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Reports on Public Health and Medical Subjects

No. 125

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postneonatal deaths
1964-1966

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PREFACE

This Report has been prepared on the basis of a confidential enquiry into post-neonatal deaths in three areas, organized by the Department in conjunction with the Medical Officers of Health of those areas working with two paediatric assessors, Professor A. V. Neale and Professor D. V. Hubble. The great volume of the work of this investigation was therefore undertaken by the staffs of the Health Departments concerned and these two paediatricians, and I record my deep appreciation of the care and skill with which this was done. The material has been assembled by Dr. F. Riley, the author of the report.

This study was undertaken because the death rate of infants at ages between one month and one year had been improving only slowly over a decade. The experience of the confidential enquiries into maternal deaths suggested that it might be possible to derive lessons of wider value in improving the care of children from a detailed study of the events leading to deaths in this age group. Enquiry is inevitably less precise and the objectives are less clearly defined than in the maternal deaths enquiry, but the information summarized in this report will no doubt be of interest to all those concerned with the care of the health of infants.

An attempt is made to define avoidable factors which may have contributed to the deaths. Such factors were thought to be present in more than a quarter of the deaths studied. Over two-thirds of these avoidable factors were described as social or were due to parental failure. In the remainder an attempt was made to identify opportunities which may have been missed by the health services. Obviously the general practitioner is the person from the health service most likely to be involved with a sick infant and, therefore, avoidable factors are most likely to be attributed to things done or left undone by the general practitioner. Against this, it must be pointed out that the number of occasions when the hospital services have the opportunity of failing must be much less and it would be wrong to suggest that the performance of the general practitioner has been less than that of his colleagues in the health service. This is not a matter of apportioning blame, but only one of considering whether there are opportunities for improving the service that can be provided.

Infective conditions especially respiratory disease and gastro-enteritis are the principal causes of death in this age group and it is there that we must look for future improvement.

It is to be hoped that the future development of health services for children in a unified health service will facilitate the general adoption of the kind of local study made here.

G. E. GODBER,
Chief Medical Officer

Department of Health and Social Security
London
January 1970

CONTENTS

	Page
Preface	iii
1. Introduction	1
2. The enquiry	5
3. General results of the enquiry	7
4. Avoidable factors in the series	18
5. A description of some of the clinical conditions	27
6. Sudden and unexpected deaths in infancy	46
7. The illegitimate infants	58
8. Conclusion	60
References	61
Appendices	
1. Form of the confidential report	62
2. Tables relating to the individual local authority areas	65

CONTENTS

1	Introduction
2	The subject
3	History of the subject
4	Scope of the subject
5	Object of the subject
6	Method of the subject
7	Importance of the subject
8	Definition of the subject
9	Classification of the subject
10	Summary
11	Index
12	Appendix
13	References
14	Notes
15	Tables
16	Figures
17	Diagrams
18	Maps
19	Photographs
20	Reprints
21	Originals
22	Manuscripts
23	Prints
24	Drawings
25	Models
26	Specimens
27	Exhibits
28	Displays
29	Shows
30	Fairs
31	Expositions
32	Conventions
33	Assemblies
34	Gatherings
35	Meetings
36	Sessions
37	Periods
38	Times
39	Hours
40	Days
41	Weeks
42	Months
43	Years
44	Eras
45	Centuries
46	Millennia
47	Periods of time
48	Intervals
49	Gaps
50	Spaces
51	Distances
52	Lengths
53	Breadths
54	Depths
55	Heights
56	Widths
57	Thicknesses
58	Volumes
59	Weights
60	Measures
61	Quantities
62	Amounts
63	Numbers
64	Figures
65	Characters
66	Letters
67	Symbols
68	Signs
69	Emblems
70	Icons
71	Pictographs
72	Idioms
73	Proverbs
74	Sayings
75	Maxims
76	Adages
77	Commonplaces
78	Truisms
79	Platitudes
80	Cliches
81	Formulae
82	Recipes
83	Instructions
84	Directions
85	Guides
86	Manuals
87	Handbooks
88	Directories
89	Almanacs
90	Calendars
91	Diaries
92	Registers
93	Records
94	Accounts
95	Statements
96	Reports
97	Documents
98	Papers
99	Books
100	Tracts
101	Leaflets
102	Pamphlets
103	Brochures
104	Books
105	Tracts
106	Leaflets
107	Pamphlets
108	Brochures
109	Books
110	Tracts
111	Leaflets
112	Pamphlets
113	Brochures
114	Books
115	Tracts
116	Leaflets
117	Pamphlets
118	Brochures
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160	Tracts
161	Leaflets
162	Pamphlets
163	Brochures
164	Books
165	Tracts
166	Leaflets
167	Pamphlets
168	Brochures
169	Books
170	Tracts
171	Leaflets
172	Pamphlets
173	Brochures
174	Books
175	Tracts
176	Leaflets
177	Pamphlets
178	Brochures
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180	Tracts
181	Leaflets
182	Pamphlets
183	Brochures
184	Books
185	Tracts
186	Leaflets
187	Pamphlets
188	Brochures
189	Books
190	Tracts
191	Leaflets
192	Pamphlets
193	Brochures
194	Books
195	Tracts
196	Leaflets
197	Pamphlets
198	Brochures
199	Books
200	Tracts

1. INTRODUCTION

Study of mortality statistics in 1963 gave rise to some concern about infant deaths in the postneonatal period, i.e. deaths occurring from four weeks to one year of age. The infant mortality rate (deaths of infants in the first year of life per 1,000 live births) was continuing to fall, as it had been doing over the years, but the decrease in infant mortality was mainly in the neonatal period (the first four weeks of life) and especially from the second day of life to one month after birth. The postneonatal mortality rate (related to 1,000 live births) had shown little improvement for some years and was levelling out at between 6-7 deaths per 1,000 live births, indicating a loss of over 5,000 baby lives each year.

Tables 1.1 and 1.2 and Figures 1.1 and 1.2 show the position prior to, at and subsequent to that time. Stillbirth and perinatal mortality figures are included to demonstrate that the postneonatal death figures were out of line with the pattern of other infant death statistics.

TABLE 1.1
Infant death statistics—rates

Year	Per 1,000 Live Births			Per 1,000 live and stillbirths	
	Infant mortality	Neonatal mortality	Postneonatal mortality	Stillbirths	Perinatal mortality
1950	29.6	18.5	11.1	22.6	37.4
51	29.7	18.8	10.9	23.0	38.2
52	27.6	18.3	9.3	22.7	37.5
53	26.8	17.7	9.1	22.4	36.9
54	25.4	17.7	7.7	23.5	38.1
55	24.9	17.3	7.6	23.2	37.4
56	23.7	16.8	6.9	22.9	36.7
57	23.1	16.5	6.7	22.5	36.2
58	22.5	16.2	6.4	21.5	35.0
59	22.2	15.9	6.3	20.8	34.1
60	21.8	15.5	6.3	19.8	32.8
61	21.4	15.3	6.1	19.0	32.0
62	21.7	15.1	6.6	18.1	30.8
63	21.1	14.3	6.9	17.2	29.3
64	19.9	13.8	6.1	16.3	28.2
65	19.0	13.0	6.0	15.8	26.9
66	19.0	12.9	6.1	15.3	26.3
67	18.3	12.5	5.8	14.8	25.4
68	18.3	12.4	5.9	14.3	24.7

FIGURE 1-1

INFANT MORTALITY, NEONATAL MORTALITY AND POSTNEONATAL MORTALITY RATE - PER
1,000 LIVE BIRTHS

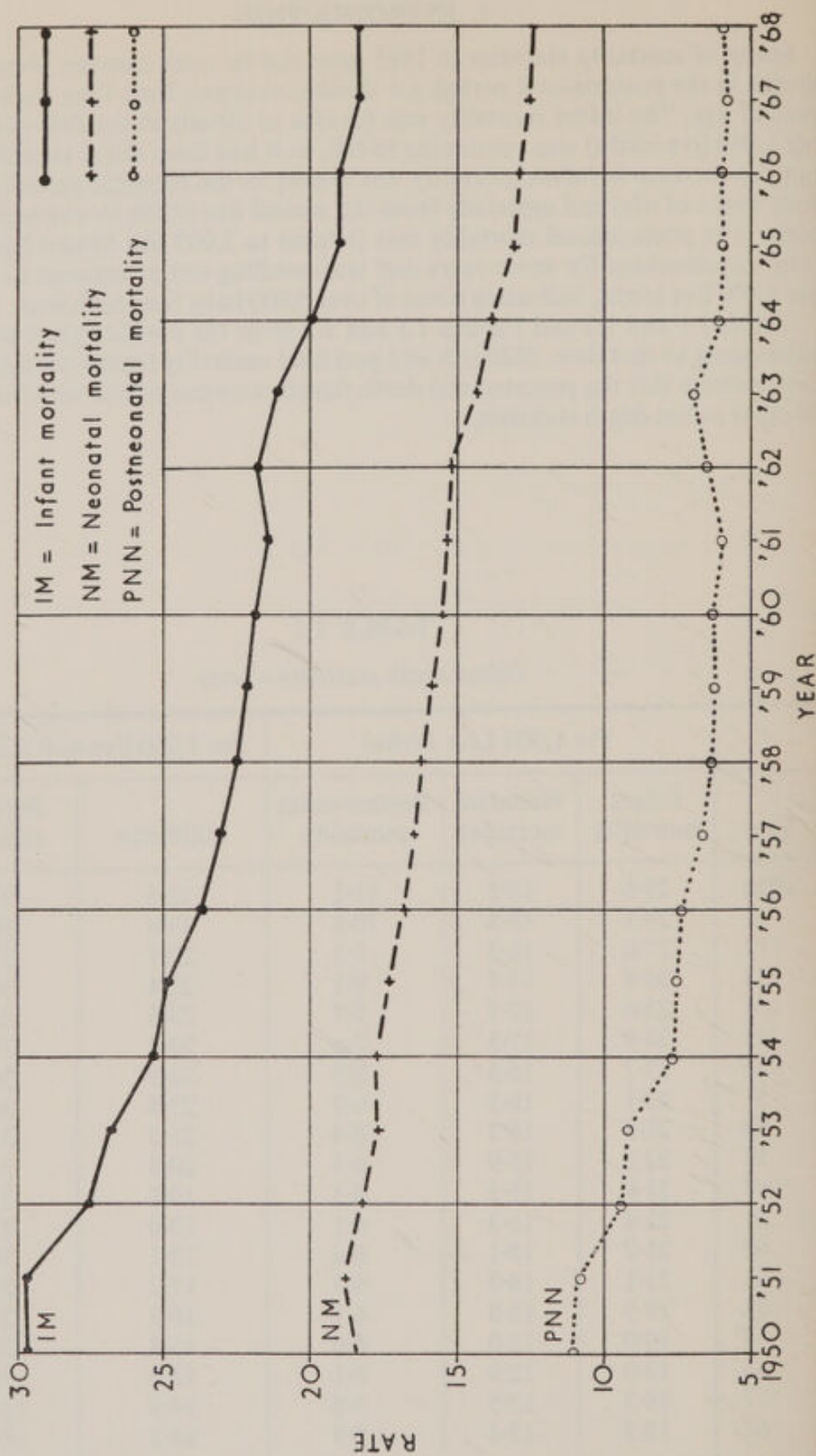


Figure 1.2

Stillbirth and Perinatal mortality rate - per 1,000 live and stillbirths.

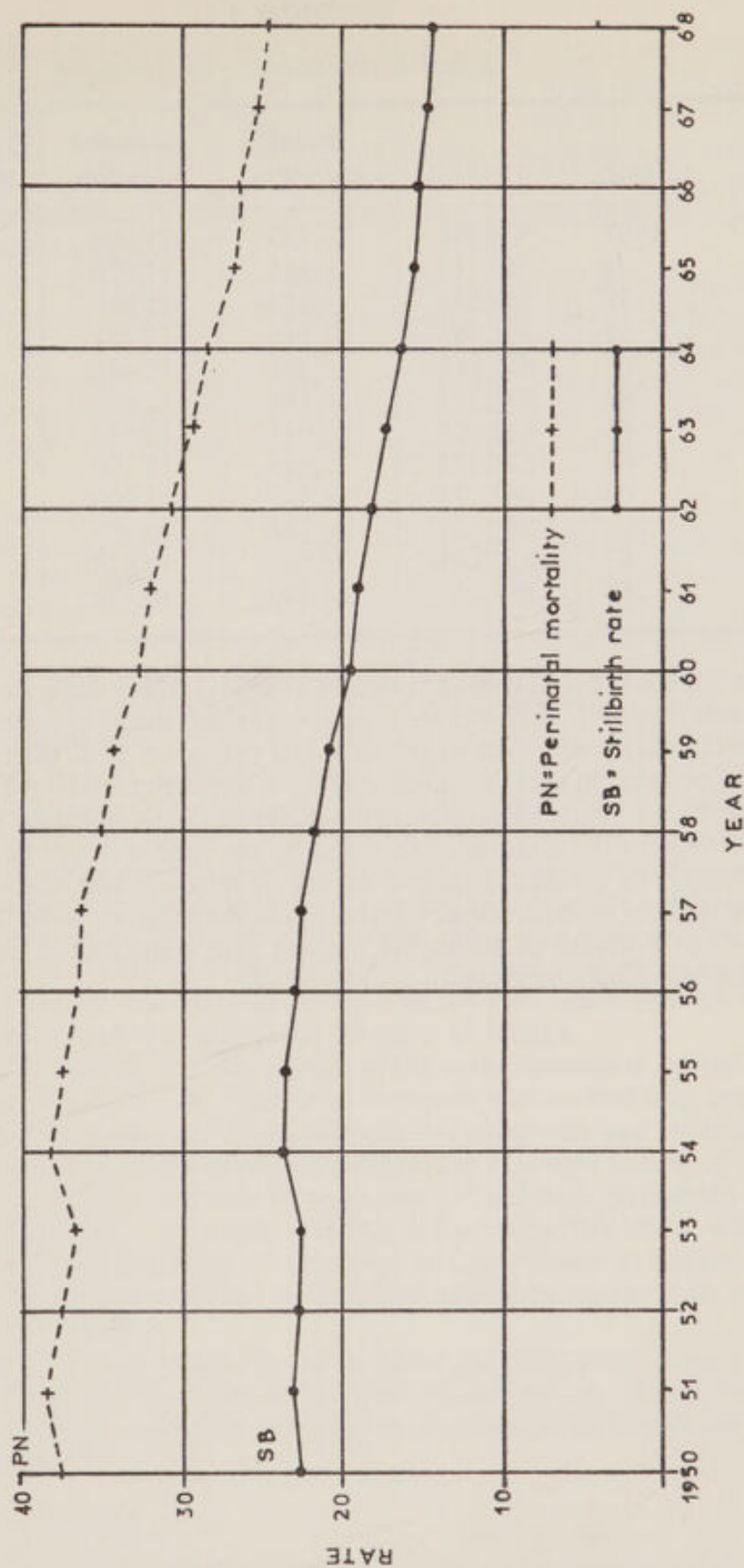


TABLE 1.2

Infant death statistics—occurrences

Year	Live births	Infant mortality	Neonatal mortality	Postneonatal mortality
1957	723,381	16,720	11,904	4,816
58	740,715	16,685	11,970	4,715
59	748,501	16,629	11,881	4,748
60	785,005	17,118	12,191	4,927
61	811,281	17,393	12,443	4,950
62	838,736	18,187	12,656	5,531
63	854,055	18,042	12,173	5,869
64	875,972	17,445	12,106	5,339
65	862,725	16,395	11,200	5,195
66	849,823	16,147	10,957	5,190
67	832,164	15,266	10,434	4,832
68	819,272	14,982	10,128	4,854

The situation is well demonstrated in Table 1.2 which deals with the numbers of infants involved. It shows that, despite the increasing number of babies born, substantially fewer died in the neonatal period in 1966 than had done so ten years before, but that the number dying in the postneonatal period had increased over the ten years, keeping roughly in step with the increased number of births.

In view of the concern engendered by the figures it was felt that it might be profitable to conduct a limited survey of postneonatal deaths in order to see what factors were involved, whether there were lessons to be learned that could result in a saving of infant life, and to give some indication of the value of possible further enquiries on a wider basis.

2. THE ENQUIRY

The Medical Officers of Health of three Local Health Authorities were invited to participate in the survey and agreed to do so. Two of the areas were County Boroughs which already had some experience of collecting information in this field, the third was a County of similar population size to one of the County Boroughs and associated with it in the maternity and child welfare fields. The effect of regional variation in postneonatal deaths was minimized by the close grouping of the three survey areas.

The organization of the enquiry was patterned on the Confidential Enquiry into Maternal Deaths in England and Wales which came into being in its present form at the beginning of 1952 and which has produced a series of reports based on a continuing examination of information since that time. The present enquiry lacked, of course, the body of information which had been built up over the years for the maternal deaths enquiry on which assessments of situations could be based.

The enquiry composed all infant deaths occurring between the ages of four weeks and one year in the years 1964, 1965 and 1966 in the three local authority areas; during this period there was a total of 119,047 live births in these areas. The enquiry in each case was initiated by the Medical Officer of Health of the authority concerned on learning of the death through local hospitals, local health authority staff or through death certification, either from the local register or the General Register Office. On learning of such a death the Medical Officer of Health sought information from those who had been involved in the health and welfare of the infant, so that, as far as possible, a picture of the clinical incident and the social background to it could be built up for the study. Appendix 1 shows the details which were sought and recorded for each infant death. In order to acquire this knowledge contact was made with the general practitioner and hospital doctors concerned, and information supplied by the parent resulted, in the main, from visits made by health visitors who were also instrumental in providing other social background material. The form was completed by the Medical Officer of Health summing-up and giving his own assessment of the incident, and the document was sent to the Ministry of Health.

Two senior paediatricians, with knowledge of the areas concerned, agreed to help in the exercise. To them each completed form was sent so that they could give an opinion as to the cause of death and whether there was any avoidable factor in the clinical care, administrative management or social setting of the case. A report of every death was seen by each assessor and each, in making his individual assessment, did so without knowledge of his colleague's views. When their assessments were dissimilar they were given an opportunity to reconsider the incident, this time with knowledge of the fellow assessor's views. Their task in all this was no mean one!

The coded material was processed by the Statistics and Research Division of the Department whose members provided much helpful advice. To all those involved in the supplying, collecting or assessing of information in this survey gratitude is expressed.

Assessment of avoidable factors

One of the chief features of this investigation was the assessment of an

“avoidable factor” or “factors” in the circumstances of the postneonatal death, that is some departure from the accepted standards of satisfactory care, in its widest sense, which may have played a part in the ensuing death. It is in no way suggested that in all cases in which avoidable factors were deemed to be present, death could have been prevented, but the presence of an avoidable factor may be regarded as an indication that the risk of death could have been, at least, materially lessened.

Presentation

In presenting an analysis of the enquiry material the report relates to the series as an entity, but some basic information by area is given in Appendix 2. Generally speaking the three sets of data are consistent, but certain disparities between the enquiry areas are brought out in the text.

3. GENERAL RESULTS OF THE ENQUIRY

During the three-year period a total of 679 infants who died in the post-neonatal period was reported and details of their cases were studied.

Incidence

The 679 deaths relate to some 120,000 live births in the areas of the three authorities, giving a rate of 5.7 postneonatal deaths per 1,000 live births. In England and Wales during the same period there was a total of 2,588,520 live births and there were 15,748 postneonatal deaths, giving a national postneonatal death rate of 6.1 per 1,000 live births.

Sex

Of the deaths in the enquiry, 360 (53 per cent) occurred in male infants and 319 (47 per cent) occurred in females. For comparison the national rates in 1966 were 56 per cent for boys and 44 per cent for girls.

Age

The age at death of the 679 infants is given in Table 3.1 and Figure 3.1.

TABLE 3.1
Age at death in weeks

Age	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	Not known
No.	169	122	106	62	47	35	26	29	21	24	23	13	2
%	25	18	16	9	7	5	4	4	3	4	3	2	0.3
% in 16-week groups	68				20				12				

The figures clearly demonstrate the vulnerability of the infant in the early months of life. By the latter half of the first year a fairly stable situation has evolved.

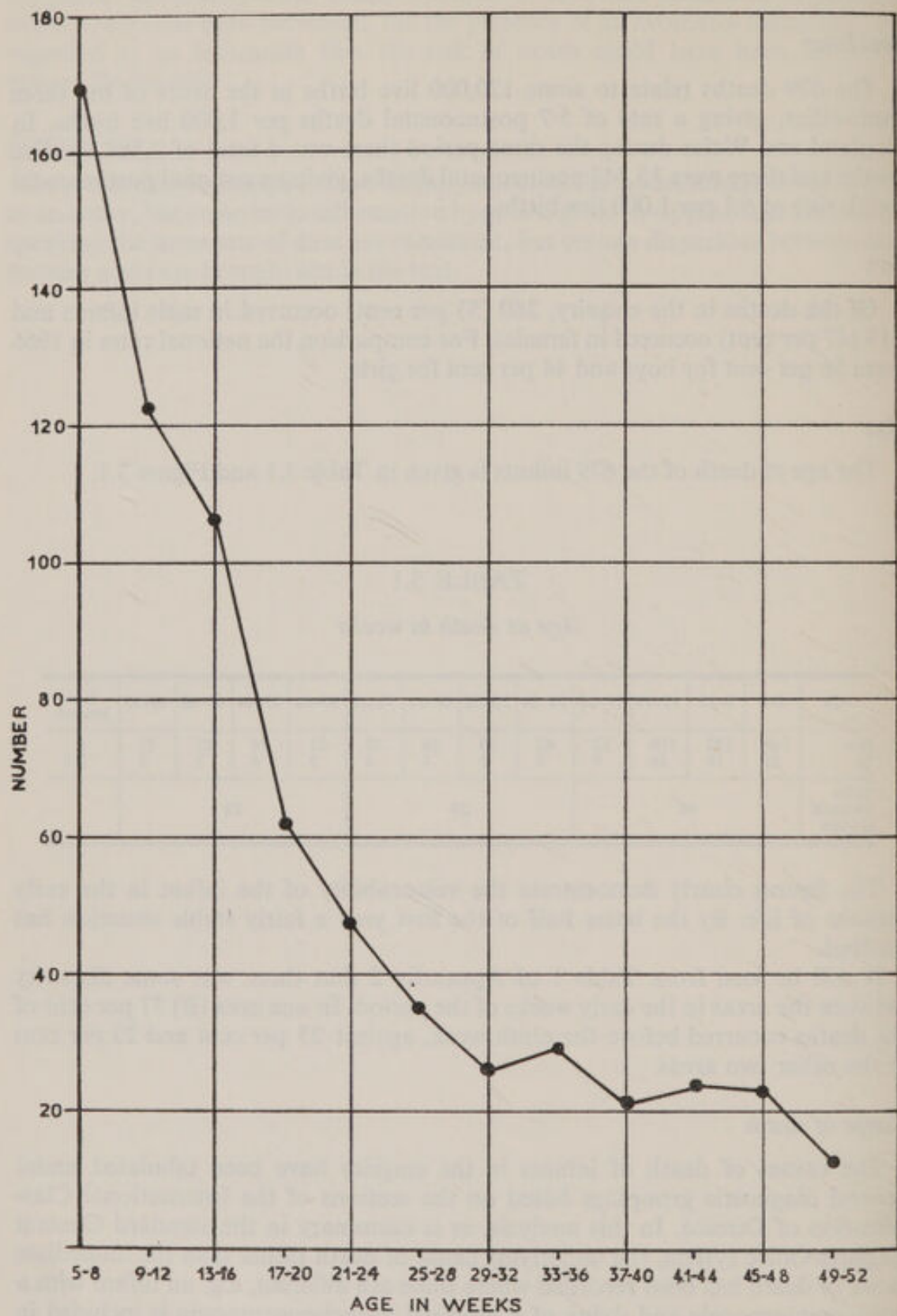
It will be seen from Table 1 of Appendix 2 that there was some disparity between the areas in the early weeks of the period. In one area (B) 37 per cent of the deaths occurred before the ninth week, against 25 per cent and 23 per cent in the other two areas.

Cause of death

The causes of death of infants in the enquiry have been tabulated under general diagnostic groupings based on the sections of the International Classification of Disease. In this analysis, as is customary in the standard General Register Office system, the underlying cause of death rather than the immediate cause of death has been recorded where these are different, e.g. an infant with a myelomeningocele and dying of a terminal bronchopneumonia is included in

Figure 3-1

Age at death in weeks



the congenital malformation group and not under diseases of the respiratory system. The breakdown of causes of death in this way is given in Table 3.2 and in Table 2 of Appendix 2 where it is related to the individual local authority areas.

The important place held by infection of the respiratory tract in this age group is well shown; over one-third of the infants who died had diseases of the respiratory system as the primary cause. In addition to these respiratory deaths, at least 72 of the other infant deaths had an associated infection of the lower respiratory tract, this frequently being the terminal factor. Respiratory infection, therefore, had some part to play in nearly half of the infant deaths in the enquiry.

The group of congenital malformations was the second commonest cause of infant deaths in the postneonatal period, involving 165 infants and being responsible for almost one-quarter of all of the deaths. Table 3.3 shows a breakdown of this section into more specific groups and demonstrates the significant place of congenital cardiovascular anomalies and of the congenital anomalies of the nervous system.

TABLE 3.2

Cause of death

I.C.D. section	I	III	IV	VI	VIII	IX	XV	XVI	XVII	XIV	II VII X XIII
Diagnostic group	Infective diseases	Endocrine, nutritional and metabolic diseases	Diseases of the blood and blood-forming organs	Diseases of the nervous system	Diseases of the respiratory system	Diseases of the digestive system	Diseases of early infancy	Ill-defined conditions	Accidents, poisoning and violence	Congenital anomalies	Neoplasms and diseases of circulatory, genito-urinary locomotor systems
No.	34	8	2	9	251	97	4	9	82	165	18
Percentage of total deaths	5	1	0.3	1	36	14	0.6	1	12	24	3

TABLE 3.3
Congenital anomalies

Underlying cause of death	No.
(a) Congenital cardiovascular anomalies	96
(b) Congenital spina bifida cystica and hydrocephalus	35*
(c) Mongols	9*
(d) Other	25
All congenital anomalies	165

* In addition 15 infants in (a) were mongols, and 1 had spina bifida.

Between them diseases of the digestive system, mainly gastro-enteritis, and "accidents, poisonings and violence", accounted for a further one-quarter of the total deaths and are important factors to be reckoned with in this age group.

Out of the 679 deaths in the series 250 came into the category of "cot deaths" or "sudden unexpected deaths", in which a child not known to be ill, or at most to have a trifling illness, is found dead in its cot. A detailed discussion of these cases and of the more common causes of postneonatal death, already mentioned, will be given in later sections of the report.

Month of death

Table 3.4 shows the months in which the 679 deaths took place. Since respiratory infections hold an important place in this age group the December and January and the first and fourth quarter figures are not unexpected but peaks in the number of births tend to occur in the second quarter and troughs in the fourth quarter of the year so that these variations may have some effect upon the seasonal situation shown in the table.

TABLE 3.4
Month in which the deaths occurred

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No.	87	57	54	50	59	39	52	37	34	56	60	94
% of all deaths	13	8	8	7	9	6	8	5	5	8	9	14
No. by quarters (%)	198 (29%)			148 (22%)			123 (18%)			210 (31%)		

Duration of illness before death

Information was sought on the length of time the child had been ill before death and this material is shown in Table 3.5.

TABLE 3.5

Duration of terminal illness

Duration	Not known to be ill	Less than 12 hours	12-48 hours	49 hours to 1 week	Over 1 week but not since birth	Since birth	Not known
No.	203	29	72	86	72	211	6
% of total deaths	30	4	11	13	11	31	0.8

The striking point in this analysis is the large number of instances in which there was little or no realization that the child was ill before death occurred, a situation with which it is difficult to cope when looking for preventive action. The other large group in which the illness was recorded as being present since birth is predominantly comprised of those infants with congenital anomalies; although symptomatic disease may not have been apparent for this whole period the anomalies by definition, had been present from birth.

Looking at this situation from the point of view of prevention, it is somewhat disheartening that almost two-thirds of these deaths were either associated with anomalies determined before the child was born or occurred in infants not known to be ill.

Place of death

Of the 679 infant deaths 363 (53 per cent) took place in hospital, 312 (47 per cent) occurred in the home, or in a few cases in an ambulance on the way to hospital, in 4 instances information was not available. The proportion of deaths at home reflects, to some extent, the fact that in many cases the child was found dead in its cot and previously was not known to be ill.

Birth weight

The birth weight of the infants who died is tabulated in Table 3.6.

TABLE 3.6

Birth weight

Birth weight	Under 3 lbs.	3-5½ lbs.	5½+ lbs.	Not known
No.	7	123	534	15
% of total deaths	1	18	78	2

During the years of the study the national figure for premature liveborn infants was of the order of 7 per cent. Some 60 per cent of first week deaths occur in premature infants. It is evident that the fact that an infant was premature had continuing importance in the postneonatal period, there being an association in 19 per cent of the deaths. The continuing vulnerability of this group must be recognized.

Efforts to obtain realistic information on the period of gestation, after the enquiry had started, did not provide worthwhile results.

Single and multiple births

Of the 679 infants studied 646 (95 per cent) were singletons, 33 (5 per cent) were from multiple births. The average frequency of twin pregnancies is of the order of 1 in 80, the frequency of these postneonatal deaths of infants from multiple pregnancies was 1 in 20. The possible significance of low birth weight in relation to the deceased infants from multiple births was examined; 17 had a birth weight of 5½ lbs. or under, 16 had a birth weight of over 5½ lbs.

A number of other factors, some of a socio-economic bearing, were analysed with the following results.

Social class

This was determined having regard to the father's occupation and with reference to the Classification of Occupations, 1966, of the General Register Office. The Social Classes are categorized as follows:

- I Professional, etc., occupations.
- II Intermediate occupations.
- III Skilled occupations.
- IV Partly skilled occupations.
- V Unskilled occupations.

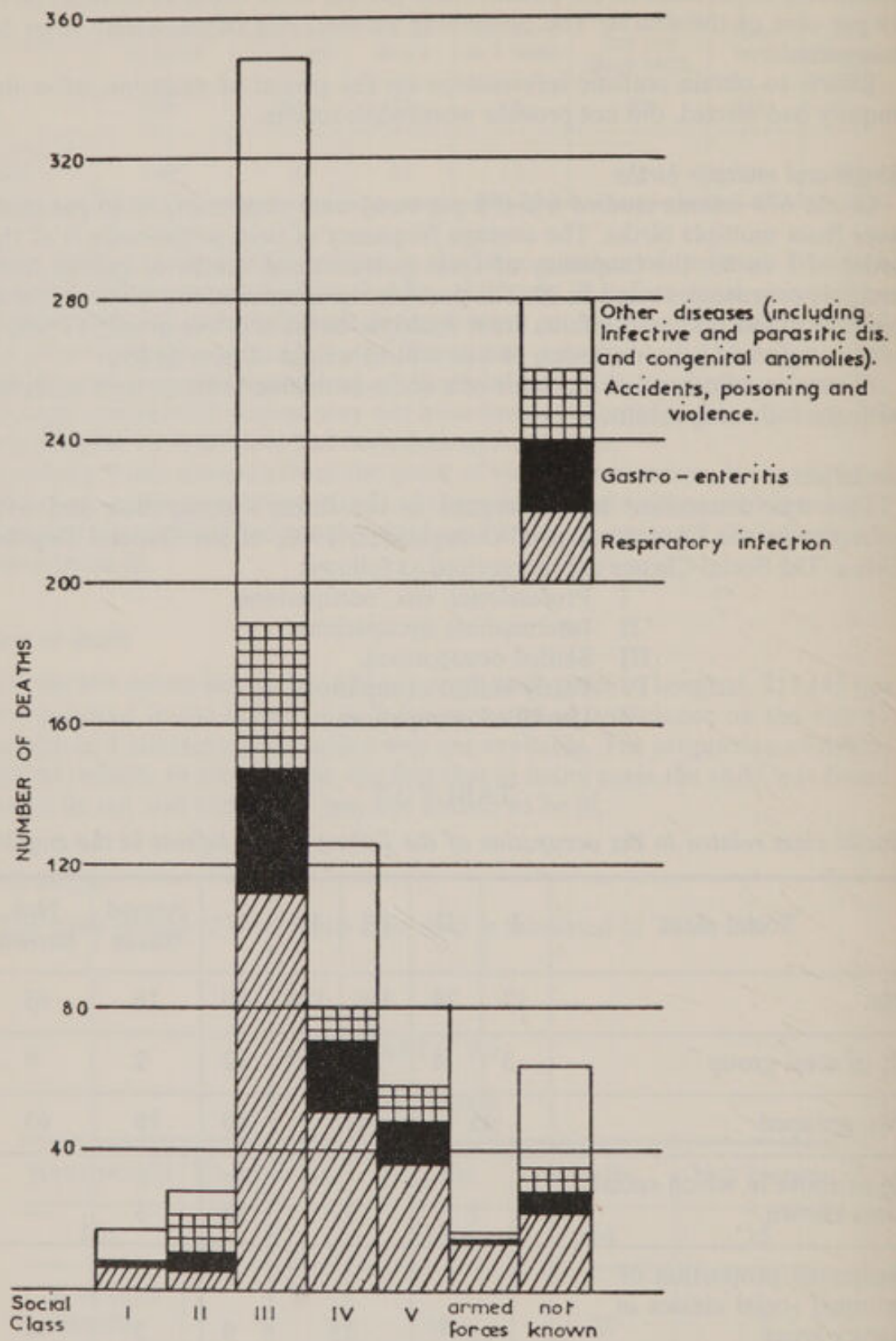
TABLE 3.7

Social class related to the occupation of the fathers of the infants in the enquiry

Social class	I	II	III	IV	V	Armed forces	Not known
No.	17	28	349	126	80	16	63
% of total group	3	4	51	19	12	2	9
No. grouped	45		475		80	16	63
% of those in which social class known	7		77		13	3	—
Estimated proportion of grouped social classes in survey areas	13		75		9	3	—

Figure 3-2

Distribution of deaths from principal causes
by Social Class



The distribution by social class in the table may be further compared with the separate area social class distribution in Table 4 of Appendix 2.

The tendency for infants in social classes I and II to be less vulnerable than those in classes III, IV and V is brought out by these figures. It is apparent from the study of the individual case material that social class is associated not only with an economic situation but with family size and, in addition, has a bearing on attitudes and standards of care which are, in themselves, of vital importance to the young infant.

The distribution of deaths from the principal causes by social class is demonstrated in Figure 3.2.

In this report the distribution by social class of postneonatal deaths is compared with the distribution by social class of economically active males in the study areas, although ideally the comparison should be with the distribution by social class of children between the ages of four weeks and one year in the period 1964-66, that is those at risk of postneonatal death.

Environment

Information was sought on housing and on other environmental factors. Criteria were devised to enable individual situations to be fitted into categories. From the accommodation point of view "ideal housing" was considered to exist when there was no overcrowding (defined as more people than rooms), house in good repair and clean, inside toilet and bathroom, child in own cot in own room or in parent's room; when one of these factors was lacking the conditions are considered to be "average", and "unsatisfactory" when more factors were lacking. On the environmental side the assessment of "satisfactory" was made on such factors as good maternal care, firm co-habitation, happy home, clinic attender, etc.; an "unsatisfactory" assessment was accorded when there was non-co-operation with health visitors, poor child care and poor general facilities, etc.

All these factors were difficult to assess from the material received and the resulting analysis could not be regarded as very meaningful.

Legitimacy

In the three years of the study there was a total of 119,047 live births in the three areas involved, and of these births 10,756 were illegitimate. Among the 679 postneonatal deaths reported 82 were of illegitimate infants. Thus it can be determined that 9 per cent of all births were illegitimate and 12 per cent of the postneonatal deaths occurred in illegitimate infants. The postneonatal mortality rates were 5.6 per 1,000 live births for legitimate infants and 7.6 per 1,000 live births for illegitimate infants.

Maternal age

The age of the mother was recorded in 590 instances and the breakdown into age groups is shown in Table 3.8.

TABLE 3.8

Age of mother—590 postneonatal deaths

Age in years	Under 16	16-19	20-29	30-40	40+
No.	1	73	368	128	20
%	0.2	12	62	22	3
National distribution of livebirths relative to maternal age (1966)		12%	63%	24%	2%

It is interesting to note the close relationship with the national figures for the age distribution of mothers having live births in 1966.

Parity and outcome of previous pregnancies

Information on these items was available in 641 cases and is detailed in Table 3.9.

TABLE 3.9

Parity and outcome of previous pregnancies

Previous pregnancies	None	1-3		4+	
		All living	1 or more died	All living	1 or more died
No.	161	359	32	65	24
%	25	61		14	

It is not easy to make strict comparisons with national figures but during 1966 in England and Wales 35 per cent of legitimate livebirths occurred as a result of first pregnancies, in 61 per cent there had been 1 to 3 previous pregnancies and in 8 per cent there had been 4 or more previous pregnancies.

Direct information on frequency of pregnancy was not obtained, but in one-third of the cases—27 out of 73—where the mother was under 20 years of age she had had one or more previous pregnancies. The length of interval between pregnancies might well be relevant because of its direct effect upon the infant; the stress of the mother coping with other young children and family planning may have some part to play.

Post mortem examination

From the information received it is known that a post mortem examination was carried out on 78 per cent of the infants that died in the postneonatal period; this reflects usual practice in the areas concerned.

Immigrancy

Information was sought on infants who died and, as the form at Appendix 1 shows, this was related to the country of origin of the mother. Of the families involved in the enquiry 179 were classified as immigrant; but 166 of these were in one local authority area (A) and only 13 in the other two. The distribution of the immigrant families by the mother's country of origin is given in Table 3.10.

TABLE 3.10
Country of origin of immigrant families

Country of origin of mother	No.
British West Indies	68
India	13
Pakistan	17
Ireland	61
Other countries or not stated	20

All but 3 of the 179 families fell in social classes III, IV or V. The distribution of deaths in this group by sex, cause, age of death and age of mother was not very different from the general pattern, except that they had more than their fair share of disease of the digestive system (40 per cent).

It is clear from a study of the individual stories that the fact of being a young infant in an immigrant family produces additional problems, e.g. in communication, in tradition of child rearing, in nutrition; these are factors to be taken into account by those concerned with illness in this group.

Other factors

The survey results revealed, not unexpectedly, that 85 per cent of the mothers finished their full-time education at 15 years of age or earlier, and that 90 per cent were not going out to work. The questions and answers on these matters were hardly profitable.

Of the deaths 16, or 2.4 per cent, involved infants who were in foster care; this proportion is much in excess of that of all children in foster care.

4. AVOIDABLE FACTORS IN THE SERIES

A prime purpose of the survey was to determine whether it was possible to pinpoint avoidable factors in the circumstances of any of the postneonatal deaths. If this could be done it was hoped that the knowledge gained might lead to prevention of similar situations in the future.

An avoidable factor was understood to be some departure from the high standards of care and management that might be expected. Where avoidable factors were deemed to be present, it cannot be assumed that death could have been prevented, but the presence of an avoidable factor may be regarded as an indication that the risk of death could have been materially lessened, at least.

The determination of whether or not avoidable factors were present was a matter of some difficulty, indeed in 62 (9 per cent) of the 679 deaths it was not possible to come to a clear decision on this point. As will be seen later a high proportion of avoidable factors related to the child's parents—especially inadequacy and incompetence—and to social conditions—especially bad housing and overcrowding; frequently there was a combination of these factors with others. Maternal inadequacy, or a large young family, in poor overcrowded living conditions, may seem to give rise to a situation of inevitability rather than avoidability, especially as far as infection is concerned, but, for the purpose of this survey, it has been considered that there are supporting services which should be geared to deal effectively with such situations.

Of the 679 postneonatal deaths in the enquiry avoidable factors were deemed to be present in 187 instances, i.e. 28 per cent. Table 4.1 shows, in broad terms, the underlying cause of death in the cases with avoidable factors and demonstrates the significant place of the respiratory and intestinal infections, which occurred in two-thirds of these infants.

TABLE 4.1

Cause of death in 187 cases with avoidable factors

Underlying cause of death	No.	% of all deaths with avoidable factors
Respiratory infection	82	44
Gastro-enteritis	42	22
Asphyxia	23	12
Trauma	10	5
Other	30	16

TABLE 4.2

Responsibility in the 187 deaths with avoidable factors

Social		Parent		General practitioner		Hospital		Local authority		Other
Wholly	In part	Wholly	In part	Wholly	In part	Wholly	In part	Wholly	In part	Other
53	28	49	30	24	14	8	5	3	2	9
81		79		38		13		5		
225										
36%		35%		17%		6%		2%		4%

Table 4.2 shows where the responsibility for avoidable factors was deemed to lie. In 146 instances one avoidable factor was present, in 41 more than one factor was operative; there was a total of 225 avoidable factors. The proportionate distribution in the bottom line of the table relates to this total of avoidable factors. The figures, bring out, in particular, the importance of social and parental factors in the study; together they accounted for 71 per cent of the avoidable factors.

Avoidable factors attributed to social causes

Housing and the family situation were considered to be significant factors in 81 deaths; in some of these both housing and the family situation were involved. The following table gives a breakdown of social avoidable factors.

TABLE 4.3

Avoidable factors—social causes

Underlying social defect	No.
Housing	74
Family situation	12

Of the 187 deaths with avoidable factors 46 per cent were associated with some social defect, 40 per cent being associated with housing conditions of a poor standard. The small group under the heading of "Family situation" includes broken families, parental desertion, and families with other serious social problems.

Although not analysed separately it has seemed clear that family size intensifies the housing situation. The overcrowding caused by large families in inadequate accommodation is a potent source of respiratory and intestinal cross-infection, and, in addition, causes, or adds to, maternal harassment, stress and distraction. Of families living in one room there were a number consisting of the two parents and three children under the age of 3 years, and more with

two parents and two children. There was an instance of two parents with five children under the age of 6 years living in two rooms, and of two parents with nine children, seven of whom were under the age of 9 years, living in three rooms. There were frequent instances of five individuals sleeping in a single room. Associated with such overcrowding there were numerous instances of lack of hot water or of indoor sanitation, of rooms which were damp and ill-ventilated, and of limited opportunities for play or fresh air. Children living in environmental conditions of this sort are undoubtedly at added risk of disease, especially disease of the respiratory or gastro-intestinal tracts, which may be endemic in the locality; ever-present is the hazard of cross infection. Despite the support of social and medical services, these children are at a health disadvantage when compared with others in more fortunate circumstances.

Rehousing and family planning advice would hit at the roots of this problem, but where this situation of bad housing and overcrowding exists it should be recognized as a real risk factor in those dealing with ill infants.

A further factor with a social connotation has been looked at separately, that is the legitimacy of the infant concerned. Of the 144 deaths in which there was a parental or social factor, sometimes both, 62 of the infants (43 per cent) were illegitimate. Illegitimacy could well, therefore, also be taken as a risk factor when the total circumstances of the sick infant are assessed.

Avoidable factors attributed to parents

In studying this group it is noteworthy that there is little mention of the part played by the father; in a few instances desertion, imprisonment or drunkenness of the father have added to the mother's stresses; in others, although no mention is made, it would seem a fair assumption that the father should share in the shortcomings attributed to the mother.

A breakdown of parental avoidable factors is given in Table 4.4. It will be appreciated that more than one of these factors was present in certain cases, and that there can be no sharp dividing line between some of the categories, e.g. low intelligence shades into inadequacy and incompetence, not far removed from neglect which is shown as wilful when positive acts of violence have contributed to an infant's death; similarly, the failure to recognize the seriousness of the situation is closely linked with the failure to summon medical aid.

In some instances inadequacy, failure of appreciation of the situation and failure to summon medical aid, were associated with maternal immaturity—not necessarily related to the stated age. These three factors accounted for 69 per cent of the total of factors attributed to parents and it would seem that there is scope for increased endeavours to teach the elements of child health to mothers and potential mothers in any way which presents. The difficulties are, however, perhaps exemplified by the case of the infant dying as a result of congenital syphilis whose mother failed to undergo any ante-natal examination.

The habit of propping up the baby unattended, in cot or pram, with its bottle of milk occurs all too frequently, and it would seem that at least two of the infants in the series died from asphyxia as a result of this situation.

From this material further risk factors become apparent, for it also seems clear that the mental capacity and the general capability of the mother need to

be taken into account in considering the proper management of the infant who is ill.

TABLE 4.4
Avoidable factors attributed to parents in 187 deaths

Parental factor	No.	% of total factors*
Mental subnormality, instability or notable low intelligence	18	17
Neglect	11	11
Incompetence or inadequacy	29	28
Failure to summon medical aid	26	25
Failure to appreciate seriousness of the situation	17	16
Wilful neglect	3	3
*Total factors	104	

Avoidable factors attributed to general practitioners

Of the 187 deaths in which there was deemed to be some avoidable factor, general practitioners were involved in 38 instances, either solely or in association with other factors. It is well appreciated that the general practitioner is at greater risk in this matter than those in other services. As the family doctor he is the point of first medical contact with most sick children, whether mildly or severely afflicted and with overt or hidden manifestations of disease. The total demands of his practice may make it difficult for him to provide the frequent visits for effective oversight which he may desire to make and he may have no direct support to help him in his task. The details in Table 4.5 and the subsequent narrative dealing with specific situations must be read with this background in mind.

Again the first three of the categories in the table shade into each other; taken together these factors, which depend upon a clinical appreciation of the situation, account for 78 per cent of the avoidable factors attributed to general practitioners.

The term "slowness in reference to hospital" has been used where the general practitioner was seeing the sick infant over an appreciable period of time. In two of these instances the child died of broncho-pneumonia. One case had been under the care of the general practitioner on account of respiratory infection of a fluctuating and relapsing character over several weeks. In the other the child had been visited daily by the family doctor for two weeks before being sent to hospital; in this case there were other concomitant respiratory infections in the crowded household and it seems likely that benefit would have accrued from

TABLE 4.5

Avoidable factors attributed to general practitioner in 187 deaths

General practitioner factor	No.	% of total factors*
Slowness in reference to hospital	5	13
Diagnostic delay or failure	10	26
Failure to realize severity of the situation	15	39
Delay in visiting	7	18
Failure to follow-up	1	3
*Total factors	38	

early admission to hospital for effective treatment and, importantly, for the avoidance of re-infection. Two other cases seen regularly over a period by the general practitioner were infants who were failing to gain; one of these had a congenital malformation of the intestinal tract, the other died of pneumonia associated with fibrocystic disease of the pancreas; in both, hospital admission was delayed despite pressure for this from the mother. The other case in this category was one in which there was an atypical and presumably intermittent intestinal obstruction seen frequently by the general practitioner over a period of two weeks before reference to hospital. All these cases could be classified as being subject to diagnostic delay but they do stand together in that they were under care over a considerable period of time.

The second category of diagnostic failure or delay includes one case of congenital heart disease, a case of renal failure, a child who ultimately died in hospital and in whom the primary reason for admission was an imperforate anus—not diagnosed until the end of the first week of life despite two general practitioner visits, a case of a relatively rare endocrine disorder with external manifestations which should have given a clue, and a number of instances of severe respiratory infection in which diagnosis was delayed or wide of the mark. It is clear that in some of these cases the paediatric diagnostic ability available was poor.

The third category in this table relates to failure to realize the seriousness of the situation and is confined almost entirely to respiratory and gastro-intestinal infections which play such a significant part in the group of cases. Infants at this age are vulnerable during respiratory infections and what appears to be a mild infection may rapidly progress to a severe pneumonia, or result in sudden or unexpected death. Gastro-enteritis can be a very acute illness with the rapid development of a serious metabolic upset, and in many cases admitted late to hospital irreversible electrolyte changes and peripheral circulatory failure put the child beyond any hope of recovery. Clearly in these two types of illness it is

of the utmost importance to assess the total situation; some would say that all babies with gastro-intestinal or respiratory infection are safer in hospital.

A further point which comes out of the study of instances in which these three avoidable factors are involved is the failure to use the domiciliary consultation service which provides for consultants to visit, at the request of the family doctor, patients who are too ill to be referred for out-patient consultation. An expert assessment in certain of the cases under review may well have saved lives.

Three infants in the category "Delay in visiting" were never seen alive during the course of their illness by the general practitioner. In one case the practitioner was apprised of the situation by a nurse and the mother was given the advice to call him if she considered it necessary; another doctor, told coincidentally of an infant's illness, again left it to the mother to decide whether a visit should be made; in another instance the parents asked for medicine for their sick child and received it without a visit being made. It can be said that no request for a visit was made in any of these cases, nevertheless it is felt that it is not sufficient to rely always on maternal judgment and that some responsibility lies with the general practitioners.

Two other situations merit mention. One is the "Sunday" or "Weekend" syndrome in which, during the course of the weekend, parents have experienced extreme difficulty in contacting any doctor and have had no clear idea of how to meet this situation. The other, not included as a general practitioner avoidable factor, is concerned with appointment systems developed by general practitioners; in at least one instance a mother, not realizing that her sick infant could be seen urgently, felt that the making of an appointment implied delay in being seen, she consequently further delayed until the child was seen at a clinic, a delay which is believed to have contributed to the death. It seems desirable that the alternative availability of doctors and the implications of appointment systems could, with benefit, be made clearer.

Avoidable factors attributed to the hospital service

Avoidable factors were attributed to the hospital service wholly in 8 deaths, in part in 5. The categories into which these factors have been grouped are given in Table 4.6.

TABLE 4.6

Avoidable factors attributed to the hospital service

Hospital service factors	No.
Diagnostic failure or delay	6
Management	3
Early discharge	1
Hospital acquired infection	3
Total	13

In considering the various incidents in this survey high standards of performance have been expected of the hospital service, as of the general practitioner service. Avoidability in the first two categories in the table has, therefore, perhaps been attributed in some cases to circumstances which, although less than ideal, may not fall far short of much common practice; but in hospital, if anywhere, support is available on the scale that ought to make the ideal situation practicable. There were a number of instances worthy of note, e.g. the infant with intestinal infection in whom failure to diagnose fully, medical hesitation and doubt were considered to have contributed to the death; or the child referred to hospital on account of failure to thrive and in whom no abnormality was detected, but who was shortly afterwards admitted with a severe pulmonary infection, including abscess formation, and the realization that it was a case of fibrocystic disease of the pancreas; or the instance of the grandfather under treatment for pulmonary fibrosis, the tuberculous nature of this only being realized when the grand-child presented with and succumbed to tuberculous meningitis. Delay caused by obstruction to admission was considered to be a significant feature in one case, as was transfer from one hospital to a second one at a critical stage of illness in another. These are comparatively isolated episodes but with others that are quoted they indicate that all elements of the service may be fallible at times.

Although stress has been placed on delayed admission or failure of admission to hospital, it is also appreciated that there may be dangers associated with being in hospital; in two instances it was felt that hospital acquired infections contributed to infant deaths. It has been said "Will there ever be a hospital without the risks of infection? Death becomes the ideal state; life remains a place of unavoidable hazard." The third case in the "infection" category is of interest in that a sibling of the infant who ultimately died was in hospital for some unassociated reason and in the ward there existed infection with an intestinal pathogen. When the sibling was discharged to his overcrowded, unhygienic home, he took the intestinal pathogen with him and the baby was assumed thus to have become infected—here is a case in which an appreciation of the total situation prior to the sibling's discharge could have paid benefits.

Avoidable factors attributed to the local authority services

It will be well appreciated already that many of the incidents under review have been associated with profound social difficulties, especially with regard to housing and problem families; many have been associated also with parental inadequacies. It is in dealing with these aspects that the local authorities have a most important role to play and, from the material available, it would seem that in this role they are providing a service. Repeatedly mention is made in the reports of frequent visits by various of the local authority services, the tendering of advice and the support given. In some instances it seems clear that the most intense involvement in the family situation could not prevent disaster, but in many instances where social circumstances were unsatisfactory more might have been done to ameliorate the situation by concentration and co-ordination of the local authorities services.

Where avoidable factors have been attributed wholly or in part to local authority services these have resulted, in the main, from the attendance of sick

infants at welfare clinics, with lack of appreciation there that the child was sick, or from failure to ensure that the sick child was seen by its general practitioner.

One instance included in this section relates to an infant who died from whooping cough, the infection contracted from an older sibling who had not been immunized but should have been.

Avoidable factors attributed to other circumstances

It could be that these cases might be included in some of the categories previously mentioned, but their stories did not clearly indicate where responsibility fell. The nine cases are summarized in the following table.

TABLE 4.7

Avoidable factors—other circumstances

Underlying cause of death	Factor	No.
Ayphsxia	Soft side of carry cot	1
	Plastic undersheet	1
	Foam or soft pillow	3
	Clothes caught on cot	1
Trauma	No clear story	2
	Car accident	1

In the asphyxial cases it was considered that the factors mentioned at least contributed to the infant deaths. The potential dangers of using a soft-sided carry cot as an infant's habitual sleeping place, of plastic sheeting and of pillows—especially when soft and foam-filled—should be well recognized; it has long been the Department's view that pillows should not be used for children under the age of twelve months.

In two of the traumatic cases it was not possible to get a clear picture of what had occurred; the outcome might have been different in the car accident case if the mother, holding the infant, had been wearing a safety belt.

Summary

This survey directs attention to a number of points:

1. It deals with a vulnerable age group in which events occur and develop rapidly so that delay in visiting or in the institution of effective treatment may be vital.

2. The importance is stressed of respiratory infections, with the dangers of sudden unexpected ("cot") deaths or rapid progression to severe pulmonary infection, or of gastro-intestinal infections with the possibility of irreversible electrolyte change developing with speed.

3. Various other risk factors need to be taken into account in assessing the total situation on which management should be based:

- (a) Bad housing, associated with large families, with overcrowding and with the subsequent risk of repeated cross-infection.
- (b) Mental subnormality or stress, low intelligence or ignorance of the parents.
- (c) Illegitimacy.

5. A DESCRIPTION OF SOME OF THE CLINICAL CONDITIONS CONCERNED

This chapter gives details of a number of groups of clinical conditions responsible for infant deaths in the enquiry. Some of the groups are of such a size as to play a significant role in the overall picture, the smaller groups are included because of elements of interest associated with them.

The various conditions are grouped under the following headings:

- (a) Respiratory infection
- (b) Gastro-enteritis
- (c) Congenital anomalies—(i) Spina bifida cystica and hydrocephalus
(ii) Down's syndrome
(iii) Congenital heart disease
(iv) Others
- (d) Meningitis
- (e) Encephalitis and Encephalopathy
- (f) Cystic fibrosis
- (g) Malignant disease
- (h) Infectious fevers
- (i) "Surgical abdomens"
- (j) Accidents and violence

Subsequent chapters deal with sudden unexpected deaths in infancy and with the deaths of the illegitimate infants in the enquiry.

(a) *Respiratory infection*

Respiratory infection was the prime cause of death in the postneonatal period in 251 infants, of these 248 had the diagnosis of acute bronchopneumonia, acute bronchiolitis or acute bronchitis. The borderlines between these conditions are hazy and they tend to merge; in consequence the cases have been analysed as a single group. The distribution of the three diagnostic labels within the group as follows:

161 deaths, 65 per cent—acute bronchopneumonia
44 deaths, 18 per cent—acute bronchiolitis
43 deaths, 17 per cent—acute bronchitis

Of the 248 deaths, 146 or 59 per cent occurred in boys, 102 or 41 per cent in girls; 33 or 13.5 per cent of the deaths involved illegitimate infants.

The age at death of this group is shown in Table 5.1.

TABLE 5.1

Age at death—248 lower respiratory tract deaths

Age in weeks	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
No.	58	44	50	31	13	12	4	9	7	11	5	4
% of group	23	18	20	12	5	5	2	4	3	4	2	2

The special vulnerability of the younger infants to respiratory infection is well shown in the table. Over 60 per cent of these deaths occurred in the first quarter (12 weeks) of the total age period (48 weeks) and over 70 per cent in the first third (16 weeks) of the period.

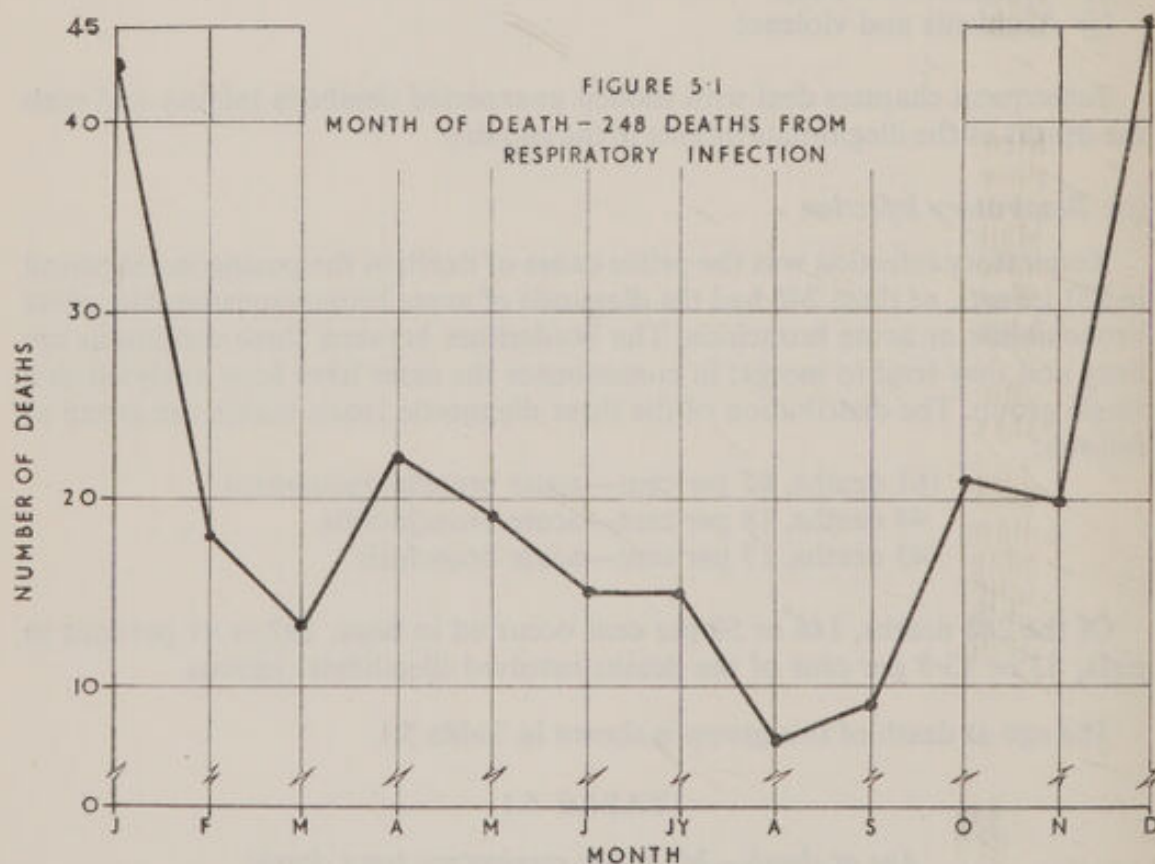
Table 5.2 relates the deaths to the months in which they occurred and shows in particular how dangerous the months of January and December were in this study, 36 per cent of these deaths occurred in these two months.

TABLE 5.2

Month of death—248 deaths from respiratory infection

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No.	43	18	13	22	19	15	15	7	9	21	20	46
% of group	17	7	5	9	8	6	6	3	4	8	8	19

Figure 5.1 visually demonstrates these findings.



The relationship of these deaths to social class based on the father's occupation is shown in Table 5.3 and in Figure 3.2, there being more involvement of social classes III, IV and V.

TABLE 5.3

Social class—248 lower respiratory infection deaths

Social class	I	II	III	IV	V	Armed forces	Not known
No.	7	6	112	50	37	13	23
% of group	3	2	45	20	15	5	9

Avoidable factors were deemed to be present in 54 instances or in 22 per cent of the group. Social factors played a predominant role, being the prime factor in 40 instances; unsatisfactory housing, with overcrowding and its risk of respiratory infection or repeated cross-infection, was the most significant element. Parental factors, implicated in seven instances, were in the main associated with a lack of appreciation of the child's condition. Avoidable factors were related to general practitioners in four instances, to the hospital service in two and to the local authority services in one case.

In this group of 248 deaths, 167 (or 67 per cent) came into the category of "cot deaths" or sudden unexpected deaths; these will be referred to in the section of the report on this specific subject. A proportion of the deaths not in the sudden unexpected group were not far removed from it, and repeatedly there were reports of "ill for twelve hours, admitted to hospital in state of complete peripheral vascular failure", or "admitted with acute respiratory distress with airway obstruction, cyanosed, hyperpyrexial, unconscious, died in two hours", or "moribund on admission"—death within 24 hours of admission was not infrequent. In addition there were some cases under treatment and progressing well when, suddenly, there was a rapid deterioration of the infant's condition, or collapse and death.

Attention was drawn in a leading article in the *British Medical Journal* (1968) to the problems of severe pneumonia in young children where reference was made to two groups of situations in which infant deaths associated with respiratory infection occur. There are those among these infants who die on the way to hospital, or very shortly after arrival there; these would seem to be closely allied to, if not the same as, some of the sudden unexpected or "cot deaths". A second group consists of the deaths occurring in children in the first year of life where the clinical diagnosis of pneumonia is made, but where there is no response to antibiotics. Particular reference was made to the work of Jones and his colleagues (1968) at Alder Hey Hospital, Liverpool, where intensive care can be provided for the seriously ill infants. This second group can be subdivided into those infants presenting with circulatory failure, those with predominantly respiratory symptoms and those with staphylococcal respiratory infections. The first of these sub-groups is of great clinical interest and has a high mortality rate. Infant deaths in this category are considered to result from the situation which Emery (1968) has suggested to account for some of the sudden unexpected "cot deaths". In this, infection or hypoxia leads to a sequence of

secondary circumstances which result in death. The *British Medical Journal* (1968) states that "The great importance of these cases lies in the need for earlier recognition and urgent treatment of incipient symptoms that indicate the onset of peripheral vascular failure, or of cerebral hypoxia, in a child during the course of what otherwise would be considered a normal upper respiratory tract infection. The present high mortality in hospital is due to the child's being irretrievably ill before resuscitation starts", and "The severe pneumonias in children require highly skilled and intensive care. . . . The most important general clinical point is the early recognition of hypoxic and circulatory disturbances in children with minor infections of the respiratory tract."

The material in the present enquiry leads to similar conclusions. Respiratory infection in infancy can be dangerous. The total circumstances need to be assessed in each case. Early reference for specialist support may save a child's life. There is a need for a full realization of the situation by all hospital staff concerned and for intensive care facilities for certain of these infants.

(b) *Gastro-enteritis*

Diseases of the digestive system accounted for 97 of the postneonatal deaths in the enquiry; gastro-enteritis was responsible for 77 of these deaths, 11 per cent of the total. Of the deaths 37 (48 per cent) involved boys, 40 (52 per cent) involved girls. Of the total of 97 deaths, 83 were in one local authority area (A) (Appendix 2, Table 2) 20 more than would be expected on the basis of their proportion of total deaths. This was the area with a substantial immigrant population which had more than its fair share of deaths from this cause.

The age at death of the infants in the group is shown in Table 5.4.

TABLE 5.4

Age at death—77 deaths from gastro-enteritis

Age in weeks	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
No.	17	14	12	8	7	3	6	2	2	1	3	2
% of group	22	18	15	10	9	4	8	3	3	1	4	3

The particular risk to infants in the earlier months of this age period is shown to apply to gastro-enteritis, as it also applies to other pathological conditions.

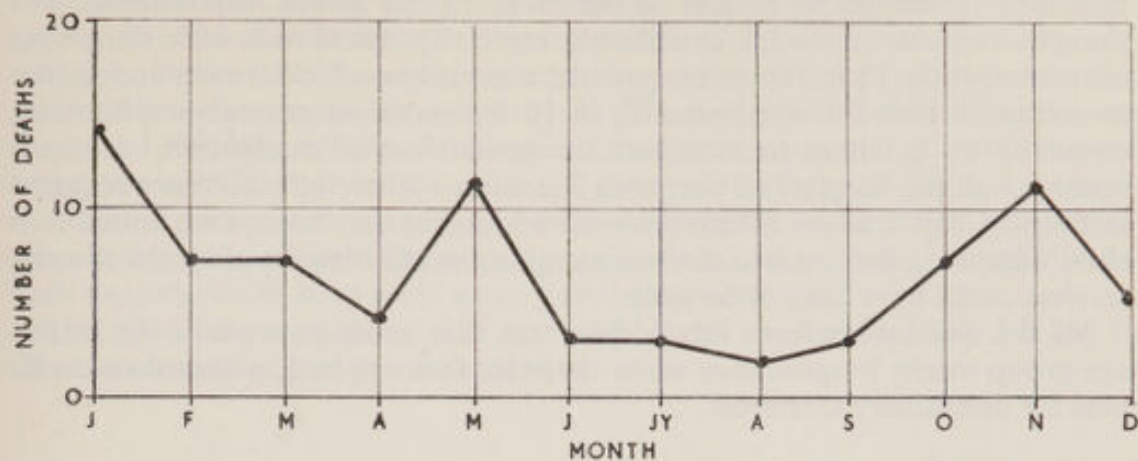
Table 5.5 relates the deaths from gastro-enteritis to the months in which they occurred and Figure 5.2 visually demonstrates this information. Numbers are small but there is no striking pattern of seasonal incidence, as is found with the respiratory infections.

TABLE 5.5

Month of death—77 deaths from gastro-enteritis

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No.	14	7	7	4	11	3	3	2	3	7	11	5

FIGURE 5.2
MONTH OF DEATH-77 DEATHS FROM GASTRO - ENTERITIS



The relationship of those deaths to social class based on the father's occupation is shown in Table 5.6.

TABLE 5.6
Social class—77 deaths from gastro-enteritis

Social class	I	II	III	IV	V	Armed forces	Not known
No.	0	5	35	20	11	1	5
% of group	0	6	45	26	14	1	6

In the group of 77 deaths attributed to gastro-enteritis 12 came into the category of "cot deaths" or sudden unexpected deaths, the child being found dead not having been known to be ill, or, at the most, only to have had minimal symptoms not giving rise to concern. Some of these deaths were associated with aspiration of vomit. The unpredictability of gastro-enteritis in infancy is brought out by other instances which seem closely allied to the group of sudden unexpected deaths. Some infants, apparently making good progress under treatment, suddenly collapsed and died in minutes, in others the onset of the illness was sudden and its course fulminating so that, even though expeditiously dealt with, they were moribund on admission to hospital.

In 53 of the 77 deaths the infant was in hospital; in 24 instances the infant died at home. In 11 cases where the infant died in hospital it was clear that there had been progressive deterioration over a period of days while under treatment at home prior to admission to hospital. On admission some of these infants, who severely dehydrated, acidotic, convulsing, hyperpyrexial and hypernatraemic, died within hours. It is possible that an earlier recognition of the seriousness of the situation, with an earlier enlistment of specialist aid, would have resulted in the prevention of some, at least, of these deaths.

In this group avoidable factors loom large and some such factor was considered to have played some part in 41 of the deaths. Although there were combinations of factors in several instances in 15 the prime responsibility was thought to rest on social conditions, especially associated with the living environment, in 12 instances on parents, especially on fecklessness and failure to recognize that the child was ill, in 10 instances on general practitioners, especially on a failure to recognize the seriousness of a situation, and in 3 instances on the hospital service, with 2 instances where infection was acquired in hospital and 1 where difficulties over admission may have contributed to a child's death. In the first two of these groups more effective use of local authority services could have been of benefit.

All the indications from this enquiry are that acute gastro-enteritis in this age group merits hospital care when diagnosed; it can be too hazardous an illness for domiciliary treatment.

(c) *Congenital anomalies*

(i) *Spina bifida cystica and hydrocephalus*. Of the 679 infant deaths 35 were associated with congenital spina bifida cystica, hydrocephalus, or both conditions (5 per cent of all deaths); 23 of these infants were girls, 12 were boys. In 24 instances both a myelomeningocele and hydrocephalus were present; in 6 there was a myelomeningocele alone and in 5 hydrocephalus existed alone.

It would seem that all these infants were reviewed in the early neonatal period and a decision taken on the desirability of surgical treatment. Half the cases (18) were not considered suitable for surgery, half (17) were surgically treated by repair and, where and when necessary, relief of intracranial pressure. In both categories, "treated" and "not treated", the age range of survival was from 5 to 47 weeks, with an average of 21 weeks in the "treated" group and 19 in those "not treated".

The cause of death was frequently complex but a simple breakdown of causes is given in Table 5.7.

TABLE 5.7
Cause of death in 35 infants with spina bifida cystica/hydrocephalus

Cause of death	No.
Increased intracranial pressure	10
Meningitis	8
Respiratory infection	7
Septicaemia or bacterial endocarditis	3
Gastro-enteritis	3
Urinary tract infection	2
Cerebral infarction	1
Cardiac failure	1

In none of these deaths was there considered to be an avoidable factor. In 3 instances sudden unexpected death occurred.

(ii) *Down's syndrome*. In the study 24 deaths occurred in infants with Down's syndrome (3 per cent of all the deaths); 6 were boys and 18 were girls. Congenital heart disease was present in 15 of the infants; of this group 4 died directly of cardiac failure but in 11 instances cardiac failure was precipitated by respiratory infection. Of the 9 deaths unassociated with congenital heart disease 5 were the result of bronchopneumonia and 4 resulted from gastro-enteritis. These figures emphasize the vulnerability of Mongol infants to infection as well as the importance of respiratory infection in this age group. In 2 instances death came into the sudden unexpected category, the infants exhibiting no signs of acute illness prior to being found dead in their cots; one infant had congenital heart disease, both were shown to have early acute pulmonary infections.

The age of the mothers of this group of infants is given in Table 5.8 and it shows the expected pattern of distribution.

TABLE 5.8

Down's syndrome—maternal age

Age of mother	No. of infants
20-24 years	4
25-29 years	4
30-34 years	4
35-39 years	1
40-44 years	9
Not known	3

In none of these deaths was there considered to be an avoidable factor.

(iii) *Congenital heart disease*. Of the 679 deaths in the series 96 were associated with congenital heart disease; 42 males and 54 females were involved and 9 of the 96 infants were illegitimate. Many of these deaths occurred in the early weeks of the postneonatal period, 56 (or 58 per cent) occurring by the end of the twelfth week, and 77 (or 80 per cent) by the end of the twentieth week.

In three instances, although congenital anomalies were known to be present, sudden unexpected death occurred; in two of these the infant also had Down's syndrome. In all, 15 of the infants with congenital heart disease had Down's syndrome; association with other congenital anomalies are shown in the detailed tables.

Many of the infants in this group had severe abnormalities incompatible with life, but in others cardiac failure was precipitated by respiratory tract infection. An avoidable factor was considered to be present in one out of the 96 deaths.

TABLE 5.9

Congenital heart disease. Females. No other congenital anomaly

Cardio-vascular anomalies	Age (weeks) at death	Cause of death
Large atrio-ventricular canal, underdeveloped mitral and tricuspid valve cusps and marked incompetence	14	Cardiac failure in association with operation
Patent ductus arteriosus	22	Cardiac failure and pneumonia
Tricuspid atresia, pulmonary stenosis	39	Cardiac failure
Transposition of the great vessels, pulmonary stenosis, patent ductus arteriosus	7	Cardiac failure
Tricuspid atresia	18	Cardiac failure in association with operation
Defect of interventricular septum	6	Cardiac failure
Mitral endocarditis	12	Cardiac failure
Pulmonary trunk greater than aorta, right ventricular hypertrophy, gross abnormalities of cusps of mitral and tricuspid valves	12	Cardiac failure
Severe cyanotic heart disease (no post-mortem)	10	Cardiac failure
Defect of interventricular septum, patent ductus arteriosus, coarctation of the aorta	14	Cardiac failure
Aortic atresia, patent ductus arteriosus	4	Cardiac failure
Aortic atresia, patent ductus arteriosus	4	Cardiac failure
Cardiomyopathy	6	Cardiac failure
Double aortic arch	7	Post-operation
Total anomalous venous drainage, hypoplasia of left ventricle and atrium, interauricular septal defect, cor triatriatum	18	Cardiac failure in association with operation
Endocardial fibroelastosis	9	Cardiac failure
Defect of interventricular septum, coarctation of aorta	4	Post-operative
Total anomalous venous drainage, defects of interventricular and interauricular septa, patent ductus arteriosus	4	Cardiac failure
Defect of interventricular septum	8	Cardiac failure
Pulmonary vein atresia, right ventricular hypoplasia, defect of interventricular septum, patent ductus arteriosus	42	Cardiac failure
Atrioventricular canal, defects of interventricular and interauricular septa, splitting of mitral and tricuspid valves	33	Post-operative
Defect of interventricular septum, dextrocardia	18	Broncho-pneumonia

TABLE 5.9—*Congenital heart disease. Females. No other congenital anomaly—continued*

Cardio-vascular anomalies	Age (weeks) at death	Cause of death
Defect of interauricular septum, coarctation of aorta, fibroelastosis	12	Cardiac failure
Truncus arteriosus arising from right ventricle	10	Cardiac failure in association with operation
Transposition of the great vessels, coarctation of the aorta, patent ductus arteriosus	7	Cardiac failure in association with operation
Endocardial fibroelastosis	14	Cardiac failure
Transposition of the great vessels	6	Post-operative
Defects of interventricular and interauricular septa, hypoplastic pulmonary artery and over-riding aorta	25	Cardiac failure
Total anomalous pulmonary venous drainage	15	Cardiac failure
Pulmonary atresia	7	Cardiac failure in association with operation
Coarctation of aorta	16	Cardiac failure
Defect of interventricular septum	8	Broncho-pneumonia
Transposition of the great vessels	44	Broncho-pneumonia
Transposition of the great vessels	7	Broncho-pneumonia
Defect of interauricular septum, mitral atresia	4	Cardiac failure
Coarctation of aorta	11	Cardiac failure

TABLE 5.10
Congenital heart disease. Females with other anomalies

Cardio-vascular anomalies	Other congenital anomalies	Age (weeks) at death	Cause of death
Defect of interauricular septum, tricuspid pulmonary valve, right ventricular hypertrophy	Hydronephrosis, adrenal and thymic hypoplasia, occipital myelomeningo-coele	7	Broncho-pneumonia
Cyanotic heart disease (no P.M.)	Bilateral cataracts, poly and syndactyly, abnormal genitalia, small head, short clavicles. No chromosome abnormality.	6	Cardiac failure
Defects of inter-ventricular and interauricular septa	Mongol	10	Cardiac failure
Defect of interventricular septum, tricuspid atresia, patent ductus arteriosus	Multiple abnormalities Trisomy 17 18	5	Cardiac failure
Defect of interauricular septum	Mongol. Duodenal atresia	6	Cardiac failure
Severe cyanotic heart disease (no P.M.)	Mongol	40	Cardiac failure
Defect of interventricular septum	Choanal atresia	17	Cardiac failure
Defect of interventricular septum	Mongol	6	Cardiac failure
Defects of interventricular and interauricular septa	Mongol	27	Cardiac failure
Congenital heart block	Mongol	7	Broncho-pneumonia
Cyanotic heart disease (no P.M.)	Mongol	23	Cardiac failure
Severe heart disease (no P.M.)	Hiatus hernia	52	Cardiac failure
Severe heart disease (no P.M.)	Mongol	9	Cardiac failure
Severe heart disease (no P.M.)	Mongol	19	Cardiac failure
Severe heart disease (no P.M.)	Mongol	30	Cardiac failure
Defects of interventricular and interauricular septa right ventricular hypertrophy, aortic stenosis	Mongol	28	Broncho-pneumonia
Single ventricle, defect of interauricular septum	Odd-looking, suspected unconfirmed chromosome abnormality	4	Cardiac failure
Defect of interventricular and interauricular septa malformation of atrioventricular valves	Annular pancreas	24	Cardiac failure
Cyanotic heart disease (no P.M.)	Mongol	13	Cardiac failure

TABLE 5.11

Congenital heart disease. Males. No other congenital anomalies

Cardio-vascular anomalies	Age (weeks) at death	Cause of death
Transposition of the great vessels	9	Cardiac failure
Defect of interventricular septum, dextrocardia	6	Cardiac failure
Transposition of the great vessels, pulmonary atresia, patent ductus arteriosus, dextrocardia	29	Cardiac failure
Defects of interventricular and interauricular septa, corrected transposition of the great vessels	16	Cardiac failure in association with operation
Tricuspid atresia	6	Cardiac failure
Fallot's tetralogy	47	Respiratory infection and cerebralvenous thrombosis
Transposition of the great vessels	12	Cardiac failure
Gross deformity of the aortic valve	10	Cardiac failure
Fallot's tetralogy	18	Cardiac failure
Truncus arteriosus	9	Cardiac failure in association with operation
Defect of interventricular septum	9	Cardiac failure
Anomalous pulmonary venous drainage, defect of intra-auricular septum	5	Cardiac failure in association with operation
Coarctation of aorta	19	Cardiac failure
Transposition of the great vessels	6	Cardiac failure
Patent ductus arteriosus	4	Cardiac failure
Transposition of the great vessels	14	Cardiac failure
Congenital absence of pulmonary veins	4	Cardiac failure
Fallot's tetralogy	12	Broncho-pneumonia
Transposition of the great vessels, defect of intra-ventricular septum, single atrium	5	Cardiac failure
Defect of interventricular septum	31	Cardiac failure
Endocardial fibroelastosis	19	Cardiac failure
Pulmonary atresia	15	Post-operative
Transposition of the great vessels	5	Cardiac failure
Total anomalous venous drainage, defect of interauricular septum	25	Cardiac failure in association with operation
Coarctation of aorta, patent ductus arteriosus	10	Respiratory infection
Pulmonary atresia, defect of interventricular septum	5	Cardiac failure
Endocardial fibroelastosis	14	Broncho-pneumonia

TABLE 5.12

Congenital heart disease. Males with other anomalies

Cardio-vascular anomalies	Other congenital anomalies	Age (weeks) at death	Cause of death
Fallot's tetralogy, mitral atresia, bicuspid pulmonary valve	Agenesis of kidney	17	Cardiac failure
Patent ductus arteriosus, atretic aortic arch	Hydronephrosis	4	Cardiac failure
Fallot's tetralogy, patent ductus arteriosus	D13-15 Trisomy arhinencephaly	12	Cardiac failure
Coarctation of aorta, patent ductus arteriosus	Clinical appearance suggestive of chromosome abnormality, webbed toes, talipes equinovarus	4	Broncho-pneumonia
Defects of interventricular and interauricular septa	Hydronephrosis	5	Broncho-pneumonia
Severe cyanotic heart disease (no P.M.)	Mongol	11	Cardiac failure
Dextrocardia	Situs inversus	5	Cardiac failure
Severe heart disease (no P.M.)	Mongol	10	Cardiac failure
Aortic stenosis, endocardial fibroelastosis	Hypospadias	17	Cardiac failure
Severe heart disease (no P.M.)	D13-15 Trisomy	10	Cardiac failure
Defect of interventricular septum and endocardial cushion	Hare-lip and cleft palate, dislocation of hip, absent kidney, undescended testes, congenital hernia	6	Peritonitis, operation for hernia
Patent ductus arteriosus	Bilateral cataract (rubella)	33	Broncho-pneumonia
Fallot's tetralogy	Myelomeningocele	9	Cardiac failure
Aorto-pulmonary fistula and defect of inter-ventricular septum	Unusual appearance of face and hands, probable chromosome abnormality	23	Cardiac failure
Severe heart disease (no P.M.)	Mongol	14	Broncho-pneumonia

(iv) *Others*. Twenty-five infants died of the effects of a variety of other congenital anomalies; 14 of the group were boys, 11 were girls and 4 of the infants were illegitimate. The various anomalies present are shown in Table 5.13.

TABLE 5.13

Deaths from congenital anomalies—other

Anomaly	Sex	No.	Age in weeks at death
Cleft palate and lip	F	1	43
Congenital hypertrophic pyloric stenosis	F	1	5
	M	1	5
Duodenal atresia (partial)	F	1	11
Megacolon	M	2	8, 21
Imperforate anus	M	1	6
Atresia of bile ducts	F	1	44
	M	1	31
Urethral valve and hydronephrosis	M	3	25, 47
Adrenogenital syndrome	F	1	13
	M	1	16
Trisomy 13 15	F	2	7, 39
Amytonia congenita	M	1	13
Osteopetrosis	F	1	35
Microcephaly	F	1	26
Multiple anomalies—skeletal, renal, brain	F	1	7
	M	3	4+, 35, 51

Avoidable factors were considered to be present in 7 of the 25 deaths, which contrasts with the low incidence in the larger groups of congenital anomalies described earlier. Failure of the mother to appreciate the situation in three of the digestive tract cases ultimately led to the admission of their desperately ill infants to hospital. Hospital treatment was not fully effective in two instances; in one an imperforate anus was not diagnosed at home for 7 days despite visits from

general practitioner and midwife, and in the other instance the difficulties of dealing with a complicated situation in the infant were aggravated by severe social complications.

A group such as this does present diagnostic difficulties; rarity, as with the salt-losing adrenogenital syndrome, may result in it not coming readily to mind—but this condition has pointers which should have led to an early diagnosis and effective treatment; silent anomalies may produce insuperable problems—in one case a renal tract anomaly was silent until 36 hours before death from infection; failure to thrive, or failure to gain, may be an early indication of some underlying congenital anomaly or other pathology, and should not be dismissed without study.

(d) *Meningitis*

In the series meningitis accounted for 14 deaths, 9 male infants and 5 female. In 5 instances the meningitis was of meningococcal origin, in 3 *H. influenzae* was responsible and there was one case of tuberculous meningitis. Details are given in Table 5.14 and these show the vulnerability of infants to the coccal infections in the early weeks of infancy.

TABLE 5.14
Deaths from meningitis

Infesting organism	Sex	Age in weeks at death	Social class	Month of death
Meningococcus	F	9	III	November
	F	10	V	January
	F	13	III	October
	M	44	III	February
	F	5	?	April
Pneumococcus	M	6	III	December
	M	11	III	February
	M	6	III	June
	M	5	V	March
	M	41	IV	November
<i>H. influenza</i>	F	36	V	October
	M	37	V	February
	M	31	IV	July
<i>M. tuberculosis</i>	M	30	III	September

Two points in particular stand out in the information received on the deaths from meningococcal, pneumococcal and *H. influenzae* meningitis. Firstly, in practically every case there was mention of acute overwhelming infection, with

rapid deterioration and death, often in hours. Secondly, the clinical picture tended to be atypical and to present diagnostic difficulties; this seemed to be especially so in the *H. influenzae* cases in which there was usually a septicaemic onset with meningeal signs occurring late. It seems clear that any suspicion of a meningeal infection in this age group brooks of no delay in admission to hospital.

The story of the child with tuberculous meningitis has been mentioned earlier in considering avoidable factors. He was diagnosed in hospital as suffering from tuberculous meningitis, but did not respond to treatment. His grandfather, who lived with the family, was being treated for pulmonary fibrosis, of which the cause only became obvious when the infant's illness was diagnosed—one of the tragic pitfalls of medicine.

(e) *Encephalitis and encephalopathy*

Twelve infants (6 boys and 6 girls) died with the diagnosis of encephalitis or encephalopathy. The details are briefly summarized in Table 5.15.

TABLE 5.15

Cause of death	Sex	No.	Age in weeks at death
Influenzal encephalitis	M	1	23
Viral encephalitis	M	1	10
	F	2	35, 44
Proteus meningoencephalitis	M	1	4+
Encephalopathy	M	3	17, 6, 40
	F	4	28, 27, 30

The striking feature of the deaths from viral encephalitis was the speed of progress and rapidity of death; in one instance the infant was playing normally, had a convulsion, became unconscious and rapidly died.

Of the 7 instances of encephalopathy 4 were thought to be possible examples of the illness described by Reye and his colleagues (1963) in which an acute encephalopathy was associated with fatty infiltration of the liver and kidneys. Bradford and Latham (1967) were able to collect over 80 cases of this syndrome for their review article. Some of the details of the few infants in this enquiry are given in Table 5.16.

Enquiry failed to elicit any common toxic agent which might have had an aetiological significance. Huttenlocher and his colleagues (1969), reporting on their observations on 10 patients, have become convinced that this is a clearly defined disorder and suggest that hepatic failure and resulting ammonia intoxication may be contributing factors in the pathogenesis of the encephalopathy. However, the problems in this field are demonstrated by the case of one of the

infant deaths in the survey which had clinically conformed to Reye's syndrome and was said to be biochemically compatible with it but at autopsy showed no visceral fatty degeneration.

TABLE 5.16

Possible cases of Reye's syndrome

	1	2	3	4
Sex	F	F	M	F
Age of death	45	30	40	28
Onset	Upper resp. infection	Vomiting, pallor	Upper resp. infection, pallor	Upper resp. infection, pallor
Vomiting	✓	✓	✓	✓
Change of consciousness	✓	✓	✓	✓
Respiratory rhythm change	—	✓	—	✓
Liver—pale, fatty degeneration	✓	✓	✓	✓
Brain—changes of encephalopathy	✓	✓	✓	✓
Kidneys—fatty degeneration of tubules	✓	✓	—	—

(f) *Cystic fibrosis*

Ten of the infants who died suffered from cystic fibrosis; 4 of them were boys and 6 girls. Details are shown in Table 5.17.

TABLE 5.17

Deaths from cystic fibrosis

Sex	Age in weeks at death	Social class	Cause of death
M	13	III	Respiratory infection
M	16	III	Respiratory infection
M	39	?	Gastro-enteritis
M	43	IV	Respiratory infection
F	7	IV	Post-operative + respiratory infection
F	10	III	Post-operative
F	10	III	Respiratory infection
F	11	IV	Respiratory infection
F	14	III	Respiratory infection
F	21	III	Respiratory infection

These few cases point to the lethal effect of cystic fibrosis in early infancy; 8 of the deaths took place between the first and fifth months. There is a need to be aware of the possibility of this disease in early infancy and its variability in presentation, e.g. respiratory, intestinal, failure to thrive. Early and intensive treatment, especially of the respiratory manifestations which are such a significant feature of these deaths, and continued control of infection has been shown to result in improvement in mortality and morbidity.

(g) *Malignant disease*

Seven infants died as a result of malignant disease; 4 were males and 3 females. Details are given in Table 5.18.

TABLE 5.18

Deaths due to malignant disease

Sex	Age in weeks at death	Social class	Length of illness	Cause
M	36	IV	10 weeks	Haemangioendothelioma—skull
M	48	II	6 weeks	Retroperitoneal neuroblastoma
M	33	III	?	Cerebellar medulloblastoma
M	6	I	6 weeks	Ependymoma of midbrain
F	23	V	2 days	Acute monoblastic leukaemia
F	11	I	?	Acute leukaemia
F	9	I	2 weeks	Retroperitoneal neuroblastoma

This is a small group of cases which demonstrates the type of lesion and speed of progress which one would expect in this group. The social class distribution with its emphasis on the higher classes is of interest and this tendency has been noted by others.

(h) *Infectious fevers*

Seventeen infants died as a result of specific infectious fevers; 5 were boys and 12 girls.

Whooping cough accounted for 13 of the deaths, 7 of which were associated with bronchopneumonia. Of the whooping cough deaths 9 occurred between the fifth and eleventh weeks of life. In two of the later age-group cases immunization had not been carried out because of clinical contra-indications. One infant caught whooping cough from an elder sibling who had not been immunized.

Measles accounted for two of the infant deaths; in each case there appeared to be failure of the mother to recognize at an early stage that the child was ill—one died quite suddenly at home, and this is the only child in this general group that was not admitted to hospital.

The remaining two deaths resulted from chicken-pox—in one case a subdural

abscess developed secondary to infected chicken-pox lesions and the other was associated with hypogammaglobulinaemia.

(i) *"Surgical abdomens"*

Eleven deaths occurred in infants with "surgical abdomens", in each case there was an element of obstruction; 8 of the infants were males, 3 were females. Details of these cases are given in Table 5.19.

TABLE 5.19

Deaths resulting from "surgical abdomens"

Sex	Age in weeks at death	Social class	Abdominal condition
M	20	III	Strangulated inguinal hernia
M	7	III	Strangulated inguinal hernia
M	12	III	Strangulated inguinal hernia
M	5	IV	Strangulated inguinal hernia
F	15	III	Intussusception—jejunum
F	20	III	Intussusception
M	35	III	Intussusception
M	9	III	Volvulus
F	8	II	Loop obstruction of gut
M	8	III	Faecal obstruction
M	4+	IV	Intestinal obstruction, cause undetermined

Some avoidable factor was considered to be present in 7 of these deaths. In three of the cases of strangulated inguinal hernia there was delay before admission to hospital was effected; parents, general practitioners and hospitals were all involved. It is perhaps not sufficiently realized that strangulated inguinal hernia is not an uncommon occurrence in infancy. In other cases avoidable factors were associated with delay in obtaining effective treatment, and it is clear that the young infant with an obstructive intestinal lesion is at risk, a risk that increases and becomes extremely serious with delay in treatment.

(j) *Accidents nad violence*

Twenty-five infants suffered death as a result of accident or violence; 15 were boys, 10 were girls.

These deaths can be grouped broadly into those resulting from the effects of fire, those associated with falls or similar incidents, and those resulting from wilful violence. Table 5.20 gives some details of the three groups.

TABLE 5.20

Deaths due to accident or violence

Group	Sex	No. of cases	Ages in weeks at death	Cause and/or circumstances of death
1. Effects of fire	M F	3 3	30, 38, 48 11, 13, 32	Asphyxia (4), burns (2) Ineffective fireguard, defective wiring, paraffin heater (3), unexplained
2. Accidents:				
(i) Falls	M F	5 2	22, 36, 46, 47, 48 24, 28	Intracranial haemorrhage Intracranial injury— Car passenger, pram struck by car Subdural haemorrhage Inhalation of nut, accidental strangulation
(ii) Road accidents	M	2	21, 40	
(iii) Accidental blow	M	1	15	
(iv) Asphyxia	F	2	13, 48	
3. Wilful violence	M F	5 1	6, 7, 8, 9, 16 26	Cerebral trauma

Of the total group, 6 of the infants were illegitimate and 2 of these were subjected to wilful violence. In this third group in which infants in the early age range tended to feature there were profound social factors involved which proved too great for the social and other support available.

Infants in the wilful violence sub-group were subjects of the "Battered-Child Syndrome", the term coined by Kempe (1962) to denote the clinical condition in young children subjected to serious physical abuse. Identification of the syndrome is important, for the child who recovers from an episode and is returned unsupervised to his home runs the risk of further injury; in families in which one child has been battered there is the risk that subsequent children may be treated in a similar manner. Kempe maintains that the syndrome should be considered in any child exhibiting evidence of fracture of any bone, subdural haematoma, failure to thrive, soft tissue swellings or skin bruising, also in any child who dies suddenly, or where the degree and type of injury is at variance with the history given. The total situation needs to be taken into account, including parental attitudes and social factors. The British Paediatric Association (1966) produced a memorandum on "The Battered Baby" containing comprehensive recommendations on the action to be taken when such cases are suspected or identified, and the effective implementation of these recommendations could go some way to preventing a degree of infant distress and death.

As would be expected, excluding the violent deaths, the infants in the whole group tend to be older than those dying, for example, from respiratory infections. Especially as far as accidental falls are concerned, increasing mobility brings with it some hazard to the infant. Avoidable factors were considered to play some part in 18 of this group of deaths, the three important elements being serious social problems, parental neglect and parental inadequacy.

6. SUDDEN AND UNEXPECTED DEATH IN INFANCY

Sudden and unexpected death in infancy, often referred to as the "cot death" in this country, is of major importance in the postneonatal period. It occurs when a child considered to be in good health or, at most, to be suffering from some trifling illness and there being no thought of a fatal outcome is found unexpectedly dead.

In the present enquiry 250 deaths were considered to come into this category, 37 per cent of the total of postneonatal deaths, 10 per cent of all infant deaths, or some 2 deaths per 1,000 live births, in the areas concerned. These figures suggest that on a national scale there might be some 1,600 infant deaths occurring annually coming into the category. Banks (1958) estimated that "cot deaths" accounted for over 20 per cent of the mortality in the age group concerned, and that over 1,400 such deaths occurred in England and Wales in 1955. Banks (1965) estimated that annually in England and Wales there are about 1,090 sudden unexplained deaths in infancy, about 1.4 per 1,000 live births. Figures from other studies, both in this country and abroad, broadly conform to this estimate.

Of the 250 sudden and unexpected deaths in the enquiry, 149 or 60 per cent occurred in boys, 101 or 40 per cent in girls. The excess of males is a common finding in studies in this field, although there are exceptions, e.g. Banks (1965) and Cooke and Welch (1964) with 49 per cent males, and Cameron and Asher (1965) with 46 per cent males.

The age at death of these infants is shown in Table 6.1 and visually portrayed in Figure 6.1.

TABLE 6.1

Age at death of 250 infants—sudden and unexpected death

Age in weeks	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
No.	52	46	55	28	17	12	4	11	7	10	4	4
% of group	21	18	22	11	7	5	2	4	3	4	2	2

These figures reflect the experience of other studies in showing the importance of this syndrome in the early months of the postneonatal period. Over 60 per cent of these deaths in the enquiry occurred between the ends of the fourth and the sixteenth weeks of life, and some 80 per cent were during the first five months of the postneonatal period.

An analysis (Table 6.2) of the 250 deaths in the group by month of occurrence shows the commonly found higher incidence in January and December; in this there is a relationship to respiratory infection which will be dealt with later. Apart from these two months, and the low figure for August, there is no obvious seasonal effect when the whole group is considered.

FIGURE 6.1
AGE AT DEATH - 250 INFANTS
SUDDEN AND UNEXPECTED DEATH

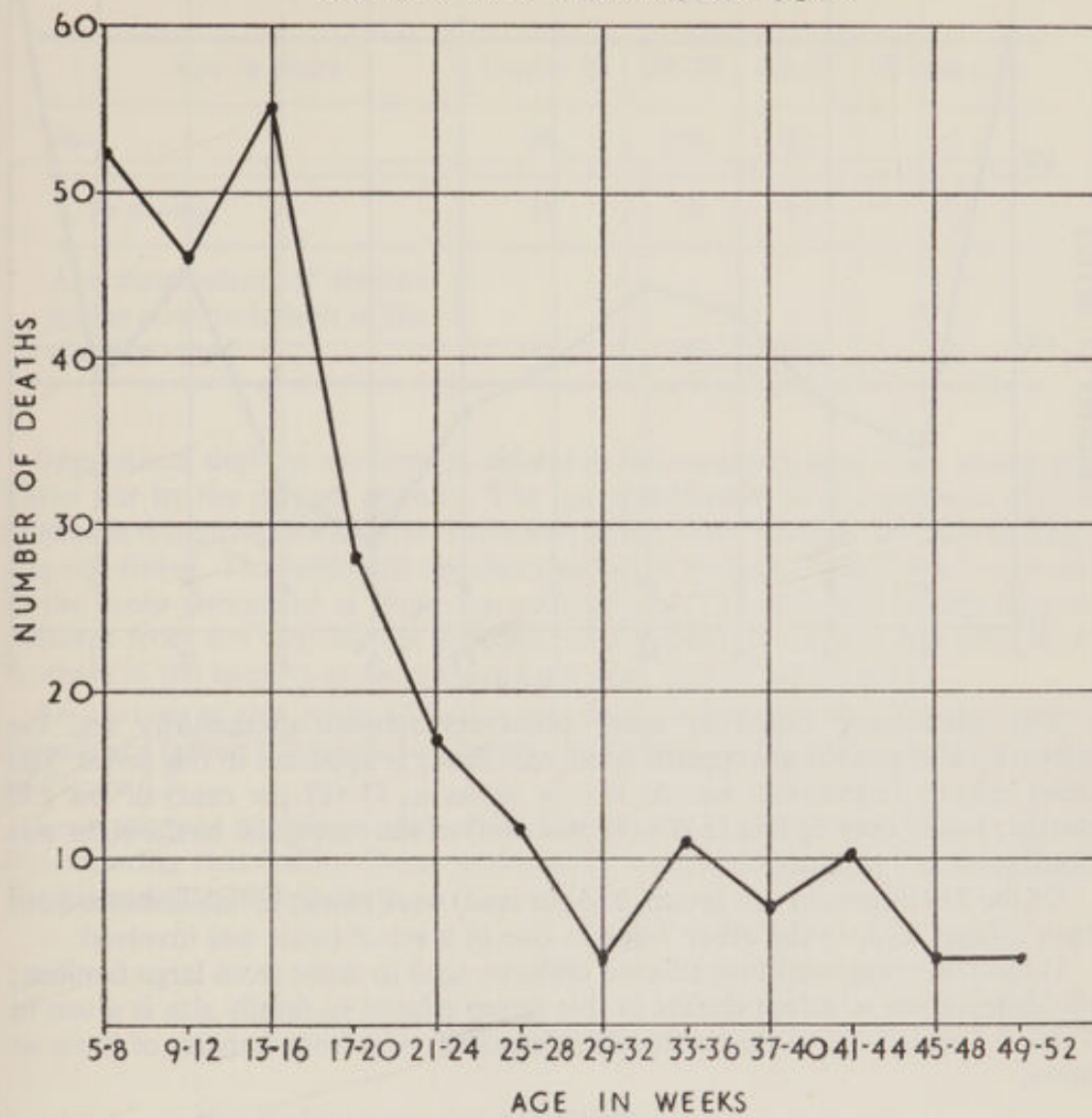
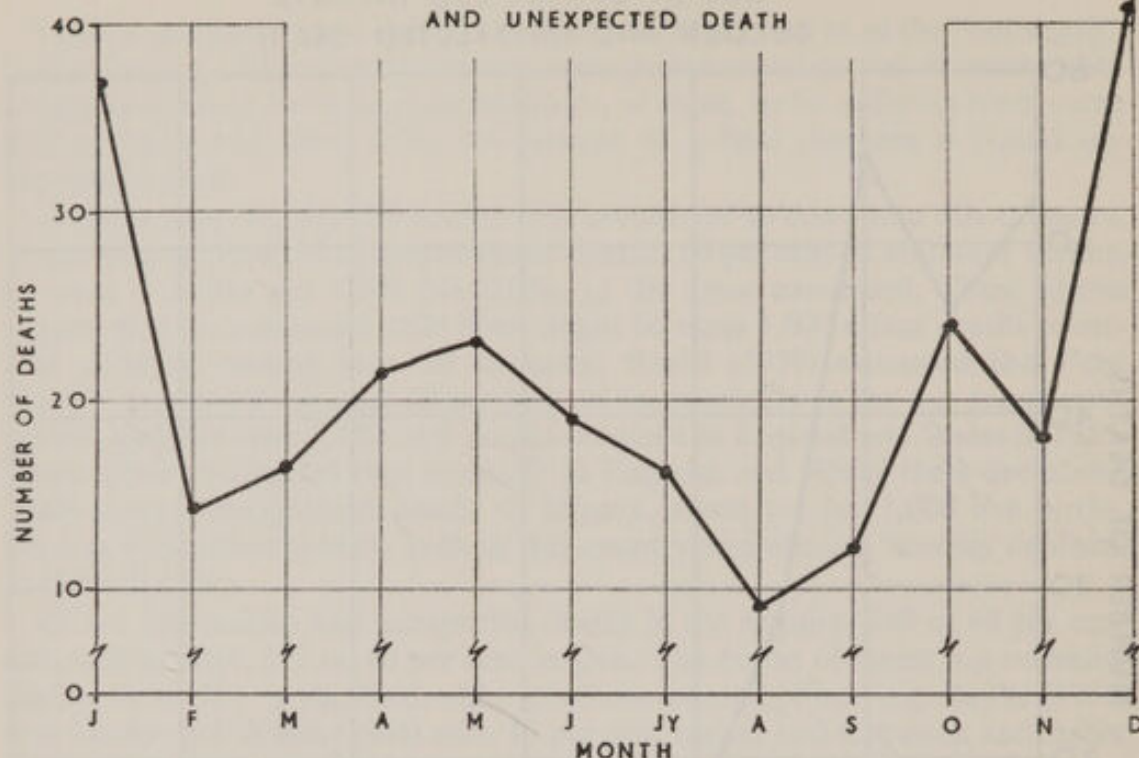


TABLE 6.2

Month of death of 250 infants—sudden and unexpected death

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No.	36	14	16	21	23	19	16	9	12	24	18	42
% of group	14	6	6	8	9	8	6	4	5	10	7	17

FIGURE 6.2

MONTH OF DEATH - 250 INFANTS - SUDDEN
AND UNEXPECTED DEATH

The relationship noted by many observers between prematurity and the occurrence of sudden unexpected death in infancy is apparent in this series. The dead infant's birthweight was $5\frac{1}{2}$ lbs. or under in 43 (17 per cent) of the 250 deaths; it was over $5\frac{1}{2}$ lbs. in 204 (82 per cent) of the cases; the birthweight was not known in 3 instances.

Of the 250 infants in this group, 9 (4 per cent) were twins; in one instance both twin infants died, in the other 7 deaths one of a set of twins was involved.

It has been suggested that affected children tend to come from large families; the distribution of infant deaths in this group related to family size is given in Table 6.3 which shows that rather less than half were from families of three or more.

TABLE 6.3
Number of children in family (including deceased infant)

Children	1	2	3	4	5+	Not known
No. of infant deaths	58	72	60	26	27	7
% of group	23	29	24	10	11	3
National Distribution of children in families*	45	34	13	5	3	—

* From Census 1961 England and Wales. Household Composition Tables, H.M.S.O. Table 31 Families: Household type by Children by Family Type.

TABLE 6.4

Maternal age—220 sudden unexpected infant deaths

Age in years	Under 20	20-29	30-39	40 and over
No.	34	156	25	5
% in group	16	71	11	2
Age distribution of women giving birth to infants in the enquiry areas	11	63	23	3

Suggestions that the mothers of infants in this category tend to be young are borne out by the present enquiry. The age distribution of the mothers of 220 infants in this group is shown in Table 6.4; in the other 30 cases the maternal age was not stated. The estimated age distribution of women giving birth to infants in the areas concerned is given for comparison. The observed distribution is different from the distribution expected on the basis of the age distribution of mothers in the enquiry areas at the 0.1 per cent level of significance.

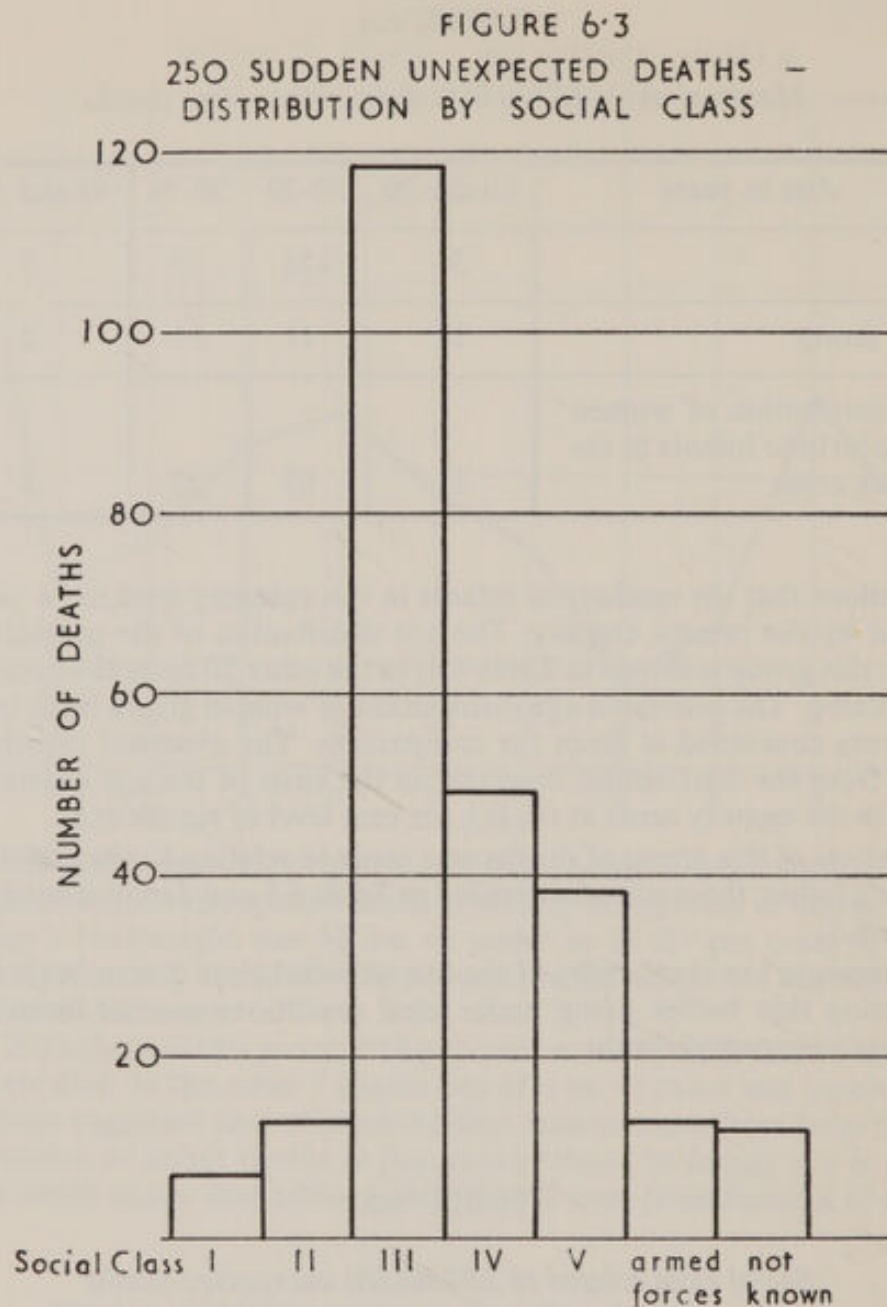
An analysis of this group of deaths was made in relation to the social class of the infant's father, the results are detailed in Table 6.5 and demonstrated visually in Figure 6.3.

Some increase in vulnerability of the lowest social class is seen but it is worth remembering that babies living under ideal conditions are not immune from sudden and unexpected death.

TABLE 6.5

Social class related to 250 sudden unexpected deaths

Social class	I	II	III	IV	V	Armed forces	Not known or indefinite
No.	7	13	118	49	38	13	12
% of group	3	5	47	20	15	5	5



The 250 instances of sudden unexpected death were grouped according to the pathological finding at post-mortem and could be roughly divided into four categories:

- (i) Those with respiratory infections.
- (ii) Those with gastro-intestinal infections.
- (iii) Those dying from asphyxia in the absence of demonstrated underlying disease.
- (iv) Others.

The distribution of all the deaths between these categories is shown in Table 6.6.

TABLE 6.6

Sudden and unexpected deaths—groupings

Cause of death at post-mortem	No.	% of group
Respiratory infection	167	67
Gastro-intestinal infection	12	5
Asphyxia	56	22
Other	15	6

The respiratory group

This group which accounts for some two-thirds of the sudden unexpected deaths includes those infants in which the diagnosis of acute bronchitis, acute bronchiolitis or acute broncho-pneumonia was made as a result of a post-mortem examination. Acute broncho-pneumonia accounted for 96 (57 per cent) of the deaths, the lungs typically showing congestion, oedema, patchy collapse and consolidation. In a number of cases there was massive pulmonary consolidation. Acute bronchiolitis and acute bronchitis were responsible for 38 (23 per cent) and 33 (20 per cent) of the deaths respectively. In many cases of this respiratory group it was considered that there was an asphyxial element; in some there had been inhalation of regurgitated or vomited material and these cases may have been closely allied to some of those in the asphyxial group.

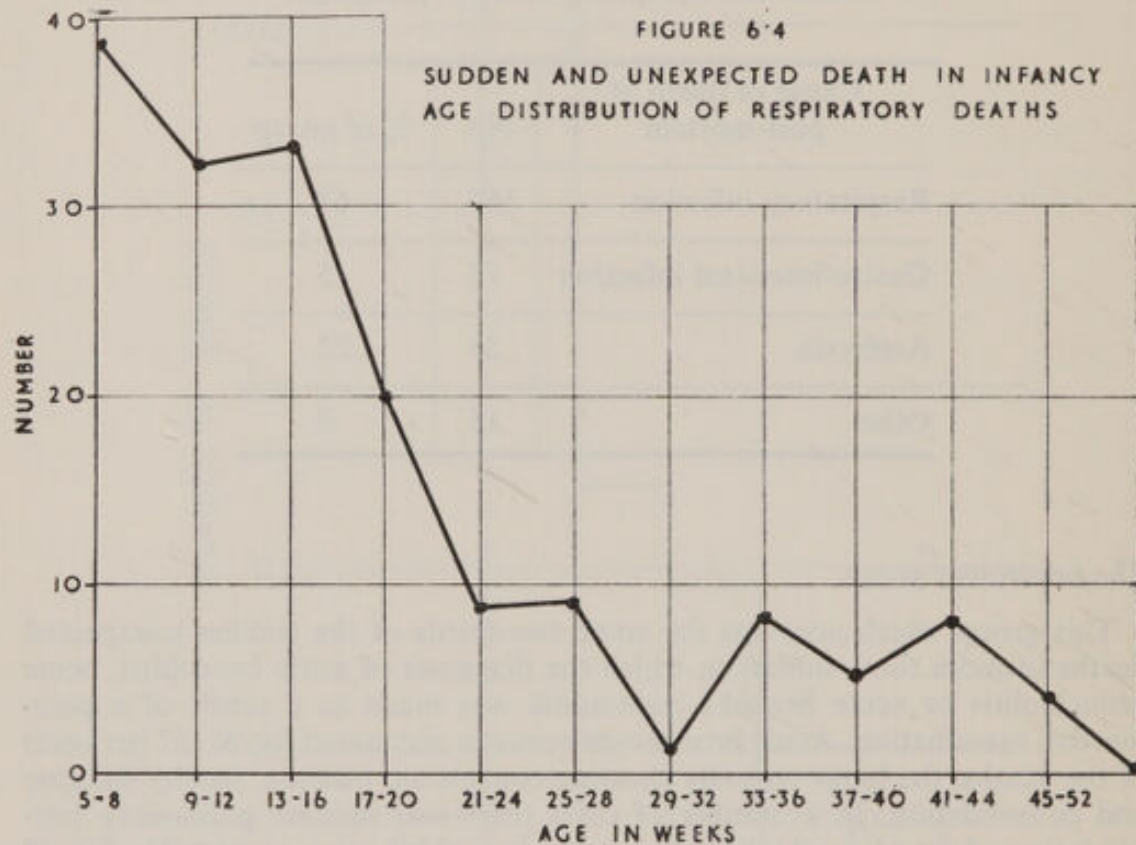
The majority of the 167 infants were not known to be ill before death occurred; a few had mild upper respiratory infections and 11 were receiving treatment from general practitioners for upper respiratory infections. It was not unusual to find a history of recent upper respiratory infection or bronchitis from which the child was considered to have made a complete recovery. One infant had been discharged from hospital "completely well" four days before death; post-mortem examination in this case showed a most extensive pulmonary consolidation. Most of these infants were found dead in their cots, a few were discovered alive but in a desperately ill condition and died before any medical aid could be given.

The age distribution of these infant deaths is shown in Table 6.7 and in Figure 6.4. Some three-quarters of the deaths occurred between the end of the fourth and the end of the twentieth week of life, a 16-week period.

TABLE 6.7

Age distribution of infants—respiratory sudden unexpected deaths

Age in weeks	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
No.	38	32	33	20	9	9	1	8	5	8	4	0
% of group	23	19	20	12	5	5	1	5	3	5	2	0

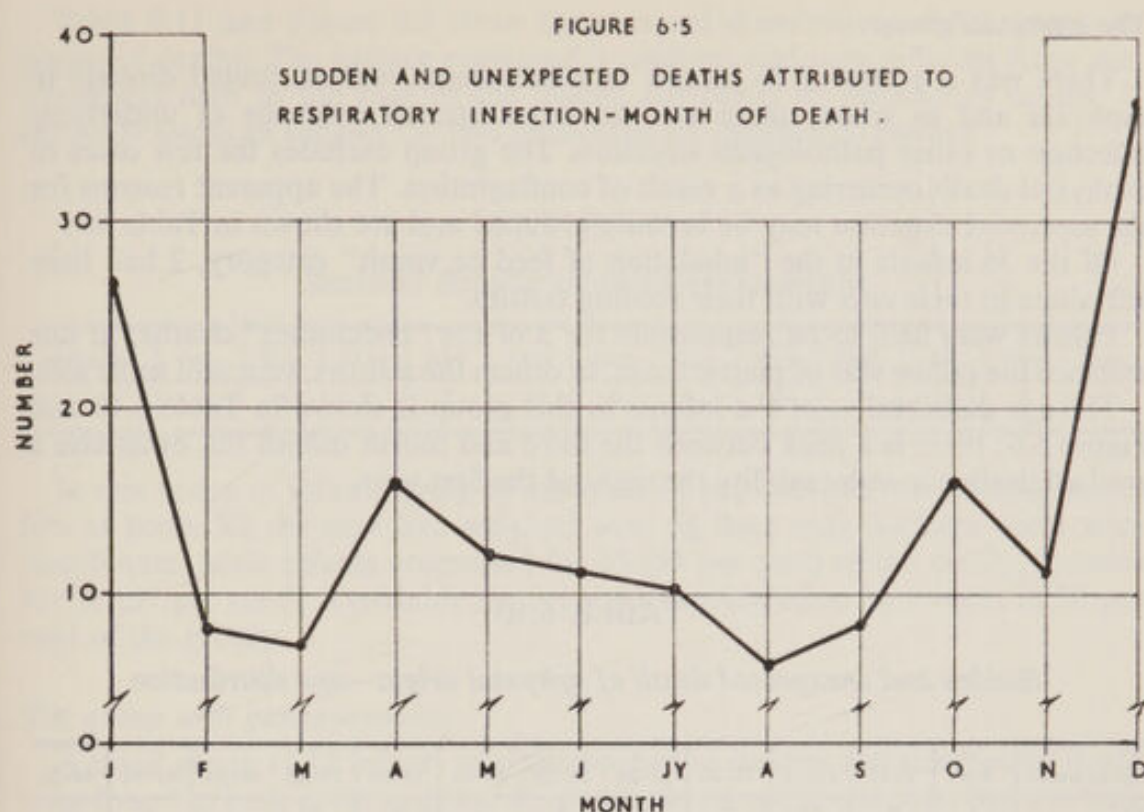


The seasonal distribution of sudden unexpected deaths attributed to respiratory infection is presented in Table 6.8 and Figure 6.5. The high figures for January and December, over two-thirds of these deaths occurred in these two months, and the general pattern of seasonal incidence emphasizes the importance of respiratory infection of some sort as an underlying feature of the sudden and unexpected deaths of infancy.

TABLE 6.8

*Sudden and unexpected deaths attributed to respiratory infection—
Month of death*

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. of deaths	26	8	7	16	12	11	10	6	8	16	11	36
% of total respiratory sudden deaths	16	5	4	10	7	6	6	3	5	10	6	22



In this group of infants 17 per cent had weighed $5\frac{1}{2}$ lbs. or under at birth, 83 per cent over $5\frac{1}{2}$ lbs.; 21 (13 per cent) of the infants were illegitimate. Male infants accounted for 99 (59 per cent) of the deaths, females for 68 (41 per cent) of the deaths in the group.

TABLE 6.9

Sudden and unexpected death—asphyxia—suggested causes

Apparent cause of asphyxia	No.
Regurgitation and inhalation of feed or stomach contents	36
Bedclothes	14
Side of carry-cot	2
Overlay	1
Enlarged thymus and vaso-vagal inhibition	1
Oedema glottidis	1
Undetermined	1

The asphyxial group

There was a group of 56 infants in whom death was attributed directly to asphyxia and in whom there was no demonstrated evidence of underlying infection or other pathological situation. The group excludes the few cases of asphyxial death occurring as a result of conflagration. The apparent reasons for the asphyxial situation may be broadly grouped and are shown in Table 6.9.

Of the 36 infants in the "inhalation of feed or vomit" category, 2 had been left alone in their cots with their feeding bottles.

Pillows were held to be responsible for 3 of the "bedclothes" deaths; in one instance the pillow was of plastic foam, in others the pillows were said to be soft.

The age distribution of the infants in this group is shown in Table 6.10 and Figure 6.6; there is a peak between the third and fourth month but otherwise a gradual decline in vulnerability throughout the first year.

TABLE 6.10

Sudden and unexpected death of asphyxial origin—age distribution

Age in weeks	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
No.	7	7	17	7	5	3	3	2	2	1	0	2

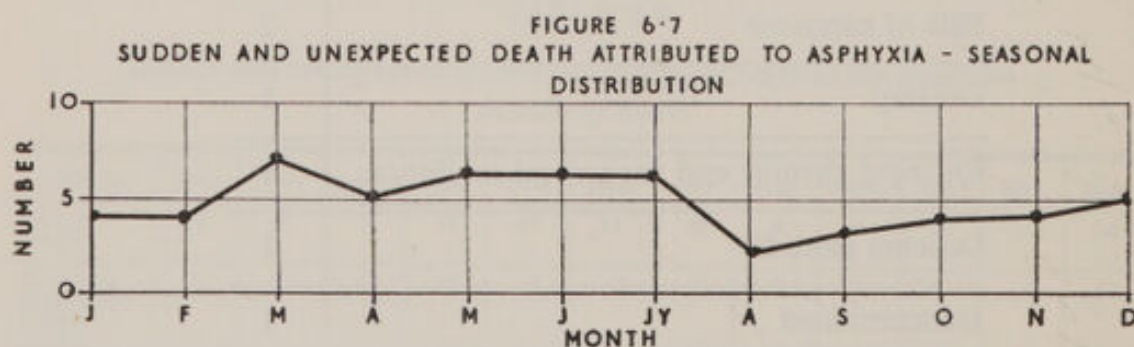
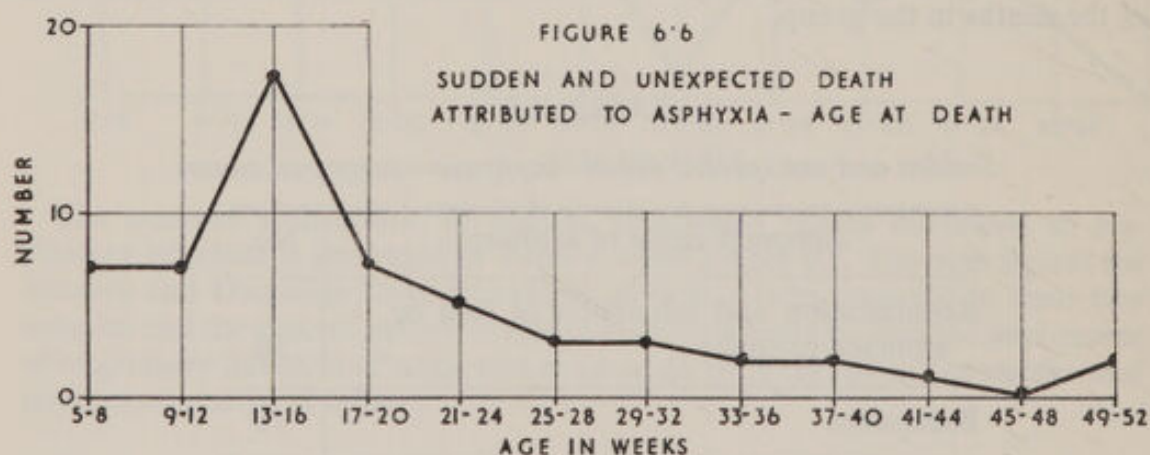


Table 6.11 and Figure 6.7 show the seasonal distribution of this asphyxial group of deaths. The pattern presented is uniform and very different from that previously seen in the case of the deaths attributed to respiratory causes. It certainly seems to suggest the two groupings are justified as entities.

TABLE 6.11
Seasonal distribution of asphyxial deaths

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No.	4	4	7	5	6	6	6	2	3	4	4	5

In this group of infants dying of asphyxia 18 per cent had weighed $5\frac{1}{2}$ lbs. or less at birth, 82 per cent had weighed over $5\frac{1}{2}$ lbs.; only 3 (5 per cent) were illegitimate. Male infants accounted for 35 (62 per cent) of the deaths, females for 21 (37 per cent). Avoidable factors were considered to be present in 36 per cent of the group.

The group with gastro-enteritis

A small group of 12 infants who succumbed to sudden and unexpected death were found to have acute gastro-enteritis which, except in one case, had not been recognized clinically before death. In these deaths there was an asphyxial element associated with vomiting.

Five of these infants died between the fifth and eighth week of life, and 8 of them between the fifth and sixteenth week, after which, in common with the respiratory infections, vulnerability appeared to be less. Seven of the deaths occurred in boys, 5 in girls, and in two instances the infant was illegitimate.

Other conditions associated with sudden or unexpected death

In 15 of the "cot deaths" a variety of pathological conditions was found. In 11 of them associated aspiration of vomit with possible asphyxia was found. In 5 instances acute otitis media was demonstrated at autopsy, 3 of the infants had spina bifida, 2 were mongols with congenital heart disease, and there was 1 case each of acute pyelonephritis, acute glomerulo-nephritis, peritonitis secondary to a volvulus of the small intestine, and malformation of the cardio-oesophageal junction allowing easy regurgitation.

These few deaths were spread throughout the age range and throughout the year; 8 were in boys, 7 in girls, and 1 occurred in an illegitimate infant.

Discussion

The incidence and importance of sudden unexpected death in infancy has been brought to notice repeatedly by numerous reports in the literature and the present enquiry confirms its place as a significant cause of infant loss. Much of the literature has been reviewed by Valdes-Dapena (1967), and her article, together with the proceedings of a conference held in Seattle on sudden death in infants [Wedgwood and Benditt (1966)], provide a comprehensive survey of the subject.

The host of hypotheses which have been put forward to account for this group of infant deaths will not be itemized again here, but those which have some bearing upon the present review will be discussed.

Parish and others (1960) put forward the view that hypersensitivity of the infant to cow's milk could result in an anaphylactic reaction and sudden death. It was postulated that antibodies may be developed to cow's milk proteins ingested by the infant; subsequently, in the sensitized child, regurgitation and inhalation of stomach contents may result in a fatal anaphylactic reaction. In the present enquiry a small number only of the asphyxial deaths was investigated from this point of view and no cow's milk sensitization was detected. Nevertheless many of the infants were shown at autopsy to have stomach contents or milk in the respiratory tract, even when there was some other underlying pathology; it may however be that the regurgitation and inhalation was a terminal event. It was unfortunate that in this enquiry no information was sought on any aspect of infant feeding; such material could have been of real value and this is perhaps a point for consideration in further surveys of this type. The work of Parish and his colleagues cannot be disregarded and there would seem to be virtue in repeating previous advice, that, in view of its possible role in preventing some cases of sudden death in infancy, as well as the other benefits which it confers, encouragement should be given to breast-feeding, especially in the early weeks of pregnancy.

An association with respiratory infection has been widely shown to exist and is well brought out in this series. There appears to be no really convincing evidence that the infants die as a direct result of sudden and overwhelming infection. However, Emery (1968) has put forward the credible suggestion that as a result of changes brought about in the lungs by infection, particularly virus infection, a variety of "vicious cycles" may be initiated which lead to the death of the infant. When, as a result of the pulmonary changes, "a degree of hypoxia has been set up there is cerebral ischaemia going on to brain oedema. This can produce convulsions and inco-ordinated activity, causing agonal intussusception of the small intestine and a terminal suffocating inhalation of regurgitated intestinal contents." This author also refers to the frequency of peripheral vascular collapse and a suggestion of cardiac failure; as has been seen earlier in this survey, this is the situation found frequently on admission to hospital of the child dying there rapidly with respiratory infection. Emery suggests that there is no one cause of death in these children, but that in any child there may be a combination of the factors described resulting in a series of rapidly developing "vicious cycles" from which the child suddenly succumbs.

A further interesting view, which associates sudden unexpected death with upper respiratory infection, was put forward recently by Shaw (1968) who points to the difficulty of young infants in adopting oral respiration and suggests that up to 6 months of age some seem almost incapable of oral respiration. He postulates, therefore, that nasal obstruction due to mild infection might well be the trigger for apnoea and asphyxia in these sudden deaths.

Froggatt and his colleagues (1968) deal widely with the epidemiology of sudden death in babies. They point out that it is unlikely that sudden unexpected death in infants is a homogeneous singly-caused entity and suggest that such deaths may be due to the interaction of several factors, each of which may be lethal only in the presence of others. They further suggest that respiratory

infection may merely increase the child's vulnerability to some other lethal mechanism, and that the general field of cardiopulmonary physiology may be involved. Dawes (1968) goes along similar lines for, from his studies, he suggests that modifications in the external form of the heart during the newborn period are accompanied by progressive elaboration of the neural control and conducting mechanisms which are incompletely developed at birth.

The present survey supports the view that there is no one trigger which fires the shot from which the infant succumbs, and in this respect the seasonal difference between the respiratory group and the asphyxial group is of interest. The outstanding feature is always the peak incidence of sudden deaths in the first 12 weeks or so of the postneonatal period. It is at this time that cardiopulmonary and neural physiological changes are taking place in the developing infant. Can it be that hypoxia from any cause may initiate the circumstances described by Emery (1968)? There is no doubt that there is room for a great deal more study in this field. It seems possible that in the physiological changes of early infancy lies the key to the problem and that further study therein might give some possible hope of prevention of this loss in infant life.

7. THE ILLEGITIMATE INFANTS

An analysis was carried out of the 82 infants who died and who were reported as being illegitimate, forming 12 per cent of the total series. Of the 82 infants 46 were males, 36 were females; 9 (11 per cent) were in foster care when they died; 17 (22 per cent) had weighed $5\frac{1}{2}$ lbs. or less at birth, 61 (78 per cent) had weighed over $5\frac{1}{2}$ lbs. at birth and in 4 instances the birthweight was not known. The age of this group of infants is given in Table 7.1 which shows a greater proportion of deaths in the early part of the postneonatal period compared with the figures for the total survey (page 7).

TABLE 7.1
Age at death in weeks

Age	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	Not known
No.	25	16	12	7	2	3	3	4	2	5	2	0	1
%	30	20	15	9	2	4	4	5	2	6	2	0	1
% in 16-week groups	74				15				10				

Table 7.2 shows the age of the mother in the 60 instances in which it was known. As expected the proportion of younger mothers is greater than in the survey as a whole (Table 3.8, page 16).

TABLE 7.2
Age of mother—60 infant deaths

Age in years	Under 16	16-19	20-29	30-39	40+
No.	1	19	28	12	0
%	2	32	47	20	0

The causes of death in this group of 82 infants are broadly classified in Table 7.3.

This distribution conforms closely to that of the survey as a whole (Table 3.2), as does the figure for sudden unexpected deaths of which there were 31 instances, i.e. 38 per cent of the illegitimate deaths, compared with 37 per cent in the total survey.

Analysis shows a greater proportion of avoidable factors operating in this group, there being 28 (34 per cent) compared with the 187 instances, i.e. 28 per cent, in the total survey. Fifteen per cent of the cases with avoidable factors were in the illegitimate group. Of the 28 instances with avoidable factors 25 were concerned with the maternal situation, the social situation or both. Maternal instability, inadequacy, indifference and immaturity receive frequent mention

TABLE 7.3
Illegitimate infants—cause of death

Cause of death	No. of deaths	% of group
Accident	4	5
Violence	2	2
Asphyxia—inhilation or bedding	4	5
Respiratory infection	33	40
Gastro-enteritis	9	11
Infectious disease	2	2
Congenital anomaly	18	22
Other	10	12

and it has seemed clear that on occasions professional workers relied on an unsupported mother's acumen to an unreasonable degree. On other occasions the support and conflicting views of the mother's own family, often resenting the illegitimacy, had caused difficulty. Some of the social problems were intense but it has been clear that in most instances the support of local authority and voluntary services was fully mobilized and that there was constant supervision, but in certain instances even this could not prevent disaster. The worst side of this picture was painted by one family doctor who wrote: "The death of this infant does not surprise me; it was already predetermined by factors in the environment in which he was conceived and born. He is the offspring of a heterogeneous illegitimate marriage in which neither parent is really suited to look after children. The mother is a social outcast depending for her emotional needs on an immigrant working man who left her when the baby was born, she has neither the intelligence nor stamina to carry out her work as a mother and could not expect help or support from the man. Added to this are the appalling living conditions under which the family live, overcrowded, ill-ventilated, inadequately furnished, inadequately heated, and without help or support from relatives or others."

Although in this group maternal and social factors loom so large, in a considerable proportion of cases mention was made of the "good and conscientious parent" and the "excellence of home care", with standards higher than in certain of the legitimate infant families.

The general conclusion to be drawn from the survey is that the pattern of infant mortality conforms generally to that of the infant population as a whole, but that illegitimacy itself results in a certain increased vulnerability which needs to be taken fully into account when assessing the total situation of the sick infant.

8. CONCLUSION

One of the original objects of the enquiry was to determine whether avoidable factors could be identified by a study of deaths in the postneonatal period. It is clear that avoidable factors considered to have had some part to play in such infant deaths can be identified. Areas in which clinical practice could be improved show themselves, but the majority of avoidable factors are associated with parental or social difficulties which, at long distance, might seem to be well nigh insoluble. It would appear, however, that, with the active co-operation and participation of those concerned with the health and welfare services as they affect children, there could be very real merit with a possible saving of infant life and a concomitant educational value in carrying out similar enquiries to this one on a local area basis. The detailed analysis of the information received in the enquiry may act as such a basis for further study and, in particular, it is clear that sudden unexpected death in infancy is an important area in this respect.

Finally, study of these infant deaths show, that it is of supreme importance to look at the total situation when confronted with an ailing infant in the post-neonatal period. It is necessary to bear in mind the general vulnerability of the young infant, especially to infection, the antecedent history of the child, e.g. birthweight, the adequacy of the parents, and the family and environmental situation. The intense rapidity with which the young infant's condition can change for the worse must constantly be borne in mind together with the desirability of early specialist help whenever there is cause for unease.

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APPENDIX 1 **Form of the confidential report**

Local health authority	Name or number of child	Sex Male ☐ ; Female ☐
Date of birth / /	Date of death / /	Legitimate ☐ ; Illegitimate ☐

Place of death: Home ☐; Hospital ☐; Other ☐

Please give address, etc., of place of death if not at home

Cause of death	I(a)
(as entered on certificate)	(b)
	(c)
	II

FAMILY CIRCUMSTANCES

Father's occupation as stated on death certificate
(where applicable, otherwise mother's)

Age and sex of other members of household, i.e. those who take meals together (including persons temporarily absent but excluding temporary visitors)

Relationship to child (to distinguish parents and brothers and sisters)	Age last birthday (yrs.)
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

Details of any stillborn children or of any live born children now dead

Date of birth	Sex M or F	Date of death	Cause of death or stillbirth (if known)
1.			
2.			
3.			
4.			
5.			

TYPE AND CONDITION OF HOUSING ACCOMMODATION AND ARRANGEMENTS

Number of rooms occupied by household (as defined on page 1)
including kitchen if used as living room

General description of accommodation. This should include details of structure (e.g. substandard or fit house); type of house (e.g. tenement, flat, house, etc.); type of ownership (e.g. owned, rented, etc.); whether family live in whole or part of house. Mention should be made of sanitary facilities, bath, w.c., hot and cold water and whether shared or not.

Sleeping arrangements

Did deceased child have its own room? Yes ☐; No ☐; Not known ☐

If not, with whom did it share? _____

Did deceased child sleep in a bed or cot? Bed ☐; Cot ☐; Not known ☐

Did deceased child sleep by itself? Yes ☐; No ☐; Not known ☐

If not, with whom did it share the bed or cot? _____

Cleanliness of household

Clean ☐; Moderately clean ☐; Dirty ☐

Type of school of mother

School leaving age of mother

Does mother go out to work? Yes ☐; No ☐; Not known ☐

If yes, please state arrangements made for child _____

Is this an immigrant family? Yes ☐; No ☐

If yes, please state country of origin and date of entry of mother _____

L.H.A. Report on Child. This should include details of other acute or chronic illness in the family and say whether the family needed frequent visits from the health visitor in view of poor child care or whether other agencies, e.g. Children's Department, Probation Officers, had to be used. Please also state if there were any transport difficulties in getting child to hospital where this is applicable.

CLINICAL AND ANTHROPOMETRIC DETAILS

Weight at birth

lbs

oz

;

Weight at death (if known)

lbs

oz

Past history of child (as given by parent(s)). This should include details of malformations, birth injuries and of illnesses prior to commencement of final illness and details of feeding. Mention should be made of any acute illness in members of family at the onset of the child's final illness.

Parent's assessment of situation. Comment here on the parent's attitude at the time the final illness commenced. Say when doctor was called in, etc.

General practitioner's report on child. This should be completed where possible by L.H.A. doctor and should include details of final illness and any other relevant data including his assessment of parental responsibility, etc.

Hospital report on child (to be completed by consultant in charge of case where possible). This should include comments on preventable factors, etc.

P.M. REPORT (if available). A copy may be attached if desired. State whether Coroner's P.M. or not.

MEDICAL OFFICER OF HEALTH'S COMMENTS. This should include cause of death if modified from that on death certificate.

Signed _____

(Medical Officer of Health)

APPENDIX 2

Tables relating to the individual local authority area

TABLE A2.1

Age at death in weeks by individual local authority area

	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	Not known
<i>AREA A</i>													
Nos.	99	80	66	44	35	24	19	19	12	15	16	10	1
Percentage	23	18	15	10	8	5	4	4	3	3	4	2	<1
<i>AREA B</i>													
Nos.	31	15	15	6	2	3	2	3	2	1	3	1	-
Percentage	37	18	18	7	2	4	2	4	2	1	4	1	-
<i>AREA C</i>													
Nos.	39	27	25	12	10	8	5	7	7	8	4	2	1
Percentage	25	17	16	8	6	5	3	5	5	5	3	1	<1

TABLE A2.2

Cause of death by individual local authority area*

Sex	I	III	IV	VI	VIII	IX	XV	XVI	XVII	II, V, VII, X, XIII, XIV
<i>AREA A</i>										
Boys	13	—	1	5	94	37	1	4	26	40
Girls	11	—	1	2	68	46	1	4	23	63
Total nos.	24	—	2	7	162	83	2	8	49	103
Percentage	5	—	<1	2	37	19	<1	2	11	23
<i>AREA B</i>										
Boys	1	1	—	—	18	2	1	1	3	15
Girls	2	1	—	—	14	2	—	—	3	20
Total nos.	3	2	—	—	32	4	1	1	6	35
Percentage	4	2	—	—	38	5	1	1	7	42
<i>AREA C</i>										
Boys	3	3	—	2	35	8	1	—	20	25
Girls	4	3	—	—	22	2	—	—	7	20
Total nos.	7	6	—	2	57	10	1	—	27	45
Percentage	5	4	—	1	37	6	1	—	17	29

* I.C.D. sections corresponding to the diagnostic groups set out in Table 3.2.

TABLE A2.3

Month of death by individual local authority area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>AREA A</i>												
Nos.	56	35	38	35	42	22	25	25	24	37	43	58
Percentage	13	8	9	8	9	5	6	6	5	8	10	13
<i>AREA B</i>												
Nos.	10	8	4	5	7	3	10	2	6	10	4	15
Percentage	12	10	5	6	8	3	12	2	7	12	5	18
<i>AREA C</i>												
Nos.	21	14	12	10	10	14	17	10	4	9	13	21
Percentage	14	9	8	6	6	9	11	6	2	6	8	14



TABLE A2.4

Social class distribution by individual local authority area

	I	II	III	IV	V	Forces	Not known
<i>AREA A</i>							
No. in enquiry	9	10	231	83	56	4	47
% distribution of total group	2	2	52	19	13	1	11
% distribution of those for whom S.C. known (i.e. 393)	2	3	59	21	14	1	
Estimated % distribution of whole population*	10	15	43	26	6	<1	
<i>AREA B</i>							
No. in enquiry	1	4	45	15	10	1	8
% distribution of total group	1	5	54	18	12	1	9
% distribution of those for whom S.C. known (i.e. 76)	1	5	59	20	13	1	
Estimated % distribution of whole population*	12	21	36	25	5	<1	
<i>AREA C</i>							
No. in enquiry	7	14	73	28	14	11	8
% distribution of total group	5	9	47	18	9	7	5
% distribution of those for whom S.C. known (i.e. 147)	5	9	50	19	9	7	
Estimated % distribution of whole population*	14	20	32	19	11	3	

* Source: Census 1961 England and Wales. Socio-economic group tables.

TABLE A2.5

Age of mother by individual local authority area

	-15	16-19	20-29	30-39	40	Not known
<i>AREA A</i>						
Nos.	1	48	239	87	13	52
Percentage	< 1	11	54	20	3	12
<i>AREA B</i>						
Nos.	—	8	55	17	3	1
Percentage	—	10	65	20	4	1
<i>AREA C</i>						
Nos.	—	17	74	24	4	36
Percentage	—	11	48	15	3	23

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December, 1970.

O.B., Truro.

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