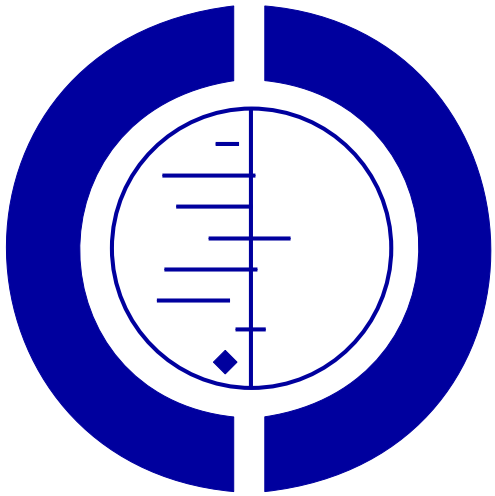
Transfer of preterm infants from incubator to open cot at lower versus higher body weight (Review)

New K, Flenady V, Davies MW



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ABSTRACT

Background
The use of incubators in helping to maintain a thermoneutral environment for preterm infants has become routine practice in neonatal nurseries. As one of the key criteria for discharging preterm infants from nurseries is their ability to maintain temperature, the infant will need to make the transition from incubator to open cot at some time before discharge. The timing of this transition is important because when an infant is challenged by cold, the infant attempts to increase its heat production to maintain body temperature. The increase in energy expenditure may affect weight gain. The practice of transferring infants from incubators to open cots usually occurs once a weight of around 1700-1800 g has been reached; however, this practice varies widely among neonatal units. This target weight appears to be largely based on tradition or the personal experience of clinicians, with little consideration of the infant's weight or gestational age at birth.

Objectives
The main objective was to assess the effects on weight gain and temperature control of a policy of transferring preterm infants from incubator to open cot at lower versus higher body weight.

Search strategy
Searches were undertaken of MEDLINE from June 2003 back to 1966, CINAHL from June 2003 back to 1987 and the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2003). The title and abstract of each retrieved study were examined to assess eligibility. If there was uncertainty, the full paper was examined.

Selection criteria
Trials in which preterm infants were randomly allocated to a policy of transfer from incubators to open cots at a lower body weight versus at a higher body weight.

Data collection and analysis
Quality assessments and data extraction for included trials were conducted independently by the reviewers. Data for individual trial results were analysed using relative risk (RR) and mean difference (MD). Results are presented with 95% confidence intervals (CI). Due to insufficient data, meta-analysis could not be undertaken.

Main results
Four studies were identified as potentially eligible for inclusion in this review. Two studies were excluded as random allocation to the exposure was not employed. One study is pending, awaiting additional information from the authors. Therefore, one study involving 60 preterm infants, employing a matched-pairs design, which compared the transfer of infants to open cots at 1700 g versus 1800 g, is included in this review. Only two outcomes could be included from this study; return to incubator and daily weight gain. No statistically significant difference was shown for either return to incubator (RR 2.00, 95% CI 0.40 to 10.11) or daily weight gain [MD 4.00 g/day (95% CI -5.23, 13.23)]. Due to small numbers, effects on clinically important outcomes could not be adequately assessed.

Authors' conclusions

There is currently little evidence from randomised trials to inform practice on the preferred weight for transferring preterm infants from incubators to open cots. There is a need for larger randomised controlled trials to address this deficiency.

PLAIN LANGUAGE SUMMARY

Not enough evidence on whether to transfer preterm infants from an incubator to open cot at a lower body weight

For preterm infants to be discharged home from nurseries, they must be able to maintain their temperature in an open cot. The timing of the transfer from the incubator to an open cot is important because if an infant is not able to maintain his/her temperature and is cold, then this could affect weight gain and delay the infant's discharge from hospital. Usually infants are transferred when their weight is around 1700-1800 grams. Earlier transfer at a lower body weight may have benefits of better access to the baby by the family and earlier discharge from hospital. Due to the poor quality of the trials in this review, there is not enough evidence to show whether transfer is better or worse at a lower body weight than at a higher body weight. Good quality trials are needed.

BACKGROUND

Preterm infants are cared for in a neutral thermal environment to prevent thermal cold stress so that minimal energy is expended, thereby minimising oxygen and energy consumption. Since improved survival of small infants cared for in warmer environments was demonstrated over 40 years ago (Silverman 1957; Silverman 1958; Silverman 1963), maintaining a thermoneutral environment for preterm infants with the use of incubator care has became routine practice in neonatal nurseries. However, at some point during hospitalisation the infant will need to make the transition from incubator to open cot. One of the key criteria for discharging preterm infants from nurseries is their ability to maintain temperature once transferred to an open cot. The timing of this transition is important because when an infant is challenged by cold, the infant attempts to increase its heat production to maintain body temperature. Vasoconstriction occurs as the infant attempts to conserve body heat and brown adipose tissue is metabolised. The increase in energy expenditure may affect weight gain. Exposure of growing preterm infants to a subthermoneutral environmental temperature in the late neonatal period results in a slowing of growth through an increase in energy expenditure (Glass 1969).

The practice of transferring infants from incubators to open cots varies widely among neonatal units, with no clear indication as to when or how this transition should take place. The usual practice is to transfer infants to open cots once a weight of around 1700-1800 g has been reached. This target weight appears to be largely based on tradition or the personal experience of clinicians with little consideration of the infant's weight or gestational age at birth. The main factors determining the preterm infant's post natal thermal stability are: (i) degree of prematurity - the more immature the infant, the thinner the skin, the less subcutaneous fat and the greater the surface area/weight ratio; (ii) birth weight - small for gestational age or lower birth weight also results in less subcutaneous fat for insulation and thermogenesis and the greater the surface area/weight ratio; (iii) postnatal age - thermo stability increases with postnatal age (McManus Kuller 1998).

Delaying transition to an open cot on the basis of not reaching a certain arbitrary weight criterion may result in longer hospitalisation than necessary, thus increasing the cost of care provided (Wilson 1998). Maternal perceptions of their infants may influence infant development (Watt 1989). Maternal perceptions may be more positive when infants are cared for in an open cot due to ease of access promoting autonomy for parents and improving parent-infant attachment, which may improve breast feeding rates. Nursing staff may perceive that caring for infants in open cots reduces workload and that better care may be provided due to increased accessibility.

While there may be benefits of earlier transfer to an open cot, there may be potential risks. Transferring infants from an incubator to an open cot before an infant is ready may result in the infant's inability to maintain temperature, leading to weight loss, resulting in extended hospitalisation and adding to the cost of care (Wilson 1998). The need for an infant to return to an incubator after making the transition to an open cot may also result in increased stress and anxiety to the parents and family.

A number of measures have been suggested to assist in the maintenance of body temperature when transferring infants from incubators to open cots. These measures have included a gradual weaning process in which infants are dressed in clothing and the incubator air temperature is reduced, thus thermally challenging the infant prior to transfer to an open cot (Wilson 1998), the use of heated water-filled mattresses and heated nurseries (Gray 2003).

Open cots are relatively inexpensive compared to the cost of air-heated incubators. Considerable economic benefit could result in both developing and developed countries, if it could be demon-

strated that transfer of an infant to an open cot at a lower body weight could be achieved without adverse outcome.

OBJECTIVES

Primary:
To determine the effects of a policy of transferring preterm infants at lower versus higher body weight on the outcomes of weight gain and temperature control. Secondary outcomes investigated will include duration from transfer to cot to discharge home (days); postnatal age at discharge (days); cost; not breast feeding at hospital discharge; parental satisfaction; parental anxiety; death.

Secondary:
To conduct sub group analysis to determine if the effects of a policy of transferring preterm infants from incubators to open cots at lower versus higher body weight differ for those infants who were:

i. born less than 1000 g or greater than or equal to 1000 g
ii. born at less than 34 weeks gestational age or greater than or equal to 34 weeks gestational age
iii. less than or greater than or equal to seven postnatal age at the time of transfer

Sub group analysis will also be conducted to determine if the results differ with the use of co-interventions:
i. use of additional heating measures i.e. heated water filled mattresses, heated nurseries, overhead heating device
ii. use of thermal challenging prior to transfer (i.e. gradual reduction the incubator temperature with increasing the infants clothing)

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

Trials in which infants were randomly allocated to a policy of transfer from incubators to open cots at a lower body weight versus at a higher body weight.

Types of participants

Preterm infants being nursed in incubators.

Types of intervention

Transferring or weaning of preterm infants from an incubator to an open cot at a lower body weight compared with higher body weight.
"Lower" is defined as transfer before reaching 1700 g, and "higher" is defined as transfer after reaching 1700 g or more.

Types of outcome measures

Primary:

- Weight gain (g/kg/day)
- Episodes of cold stress (e.g. temperature <36.3 degrees C) or requiring assistance with heating (i.e. overhead heater)
- Requiring to be returned to incubator

Secondary:

- Duration from transfer to cot to discharge home (days)
- Postnatal age at discharge (days)
- Length of hospital stay
- Cost
- Not breast feeding at hospital discharge
- Parental satisfaction
- Parental anxiety
- Death (by 28 days or prior to hospital discharge and also by 12 months if reported)

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Neonatal Group methods used in reviews.

The standard search strategy for the Cochrane Neonatal Review Group was used. See: Neonatal Review Group search strategy. This includes searches of electronic databases: The Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2003), CINAHL (1987 - 2003) and MEDLINE (1966 - 2003) .

In addition to the neonatal review group searches, searches of the electronic databases were based on the following search terms:

The MeSH terms 'Infant, Newborn' OR 'Nurseries, Hospital' OR 'Intensive Care Units, Neonatal'

AND
The MeSH terms 'Skin Temperature' OR 'Body Temperature' OR 'Body Temperature Regulation' OR the text word 'Therm*' OR 'Temperature'

AND
The MeSH term 'Incubators, Infant' OR the text words 'Cot' OR 'Crib' OR 'Isolette' OR 'Incubator' OR 'cot-nurs*'

AND
The highly sensitive search strategy developed by Kay Dickersin to identify RCTs (Dickersin 1994)

We also searched previous reviews including cross-references, abstracts, conference and symposia proceedings, expert informants, journal hand searching in the English language. No other language restrictions will apply.

The title and abstract of each retrieved study was examined to assess eligibility. If there was uncertainty, the full paper was examined.

METHODS OF THE REVIEW

Standard methods of the Cochrane Collaboration and its Neonatal Review Group were used.

Quality assessment:
Two of the three reviewers worked independently to search for trials for inclusion and all reviewers independently assessed methodological quality. Study quality was assessed using the following key criteria: blinding of allocation, blinding of intervention, completeness of follow up and blinding of outcome measurement, assigning a rating of 'Yes', 'No' or 'Cant tell' for each. Data were extracted independently by the reviewers. Differences were resolved by discussion and consensus of the reviewers.

Methods used to collect and synthesise data from included studies: Two of the three reviewers independently extracted data, then compared and resolved differences. The authors of one included trial (Sutter 1988) and one awaiting assessment (Heimler 1981) have been contacted for further information concerning outcomes and exclusions. Additional data requested include: whether blinded assessment of outcomes was undertaken (Heimler 1981; Sutter 1988), timing of exclusion of infants from the study (pre or post randomisation) (Heimler 1981), and allocation of excluded infants by treatment group (Heimler 1981; Sutter 1988). Any forthcoming information will be considered for inclusion in the next update of this review.

Due to insufficient data it was not possible to conduct a meta-analysis. For individual trials, where possible, mean differences and 95% confidence intervals (CI) are reported for data measured on a continuous scale. For categorical outcomes, relative risk and 95% confidence intervals (CI) are reported.

DESCRIPTION OF STUDIES

Four studies were identified as potentially eligible for inclusion in this review. Two studies were excluded as random allocation to the exposure was not employed (Medoff-Cooper 1994; Roncoli 1992). One study (Heimler 1981) is awaiting assessment pending further data on infants excluded from the study as 30% of the infants were excluded and it is not known whether these infants were excluded pre or post randomisation. Some of the infants were excluded due to apnoea and feeding problems which may have been associated with the intervention. Therefore, this review includes one eligible study (Sutter 1988).

Participants in the included trial were preterm infants (mean gestational ages 30.1 weeks and 28.6 weeks, mean birthweights 1207 g and 1215 g for the two study groups). Infants were cared for in a single-walled incubator and allocated to one of two study groups: Group 1 was transferred to an open cot at a weight of 1700 g and Group 2 at a weight of 1800 g, following a weaning process. Each infant was weaned gradually by decreasing the incubator temperature by 1^oC each hour until the incubator temperature reached 28^oC. Infants were clothed in a cotton shirt, with one or two blankets when moved into an open cot. If the infant's temperature dropped to less than 36^oC at any time during the weaning process or any time after, the infant was returned to an incubator and weaning could recommence 48 hours later. Nursery temperature was maintained at 22^oC. Infants were receiving feedings of 120 kcal/kg/day to 150 kcal/kg/day, via breast, bottle or gavage.

The main outcome measures were hypothermia requiring the infant to be returned to the incubator and weight gain (mean 24 hr weight gain). A third outcome, duration (days) from transfer to cot to discharge home, could not be included in this review as day of discharge was defined to be 24 hours after successful weaning from incubator to open cot, due to delayed discharge of some infants for social reasons. The weaning process as described above was deemed successful if the infant's temperature did not drop below 36^oC and the weaning process did not need to be stopped.

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

METHODOLOGICAL QUALITY

The included trial (Sutter 1988) used a matched-pairs design for allocation to study group. Infants were randomised in blocks of two, matched by birth weight in one of four strata (1251 to 1500 g; 1001 to 1250 g; 751 to 1000 g; and less than 751 g). The first eligible subject was randomly assigned to one treatment and the other subject in the pair was assigned to the other treatment when entered into the study. There was no blinding of allocation to treatment group, interventions were unable to be blinded and it is not known whether blinding of outcome measurements occurred. Sixty-two infants were enrolled in the study, but completeness of follow up did not occur as two infants were not included in the analysis as they did not have matching pairs. Four pairs of infants received the opposite treatment to that which was randomly allocated; however, an intention to treat analysis was performed.

The methodological quality of this study is considered to be poor.

RESULTS

The results of one trial with a total of 60 infants are included in this review (Sutter 1988). Only two outcomes could be reported from this study, return to incubator and daily weight gain. No statistically significant difference was found for either return to incubator (RR 2.00, 95% CI 0.40 to 10.11) or daily weight gain

[MD 4.00 g/day (95% CI -5.23, 13.23)]. Due to small numbers, effects on clinically important outcomes could not be adequately assessed and planned sub group analyses could not be undertaken.

DISCUSSION

This review includes one small randomised controlled trial of poor quality, involving 60 preterm infants (Sutter 1988). Only two outcomes were able to be included, return to incubator and daily weight gain. No statistically significant differences were shown for either return to incubator or daily weight gain for infants transferred from incubators to open cots at a lower body weight versus higher body weight. Although the authors of this trial concluded that earlier transfer appeared safe and effective, caution was expressed for those infants born less than 1000 g due to an increased rate of return to incubator. This conclusion was based on a subgroup analysis of the six infants born less than 1000 g. Due to this small number, planned subgroup analysis of infants born less than 1000 g was not undertaken in this review. Numbers are too small for these findings to be considered reliable.

Due to insufficient data and poor methodological quality, this trial does not provide reliable evidence to support or refute the transfer of preterm infants from incubators to open cots at a lower body weight versus at a higher body weight. Given that transferring preterm infants from incubators to open cots at a lower body weight may result in inability to maintain temperature, greater weight loss, extended hospitalisation and increase in the cost of care, this intervention needs to be assessed in rigorously designed trials.

Future trials should include a sufficient number of infants to address clinically important outcomes including temperature stability, weight gain, parental satisfaction, time to discharge and cost. It is hoped that the trial in progress (New 2003) will address some of these outcomes.

AUTHORS' CONCLUSIONS

Implications for practice

The results of this review do not provide sufficient evidence to guide clinical practice on the preferred weight for the transfer of preterm infants from incubators to open cots.

Implications for research

There is an urgent need for well designed randomised controlled trials to establish if there is any benefit in transferring preterm infants from incubators to open cots at a lower body weight and without significant harm.

Future studies should include sufficient numbers of infants to assess the effects of this intervention on the outcomes of temperature stability, weight gain, parental satisfaction, time to discharge and cost. Studies should also include sufficient numbers of infants born less than 1000 g to adequately assess these effects in this high-risk population.

POTENTIAL CONFLICT OF INTEREST

Two of the reviewers (Karen New & Mark Davies) are co- investigators of an ongoing randomised control trial in which preterm infants are transferred to an open cot at either 1600 g or 1800 g.

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- Centre for Clinical Studies, Mater Hospital, Brisbane AUSTRALIA
- Dept of Paediatrics and Child Health, University of Queensland, Brisbane AUSTRALIA

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Sutter TW, Phan D, Pierchala CE, Rishel W. Weaning of premature infants from the incubator to an open crib. *Journal of Perinatology* 1988;**8**:193–8.

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References to ongoing studies

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Watt J. Mothers' perceptions of their preterm neonates: some possible consequences. *NZ Family Physicians* 1989;**14**:95–7.

Wilson 1998

Wilson SK. Incubator to open crib: a three phase process. *Mother Baby Journal* 1998;**3**:7–26.

* *Indicates the major publication for the study*

TABLES

Characteristics of included studies

Study	Sutter 1988
Methods	Blinding of randomisation: no Blinding of intervention: no Completeness of follow up: no Blinding of outcome measure: unknown
Participants	60 preterm infants Mean gestational age 30.1 weeks and 28.6 weeks Mean birthweight 1207 g and 1215 g
Interventions	Matched-pairs design. Group 1 (intervention): infant weaned to an open cot at 1700 g Group 2 (control): infant weaned to an open cot at 1800 g Each infant weaned by decreasing incubator temperatue by 1oC each hour until 28oC reached. Infant then moved into an open cot. If infant's temperature dropped to less than 36oC, weaning stopped and recommenced 48 hours later. Nursery temperature maintained at 22oC. Infants clothed in a cotton shirt, with one or two blankets. Feedings of at least 120 kcal/kg/day
Outcomes	Weight gain, hypothermia requiring return to incubator, and days to discharge
Notes	The first infant of a matched pair was randomised, using a randomisation list; however, the clinical staff accessed the randomisation list and knew treatment assignment of the next eligible infant prior to recruitment. The second member of the pair was assigned the opposite treatment. Therefore, there was no blinding of allocation for either the first or second pair member. Day of discharge defined in study to be 24 hours after successful weaning due to delayed discharge of some infants for social reasons.
Allocation concealment	C

Characteristics of excluded studies

Medoff-Cooper 1994	Not a randomised controlled trial. A project that tested a research-based protocol to wean very low birth weight infants to an open crib.
Roncoli 1992	Not a randomised controlled trial. An overview of thermoregulation and principles related to weaning an infant to an open crib.

Characteristics of ongoing studies

Study	New 2003
Trial name or title	Transition from incubator to open cot: early versus late
Participants	Preterm infants born less than 1600 grams
Interventions	Infants randomised to either intervention or control group on first weight equal to or greater than 1600g. Intervention group transferred to open cot at 1600g; control group transferred to open cot at 1800g
Outcomes	Temperature stability; weight gain; time to discharge
Starting date	23rd June 2003
Contact information	Karen New

Characteristics of ongoing studies (*Continued*)

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Notes

ANALYSES

Comparison 01. Transfer from incubator to cot at lower versus higher body weight

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Return to incubator	1	60	Relative Risk (Fixed) 95% CI	2.00 [0.40, 10.11]
02 Daily weight gain (g/day)	1	60	Weighted Mean Difference (Fixed) 95% CI	4.00 [-5.23, 13.23]

INDEX TERMS

Medical Subject Headings (MeSH)

Body Temperature Regulation; *Body Weight; *Incubators, Infant; *Infant Equipment; Infant, Newborn; Infant, Premature [*physiology]; *Transportation of Patients; Weight Gain

MeSH check words

Humans

COVER SHEET

Title	Transfer of preterm infants from incubator to open cot at lower versus higher body weight
Authors	New K, Flenady V, Davies MW
Contribution of author(s)	All reviewers contributed equally to the development of this review.
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Review first published	2004/2
Date of most recent amendment	12 May 2004
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What's New	Information not supplied by author
Date new studies sought but none found	Information not supplied by author
Date new studies found but not yet included/excluded	Information not supplied by author
Date new studies found and included/excluded	Information not supplied by author
Date authors' conclusions section amended	Information not supplied by author
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GRAPHS AND OTHER TABLES

Analysis 01.01. Comparison 01 Transfer from incubator to cot at lower versus higher body weight, Outcome 01 Return to incubator

Review: Transfer of preterm infants from incubator to open cot at lower versus higher body weight

Comparison: 01 Transfer from incubator to cot at lower versus higher body weight

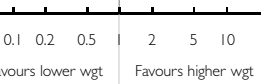
Outcome: 01 Return to incubator

Study	Lower body weight n/N	Higher body weight n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
Sutter 1988	4/30	2/30		100.0	2.00 [0.40, 10.11]
Total (95% CI)	30	30		100.0	2.00 [0.40, 10.11]

Total events: 4 (Lower body weight), 2 (Higher body weight)

Test for heterogeneity: not applicable

Test for overall effect z=0.84 p=0.4



Analysis 01.02. Comparison 01 Transfer from incubator to cot at lower versus higher body weight, Outcome 02 Daily weight gain (g/day)

Review: Transfer of preterm infants from incubator to open cot at lower versus higher body weight

Comparison: 01 Transfer from incubator to cot at lower versus higher body weight

Outcome: 02 Daily weight gain (g/day)