# Effects of Clear Topical Ointment on Transepidermal Water Loss in Jaundiced Pretrem Infants Receiving Phototherapy

SIRIWAN WANANUKUL, M.D.*,
PRAMOTE PRAISUWANNA, M.D.*,
KRIDAKORN KESORNCAM, M.D.*

**Abstract**

Thirty jaundiced preterm infants, gestational age ≤ 34 weeks and postnatal age ≤ 7 days, receiving conventional phototherapy for hyperbilirubinemia of prematurity in incubators were included. 1.5 ml of clear topical ointment was applied on the right side of the trunk and extremities while the left side was used as control. Data collection included transepidermal water loss (TEWL), ambient temperature and ambient humidity, before and at 30 minutes, 4-6 hours after application of the ointment during phototherapy. The measurements were executed both the right and left side in 3 positions; upper arm, back, lower leg. TEWL was reduced by 29 per cent (P value < 0.002) and 26 per cent (P value < 0.011) at 30 minutes and 4-6 hours after the application of clear topical ointment, respectively. Ambient temperature and humidity were not significantly different (P value > 0.18). We concluded that application of clear topical ointment on the skin of jaundiced preterm infants receiving conventional phototherapy in incubators reduced TEWL significantly.

**Key word :** Transepidermal Water Loss, Phototherapy, Preterm Infant, Clear Topical Ointment

**WANANUKUL S,
PRAISUWANNA P, KESORNCAM K
J Med Assoc Thai 2001; 84: 837-841**

Premature infants have immature skin with an ineffective epidermal barrier. Water loss from the skin of a newborn baby is a major factor of overall water balance[1-5]. Premature infants have high water losses in the first week[1]. The TEWL decreases exponentially as the gestational age of the infant increases[3]. Water loss may be 10 to 15 times greater in the premature infant born at 25 weeks of gestation than in the term infant[3,5]. This excessive loss of water leads to a high rate of eva-

* Department of Pediatrics, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

**Table 1. Transepidermal water loss before and after clear topical ointment therapy.**

| TEWL ($g/m^2h$) | Time 0 | | | At 30 minutes | | | At 4-6 hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | a | b | c | a | b | c |
| Treated side | | | | | | | | | |
| Mean | 8.62 | 9.10 | 9.57 | 6.08 | 6.10 | 6.67 | 6.73 | 5.97 | 6.32 |
| SD | 3.34 | 4.11 | 4.33 | 2.88 | 2.27 | 2.82 | 3.34 | 2.31 | 2.65 |
| Control side | | | | | | | | | |
| Mean | 9.17 | 9.29 | 10.06 | 8.72 | 8.49 | 9.31 | 8.87 | 8.10 | 9.20 |
| SD | 3.45 | 3.53 | 4.13 | 3.28 | 2.78 | 3.59 | 2.94 | 2.22 | 2.76 |
| P value | 0.5382 | 0.8483 | 0.655 | 0.0016* | 0.006* | 0.0024* | 0.0109* | 0.0006* | 0.0001* |

a = upper arm, b = back, c = lower leg

**Table 2. Percentage of TEWL reduction after application of clear topical ointment.**

| Site of measurement | Per cent TEWL reduction | |
|---|---|---|
| | At 30 minutes % | At 4-6 hours % |
| Upper arm | 30.28 | 24.09 |
| Back | 28.15 | 26.22 |
| Lower leg | 28.39 | 26.30 |
| Mean | 28.94 | 25.54 |

porative heat loss. In extremely premature infants, TEWL may result in significant morbidity secondary to dehydration, electrolyte imbalance and thermal instability[2,5,6]. Various topical applications have been examined for their waterproofing effect on adult skin[7]. Creams had a high water content and were ineffective for waterproofing. Oils produce a modest fall in water loss, but paraffin in grease form had a pronounced sustained waterproofing effect[7]. Topical ointment therapy is beneficial in decreasing TEWL in premature infants[8].

Hyperbilirubinemia is a very common problem in premature infants. Phototherapy is an effective means of preventing or treating hyperbilirubinemia[9]. During phototherapy, there is a marked increase in insensible water loss in premature infants which may be as much as 80 per cent to 190 per cent in non - servocontrolled incubators[10]. This may be due to a marked increase in skin blood flow and immature skin in premature infants[11]. On phototherapy, the depth to which light penetrates the skin depends on the color or wavelength of the light ; the longer the wavelength, the deeper the penetration[12]. Thick application of petrolatum and emollient creams can reduce transmission of UVB, but not clear liquid emollient[13]. Bilirubin absorbs only violet, blue and some green light[9], which have a longer wavelength than UVB.

The aim of this study was to study the effects of clear topical ointment on TEWL in jaundiced preterm infants receiving phototherapy in incubators. Measurement of the evaporation rate was made directly from the skin exposed to phototherapy, before and after applying topical ointment on half of the body using the untreated side as control.

## PATIENTS AND METHOD

Premature infants, not more than 34 weeks of gestation, requiring phototherapy were included. All infants had a birth weight appropriate for gestational age. Their condition was stable and received phototherapy for hyperbilirubinemia of prematurity in incubators. Premature infants with skin disease, or respiratory distress were excluded from the study. This study was approved by the Ethics Committee of Faculty of Medicine, Chulalongkorn University. Informed consent was obtained before the infant was included in all cases.

## METHOD

The patients were clothed only with diapers and eyes were covered by guaze eye pads. The patients were placed in the prone position in incubators using the mode of servocontrol of skin temperature. The conventional phototherapy equipment was placed above the incubator. The evaporation rate (ER) was measured by a method based on determination of the water vapor pressure gradient in the air layer close to the skin surface (Tewameter TM 210, Courage & Khazaka, Koln, Germany)[15]. ER was measured from the skin of the upper arm, the back and lower legs of both sides. The right side of the trunk and extremities

**Table 3. TEWL of untreated side during the period of study.**

| Control side TEWL | At 30 minutes | | | At 4-6 hours | | |
|---|---|---|---|---|---|---|
| | a | b | c | a | b | c |
| P value | 0.6094 | 0.3339 | 0.4578 | 0.7214 | 0.1226 | 0.3485 |

a = upper arm, b = back, c = lower leg

**Table 4. Ambient temperature before and after application of clear topical ointment.**

| Ambient temperature (°C) | Time 0 | | | At 30 minutes | | | At 4-6 hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | a | b | c | a | b | c |
| Treated side | | | | | | | | | |
| Mean | 30.75 | 31.36 | 31.80 | 31.70 | 32.09 | 32.05 | 31.90 | 32.07 | 31.89 |
| SD | 1.68 | 1.54 | 1.36 | 1.33 | 1.30 | 1.38 | 1.62 | 1.40 | 1.76 |
| Control side | | | | | | | | | |
| Mean | 31.16 | 32.03 | 32.27 | 31.53 | 31.87 | 31.99 | 31.71 | 31.73 | 32.40 |
| SD | 2.42 | 1.41 | 1.40 | 2.00 | 1.87 | 1.71 | 1.63 | 1.58 | 1.72 |
| P value | 0.4518 | 0.0844 | 0.1875 | 0.6991 | 0.6049 | 0.8817 | 0.6406 | 0.3922 | 0.2652 |

a = upper arm, b = back, c = lower leg

were applied with 1.5 ml of clear topical ointment (vasaline: liquid paraffin = 1:1) while the left side received no topical ointment. ER was measured at the same point at 30 minutes and 4-6 hours during phototherapy. Skin ambient temperature and humidity were measured simultaneously with ER. During measurements the infants were mostly asleep and showed little motor activity. To avoid errors due to moisture on the investigator's hands, rubber gloves were worn. The skin condition on the treated side was observed and compared with the untreated side. For statistical testing, paired student *t* test was used to compare the values for each measured parameter.

## RESULTS

Thirty preterm infants (15 F and 15 M) were born at a mean gestational age of 32 ± 1.8 weeks (range 27-34), with a mean birth weight of 1,416 ± 195 g (range 930-1,700). Their mean postnatal age at the start of the measurements was 3.7 ± 0.9 days (range 2-4). Their mean bilirubin at the day of measurement was 8.7 ± 1.0 mg/dl (range 7-10.3).

TEWL in the treated and untreated side was not different before the application of clear topical ointment (Table 1). On the treated side, mean of TEWL dropped 29 per cent at 30 minutes (P= 0.0024) and 26 per cent at 4-6 hours (p=0.0109) (Table 2) after application of clear topical ointment. On the untreated side, mean of TEWL was not significantly different at 30 minutes and 4-6 hour (p > 0.5, Table 3).

Ambient temperature and ambient humidity on the treated side were not statistically significant from the untreated side.

The mean bilirubin was 7.7 ± 0.5 mg/dl (range 6.5-9.1) 24 hours after phototherapy. There was no rash or sign of abnormalities on the treated side 24 hours after treatment.

## DISCUSSION

Premature infants have immature skin and ineffective barrier function[5]. TEWL in premature infants is higher than in term infants[1,16]. Phototherapy is another factor that increases TEWL[17, 18]. In this study, liquid paraffin and vasaline decreased ER 29 per cent at 30 minutes and 26 per cent at 4-6 hours on the treated side compared to the untreated side. We also studied time-dependent variations of TEWL, which were higher in the evening and night than in the morning[19]. ER in the untreated side was not different at 30 minutes and 4-6 hours (p>0.05), which means that there was no time-defendant variation during this short period of time.

In a previous study, Nopper et al[8] found that topical ointment decreased TEWL 47 per cent at 30 minutes and 34 per cent at 4-6 hours. The mean gestational age of infants included in that study was lower than in this study. The ointment

**Table 5. Ambient humidity before and after clear topical ointment therapy.**

| Ambient temperature (%) | Time 0 | | | At 30 minutes | | | At 4-6 hours | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | a | b | c | a | b | c |
| Treated side | | | | | | | | | |
| Mean | 56.19 | 55.24 | 55.78 | 52.66 | 52.71 | 53.91 | 52.27 | 51.37 | 51.71 |
| SD | 8.30 | 6.61 | 8.47 | 6.66 | 7.11 | 9.27 | 6.92 | 6.60 | 7.52 |
| Control side | | | | | | | | | |
| Mean | 54.11 | 53.19 | 54.61 | 53.83 | 52.82 | 54.88 | 53.30 | 52.00 | 53.42 |
| SD | 6.02 | 5.73 | 7.00 | 7.03 | 7.38 | 7.68 | 7.56 | 6.60 | 6.41 |
| P value | 0.2719 | 0.2044 | 0.5600 | 0.5119 | 0.9547 | 0.6606 | 0.5867 | 0.7115 | 0.3468 |

a = upper arm, b = back, c = lower leg

was composed of petrolatum, mineral oil, mineral wax and wool wax alcohol. It has pale yellow color, which may affect phototherapy. This agent is expensive and not available in Thailand. Various topical agents have been used in newborn skin. Creams are ineffective in sustained waterproofing effect(7). Repeated application of emollient cream to a premature neonate's skin did not have significant difference in TEWL(20). Paraffin reduced evaporative water and heat losses of preterm infants (7). Vasaline does not act like an epicutaneous impermeable membrane but it permeates throughout the stratum corneum interstices, allowing normal barrier recovery in acetone – induced barrier disruption in human volunteers(21). In this study, liquid paraffin and vasaline in the ratio of 1:1 which is a clear topical ointment that theoretically will not reduce the penetration of violet, blue and some green light used for phototherapy. We followed-up the bilirubin 24 hours after phototherapy and found that bilirubin level declined as usual. Further studies are needed to confirm that application of a clear topical ointment to the whole body does not effect phototherapy.

We concluded that the application of a clear topical ointment on the skin of jaundiced preterm infants receiving conventional phototherapy in incubators, reduced TEWL significantly.

## ACKNOWLEDGEMENT

The authors wish to thank Dr. Krisana Kaisintu, Head of R&D Institute, a government pharmaceutical organization for allowing us to use the Tewameter.

(Received for publication on February 19, 2001)

## REFERENCES

1. Rutter N, Hull D. Water loss from the skin of term and preterm babies. Arch Dis Child 1979; 54: 858-68.
2. Barker N, Hadgraff J, Rutter N. Skin permeability in the newborn. J Invest Dermatol 1987; 88: 409-11.
3. Hammarlund K, Sedin G. Transepidermal water loss in newborn infants III. Relation to gestational age. Acta Paediatr Scan 1979; 68: 795-01.
4. Evans NJ, Rutter N. Development of the epidermis in the newborn. Biol Neonate 1986; 49: 74-80.
5. Rutter N. The immature skin. Br Med Bull 1988; 44: 957-70.
6. West DP, Worobec S, Solomon LM. Pharmacology and toxicology of infant skin. J Invest Dermatol 1981; 76: 147-50.
7. Rutter N, Hull D. Reduction of skin water loss in the newborn. I. Effect of applying topical agents. Arch Dis Child 1981; 56: 669-72.
8. Nopper AJ, Horii KA, Sookdeo-Drost S, Wang TH, Mancini AJ, Lane AT. Topical ointment benefits premature infants. J Pediatr 1996; 128: 660-9.
9. Maisels MJ. Jaundice. In : Avery GB, Fletcher MA, Mac Donald MG, Eds. Neonatology : patho-

physiology and management of the newborn 5th ed. Philadelphia: Lippincott, 1999: 765-19.
10. Wu PYK, Hodgman JE. Insensible water loss in premature infants : changes with post - natal development and non - ionizing radiant energy. Pediatrics 1974; 54: 704-12.
11. Wu PYK, Wong WH, Hodgman JE, et al. Changes in blood flow in the skin and muscle with phototherapy. Pediatr Res 1974; 8: 257-62.
12. Anderson RR, Parrish JA. The optics of human skin. J Invest Dermatol 1981; 77: 13-9.
13. Lebwohl M, Martinez J, Weber P, Deluca R. Effect of topical preparations on the erythemogenicity of UVB : implications for psoriasis phototherapy. J Am Acad Dermatol 1995; 32: 469-71.
14. Sedin G, Hammarlund K, Nilsson GE, Stromberg B, Oberg PA. Measurements of Transepidermal Water loss in Newborn Infants. Clin Perinatol 1985; 12: 79-99.
15. Pinnagoda J, Tupker RA, Agner T, Serup J. Guidelines for transepidermal water loss (TEWL) measurement. A report from the standardization group of the European Society of Contact Dermatitis. Contact Dermatitis 1990; 22: 164-78.
16. Agren J, Sjors G, Sedin G. Transepidermal water loss in infants born at 24 and 25 weeks of gestation. Acta Paediatr 1998; 87: 1185-90.
17. Engle WD, Baumgart S, Schwartz JG, Fox WW, Polin RA. Insensible water loss in the critically ill neonate. Combined effect of radiant-warmer power and phototherapy. Am J Dis Child 1981; 135: 516-20.
18. Oh W, Karecki H. Phototherapy and insensible water loss in newborn infants. Am J Dis Child 1972: 124: 230-2.
19. Yosipovitch G, Xiong GL, Haus E, Sackett-Lundeen L, Ashkenazi I, Maibach HI. Time-dependent variations of the skin barrier function in Humans: Transepidermal water loss, stratum corneum hydration, skin surface pH, and skin temperature. J Invest Dermatol 1998; 110: 20-3.
20. Lane A, Drost S. Effects of repeated application of emollient cream to premature neonates' skin. Pediatrics 1993; 92: 415-9.
21. Ghadially R, Halrier-Sorensen L, Elias PM. Effects of petrolatum on stratum corneum structure and function. J Am Acad Dermatol 1992; 26: 387-96.

# ผลการทาสารประกอบน้ำมันที่มีต่อการสูญเสียน้ำทางผิวหนังในทารกคลอดก่อนกำหนดตัวเหลืองที่ได้รับการรักษาด้วยการส่องไฟ

*ศิริวรรณ วนานุกูล, พ.บ.*,*
*ปราโมทย์ ไพรสุวรรณา, พ.บ.*, กฤดากร เกษรคำ, พ.บ.**

ทำการวัดผลของการทาสารประกอบน้ำมันต่อการสูญเสียของน้ำผ่านผิวหนัง ในเด็กทารกคลอดก่อนกำหนดที่มีอายุครรภ์น้อยกว่าหรือเท่ากับ 34 สัปดาห์ และอายุไม่เกิน 7 วัน จำนวน 30 คนที่ได้รับแสงบำบัดเนื่องจากภาวะตัวเหลือง โดยทาสารประกอบน้ำมัน ปริมาณ 1.5 มล. ที่ลำตัวเฉพาะข้างขวาและแขนขาข้างขวา โดยข้างซ้ายของลำตัวจะไม่ได้รับการทาน้ำมันเพื่อใช้เป็นตัวเปรียบเทียบ แล้ววัดการระเหยของน้ำผ่านผิวหนัง อุณหภูมิ และความชื้นสัมพัทธ์เหนือผิวหนังทั้ง 2 ข้าง ก่อนทาและหลังทาสารประกอบน้ำมัน 30 นาที และ 4-6 ชั่วโมงขณะฉายแสง โดยวัดที่ แขน หลัง และขา ผลการศึกษาพบว่าสารประกอบน้ำมันสามารถลดการระเหยของน้ำผ่านผิวหนังร้อยละ 29 ($p < 0.0024$) ที่ 30 นาที และร้อยละ 26 ($p < 0.1$) ที่ 4-6 ชั่วโมง เมื่อเปรียบเทียบกับข้างที่ไม่ได้ทาสารประกอบน้ำมัน อุณหภูมิ และความชื้นที่เหนือผิวหนังไม่แตกต่างกันทั้ง 2 ข้าง ($p > 0.18$) โดยสรุปการทาสารประกอบน้ำมันสามารถลดการระเหยของน้ำผ่านผิวหนังในเด็กทารกคลอดก่อนกำหนดที่ตัวเหลืองและได้รับแสงบำบัดในตู้อบอย่างมีนัยสำคัญทางสถิติ

**คำสำคัญ** : การสูญเสียของน้ำผ่านผิว, แสงบำบัด, เด็กคลอดก่อนกำหนด, สารประกอบน้ำมัน

**ศิริวรรณ วนานุกูล, ปราโมทย์ ไพรสุวรรณา, กฤดากร เกษรคำ**
**จดหมายเหตุทางแพทย์ ฯ 2544; 84: 837-841**

* ภาควิชากุมารเวชศาสตร์, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330