Archives of Disease in Childhood, 1986, **61**, 459–463

Prevention of postneonatal mortality

R J MADELEY, D HULL, AND T HOLLAND

Departments of Community Medicine and Epidemiology and Child Health, University of Nottingham Medical School, and Community Nursing Services, Nottingham Health Authority

SUMMARY Studies of postneonatal mortality in Nottingham between 1974 and 1977 showed a familiar pattern of high death rates in socially deprived parts of the city.

A birth scoring system was devised, which identified at birth 9% of infants in whom 53% of postneonatal deaths could be expected to occur. From 1 January 1978 this group was identified by midwives and followed up intensively by health visitors.

The postneonatal mortality in the city of Nottingham fell from 8·7/1000 live births in 1974 to 3·6/1000 in 1981. It was not possible, however, to show that the rate of improvement after the introduction of the birth scoring system was greater than the trend present before its introduction.

The causes of postneonatal death, and their geographical and seasonal distribution, were similar in 1978–81 and 1974–77, despite an absolute fall in numbers. By 1981 the important risk factors were either recorded on the birth notification or known to the health visitor in any case. Although nurse managers and most health visitors have found the scheme useful in other respects—for example, resource allocation—it was considered that these could be achieved without a formal scoring system. Therefore, the birth scoring system was stopped at the end of March 1985. Health visitors are still being encouraged to pay more attention to high risk cases as a part of normal clinical practice.

The existence of the Court Working Party, the Committee on Child Health Services, and the publication of its report 'Fit for the Future'[1] in December 1976, stimulated many health authorities in the mid–1970s to review their services and their children's health statistics. In Nottingham this was done through the mechanism of the newly formed Health Care Planning Team for Child Health, set up following a reorganisation of the National Health Service in 1974.

At an early meeting of the team it was decided to concentrate on postneonatal mortality in the local government district of the City of Nottingham because the postneonatal mortality was consistently higher there than in the three surrounding suburban local government districts of Broxtowe, Gedling, and Rushcliffe. These four local government districts make up what is known as the Nottingham conurbation.

At the same time, publicity was being given to a birth scoring system devised by our near neighbours in Sheffield aimed at reducing the incidence of the sudden infant death syndrome. Early results had claimed that such an intervention was beneficial,[2–4] although scepticism was also expressed.[5] It was decided to set up such a system in Nottingham in the hope that it might reduce postneonatal mortality in total—not just sudden infant death syndrome. Since that time the results of the Sheffield system have remained controversial.[6–9]

The chief objective of this paper is to help in the resolution of this controversy, based on our experience of more than seven years of the Nottingham birth scoring system in practice.

Design of the birth scoring system

A study of postneonatal mortality in the city of Nottingham in the years 1974–76 was carried out using data available on routine death notifications received by the then Nottinghamshire Area Health Authority (Teaching). It showed that most deaths occurred at home, in the winter, and in the less well off parts of the city and were attributed to respiratory infections and the sudden infant death syndrome.[10]

Additionally, a case control study was carried out to contrast infants who died with those infants who

did not. This was done by obtaining data from the birth notification of the dead infant and comparing these with two notifications chosen at random from liveborn children born on the same day. A comparison of the two groups[11 12] revealed that those who died were significantly more likely to be of low birth weight (<2500 g), bottle fed, born in a household the head of which was a partly skilled or unskilled manual worker, and born in a polling district classified by the Nottinghamshire County Council as socially deprived.[13]

The health visitor records of the dead infants were compared with those of the control group. This was carried out personally by one of the authors (RJM). The records of the dead infants were stored at the headquarters of the Nottingham Community Child Health Service, whereas those of the control group were held in the relevant child health clinic. This analysis showed that those infants who died were significantly more likely not to have attended a child health clinic by 6 weeks of age and not to have established a set feeding pattern by 4 weeks (either breast or bottle).

The data were then analysed using the method of step wise discriminant analysis, as used by Carpenter and Emery in the derivation of the Sheffield birth scoring system.[2 4 6] As a result of this, a birth scoring system was devised, which identified a high risk group of 9% in which 53% of postneonatal deaths occurred (relative risk=11·6, 95% confidence limits 21·90 and 5·79).

Babies ending with a score of +500 points or more were assigned to the high risk category (Table 1).

After intensive discussions with various groups of health professionals it was decided that from 1 January 1978 each liveborn infant delivered by a mother living within the then Nottingham North and South Health Districts would be scored by the midwife in the maternity unit. Those infants designated as being at high risk would be followed up intensively by their health visitor, who also had the responsibility of liaising with the general practitioner.

Table 1 *The Nottingham birth scoring system*

Starting score	+1000
1 January 1978–31 March 1985:	
Born in deprived polling district	+200
Birth weight <2000 g	+425
2000–2499 g	+215
2500–2999 g	—
3000–3499 g	−215
≥3500 g	−425
Age of mother	−30 (x age in years)
1 January 1978–31 December 1979:	
Breast fed baby	−400
Second stage of labour 15 minutes or less	+400
1 January 1980–31 March 1985:	
Legitimate birth	−400
Delivery less than 18 months after birth of previous child	+400

Detailed accounts of the derivation of the scheme and its implementation have been published,[11 12] as has an interim report of the first three years of the scheme,[14] which described a number of operational changes.

The most important change was the substitution of two new risk factors in the birth scoring system from 1 January 1980 and the removal of 'Feeding method' and 'Short second stage'. This change had the effect of reducing the size of the high risk group from 11·9% of live births to 4·6% in the first six months of 1980. It was thought by the health visitors that this percentage was too low, so that from 1 July 1980 the cut off point for inclusion in the high risk group was lowered to +300 or higher. This raised the level of the high risk group to 8·0% in the period 1 July–31 December 1980. It remained near to this level until the scheme was stopped at the end of March 1985.

Results

A comparison of causes of postneonatal death in the years 1974–76 and 1978–81 has been undertaken.

The most striking feature of the results shown in Table 2 is the apparently large reduction in the numbers of deaths from sudden infant death syndrome. The change is explained, however, by the arrival of a specialist consultant paediatric pathologist in 1979. In particular, the criteria for sudden infant death syndrome were considerably tightened, with a greater tendency to relate inflammatory change in the lungs to respiratory disease rather

Table 2 *Causes of death recorded on death certificates for postneonatal deaths in the city of Nottingham for 1974–77 and 1978–81*

Cause of death	*1974–77*		*1978–81*	
	No	*%*	*No*	*%*
Respiratory infections	26	28·3	25	43·9
Sudden infant death syndrome	37	40·2	14	24·6
Congenital abnormalities	14	15·2	9	15·8
Gastroenteritis	5	5·4	3	5·3
Meningitis	3	3·3	2	3·5
Cardiomyopathy	2	2·2	—	—
Epiglottitis	2	2·2	—	—
Trauma	2	2·2	2	3·5
Otitis media	1	1·1	—	—
Septicaemia	—		1	1·8
Intussusception	—		1	1·8
Total	92	100	57	100
Postneonatal death rate per 100 live births		7·4		4·7

than the syndrome. This is an example at local level of the problems outlined by Weatherall and White[15] and more recently by Gardner[16] in obtaining reliable trends in the incidence of sudden infant death syndrome.

The key point is the remarkably constant percentage of deaths, if the groups with respiratory infection and sudden infant death syndrome are taken together—68% of all postneonatal deaths in 1974–77 and 68% in 1978–81. More infants died at home or were dead on admission to hospital during the period 1978–81 (43 of 57 (75%)) than the earlier period 1974–1977 (61 of 92 (66%)), but the difference is not significant. There was no significant change in age distribution. In both periods three quarters of postneonatal deaths occurred before the end of the child's fifth month. In both periods there was a strong seasonal relation with postneonatal death, with more deaths occurring in the winter months.

A measurement that created much interest in the original analysis of the 1974–76 data was the clustering of the addresses of the families in which a postneonatal death had occurred in certain well defined parts of the city. Plotting such addresses showed that in 1978–81, although there was still some clustering of deaths in inner city wards, this effect was less pronounced (Fig. 1).

Throughout the study period, as a result of the housing policy of the Nottingham City Council, there was a movement of population in Nottingham from the inner city to the periphery. This effect can be seen by comparing data from the censuses of 1971 and 1981.[17]

Analysis of trends in postneonatal mortality derived from routine Office of Population Censuses and Surveys data (SD52 returns) was undertaken for the period 1972–82, taking advantage of the easy availability of this routine data (Fig. 2). The visual impression is that there has been a steady downward trend in the city of Nottingham throughout the period in question from a rate well above that for

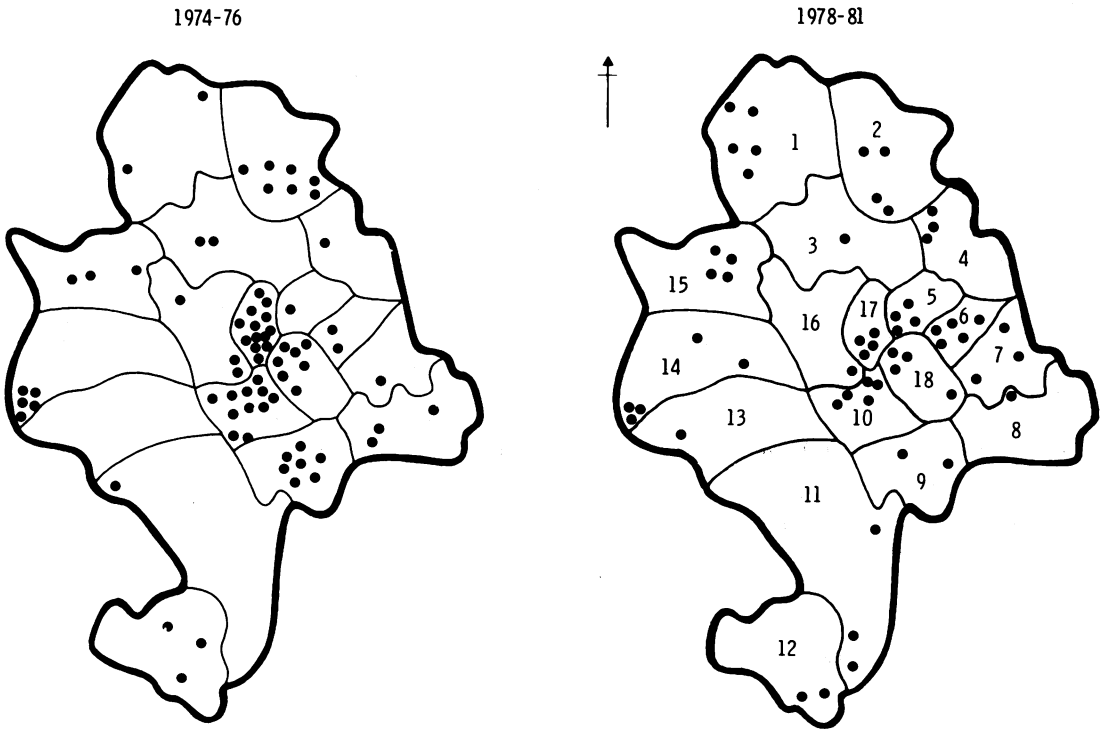

Fig. 1 *Map of the wards in the city of Nottingham, showing the addresses of postneonatal deaths in the periods 1974–76 and 1978–81. Each dot represents a postneonatal death.*

Key to wards: 1=St Albans; 2=Byron; 3=Portland; 4=Mapperley; 5=Forest; 6=St Anns; 7=Manvers; 8=Trent; 9=Bridge; 10=Lenton; 11=University; 12=Clifton; 13=Abbey; 14=Wollaton; 15=Broxtowe; 16=Robin Hood; 17=Radford; 18=Market.
Broxtowe ward (15) has no relation to Broxtowe Local Government District, which is one of three suburban districts (along with Gedling and Rushcliffe) that surround the city.

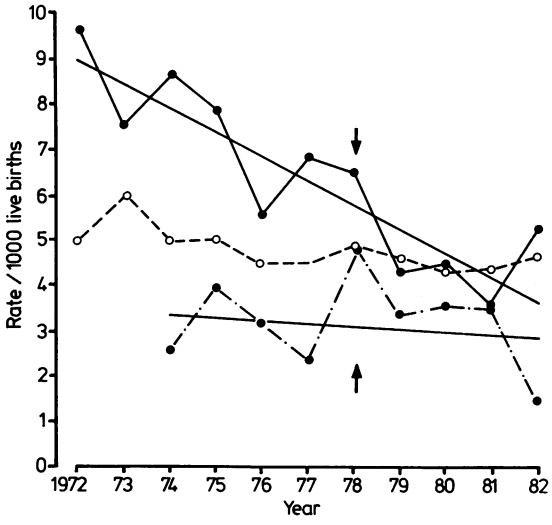

Fig. 2 *Comparison of trends in postneonatal mortality in the city of Nottingham, three combined suburban districts of Nottingham (Broxtowe, Gedling, and Rushcliffe), and England and Wales for the period 1972–82. (●——●=figures for city of Nottingham; ●-·-·-·-●=combined figures for the three suburban districts; ○- - - -○=figures for England and Wales, obtained from Office of Population Censuses and Surveys). Arrows indicate the introduction of the birth scoring system into Nottingham. Lines represent mean trends.*

England and Wales to one closely resembling it. There is no suggestion of a trend in the data for the three combined suburban districts (Broxtowe, Gedling, and Rushcliffe) throughout the period of the graph. There seems to be a slow downward trend in the rate for England and Wales for the first part of the period but a static rate during the period 1978–82.

Crucially, there seems to be little suggestion, in the graph relating to the city of Nottingham, of an acceleration in the rate of decline after the introduction of the birth scoring system in 1978.

This visual impression is confirmed by regression analysis. The regression coefficient for the period 1978–82 falls within the 95% confidence limits of that for the period 1972–77.

By means of a second case control study covering the period 1978–81, using four liveborn controls for each death, it is possible to compare the relative risks for different risk factors in the two periods. If the high risk intervention is successful the outcome of the children designated as high risk should be the same as that in those not so designated, and the relative risk would fall to 1. Although there is such a fall in most of the major risk factors studied, in no case is the fall significant. Some important risk factors still have significantly raised relative risks—for example, low birth weight, bottle feeding.

A comparison of the two control groups in the two periods 1974–76 and 1978–81 showed that only two out of nine important risk factors for postneonatal mortality have changed significantly in prevalence between 1974–76 and 1978–81. There has been a significant fall in parity and in the number of births to mothers living in polling districts designated as 'very deprived'.

An analysis of a random sample of health visitors' records carried out by one of the authors (RJM) shows that they did, in fact, visit the high risk infants as requested. Interestingly, contact with low risk infants also increased. This was partly because the total number of health visitors increased at a time when the birth rate was falling.

Discussion

The evaluation of birth scoring systems is not an easy exercise. A major problem is that in no case known to the authors has it been possible to mount a randomised clinical trial of a scoring system for any duration. There were extensive discussions in Nottingham about the feasibility of such a trial, but it became clear that it would be opposed by large numbers of midwives, health visitors, and doctors, thus rendering the exercise impractical.

Because of the absence of a trial it is impossible to conclude that the fall in mortality in the period 1978–81 is in any way due to the effect of the birth scoring system. Our view is that such factors as the large concurrent fall in the birth rate in high risk groups, an increase in breast feeding, a documented improvement in housing conditions, the impact of the original research on which the system was based, and general improvements in services are more likely to have had a bigger impact.

This is not to say that the system may not have prevented some deaths; 'Cannot be shown statistically' does not mean 'Had no effect'. Because of the comparative rarity of postneonatal death it is extremely unlikely that even a very successful birth scoring system would produce a reduction in mortality significant at the 5% level within a 10 year period.

Therefore, the decision about whether or not to set up a birth scoring system, or to continue with an existing one, is essentially a matter of local judgment. In coming to a conclusion it is essential to consider the main objectives of the health visiting services and of primary health care in general. Broadly speaking, in the context of this article they are to provide relevant services for children, particu-

larly of a preventive and developmental nature. Paying more attention to individuals and groups at higher risk of a given outcome has always been part of normal clinical practice.

In the opinion of nurse managers and most health visitors in Nottingham the birth scoring system has been a useful exercise in a number of respects. Firstly, it made health visitors aware of what the important risk factors for postneonatal mortality were. Secondly, it helped in the day to day allocation of the time of an individual health visitor. Thirdly, it provided data that were helpful in resource allocation, especially in identifying areas of high need into which additional services could be channelled.

The central issue is whether or not the extra paper work created by the system and the significant additional demands placed on staff such as midwives is worth it. By the 1980s postneonatal mortality in Nottingham had fallen to very low levels, leading to a reduction in the general degree of urgency. The midwives increasingly questioned the value of the exercise.

Finally, the really important risk factors at the present time are either recorded on the routine birth notification—for example, low birth weight—or known to the health visitors in any case—for example, feeding method. Therefore, we thought that, on balance, the scheme should be stopped from 31 March 1985. Health visitors will be encouraged to pay more attention to high risk cases as part of normal practice but without a formal scoring system.

On the basis of our experience in Nottingham, and our reading of published articles concerning the Sheffield scheme, we conclude that district health authorities should not be recommended to set up birth scoring systems. Where they already exist their future should be determined by local decision.

Thanks are due to Professor J M Elwood and Dr J C G Pearson for help with the analysis and Dr J Little for editing the draft; also to Miss R Buxton for typing the manuscript and Mr G Lyth for the map and graph; and above all to the health visitors and midwives of Nottingham Health District.

References

1. Committee on Child Health Services. *Fit for the future*. London: HMSO, 1976. (Cmnd 6684).
2. Carpenter RG, Emery JL. Identification and follow-up of infants at risk of sudden death in infancy. *Nature* 1974;**250**:729.
3. Carpenter RG, Emery JL. Final results of study of infants at risk of sudden death. *Nature* 1977;**268**:724–5.
4. Carpenter RG, Gardner A, McWeeny PM, Emery JL. Multistage scoring system for identifying infants at risk of unexpected death. *Arch Dis Child* 1977;**52**:606–12.
5. Magura S. Sudden death in infancy. *Nature* 1975;**256**:519.
6. Carpenter RG. Scoring to provide risk related primary health care; evaluation and up-dating during use. *Journal of the Royal Statistical Society* 1983;**146**:1–32.
7. Carpenter RG, Gardner A, Jepson M, *et al*. Prevention of unexpected infant death; evaluation of the first seven years of the Sheffield intervention programme. *Lancet* 1983;i:723–7.
8. Gedalla B. Sheffield cot-deaths project. *Lancet* 1983;ii:48–49.
9. Knowelden J, Keeling J, Nicholl JP, *et al*. A multicentre study of postneonatal mortality. Sheffield: University of Sheffield, 1984.
10. Madeley RJ. Social factors associated with postneonatal death in Nottingham, 1974–76. *Arch Dis Child* 1977;**52**:809.
11. Madeley RJ. Relating health services to needs by the use of simple epidemiology. *Public Health* 1978;**92**:224–30.
12. Madeley RJ, Latham A. Management aspects of high-risk strategies in child health. *Community Med* 1979;**1**:36–9.
13. Nottinghamshire County Council Planning Department. *County deprived area study*. Nottingham: Nottinghamshire County Council, 1975.
14. Madeley RJ. Positive discrimination in child health; an interim report from Nottingham. *Public Health* 1982;**96**:358–64.
15. Weatherall JAC, White GC. Variations in the recording of sudden infant death syndrome on death certificates. In: HMSO, eds. *Studies on medical and population subjects* No 31. London: HMSO, 1976.
16. Gardner A. An attempt to identify cases of the sudden infant death syndrome from death certificates and hence determine the incidence. In: HMSO, eds. Studies in the sudden infant death syndrome, *Studies on Medical and Population Subjects* No 45. London: HMSO, 1982:33–8.
17. Nottinghamshire County Council Planning Department. *Disadvantage in Nottinghamshire: county deprived area study*. Nottingham: Nottinghamshire County Council, 1983.

Correspondence to Dr R J Madeley, Department of Community Medicine and Epidemiology, University of Nottingham Medical School, Queen's Medical Centre, Clifton Boulevard, Nottingham NG7 2UH, England.

Received 29 January 1986