ORIGINAL ARTICLE

Efficacy of phototherapy for neonatal jaundice is increased by the use of low-cost white reflecting curtains

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Objective: To determine whether the addition of low-cost reflecting curtains to a standard phototherapy unit could increase effectiveness of phototherapy for neonatal jaundice.

Design: Randomised controlled clinical trial.

Setting: Level-one nursery of the Hospital Universiti Sains Malaysia, Kelantan, Malaysia.

Patients: Term newborns with uncomplicated neonatal jaundice presenting in the first week of life.

Interventions: Phototherapy with white curtains hanging from the sides of the phototherapy unit (study group, n = 50) was compared with single phototherapy without curtains (control group, n = 47).

Main outcome measures: The primary outcome was the mean difference in total serum bilirubin measured at baseline and after 4 h of phototherapy. The secondary outcome was the duration of phototherapy.

Results: The mean (standard deviation) decrease in total serum bilirubin levels after 4 h of phototherapy was significantly ($p < 0.001$) higher in the study group (27.62 (25.24) $\mu\text{mol/l}$) than in the control group (4.04 (24.27) $\mu\text{mol/l}$). Cox proportional hazards regression analysis indicated that the median duration of phototherapy was significantly shorter in the study group (12 h) than in the control group (34 h; χ^2 change 45.2; $p < 0.001$; hazards ratio 0.20; 95% confidence interval 0.12 to 0.32). No difference in adverse events was noted in terms of hyperthermia or hypothermia, weight loss, rash, loose stools or feeding intolerance.

Conclusion: Hanging white curtains around phototherapy units significantly increases efficacy of phototherapy in the treatment of neonatal jaundice without evidence of increased adverse effects.

Neonatal jaundice is a common problem worldwide and it is effectively treated with phototherapy. Multiple phototherapy units are sometimes used to increase the light intensity and thus improve the efficacy of phototherapy.¹ However, light intensity and the area of light-exposed skin can also be increased through the use of reflecting surfaces (eg, white curtains hung from the sides of the phototherapy unit).² To the best of our knowledge, only one small, non-randomised study has thus far compared conventional single phototherapy with single phototherapy augmented with low-cost reflecting surfaces in the phototherapy units.³

In developing nations, where the number of babies with jaundice may be high, approaches to obtain the maximum possible effect and use from each phototherapy unit seem worthy of study. Thus, De Carvalho *et al*⁴ showed that intensive phototherapy could be provided by a locally made unit using daylight fluorescent phototherapy lamps instead of much more expensive blue lamps. Similarly, if it could be proved that single phototherapy with low-cost reflecting curtains is more effective than single phototherapy alone, it might be a valuable alternative to double phototherapy in the treatment of infants with jaundice.

Our study aimed to compare the efficacy of single phototherapy without curtains with that of single phototherapy with white curtains hanging from the sides, and to assess the safety of the second method.

METHODS

All babies admitted to the special care nursery of the Hospital Universiti Sains Malaysia, Kelantan, Malaysia, during the

study period, owing to uncomplicated neonatal jaundice and requiring single phototherapy, were eligible for the study. The need for phototherapy was determined using the Malaysian clinical practice guidelines for management of jaundice in healthy term newborns.⁵ Babies who had serum bilirubin levels close to the exchange transfusion limit were excluded from the study.

The number of participants needed was calculated on the basis of the main outcome measure (mean difference in total serum bilirubin between that measured at baseline and at 4 h after phototherapy) by selecting a power of 0.9 and a two-tailed $\alpha = 0.05$. The sample size was estimated to be 50 neonates for each group to show a 10 μmol difference in serum bilirubin between study groups.

In all, 100 babies were included based on the convenience of the main investigator (when he was working regular hours or was on call). The babies included in the study were randomised either to receive single phototherapy without curtains (control group) or single phototherapy with white curtains at both sides of the phototherapy unit as shown in fig 1 (intervention group). After randomisation to one of the groups, the infant remained in that group until phototherapy could be stopped or until the infant exited the study.

The best material for the white curtains to be used in the study was determined during a prestudy testing of three materials that are readily available in most neonatal intensive care units and special care nurseries in developing countries. Light intensity was measured as spectral irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$) using the light intensity meter Minolta/Narco scientific fluoro-lite meter 451 (Minolta Camera, Osaka, Japan). Table 1 lists the materials used and the light intensities measured. Among the materials tested, locally produced underpads

Figure 1 Set-up for the intervention group using the white reflecting curtain hanging on both sides of the phototherapy unit.

used to protect the sheets of the cots against faecal or urinary soiling (Pharmaniaga Logistic, Syah Alam, Selangor, Malaysia) increased light intensity most and were used in the study. The white plastic side of the underpads faced the inside of the cot.

The phototherapy units used were manufactured by Phoenix Medical Systems, Jawaharlal Nehru Salai Ekkaduthangal, Chennai, India (CFL-101 phototherapy unit with six compact blue fluorescent lamps). All units used in the study were serviced just before the study began and were maintained in optimal working condition for the whole duration of the study. The distance between the phototherapy unit and the baby was standardised at 45 cm.

The primary outcome measure was the mean difference in serum bilirubin between baseline and after 4 h of phototherapy. Secondary outcome measures included the total duration of phototherapy. Decisions to stop phototherapy were made according to guidelines from the Clinical practice guidelines given by the Ministry of Health, Malaysia.⁵ While on phototherapy, serum bilirubin was measured at 4, 10, 24 and 48 h after initiation of treatment. An additional blood sample was taken 24 h after stopping phototherapy.

The safety of both methods was assessed and compared by monitoring the body temperature, hydration status (monitored clinically and by weighing the baby), skin problems (such as rashes or bronze baby syndrome) and gastrointestinal problems (such as loose stools or feeding intolerance). All babies underwent a thorough neurological examination by the treating paediatrician. Otoacoustic emissions were checked as part of the screening programme before discharge.

The babies were randomised using block randomisation. The investigators were blinded to the allocation until the inclusion of the infant in the study had been confirmed.

Statistical analysis

Data were entered and analysed using SPSS V.12.0.1.

The decrease in serum bilirubin was analysed by comparing the means with independent *t* tests. The duration of phototherapy in each group was analysed by Cox regression analysis.

The study was approved by the research and ethics committee of the Medical School of Universiti Sains Malaysia, Malaysia, and written parental consent was obtained.

RESULTS

In all, 49 babies were allocated to the control group and 51 were allocated to the intervention group. Three babies (one from the intervention group and two from the control group) had levels of bilirubin increasing up to a level close to the exchange transfusion level. They exited the study prematurely and were excluded from analysis.

Patients were recruited between 1 September and 1 December 2005. Both groups showed quite similar baseline data but, fortuitously, a non-significant higher proportion of patients with glucose-6-phosphate dehydrogenase deficiency and ABO incompatibility was allocated to the control group. Table 2 lists the most relevant baseline data.

The mean (standard deviation (SD)) decrease in serum bilirubin after 4 h of phototherapy in the intervention group was 27.62 (25.24) $\mu\text{mol/l}$ and that in the control group was 4.04 (24.27) $\mu\text{mol/l}$ ($p < 0.001$). The median duration of phototherapy was 12 h (25th quartile 7 h, 75th quartile 14 h) in the intervention group and 34 h (25th quartile 17 h, 75th quartile 40 h) in the control group. Cox proportional hazards regression analysis indicated that the median duration of phototherapy was 22 h shorter in the intervention group than in the control group (χ^2 change 45.2; $p < 0.001$; hazard ratio 0.20; 95% confidence interval 0.12 to 0.32). Figure 2 shows the duration of phototherapy for the two groups.

The mean (SD) serum bilirubin levels 24 h after stopping the phototherapy were not significantly different between the intervention and control groups (188.60 (43.23) $\mu\text{mol/l}$ v 194.87 (36.90) $\mu\text{mol/l}$, respectively; $p = 0.444$). None of the babies required phototherapy for rebound hyperbilirubinaemia. None of the babies developed hypothermia or hyperthermia. None experienced significant weight loss while on phototherapy. The other side effects, which were actively looked for (as mentioned in Methods), did not occur during the study. None of the babies showed any detectable abnormality on neurological examination before discharge. All the babies passed the otoacoustic emissions test on both ears.

Table 1 Light intensities measured during a prestudy evaluation of different materials

Light intensity ($\mu\text{W}/\text{cm}^2/\text{nm}$) measured				
	Single phototherapy without curtain	Underpad (white side towards baby)	White pillow	White napkin
In front of the baby	8.01	10.79	9.05	9.28
At the right side of the baby	5.83	7.71	7.14	6.67
At the left side of the baby	4.98	7.67	7.05	5.46

The materials were fixed as curtains to the right and left sides of the phototherapy unit.

Table 2 Baseline data of the babies included in the study

	Intervention group	Control group	p Value
Body weight (kg)	3.01 (0.49)	3.07 (0.44)	0.642
Age at start of phototherapy (days)	4.30 (2.08)	4.45 (2.07)	0.375
Male sex (n)	30 (60%)	26 (55.32%)	0.641
ABO incompatibility (n)	6 (12%)	10 (21.28%)	0.219
Glucose-6-phosphate dehydrogenase deficiency (n)	8%	7 (14.89%)	0.285
Total serum bilirubin at start of phototherapy ($\mu\text{mol/l}$)	262.94 (61.51)	264.76 (56.63)	0.913
Temperature ($^{\circ}\text{C}$)	36.96 (0.08)	36.93 (0.21)	0.641
Breast feeding*			
Before admission (n)	50	47	
Rooming-in mothers (n)	29 (58%)	26 (55.3%)	0.839

*During admission all mothers continued breast feeding. Babies of mothers who were not rooming-in received formula milk at night.

Values are mean (SD) or n (%).

DISCUSSION

Our results show that the use of white curtains at the sides of a phototherapy unit can safely increase the efficacy of phototherapy. This simple and cheap method may be of great use to neonatal units in developing nations, where acquisition and maintenance of a sufficient number of phototherapy units may be a challenge to limited budgets. These results can probably be extrapolated to settings outside Malaysia, assuming that the response to phototherapy is quite similar among different ethnic groups.

During this study, all the babies were monitored and nurses made their observations either from the foot end or after lifting up the curtains for a very short time. No adverse events were noted. As far as absolute safety is concerned, a much larger study may be necessary to draw definite conclusions.

The evidence that phototherapy with simple white curtains hung at the sides of a phototherapy unit is more effective than phototherapy without curtains is quite strong. This may translate into potential cost reduction in two ways. Firstly, as the shorter duration of treatment means that more patients can

What is already known on this topic

- White reflecting curtains hung around a phototherapy unit increase light intensity.
- Use of curtains may increase efficacy of phototherapy for neonatal jaundice (one small non-randomised controlled trial published in a non-English journal).

What this study adds

- The use of white reflecting curtains increases the efficacy of phototherapy.
- This method is safe.

Figure 2 Cumulative proportion of duration phototherapy according to the type of intervention. Group A, intervention group; group B, control group.

be treated with fewer phototherapy units, there will be a cost saving in terms of acquisition and maintenance of phototherapy units. Secondly, decreasing the duration of phototherapy should translate into a shorter length of hospitalisation. This would also mean considerably less separation from the mother and less interruption of breast feeding. These advantages would indeed be of major importance in developing nations, but all of the above are also valid for developed countries, where cost effectiveness is becoming increasingly important.

The absence in this study of considerable rebound after stopping phototherapy is quite different from recently published findings by Kaplan *et al*⁶ and Maisels *et al*,⁷ but this could possibly be explained by the exclusion of babies with more severe jaundice.

In conclusion, this study strongly suggests that hanging curtains around the sides of a phototherapy unit may markedly increase the efficacy and shorten the duration of phototherapy.

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IMAGES IN NEONATAL MEDICINE.....

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Abdominal cellulitis due to *Escherichia coli* in a two month old premature newborn

This girl was born at 28 weeks gestation, weighing 780 g. Her first two months of life were unremarkable, with oxygen therapy for moderate bronchopulmonary dysplasia, good growth, and normal neurological examinations. She was not colonised by multiresistant bacteria. On the 60th day of life, the expected discharge date, a small violet spot was seen on her right flank, without any history of local trauma. Twelve hours later, she developed respiratory distress and shock. Biological inflammatory variables were moderately raised. Lumbar puncture was normal. Probabilistic antibiotic therapy was begun. She was intubated, ventilated, and referred to the paediatric intensive care unit. On admission, she was hypoxaemic, hypotensive, and pancytopenic. She was switched from conventional ventilation to oscillatory ventilation. Overall, she needed 100 ml/kg fluids and transfusions during the first 12 hours and continuous infusion of vasopressors on a central venous catheter. Tracheal, blood, and urinary cultures were negative. Cerebral and abdominal ultrasounds were normal. Despite intensive treatment, the skin lesion progressively enlarged (fig 1), and ventilatory and haemodynamic requirements increased. A surgical debridement was performed 24 hours after her admission.¹ Peroperative observation confirmed the diagnosis of cellulitis without fascia injury. One can assume that the prompt surgical treatment prevented the occurrence of necrotising fasciitis.² Cultures of the abdominal wall showed cephalosporin sensitive *Escherichia coli*,³ also found in her rectal colonisation. Her clinical status improved rapidly after surgery.⁴ She was weaned from vasopressors after 12 hours and from the ventilator after five days. She received a skin autograft one month later and was discharged home in good health.

Figure 1 Cutaneous presentation of abdominal cellulitis immediately before surgical debridement. The child's parents have consented to the publication of this picture.

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