Research from the South

Ward design and neonatal jaundice in the tropics: report of an epidemic

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Abstract

Architectural modifications to an existing tropical obstetric ward involved extension of the roof overhangs to a width of several metres. These extensions excluded most of the daylight from the ward. An alarming increase in the incidence of jaundice (bilirubin concentration $\geq 240 \mu\text{mol/l}$ ($\geq 14 \text{ mg/100 ml}$)) from 0.5% to 17% in newborn infants occurred after the modifications. Tropical obstetric wards and nurseries should continue to be built with windows facing north-south for coolness. They should, however, have as many windows as possible and the roof overhangs should be limited to about 1 m to allow adequate indirect sunlight to enter, giving a high intensity of illumination, and help prevent neonatal jaundice.

Introduction

It has been known since 1958 that sunlight is effective in breaking down bilirubin in the skin of newborn infants.¹ Increasing the environmental lighting of nurseries, together with keeping infants' skin exposed to the light, has been shown to help prevent the hyperbilirubinaemia of prematurity. Nevertheless, the increase in lighting achieved by improvements in overhead lighting was only from 110 to 990 lumen/m² (10 to 90 footcandles) in one study.² Measurements of light intensity in a nursery in Montreal, Canada, showed that infants nursed in a ward exposed to sunlight sometimes receive an intensity of illumination of up to 27 500 lumen/m² (2500 footcandles).³ The authors, therefore, suggested that the physical structure of the nursery and the amount of sunlight available should be considered when nurseries and their illumination are planned. Unfortunately, such information has not always been considered in the design of obstetric wards and neonatal nurseries in the tropics. We report an epidemic of neonatal jaundice occurring after the completion of architectural changes, which greatly decreased the amount of daylight entering an existing obstetric ward.

Patients and methods

Charts of all deliveries and newborn infants were studied for a total of 16 months from 16 June 1982 until 15 October 1983. The study period was broken down into four equal periods of four months for the purpose of analysis. Two periods were analysed before any architectural changes, one

during the changes, and one after all work had been completed. In all cases where clinical jaundice was noted and bilirubin determinations ordered, the results of these were compiled. The same doctor and midwife were in charge of the ward during all four study periods. The total number of neonatal laboratory results was verified in the laboratory record books. Bilirubin requests were also verified in this way. Biochemical analysis was performed under the supervision of a Canadian biochemistry laboratory instructor, and the same method was used throughout the study. The total number of neonatal infections occurring in the obstetric ward was determined by reviewing the microbiology record books in the laboratory. Charts of jaundiced infants were analysed to determine the numbers of infants receiving artificial feeding (if any), and the number of cases in which the mothers had received sulphonamide drugs during pregnancy. Obstetric record books were also reviewed for the four periods to determine how many infants had been delivered by caesarean section or vacuum extraction, and the number who underwent other difficult, abnormal, or unsupervised home deliveries. All other infants had been delivered by normal vaginal births.

Results

The architectural changes that were made to our obstetric ward included initially the addition of a 1 m overhang to an already existing roofed verandah 2 m wide. This was constructed in 1979 to stop heavy rains blowing on to the verandah. The new overhang slightly decreased the amount of indirect sunlight entering the ward. There was an undocumented impression that the incidence of neonatal jaundice increased slightly after this modification. In the period 1978-82, however, no infants required exchange transfusion. In early 1983, the roof overhang on the other side of the ward was extended to a total width of 5 m to provide a sheltered area for the numerous guardians of our patients. The building was originally built with windows facing north-south for coolness, but before the additions it had been bright and well lit by daylight. After the extensions to the overhangs had been completed the ward was dimly lit during the daytime. Subsequently, a pronounced increase in the number of cases of neonatal jaundice was noted, and several infants had to undergo exchange transfusion. Even more cases were noted when it rained for many days in succession, and the mothers were unable to go outside with their infants. We reviewed our patient records to see how many cases of jaundice had been noted and how many bilirubin requests made (table I). In the first four months in the year preceding the architectural changes only one infant out of 215 births had a bilirubin concentration $\geq 240 \mu\text{mol/l}$ ($\geq 14 \text{ mg/100 ml}$) (12 infants had a birth weight $< 2.2 \text{ kg}$). In the same four month period the

TABLE I—Number of cases of neonatal jaundice in two four month periods before, one during, and one after architectural changes. (Percentages are given in parentheses)

	Before	Before	During	After
Bilirubin concentration ($\mu\text{mol/l}$):				
≥ 240	1 (0.5)	1 (0.7)	12 (6.4)	17 (9.7)
≥ 342	0 (0)	1 (0.7)	5 (2.7)	12 (6.9)
Total No of neonatal bilirubin requests	2	4	44	93
Total No of newborn infants	215 (100)	147 (100)	187 (100)	175 (100)
Birth weight $< 2.2 \text{ kg}$	12 (5.6)	22 (15)	19 (10)	14 (8)
Positive neonatal cultures	7 (3.3)	29 (20)	32 (17)	13 (7.4)

Conversion: SI to traditional units—Bilirubin: $1 \mu\text{mol/l} \approx 0.06 \text{ mg/100 ml}$.

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following year, after the extension, out of 175 births, 17 had bilirubin concentrations $\geq 240 \mu\text{mol/l}$ ($\geq 14 \text{ mg/100 ml}$) and 12 concentrations $\geq 342 \mu\text{mol/l}$ ($\geq 20 \text{ mg/100 ml}$) (14 infants had a birth weight $< 2.2 \text{ kg}$). Thus there was an increase from 0.5% to 17% of babies having appreciably increased bilirubin concentrations. Bilirubin analysis was requested only for infants who were already clinically jaundiced. An increase from two requests for neonatal bilirubin analysis in the four months before the changes to 93 in the same period after placed a heavy strain on our small laboratory staff. This alarming increase in the incidence of jaundice caused some dismay when we realised that our ward improvements were probably responsible.

The situation slightly improved, as a result of the advice of a paediatric consultant, when we modified our simple homemade phototherapy light by installing two additional 20 W tubes with the single existing tube. The bulbs were also changed every three months to ensure that they were effective, and the ward lights were kept on during the day time. The mothers were encouraged not to keep their infants covered all the time and to take their babies out into the sunlight when it was not raining. We do not have a separate nursery; babies are kept in small metal cots at the foot of the mothers' beds. This is the safest and easiest method because of the limited staff and because most mothers breast feed their babies.

Other possible causes for the unprecedented rise in neonatal jaundice were considered. Although the neonatal infection rate has always been high in the ward, there did not appear to be any relation between the number of neonatal infections and the incidence of jaundice when the four groups were compared, as can be seen in table I. None of the jaundiced babies in any group had been artificially fed. Two mothers of jaundiced babies had received sulphonamide drugs during their pregnancy. These two cases occurred in the last of the four month periods. One mother had last received sulphonamide drugs 11 days before delivery and the other two months before delivery. The method of delivery was similar in the four groups (table II). Accurate determination of gestational age by dates is impossible for most villagers in Papua New Guinea. Birth weights are relatively low in coastal areas, probably because of chronic malaria and complex food taboos. It was therefore difficult to be sure of the exact numbers of premature babies in each group. Three jaundiced babies in the third group and four in the fourth were considered to be premature. There did not appear to be appreciable differences in the number of low birthweight babies in the four groups.

TABLE II—Method of delivery and peripartum complications in the two four month periods before, one during, and one after architectural changes. Figures are numbers of infants

	Before	Before	During	After
Caesarean section	13	11	13	9
Vacuum extraction	4	9	8	9
Breech, face, born before arrival, antepartum and postpartum haemorrhage	27	11	13	12

Discussion

Architects and obstetric ward staff need to be more aware that the appropriate design of obstetric wards and neonatal nurseries is important in preventing neonatal jaundice. When modifications

were made to our obstetric ward that prevented the entry of most of the daylight, a pronounced increase in the incidence of neonatal jaundice from 0.5% to 17% of all babies occurred. Unexplained fluctuations in the incidence of neonatal jaundice have been reported elsewhere in Papua New Guinea.⁴ The changes noted in the present study may possibly have been due to some other cause, but our findings strongly suggest an architectural one.

Wards in the tropics are normally designed with the windows facing north-south to prevent the direct entry of sunlight and overheating of the ward. Even with a standard 1 m roof overhang, however, wards remain bright during the daytime. The amount of light that enters such wards appears to be adequate to prevent most cases of neonatal jaundice, especially if babies are left unwrapped. This is not surprising when it is considered that sunlight can have an intensity of 110 000 lumen/m² (10 000 footcandles),⁵ whereas in a ward that is rather dimly lit there may be an intensity of 110 lumen/m² (10 footcandles). In smaller hospitals with limited staff, premature babies probably thrive best when taken care of at the mother's bedside with the staff assisting the mother. Good illumination is therefore important in such obstetric wards as well as in specialised nurseries. When tropical obstetric wards or nurseries or both, either in hospitals or health centres are designed, the following points should be considered: (a) long wards should be constructed with a row of beds along either side and as many windows as possible, (b) roof overhangs should be limited to 1 m in width, and (c) buildings should be built with windows facing north-south for coolness; this should still allow adequate light into the building if the first two factors are taken into account.

Careful architectural planning may do much to prevent serious problems of neonatal jaundice. The management of large numbers of such cases is time consuming for medical and nursing staff and can result in permanent brain damage to newborn infants if treatment is delayed. Since effective treatment may not be instituted quickly in poorly staffed tropical wards prevention by proper ward design is imperative.

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MATERIA NON MEDICA

Keeping pace

When I go walking in the hills I have an unseen companion. Sometimes he walks along with me, occasionally he follows behind, but usually he strides on ahead at a constant remorseless pace, whatever the weather, terrain, or distance. He may be invisible, but I know exactly what he looks like. He is tall, gaunt, and tanned, and is dressed in tweeds and nailed leather boots, with an old canvas rucksack—not for him the wonders of Goretex waterproofs, lightweight boots, or an ergonomically designed sack endorsed by Chris Bonnington. His name is Naismith, W W Naismith, who at the turn of the century proposed his now well known formula: a good pace when hill walking is an hour for three miles of distance and an hour for two thousand feet of climbing (or since the Ordnance Survey went metric, five kilometres an hour and six hundred metres of climbing an hour).

Now this is a brisk step to keep up for any length of time. So it was with some satisfaction that, on a recent foray to the Highlands, we found

ourselves after ten and a half hours of striding over rough and remote country to be a clear ninety minutes ahead of Naismith. I fancy he would have scorned our offer of a cup of tea when he arrived, and would have looked askance at our luxurious down sleeping bags as we settled down to bivouac high on the slopes of Carn Eige, the highest mountain north of the Great Glen. But, huddled down a gaberdine cape and puffing his pipe, I am sure he would have enjoyed the magnificent view as the sun went down behind Skye and the whole jagged length of the Cuillin ridge was silhouetted in fine detail.

But we paid for our exertions and hubris the next day, when blistered feet and exhaustion forced us to curtail our intended route and limp back to the car the most direct way. Even so it was early evening by the time we hobbled into the Cluanie Inn. Then, as I ordered up the pints, I am sure I glimpsed a familiar figure comfortably ensconced in a corner by the fire, and there was a twinkle in his eye as he raised his glass of whisky to us.—FERGUS MACBETH, senior registrar, Cambridge.