Hats for the newborn infant

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Summary and conclusions

The efficacy of a Gamgee-lined hat in reducing the rate of fall in rectal temperature of infants during the first 30 minutes of life was studied. The trial, which included 211 infants, was randomised, prospective, and controlled. One hundred and seven infants were exposed to overhead radiant heaters. Of these, only 30 had normal deliveries, so the analysis was confined to the infants who were not subjected to radiant heat, and in this group no conclusions were drawn about the efficacy of a hat or a radiant heater. In the 104 infants not subjected to radiant heat, body weight, initial rectal temperature, the application of hat, the environmental temperature, and the duration of exposure while naked were all found to influence measurably the rate of fall in rectal temperature during the first 30 minutes.

Gamgee-lined hats should be routinely used to minimise heat loss, especially in small infants exposed at birth, during surgical operations, and during investigations necessitating prolonged exposure.

Introduction

The mortality of newborn babies is dramatically reduced if they are kept warm.[1-4] In addition, Stanley and Alberman[5] state that respiratory distress ". . . could be reduced if particular attention were paid to the maintenance of body temperature."

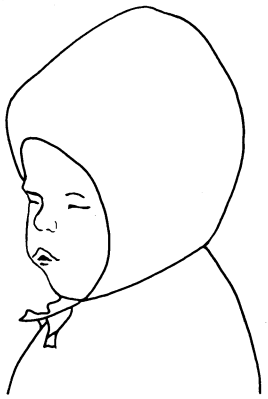
The brain of the newborn infant is a major heat-producing organ.[6] By November 1977 Stothers and Warner had completed investigations which were reported to the Neonatal Society on 2 February 1978. They found that a closely fitting Gamgee hat (see figure) as opposed to a stockinette hat provided the neonate with measurable thermal protection in a cool environment. Thus at 26°C infants wearing Gamgee hats had an oxygen consumption of 7·4 ml/kg/min compared with a consumption of 8·8 ml/kg/min in naked infants. The same insulation applied to the lower abdomen did not have a measurable effect.

As the time of the greatest heat loss is immediately after birth we decided to undertake a hat trial in newborn infants.

Methods

We measured the effect of head insulation in a prospective, randomised, controlled trial of hats. The trial was performed at the North Middlesex Hospital and was accepted by the hospital's obstetricians and paediatricians, its ethical committee, and its midwifery staff.

The trial was not conducted blind, for our ingenuity did not run to a control hat which had the appearance of the real article but which conferred no thermal insulation. We expected that birth weight, length of exposure, and several other variables would alter the baby's rate of heat loss. A balanced allocation of the treatments within strata was not considered feasible, partly because of its complexity and partly because of the need to apply the hat very soon after birth before many of the other relevant variables could be measured.



Area of head covered by woollen hat lined with a single layer of Gamgee (Vernaid gauze and cotton tissue, medium quality, Code No 1695).

The research nurse appointed to conduct the trial was provided with a separate sealed envelope containing instructions for each infant entering the trial, which she opened during the delivery. Each group of four envelopes contained equal numbers of control and experimental instructions, thus keeping the two groups matched for size at different seasons of the year.

At first we had hoped to obtain both the mother's and the infant's rectal temperatures, but the maternal measurement interfered too much with the conduct of the delivery and was abandoned. Once the baby had been delivered the research nurse started a stopwatch and inserted a thermistor probe into the rectum of the infant within one minute. The temperature was then recorded one to four minutes later. We could not fully define the environment of each labour ward, but the temperature was measured near the baby's crib in a position free from obvious draughts and overt infrared radiation. Notes were made of the time and the nature of all procedures carried out on the baby. The exposure time of a baby was the period before a nappy and nightgown had been applied and before the application of two to three blankets by the nurse. About half the nurses would routinely draw up a blanket in the form of a hood partially protecting the baby's head. The baby was normally given briefly to the mother at this time. Exposure time was increased by the baby being undressed for a clinical examination. Further readings of the baby's temperature and its environment were made at 30, 60, and 120 minutes.

After 30 minutes some babies were moved to a nursery, the special care unit, or an incubator at the discretion of the medical or nursing staff. We therefore confined the analysis of our results to the first half hour of life and used the precise time interval between readings to calculate the rate of temperature fall in °C per hour. Notes were made of any other interventions such as the switching on of overhead radiant heating for the baby. It seemed best that the staff should exercise their own skill and judgment in caring for the infants by these various interventions, even if it seemed to the research nurse that babies without hats were more often given extra heating.

Results

Two hundred and twenty-eight babies entered the trial from January to December 1978. Seventeen of these babies were later excluded from the analysis because of gross abnormality of the baby,

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maternal pyrexia, the baby being placed in an incubator, or failure of the recording system. Thus 211 eligible infants were left in the trial. The nursing staff of the maternity unit chose to expose 107 of these babies to a radiant heater for varying periods. While the lengths of such exposure were recorded it was not possible to obtain a measure of the quantity of radiation each infant received. In addition, although there were no differences in body weight, initial temperature, or exposure this group of 107 infants contained a higher proportion of infants who had had operative deliveries: there had been 50 caesarian sections and 27 forceps deliveries in this group, compared with only three caesarian sections and 21 forceps deliveries in the 104 infants not exposed to radiant heaters.

Because of these differences between the radiant heater and non-radiant heater groups we confined the present analysis to the latter 104 infants.

The frequency with which nurses partially covered infants' heads with blankets did not differ significantly between the hat and no hat groups. There were no babies of less than 2000 g body weight in this study, the range being 2180 to 4560 g.

The data were first examined to see how variables determining loss of heat were distributed between the hat and no hat groups (table I). There was no significant difference between the two groups in body weight, initial body temperature, environmental temperature, or exposure time. The rate of fall in rectal temperature in the hat group (1·40 ± 0·09 (SE)°C/h) was significantly lower ($P < 0·005$) than the value in the no hat group (1·86 ± 0·12°C/h).

TABLE I—*Comparison of hat and no hat groups. Values are means ± SE of mean*

	Hat	No hat
No of infants	54	50
Body weight (g)	3340*	3190*
Initial body temperature (°C)	37·20 ± 0·06	37·24 ± 0·06
Environmental temperature (°C)	24·68 ± 0·22	24·84 ± 0·29
Exposure time (min)	7·17 ± 0·56	7·24 ± 0·54

*Median value because of skewed distribution in no hat group.

Differing combinations of the four independent variables shown in table I and the degree of insulation provided by the presence or absence of a hat will all influence the rate of temperature fall in any individual infant. Consequently, the effect of all these variables in combination was analysed by multiple regression using computer programs BMDO2R and BMDO3R.[7] Temperature fall over the first 30 minutes expressed in °C/h was taken as the dependent variable (y). Independent variables (x_{1-6}) were body weight, initial temperature, "hattedness" (scored as 0 or 1), environmental temperature, exposure time, and the serial number of accession to the trial (table II). The

TABLE II—*Results of multiple regression of the rate of temperature fall in °C/h (y) against independent variables (x_{1-6})*

	Mean	Regression coefficient	t	P
x_1 Body weight (g)	3312	−0·615	−3·975	<0·001
x_2 Initial temperature (°C)	37·221	+0·555	3·444	<0·001
x_3 Hattedness (0-1)	0·519	−0·425	−3·297	<0·005
x_4 Environmental temperature (°C)	24·755	−0·183	−5·005	<0·001
x_5 Exposure time (min)	7·202	+0·067	4·131	<0·001
x_6 Accession number	118·644	+0·0001	0·115	NS

last variable was included to detect time-dependent variation (such as seasonal temperature or change in nursing practice) within the trial.

Examination of the distributions of residuals about the estimate showed no departure from randomness or anything to suggest that a better fit could be achieved from a non-linear combination of the dependent variables. Fall in temperature related significantly to all the independent variables except for accession number. Thus, wearing a hat was inversely related to the rate of fall in temperature to a highly significant degree. The full regression equation may be written as:

$$\text{Rate of fall in rectal temp (y)} = -12·746 - 0·615x_1 + 0·555x_2 - 0·425x_3 \text{ (hattedness)} - 0·183x_4 + 0·067x_5$$

From this it can be seen that wearing a hat reduced the rate of fall in temperature over this period by 0·42°C per hour.

Discussion

To turn table II into words one may state that large babies cool more slowly and that an increased baby-environment temperature differential causes a greater fall in rectal temperature, as does being naked for a longer time in a thermally hostile environment. None of these facts are new and they all conform to Newton's law of cooling. The new fact is that even when all these variables are taken into account the hats used in this study significantly diminished the rate of cooling of the infant. Although this trial did not include very small babies (who were put in incubators), there is every reason to conclude that the effect of a hat would be greater in such infants, who have a greater surface:volume ratio and a relatively larger brain. Where the delivery conditions are more adverse than those at the North Middlesex Hospital the hat should offer useful protection against cooling. It should also offer advantages to the infant during surgical operations and investigative procedures necessitating prolonged exposure.

We suggest that Gamgee-lined hats should be routinely used for abnormally fragile babies but would sound a warning that they could be dangerous if left on carelessly when the baby is placed in an incubator which is genuinely providing a thermoneutral environment.[8]

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ONE HUNDRED YEARS AGO A few days ago, I attended a poor woman in her first confinement, who was delivered, after a long tedious labour, of a female child, small but healthy in appearance, and with a very strong cry. To my great surprise, I found the colon and nearly the whole of the small intestines outside of the abdomen, from which they had escaped by an opening about an inch and a half below and a little to the right of the umbilicus. The protruded intestines were distended with flatus, granular in appearance and of a dark colour, congested doubtless from constriction at the narrow opening of exit, which was so small that I had to enlarge it with a bistoury in order to return the displaced mass of intestines. This being done (although with much difficulty) I closed the wound with silver wire sutures and applied a pad and bandage, and left the child. Returning again a few hours afterwards, I found it had taken the breast very readily, and appeared to be doing very well; but, on my visit the following morning, I ascertained that some castor-oil had been given, after which the child was much worse, and it died thirty hours after birth.

In considering this curious case, it is quite evident, from the congested appearance of the intestines and from the thickening round the opening at the point of exit, that the extrusion must have taken place some time previously to the birth of the child. The question is: How long—also, under what circumstances? It is a puzzle to me, and such a case never occurred before in my practice nor in that of my lather, who assisted me in the operation, and who has attended about three thousand cases of midwifery; nor have I heard of a similar case. (*British Medical Journal*, 1879.)