

Reduction of skin water loss in the newborn.

I. Effect of applying topical agents

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SUMMARY The waterproofing effect of a number of creams, oils, and greases was examined by measuring water loss from adult skin before and after topical application. Creams had a high water content and were ineffective, oils produced a modest fall in water loss, but paraffin in grease form had a pronounced, sustained waterproofing effect. A paraffin mixture (80% soft, 20% hard paraffin BP) was then applied to the skin of 3 preterm babies nursed naked in incubators. Overall skin water loss fell by 40 to 60% after application and was still lower than pretreatment levels 6 hours later. The topical application of paraffin offers a new approach to reduction of the high evaporative water and heat losses of preterm babies.

Preterm babies have high insensible weight losses compared with mature babies,^{1,2} a result of a high water loss from the skin.^{3–5} These losses are particularly high in babies of less than 30 weeks' gestation during the first few days of life. The most likely explanation is that very immature babies have a thin, poorly keratinised stratum corneum which offers a low resistance to the diffusion of water.

This excessive loss of water leads to high rates of evaporative heat loss which may even exceed the infant's resting rate of heat production. Clinically the losses of water and heat can be replaced by extra fluids and environmental warmth but there is then only a narrow margin of safety. Reduction of skin water losses would appear to be to the infant's advantage for it would assist body temperature control and, by saving calories, improve growth.

Skin water losses may be reduced by increasing the ambient humidity,^{4,6–8} or by making the skin more 'waterproof' by topical applications. Nursing infants in humid conditions introduces an increased risk of infection and, when used in incubators, it reduces visibility because moisture condenses on the relatively cooler incubator walls. Transparent plastic coverings lying over the infant have been used successfully to reduce water and heat loss.^{9,10} In effect they produce a warm, humid microclimate close to the skin. For centuries it has been the practice in many cultures to anoint and oil the skin of newborn infants, often at frequent intervals after birth. Nobody has investigated what effects these practices have, if any, on water and heat losses.

As observation of the exposed trunk is often essential in the preterm infant in the first critical days of life when water losses are at their highest, and application of agents aimed at increasing resistance to water diffusion appears to offer a promising approach to improving the infant's water and thermal balances. In this study several oils, greases, and creams were applied to adult skin to ascertain the waterproofing effect of each. The most effective agent was then applied to babies and the effect measured. The substances were chosen either because they had been applied to newborn skin in the past or because it was thought that they might be suitable on the basis of their dermatological use.

Methods

Five creams, 3 oils, and 3 greases were examined (Table). Water loss (g/m² per hour) was measured at 3 skin sites on an adult's arm: the forearm, dorsum, and palm of the hand. Measurements were made using the Evaporimeter Ep 1 (Servomed, Sweden).¹¹ The probe was placed on each skin site until a stable reading was obtained. The substance to be examined was then smeared on the site and water loss was immediately measured again. The study was carried out in a small, closed room at a temperature of 22°C and a humidity of 42%. Each substance was tested 3 times at the same sites, the skin being washed and dried between each test.

The duration of the waterproofing effect of olive oil and soft paraffin was then examined in an adult by applying each agent to the forearm, dorsum, and

Table *The creams, oils, and greases which were studied for their waterproofing effect on adult skin*

<i>Creams</i>	<i>Oils</i>	<i>Greases</i>
E45 cream (a mixture of water and paraffin used as a vehicle for other agents)	Olive oil (a vegetable oil)	Soft paraffin BP—white (a bleached mixture of petroleum hydrocarbons)
Oily cream BP (a mixture of water and paraffin, used as an ointment base)	Arachis oil (a vegetable oil)	Soft paraffin BP—yellow (an unbleached mixture of petroleum hydrocarbons)
Ung. Merck cream (a complex mixture used as an emollient and a diluent)	Liquid paraffin (a mixture of petroleum hydrocarbons)	Paraffin mixture (80% soft paraffin BP, 20% hard paraffin BP)
Natuderm cream (a lipid-containing cream used as an emollient)		
Silicone barrier cream (a silicone-containing mixture used as a water repellent)		

palm of the hand of one arm. The effect of the application was then studied for 4 hours by measuring water loss with the Evaporimeter. Measurements were made from each treated area and compared with those from an untreated area of skin immediately adjacent to it.

Soft paraffin, which had a pronounced waterproofing effect on adult skin, was much less effective when used on a baby's skin inside a warm incubator. For this reason, its melting point was raised by heating soft paraffin BP (80%) and hard paraffin BP (20%) together, and allowing the liquid to cool to a grease. The waterproofing effect of this mixture was then examined on an area of skin in 2 preterm babies. The babies were nursed naked in a standard incubator (79, Vickers Medical) under neutral thermal conditions. The paraffin mixture was generously applied to the front of the thigh of a baby of 26 weeks' gestation, birthweight 0.88 kg, who was 3 days old, and to the abdomen of a baby of 32 weeks' gestation, birthweight 1.18 kg, who was

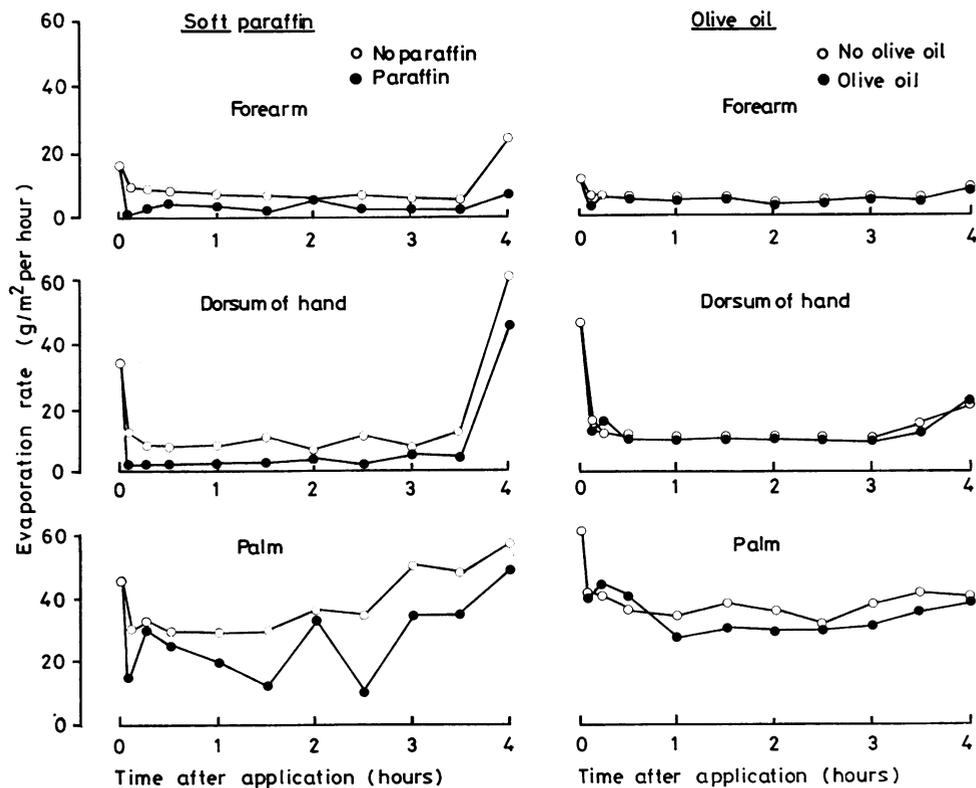


Fig. 1 *Effect of soft paraffin and olive oil on the rate of evaporation of water from three sites on adult skin. After application of the agents evaporation of water from the treated areas was compared with adjacent untreated areas.*

6 days old. In each case skin water loss was measured before application and then at intervals afterwards.

Finally, the effect of applying the paraffin mixture to most of a baby's skin was measured. Three preterm babies, of gestational ages 26 to 30 weeks, birthweights 0.96 to 1.24 kg, and aged 1 to 4 days were nursed in an incubator whose air temperature was set to provide a neutral thermal environment. Before the paraffin mixture was applied, skin water loss was measured at 18 different skin sites and an overall value of skin water loss was derived as

previously described.³ The mixture was then applied gently to the whole of the baby's skin, avoiding only the skin around the mouth and eyes. Similar measurements of water loss at 18 sites were made at intervals after the application.

Results

All the creams gave similar results. After application, water loss from the adult forearm and dorsum of the hand increased, while the initially high rate of loss over the palm fell slightly. This is because creams themselves have a high content of water, which evaporates after application. Thus similar rates of water loss were found over a piece of paper after application of cream. Oils contain no water. They produced a modest fall in water loss at all 3 sites. Likewise greases do not contain water. They were far more effective than oils, producing a pronounced fall in water loss at all 3 sites.

The duration of the waterproofing action was examined, using olive oil and soft paraffin (Fig. 1). Soft paraffin, unlike olive oil, produced a substantial fall in water loss at all 3 skin sites, which lasted at least 4 hours. The high skin water losses at the beginning and end of this study, particularly from the hands, are probably due to thermal sweating, which suggests that the application of soft paraffin does not prevent sweating.

When the paraffin mixture was applied to a single skin site in 2 preterm babies, water loss was stopped immediately after application. Six hours later the water loss was still only about 10% of the pre-treatment level.

When the paraffin mixture was applied to the whole of the skin it was calculated that skin water loss fell by about 50% (range 40-60). Although the effect diminished with time, it was still present 8 hours later (Fig. 2).

Discussion

Paraffin was the most effective waterproofing agent. Two factors determine the effect of an agent on reduction of skin water loss: its physical properties, and the thickness of its application. Paraffin is a mixture of petroleum hydrocarbons whose melting point increases as the number of carbon atoms and branches in the carbon chain increases. Liquid, grease, and solid forms exist at room temperature. Liquid paraffin BP did not seem to be suitable for reducing skin water loss, presumably because it only forms a thin layer when applied to skin. The same is true for the other oils and for soft paraffin BP when

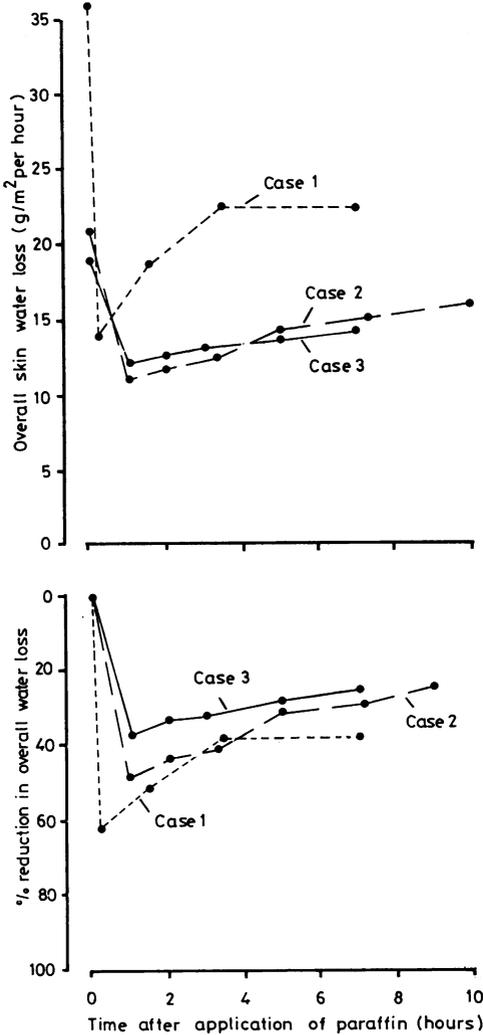


Fig. 2 Effect of topical application of a paraffin mixture on the overall skin water loss of three preterm babies nursed in incubators.

it is used inside a warm incubator. It is for this reason that we made a paraffin mixture with a higher melting point than soft paraffin, by adding hard paraffin. The mixture of 80% soft and 20% hard paraffin proved suitable for application and had a useful, sustained waterproofing effect on babies' skin. It might be improved further by using a mixture with a higher percentage of hard paraffin and applying it more thickly.

These findings are consistent with those of Spruit¹² who, using a ventilated capsule technique, examined the waterproofing effect of several agents when applied to adult skin. He found that olive oil had a slight effect, liquid paraffin and lanolin were rather more effective, and soft paraffin had a profound effect. Olive oil, which has been widely applied in the past to the skin of small babies, has very little effect on water loss. Thus any benefits it has on the well being of the baby cannot be ascribed to reduction in water and heat loss.

Is it safe to use a paraffin mixture on the thin, poorly developed skin of very low birthweight babies? This cannot be assumed with certainty but paraffin is an inert substance which is insoluble in water, alcohol, and acetone. It has been widely used for many years in dermatology where it is applied to diseased areas of skin whose epidermal barrier is deficient. It is liberally applied on gauze dressings to burnt skin, deprived of any barrier to the passage of drugs into the dermis. Furthermore in liquid form it is swallowed in large quantities as a laxative. Paraffinomas have been described in mesenteric lymph nodes but considering that mucous membranes offer little resistance to the diffusion of pharmacological agents, these are exceptionally rare. Paraffin therefore shows a remarkable lack of absorption by healthy or diseased skin and by mucous membranes. Because it has a useful effect in reducing skin water loss in small babies, and thus might be expected to benefit the infant by reducing both water and heat loss, a fuller clinical evaluation was undertaken.¹³

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