A new hierarchical classification of causes of infant deaths in England and Wales

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Abstract

In 1986 The Office of Population Censuses and Surveys (OPCS) introduced new certificates for stillbirths and neonatal deaths. This allowed certifiers more flexibility in the completion of the certificate, and the number and ordering of the causes given. Tabulations have been published of the fetal and maternal causes of death mentioned on the certificates for every year from 1986 to 1991 in annual reference volumes. It has not been possible either to derive a single cause group for each death, however, or to compare the information available on neonatal deaths with that on postneonatal deaths, which are still derived from the standard death certificate. The aim of the work described here was to adapt previous classifications to derive a single cause grouping for stillbirths and infant deaths which would provide the maximum information about preventability and yet meet the national and international responsibilities of OPCS. The methods used and the tests carried out on the validity and consistency of the chosen classification are described.

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It has long been acknowledged that an analysis of causes of perinatal deaths is not complete without taking into account maternal as well as fetal factors.¹⁻³ Baird and Thomson,⁴ however, also acknowledged that 'is not easy to classify

the causes of perinatal deaths in an informative way ... An unduly complex classification may create difficulties during statistical analysis and will tend to obscure broad trends. We consider it is desirable wherever possible to allocate each case to a single cause group, which gives the maximum information with regard to preventability'. It is this philosophy which underlies the more recent attempts by clinicians to classify early deaths.⁵⁻⁸

Such classifications could not be applied to the causes of perinatal deaths derived from death certificates in England and Wales before 1986 because causes of neonatal deaths were derived from the standard medical certificate used for deaths of all ages, and differed from those derived from stillbirth certificates which asked for information on maternal and fetal causes. Moreover, the format of the two systems required the medical certifier to select a single underlying cause, the choice of which would not necessarily be compatible with the philosophy described above. In 1986, in response to national and World Health Organisation recommendations for the introduction of a certificate which would elicit similar data for stillbirths and neonatal deaths,^{9 10} the Office of Population Censuses and Surveys (OPCS) introduced revised certificates for stillbirths and deaths of live births occurring up to 27 completed days. This allowed certifiers more flexibility in the completion of the certificate, and the number and ordering of the causes given. Because of the small number of postneonatal deaths other than congenital anomalies attributable to maternal or perinatal causes, the use of the new certificate was not extended to postneonatal deaths.¹¹

The background to this change and the results of a pilot investigation of the use of the new forms were published in 1985,¹² but the format was subsequently altered to allow more than one main fetal and maternal cause to be given (fig 1). The line asking for 'other relevant causes' has been reserved for codes for external causes of violence or accident, or for the type of medical interventions, and any other causes given on this line are coded as for the 'other' causes.

The OPCS has published tabulations of the fetal and maternal causes mentioned on the certificates for every year from 1986 to 1991 in the annual reference volumes for childhood mortality¹³ and for perinatal and infant mortality.¹⁴ Up to the present time, however, it has not been possible either to derive a single cause group for each death, or to compare the new information available on neonatal with that on postneonatal deaths. Causes of

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BIRTHS AND DEATHS REGISTRATION ACT 1953
(Form prescribed by the Registrar of Births, Deaths and Marriages (Amendment) (No. 2) Regulations 1985)

MEDICAL CERTIFICATE OF CAUSE OF DEATH OF A LIVE-BORN CHILD DYING WITHIN THE FIRST TWENTY-EIGHT DAYS OF LIFE

For use only by a Registered Medical Practitioner WHO HAS BEEN IN ATTENDANCE during the deceased's last illness, and to be delivered by him forthwith to the Registrar of Births and Deaths.

MED B 000000

Register or copy No of Death Entry

Name of child

Date of death day of 19 SEX

Age at death days (complete period of 24 hours) hours

Place of death

Place of birth day of

Last seen alive by me day of

1 The certified cause of death has been confirmed by post-mortem. Please ring appropriate date and time.

2 Information from post-mortem may be available later. a Seen after death by me.

3 Post-mortem not being held. b After death by another medical practitioner.

4 I have reported this death to the Coroner for further action. c Not seen after death by a medical practitioner.

[See overleaf]

CAUSE OF DEATH

a. Main diseases or conditions in infant

b. Other diseases or conditions in infant

c. Main maternal diseases or conditions affecting infant

d. Other maternal diseases or conditions affecting infant

e. Other relevant causes

I hereby certify that I was in medical attendance during the above named deceased's last illness, and that the

Signature

Qualifications as registered by General Medical Council

Figure 1 Medical certificate of cause of death of a live born child dying within the first 28 days of life.

postneonatal deaths are still derived from the standard death certificate with a single underlying cause extracted as in the past.

There was clearly a need for a classification system which would allow the derivation in a systematic way of a single cause group, compatible across stillbirths, neonatal, and postneonatal deaths. There are, however, special characteristics needed for a classification introduced for presenting national statistics.¹⁵ This needs to be robust in spite of the lack of clinical details; to be compatible with existing regional, national, and international classifications; to be capable of giving consistent year-on-year trends; and for its introduction not to lead to abrupt changes in previous time trends. Cole *et al* described an international classification for infant deaths which met many of these needs.¹⁵ This was adapted from the growing amount of published work on classifications of perinatal deaths, largely produced by clinicians who had available clinical information additional to that entered on the death certificate.

None of these could be applied directly to the multicausal type of data now collected for stillbirths and neonatal deaths in England and Wales, however, for which no existing classification has been found to be adequate. The aim of the work described in this paper was to adapt previous classifications to derive a single cause grouping for stillbirths and infant deaths which would 'provide maximum information regarding preventability' and yet meet the national and international responsibilities of OPCS. This work is described, as are the methods used to test the validity and consistency of the chosen classification. This account applies to infant deaths only. A subsequent paper will present the results of applying the classification to stillbirths.

Methods

RATIONALE OF THE GROUPING

The aim was to exploit the range of cause of death information available to identify a single cause which was the first in a hierarchy of events to lead to the neonatal death. The method used to identify these was established with the help of an expert group, which included paediatric pathologists, paediatricians, obstetricians, and specialists in public health. As a preliminary, infant and maternal conditions for neonatal deaths and the underlying cause of postneonatal deaths were grouped according to the main stage in the development of the fetus or infant at which they probably first acted, thus providing a basis for planning preventative action. The final grouping consisted of nine, mutually exclusive, categories:

- Before the onset of labour
 - 1 Congenital defects
 - 2 Antepartum infections
 - 3 Conditions related to immaturity
- In or shortly after labour
 - 4 Asphyxia, anoxia, or trauma

Postnatal

- 5 External conditions
- 6 Infections
- 7 Other specific conditions
- 9 Sudden infant deaths

Unclassified

- 0 Other conditions

Code 8 is used only for a category among stillborn infants.

METHODS USED FOR THE ALLOCATION OF THE CLASSIFICATION

For neonates, draft algorithms were prepared which used all mentions on a certificate, after coding using the ninth revision of the International Classification of Diseases (ICD), to allocate each death to one of the described groups. A major feature was the splitting off at the outset of the stillbirths, which subsequently followed a path separate from, but related to, that of deaths of live births. Where there was more than one cause mentioned on the certificate, the determinant of the class to which the case was allocated was that cause which allocated the death to the earliest of the possible groups in the hierarchy. This included the investigation of using 'other infant' or 'other maternal' mentions to be chosen as the determining factor if they directed the death to an earlier group in the list than would mentions given as 'main infant' or 'main maternal' conditions.

Computer programs for three versions of the algorithm were written and tested on sample data for the Northern Regional Health Authority and one other region for one year. The first version was based on any mention on any line, except on that for other relevant causes (which are used for special codes for accidents and violence). The second algorithm was based only on the first mention on the main infant line and the third on all main infant and all main maternal mentions, but excluded consideration of other mentions. Eighty eight per cent of neonatal deaths in the sample data retained the same classification for all three of these bases. This being so, it was decided to use the first algorithm to use the data to the maximum.

Dr Hey of the Northern Regional Health Authority then carried out an additional check on the grouping of individual cases for the sample for which he had additional clinical data obtained in the course of producing the regional health authority's annual report on perinatal and late neonatal deaths. As a consequence, minor changes were made to the algorithm, leading to one which was close to, but not identical with that used in the Northern region. The main differences are that: (a) the OPCS algorithm does not, in the first instance, use birth weight (which is not available until the death certificate is linked with the corresponding birth certificate); (b) that because of the importance of deaths certified as due to antepartum infection the OPCS Medical Advisory Committee requested that these were selected before those classed as related to

Table 1 Range of International Classification of Diseases (ICD) codes used in different categories in the algorithm

Category	Range of ICD codes	Category	Range of ICD codes
1 Congenital malformations or defects		6 Infections	
Defects of amino acid metabolism	270.0 273.9	Infections and parasitic disease excluding congenital syphilis	001.0 088.0
Other and unspecified metabolic disorders	277.0 277.9	Abscess of thymus gland	091.0 139.0
Disorders of immune mechanism (not AIDS)	{ 279.0 279.0 279.2 279.9	Meningitis/intracranial abscess	254.1 254.1
Hereditary haemolytic anaemia	282.0 282.9	Otitis media	320.0 326.0
Constitutional aplastic anaemia	284.0 284.0	Acute cardiac infections	382.0 382.9
Coagulation defects	286.0 286.4	Acute upper respiratory infections	420.0 422.9
Primary thrombocytopenia	287.3 287.3	Peritonsillar or laryngeal infections	460.0 466.1
Disorders of neutrophils	288.1 288.2	Pneumonia, influenza, bronchitis	475.0 476.1
Cerebral degenerations	330.0 330.9	Bronchiectasis	480.0 491.9
Werdnig-Hoffman disease	335.0 335.0	Empyema, pleurisy	494.0 494.0
Infantile cerebral palsy	343.0 343.9	Abscess of lung or mediastinum	510.0 511.9
Cerebral cysts	348.0 348.0	Appendicitis	513.0 513.1
Muscular dystrophy/myopathy	359.0 359.3	Peritonitis	540.0 542.0
Endomyocardial fibrosis etc	{ 424.0 424.3 425.0 425.1 425.3 425.4	Infections of kidney	567.0 567.9
Conduction disorders	426.0 426.9	Other urinary tract infection	590.0 590.9
Cirrhosis of liver and biliary system	571.4 571.9	Other specific neonatal infections	599.0 599.0
Chromosomal abnormality of fetus (maternal code)	655.1 655.1	7 Other specific conditions	771.3 771.8
Congenital malformation (of)		Malignant or endocrine disorder	140.0 253.9
Central nervous system	740.0 743.9	Thymus disorder excluding abscess	254.2 254.9
Ear, face, and neck	744.0 744.9	Adrenal disorder	255.0 255.9
Heart	{ 745.0 746.9 747.1 747.9	Acquired haemolytic anaemia	283.0 283.9
Respiratory system	748.0 748.9	Acquired coagulation deficiency (excluding neonatal vitamin K deficiency)	286.7 286.7
Cleft palate/cleft lip	749.0 749.2	Maternal cerebral degeneration	331.0 331.9
Other of upper alimentary tract	750.1 751.9	Other disease of pericardium	423.0 423.9
Anomalies of female genitalia	752.4 752.4	Cardiac dysrhythmia	427.0 427.9
Anomalies of male genitalia	752.6 752.9	Aneurysm	441.0 442.9
Anomalies of the urinary system	753.0 753.9	Asthma or bronchiectasis	493.0 494.0
Certain other musculoskeletal	{ 754.3 754.3 754.8 754.8 755.2 757.3 757.8 757.9	Non-infective enteritis/colitis	556.0 558.9
And integument	758.0 758.9	Maternal infection	760.2 760.2
Chromosomal anomalies	759.0 759.9	Maternal injury or surgery	760.5 760.6
Other and unspecified anomalies	774.0 774.0	Placental transfusion syndrome	762.3 762.3
Perinatal jaundice due to hereditary anaemia	777.0 777.0	Other anomalies of chorion or amnion	762.8 762.9
Meconium ileus due to mucoviscidosis		Fetal blood loss from cord or placenta	772.0 772.0
2 Antepartum infections		Other fetal blood loss	772.3 772.9
Congenital syphilis	090.0 090.9	Isoimmunisation	773.0 773.5
Congenital AIDS	279.1 279.1	Perinatal jaundice – other excessive haemolysis	774.1 774.1
Maternal virus disease damaging fetus	655.3 655.3	Perinatal jaundice remaining causes	774.3 774.6
Chorioamnionitis	762.7 762.7	Neonatal endocrine/metabolic disturbance	775.0 775.9
Congenital pneumonia	770.0 770.0	Fetal/neonatal haematological disorders	{ 776.0 776.5 776.7 776.9
Other congenital infections	771.0 771.2	Perinatal disorders of digestive system	{ 777.1 777.4 777.6 777.9
3 Immaturity		Hydrops fetalis not due to isoimmunisation	778.0 778.0
Incompetent cervix/premature rupture of membranes	761.0 761.1	Neonatal temperature regulation problems	778.4 778.9
Spontaneous abortion	761.8 761.8	Neonatal drug reactions/intoxications	779.4 779.5
Disorders related to short gestation/low birth weight	765.0 765.1	Maternal shock without mention of trauma	785.5 785.5
Respiratory distress syndrome	769.0 769.0	9 SID	
Interstitial emphysema etc	770.2 770.2	Sudden infant death syndrome (SIDS)	798.0 798.0
Atelectasis	770.4 770.5	Instantaneous death	798.1 798.1
Respiratory problems after birth	770.7 770.8	Unexplained death	798.2 798.2
Intraventricular haemorrhage	772.1 772.1	Unattended death	798.9 798.9
Neonatal jaundice associated with preterm birth	774.2 774.2	Respiratory failure	799.1 799.1
Kernicterus not due to isoimmunisation	774.7 774.7	0 Other conditions occurring in 1991 neonatal deaths	
Anaemia of prematurity	776.6 776.6	Acidosis	276.2 276.2
Necrotising enterocolitis	777.5 777.5	Volume depletion	276.5 276.5
Legal termination of pregnancy	779.6 779.6	Hyperpotassaemia	276.7 276.7
4 Asphyxia, anoxia, or trauma		Anaemia (unspecified)	285.9 285.9
Antepartum haemorrhage (maternal codes)	641.0 642.9	Encephalopathy (unspecified)	348.3 348.3
Maternal hypertension (perinatal code)	760.0 760.0	'Other' myoneural disorder	358.8 358.8
Effects of maternal complications (perinatal code)	761.6 761.7	Acute myocardial infarction	410.0 410.0
Placental problems (perinatal codes)	762.0 762.2	Primary pulmonary hypertension	416.0 416.0
Cord problems (perinatal codes)	762.4 762.6	Heart failure	428.0 428.0
Other complications of labour/delivery (perinatal code)	763.0 763.9	Occlusion of the cerebral arteries	434.0 434.9
Slow fetal growth/malnutrition (perinatal code)	764.0 764.9	Other and ill defined cerebrovascular	437.1 437.3
Long gestation/high birth weight/birth trauma/hypoxia	766.0 768.9	Other venous embolism or thrombosis	453.0 453.9
Massive aspiration syndrome	770.1 770.1	Unspecified hypotension	458.9 458.9
Subarachnoid haemorrhage	772.2 772.2	Pulmonary congestion and hypostasis	514.0 514.0
Other and unspecified postnatal respiratory problems	779.0 779.2	Other pneumopathy	516.8 516.8
5 External		Other diseases of the lung	518.8 518.8
Malnutrition	260.0 263.9	Other diseases of the respiratory system	519.8 519.8
Pneumonitis due to solids or liquids	507.0 507.8	Hepatorenal syndrome	572.4 572.4
Hypothermia or scleroderma	778.1 778.3	Unspecified acute renal failure	584.9 584.9
Feeding problems in newborn	779.3 779.3	Renal failure unspecified	586.0 586.0
Other injury or poisoning	800.0 999.9	Intestinoenteric fistula or renal infarction	593.8 593.8
		Congenital deformity spine/congenital dislocation of hip	754.2 754.3
		Patent ductus arteriosus	747.0 747.0
		Maternal renal and hypertensive disorder	760.1 760.1
		Pulmonary haemorrhage	770.3 770.3
		Other maternal disease or injury	761.3 761.5
		Other and ill defined (other/unspecified)	779.8 779.9
		Debility unspecified	799.3 799.3
		Unknown	799.6* 799.9

The position of the mention on the certificate will indicate whether the cause is maternal or infant. * = OPCS code.

immaturity; and (c) to avoid confusion, causes due to oxygenation problems thought to be related to immaturity are selected out before those in other infants.

Table 1 gives the current full list of ICD codes for the conditions which constitute each category.

VALIDATION OF THE CLASSIFICATION

The validity of the algorithm was tested in several ways. First any break in trend was sought in the distribution and pattern of the groups derived from the same ICD codes before and after the use of the new certificate and the algorithm. As stated earlier, one of the

Table 2 Neonatal deaths 1991: total mentions by place on certificate

Place on certificate	No (%) mentions	Cases (%) [*]
First main infant	3041 (37.6)	99.6
Second main infant	587 (7.2)	19.2
Third main infant	121 (1.5)	4.0
First main maternal	767 (9.5)	25.1
Second main maternal	84 (1.0)	2.8
Third main maternal	11 (0.1)	0.4
First other infant	1985 (24.5)	65.0
Second other infant	795 (9.8)	26.0
Third other infant	257 (3.2)	8.4
Fourth other infant	72 (0.9)	2.4
Fifth other infant	21 (0.3)	0.7
Sixth other infant	8 (0.1)	0.3
Seventh other infant	1 (0.0)	0.0
Eighth other infant	1 (0.0)	0.0
First other maternal	301 (3.7)	9.9
Second other maternal	44 (0.5)	1.4
Third other maternal	2 (0.0)	0.1
Fourth other maternal	0 (0.0)	0.0
Total mentions	8098 (100)	
Total cases	3052	
Mentions/case	2.7	

^{*}Adds up to over 100%.

requirements for the new classification was that its use should cause minimal perturbation to time trends. Second, any undue perturbation was sought in the pattern of causes between the neonatal period, where the new certificate was used, and those in the post-neonatal period where the old certificate was still in use. Lastly, the data were examined to see whether the use of the new classification revealed the expected relations between birth weight and cause group.

Results

MENTIONS IN DIFFERENT PARTS OF THE NEONATAL CERTIFICATE

Before describing the testing of the new grouping a brief account will be given of the frequency and pattern of mentions and the order in which they occur on the new certificates. For simplicity, only data for neonatal deaths registered in 1991 will be described in detail.

In 1991 there were 3052 neonatal deaths registered in England and Wales. In total there were 8098 coded mentions of conditions derived from the medical certificate of death. Overall, there was an average of 2.7 mentions for each case, with 99% of the neonatal deaths having at least one mention on the main infant line, 25% at least one mention on the main maternal line, and 65% at least one mention on the other infant line. Table 2 gives the distribution of mentions. Certifying doctors often took the opportunity to enter several

Table 3 Neonatal deaths 1991: number of infants by maternal code

No infant codes	No maternal codes						Total
	0	1	2	3	4	5	
0	2	3	0	1	0	0	6
1	710	116	54	8	0	1	889
2	758	249	79	19	0	0	1105
3	424	169	38	6	2	0	639
4	175	67	23	3	2	0	270
5	54	24	13	2	0	0	93
6	23	3	4	1	1	0	32
7	9	1	1	0	0	0	11
8	1	2	1	0	0	0	4
9	1	1	0	1	0	0	3
All	2157	635	213	41	5	1	3052

causes on each line, particularly the 'other' infant causes. Table 3 presents a tabulation of total infant mentions by total maternal mentions.

CONTRIBUTION OF MENTIONS ON DIFFERENT LINES TO THE CAUSE GROUPS

The expert group proposed that OPCS should send an inquiry to the notifying doctor where the final cause group was determined by a cause other than one registered as main by the certifying doctor. The proportion of neonatal deaths in which such inquiries will be required, if this recommendation is followed, can be estimated by examining where on the certificate the mention which determined the final cause grouping was placed. It should be noted that in the small proportion of cases where there is clearly an illogical sequence on the certificate the coding clerks in OPCS will change the order, and the following analysis is based on the amended order.

Table 4 shows that in the 3052 deaths registered in 1991 the cause group was determined by the first, second, or third main infant mentions in 2682 (88%), 85 (3%), and six (0.2%) respectively, and by any main maternal mention in 32 (1%). Only 73% of the allocations to the congenital malformation and defect group had been based on the first main infant cause, but this cause had determined the grouping of 97% of the cases allocated to immaturity group, and 80% of those allocated to asphyxia, anoxia, and/or trauma.

In about 10% of cases use of the algorithm led to a cause based on a mention on an 'other' line. This is the situation which would prompt an inquiry to the certifying doctor to confirm that the suggested grouping is in accordance with the clinical opinion.

Table 4 Mention which determined hierarchical group

Group	First main infant	Second main infant	Third main infant	First main maternal	Second main maternal	First other infant	Second other infant	Third other infant	Fourth other infant	Total
Congenital malformation	710	30	4	0	0	175	43	10	1	973
Antepartum infection	11	4	0	0	0	11	3	0	0	29
Immaturity	1339	43	2	0	0	0	0	0	0	1384
Asphyxia	295	7	0	29	1	24	7	5	2	370
External factor	20	0	0	0	0	0	0	0	0	20
Infection	102	0	0	0	0	9	2	1	0	114
Other specified factor	39	1	0	0	0	6	1	0	0	47
SIDS	63	0	0	0	0	0	0	0	0	63
Other	49	0	0	3	0	0	0	0	0	52
Total	2682	85	6	32	1	225	56	16	3	3052

No certificate change

Figure 2 Trend in cause groups of postneonatal deaths in England and Wales, 1981–91.

USING THE NEW GROUPING TO EXAMINE THE EFFECTS OF THE NEW CERTIFICATE ON TRENDS OVER TIME

To examine the effect on trends, rates using the same ICD grouping were plotted based on underlying cause from 1981 to 1985, and the grouping derived from all mentioned conditions using the algorithm from 1986 to 1991. Figure 2 shows that the overall trends for postneonatal deaths, where there has been no change in certification, remain reasonably consistent over the two time periods, suggesting that the classification is generally robust. Figure 3 for the neonatal deaths, however, shows that in the 1986 data there were small stepwise increases in the congenital malformation and the immaturity groups. These are attributable to the increases in the numbers so classified using all the mentions on the new certificate. After 1986 the trends are consistent.

USING THE NEW GROUPING TO EXAMINE TRENDS BY AGE AT DEATH

Crude trends of infant deaths obscure the fact that almost half of all neonatal deaths occur in

Change of certificate 1986

Figure 3 Trends in cause groups of neonatal deaths in England and Wales, 1981–91.

the first week of life, most in the first day. Figure 4 gives the new cause groups by age subgroups for infant deaths registered in 1991. The overwhelming numerical importance of immaturity as a cause in the deaths at early ages is clearly shown. Figure 5 gives the same data but expressed as the percentage due to different causes groups at different ages. Congenital malformations and defects are consistently important, though more so during the first three weeks of life, whereas the predominance of immaturity in the first weeks gives way first to postnatal infection in the fourth week, and then to sudden infant death in the second month.

It is likely that the changeover from the neonatal to the standard death certificate after four weeks of life will have affected these proportions to some extent. Nevertheless, the expected increase in sudden infant deaths from the second week to the third month shows a fairly steady trend. Similarly, there is a consistent decrease in deaths due to congenital malformations or defects, crossing over the ages at which there is a change in the type of certificate used. The proportion of other deaths whose causes did not fall into one of the defined groups increased fairly sharply after the neonatal period, however (fig 5). This probably reflects the restricted amount of information available from the single underlying cause derived from the standard death certificate.

USING BIRTH WEIGHT DATA TO VALIDATE THE NEW GROUPS

As birth weight is currently not available for infant deaths until after the annual linkage with birth registration data, the new classification does not initially take birth weight into account. An important method of validation is therefore to study the birth weight distributions of the cause groups, particularly the immaturity group which would be expected to comprise mostly infants of very low birth weight.

In 1986 less than 1% of all live births and only 3% of neonatal deaths did not have a recorded birth weight, although this increased to 5% for deaths in the other cause group and 6% in that due to external causes (which include unattended labour) (table 5). Eighty nine per cent of the 'immaturity' group of neonatal deaths were known to have weighed less than 2000 g and 5% less than 500 g. In 1991 levels of unstated birth weight were four times as common in neonatal deaths as in live births, but even so 79% of the immaturity group were known to have weighed less than 2000 g and 8% less than 500 g, whereas 17% were of unknown weight. Gestational age, which would be important in this context, is not recorded at the registration of live births.

The grouping used showed how misleading it may be to classify deaths as due to immaturity by birth weight alone. In the years where birth weight is most complete, 1986–8, 25% of the neonatal deaths classified as due to congenital defects, 64% of the small group of those with

congenital infections, and 45% of those of other specific causes weighed less than 2000 g. In these years only 2% of all live births were of this birth weight group. Only in the group including causes of birth asphyxia and trauma is there a predominance of infants of heavier weight, 59% weighing 2500 g or more and 20% weighing 3500 g or more, though this proportion is relatively low compared with the 37% of live births of this weight in the same period.

Figure 4 Trends in numbers in causes of infant deaths by age subgroups in England and Wales, 1991.

Figure 5 Trends in percentage of causes of infant deaths by age subgroups in England and Wales, 1991.

Table 5 Neonatal (NND) and postneonatal (PND) deaths 1986: percentage by birth weight and cause group

Birth weight (g)	Total		Congenital malformation		Antepartum infection		Immaturity		Asphyxia, anoxia/ trauma		External		Infection		Other specific		SIDS		Other	
	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND	NND	PND
≤500	2.3	0.1	0.4	0.0	0.0	0.0	4.9	1.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
501-999	28.5	4.3	5.7	0.7	27.3	0.0	56.2	51.2	11.0	6.9	6.3	3.5	11.7	1.9	13.3	3.9	0.0	0.9	25.0	3.8
1000-1499	15.5	4.4	12.2	2.7	22.7	0.0	21.0	32.5	6.7	3.5	6.3	3.5	20.7	2.4	15.6	3.9	1.5	2.5	12.5	4.5
1500-1999	10.4	6.7	15.3	9.6	13.6	0.0	7.3	6.3	6.9	0.0	0.0	2.4	8.1	7.1	15.6	9.8	2.9	5.6	17.5	8.3
2000-2499	9.6	10.0	16.8	17.4	4.5	0.0	2.0	1.3	12.4	3.5	18.8	10.6	18.0	11.4	15.6	11.8	5.9	7.4	5.0	10.8
2500-2999	10.6	21.4	18.8	24.3	18.2	50.0	2.0	1.9	13.6	17.2	12.5	21.2	11.7	20.5	17.8	17.7	17.6	22.8	7.5	23.6
3000-3499	11.7	29.6	16.8	26.1	0.0	50.0	1.6	1.3	25.1	37.9	31.3	35.3	18.9	31.7	8.9	27.5	36.8	33.9	22.5	24.2
≥3500	8.6	23.0	11.4	18.7	9.1	0.0	1.6	0.6	20.1	27.6	18.8	23.5	9.9	24.8	11.1	23.5	35.3	26.9	5.0	24.2
Not stated	3.0	0.4	2.6	0.4	4.5	0.0	3.3	3.1	3.6	3.5	6.3	0.0	0.9	0.2	2.2	2.0	0.0	0.0	5.0	0.6
Total (100%)	3449	2760	1253	551	22	4	1476	160	418	29	16	85	111	420	45	51	68	1303	40	157

CONTRIBUTION OF MATERNAL CAUSES

For neonatal deaths the maternal causes were more valuable for looking at associations between mentions than for determining the cause classification. Maternal causes were most often given in the asphyxia group, where 15% of all mentions fell into the first main maternal category. Thirty eight per cent of these referred to an antepartum haemorrhage, 9% to hypertension, and 5% to malpresentation. In only 6% was the mention that determined the cause group found on a maternal line. In the immaturity group 11% of all mentions were found in the first main maternal line, and of those 18% referred to antepartum haemorrhage, 20% to hypertension, 18% to early onset of delivery, 9% to multiple pregnancy, and 14% to problems with the amniotic cavity or membranes.

Discussion

The main aim of this paper is to describe the new OPCS hierarchical classification of causes of neonatal deaths, developed after the introduction of the new medical certificate for neonatal death which invites mentions of multiple causes. The use of this new classification has reduced the proportion of cases documented on the new form which were difficult to allocate into a single main cause group. The availability of multiple causes and the use of the algorithm slightly increased the proportion attributed to congenital malformation or defect and immaturity compared with the same grouping based on the single underlying cause derived from the old certificates. Overall, its use has caused little disturbance in terms of the continuity of trends, and the grouping had validity in terms of patterns of birthweight distribution for the different causes.

The classification is designed to help plan preventative action and to indicate the developmental period where the first insult had an effect. Of the 3052 neonatal deaths that occurred in 1991, 33% were attributable to a congenital malformation, defect or infection and another 45% to immaturity, accounting together for 78% of the deaths. Neonatal deaths thought to be due to asphyxia, anoxia, or trauma accounted for 12% and another 4% were attributed to infections. Comparable figures for the postneonatal deaths suggested that 23% were attributable to congenital malformations or defects, 3% to immaturity, less

than 1% to asphyxia or trauma, 23% to infections, and 36% to sudden infant death. The data confirm what is now well recognised, namely that most of the neonatal deaths occur because of prenatal problems, contrasting with the postneonatal deaths which are more likely to be due to environmental hazards.

A simplified form of this classification is being used for the confidential inquiry into stillbirths and infant deaths currently under way in England and Wales.¹⁶ The analysis of these data will give further insight into its usefulness, but the first year's full data will not be available until 1994.

The new grouping will enable us again to compare the associations of social class, region of residence, maternal age, and marital status with similar causes in neonatal and postneonatal deaths and has allowed the use of all the causes on the neonatal certificate. Work is in preparation to allow similar data from stillbirth certificates to be analysed in the same way.

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