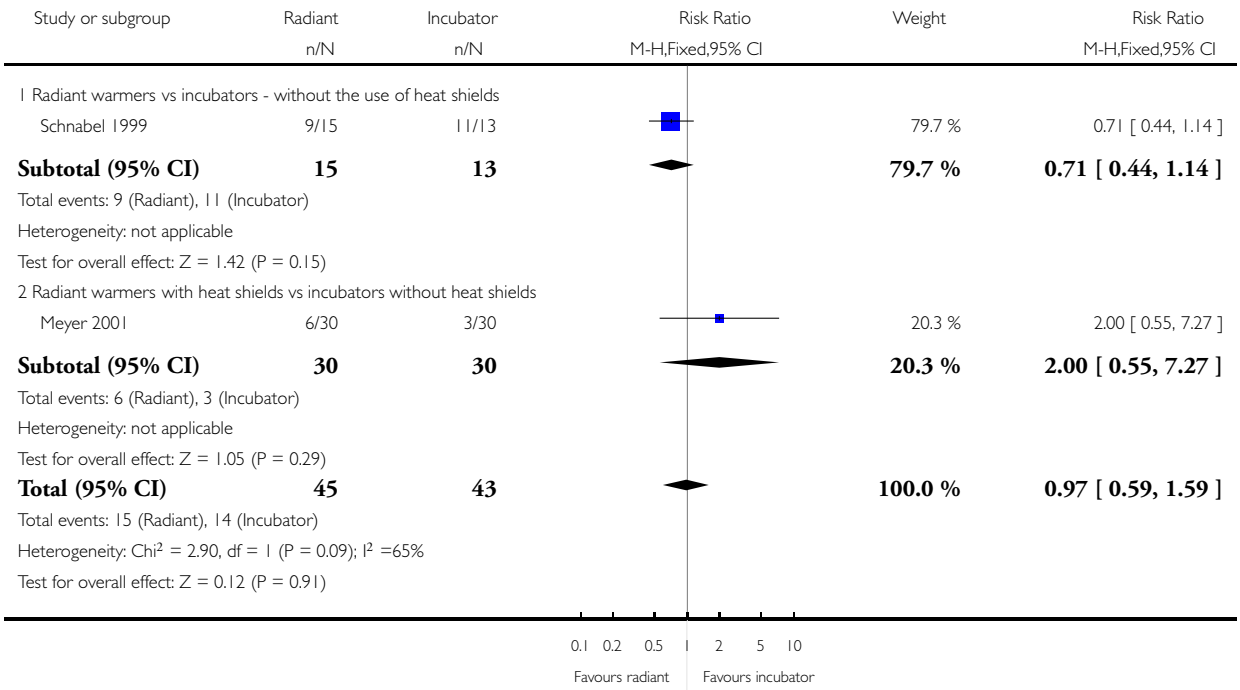
Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields					
Schnabel 1999	3/15	2/15		28.6 %	1.50 [0.29, 7.73]
Subtotal (95% CI)	**15**	**15**		**28.6 %**	**1.50 [0.29, 7.73]**
Total events: 3 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.48 (P = 0.63)					
2 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	4/30	5/30		71.4 %	0.80 [0.24, 2.69]
Subtotal (95% CI)	**30**	**30**		**71.4 %**	**0.80 [0.24, 2.69]**
Total events: 4 (Radiant), 5 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.36 (P = 0.72)					
Total (95% CI)	**45**	**45**		**100.0 %**	**1.00 [0.38, 2.62]**
Total events: 7 (Radiant), 7 (Incubator)					
Heterogeneity: Chi^2 = 0.36, df = 1 (P = 0.55); I^2 =0.0%					
Test for overall effect: Z = 0.0 (P = 1.0)					

Analysis 2.8. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 8 Retinopathy of prematurity - all stages.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 8 Retinopathy of prematurity - all stages

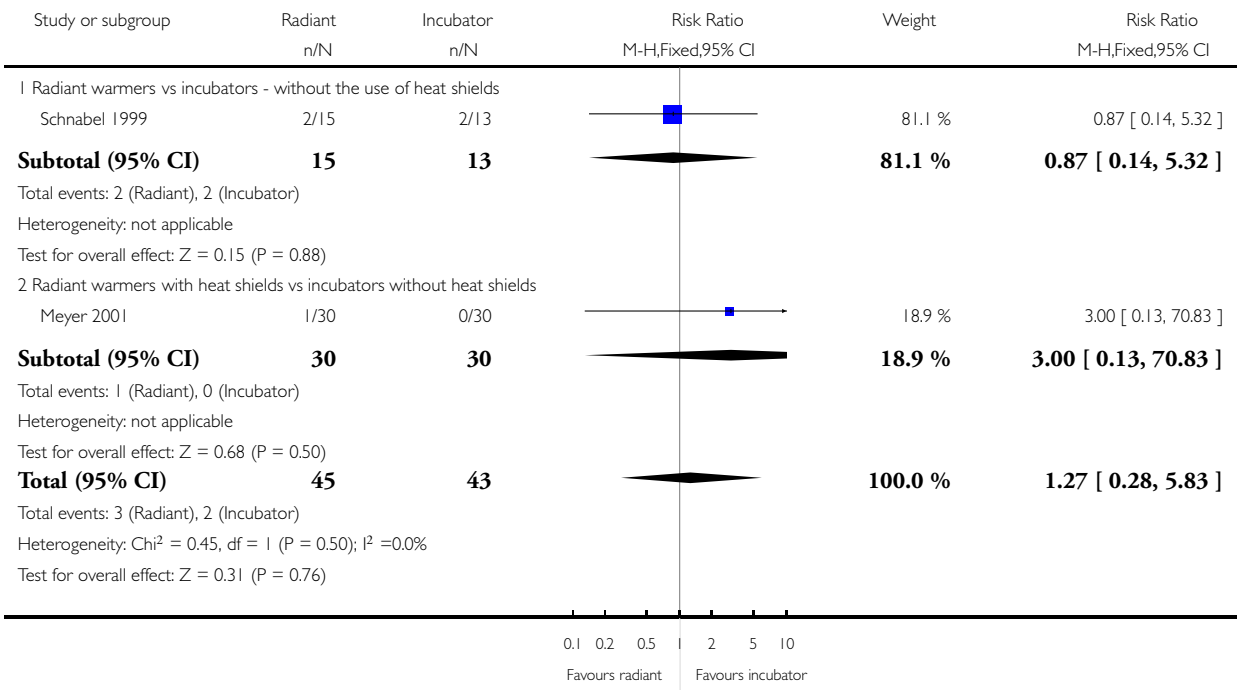


Analysis 2.9. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 9 Retinopathy of prematurity - Stages III and IV.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 9 Retinopathy of prematurity - Stages III and IV



Analysis 2.10. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 10 Intraventricular haemorrhage - all grades.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 10 Intraventricular haemorrhage - all grades

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields					
Schnabel 1999	0/15	1/15		17.6 %	0.33 [0.01, 7.58]
Subtotal (95% CI)	**15**	**15**		**17.6 %**	**0.33 [0.01, 7.58]**
Total events: 0 (Radiant), 1 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.69 (P = 0.49)					
2 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	6/30	7/30		82.4 %	0.86 [0.33, 2.25]
Subtotal (95% CI)	**30**	**30**		**82.4 %**	**0.86 [0.33, 2.25]**
Total events: 6 (Radiant), 7 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.31 (P = 0.75)					
Total (95% CI)	**45**	**45**		**100.0 %**	**0.76 [0.31, 1.91]**
Total events: 6 (Radiant), 8 (Incubator)					
Heterogeneity: Chi^2 = 0.32, df = 1 (P = 0.57); I^2 =0.0%					
Test for overall effect: Z = 0.57 (P = 0.57)					

Analysis 2.11. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 11 Intraventricular haemorrhage - Grades 3 and 4.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 11 Intraventricular haemorrhage - Grades 3 and 4

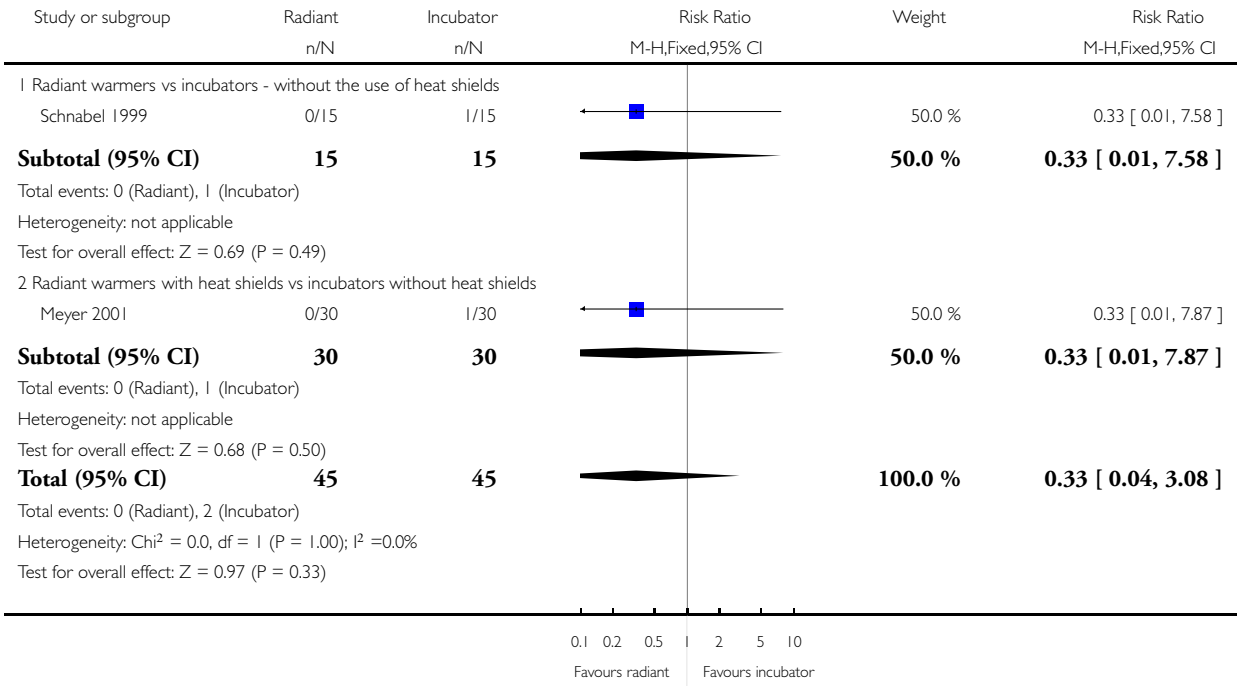
Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields				
Schnabel 1999	0/15	0/15		0.0 [0.0, 0.0]
Subtotal (95% CI)	**15**	**15**		**0.0 [0.0, 0.0]**
Total events: 0 (Radiant), 0 (Incubator)				
Heterogeneity: not applicable				
Test for overall effect: Z = 0.0 (P < 0.00001)				
2 Radiant warmers with heat shields vs incubators without heat shields				
Meyer 2001	0/30	1/30		0.33 [0.01, 7.87]
Subtotal (95% CI)	**30**	**30**		**0.33 [0.01, 7.87]**
Total events: 0 (Radiant), 1 (Incubator)				
Heterogeneity: not applicable				
Test for overall effect: Z = 0.68 (P = 0.50)				
Total (95% CI)	**45**	**45**		**0.33 [0.01, 7.87]**
Total events: 0 (Radiant), 1 (Incubator)				
Heterogeneity: Chi² = 0.0, df = 0 (P = 1.00); I² =0.0%				
Test for overall effect: Z = 0.68 (P = 0.50)				

Analysis 2.12. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 12 Cerebral cystic lesions.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 12 Cerebral cystic lesions



Analysis 2.13. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 13 Chronic lung disease.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 13 Chronic lung disease

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	0/30	2/30		100.0 %	0.20 [0.01, 4.00]
Total (95% CI)	**30**	**30**		**100.0 %**	**0.20 [0.01, 4.00]**
Total events: 0 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.05 (P = 0.29)					

Analysis 2.14. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 14 Neonatal death.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 14 Neonatal death

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers vs incubators - without the use of heat shields					
Schnabel 1999	1/17	2/17		36.4 %	0.50 [0.05, 5.01]
Subtotal (95% CI)	**17**	**17**		**36.4 %**	**0.50 [0.05, 5.01]**
Total events: 1 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.59 (P = 0.56)					
2 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	0/30	3/30		63.6 %	0.14 [0.01, 2.65]
Subtotal (95% CI)	**30**	**30**		**63.6 %**	**0.14 [0.01, 2.65]**
Total events: 0 (Radiant), 3 (Incubator)					
Heterogeneity: not applicable					

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Test for overall effect: Z = 1.31 (P = 0.19)					
Total (95% CI)	**47**	**47**		**100.0 %**	**0.27 [0.05, 1.59]**
Total events: 1 (Radiant), 5 (Incubator)					
Heterogeneity: Chi^2 = 0.45, df = 1 (P = 0.50); I^2 =0.0%					
Test for overall effect: Z = 1.45 (P = 0.15)					

Analysis 2.15. Comparison 2 Radiant warmers vs incubators - subgrouped by use of heat shields, Outcome 15 Serum sodium >150mmol/L.

Review: Radiant warmers versus incubators for regulating body temperature in newborn infants

Comparison: 2 Radiant warmers vs incubators - subgrouped by use of heat shields

Outcome: 15 Serum sodium >150mmol/L

Study or subgroup	Radiant n/N	Incubator n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Radiant warmers with heat shields vs incubators without heat shields					
Meyer 2001	6/30	2/30		100.0 %	3.00 [0.66, 13.69]
Total (95% CI)	**30**	**30**		**100.0 %**	**3.00 [0.66, 13.69]**
Total events: 6 (Radiant), 2 (Incubator)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.42 (P = 0.16)					

WHAT'S NEW

Last assessed as up-to-date: 12 January 2005.

13 February 2009	Amended	Updated contact details

HISTORY

Protocol first published: Issue 2, 1997

Review first published: Issue 1, 1998

16 October 2008	Amended	Converted to new review format.
28 January 2005	New search has been performed	This review updates the existing review "Radiant warmers versus incubators for regulating body temperature in newborn infants" published in The Cochrane Library, Issue 1, 1998 and substantively updated in Issue 3, 2003 (Flenady 2003) with additional data for two of the included studies incorporated into the review and one trial which was awaiting assessment subsequently excluded. No new trials were identified in the search updated to January 2005, and as a result no substantive changes were made to the review
17 June 2003	New citation required but conclusions have not changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

The reviewers worked collaboratively and equally on each stage of the review.

DECLARATIONS OF INTEREST

None

SOURCES OF SUPPORT

Internal sources

- Centre for Clinical Studies - Women's and Children's Health, Mater Hospital, South Brisbane, Queensland, Australia.
- J P Kelly Research Foundation, Mater Hospital, South Brisbane, Queensland, Australia.
- Department of Neonatology, Mater Mothers' Hospital, South Brisbane, Queensland, Australia.

External sources

- Commonwealth Department of Health and Ageing, Canberra, Australian Capital Territory, Australia.

INDEX TERMS

Medical Subject Headings (MeSH)

*Body Temperature Regulation; *Heating [instrumentation]; *Incubators, Infant; Infant, Newborn

MeSH check words

Humans