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EVAPORATIVE WATER LOSS IN THE NEW-BORN BABY

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SUMMARY

1. Measurements of total evaporative water loss (EWL) were made on sixty-three premature and full-term babies 0–65 days after birth within a closed Perspex chamber under varied environmental conditions by measuring the flow and absolute humidity of air entering and leaving the chamber. Control experiments suggested that the method underestimated loss by about 5%. Measurements of O_2 consumption were made concurrently by recording the volume change of the closed gas circuit.

2. The total basal EWL averaged 10·8 g H_2O/m^2.hr in infants 2–10 days old when ambient water vapour pressure (P_{H_2O}) was 18 mm Hg; basal EWL was correlated with basal metabolic rate at all ages studied and evaporative heat loss accounted for ~ 23 % of basal heat production.

3. Respiratory water loss was measured by detecting the water added to air at 33° C passed across the face of eight infants in a trunk plethysmograph. Respiratory water loss was inversely related to the water vapour content of the inspired air; gas appeared to leave the nose ~ 95% sat. at 35·6° C.

4. Measurements of total EWL were obtained when humidity was varied and skin loss was calculated by subtracting estimated respiratory loss from total loss; changing P_{H_2O} from 7 to 25 mm Hg appeared to decrease basal skin water loss by only 1·5 g/m^2.hr.

5. No consistent changes in EWL were obtained when environmental temperature (T_E) was varied between 28 and 34° C. Active sweating occurred in infants 0–10 days old born within 3 weeks of term when T_E exceeded 34–35° C and rectal temperature (T_R) rose above 37·2° C. The threshold rectal temperature at which sweating was detected fell significantly in the first 10 days of life; EWL increased two to fourfold when T_R rose to between 37·5 and 37·8° C.

6. In infants of less than 215 days post-conceptual age (term ~ 268 days) EWL increased less than 50% at T_R 37·7–37·8° C; it is concluded that the sweating mechanism is defective in these infants.

INTRODUCTION

Insensible water loss from the skin and respiratory tract is an important channel for heat loss in man; this evaporative loss from the body can be further augmented in a controlled manner by sweating. A knowledge of evaporative water loss under varying environmental conditions is therefore essential in any study of temperature control in the new-born human baby. Values for basal evaporative water loss in the first year of life were established by Levine, Kelly & Wilson (1930): the subjects were dressed and asleep under normal room conditions and the water loss was estimated by weighing. Few babies have been studied in the first week of life, and the way in which their total evaporative water loss varies with environmental temperature has never been established. Even less is known about basal water loss or sweat function in prematurely born babies.

The closed-circuit metabolic chamber of Hill & Rahimtulla (1965) has therefore been modified in order to measure the basal water loss of mature and premature infants. We have determined the variation in evaporative water loss that occurs when environmental temperature or humidity is altered; the relationship of sweat function to post-conceptual age has also been examined.

METHODS

A total of sixty-three healthy mature and premature babies of known gestation have been studied with the consent and co-operation of their parents, after delivery in the maternity wards of The London Hospital. Three of the infants were receiving prophylactic antibiotics, but none was on other drugs or sedated in any way. The weight of each infant (W) in grams was measured immediately before study, and the surface area (S) in square centimetres estimated from the formula

$$S = 4{\cdot}688\,W^{(0{\cdot}8168 - 0{\cdot}0154 \log W)}$$

derived by Boyd (1935). The infant's post-natal age was calculated from the time and date of delivery, while the post-conceptual age was taken as originating with ovulation an average of 14 days after the first day of the mother's last menstrual period. This date was confirmed by physical assessment (Usher, McLean & Scott, 1966) and sequential neurological examination of the infant (Brett, 1965; Robinson, 1966; Babson & McKinnon, 1967). Gestation was accepted as having reached term 268 days after the calculated date of conception (Stewart, 1952). Where, after full assessment, any genuine doubt remained as to the infant's period of gestation, the results obtained were set aside.

The infants wore nothing except a thin napkin weighing less than 6 g and a small carefully applied urine bag (Baldwin, Clayton, Jenkins, Mitchell & Renwick, 1962). They were placed in a Perspex metabolic chamber (Hill & Rahimtulla, 1965) in which the environment could be exactly specified and easily controlled. The construction of the chamber and the methods used to define environmental temperature have been described previously (Hey, 1969). Mean air temperature never differed from the mean temperature of the inner surface of the chamber walls by more than 1·1° C. Oxygen concentration was monitored with a paramagnetic oxygen meter; it was shown to be constant, and close to that of room air. Air movement within the chamber with a baby present was between 4 and 5 cm/sec. Absolute humidity was changed by varying the temperature of the water circulating around the condenser (Fig. 1). Measurements of oxygen consumption and evaporative water loss were made over periods of 10–20 min after the environmental temperature became stable. The estimates of metabolic rate thus obtained were expressed in kcal/m^2.hr, on the assumption that 1 l. O_2 at s.t.p.d. is equivalent to 4·83 kcal. The errors inherent in this assumption have been discussed by Karlberg (1952); the true value will vary between 4·7 and 5·0, depending on the proportions of protein, fat and carbohydrate metabolized.

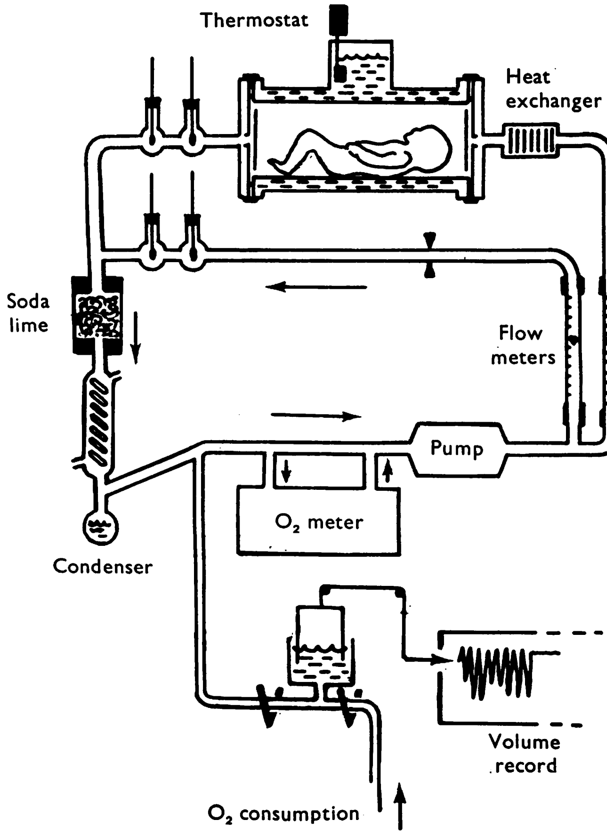


Fig. 1. Diagram of the Perspex metabolic chamber and closed gas circuit. Flow through the chamber and the by-pass was kept comparable by adjusting a screw clip on the by-pass tubing.

The absolute humidity of the air entering and leaving the chamber was monitored by wet and dry bulb thermometers, and humidity in the chamber taken to be the mean of the inlet and outlet humidity. Air speed past both pairs of thermometers was kept close to 400 cm/sec. The estimates of water content were in fact negligibly altered when air speed was varied between 300 and 500 cm/sec. The thermometers were calibrated and matched. The wet-bulb wicks were changed weekly. Small stable discrepancies (always $< 0·2$ mg H_2O/l. air) were, nevertheless, sometimes encountered in the readings taken each day with the chamber empty; an allowance was made for this 'base line' discrepancy on these occasions. Using these methods it proved possible to measure the amount of water in the air with accuracy; repeated readings usually agreed within 0·05 mg H_2O/l. air. Approximately 1 g H_2O/hr evaporated from the wick of each wet-bulb thermometer. The circuit was therefore modified as shown in Fig. 1, so that this release of water did not interfere with the measurement of water loss from the baby.

The infants' evaporative water loss was determined by subtracting the water content of the air entering the chamber from that of the air leaving the chamber and multiplying by the measured air flow (0·3–0·5 l./sec). Evaporative heat loss was calculated on the assumption that the evaporation of 1 g water results in the loss of 0·6 kcal of heat from the body (Hardy, 1949). Tests were made to ensure that the chamber was dry at the beginning and end of each study, and regular checks performed to see that the child did not dribble, and that there was no leak of urine or faeces during the study. To test the accuracy of the method employed, estimates of evaporative loss were obtained over 1–3 hr while weighed quantities of water were allowed to evaporate within the empty chamber. The measured values underestimated the true water loss by an average of 5 % (Fig. 2).

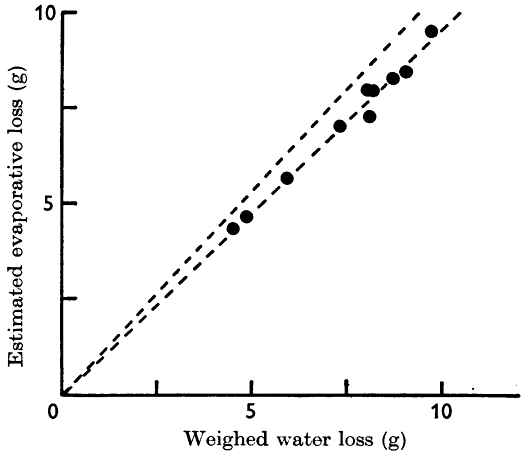


Fig. 2. Apparatus calibration tests. Results accurate to within ± 5 % fall between the interrupted lines. The apparatus underestimates evaporative water loss by an average of 5 %.

Evaporative water loss from the respiratory tract was measured in eight clothed infants using a trunk plethysmograph (Cross, 1949). The pressure changes within the plethysmograph were measured with a sensitive gas transducer. Pulmonary ventilation was calculated from the record of frequency and tidal volume thus obtained, after calibration using a motor-driven syringe and with due allowance for the volume within the plethysmograph occupied by the child and its clothing. A water-jacketed Perspex hood was placed over the infant's face and an airtight seal obtained with a rubber 'O' ring and quick-release tension fasteners. Air from Douglas bags was drawn through the hood at 33° C and over the infant's face at a measured rate (2–5 l./min), and then through tubes of separately weighed desiccant (magnesium perchlorate). The increase in weight of the desiccant in the first two tubes over a 10 min period, less the increase in weight observed when a volume of the same air was passed directly through the desiccant, was used to estimate respiratory water loss. Skin and rectal temperatures were measured with thermistors, and starch paper previously impregnated with iodine vapour was used to check that no facial sweating occurred. Expired air temperature was measured with a fine thermistor probe with a fast response (0·1 sec time constant) mounted centrally within a 1 cm length of vinyl plastic tubing inserted into the nostril.

Where the mean of a series of observations is reported the estimated standard deviation of the observations has been supplied. Linear relations have been estimated using the method referred to in the preceding paper (Hey, 1969).

RESULTS

Basal evaporative water loss

In the main group of results reported here the mean water vapour pressure of the air (P_{H_2O}) within the metabolic chamber was between 17 and 19 mm Hg. The total evaporative water loss was measured over a 20 min period when the rectal temperature was between 36·5 and 37·0° C while the infant lay naked and completely quiet in a thermal environment of 33–34·5° C. The measured water loss for infants of different weights is

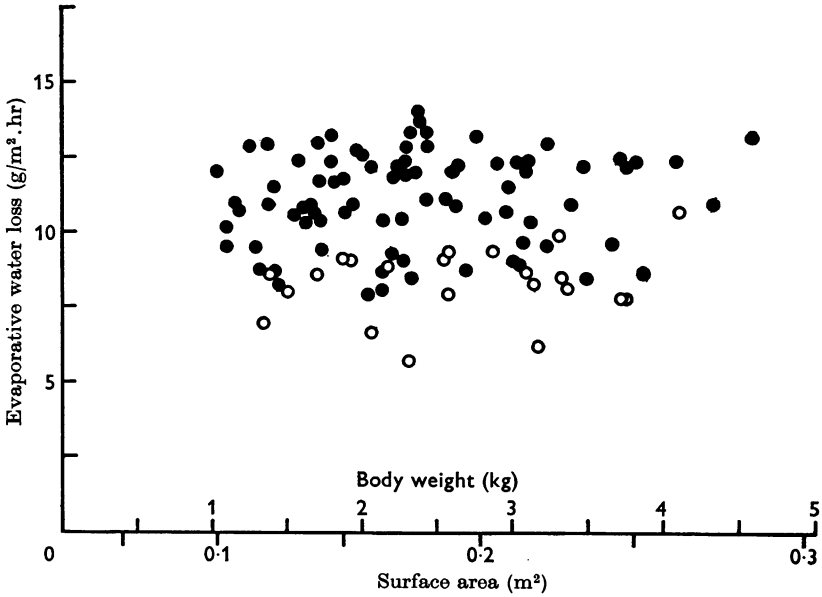


Fig. 3. The relation between body weight, estimated surface area and the basal evaporative water loss of babies 0–10 days after birth in grams per square metre of skin surface per hour at normal rectal temperature when in a neutral thermal environment. Results obtained on infants under 48 hr old are indicated by open circles.

shown in Fig. 3. The average loss for babies less than 2 days old was $7·86 \pm 1·25$ and for babies 2–10 days old $10·81 \pm 1·68$ g/m^2.hr. There was no correlation between body weight and water loss per unit surface area in either age group (r = 0·100 and 0·018 respectively). However, water loss per unit surface area appeared to rise with age in a manner similar to the known rise in basal metabolic rate (B.M.R.) (Hill & Rahimtulla, 1965; Scopes & Ahmed, 1966; Hey, 1969), and the correlation (Fig. 4*a*) between concurrent estimates of evaporative water loss (EWL) and B.M.R. in the present infants was strong (r = 0·652; P < 0·001). The line of best fit is

EWL = $(0{\cdot}355 \pm 0{\cdot}045)$ B.M.R. + 0·42; the intercept does not differ significantly from zero. The same relation between B.M.R. and basal water loss was found in a group of small babies seen on a number of occasions in the first two months of life (Fig. 4*b*).

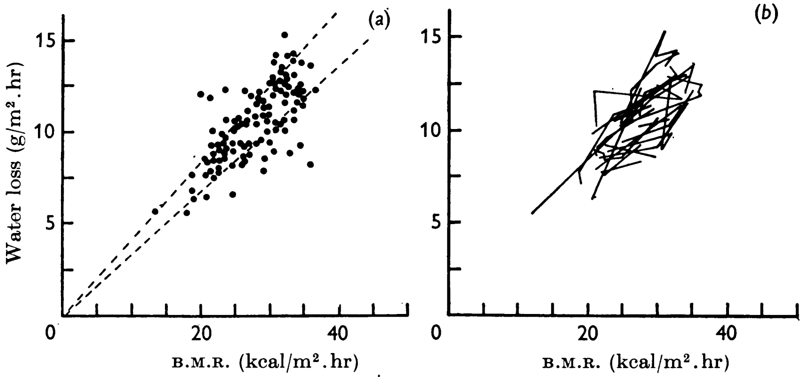


Fig. 4. The correlation between basal evaporative water loss and concurrent estimates of basal metabolic rate. (*a*) Results from forty-nine babies seen during the first 65 days after birth. Experiments in which evaporative heat loss accounted for between 20 and 25 % of heat production fall between the two interrupted lines. (*b*) Results from twenty of these babies who were seen on more than one occasion. Most of the data were obtained in babies less than 20 days old. Each line refers to one baby. Evaporative water loss and B.M.R. both rise with age.

The effect of temperature

Measurements of evaporative water loss were made in babies 0–10 days old and born within 3 weeks of term over a range of temperatures. Water vapour pressure was 17–19 mm Hg. Below an environmental temperature of 34–35° C water loss appeared to remain nearly constant except when the infant cried; above this temperature water loss rose with what was taken to be the onset of active sweating while the infant remained quiet, and frequently asleep (Fig. 5). No consistent changes in respiratory rate were detected under such conditions and it seems very unlikely that increased respiratory water loss contributed much to the observed rise in total evaporative loss.

Water loss frequently increased up to 30 % when the infant became active and cried at the low environmental temperatures, while the increase was even more marked on the rare occasions when infants became really restless and agitated at environmental temperature between 31 and 35° C and rectal temperature was raised. Day made a similar observation in 1943. Starch iodine paper tests confirmed the visual impression that part at least of the increased loss on these occasions was due to sweating.

The relation between evaporative water loss and rectal temperature is shown in Fig. 6*a*. No significant rise in water loss occurred until rectal temperatures rose above normal ($\geqslant$ 37·2° C), and evaporative loss frequently did not double before rectal temperature reached 37·5° C. On at least seven occasions there was clear evidence that the relation between evaporative loss and body temperature changed with post-natal age and that the threshold temperature for sweating fell progressively (Fig. 6*b*).

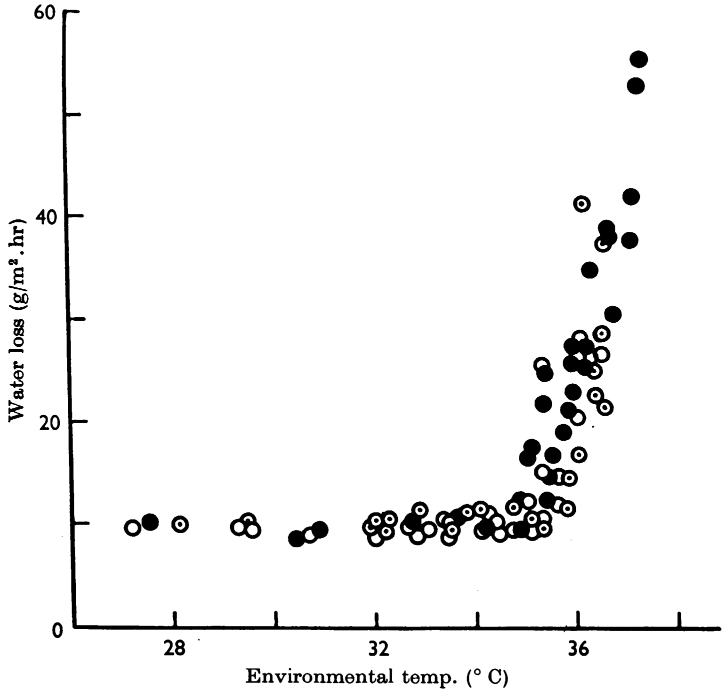


Fig. 5. The relation between evaporative water loss and environmental temperature in three healthy babies (indicated by different symbols) born within 3 weeks of term, studied while quiet or asleep on the first day of life and on two further occasions in the first 9 days of life. When the environmental temperature rose above 35° C water loss from these three babies increased by an average of 15 g H_2O per ° C, but the increase was less than this in many babies.

A significant rise in evaporative water loss was, however, already present on the day of birth in all the eleven infants studied that early.

The results obtained in a series of infants born more than 3 weeks before term were similar, but the increase in evaporative water loss at high rectal and environmental temperature was often delayed and small, and sometimes almost non-existent (Fig. 6*c*).

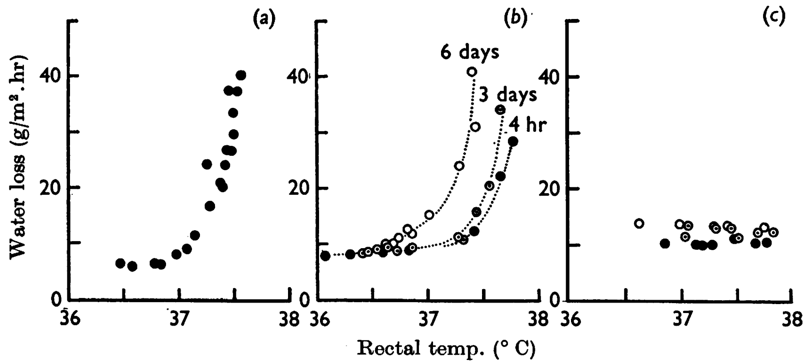


Fig. 6. The relation between evaporative water loss and rectal temperature. (*a*) Response on the day of birth in a girl born 2 weeks before term. (*b*) Response on three separate occasions in a girl born 3 weeks before term (age 4 hr: ●; 3 days: ⊙; 6 days: ○). (*c*) Response on three separate occasions (different symbols) during the first 10 days of life in a girl born 6 weeks before term.

The effect of humidity

In eight healthy infants born within 3 weeks of term and 2–10 days old paired studies were undertaken on consecutive days: on one day the water vapour pressure of the air in the chamber was low (6–8 mm Hg), and on the other day high (24–26 mm Hg). In all other respects the paired studies were kept as identical as possible. In four babies the low humidity study was undertaken first, while in the other four the order was reversed. Oxygen consumption, heat balance and evaporative water loss were studied each day at five environmental temperatures between 31 and 36·5° C. Basal evaporative water loss was consistently some 30 % lower at high humidity (Fig. 7); after the onset of active sweating the differences in water loss were in the same direction but much less consistent.

To find what proportion of this change in total evaporative water loss with change in humidity might be due to change in water loss from the respiratory tract, direct measurements of respiratory water loss were made on eight infants along with measurements of body temperature and expired air temperature. Measurements were made with each infant when the water vapour pressure of the inspired air was approximately 5, 10 and 22 mm Hg. The hood temperature and air temperature over the baby's face were 33° C in each case. Air left the nose at 35·6 ± 0·2° C, and measured water loss indicated that the expired air was 94·6 ± 6·3 % saturated at this temperature. Variation in the humidity of the inspired air did not noticeably influence the saturation of the expired air (the relation in Fig. 8 has a slope that does not differ significantly from − 1). The observed respiratory water

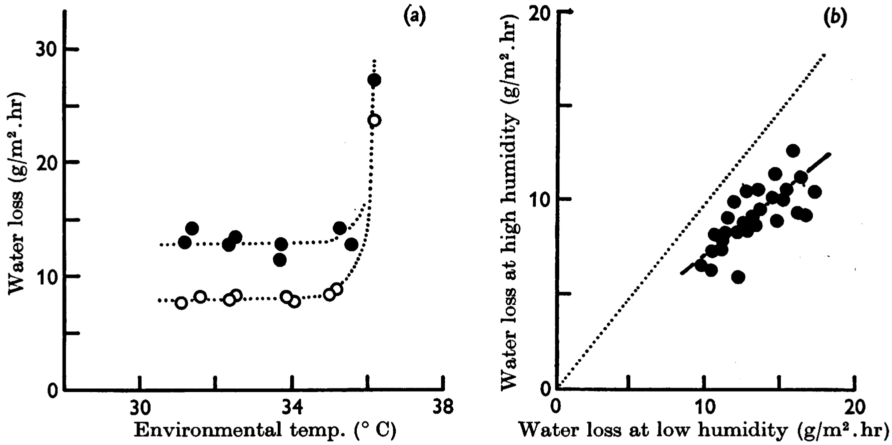


Fig. 7. The effect of humidity on total evaporative water loss. (*a*) Results of a paired study in a girl 3 and 4 days old, born 2 weeks before term, with P_{H_2O} 6–8 mm Hg ●, and 24–26 mm Hg ○. (*b*) Summary graph of the paired estimates of basal water loss in all eight infants studied. (The line of best fit is $y = (0{\cdot}61 \pm 0{\cdot}15)x + 0{\cdot}96$ with $r = 0{\cdot}594$; the y intercept does not differ significantly from zero.)

TABLE 1. The effect of ambient water vapour pressure on basal evaporative water loss (insensible loss) in eight mature babies between 2 and 10 days old when asleep in an environmental temperature of between 31 and 34·5° C (cf. Fig. 7). Water loss from the skin was estimated from the data on respiratory water loss summarized in Fig. 8 and the measured oxygen consumption, on the assumption that 25 ml. of air (at b.t.p.s.) are breathed for each ml. of oxygen consumed (Cross, 1961)

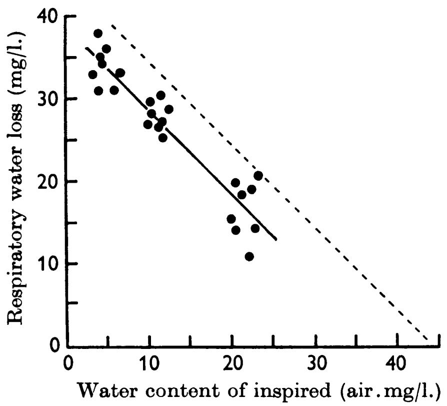
Mean ambient vapour pressure (mm Hg)	7·3 ± 0·5	25·1 ± 0·4
Mean total evaporative water loss (g/m².hr)	13·22 ± 2·36	9·03 ± 1·68
Number of observations (n)	28	28
Estimated respiratory water loss (g/m².hr)	4·9	2·2
Calculated residual water loss (g/m².hr)	8·3	6·8

loss was then subtracted from the mean total water loss at each ambient humidity to give estimates of evaporative water loss from the skin as indicated in Table 1.

Age and the magnitude of the rise in evaporative water loss

All babies born within 3 weeks of term increased their evaporative water loss when the environmental temperature was 36° C or more and the rectal temperature above 37·5° C; the seven babies who were first examined 4–12 hr after birth also responded under these conditions. The onset of the response was often sudden and clear-cut, but high levels of evaporative water loss were sometimes only poorly maintained. When the infants were subjected for at least 20 min to similar high environmental temperatures on two or more occasions in the first 10 days of life and measurements obtained at the same rectal temperature (to within 0·1° C) the response almost always increased with age (Fig. 9). It is probable that this reflects the decrease in the threshold body temperature at which a response is elicited, already noted in the small group of babies on whom rather more detailed observations were made (cf. Fig. 6*b*).

The maximal evaporative water loss recorded in infants in the first 10 days after birth at high environmental temperature ($\geqslant$ 36° C) when the rectal temperature was above 37·5° C varied with the post-conceptual age. Most infants born near term were able to triple their basal evaporative



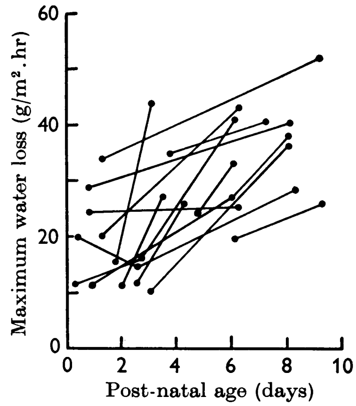


Fig. 8. The effect of the humidity of the inspired air on the water loss from the face and respiratory tract of eight babies. Water loss has been expressed as mg H_2O per litre of air breathed (at b.t.p.s.). The inspired air had a temperature of 33° C in each case, but its water vapour content was varied. The line of best fit is $y = (-1{\cdot}01 \pm 0{\cdot}09)(x - 38{\cdot}5)$ with $r = 0{\cdot}927$, indicating that the expired air contained about 38·5 mg water vapour per litre, and that its humidity was not influenced by that of the inspired air over the range investigated ($P_{H_2O} \sim$ 5–22 mm Hg). The interrupted line indicates the loss that would have been expected if air left the nose fully saturated at deep body temperature.

Fig. 9. The effect of post-natal age on total evaporative water loss at a rectal temperature of 37·5° C in a group of infants born within 3 weeks of term. The environmental temperature was 36° C or more, and P_{H_2O} 17–19 mm Hg.

water loss. All infants of over 250 days post-conceptual age were able to at least double this loss, but infants of under 215 days post-conceptual age appeared unable to increase evaporative water loss 50 % even after 30 min at a rectal temperature above 37·7° C (Fig. 10*a*). The results are summarized in Table 2. Very premature infants who did not sweat at birth and who were studied regularly over the first 4–8 weeks of life first showed clear evidence of an increased evaporative water loss at high environmental temperature when they reached a post-conceptual age of 215–225 days; by 240 days post-conceptual age most were able to triple their evaporative water loss (Fig. 10*b*).

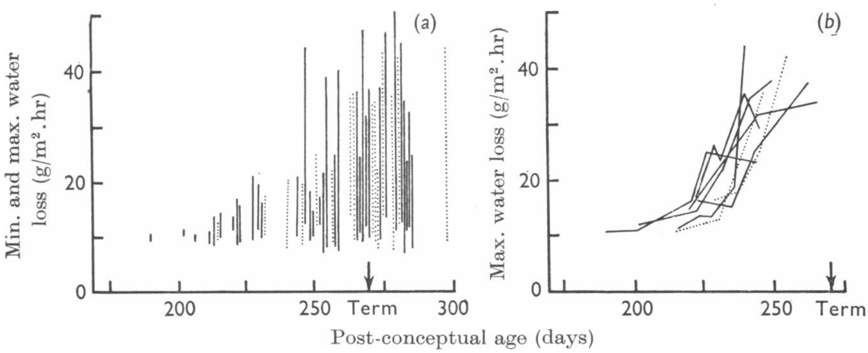


Fig. 10. The maturation of the sweat response with post-conceptual age. Estimates of minimal evaporative water loss were made in an environment of 33–34·5° C when rectal temperature was between 36·5 and 37·0° C, and estimates of maximum loss in an environment of 36° C or more when rectal temperature was between 37·5 and 37·8° C. Ambient vapour pressure was 17–19 mm Hg. Dotted lines link the results obtained in those infants who were more than 25 % below average weight at birth for the period of gestation (Butler & Bonham, 1963; Butler, 1965). (*a*) Lines link the maximum and minimum values in forty-nine infants on the day the largest response was recorded in the first 10 days after birth. (*b*) The development of a sweat response with increasing post-natal age in eight of these babies who were born more than 6 weeks before term. Each line refers to one infant.

TABLE 2. Estimates of basal and maximal evaporative water loss in babies of differing maturity and weight, 2–10 days after birth. Mean results, each with the standard deviation of the *n* observations. Infants who were more than 25 % below average weight for their period of gestation have been classified as 'small for dates'. The conditions under which the estimates of basal and maximal water loss were obtained are the same as those given in the legend to Fig. 10

Post-conceptual age and weight at birth	Evaporative water loss (g/m^2.hr) Basal	Evaporative water loss (g/m^2.hr) Maximum	Average weight (kg)	Number of subjects	Number of studies (n)
180–220 days					
Normal weight	11·4 ± 1·4	13·6 ± 2·4	1·52 ± 0·30	9	14
Small for dates	10·8	11·5	1·10	1	3
220–250 days					
Normal weight	10·8 ± 1·7	21·3 ± 9·6	2·66 ± 0·65	9	13
Small for dates	10·6 ± 2·4	21·3 ± 10·2	1·68 ± 0·32	4	10
250–290 days					
Normal weight	10·6 ± 2·0	32·1 ± 11·3	3·39 ± 0·41	16	25
Small for dates	10·7 ± 2·0	33·4 ± 6·3	2·41 ± 0·18	9	14

DISCUSSION

Total evaporative water loss in the human baby has been estimated indirectly from insensible weight loss by several investigators. Although this method is capable of producing very consistent results (Levine, Wilson & Kelly, 1929; Ginandes & Topper, 1936), it overestimates water loss by about 10 % because of the weight loss caused by the respiratory exchange of carbon dioxide for oxygen. Little, Brodsky & Greathouse (1955) observed a low water loss in infants less than a day old similar to that described here. Studies on older infants (Levine, Kelly & Wilson, 1930; Law, 1938) have revealed higher evaporative losses per square metre. The evaporative loss per square metre in the first week of life is only two thirds of that found in adults.

Soderstrom & Du Bois (1917) were apparently the first to demonstrate the close correlation between B.M.R. and basal insensible water loss: they reported that evaporative heat loss accounted for almost exactly 24 % of basal heat production in a wide range of subjects. Similar findings were obtained in young children (Levine & Wilson, 1927, 1928; Levine & Marples, 1930). Confidence in the constancy of this relation led Benedict (Benedict & Root, 1926) and Newburgh (Newburgh, Johnston, Lashmet & Sheldon, 1937) to utilize insensible weight loss to assess B.M.R., while more recently the same method has been used to assess metabolism during recovery from malnutrition in infancy (Krieger, 1966). It would seem, however, that insensible weight loss is not an accurate method of assessing total daily metabolic heat production (Levine & Wheatley, 1936).

The data summarized in Fig. 4 add support to the suggestion that there is a correlation between basal heat production and evaporative loss. The new evidence seems to indicate that the relation is present even in the first few days of life and that it is independent of body weight or surface area. In most of the babies reported here insensible water loss accounted for between 20 and 25 % of basal heat production (Fig. 4); after correction for the probable 5 % underestimation of water loss, the average fraction of basal heat loss due to evaporation was 23·3 %. This is remarkably similar to the figure of 24 % obtained by Soderstrom & Du Bois (1917) in adults and of 24 and 27 % obtained by Levine & Wilson (1927, 1928) in children and young infants. Slight increases in evaporative loss at high temperature could obscure this relation. Conversely total evaporative water loss does not increase when heat production rises at low environmental temperature unless the child begins to cry. It is therefore not surprising that Levine & Wheatley (1936) found a poor correlation between insensible weight loss and *total* daily heat production.

The estimates of evaporative loss from the respiratory tract are in agreement with those of Hooper, Evans & Stapleton (1954), who used similar methods. The total evaporative loss from the respiratory tract is closely linked to ambient humidity, as in adults (Burch, 1945; McCutchon & Taylor, 1951; Walker, Wells & Merrill, 1961). Estimates of the effect of ambient humidity on evaporative loss from the skin in an environment at 31–34·5° C were obtained from the data on total evaporative loss using the results summarized in Fig. 8. Evaporative loss from the skin is clearly related to ambient humidity (Table 1), but the effect of a considerable change in humidity is small. This is in agreement with estimates of the effect of humidity on total heat loss in infants at an environmental temperature below the thermoneutral range (Hey & Maurice, 1968). The change is also comparable with that observed in adults (Hale, Westland & Taylor, 1958).

The present results provide indirect evidence that the maturation of the sweat mechanism is linked to gestational age: in contrast there is little indication that birthweight or post-natal age influences the date at which significant sweating first occurs. The full-term infant is capable of more than doubling its total evaporative heat loss within 4–12 hr of birth, and there can be little doubt that the increase is largely due to active sweating. The onset of sweating was usually sudden, and recognized at the time without difficulty. It may be difficult to detect the sweat response visually, especially when the ambient humidity is low, but beads of sweat can often be detected on the temple and forehead, and other discrete areas of sweating can be detected with starch iodine paper. Nearly all the infants remained completely quiet and most continued to sleep peacefully after the evaporative water loss rose. No consistent or notable changes in respiratory frequency were recorded and it seems unlikely that respiratory water loss changed much. Respiratory water loss would have had to increase more than fourfold to account for the minimum increase in evaporative loss observed.

Sweating was never seen in quiet resting infants unless environmental temperature was above 34° C and rectal temperature also above 37° C. In Day's important study of thermoregulation in the premature baby published in 1943, environmental temperature was not taken above 34° C, which explains why no consistent thermal sweat response was detected. It seems that both conditions must normally be fulfilled before active sweating can be detected in the quiet baby. Under these conditions average skin temperature is almost always above 36° C. In contrast, an adult starts to sweat when the environmental temperature exceeds about 30° C and the average skin temperature reaches 34° C (Winslow, Herrington & Gagge, 1937; Hardy & Soderstrom, 1938).

In most of the new-born infants studied here a high evaporative water loss was only obtained when rectal temperature had risen nearly 1° C above normal. These infants appeared to differ from adults in allowing rectal temperature to rise significantly before bringing the sweat mechanism fully into play. In the studies reported here rectal temperature was not allowed to exceed 37·8° C; under these conditions only a few infants appeared able to quadruple their evaporative loss, even for a short time, in the first few days after birth. The average new-born baby, unlike the adult, is therefore unable to maintain thermal equilibrium, even temporarily, when environmental temperature is as high as body temperature. However, the maximum response increases with age (Fig. 9), and in a number of infants born near term there was clear evidence that the threshold body temperature for sweating decreased considerably in the first two weeks after birth (Fig. 6*b*).

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