

# Process and Outcome

## Medical audit in neonatal care

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### Summary and conclusions

**A system of medical audit on a neonatal unit based on the primary reason for admission may be used alongside the more conventional type of audit of mortality and morbidity by birthweight and gestation using a diagnostic classification of disease. The method provides a more accurate description of all babies admitted to a neonatal unit and thus a more comprehensive measure of work undertaken.**

Although medical audit on a neonatal unit has as its main purpose the description of the morbidity and mortality of its babies, it should also provide a means of monitoring the work undertaken and the use made of a neonatal service by the population it serves. By studying outcome in individual babies high risk groups should be identified and methods of their medical care kept under surveillance.

Conventional neonatal audit usually concentrates on details of birth weight and gestation of babies admitted, together with incidence of major disorders and causes of death described by a diagnostic classification such as the *British Paediatric Association (BPA) Classification of Disease*.<sup>1</sup> We have come to realise, however, that in being concerned primarily with diagnosis, this method of audit is of limited value when it comes to understanding the origins of the problems giving rise to admission of babies and their outcome. Without this data it is difficult to appreciate completely the perspectives of neonatal unit responsibilities.

We have therefore evolved a system of neonatal audit that focuses particular attention on the reasons for admission and outcome. It may be used to complement the more conventional diagnosis-type audit. In this paper the system is explained and illustrated by considering the admissions in 1979 to the neonatal unit of the Leicester Royal Infirmary Maternity Hospital.

### Method

This neonatal unit provides a comprehensive neonatal service (including intensive care and neonatal surgery) for about 5300 of the babies born each year in the hospital. It also offers an intensive care and surgical service for a further 5000 or so babies born elsewhere in the Leicester area. From our well-established criteria for admitting babies to this unit (table I) we have categorised the babies into three major groups according to whether the problem requiring admission originates *before, at, or after* birth. Table II describes these groups together with their subgroups and definitions. Each baby has

to have one primary reason for admission only, for which it receives the code number shown in table II. When there appear to be two possible reasons for admission—for instance, birth asphyxia complicating delivery of a 32-week preterm baby—the order of precedence shown in table II is followed. Thus in this particular example “preterm” would become the primary reason for admission. Each group is necessarily broad to be discrete and to make classification easily comprehensible by limiting the total number of subgroups.

TABLE I—Criteria for admitting babies to the neonatal unit of Leicester Royal Infirmary Maternity Hospital

From labour ward	From lying-in wards
1 Birthweight <2000 g or gestation 35 weeks and below. These constitute most “light-for-dates” babies born at term and also most preterm babies. Babies of 36 weeks’ gestation not admitted routinely	1 Jaundice needing phototherapy 2 Other illness—for example, low body temperature (<35°C), feeding problem, cyanotic attacks, convulsions, etc
2 Severe birth asphyxia or spontaneous respiration slow to establish	
3 Definite aspiration of meconium or suspicion that this might have occurred	
4 Low body temperature (<35°C)	
5 Haemorrhage from cord or placenta	
6 Symptoms of respiratory distress irrespective of gestation	
7 Risk of congenital infection—for example, in prolonged rupture of membranes of “smelly baby”	
8 When neonatal complications expected because of maternal disease—for instance, diabetes, thyroid disease, or drug addiction	
9 Severe overt congenital abnormalities—for example, meningomyelocele, gastroschisis	

To provide a measure of outcome each baby is further classified according to whether he (a) was only “observed” (being defined as the need to stay in the neonatal unit for less than 48 hours when no treatment other than tube feeding was required), (b) received continuing care, (c) was transferred to another hospital, or (d) died. For observation the letter O was appended to the admission code, T when the baby was transferred to another hospital, and D for death. Since our unit offers a service for babies needing intensive care and neonatal surgery, admissions from other hospitals in the area are also included and classified using the same scheme but of necessity as a separate item.

All information required for the audit is recorded in an admissions book, a standard issue ledger (Guildhall Ref-No51/FT) ruled and titled by the ward clerk. This contains the usual details of name, address, and hospital number, and the dates of admission and discharge or death entered by the nursing staff. To these medical staff add at discharge (or death) (a) the gestation of the baby, determined from consideration of obstetric and paediatric information, (b) the primary reason for admission code with outcome appendage, (c) diagnoses by the BPA classification,<sup>1</sup> and (d) an indication as to whether the baby received various procedures that we thought necessary to record. These include respiratory assistance, intravenous feeding, blood transfusion, and phototherapy. Extraction and analysis of the data is performed monthly and recorded on a standard sheet that is presented at the monthly hospital perinatal mortality and morbidity meeting.\*

\* An example of the complete monthly audit is available on request.

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**Results and comments**

We illustrate the system of audit by considering admissions to our neonatal unit in 1979, the first complete year of its application. The total number of admissions was 669, of which 47 were admitted from outside hospitals. The total number of babies born at Leicester Royal Infirmary Maternity Hospital was 5463, of which 56 were stillbirths: the admission rate of livebirths to the neonatal unit was therefore 11.2%. Of all babies born in the hospital weighing more than 2500 g, only 6.3% were admitted. There were 59 deaths within the first week of life and a further six during the following three weeks on the neonatal unit. This gives a perinatal mortality rate of 21.0 per 1000 and a neonatal mortality of 12.0 per 1000—this does not include any deaths that occurred outside the unit or in babies who might have been transferred elsewhere—for instance, with major congenital heart disease. Gestation and birth weight distributions of these babies are shown in tables III and IV.

**ANALYSIS BY PRIMARY REASON FOR ADMISSION**

Table V shows the primary reasons for admission with outcome in the various subgroups. Several aspects deserve comment. Nearly one-third (30%) of all babies admitted were only "observed." "Extreme preterm" (group 1.1) showed the highest death rate at 58%. Five babies in this group died at a gestation of under 26 weeks, one with severe congenital abnormalities and the others with respiratory problems relating to surfactant deficiency, apnoea of prematurity, perinatal asphyxia, or a combination of these reasons. Only two of the 21 survivors did not require respiratory assistance. In contrast "preterm 31-35 weeks" (group 1.2) was a large group in which only eight babies (5%) died: three from congenital abnormalities and the remaining five as a result of the respiratory distress syndrome, but with birth asphyxia contributing to two of these deaths. The major morbidity was caused by the respiratory distress syndrome, and 26% of these required respiratory assistance in some form.

For babies of over 35 weeks' gestation "birth insult" (group 2.1) was the major reason for admission—128 (18%) of the total. Most had no complications and in fact 60% were only "observed." The causes of death, of which there were 12 (9%), and the major causes of morbidity are shown in tables VI and VII.

Table VIII analyses some "overt congenital abnormalities" (group 1.3). Five major congenital abnormalities occurred in babies of under 35 weeks' gestation, from which four died. Three presented as a problem in the "birth insult" group and represent one of the deaths in this group, the baby subsequently being found to have a complex heart lesion. One accounted for one of the deaths among babies who

presented with the problem of "respiratory distress at >35 weeks" (group 2.1), likewise with a heart abnormality. Other congenital abnormalities admitted are represented in the group of "other illness" (group 3.2), the lesion not being evident at birth (see table IX). "Light for dates" describes those babies who were less than 2000 g at over 35 weeks' gestation and who did not have any overt abnormality. Although there was no major morbidity in this group, 62% required prolonged admission beyond the period of observation.

TABLE VIII—Group 1.3 overt congenital abnormalities

Systems concerned	No of cases	No died
Neural tube	12	4
Gastrointestinal	14	4
Cardiac	5	2
Multiple	4	3
Other	3	
(2 cleft palates, 1 sacral teratoma)		
<b>Total</b>	<b>38</b>	<b>13</b>

TABLE IX—Group 3.2 "other illness"

Main sign symptoms	No of cases	Observed only	Significant pathology	
Vomiting	11		1 Meconium plus 1 Ischaemic colitis/ Down's syndrome 1 Volvulus 1 Malrotation 2 Jejunal atresia 2 Meconium ileus 1 Oesophageal atresia	Died
Poor feeding lethargy	26	12	1 Congenital heart 1 Pneumonia 3 Septicaemia 1 Meningitis 1 Hypoglycaemia 1 Turner's syndrome	Died Died 2 Died
Major convulsions } Jittery	10	2	3 Cause undiagnosed 2 Hypoglycaemia 1 Meningitis	1 Died
Cyanosis	13	5	5 Congenital heart 1 Hypoglycaemia 1 Meningitis	1 Died
Tachypnoea	4	1	1 Pneumonia	
Stridor	3	1		
Bloody stools	3	3	1 Anaemia 1 Hydrocoele 1 Haemorrhagic disease	
Others	7	4		
<b>Total</b>	<b>77</b>	<b>28</b>		<b>7</b>

**MINIPRINT TABLES II-VII**

**Table II—Classification of babies admitted to the neonatal unit according to primary reason for admission**

IIm		Vm	
From problems arising before birth		From problems arising before birth	
1.1 Extreme preterm	Gestation 30 weeks or less	1.1 Extreme preterm	50 (8)
1.2 Preterm 31-35 weeks	All babies whatever their problems of gestation 31-35 weeks inclusive	1.2 Preterm 31-35 weeks	148 (8)
1.3 Overt congenital abnormalities	When evident at birth and prime reason for admission	1.3 Overt congenital abnormalities	38 (9)
1.4 Light for dates	Babies weighing < 2000 g at over 35 weeks' gestation	1.4 Light for dates	41
1.5 Maternal medical disease	Mother suffers from some disease as a result of which baby requires observation—for example, diabetes	1.5 Maternal medical disease	34
1.6 Haemolytic disease	Prenatal evidence of potential haemolytic disease necessitating admission directly after birth	1.6 Haemolytic disease	4
From problems arising after birth		From problems arising after birth	
2.1 Birth insult	Birth asphyxia/birth trauma/meconium aspiration (suspected or proved)/haemorrhage from cord or placenta. Other perinatal insult not described below	2.1 Birth insult	128 (5)
2.2 Respiratory distress at < 35 weeks	Respiratory distress whatever cause when gestation < 35 weeks	2.2 Respiratory distress at < 35 weeks	60 (4)
2.3 Infection risk	Prolonged rupture of membranes/risk of other intrapartum infection	2.3 Infection risk	10
2.4 Low body temperature (< 35°C)	When this is the real or supposed reason for admission and results from cooling at birth	2.4 Low body temperature	23
From problems arising after birth		From problems arising after birth	
3.1 Jaundice	Jaundice developing in postnatal period necessitating treatment	3.1 Jaundice	39 (1)
3.2 Other illness	Any other reason for admission from maternity wards—for instance, cyanotic episodes, feeding problem, etc	3.2 Other illness	72 (11)
3.3 Transfer back	Transfer back from another hospital after investigation or treatment	3.3 Transfer back	7
3.4 Readmission from home	Readmitted from home with illness or other problem	3.4 Readmission from home	10

**Table V—Primary reason for admission and outcome in 1979. (Figures in parentheses indicate numbers within that subgroup admitted from other hospitals)**

	No of cases	Observed	Transferred	Died
From problems arising before birth				
1.1 Extreme preterm	50 (8)	12	1	29 (4)
1.2 Preterm 31-35 weeks	148 (8)	12	6	8 (1)
1.3 Overt congenital abnormalities	38 (9)	2	6	13 (1)
1.4 Light for dates	41	2		
1.5 Maternal medical disease	34	26		
1.6 Haemolytic disease	4			
From problems arising after birth				
2.1 Birth insult	128 (5)	74 (2)	1	12
2.2 Respiratory distress at < 35 weeks	60 (4)	19 (1)		2 (4)
2.3 Infection risk	10	5		
2.4 Low body temperature	23	20		
From problems arising after birth				
3.1 Jaundice	39 (1)	28 (2)	4	7
3.2 Other illness	72 (11)			
3.3 Transfer back	7			
3.4 Readmission from home	10			
<b>Total</b>	<b>669 (47)</b>	<b>204 (5)</b>	<b>12 (3)</b>	<b>71 (6)</b>

**Table VI—Causes of death in group 2.1 "birth insult"**

Birth asphyxia and meconium aspiration	Birth asphyxia	Asphyxia from perinatal haemorrhage	Resuscitation complications
Pneumonia (3)	Directly after birth (2)	APH vasa praevia (2)	Bilateral pneumothorax (1)
Airways obstruction	After protracted fits (2)		
2 Pneumonia (1)			

**Table VII—Major causes of morbidity in group 2.1 "birth insult"**

Meconium aspiration pneumonia	Fits after asphyxia	Palaei	Other minor problems
Severe (requiring respiratory assistance) (5)	8 (2 with associated hypoglycaemia)	Facial (2); Erb's (1)	11
Minor (transient symptoms) (11)	2 also had significant meconium aspiration		

**Table III—Gestation distribution of babies born at L.R.I.M.H. and admitted to neonatal unit in 1979**

Gestation period (weeks)	28	28-30	31-33	34-36	37
No. of deaths	14 (19/74)	10 (23/43)	7 (52/13)	8 (16/51)	28 (346/7)

**Table IV—Birthweight distributions of babies born at L.R.I.M.H. and admitted to neonatal unit in 1979**

Birthweight	1000 g	1000-1500 g	1501-2000 g	2001-2500 g	2500 g
No. of deaths	14 (18/77)	13 (45/29)	6 (107/6)	10 (120/8)	22 (315/7)

The commonest "maternal medical disease" (group 1.5) necessitating admission of the baby was diabetes (82%). The other mothers in this group suffered from thyroid disease (12%), one was taking steroids, and one was a heroin addict.

Only four babies were admitted with prenatal evidence of "rhesus isoimmunisation" (group 1.6). Three needed exchange transfusion. One unexpected case of rhesus isoimmunisation was admitted because of severe birth asphyxia and meconium aspiration. She also needed exchange transfusion. Only 6% of total admissions in the neonatal unit were primarily because of "jaundice" presenting in the postnatal period needing phototherapy (group 3.1). One of this group needed exchange transfusion.

"Infection risk" (group 2.3) was an unusual reason for admission. This group represents those term babies who were at risk of infection from intrapartum events, such as prolonged rupture of membranes. There were no important sequelae with 50% receiving antibiotics while the rest were simply "observed."

Most (87%) term babies admitted only because of "low body temperature" (<35°C) (group 2.4) resulting from cooling at birth were discharged within 48 hours without complications.

"Respiratory distress at over 35 weeks" (group 2.2) was commonly transient in that symptoms resolved within the first 12 hours of life. These constituted 67% of the total in this group, and of these 33% were "observed." It is often difficult to define the cause of this problem, and it was our routine policy to treat all those in which the condition was not transient with antibiotics. Seven were clearly due to

congenital pneumonia, and 10 were likely to have been related to surfactant deficiency. One death was caused by congenital pneumonia in a baby who was transferred from another hospital, and the second baby was found at necropsy to have a single functional ventricle.

Babies admitted in the group termed "other illness" (group 3.2) resulted from problems developing on the maternity wards (table IX). They were grouped together because symptoms and signs are often non-specific and could herald insignificant or major disease. A large proportion were only observed (36%), but others had illnesses for various reasons—described in table IX according to the main presenting features. Particularly important is the 10% mortality in this group. In fact not until we examined in detail origins of the problem requiring admission did we realise the considerable morbidity and mortality in babies who were previously well on the lying-in wards but who required later admission because illness developed. Such babies must clearly be treated with the utmost respect—a point of particular importance to the paediatric resident responsible for babies on lying-in wards.

Other admissions to the neonatal unit were of babies transferred back from other hospitals after treatment or investigation (group 3.3). A few babies were readmitted from home (group 3.4) when it was considered that the neonatal unit was a more suitable place for their management than the general paediatric wards.

### Conclusion

Neonatal disorders and diseases are comprehensively documented in the *BPA Classification of Diseases*.<sup>1</sup> Many babies are

admitted to a neonatal unit, however, because a problem is expected but which in fact never materialises—for example, a baby admitted from labour ward with suspected meconium aspiration but who does not develop any symptoms. In some hospitals babies born by caesarean section are routinely admitted. These babies all require medical and nursing care, but it is difficult to hang a diagnostic label on them, and a diagnosis-based audit cannot be used without producing misleading results. To overcome this important limitation we devised our system of audit to consider the reasons for admission and outcome along with the more conventional data. We do not pretend the method is without fault, but it does have the advantage of being simple and comprehensive, easily identifies high risk groups, and is better able to describe accurately the nature of work undertaken on a neonatal unit.

We thank the many neonatal residents and nursing staff of the neonatal unit at the Leicester Royal Infirmary Maternity Hospital for their help and advice in the undertaking of this investigation, and Miss Linda Smith for typing the manuscript.

### Reference

- <sup>1</sup> British Paediatric Association. *British Paediatric Association classification of diseases*. London: BPA, 1979.

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## MATERIA NON MEDICA

### Princess Elizabeth

This summer I took my 4-year-old son to see LMS No 6201 *Princess Elizabeth*, who had graciously travelled from Manchester Victoria to Liverpool Edge Hill to help celebrate the 150th anniversary of the opening of the Liverpool and Manchester Railway.

I was pleased that he still had an opportunity to see the spectacle of a steam locomotive hauling a full load of coaches. The stirring sight of her shining maroon paintwork and the clouds of steam and smoke—once smelt, never forgotten—revived memories of my earlier interest in steam locomotives.

It all began at the tender age of 3 when I used to visit my grandmother, travelling by rail from Uttoxeter to Manchester London Road along the now axed Churnet Valley line. The coaches were musty, with windows that were adjusted by leather straps, and on the walls were interesting water-colour prints of far-away places served by the then expansive railway system. Teddy was a constant companion on these journeys and there was always the treat of a chocolate biscuit.

Later, in my early teens, I and several schoolfriend enthusiasts enjoyed the excitement of seeing mainline expresses diverted through the otherwise quiet town of Uttoxeter because of electrification work on the London-Crewe line. Royal Scot, Jubilee, Patriot, and Britannia class locomotives in their coloured liveries, all came and were carefully logged. There was also the disappointment when the express was hauled by a mundane Black Five—plain black and anonymous. Numerous half-pennies of the old currency, which we mischievously placed on the rails, were flattened by these thundering giants.

After joining my local railway society trips were undertaken to various parts of the country. Stumbling around a Birmingham engine shed in the rain at 2 o'clock in the morning, searching for numbers with a torch, is still well-remembered.

In 1975 my wife, then six-months pregnant, bravely showed an interest in the 150th anniversary celebrations of the opening of the Stockton and Darlington Railway held at Shildon. Could it be this is where my unborn son's interest in railways started? He has, since birth, albeit encouraged by me, taken a great interest in railways, as is evident from his collection of railway toys and books. *The Railway Series*—26 books in all—by the Rev W Awdry, which features Thomas the Tank Engine and friends, is a firm favourite for both of us. All these were memories as Her Royal Highness gracefully moved out of Edge Hill station. The steam and smoke

were blown over us by a gentle breeze, she gave a proud whistle and then disappeared under a bridge on her return journey.

We were both agreed. Long live *Princess Elizabeth*!—PAUL WRIGHT (microbiologist, Luton).

### South American journey

After a hot and dusty fortnight in the Andes we sat in the patio of the local bar drinking bottles of beer with the chief vet of C, South America, and his friends. A group of Indian musicians filed into the patio to begin a weekend fiesta. The din of the music was shattering in the small courtyard—music originally designed for soft flutes, Indian stringed instruments, and drums and not for the modern brass instruments they played. At first their faces were gloomy, but a few rounds of beer soon brought merriment. "These chaps can go on for days without stopping once they get high on coca, pisco liquor, and beer," said the vet. "You wouldn't think from their poverty-stricken appearance that many of them have a lot of money salted away. They don't mind spending some on their animals' illnesses but certainly would not for their wife's or children's." (Shades of farmers and peasants the world over, I thought.) "Unfortunately I have to spend a lot of my time treating the peasants and not their animals as the local doctor is so bad." Here his friend gave a vivid pantomime of a large painful injection into the buttock followed at once by the coup de grace and rigor mortis, repeated at every mention of the unfortunate doctor's failings.

Later, impressed by my POWAR's\* card, he insisted that we stayed in his apartment overnight—"small but comfortable." We followed him into the street and through a nearby imposing door into a Dickensian slum background, full of filth and grime. In the corner was his apartment, a small one-roomed shack under a large overhanging tin roof. The glassless windows were blocked by large Weedol adverts. Inside the vet slightly shamefacedly seized a broom and made a small clearing in the mounds of litter covering the floor. "You can put your sleeping bags there—I've got to go out now to see a friend" (with a wink). It was too late to refuse, so after a miserable night we managed to escape next morning back to the main town, getting a lift in a car full of dentists.—A PINES (consultant physician, East Herts Hospital).

\*BMA place of work accredited representative.