Phototherapy for hyperbilirubinaemia in low birthweight infants

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Elliott, E., Moncrieff, M. W., and George, W. H. S. (1974). *Archives of Disease in Childhood*, 49, 60. **Phototherapy for hyperbilirubinaemia in low birth-weight infants.** Eighty-eight babies whose birthweights were between 1500 g and 2500 g, and whose serum bilirubin reached 10 mg/100 ml, were entered into a controlled trial of phototherapy. Alternate babies were treated with 4000 to 5000 lux, and control cases were not treated unless the bilirubin exceeded 15 mg/100 ml. No baby in the treated group developed a serum bilirubin greater than 15 mg/100 ml, compared with 44% of untreated cases, a highly significant difference. No side effects occurred apart from overheating in a few babies. We conclude that phototherapy is a safe and effective way of treating hyperbilirubinaemia in low birthweight infants, and suggest it should be started when the bilirubin reaches 12 mg/100 ml, except for babies under 1500 g birthweight when it should be started at 10 mg/100 ml.

Hyperbilirubinaemia in low birthweight infants still poses difficult problems in management. Kernicterus may occur in these infants, especially if ill, at levels of bilirubin well below 20 mg/100 ml (Gartner *et al.*, 1970); and though the bilirubin can be rapidly reduced by exchange transfusion, mortality is high at about 4% (McKay, 1964), and indications for exchange transfusion in low birthweight infants are not well established.

Phototherapy for neonatal jaundice was first advocated by Cremer, Perryman, and Richards (1958), but many years later doubt about its effectiveness and safety was still being expressed (*British Medical Journal*, 1970). There are few reports of controlled trials in low birthweight infants. The studies of Lucey, Ferreiro, and Hewitt (1968), Porto, Pildes, and Goodman (1969), and Hodgman and Schwartz (1970) showed that continuous treatment from soon after birth resulted in a significant decrease in the number of babies developing hyperbilirubinaemia. In limiting phototherapy to infants whose serum bilirubin level rose above 10 mg/100 ml, Giunta (1971) and Shepard and Lucey (1971) found a significant difference in bilirubin concentration between treated cases and controls. Intermittent therapy was reported by Zachman (1972) to be as effective as continuous therapy, and treatment for as little as 12 or 24 hours

was shown by Tabb *et al.* (1972) to be sufficient to prevent the serum bilirubin exceeding 13 mg/100 ml in 80% of infants.

Phototherapy was introduced in Derby in 1960 by Dr. B. M. Laurance, and though there was a strong impression that it prevented high levels of bilirubin developing in low birthweight infants, no controlled studies were performed. In order to substantiate this impression and to define better the indications for phototherapy, we report the results of a controlled trial in infants weighing 1500 to 2500 g at birth, whose bilirubin level reached 10 mg/100 ml. Babies weighing less than 1500 g at birth were excluded, as it was felt unethical to withhold treatment in these infants who have a high risk of developing kernicterus.

Materials and methods

In 1972, 200 babies whose birthweights were between 1500 and 2500 g were admitted to the Special Care Baby Unit. Those with clinical jaundice had their serum bilirubin measured daily by direct spectrophotometry. All babies whose bilirubin reached 10 mg/100 ml or above were included in the trial with the following exceptions: those with known blood group incompatibility, those treated with phenobarbitone (all were babies with cerebral birth injury), and one baby whose first serum bilirubin level was 16 mg/100 ml. 92 babies were entered into the trial, alternate cases being treated with phototherapy, group I. Control cases,

group II, were treated with phototherapy only if their bilirubin reached 15 mg/100 ml. There were two deaths in each group that have been excluded from further analysis; and two further babies in each group have also been excluded because the trial protocol was not followed accurately, leaving 41 babies in group I, and 43 babies in group II. The two groups have been compared for birthweight, gestational age, sex, bruising, and neonatal illnesses (Table I). Gestational age was assessed

TABLE I

Some clinical features in two groups of low birthweight infants

	Group I	Group II
Sex (M/F)	21/22	27/18
Mean birthweight (kg)	1.99	2.04
Mean gestation (wk)	34.6	35.1
Severe bruising	6	4
Respiratory distress syndrome	6	6

clinically using the criteria of Robinson (1966) and Usher, McLean, and Scott (1966).

Phototherapy was continued until the bilirubin had fallen to 10 mg/100 ml and was restarted if it rose above 10 mg/100 ml again. Phototherapy was given by means of a cradle on which were mounted eight 40 watt, white fluorescent strip lights, giving a light intensity of 4000 to 5000 lux on the infant. Babies were nursed naked except for bandages covering the eyes, were turned hourly, and received a liberal fluid intake. They were observed closely for possible side effects and the skin temperature was measured hourly. All were given 0.5 mg vitamin K₁ and none received phenobarbitone or any drug known to potentiate jaundice.

Results

The number of infants in each group whose bilirubin rose above 12, 13, 14, and 15 mg/100 ml is shown in Table II. There was a significant

TABLE II

Percentages in each group of babies whose bilirubin exceeded the level shown

Bilirubin (mg/100 ml)	Group I (%)	Group II (%)
> 12	68	72
> 13	39	60
> 14	12	49
> 15	0	44

difference between the two groups for levels above 15 mg ($P < 0.001$). The mean daily bilirubin level in the two groups is compared in the Fig., which shows a marked difference between treated and

FIG.—Mean daily serum bilirubin levels in infants treated with phototherapy (Group I) and untreated (Group II) infants.

untreated cases. The mean duration of phototherapy in group I was 62 hours with a range of 24 to 168 hours. No serious side effects were observed, though a few of the babies became over-heated, and for these the number of lights was reduced temporarily. No baby developed loose green stools as has sometimes been recorded (Washington, Brown, and Starrett, 1972).

The 4 infants who died all suffered from severe idiopathic respiratory distress syndrome. They showed no clinical evidence of kernicterus and at necropsy examination on 2 there was no evidence of kernicterus.

Discussion

The two groups were comparable for the features recorded in Table I, and the results show clearly that phototherapy effectively controlled the serum bilirubin level. No baby in the treated group developed a bilirubin above 15 mg/100 ml compared with 44% of those in the control group, and despite phototherapy at this stage the bilirubin in 3 (8%) of these babies reached 18 mg/100 ml but then fell rapidly. None required exchange transfusion.

Our results are similar to those previously reported, where phototherapy was used for low birthweight babies with a bilirubin level greater than 10 mg/100 ml. Shepard and Lucey (1971) found that it exceeded 15 mg/100 ml in only 2% of treated infants compared with 28.6% of untreated infants, and Giunta (1971) reported that 3.1% of treated cases had a bilirubin greater than 12 mg/100 ml compared with 27.5% of control infants.

Phototherapy has been shown in this study to be an effective and safe method of controlling hyperbilirubinaemia in low birthweight infants. In order to avoid unnecessary treatment, we suggest that it is started when the bilirubin reaches 12 mg/100 ml; the maximum level would then be unlikely to exceed 17 mg/100 ml. With this criterion, phototherapy is likely to be required for 30% of small infants. For infants under 1500 g, treatment might well be started at the lower level of 10 mg/100 ml. We have not found any short-term complications apart from overheating in a few babies, and long-term sequelae seem unlikely as phototherapy has been used in Derby for 13 years with none being recognized. However, we intend to follow up our treated babies carefully.

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REFERENCES

- British Medical Journal* (1970). Leading article. Blue light and jaundice, **2**, 5.
- Cremer, R. J., Perryman, P. W., and Richards, D. H. (1958). Influence of light on the hyperbilirubinaemia of infants. *Lancet*, **1**, 1094.
- Gartner, L. M., Snyder, R. N., Chabon, R. S., and Bernstein, J. (1970). Kernicterus: high incidence in premature infants with low serum bilirubin concentrations. *Pediatrics*, **45**, 906.
- Giunta, F. (1971). A one-year experience with phototherapy for jaundice of prematurity. *Pediatrics*, **47**, 123.
- Hodgman, J. E., and Schwartz, A. (1970). Phototherapy and hyperbilirubinemia of the premature. *American Journal of Diseases of Children*, **119**, 473.
- Lucey, J., Ferreiro, M., and Hewitt, J. (1968). Prevention of hyperbilirubinemia of prematurity by phototherapy. *Pediatrics*, **41**, 1047.
- McKay, R. J. (1964). Current status of use of exchange transfusion in newborn infants. *Pediatrics*, **33**, 763.
- Porto, S. O., Pildes, R. S., and Goodman, H. (1969). Studies on the effect of phototherapy on neonatal hyperbilirubinemia among low-birth-weight infants. I. Skin color. *Journal of Pediatrics*, **75**, 1045.
- Robinson, R. J. (1966). Assessment of gestational age by neurological examination. *Archives of Disease in Childhood*, **41**, 437.
- Shepard, K. S., and Lucey, J. F. (1971). The selective prevention of hyperbilirubinemia of prematurity by phototherapy. *Proceedings of the 13th International Congress of Pediatrics*, Vienna, Vol. 1, p. 387. Vienna Academy of Medicine, Vienna.
- Tabb, P. A., Inglis, J., Savage, D. C. L., and Walker, C. H. M. (1972). Controlled trial of phototherapy of limited duration in the treatment of physiological hyperbilirubinaemia in low-birth-weight infants. *Lancet*, **2**, 1211.
- Usher, R., McLean, F., and Scott, K. E. (1966). Judgement of fetal age. *Pediatric Clinics of North America*, **13**, 835.
- Washington, J. L., Brown, A. W., and Starrett, A. L. (1972). The question of diarrhea and phototherapy. *Pediatrics*, **49**, 279.
- Zachman, R. D. (1972). Alternate phototherapy in neonatal hyperbilirubinemia. *Journal of Pediatrics*, **81**, 178.

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