PAPERS AND SHORT REPORTS

Changing overall workload in neonatal units

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Abstract

An epidemiological study was carried out in the current Nottingham health district to determine changes in both neonatal unit workload and in the infants requiring neonatal care during two study periods. All admissions for 1977 and again for the 12 months 1 April 1983 to 31 March 1984 were reviewed. Total numbers of admissions have shown roughly a 50% reduction because of a more rigorous admission policy locally. The admissions of infants of 33 weeks' gestation or less have shown a significant increase, while the overall survival of infants less than 33 weeks' gestation has improved.

Introduction

Those concerned in neonatal intensive care have little doubt that a change has occurred in the workload in neonatal units since these became widely available in the mid-1970s. Unfortunately few population based data are available to confirm such a change, or to aid an investigation into the mechanism by which such a change has occurred. A series of reports in the 1970s, which highlighted some of the undesirable aspects of neonatal care,¹⁻⁴ led to a progressive reduction in admissions to neonatal units for observation and relatively straightforward treatment measures such as phototherapy. In addition, technological advances combined with increased medical and nursing skills seem to have led to a state of affairs in which infants of lower gestation are surviving to spend longer receiving the most

advanced forms of neonatal care. There is no universal agreement that neonatal intensive care lowers mortality.

National figures show that the incidence of low birth weight has been remarkably constant for at least the past 10 years, while perinatal mortality has shown a definite decline.⁵⁻⁸ Changes in neonatal practice have not taken place in isolation, however, and appreciable alterations in obstetric management have occurred, not least in attitudes to the potential viability of preterm infants. Studies on hospital based data, especially when these are referral centres, do little to identify fundamental aspects of change and aspects where improvements may have occurred.⁹

We have attempted to assess formally the change in neonatal workload from the mid-'70s to the present era by carrying out a population based study during two one year periods and using the current Nottingham health district as a geographically defined population.

For this paper the terms neonatal intensive care and special care are used synonymously.

Methods and comment

The current Nottingham health district was formed in 1982 by the amalgamation of the previous North and South Nottingham health districts plus the small town of Hucknall (population 20 000). The Nottingham health district has a resident population of about 600 000. We chose to study infants requiring neonatal care whose mothers' permanent address was within the Nottingham health district and who were born either during 1977 or between 1 April 1984 and 31 March 1984. Routine data from the Office of Population Censuses and Surveys (OPCS) are available for the various mortality statistics relating to the first year of life during the period 1974-83 based on 97% of the study population.¹⁰ Over the period of our study (1977-83) there was a significant reduction in neonatal mortality and infant mortality. The incidence of postneonatal deaths fell from 1977 to 1983 but not significantly; however, the fall over the period 1974-83 was significant (tables I and II).

It is hard to attribute any of these improvements in mortality to changes in population. During 1977-83 there was no significant change in maternal age, legitimacy, percentage of births to mothers born in the new Commonwealth, or the incidence of low birth weight. During the period 1974-9 there was a significant fall in parity.¹¹

During 1977 two special care/neonatal care units were in operation, one at the Women's Hospital, which carried out mainly special nursing care, and the other at the City Hospital, the subregional neonatal

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TABLE I—Mortality based on 97% of the Nottingham health district population. (Figures are given as rate per 1000 live births* with actual numbers in parentheses)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Infant mortality	15.3 (117)	18.5 (129)	13.0 (89)	12.6 (82)	14.6 (97)	13.7 (97)	9.2 (70)	11.4 (81)	8.9 (66)	9.1 (69)
Neonatal mortality	9.5 (73)	12.3 (86)	8.6 (59)	8.0 (52)	8.9 (59)	9.9 (70)	5.1 (39)	7.9 (56)	5.6 (41)	4.9 (37)
Early neonatal mortality	7.3 (56)	10.0 (70)	7.6 (52)	6.5 (42)	7.2 (48)	6.1 (43)	4.1 (31)	5.4 (38)	4.3 (32)	4.3 (33)
Postneonatal mortality	5.7 (44)	6.2 (43)	4.4 (30)	4.6 (30)	5.7 (38)	3.8 (27)	4.1 (31)	3.5 (25)	3.3 (25)	4.2 (32)
Perinatal mortality*	19.6 (152)	19.6 (138)	14.7 (101)	13.2 (86)	14.1 (94)	13.6 (96)	9.6 (73)	10.7 (76)	9.8 (73)	9.9 (76)
Stillbirths*	12.4 (96)	9.7 (68)	7.1 (49)	6.7 (44)	6.9 (46)	7.5 (53)	5.5 (42)	5.3 (38)	5.5 (41)	5.6 (43)
No of live births	7651	6974	6841	6511	6661	7059	7585	7080	7376	7614
Total births	7747	7042	6890	6555	6707	7112	7627	7118	7427	7657

*Per 1000 total births for perinatal and stillbirth rates.

TABLE II—Regression analysis of infant mortality statistics based on 97% of the Nottingham health district for 1974-83 and 1977-83

Measurement	Rate per 1000 (a)	Regression (95% confidence limit in parentheses) (b)	Standard error of b	Test of hypothesis $b = 0$ (t value) $df = \text{degrees of freedom}$	p
Perinatal mortality 1974-83	102.54	-1.13 (-1.48, -0.79)	0.2	-6.55 (8 df)	<0.001
Perinatal mortality rate 1977-83	72.7	-0.76 (-1.22, -0.3)	0.2	-3.33 (5 df)	<0.05
Early neonatal mortality 1974-83	47.3	-0.52 (-0.75, -0.3)	0.1	-4.63 (8 df)	<0.01
Early neonatal mortality 1977-83	42.8	-0.47 (-0.76, -0.18)	0.1	-3.24 (5 df)	<0.05
Stillbirth rate 1974-83	56.0	-0.62 (-0.91, -0.33)	0.1	-4.3 (8 df)	<0.01
Stillbirth rate 1977-83	29.9	-0.30 (-0.54, -0.05)	0.1	-2.42 (5 df)	<0.07 NS
Postneonatal mortality 1974-83	24.4	-0.25 (-0.4, -0.10)	0.1	-3.39 (8 df)	<0.01
Postneonatal mortality 1977-83	22.2	-0.23 (-0.48, +0.04)	0.1	-1.7 (5 df)	0.5 > p > 0.1 NS

TABLE III—Numbers of live births, stillbirths, and admissions to neonatal unit for Nottingham health district in each study period

Year	1 January-31 December 1977	1 April 1983-31 March 1984
Live births	6819	7602
Stillbirths	51	45
Total births	6870	7647
No (%) of admissions to neonatal unit	847 (12)	448 (5.8)

*As percentage of live births.

intensive care unit. All other units carrying out deliveries within the district transferred infants requiring any form of special care to one of these units. During the period 1983-4 there was an integrated neonatal service operating from two centres (the City Hospital and the University Hospital).

For both study periods neonatal records were examined to determine those infants who were eligible on grounds of birth address. During 1983-4 babies requiring neonatal care were assigned prospectively to one of 10 categories determined by the factor thought most important in precipitating their admission. In 1977 babies were categorised with information obtained from the notes. We successfully completed the notes review for all infants admitted to either unit in 1977. Eight hundred and forty seven of the 1217 cases examined were eligible for inclusion on the grounds of birth address. For both periods in cases where the predominant cause of admission was not clear the final decision on categorisation was always taken by one of us (DF).

Reasons for admission were categorised as follows: (a) respiratory illness requiring added oxygen but not related to asphyxia, congenital anomaly, or infection; (b) prematurity but without respiratory difficulties of sufficient magnitude to require oxygen; (c) jaundice; (d) asphyxia; (e) observation; (f) light for gestational age; (g) cerebral irritation occurring without apparent pre-existing asphyxia; (h) congenital anomalies or inherited disorders; (i) surgery not related to congenital anomalies; (j) infection—local or systemic.

For each infant the minimum information recorded in addition to reasons for admission was length of stay, gestation, and birth weight. Where social circumstances unduly extended an infant's stay the date that the infant became medically fit for discharge was used to determine the length of admission. This cut off was used for fewer than 10 babies in each period. Gestation was determined on the basis of the most accurate information available for each particular infant. When an early ultrasound scan had been performed for dating, or when the mothers' dates were considered accurate by the obstetricians, these assessments were used in preference to the Dubowitz or Farr scores, which were used alone in the remainder. When possible, and especially in babies developing respiratory illness or infants who subsequently died, the obstetric details were also recorded.

We examined delivery suite records for each maternity unit

operating in the district to ensure that details relating to registered stillbirths and neonatal deaths were complete. To be sure that no infant from the Nottingham health district had received neonatal care outside the district we reviewed the admission books of all units whose catchment area bordered that of the Nottingham health district.

Results and comment

Table III shows details of total births for the current Nottingham health district during the two study periods. Although the number of live births increased during the later study period, admissions to the neonatal unit were reduced by half (table IV). This shows that there has been a big fall in admissions, confined mainly to four categories—namely, jaundice, asphyxia, observation, and light for gestational age. The preterm group of infants is now significantly less mature ($p < 0.001$, Student's t test) and significantly lighter ($p < 0.01$, Student's t test) while spending significantly less time ($p < 0.05$, Student's t test) within the neonatal unit. The light for gestational age group of infants now have a significantly lower birth weight ($p < 0.001$, Student's t test). Overall mean birth weight and gestational age have fallen while the average length of stay has increased.

Because of gross differences in the number of admissions during the two study periods we examined the pattern of admission by gestation (fig 1).

The admission policy on preterm infants in 1977 was such that the figures shown probably represent all liveborn infants of 35 weeks' gestation and less. During the more recent period the admission policy required that all infants of 33 weeks' gestation and less should be

FIG 1—Distribution of gestation among all admissions for each study period.

admitted. Therefore any real change in numbers of preterm infants should be seen in the whole group up to and including 33 weeks' gestation. In 1977 there were 83 such infants compared with 151 in the more recent study period. This increase is significant ($p < 0.001$, χ^2 , 1 df).

We examined obstetric records relating to births of ≤ 33 weeks'

gestation to identify how many were brought about because of concern over the continued wellbeing of the mother or baby or both but when a spontaneous onset of labour had not occurred. This occurred in nine out of 83 cases in 1977 and 24 out of 151 cases in 1983-4. This increase was not significant.

In an attempt to further clarify the situation regarding the increased

TABLE IV—Total number of admissions for each study period according to reason for admission. Details of mean birth weight, gestation, and length of stay are also shown for each group

Category	No	Mean birth weight (g)	Mean gestation (weeks)	Mean length of stay (days)	Deaths (all causes)
Respiratory disease					
1977	121	1970	33.7	22.3**	23
1983-4	130	1700	31.9	31.3	24
Prematurity with no respiratory disease					
1977	153	2050*	35.0***	19.1†	0
1983-4	130	1940	33.7	15.0	0
Jaundice					
1977	141	3050**	39	4.9	0
1983-4	7	2730	38.3	6.3	0
Asphyxia					
1977	111	3160	39.5	4.6	0
1983-4	25	2940	38.7	7.0	5
Observation					
1977	149	3130*	39.1	4.93	0
1983-4	81	3290	39.4	3.5	0
Light for gestational age					
1977	112	2160***	38.6	10.9	0
1983-4	37	1870	37.5	9.08	0
Cerebral irritation					
1977	13	3260	38.7	7.54	1
1983-4	1	3760	40	1	0
Congenital anomaly					
1977	36	2600	37.8	7.73	19
1983-4	24	2660	37.4	9.8	11
Surgery—not related to congenital anomaly					
1977	2	2760	39.0	4	0
1983-4	4	2810	37.5	3.8	0
Infections					
1977	9	2340	36.1	31	2
1983-4	8	3170	38.1	9.63	1
Totals					
1977	847	2600	38.6	11.2	45
1983-4	447	2250	35.2	19.7	41

Total baby days: 1977, 9445; 1983-4, 7182.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p < 0.02$.

FIG 2—Percentage of infants weighing < 1000 g, 1001-1500 g, 1501-2000 g, 2001-2250 g born annually in England between 1970 and 1982. (Information from LHS 27/1 returns.)

FIG 3—Stillbirths as a percentage of total births (live and still) in each weight range. (Information from LHS 27/1 returns and relates to births in England 1970-82.)

numbers of infants of shorter gestation we obtained details of gestation on all 51 registered stillbirths in 1977 and in 43 out of 45 in the 1983-4 study period. There was no significant difference in the mean gestation (or standard deviation) in the two periods (mean 35.6 (4.1) weeks in 1977; and mean 35.0 (3.85) weeks in 1983-4). There were 13 stillbirths of infants of ≤ 33 weeks' gestation in 1977 (13.5% of the 96 births of ≤ 33 weeks' gestation). In the second study period there were 14 stillbirths of ≤ 33 weeks' gestation (9% of the 165 births of ≤ 33 weeks' gestation). This change was also not significant.

Figures are not collected nationally from gestational age data but instead rely on birth weight as a more objective measure. As has been stated, these figures show that the percentage of low birthweight infants occurring in Britain has been remarkably constant for some years (fig 2).⁵⁻⁸ There has, however, been a steady decrease in the percentage of stillbirths occurring among all of the low birthweight groups of infants (fig 3). Even at a national level this represents roughly only an additional 1220 babies live born of ≤ 2000 g in 1982 compared with 1971. Assuming the national trends shown in figures 2 and 3 continue unchanged for our recent study period, one would predict that the increase in infants of ≤ 2000 g among our population of 600 000 would have been roughly 16. Data from the study showed that the actual increase was 15 (184 in 1977 and 199 in 1983-4).

Table V shows mortality figures for infants of ≤ 33 weeks' gestation with the total number of liveborn infants for each one week

TABLE V—Incidence of deaths among infants ≤ 33 weeks' gestation for each one week gestation band

Gestation in weeks:	33	32	31	30	29	28	27	≤ 26
1977								
Deaths	2	4	4	4	5	2	0	5
Live births	24	22	12	9	8	3	0	7
1983								
Deaths	2	1	2	3	4	6	2	8
Live births	40	34	19	18	15	10	5	10

Relative risk 1977 v 1983-4 for period 29-32 weeks = 3.8 (8.9, 1.6), $\chi^2 = 8.2$, 1 df ($p < 0.01$).

gestation band. There has been a significant reduction in deaths ($p < 0.05$, χ^2 , 1 df) among all infants of ≤ 33 weeks' gestation. With the use of the Mantel-Haenszel test^{12,13} it may be seen that for infants of < 28 weeks' gestation and > 33 weeks' gestation risk of death was unchanged, while for infants of 29-32 weeks' gestation mortality risk showed a fourfold reduction to give a relative risk (1977 v 1983-4) of 3.8 (8.9, 1.6), $\chi^2 = 8.2$, 1 df, $p < 0.01$ for the unadjusted value and 4.8 (12.1, 1.9) for the adjusted value. There was no significant difference in the relative risks (1977 v 1983-4) between the 29, 30, 31, and 32 week bands (homogeneity $\chi^2 = 0.19$, 3 df) or between (29+30) weeks and (31+32) weeks (homogeneity $\chi^2 = 0.05$, 1 df). This means that the lower risk was found in each of the one week gestation bands between 29 and 32 weeks and not simply in the group 29 to 32 weeks as a whole.

Discussion

It will be quite obvious to those closely concerned in neonatal care that many of the observed changes in the pattern of neonatal admissions have occurred as a result of elective changes in admission policy. This applies particularly to infants requiring phototherapy; those infants of less than 37 but over 34 weeks' gestation, who by definition are preterm but cause few problems; those who are marginally light for dates; and those babies who have suffered a period of intrapartum asphyxia but received prompt and adequate resuscitation. The same change in attitude also explains why, while being significantly more immature in 1983-4, the "preterm" group of admissions remained in the neonatal unit significantly less time on average and by implication spent significantly more time with their mothers, either at home or on the postnatal ward. This change in approach has important implications for neonatal statistics. To use the group of infants who were admitted with asphyxia as an example it would appear that since the admissions of infants with this problem have fallen from 111 to 25 between the two study periods a general reduction in the incidence of birth asphyxia must have occurred. In fact, as stated above, most of these babies are now thought simply not to require admission. In addition, babies who are very severely asphyxiated are now sometimes resuscitated and offered intensive care when previously these infants would have been considered stillbirths.

The increase in the number of infants of ≤ 33 weeks' gestation occurring in Nottingham over the study period (83 in 1977 and 151 in 1983-4) is of considerable interest. Reliable information on outcome of pregnancies aborting between 24 and 28 weeks' gestation is not available. We have tried, however, to identify changes in obstetric practice which may have led to the increased numbers of preterm infants of ≤ 33 weeks' gestation. A few seemed to have resulted from an increased use of elective delivery in high risk pregnancies. Similarly a small increase seems to have resulted from a reduced stillbirth rate among infants of 33 weeks' gestation. There remains a considerable increase which is not adequately explained. It would appear likely that previously these infants were born and died before 28 weeks' gestation. We have not been able to show whether these infants now can be considered live births because obstetric management has been able to prolong their gestation or because paediatricians intervene at deliveries where previously no resuscitation would have been provided. A further explanation which must be considered is some other factor operating within the community which has led to an increased incidence of preterm labour and delivery.

Mortality for the group of liveborn infants of ≤ 33 weeks' gestation was significantly reduced in the 1983-4 period, and for the most part this reduction in mortality has occurred

among infants of 29-32 weeks' gestation. An increased number of low gestation infants is not accurately reflected in either the national or our own low birthweight data. A likely explanation for this is that the main increase in lower gestation infants has occurred among 32 and 33 week gestation babies, where the 50th centiles for weight are 2.0 and 2.2 kg respectively. As a result any change in the absolute numbers of these infants may well be masked by the large numbers of more mature infants whose weight range extends well into this range.

In conclusion, it would appear that changes in neonatal intensive care admissions have been largely determined by two factors. Firstly, clearer guidelines have been provided for junior staff on the criteria for admissions to the neonatal unit. Secondly, there has been an increased workload created by larger numbers of less mature infants. It would appear unlikely that the total number of babies entering the neonatal unit can be reduced further by an even more stringent admission policy. Increased numbers of immature babies are having a major effect on increasing the requirement for the most advanced forms of neonatal intensive care, but we have no information that will accurately predict future trends in preterm deliveries. Such information is of great importance since if mortality figures are to continue their downward trend further expansion of neonatal services may well be required.

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Correction

Severe cutaneous reactions to captopril

We regret that an error occurred in this paper by Dr M J Goodfield and Dr L G Millard (13 April, p 1111). In the third paragraph of the Comment the third sentence should have read "The pattern of onset suggests a photosensitive element. . . ."