Referral of mothers and infants for intensive care

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Summary and conclusions

During 1975-7, 96 mothers were referred to University College Hospital for delivery from 39 other hospitals because their pregnancies were considered to be at very high risk. One hundred of the 111 infants born to the 96 mothers weighed 2500 g or less and 60 weighed 1500 g or less. A high proportion of the infants developed serious illnesses necessitating intensive care. The birth-weight-specific neonatal mortality rates of the infants were much lower than those of infants born in England and Wales as a whole and were also lower than those of the 370 infants transported to this hospital for intensive care after delivery elsewhere.

Whenever possible mothers with very high-risk pregnancies should be referred for delivery to centres with full facilities for the intensive care of the mother, fetus, and newborn infant.

Introduction

The neonatal intensive care unit (NICU) at University College Hospital (UCH) is a regional referral centre for the North-east Thames Region. It also accepts infants from other regions. A transport team based at the unit collects the infants by ambulance, or occasionally by helicopter, taking with it all the equipment necessary for safe transfer. In 1975 in describing our experience with the transport of sick infants in 1972-4¹ we showed that very ill infants could safely be moved from as far as 50 miles away, even if they needed mechanical ventilation in transit. Their survival rate was high, and their long-term prognosis was nearly always good.²

Although transport systems for sick infants can be made to work well, they suffer from two important disadvantages. Firstly, it may be difficult for the referring hospital to keep the infant in good condition until the transport team arrives.¹ Secondly, unless the mother can be moved at the same time she is separated from her infant during the first few days of life, thus increasing her anxiety and interfering seriously with the development of normal mother-child relationships.³ We believe that whenever possible it is preferable for mothers with very high-risk pregnancies to be transferred to regional centres with NICUs for delivery.

We describe here the characteristics and outcome for infants whose mothers were referred to UCH for delivery. We have compared birth-weight-specific mortality rates of the infants with those of infants collected from referring hospitals after delivery and with figures for England and Wales as a whole.

Patients and methods

A total of 80 hospitals within a radius of 70 miles of UCH transferred patients in 1975-7.

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TRANSFER OF MOTHERS FOR DELIVERY

Ninety-six mothers were transferred for delivery from 39 hospitals, 11 in the North-east Thames Region and 28 in other regions. Twenty-seven hospitals transferred one or two mothers, 10 transferred three to five, one transferred six, and one transferred 17. The antenatal care of nine mothers who were initially booked for delivery in other hospitals was undertaken at UCH from early in pregnancy because of severe rhesus haemolytic disease (in eight cases) and a quintuplet pregnancy (in one). The remaining mothers were referred after the 24th week of gestation because the mother or fetus was considered to be at risk of death or severe illness. When this problem arose the referring obstetrician telephoned the admitting obstetric staff at UCH. If a bed was available for the mother and if space was available in the NICU for the infant the mother was transported by ambulance, accompanied by a midwife and, if necessary, a doctor from the referring hospital. The principal diagnoses in the mothers were preterm labour in 27, severe pre-eclamptic toxæmia in 24, premature rupture of the membranes in 21, multiple pregnancy in 12, and antepartum haemorrhage in 7. No obstetric emergencies arose during the journey.

Once the mother arrived attempts were made, whenever appropriate, to postpone delivery of the infant by, for example, infusing salbutamol in preterm labour or using hypotensive drugs to control hypertension. Fifty-one of the 96 mothers were delivered by caesarean section. Eighty-four mothers had singletons, 8 twins, 2 triplets, one quadruplets, and one quintuplets. One of the mothers referred after 24 weeks' gestation had a spontaneous abortion at 26 weeks, and three had stillbirths at 30-32 weeks, two because of infection and one because of placental infarction.

TRANSFER OF INFANTS AFTER DELIVERY

Three hundred and seventy infants were transported after delivery from 68 hospitals, 22 in the North-east Thames Region and 46 outside it. Thirty hospitals referred one or two infants, 12 referred three to five infants, 12 referred six to nine infants, and 14 referred 10 to 19 infants.

The NICU was telephoned by a paediatrician or obstetrician in the referring hospital requesting the transfer of the infant. On 20 occasions this was done before the infant was born, so that the transport team from UCH could attend the delivery in the referring hospital. When the request was made an ambulance was called and members of the staff of the NICU, usually a doctor and a nurse, travelled in the ambulance, taking with them all the equipment necessary for stabilising the infant's condition before and during the journey. If traffic was heavy a police escort was obtained. Six infants were transported by helicopter from one referring hospital (at a US Air Force base). The transport incubator was the Vickers Model 77, modified as described.¹ The techniques used for monitoring sick infants during transfer and for the mechanical ventilation of those with severe respiratory illnesses have been reported in detail elsewhere.¹

Altogether 270 (73%) of the 370 referred infants were transported on the first day of life, 42 (11%) on the second day, 44 (12%) between 3 and 7 days; and 14 (4%) between 8 and 28 days. One hundred and fifty-nine (43%) of the transported infants needed mechanical ventilation in transit. Two infants, both of whom had suffered extremely severe birth asphyxia, died during the journey.

Results

The birth weight, gestational age, and sex of infants born to mothers transferred for delivery and of those transported afterwards are shown in table I. The principal diagnoses of the infants are shown in table II. The numbers requiring continuous monitoring of arterial oxygen tension, ventilatory support, and total parenteral nutrition are shown in table III. Neonatal (28-day) mortality rates are compared

with figures for England and Wales in table IV, and neonatal mortality rates by gestational age are given in table V.

The main findings at necropsy were hyaline membrane disease in 48 infants, intracranial haemorrhage in 42, sepsis in 15, and congenital abnormalities in 10. Twelve infants, three of whom were born to mothers transferred before delivery, died after the neonatal period aged 29-108 days. They all died from chronic lung disease after mechanical ventilation, the late effects of intraventricular haemorrhage, or necrotising enterocolitis.

TABLE I—Sex, gestational age, and birth weight of infants born to mothers referred before delivery and infants referred after delivery, in 1975-7. Data from the two infants who died during the journey are included in this and subsequent tables

	Infants referred:	
	Before delivery	After delivery
No (%) of infants:	111	370
Boys	62 (56)	231 (62)
Girls	49 (44)	139 (38)
Mean gestational age and range (weeks)	32 (25-40)	32 (24-43)
Mean birth weight and range (g)	1616 (650-3742)	1656 (618-3832)

TABLE II—Principal diagnoses of the infants. Results are numbers (percentages) of infants

	Infants referred:	
	Before delivery	After delivery
Total No of infants	111	370
Low birth weight (<2500 g)	100 (90)	303 (82)
Very low birth weight (<1500 g)	60 (54)	157 (42)
Hyaline membrane disease	35 (32)	159 (43)
Infection	4 (4)	33 (9)
Transient tachypnoea	2 (2)	33 (9)
Recurrent apnoea	1 (1)	33 (9)
Congenital abnormalities	4 (4)	19 (5)
Birth asphyxia	0	15 (4)
Haemolytic disease	8 (7)	2 (0.5)
Necrotising enterocolitis	1 (1)	9 (2)
Milk aspiration	0	6 (2)
Meconium aspiration	0	5 (1)
Other	0	12 (3)

TABLE III—Numbers (percentages) of infants who needed intensive care

	Infants referred:	
	Before delivery	After delivery
Continuous intravascular monitoring of arterial oxygen tension*	38 (34)	152 (41)
Ventilatory support:	45 (41)	232 (63)
Mechanical ventilation with or without CPAP	21 (19)	111 (30)
Mechanical ventilation alone	16 (14)	103 (28)
CPAP alone	8 (7)	18 (5)
Total parenteral nutrition	18 (16)	84 (23)

*Many other infants were monitored with transcutaneous oxygen electrodes. CPAP = Continuous positive airway pressure.

TABLE IV—Neonatal (28-day) mortality rates according to birth weight

Birth weight (g)	Infants referred:				Neonatal mortality of all infants born in England and Wales 1975-7* (% _o)
	Before delivery		After delivery		
	No	No (% _o) who died	No	No (% _o) who died	
≤1000	12	4 (33)	58	27 (47)	77
1001-1500	48	7 (15)	99	28 (28)	35
1501-2000	25	2 (8)	89	14 (16)	10
2001-2500	15	1 (7)	57	14 (25)	3
> 2500	11	0 (0)	67	13 (19)	1

*Data for England and Wales were kindly supplied by Professor Eva Alberman.

Three infants weighing 1001-1500 g whose mothers were transferred before delivery died later than 28 days of age. Nine infants transferred after delivery died later than 28 days: 7 weighed 1001-1500 g; 1 1501-2000 g; and 1 >2500 g.

TABLE V—Neonatal mortality rates by gestational age

Gestational age (weeks)	Infants transferred			
	Before delivery		After delivery	
	No	No (%) who died	No	No (%) who died
24-25	1	1 (100)	4	3 (75)
26-27	6	3 (50)	42	22 (52)
28-29	25	4 (16)	59	16 (27)
30-31	20	2 (10)	63	16 (25)
32-33	28	3 (11)	72	12 (17)
34-35	17	1 (6)	45	10 (22)
36-37	10	0 (0)	42	4 (9)
38-43	4	0 (0)	43	13 (30)

Three infants born at 28-29 weeks of gestation to mothers referred before delivery died later than 28 days of age. Nine infants transferred after delivery died later than 28 days: 2 were born at 26-27 weeks of gestation; 5 at 28-29 weeks; and 2 at 30-31 weeks.

Discussion

Ninety per cent of the infants born to mothers referred for delivery were of low birth weight (<2500 g) and 54% of very low birth weight (<1500 g); 46% were born at gestational ages less than 32 weeks. These proportions were similar to those of the infants referred after delivery. The incidence of serious illness, such as hyaline membrane disease, and the need for mechanical ventilation or total parenteral nutrition were less in infants born to the referred mothers than among infants transported after delivery—though not greatly so. We conclude that the selection of mothers for referral was good, since such a high proportion of them went on to deliver infants of low birth weight who became severely ill and required intensive care. Selection was, however, not difficult, since by far the most common diagnoses in the mothers were very preterm labour, prolonged rupture of the membranes, and severe pre-eclamptic toxæmia.

The birth-weight-specific neonatal mortality rates for the infants born to referred mothers were lower than those reported for England and Wales as a whole, in spite of the fact that the mothers were selected for referral because their pregnancies were considered to be at very high risk. Mortality rates in the two lowest birth-weight groups (<1000 g and 1001-1500 g) were particularly low, being less than half the national rates. By the time a pregnancy had reached 26 to 27 weeks' gestation the chances for survival of the infant had reached 50%.

When the infants were referred after delivery their chances of survival were less than when the mother had been transferred before delivery, no doubt partly because the incidence of serious illness was higher. Nevertheless, the mortality rates for infants of very low birth weight (<1500 g) were again lower than the national rates, even though a high proportion of the infants were severely ill and 74 (47%) needed mechanical ventilation during the journey. The high mortality rate among the transferred infants who weighed more than 2000 g was explained by the fact that many of them had lethal congenital malformations (nine infants), had been very severely asphyxiated at birth (six infants), or were suffering from overwhelming sepsis (four infants). These results for transported infants are similar to those reported in our previous study.¹

IMPLICATIONS FOR THE ORGANISATION OF PERINATAL CARE

In 1971 the Sheldon report¹ recommended a two-tier system for the care of sick infants in England and Wales. It envisaged that all maternity units in district general hospitals should have special care baby units (SCBUs) capable of dealing with most neonatal problems, and that there should be many fewer NICUs, with greater resources, sited in hospitals with major obstetric departments. The report suggested that, whenever possible, women with high-risk pregnancies should be delivered in these centres; failing this, the intensive care units should be responsible for transporting and caring for infants that could not be offered optimal care in the SCBUs. The Oppé report in

1974⁵ and the Court Report in 1976⁶ endorsed these recommendations, and they became official DHSS policy in 1976.⁵

In 1978 the Joint Liaison Committee of the British Paediatric Association and the Royal College of Obstetricians and Gynaecologists⁷ pointed out that grave deficiencies still existed in the perinatal services in Britain. The committee concluded that most district general hospitals should be capable of undertaking short-term intensive care of newborn infants, particularly in the immediate postpartum period, and it reaffirmed that referral centres should be available for women with very high-risk pregnancies and for very ill infants. While some progress has been made in setting up NICUs in the UK,⁸ the concept of perinatal referral centres with full facilities for the intensive care of the mother, fetus, and newborn infant has not gained general acceptance. To do so would imply that when a regional NICU was set up there should be a parallel development in the adjacent obstetric department, with beds set aside for the emergency admission of women from other maternity hospitals and beds also made available for the mothers of infants who needed transfer to the NICU after being delivered elsewhere, so that the separation of mother and infant could be kept to a minimum.

Our data show that a population of women who will deliver infants of very low birth weight requiring intensive care can be selected with some precision by district general hospitals. We think, therefore, that when planning services for sick infants, it is no longer rational to encourage the development of regional NICUs without allowing for the implications for the obstetric services. We suggest that it is now time to plan a network of regional perinatal referral centres, rather than just NICUs. The median number of women transferred to our own unit from each of our referring hospitals was only one per year in 1975-7, and only 1-2% of all newborn infants require intensive care for more than a few hours (4-6), so we do not expect that more than one or two such centres would be required in each region or that more than a very few women would need to be transferred to them.

The development of regional perinatal referral centres might have quite a large impact on the perinatal mortality rate. To take a hypothetical case, if a district general hospital with 1000 deliveries per year referred three women with very high-risk pregnancies (due, for example, to very preterm labour or severe hypertension) to a perinatal referral centre in the course of one year, and if the infants survived whereas they would otherwise have died, then the perinatal mortality rate in that DGH would have fallen by 3 points from, say, 16 per 1000 to 13 per 1000 during the year.

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ONE HUNDRED YEARS AGO A remarkable experiment in the transplantation of teeth is recorded in the *Gazette des Hôpitaux*, No 2, 1879. On July 30th, M Pietkiewicz extracted an anomalous right lower lateral incisor, which grew under the tongue in a young woman of twenty-six, and planted it in the upper jaw on the same side, in the alveolus of the lateral incisor, which he had just removed for extensive caries, and which was rotated congenitally on its axis. At the same time, by a special apparatus exercising constant pressure, he was able to bring back the right inferior canine into line. In spite of an accident, six weeks later, the experiment succeeded perfectly, the tooth becoming fixed with great firmness. It has been long known to be possible to replace a tooth just removed by another similar to it in regard to age, volume, form, etc, if recently extracted. Indeed, Professor Alquié of Montpellier showed, in 1858, that a carious tooth could be replanted after resection of its decayed portion. But it is pointed out that, in M Pietkiewicz's case, there were very remarkable anatomical differences between a lower and upper lateral incisor. The root of the former is finer, and flattened transversely and grooved; that of the upper is fuller and rounded. In fact, the fang of the lower by no means filled the upper alveolus, while at the same time it was considerably too long for it, requiring removal of a third of the crown to bring the edge into line with its neighbours. In spite of all this, the success was perfect, and suggested to the surgeon mentioned the possibility of utilising anomalous teeth for transplantation, even to replace others not anatomically analogous to them, the difference in shape being remedied by cutting and shaping with instruments. The teeth of other mammals might also, perhaps, be successfully employed for the same purpose.

Transplantation of teeth from one person to another is a subject which has always the privilege of exciting curiosity, as at the present moment; it has indeed a tolerably copious history, ancient and modern. In the days of Rowlandson, the question had become so notorious, as to call forth one of his best caricatures. In the museum

of the Odontological Society will be found an amusing sketch of the charlatan, who has induced sweeps and beggars to come to his rooms to supply the dental deficiencies of his wealthy clients. The wrinkled belle and padded beau may be seen criticising the handiwork of the quack, while the toothless wretch approaches the door and looks with dubious face at the coin he has received as an equivalent for his lost tooth. There is little question that the practice was known to the ancients; and there is reason to believe that both the Israelites and ancient Egyptians performed the operation. Natural teeth, fastened in by gold wires, have been found among the mummies. Transplantation of the teeth is not only physiologically possible, but was warmly advocated by John Hunter in 1783, and again in 1788. Whether it is, however, justifiable, as more than a very exceptional resort or expedient, is a very different matter. There are the obvious risks of severe inflammatory symptoms supervening; the doubtfulness of the new tooth fitting accurately the old socket; the known impossibility of preserving the vitality of the dental nerve-pulp; and the more than probability of not obtaining perfect vascular union between the socket and the periosteal membrane of the tooth. Added to these sufficiently cogent objections to the operation, we have, it has been pointed out, the rather remote possibility of transplanting the germs of disease with the tooth. There remains the ethical question of maiming one person to beautify another. That it has been the dangerous plaything of quacks and the bait of impostors is probably a matter that we need not here discuss, although it is certainly a point which it would be well should not be forgotten. Replantation of an extracted tooth needs no comment: it is as well established in dental practice, under certain limits, as the resection of bones or excision of joints; and all standard authors, including Wedl, Tomes, and Mitscherlich, justify and advise its performance under a variety of stated conditions. It has been employed rather extensively during the last few years in one of the metropolitan hospitals. (*British Medical Journal*, 1879.)