Confidential paediatric inquiry into neonatal deaths in Wessex, 1981 and 1982

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Abstract

From 1 January 1981 to 31 December 1982, 66 256 births and 386 neonatal deaths were recorded in the Wessex Regional Health Authority, giving a neonatal mortality of 5·8/1000 live births. An experienced consultant paediatrician undertook a confidential inquiry into each death shortly after it had been reported. One hundred and forty four deaths (37%) were found to be due to lethal or severe malformations, an incidence of 2·2/1000 births. Of the 242 normally formed infants, 111 (46%) died within 24 hours of birth. Seventy seven (32%) weighed over 2500 g at birth.

Factors operating before delivery accounted for 104 (43%) of the deaths of normally formed infants. The commonest factors were short gestation and low birth weight, and intrauterine hypoxia and birth injury. Factors after delivery accounted for 81 deaths (33%), the commonest being infections and sudden infant deaths. In the remaining 57 deaths (24%) it seemed that a combination of factors before and after birth had led to the death. Factors before birth thus played a part in two thirds of all deaths. Possible adverse factors in medical care were sought in 154 potentially viable babies and were identified in 38—that is, 10% of all neonatal deaths.

Better provision and training of district staff in immediate care at birth would achieve more in lowering neonatal mortality in Wessex than the setting up of a regional unit specialising in advanced neonatal intensive care. Moreover, the greatest scope for improving the outcome of childbirth in Wessex would be offered if there were further advances in obstetric rather than neonatal care.

Introduction

Confidential inquiries into perinatal deaths have been widely promoted by professional bodies as a way of improving health care. There is now considerable interest and activity in the subject.[1] In this paper we present the results of the largest such United Kingdom study to date, in which neonatal deaths from 66 256 births in Wessex in 1981 and 1982 were investigated by an experienced consultant paediatrician. Other inquiries have examined neonatal deaths from 53 290 births in Northern Ireland in 1974[2] and perinatal deaths from 62 895 births in Scotland in 1977.[3] Smaller studies include those of the Avon area, with 36 810 births from 1976 to 1979,[4] and half of Mersey Regional Health Authority, with 18 716 births in 1979.[5]

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The Wessex Regional Health Authority is responsible for a population of about 2 750 000 in the south of England with about 33 000 births a year. There are 10 district health authorities, 14 consultant maternity hospitals, and 25 general practitioner maternity hospitals. Ninety nine per cent of births occur in hospital. Screening of α fetoprotein concentrations for neural tube defects is offered in six districts (55% of mothers). All but one district has facilities for intensive care of the newborn including ventilation. There is no centralised regional neonatal intensive care unit except for specific surgical and cardiac conditions.

A report on services for the newborn in 1978 by a working group of the Wessex paediatricians led the regional health authority to set up a confidential inquiry into neonatal deaths.[6] The objectives were, firstly, to record all neonatal deaths occurring within the first 28 days of life in babies born in Wessex in 1981 and 1982 who weighed more than 500 g at birth or were of over 24 weeks' gestation; and, secondly, by personal inquiry to assess those factors that might have contributed to each neonatal death and in particular to consider whether improved staffing, better equipment, alternative organisation of services, or different action by staff or the mother might have reduced the likelihood of the death.

Patients and methods

The inquiry was organised by an interdisciplinary steering group, and a consultant paediatrician (BW) carried out the fieldwork over the two years from 1 January 1981 to 27 January 1983. All paediatricians in the region were asked to report neonatal deaths by telephone to a central office. Copies of all neonatal death certificates were also scrutinised. Coroners' offices and family practitioner committees were notified about the inquiry and gave full cooperation.

When a death was notified BW arranged to visit the maternity unit in the district where the death had occurred either as soon as the necropsy had been done or more usually to coincide with the local perinatal audit meeting when the death was discussed. A standard form was completed with the help of the staff who had cared for the infant. Information collected was identifiable only by a code number to ensure anonymity. Deaths were grouped according to whether they were due to factors operating before delivery, after delivery, or both using defined criteria, and were classified using the World Health Organisation *International Classification of Diseases* (9th revision).

For a death to be assigned to a cause operating before delivery the infant's condition at birth had to have been seen to be "critical" as evidenced by birth weight of 750 g or less, very slow fetal growth below the fifth percentile on the Aberdeen scale,[7] a five minute Apgar score of 3 or less, or unequivocal necropsy evidence of birth trauma or intrauterine hypoxia. Causes after delivery were assigned to infants who had been in "good" condition at birth as shown by all of the following: weight over 750 g, weight over the fifth centile for gestational age, and a five minute Apgar score of over 6. "Combined" causes were allotted to those infants who fell between these limits. Necropsies were performed in 77% of all cases.

Results

In 1981 and 1982, 66 256 live infants were born in Wessex. Three hundred and eighty six neonatal deaths were notified and studied, giving a neonatal mortality of 5·8/1000 live births. The figures of the Office of Population Censuses and Surveys based on residents for these years gave 388 neonatal deaths, which suggested that the completeness of notification in the inquiry was high.

MALFORMED INFANTS

There were 144 deaths (2·2/1000 live births) caused by lethal or severe malformations, which accounted for 37% of all deaths. Table I summarises these causes. Most conditions were incompatible with life and included anencephaly, severe spina bifida with hydrocephalus, hypoplastic left heart syndrome, renal agenesis, and multiple major defects. The remainder of the babies had such severe malformations that they died despite treatment. Sixteen open neural tube defects arose in districts where screening for serum α fetoprotein concentration was not offered. Eight, however, occurred in districts where screening was offered: serum α fetoprotein concentrations were apparently normal in four cases and were borderline in two; in two the test was not performed.

TABLE I—*Deaths due to congenital malformations*

Congenital malformation	No of deaths
Nervous system (ICD 740-742)	32
Cardiac and circulatory (ICD 745-747)	40
Urinary (ICD 753)	23
Musculoskeletal (ICD 754-756)	18
Other and multiple (ICD 759)	22
Chromosomal (ICD 758)	9
Total	144

ICD = International Classification of Diseases.

TABLE II—*Deaths due to factors operating before delivery*

	No of deaths
Before delivery:	
Maternal disease unrelated to present pregnancy (ICD 760)	2
Maternal complications of pregnancy (ICD 761)	3
Complications of placenta, cord, or membranes (ICD 762)	14
Slow fetal growth (ICD 764)	6
Short gestation and low birth weight (ICD 765)	41
Haemolytic disease of the newborn (ICD 773)	1
Conditions affecting the integument (ICD 778)	2
During delivery:	
Complications of labour or delivery (ICD 763)	11
Birth trauma (ICD 767)	2
Intrauterine hypoxia and birth injury (ICD 768)	22
Total	104

TABLE III—*Deaths due to factors occurring after delivery*

	No of deaths
Respiratory factors:	
Respiratory distress syndrome (ICD 769)	9
Other respiratory conditions (ICD 770)	9
Non-respiratory factors:	
Infections (ICD 771)	24
Haemorrhage (ICD 772)	4
Kernicterus from haemolytic disease of the newborn (ICD 773)	1
Endocrine and metabolic disturbances (ICD 775)	2
Haematological conditions (ICD 776)	2
Disorders of the digestive tract (ICD 777)	3
Other and ill defined conditions (ICD 779)	5
Sudden unexplained deaths (ICD 798)	22
Total	81

NORMALLY FORMED INFANTS

Altogether 242 normally formed infants died (3·7/1000 live births), accounting for 63% of all deaths. One hundred and eleven infants (46%) died within the first 24 hours.

The incidence of survival of normally formed infants according to birth weight was calculated. Of those weighing 501-1000 g, 54 (41%) survived out of 132; of those weighing 1001-1500 g, 322 (87%) survived out of 372; and of those weighing 1501-2000 g, 752 (97%) survived out of 775. Birthweight specific mortality was compared between districts, but there were no significant differences ($p<0·05$), possibly due to small numbers. Although the smaller infants had a much higher mortality, in actual numbers there were 77 deaths (32%) among infants weighing over 2500 g.

Factors operating before delivery—One hundred and four babies were in a critical condition at birth (table II). Forty one weighed 750 g or less at birth, and among the remainder causes operating before and during birth occurred in equal proportions. Although slow fetal growth below the 10th percentile on the Aberdeen scale[7] was found in 20 babies, only six babies, all below the fifth percentile, were in such poor condition at birth that this was considered to be the sole cause of death.

Factors operating after delivery—Eighty one babies were in good condition at birth (table III). Eight of the 24 infections (two herpes, six group B streptococcal) were probably acquired from the mother. Eight of the other infected babies were readmitted with infection thought to have been acquired at home. Of the 22 sudden unexplained deaths, 16 occurred in 1981 and only six in 1982.

Factors operating before and after delivery—Fifty seven babies were allocated to this group, and table IV shows the causative factors. Causes before and during delivery seemed to be of equal importance; problems after delivery were mostly respiratory (75%).

TABLE IV—*Deaths due to factors before and after delivery*

Before delivery	After delivery		Total
	Respiratory	Non-respiratory	
Before delivery:			
Maternal disease (ICD 760)	1		1
Maternal complications (ICD 761)	8	5	13
Complications of placenta, cord, or membranes (ICD 762)	9	3	12
Slow fetal growth (ICD 764)	3		3
Haemolytic disease of the newborn (ICD 773)		1	1
During delivery:			
Complications of labour (ICD 763)	10	1	11
Birth trauma (ICD 767)	2		2
Intrauterine hypoxia (ICD 768)	10	4	14
Total	43	14	57

ADVERSE FACTORS IN MEDICAL CARE

In order to examine which perinatal factors might have reduced the likelihood of each death we decided to concentrate on the potentially viable infants by excluding the 41 infants of 750 g or less; the 22 babies who had an apparently normal perinatal course until their sudden unexplained death; 19 "return" babies who acquired a fatal illness outside hospital after an otherwise normal neonatal course; and six further cases where the cause lay with the mother (three concealed pregnancies, two concealed and unattended births, and one case of infanticide). This left 154 babies.

In 116 deaths no evidence of departures from accepted practice was found. In the remaining 38 deaths, however, adverse factors were identified. In the absence of controls it cannot be concluded that these factors caused the deaths but only that they may have prejudiced survival.

Among the 16 deaths with adverse factors before delivery there were eight instances of delayed response to fetal distress: three due to delay in finding an anaesthetist, one due to monitor paper running out, and four with delays of an hour or more between evidence of fetal distress and delivery of the infant. In one of these there was a degree of maternal non-cooperation. Inappropriate level of care was judged to have occurred in one instance when a baby was delivered at 27 weeks after a breech presentation by a senior house officer and not a more senior staff member and, in a second case, when the rapid advance into the second stage of labour was not detected by a pupil midwife or her supervisors. Mistaken gestation or lack of liaison led to two babies weighing 1050 g and 810 g and twins of 850 g and 950 g not being resuscitated promptly. A woman with abdominal pain was subjected to a laparotomy at 27 weeks' gestation and as the pregnancy was considered to be secure the paediatricians were not alerted. Without warning they had to deal with the sudden delivery of a 1200 g infant in an adult intensive care unit with flying squad equipment. After the diagnosis of vaginal herpes in a woman near term, labour was induced and vaginal delivery performed rather than a caesarean section.

Among the 11 deaths with adverse factors after delivery there were six cases of failure in ventilation: two due to intubation difficulties, two due to equipment malfunction being undetected for some time, and two in which the level of care was that of a senior house officer when the severity of the infant's illness should have prompted more senior participation. There were four cases of paediatric delay: two due to slowness in starting antibiotic treatment after an infection screen, one to late diagnosis of pneumothorax, and one to haemolytic jaundice in a triplet going untreated. There was one inappropriate discharge of a 1000 g 30 week twin to a peripheral special care baby unit at 48 hours of age. Two days later the baby was readmitted with a fatal and obscure peritonitis.

The 11 deaths affected by adverse administrative factors included three cases from a district lacking a neonatal intensive care unit.

Two were transferred in established respiratory distress at a few hours of age and died within a day; the other was transferred in utero but was rerouted half way to another hospital and the infant was delivered in the ambulance. There were three cases of "mismatching." This term was used to describe the position in two districts where each had two separate maternity units but the paediatric back up was concentrated in only one neonatal intensive care unit. Two deaths occurred quite unpredictably. The first was of an unexpectedly asphyxiated full term infant with a five minute Apgar score of 0. Intubation had been attempted by the obstetric resident, and the infant died at 32 hours after intractable fits. Another similar big baby had to be intubated by an anaesthetic registrar; the infant remained blue, and bilateral pneumothoraces were eventually detected. In the third case the mother had already had two previous infants with low birth weights and she went into labour at 32 weeks in the unit without an infant neonatal intensive care unit. The 1500 g child had to be transferred at three hours with severe respiratory distress and died at 28 hours. In five instances a district neonatal intensive care unit was overcommitted or understaffed. Infants weighing between 1000 g and 3300 g had to be transferred without adequate support services to another district, where they died within 42 hours.

Discussion

Wessex has one of the lowest neonatal death rates in the United Kingdom, but, nevertheless, this study suggests that improvements could still be made.[8] For example, the death rate from lethal or severe malformations, currently 2·2/1000 live births, is already lower than that in Belfast (4·1)[2] and in Avon (3·6).[4] If screening of α fetoprotein concentrations was universally provided and the specificity of the test improved, however, the death rate could be reduced to below 1·8 if affected mothers underwent therapeutic legal termination.

The group of normally formed infants offer the greatest scope for improvement. Surprisingly, the study reiterates reports of a quarter of a century ago that nearly half of neonatal deaths occur within 24 hours of birth and that about a third occur in babies of 2500 g or more.[9,10] It is true that over this period perinatal mortality has been reduced by two thirds. But amid all the attention given to the care and survival of infants with low birth weight the deaths of big, well formed babies should not escape notice. In addition, it should be emphasised that in 43% of cases factors operating before delivery were the prime cause of death and in a further 24% they were a contributory factor. Thus in two thirds of deaths of normally formed infants there was an important obstetric element. Clearly, then, if there were further advances in care before delivery these would have a major impact on neonatal mortality—over and above any effect on stillbirths.

Data on birthweight specific mortality among normally formed infants are not currently available for sufficiently large populations for useful comparisons to be made with Wessex. Our rates are better than those of Avon, which is to be expected as the Avon study concerned the period 1976-9.[4] Only with comparable data from areas with different services can inferences be drawn about the most effective organisation of neonatal services, such as the case for regional units for neonatal intensive care. By examining possible adverse factors in the delivery of obstetric and neonatal care, areas of improvement may be proposed.

In our study 154 potentially viable infants died, and if these had survived the overall neonatal mortality would have fallen from 5·8 to 3·5/1000. But in only a quarter of cases (38) were adverse factors positively identified. If these were instrumental in causing death and had been avoided the mortality would have been 5·2/1000. We would agree that this type of assessment is highly subjective and is likely to vary according to the background and experience of the researchers. Perhaps this is why the proportion of deaths attributable to obstetric, paediatric, and social factors shows wide differences between Wessex, Merseyside,[5] and Leicester.[11] We would agree with Dunn that avoidable factors are more likely to be detected by those expert in the field from which they are sought.[12]

With this in mind close scrutiny of the 38 "avoidable" deaths showed that the problems lay more with inadequate attention to standard care than with lack of specialised high technology resources, such as might be provided by a regional neonatal intensive care unit. Such deficiencies of care occurred through inadequate staffing, inappropriate decision making by inexperienced juniors, and geographical problems. Cooke's suggestion of better provision and training of district staff in immediate care at birth would probably be of more benefit in Wessex than the setting up of a regional unit specialising in advanced neonatal intensive care.[13] There is general agreement among paediatricians in the region that the transfusion of additional resources into district maternity and neonatal services is of higher priority than regionalisation. As well as improving outcome it would avoid parents having to travel long distances to visit their babies and relegating paediatricians in the periphery to a minor role in neonatal care.

The confidential inquiry, in addition to pointing the way for the future in the organisation of neonatal services, has also had an important educational impact. District perinatal audit meetings have been enhanced by the presence of a credible, experienced, and acceptable outsider. This may have provided a stimulus to better care; this was certainly the feeling of many midwives. Although the study cost little compared with the total budget spent on maternity services, we do not think that such an in depth scrutiny needs to be continuous. Instead district audits with anonymous regional summaries published regularly should be encouraged, supplemented by the occasional confidential inquiry perhaps at intervals of five years.

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References

1 National Perinatal Epidemiology Unit. *Annual report 1982*. Oxford: Radcliffe Infirmary, 1982.
2 Scott MJ, McClure G, Reid MMcC, Ritchie JWK, Keilty RK. Neonatal death in Northern Ireland. *Br Med J* 1978;ii:987-9.
3 McIlwaine GM, Howat RCL, Dunn F, MacNaughton MC. The Scottish perinatal mortality survey. *Br Med J* 1979;ii:1103-6.
4 Mutch LMM, Brown NJ, Speidel BD, Dunn PM. Perinatal mortality and neonatal survival in Avon: 1976-9. *Br Med J* 1981;**282**:119-22.
5 Mersey Region Working Party on Perinatal Mortality. Confidential inquiry into perinatal deaths in the Mersey region. *Lancet* 1982;i: 491-4.
6 Anonymous. *Wessex neonatal survey 1978. Better health for the newborn*. Dorset: Poole General Hospital, 1980.
7 Thomson AM, Billewicz WZ, Hytten FE. The assessment of fetal growth. *Journal of Obstetrics and Gynaecology of the British Commonwealth* 1968;**75**:903-16.
8 Office of Population Censuses and Surveys. *Infant and perinatal mortality 1982*. London: Office of Population Censuses and Surveys, 1983. (OPCS Monitor DH3 83/2.)
9 Butler NR, Bonham DG. *Perinatal mortality. The first report of the British perinatal mortality survey*. London: Livingstone, 1963:193.
10 Bound JP, Butler NR, Spector WG. Classification and causes of perinatal mortality. *Br Med J* 1956;ii:1191-6, 1260-5.
11 MacVicar J. Perinatal mortality—an area survey. In: Chalmers I, McIlwaine G, eds. *Perinatal audit and surveillance. Proceedings of the eighth study group of the Royal College of Obstetricians and Gynaecologists 1980*. London: Royal College of Obstetricians and Gynaecologists, 1980:133-47.
12 Dunn PM. Discussion on perinatal mortality—an area survey. In: Chalmers I, McIlwaine G, eds. *Perinatal audit and surveillance. Proceedings of the eighth study group of the Royal College of Obstetricians and Gynaecologists 1980*. London: Royal College of Obstetricians and Gynaecologists, 1980:159.
13 Cooke RWI. In utero transfer to specialist centres. *Arch Dis Child* 1983; **58**:483-4.

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