PAPERS AND ORIGINALS

Current vital statistics: methods and interpretation*

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In the United Kingdom we are fortunate in having systems for medical statistics that in many respects are more comprehensive than those of other countries. Both the statistics and their use depend on their being accepted and promoted by the medical professions. Most national medical statistics are managed by the Office of Population Censuses and Surveys (OPCS).[1] One of the main functions of its medical statistics division is developing and exploiting statistical systems by which to analyse the changing state of health of the nation. In this paper I discuss some general principles and recent statistics.

Decline in mortality

The death rates for 1900-75 by generations (fig 1) declined consistently between successive five-year cohorts[2] for ages up to about 40, with two exceptions. The first is during 1914-8 world war, when there was a severe influenza pandemic that struck mainly at young people. The second exception is that girls aged 15-19 in the latest cohort had a higher death rate than had the previous cohort—the result of increased deaths from accidents.

After the second world war there was a sharp decline in mortality for ages up to about 25; for older ages the rate of decline diminished progressively with age. The steep postwar decline in mortality of adolescents and young adults resulted largely from the demise of tuberculosis.[3] This eliminated the bump in the generation curve of mortality of young women. For young men, despite a similar decline in tuberculosis, a bump in the mortality curve has persisted, mainly because of increasing accidental deaths. Whereas curves representing mortality of successive generations of older men bunch together, between the generations of women born before 1916 the decline in mortality has been consistent. But the curve representing the generation born around 1916 joins its predecessor at the 50-54-year point, while the curve for 1926 meets its predecessor at the 40-45-year point. Thus the bunching curves of mortality of successive generations of women, resembling the picture for many previous generations of men, indicates a probable halt in the decline also of female death rates above middle age.

*Based on the presidential address given to the epidemiology section of the Royal Society of Medicine.

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Sex ratio and regional variations in mortality

The ratio of male to female death rates until recently increased consistently during the previous 50 years, especially in the age groups around 20 and around 60 years. The difference in young adults results largely from the difference between the sexes in violent deaths; at around 60 years of age the difference is due mainly to the greater mortality from heart disease, chronic lung disease, and cancer of the lung and bronchus in men. The rise in the male:female ratio of death rates from all causes during this century reinforces the credibility of figures showing that men suffered the main increase of ischaemic heart disease and lung cancer.

The broad pattern of regional variation in death rates has been remarkably constant over the century. London has improved its relative position, but Wales and the Northern region have retrogressed, and Lancashire in the North-western region has retained its poor position. The south-to-north gradient of mortality in England continues into Scotland. Within regions variation in death rates between social classes are surprisingly constant, and within classes the geographical differences persist, regional and class differences being almost entirely independent in adult mortality. On the other hand, the geographical variation of infant mortality is partially related to the social class of the father (see below).

International comparisons

Table I shows, for the years 1900-2 and 1974, within age groups, rankings of the death rates of England and Wales among nine countries. England and Wales have done well, especially between the ages of 5 and 44. But, as is well known, infant mortality has not declined as fast as in other countries, and after middle age the comparison is also unfavourable. Perinatal mortality is considered to be an indicator of healthiness of a community. In recent years the United Kingdom's record, despite continued improvement in stillbirth and infant mortality rates, has been disappointing when compared with that of many other countries.

Interpreting differences in figures for stillbirths and infant mortality between countries is difficult because of the differing laws and customs of registering births and deaths and because of the paucity of relevant items such as birth weight. Table II shows, by birth weight, neonatal (first 28 days) death rates for England and early neonatal (first seven days) rates for Sweden, no more comparable statistics

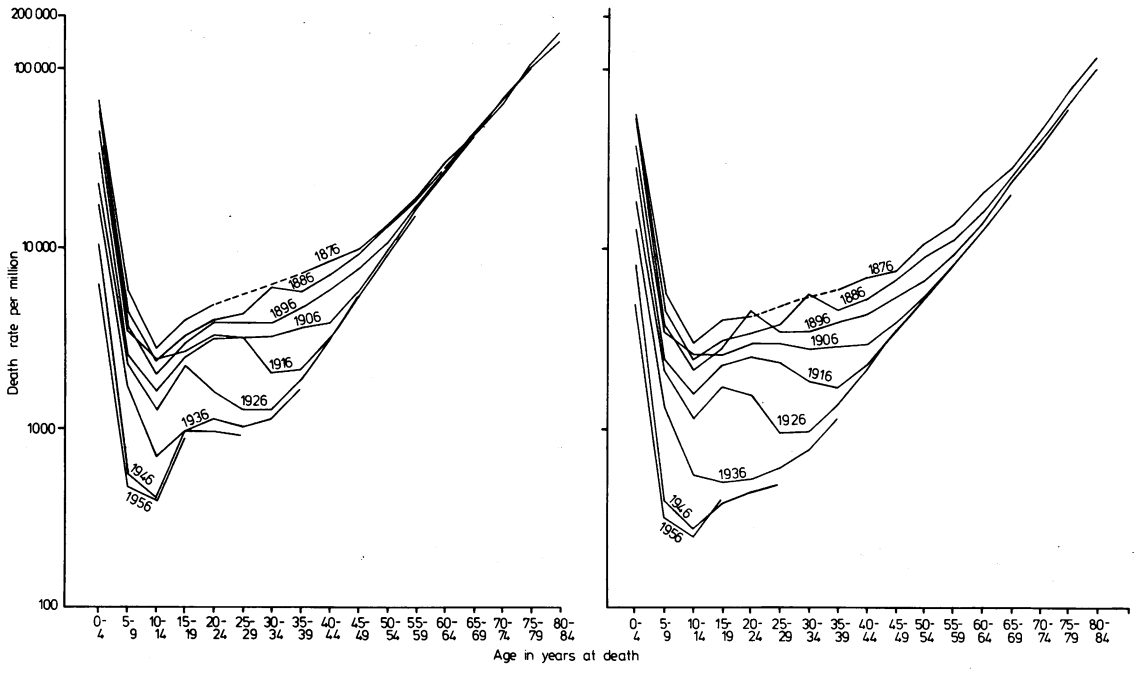

FIG 1—Deaths from all causes: rates for five-year cohorts by median year of birth.[2]

TABLE I—*Rank order of mortality rates of England and Wales among nine countries (Scotland, Ireland, Denmark, Sweden, Italy, France, Australia, New Zealand)*

Years	Age (y):	0	1–4	5–14	15–24	25–34	35–44	45–54	55–64	65–74	75	Total
1900–2	Males	7	NA	4	2	4	7	8	8	8	5	6
	Females		NA	3	2	2	5	7	7	6	6	4
1974	Males	6	4	2	1	1	1	4	7	7	6	8
	Females	6	3	5	2	2	4	5	5	6	5	8

NA = Not available.

TABLE II—*Neonatal death rate per 1000 live births: England and Sweden, 1971*

Birth weight (g)	England	Sweden
	Neonatal death rate	Early neonatal death rate
⩽1000	799·7	873·9
1001-1500	436·8	429·3
1501-2000	139·7	143·4
2001–2500	31·2	31·1

Observed early neonatal death rate: 9·8 per 1000 live births.
Expected early neonatal death rate: 9·2 per 1000 live births.

being available.[4] Despite the advantage to Sweden in comparing deaths for only the first week of life with the first four weeks for England, mortality rates in each category of weight from 1001 g to 2500 g are similar; the difference in neonatal mortality rates between the countries results from the relative numbers of small babies—for example, in England in 1971 6·4% of live-born babies weighed between 1001 and 2500 g, while in Sweden in 1976 these constituted 3·9%. In England the 6·4% of babies weighing between 1001 and 2500 g accounted for 58% of neonatal deaths.

Socioeconomic factors

During the nineteenth century Farr showed that death rates were related to environment and life style, and since 1911 the Registrar General has therefore analysed mortality around census years by social class (I—professional; II—intermediate; III—skilled; IV—semi-skilled; V—unskilled). These analyses showed a gradient of mortality, rates being highest in the unskilled classes of men and their wives and children and lowest among those in the professional classes.

As the most recent decennial report[5] shows, the gradient of mortality between classes is present throughout the life span. Because of the increasing numbers of women who work in industry, this report has analyses of female mortality. It also shows how a social classification is able to separate the effects on health of life style from those of occupation or the local environment. The gradient in mortality between social classes is found wherever sought in developed countries.

Comparing time trends in the mortality of the different social classes would at first sight seem straightforward but is in fact complicated by changes in the distribution of people between occupations, and by changes in the classification of occupations and the associated composition of social classes. For example, between 16 and 64 years of age the proportion of all men in social class V fell from about 16% in 1931 to about 6% in 1971. Most of the change resulted from increased mechanisation and the decreased need for unskilled workers but some from different rules for deriving social classes from occupations. In addition to the changing structure of the work force, mobility between classes is likely to be selective—for example, people who move into class V may be the least healthy and those who move into higher classes the healthiest. Even when officials shift categories of occupations between classes, these are likely to be selective. In the following analyses, to reduce the effects of changing classifications, I have combined social class I with II and IV with V.

INFANT MORTALITY

Compared with the rates of 1964, stillbirths have declined most (now 63%) and postneonatal deaths least (82%). Differences between the social classes have not changed much, the sharpest gradient being among postneonatal deaths (table III). But there have been changes in the numbers of births and their proportions in the different classes.

TABLE III—*Infant mortality in 1975 as percentage of rates for 1964 (1975 rates per 1000 live births in parentheses)*

Social class of father (married)	Stillbirths	Neonatal deaths	Postneonatal deaths
I and II	68 (8·0)	91 (8·4)	91 (3·2)
III	65 (10·1)	83 (9·8)	78 (4·2)
IV and V	73 (12·6)	93 (12·3)	86 (6·5)
All births	63 (10·3)	78 (10·7)	82 (5·0)

In 1964 there were 812 632 legitimate live births and in 1975 only 548 554; the proportions in social classes IV and V combined were 30% and 21% in these two years.

MORTALITY OF ADULTS BY SOCIAL CLASS

Age standardised death rates for men aged 16-64 since 1930 are compared in table IV for social classes, rates for doctors being shown separately because their records are likely to be extremely reliable for both occupation and cause of death. For all causes of death in adults aged 16-64, from around 1931 to around 1971, there has been a sharpening of the gradient of mortality between the social classes; the rates have fallen proportionately more in classes I and II than in IV and V in each age group. Between the periods around 1951 and 1961 censuses, at ages above 45, there was a particularly marked divergence of death rates between classes. For married women (not included in the table) the trends resemble those of men, though their rates have been lower than those of men and declined faster. Between the periods of the 1961 and 1971 censuses, however, there was an increase in the rates of the three classes, most marked in IV and V.

In 1931 male doctors had a death rate similar to men of social classes IV and V, but thereafter their rate improved relatively as well as absolutely. It was close to that of classes I and II in 1951, deteriorated relatively in 1961, and is now slightly better than for men in classes I and II.

TABLE IV—*Mortality from all causes, lung cancer, and ischaemic heart disease. Comparative mortality figure for all men and for doctors (England and Wales) (100= population of 1971 age 15-64)*

	1930–2	1949–53	1959–63	1970–2
		All causes		
All men	142	115	104	100
I and II	133	102	84	81
III	138	117	105	106
IV and V	152	121	120	121
Doctors	151	104	93	80
		Lung cancer (ICD(8)162 and equivalents)		
All men	13	80	103	100
I and II	12	66	72	66
III	13	86	110	110
IV and V	13	83	122	130
Doctors	18	43	50	33
		Ischaemic heart disease (ICD(8)410-4 and equivalents)		
All men	42	72	86	100
I and II	45	78	82	91
III	40	75	91	109
IV and V	43	53	88	109
Doctors	74	101	100	(*SMR 88)

Cancer of the lung and bronchus and ischaemic heart disease

Two of the main chronic disorders that apparently have increased their death rates during the century are ischaemic heart disease and cancer of the lung and bronchus.

CANCER OF LUNG AND BRONCHUS

Rates of mortality of men who were born after 1900 are declining; in successively younger men the decline began in later cohorts, suggesting a period effect (for example, a reduction of an environmental factor affecting all ages at the same time). But the main impression is of a cohort effect, as would be expected from the figures for cigarette smoking; and the decline in death rate is relatively small

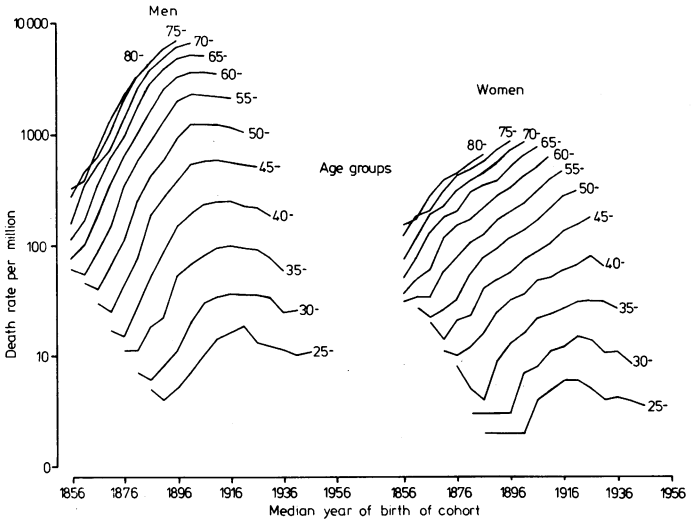

FIG 2—Deaths from cancer of the lung and pleura: rates for five-year cohorts by median year of birth.[2]

(fig 2). For women above 45 years of age rates of mortality rise constantly and sharply; below 45 beginning with women born around 1921 rates have levelled and turned down. Around 1931 death rates for men did not vary much between social classes, but marked differences between the classes (high in IV and V) appeared around 1951 and increased thereafter until in 1970-2 the death rate from lung cancer for classes IV and V was virtually twice that of classes I and II. Rates for men increased sharply until 1961 and subsequently declined moderately. Within social classes, however, these trends differ; the rise is least and the subsequent decline greatest in social classes I and II. Among male doctors mortality from lung cancer had the highest rate around 1931 (possibly because of better diagnosis), fell below the rate for social classes I and II around 1951, and in 1970-2 was half that for classes I and II and one-third that of for all men.

Among married women mortality for lung cancer did not vary between classes until around 1961; the subsequent increase, present in every class, is least for classes I and II and most for IV and V.

MORTALITY FROM ISCHAEMIC HEART DISEASE

Time trends of mortality from ischaemic heart disease (IHD) in social classes differ fundamentally from those of lung cancer. Figures for men from the decennial supplements (table IV), indicate continuously rising rates up to 1970-2. In 1930-2 social classes I and II had somewhat higher rates and the gradient between classes had increased around 1951. In 1959-63 this was reversed. The highest rates were in social classes IV and V and by 1970-2 the mortality gap between the classes had widened, especially in younger men.

For women mortality from IHD has always been considerably lower than the rates for men. Mortality in each age group declined until about 1961, since when it has been rising. Unlike for men, there has been a mortality gradient between the classes (higher in unskilled) since 1930-2. The gap widened in 1959-63 and again in 1970-2.

SMOKING, LUNG CANCER, AND ISCHAEMIC HEART DISEASE

According to the Tobacco Research Council's figures, taken at face value the gradient between classes in the proportion of smokers[6]—highest in unskilled workers—has been widening, but it appears to have been present even in the 1930s among young men.[7] The general household survey in 1975 and 1976 showed that in men over 60 the percentages of smokers and ex-smokers combined in the social classes from I to VI were: 67, 78, 81, 83, 84, 86. This suggests that at the age when smoking usually begins—that is, some 40 years previously—there was already a gradient between the social classes. Among women over 60 years of age there were considerably fewer smokers than among men, but the younger the women the smaller the differences between the sexes. There was no noteworthy difference between the classes in the proportion smoking among women over 65, but below age 65 a gradient between classes was present and it increased in younger women, as for men.

These statistics of smoking help to explain some of the trends for lung cancer mortality: lower rates for women though rising steeply above the age of 45 years, and differences in rates for men between social classes that appeared around 1951 and increased thereafter. Among women, social class differences in mortality appeared only around 1961 and are not yet as wide as for men.

A survey of smoking in professions[8] showed that the lowest proportion of smokers were among doctors (21% of general practitioners and 25% of hospital doctors). This would explain their striking decline in lung cancer. But the levelling and subsequent decline in mortality from lung cancer in men in general and the recent decline for young women suggests that another factor, possibly the reduction of air pollution, has played a part; more recently the reduction of tar and addition of filters in cigarettes may also have played a part.

These statistics for cigarette smoking may also help to explain the recent increase in mortality from IHD in women and its increasing gradient between the social classes.

Prospective studies

The facility for carrying out prospective studies with the aid of routinely assembled records on a nationwide scale adds greatly to our analytic capacity. The OPCS's cohort study,[9] for example, is based on a 1% sample of 1971 census records.

AGE AT BIRTH OF FIRST CHILD

A preliminary analysis of mortality of women by marital conditions, age at birth of first child, and social class of husband (table V) shows that differences associated with age at birth of first child vary by social class; wives of manual workers who had their first child after the age of 30, or had no children, experienced higher death rates than did wives of non-manual workers with similar child-bearing records. In looking at the effects of childbearing on subsequent experience we shall be looking at specific conditions such as cancer of the breast and hypertensive disease; but as our longitudinal study is based on records of only 1% of the population there are so far too few deaths for detailed analysis.

TABLE V—*Mortality of women aged 35-59 by marital condition, husband's social class, and age at birth of first child. Longitudinal study 1971-5*

	Observed	Expected	SMR
Married women			
Non-manual husbands			
1st child born at:			
<20 years	10	11·5	87
20-24	87	108·2	80
25-29	106	133·4	79
30 and over	56	78·9	71
No children	54	64·5	84
Manual husbands			
1st child born at:			
<20 years	42	44·0	95
20-24	225	236·0	95
25-29	155	179·3	86
30 and over	108	99·7	108
No children	115	100·5	114
Insufficient information	132	82·8	159
Single women	131	111·1	118
Widowed women	116	94·7	122
Divorced women	37	29·6	125
All women aged 35–59	1374	1374·2	100

MORTALITY OF IMMIGRANTS

Since 1969 country of birth has been noted on death certificates, and with the addition of similar information from the census, an analysis of mortality of immigrants for 1970-2 is progressing.[5] Because country of birth does not identify race, we have used names to decide between Asian and British backgrounds for those born in the Indian subcontinent and between Africans, Europeans, and Asians for those born in the African Commonwealth. Since there are no population statistics of ethnic origin (apart from country of birth) corresponding to the figures derived from death certificates, death rates for specific causes have to be based on proportions of all deaths age standardised. Table VI shows mortality from cancers of the stomach and intestine among those born in the Indian subcontinent. Proportional mortality rates for stomach, intestinal, and for rectal cancer are low for both sexes—between 46% and 75% of the expected rates. Asians, however, had considerably lower mortality rates than did the British born there.

TABLE VI—*Deaths and proportional mortality rates (PMRs)* from cancer of the stomach and intestine. Immigrants born in the Indian subcontinent England and Wales 1970-2*

	Cancer of:					
	Stomach (A47)		Intestine (A48)		Rectum (A49)	
	Male	Female	Male	Female	Male	Female
Asian						
PMR	31	64	37	27	47	12
Deaths	14	7	11	4	9	1
British						
PMR	69	61	68	90	66	72
Deaths	34	31	24	53	17	19
Total						
PMR	46	64	57	75	58	59

*PMR = $\frac{\text{Observed} \times 100}{\text{Expected (based on all deaths in England and Wales, age standardised)}}$

Table VII shows PMRs for hypertensive disease for people born in the African Commonwealth and West Indies; mortality from hypertension is high for all groups. While the paucity of deaths from hypertension in Asian and British groups makes for unreliable statistics, there is no doubt about the very high mortality rates among Africans and West Indians, both men and women. For IHD, however, the Asians have fairly high rates, while the Africans and West Indians have low rates. Although proportional mortality rates are not as reliable as rates based on populations there can be no doubt of their significance when they are as exceptional as these. Death rates from strokes among African immigrants and immigrants from the West Indies and Guyana are also high, and similar to those for hypertension.

TABLE VII—*Deaths and proportional mortality rates (PMR) for hypertensive disease and ischaemic heart disease among immigrants born in Commonwealth Africa and the West Indies and Guyana*

	Hypertensive disease (A82)		Ischaemic heart disease (A83)	
	Male	Female	Male	Female
People born in Commonwealth Africa				
Asian:				
PMR	182	196	120	163
Deaths	2	1	23	6
African:				
PMR	534	870	56	
Deaths	14	4	28	0
British:				
PMR	225		80	14
Deaths	4		29	1
Other:				
PMR				
Deaths	0	2	8	4
Total				
PMR	332	350	78	64
Deaths	20	7	90	11
People born in West Indies and Guyana				
PMR	426	532	49	70
Deaths	83	55	198	65

Discussion

I have shown some of the results of current interest coming from our statistical analyses. Mortality rates in England and Wales are favourable for children and young adults compared with those of other countries, but lag behind for infants and after middle age. Generation mortality of women after middle age seems to be following the pattern established for men, suggesting the end of the decline. Analysis of occupational mortality for 1970-2 highlights the continuing effects of social factors on health at every stage of the life cycle. It has identified the separate effects on mortality of social, geographical, and

occupational factors. Figures of smoking by age from the General Household Survey suggest that as far back as the 1930s manual workers smoked more than non-manual workers, and that this difference, which has been widening, could account for some of the differences in mortality between social classes.

Comparison of rates of specific causes of death among immigrants with those of all people in England and Wales underlines the importance of life style on health. There is a growing interest, both official and public, in the effects on health of environment, occupation, and life style. An important method of investigating these effects is the prospective study, which follows up individuals and finds out what happens. Since it is not feasible to predict the health questions that will need to be answered, we aim to develop systems to facilitate the widest range of investigations based on routinely collected national vital and health statistics.

To complement statistics based on current data the OPCS has introduced continuing systems of record linkage: a 1% random sample of records from the 1971 census linked to records of births, deaths, registered cases of cancer, and migration; records of births linked to those of infant deaths; and ad hoc samples of records of individuals to be studied in terms of mortality or cancer.

Much of the information in these systems comes from the everyday work of clinicians, as do most of the clues of healthy and hazardous ways of life. To improve the information systems and to exploit them we need the collaboration of all in the medical and related professions. They must build up their trust and reliance on statistics. This is happening, but slowly. Needless to say, we attach the greatest importance to safeguarding confidential information, whether on computer or on hard copy. Linking depends on numbers, and no confidential information that could be associated with an individual would ever be released. Output is only anonymous statistics.

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Neonatal death in Northern Ireland

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Summary and conclusions

A survey of neonatal deaths occurring over two years in Northern Ireland disclosed that many hospitals where babies could be born probably could not be staffed and equipped to deal effectively with major perinatal problems. The incidence of congenital malformations, especially neural tube defects, was high. A reduction in neonatal deaths from this cause might be expected if facilities for antenatal diagnosis and termination of pregnancy were made available, although this raises grave ethical problems. Many infants died of prematurity and the idiopathic respiratory distress syndrome. A considerable reduction in neonatal deaths might be expected with improved care at the place of delivery backed by a regional centre with facilities for transporting and treating severely ill infants needing intensive care.

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Introduction

Yearly neonatal mortality rates in Northern Ireland are higher than in many other developed countries. In a comparison of deaths in the first year of life in 1973 in 17 developed countries the neonatal figure for Northern Ireland was exceeded only by that for Yugoslavia.[1] During 1965-73 the neonatal mortality in these countries fell by an average of 3·7 per 1000 live births but that in Northern Ireland fell by only 3·2. Examination of neonatal mortality rates in the United Kingdom[1] indicates that the figure for Northern Ireland exceeds that in other areas, the 1973 rate of 14·6 per 1000 live births contrasting with 11·1 in England, 12·7 in Scotland, and 10·5 in the Welsh region. Only in the Birmingham, Manchester, Liverpool, and Leeds regions did the neonatal mortality rate exceed 12, the highest rate being 12·9 in Leeds; in four areas the rate was below 10, that for the East Anglian region being only 9·1.

Recent experience in many centres has shown that providing special or intensive care for high-risk fetuses and neonates may substantially reduce perinatal and neonatal death rates. Furthermore, the fears expressed by many clinicians that the handicap rate among survivors of intensive care would create an increasing problem have proved to be unjustified.[2] A British working party[3] convened to report on the prevention of early neonatal mortality and morbidity recommended that "Health authorities should review as a matter of urgency, the arrangements for special care including intensive care of the newborn."

Workers in neonatology in Northern Ireland have for some