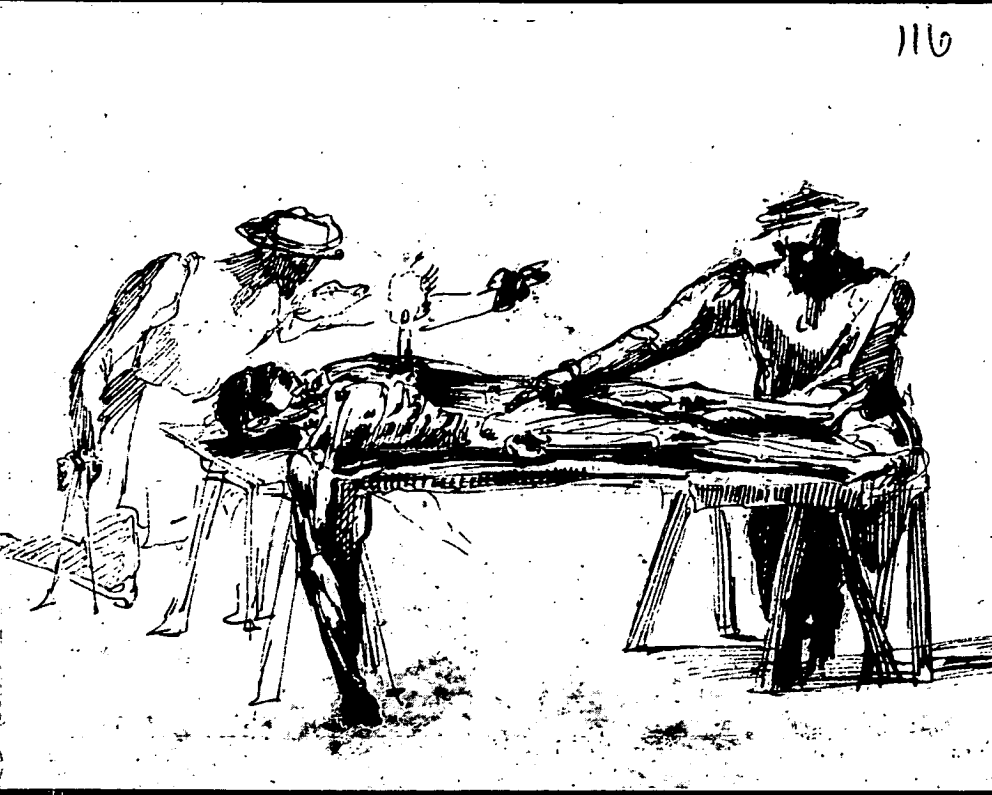
INTIMATIONS OF QUALITY

Ante-Mortem and Post-Mortem Diagnoses



H. A. WALDRON AND LORNA VICKERSTAFF

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H. A. WALDRON and
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INTRODUCTION

A recent Trust publication[1] contained a paper by Dr. Waldron and Mrs. Vickerstaff on the role of the autopsy in medical care. It reported the results of an investigation of the autopsy which confirmed the impressions of the Trust's Group concerned with the quality of care: that autopsy rates had fallen substantially in the last few decades; and that most clinicians believe the examination is still important and greatly regret the decline of its use.

The paper also included a brief reference to a prospective study of which the full results are given in the present publication. Its aim was to assess the contribution of the autopsy, by estimating the extent of disagreement between ante-mortem and post-mortem diagnoses. For it has been said that one reason, and perhaps the most important, for the decline of the autopsy is that it is no longer so essential in clinical practice, because the ante-mortem diagnosis can be made with confidence now that it is supported by laboratory, radiological and other findings.

Anyone who takes this comforting view should consider carefully the findings from Dr. Waldron's and Mrs. Vickerstaff's enquiry. (The reader should not be discouraged by the extensive tabulations, for the results are clearly summarised in the text.) They show that the clinical and pathological diagnoses disagreed in about a quarter of the cases studied, and there was partial disagreement in as many more. However they suggest that some of these errors were often not serious, since they were in elderly people with multiple abnormalities, whose lives were unlikely to have been prolonged by different treatment based on more accurate diagnosis. The proportion

[1] *A Question of Quality* (ed. G. McLachlan) (Oxford: Oxford University Press), 1976.

of patients for whom a more accurate clinical diagnosis might have resulted in treatment which would have altered the outcome could not be estimated accurately, but it was below, and perhaps considerably below ten percent.

The results are also disturbing for those of us who have attempted to interpret national mortality data derived from the certified cause of death. We have been well aware of the uncertainties which result from changes in classification of cause of death and the unreliability of diagnosis in the nineteenth and early twentieth centuries; but it is salutary to be reminded that even today the certified cause of death cannot be relied on in a substantial proportion of cases unless it is confirmed by post-mortem examination.

The results of this enquiry fully support the concern expressed initially by the Trust's Group working on evaluation of the quality of care. There is no doubt that the autopsy still makes an important contribution to clinical practice and the decline of its use is a matter for regret and for action.

Thomas McKeown

ACKNOWLEDGEMENTS

We are most grateful to the clinicians and pathologists who so kindly completed the forms from which the results of this study were obtained, and also to the many administrators and their staffs who undertook the distribution and return of the forms.

We are also indebted to the Nuffield Provincial Hospitals Trust for their support and encouragement.

CHAPTER 1

BACKGROUND AND METHODS

The autopsy was placed at the centre of the medical stage by the physicians working in Paris during the early part of the nineteenth century. The Paris model was widely adopted throughout Europe and later taken to America, and the autopsy held its pre-eminent role well into the 1950s'. Since then it has come increasingly under attack and its value has been brought into question by physicians and pathologists alike.

Starr(1) was probably the first to express the view that the autopsy was in decline because, he said, clinicians were becoming increasingly interested in functional aspects of disease which, unlike anatomical lesions, were susceptible to treatment. The publication of his paper gave rise to a spirited debate which has continued down to the present day. The champions of the autopsy(2-8) have gone into print more often than its detractors, and their twofold aims have been to discuss the reasons for the decline, which seems to be acknowledged, and to show in what way the autopsy is still important to the practice of medicine(9,10).

Our earlier studies have confirmed that the autopsy rate has fallen markedly in the Birmingham teaching hospitals during the last decade and a half(11), even though clinicians still attach considerable importance to it, both in their own practice and in medical training(12). Moreover, a retrospective analysis indicated that in about 20% of cases there was a difference between the ante-mortem and post-mortem diagnosis of the underlying cause of death. This measure of disagreement appeared to warrant further examination. The aim of the present study was to examine the degree of agreement between the ante-mortem and post-mortem causes of death, and to assess the reasons for any major disagreements, should these be found.

Notes and references begin on page 41.

The methods were modelled on the now classic study of Heasman and Lipworth(13). The hospitals which agreed to take part in the study were sent forms consisting of two parts, both of which were dummy death certificates, with instructions for their completion printed on the reverse(14).

When a patient died and came to autopsy, the clinician was asked to complete the first part of the form, following the rules for the completion of the death certificate laid down by the World Health Organisation(15). He was asked to indicate on the form whether he considered his diagnosis to be 'fairly certain', 'probable' or'uncertain'. Any doctor who had had close clinical contact with the patient before death was eligible to complete this part of the form. If a death certificate had been issued before the autopsy was carried out, then it was suggested that the part of the form which the clinician filled in should be a copy of this certificate.

With the first part completed, the form was sent to the pathology department in the patient's notes, so that the second part could be filled in by the pathologist who had conducted the autopsy. This was done preferably after discussion with the clinician in charge of the case, so this part of the form should have represented the most accurate statement of the underlying cause of death as it was possible to get from the information available. In the event that the clinician and the pathologist failed to agree on the proper wording of the second part, then a note to this effect was to be entered at the end of the form. With both parts completed, the forms were sent to the records office of the hospital, from where they were returned to us at monthly intervals.

In addition to the ante-mortem and post-mortem diagnosis of cause of death, personal details of the patient (name, age, sex), together with the dates of admission and death, the name of the hospital and the hospital number were to be entered. This information was treated in confidence, and an undertaking was given that no individual patient, clinician, pathologist or hospital would be identified (or identifiable) in any reports to be based on the results of the study.

All the clinicians and pathologists in the West Midlands and the Trent regions were invited to help with the survey.

During November 1974, a letter was written to each one individually, in which the aims of the study were outlined. The methodology of the study was carefully explained and a sample of the form which was to be used was enclosed with the letter. At the same time, we also wrote to all the Area Administrators in the regions, asking if they would assist with the circulation and return of forms. The hope was that one of the forms would be completed for all patients coming to autopsy in the hospitals which agreed to help.

The study was originally planned to begin in January 1975 and run for one year, but, because there were some delays in starting, the closing date was extended to April 1976.

DATA ANALYSIS

The data on the forms were coded so that they were suitable for transfer on to punched cards and subsequent analysis by computer.

The underlying cause of death in the first part of the form was established following the instructions laid down by the World Health Organisation(15). This cause of death(16) was given the three digit code listed in the eighth revision of the International Classification of Diseases (ICD)(17). The underlying cause of death in the second part of the form was similarly established and coded, as were all other conditions listed in this section. The ante-mortem cause of death was compared with the conditions in the post-mortem section of the form, and assigned to one of the following diagnostic categories:

Category A: Complete agreement. The underlying cause of death in the clinical section corresponded exactly with that in the post-mortem section.

Category B: Partial agreement. The underlying cause of death in the clinical section appeared in the post-mortem section, but not as the underlying cause of death.

Category C: Disagreement. The underlying cause of death in the clinical section did not appear at all in the post-mortem section.

CHAPTER 2

RESULTS OF THE STUDY

A total of 1240 forms was returned, but in 114 (9.2%) only one section had been completed (usually the post-mortem section) and so had to be discarded. Thus the final analyses were made on the 1126 forms which remained.

SEX AND AGE DISTRIBUTION

There were 603 males and 519 females in the sample and four forms gave no indication of the patient's sex. For five males and four females no age or date of birth was shown on the form, nor was the age given on the four sexless forms. The total number for which age is known is thus 1113. Figures 1 and 2 show the percentage distribution by age-group and sex of the autopsy sample, together with the mean age and sex distribution of all deaths in England and Wales for the years 1969-1973 inclusive(18). From these figures it can be seen that the males in the autopsy sample are over-represented in the first, second, fourth and fifth age-groups, slightly under-represented in the third, and greatly under-represented in the sixth. The females are over-represented in all except the last age-group, where there is a considerable deficit. These differences are in keeping with the fact that deaths in hospital have a younger age distribution than domiciliary deaths(19).

MEASUREMENT OF AGREEMENT BETWEEN ANTE-MORTEM AND POST-MORTEM DIAGNOSES

The assignment of the ante-mortem disgnoses into the three diagnostic categories defined in Chapter 1 is shown in Table 1, page 6.

In nine cases the clinicians were not able to make an ante-mortem diagnosis and these have been excluded from the analysis. Of the 1117 cases remaining, 531 (47.5%) were allocated

FIGURE 1

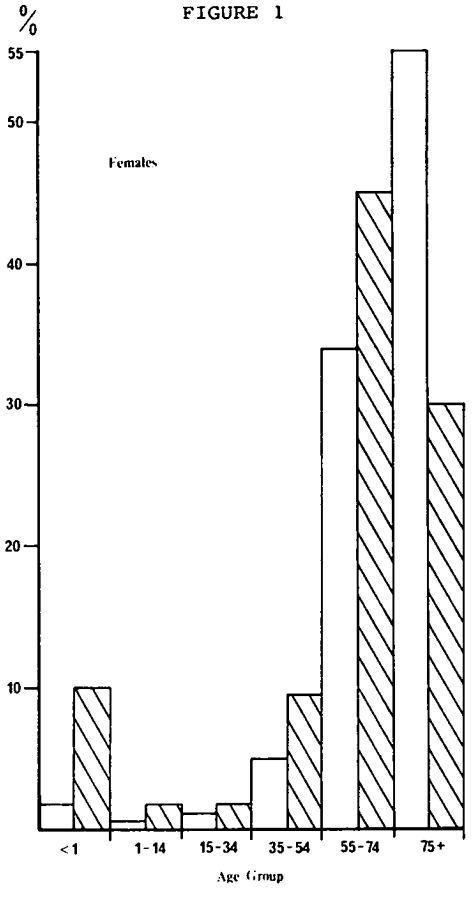

FIGURE 2

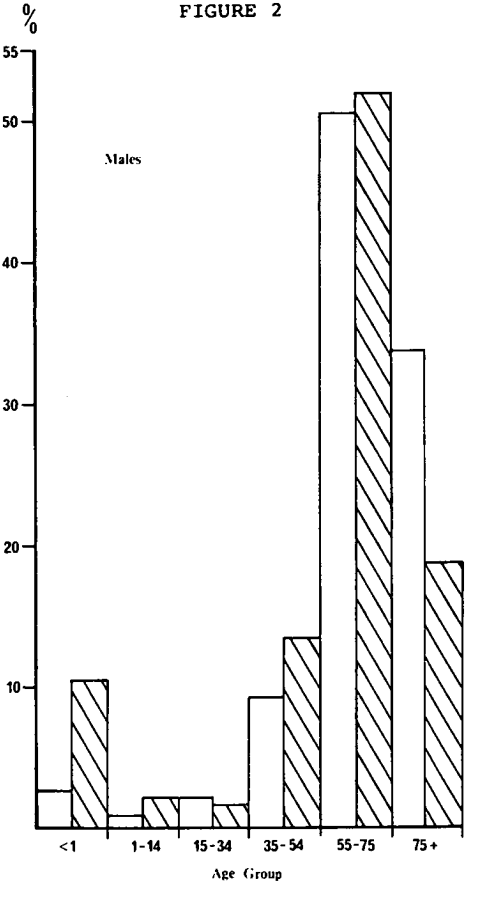

FIGURE 1. Percentage age-distribution of female patients in the prospective autopsy sample (shaded columns) and the mean age-distribution for all deaths in England and Wales, 1968-1973 (blank columns).

FIGURE 2. Percentage age-distribution of male patients in the prospective autopsy sample (shaded columns) and the mean age-distribution for all deaths in England and Wales, 1968-1973 (blank columns).

TABLE 1. *Allocation of ante-mortem diagnoses.*

		Category			
		A	B	C	Total
Males	n	302	162	134	598
	%	50.5	27.1	22.4	100
Females	n	227	131	157	515
	%	44.1	25.4	30.5	100
Total	n	531	295	291	1117
	%	47.5	26.4	26.1	100

The total includes some forms on which sex was not given (see also page 9).

TABLE 2. *Allocation of ante-mortem diagnoses by ICD group.*

	Number in Category			
ICD Group	A	B	C	Total
I	10	4	10	24
II	116	68	60	244
III	12	5	7	24
IV	5	3	0	8
V	1	3	2	6
VI	4	2	1	7
VII	183	146	130	459
VIII	41	36	43	120
IX	56	13	18	87
X	11	9	13	33
XII	1	0	0	1
XIII	1	1	0	2
XIV	56	0	0	56
XV	34	5	4	43
XVI	0	0	3	3
Total	531	295	291	1117
%	47.5	26.4	26.1	100

A = Complete agreement; B = Partial agreement; C = Disagreement.

to category A, 295 (26.4%) to category B, and 291 (26.1%) to category C.

Each of the forms was sorted into the major ICD groups according to ante-mortem diagnosis, and this sub-division is also shown in Table 2, page 6. The number of cases in each group varied greatly, but the majority fell into one of four groups, II, VII, VIII, and IX, as would be expected from the national mortality statistics(19).

The proportion of agreed cases in each of the ICD groups varied widely, as Table 3, page 8 shows. In this table the groups with a total of more than ten cases are arranged in rank order according to the percentage allocated to category A. Group XIV, with a score of 100%, heads the list by a comfortable margin. However, this group comprised the congenital disorders which are often readily apparent to the eye, or easily discovered by clinical investigation, and so this result is no surprise.

In the four largest groups (IX, II, VII and VIII) the difference in proportions which are seen in category A (64.4%, 47.5%, 39.9% and 34.2% respectively) are significantly different ($P < 0.001$) and may thus reflect a real difference in the ease with which individual diseases within these groups lend themselves to a diagnosis which can be sustained at post-mortem. We shall return to the consideration of the individual diseases later.

Agreement Between Ante-Mortem and Post-Mortem Diagnosis According to Hospital

Of the 1117 forms analysed, 396 were from teaching hospitals and 721 from non-teaching hospitals (35.4% and 65.6% respectively). This proportion, however, was not constant within each of the three diagnostic categories, as may be seen in Table 4, page 8. Overall, there was a higher than expected percentage of forms from the teaching hospitals in category A, and a lower than expected percentage in both B and C. These differences were significant at the 0.1% level. The results are biased slightly by the inclusion of cases of congenital abnormality which would be expected *a priori* to be correctly diagnosed. In all, there were 56 cases in this group, 38 of which were from the teaching hospitals. Even when these 56 were removed from the total, the difference in

TABLE 3. *Rank order of ICD groups by percentage of cases in category A.*

Rank order	ICD group	Percentage of cases in category			Total no. of cases
		A	B	C	
1	XIV	100.0	0	0	56
2	XV	79.1	11.6	9.3	43
3	IX	64.4	14.9	20.7	87
4	III	50.0	20.8	29.2	24
5	II	47.5	27.9	24.6	244
6	I	41.7	16.6	41.7	24
7	VII	39.9	31.8	28.3	459
8	VIII	34.2	30.0	35.8	120
9	X	33.3	27.3	39.4	33

Groups with a total of less than 10 cases have been excluded from this table.

TABLE 4. *Percentage of cases in diagnostic categories according to type of hospital and ICD classification.*

	Category						
	A		B		C		
ICD group	T	NT	T	NT	T	NT	P
II	36.2	63.8	30.9	69.1	31.7	68.3	ns
VII	40.4	59.6	25.3	74.7	30.0	70.0	<0.05
VIII	42.5	57.5	16.7	83.3	27.9	72.1	ns
IX	37.5	62.5	69.2	30.8	22.2	77.8	<0.05
Remainder	48.9	51.1	53.1	46.9	30.0	70.0	ns
Remainder -XIV	35.4	64.6	53.1	46.9	30.0	70.0	ns
Total	41.4	58.6	30.5	69.5	29.6	70.4	<0.001
Total -XIV	38.3	61.7	30.5	69.5	29.6	70.4	<0.05

T = Teaching hospital. NT = Non-teaching hospital.

The figures in the rows represent the number of cases as a percentage of the total number of cases from the teaching and non-teaching hospitals in each of the ICD groups.

allocation into the three categories was still significant, although now only at the 5% level.

So far as the four major disease groups are concerned, the differences in the percentages of teaching and non-teaching hospital cases in the three categories were significant only in groups VII and IX. The differences in the remainder, both including and excluding group XIV, were not significant.

There is no clear trend when considering the results from the teaching hospitals in all three diagnostic categories. Thus B never occupies a position which is exactly midway between A and C, but may approximate closely to C, as in group II and the total, be much lower than either A or C, as in group VIII, or be higher than either A or C, as in group IX and the remainder (see Table 4).

Allocation By Confidence in Ante-Mortem Diagnosis

On the first part of the form, the clinicians were asked to indicate whether their diagnosis was 'fairly certain', 'probable' or 'uncertain' and all but 56 forms contained this information. The degree of confidence which the clinicians attached to their diagnosis is related to the allocation into the three catefories in Table 5, page 10. The differences seen in the table are significant at the 0.1% level.

From Table 5 it may be seen that the proportion of cases in category A is directly related to the degree of certainty of the diagnosis. Whereas by contrast, allocation to category C is greatest when the clinical diagnosis is most in doubt. Allocation to category B appears to be independent of the certainty of diagnosis.

These trends hold good for three of the four main ICD groups (II, VII, and VIII), but not for group IX. Allocation of cases from this last group to category A is not dependent upon the certainty of diagnosis, although allocation to category C does follow the trend shown in Table 5. Only in groups II and VII, however, do the observed differences achieve formal statistical significance(20).

Effect of Sex on Allocation

Of the 1117 forms used in the analyses reported so far, four gave no indication of the patient's sex. Of the remainder, 598 (53.7%) were from males, and 515 (46.3%) from females.

TABLE 5. *Allocation into diagnostic categories as a function of confidence in ante-mortem diagnosis.*

Confidence of ante-mortem diagnosis		*Category* A	B	C	
Fairly certain	n	324	146	93	563
	%	57.6	25.9	16.5	100.0
Probable	n	149	103	118	370
	%	40.3	27.8	31.9	100.0
Uncertain	n	37	30	61	128
	%	28.9	23.4	47.7	100.0
Not stated	n	21	16	19	56
	%	37.5	28.6	33.9	100.0
	n	531	295	291	1117
	%	47.5	26.4	26.1	100.0

$\chi^2 = 76.68 \quad P < 0.001.$

TABLE 6. *Allocation into diagnostic categories as a function of sex.*

		Category A	B	C	Total
Males	n	302	162	134	598
	%	50.5	27.1	22.4	100.0
Females	n	227	131	157	515
	%	44.1	25.4	30.5	100.0
Total	n	529	293	291	1113
	%	47.5	26.3	26.2	100.0

$\chi^2 = 9.49 \quad P < 0.01.$

The allocation of these forms into the three diagnostic categories shows that there is a higher proportion of male than female cases in A, whereas the converse is true in C (Table 6). These differences are significant at the 1% level.

The Effect of Age at Death on Allocation

The likelihood of the ante-mortem and post-mortem diagnoses agreeing completely diminishes with increasing age. This is apparent from Figures 3 and 4, which show an age shift to the right in categories B and C for both sexes. The mean age at death of the patients in each of the diagnostic categories was for the females: A, 52.8; B, 61.5; and C, 66.6. For the males the means were: A, 50.2; B, 64.7; and C, 63.4. In both males and females, the mean age in categories B and C was significantly different from that in A ($P < 0.001$).

The older age at death of the patients in categories B and C was examined further by dividing the patients into one of two groups depending whether their age at death was either in the range 0-54, or 55 and over. The cases in the two groups were then allocated to the appropriate diagnostic category. Having done this, the forms were resorted, this time into groups whose age at death was 0-74, or greater than 75. Allocation with diagnostic category followed as before. In the male cases, age has a profound effect upon diagnostic allocation. Thus 85.6% of males under 54 appear in category A, and only 14.2% in C, whereas only 42.5% of males over 55 appear in A and 22.5% in C. The males aged 75 or over were allocated almost equally between the three groups (33.3% to A, 34.2% to B and 32.4% to C). By contrast, the allocation of the under 75's was: A, 54.4%; B, 25.7%; and C, 19.9%.

A similar trend was noted for the female cases. Thus of the 0-54's, 66.9% were allocated to A and only 19.4% to C. For the group aged 55 and over, the proportions in A and C were 37.0% and 33.6% respectively. Of the women aged over 75, approximately a third were allocated to each of the three categories, whereas for the under 75's the proportions were: A, 49.3%; B, 23.4%; and C, 27.3%.

In all these cases, the observed differences are highly significant ($P < 0.001$).

Effect of Length of Stay

We were able to compute the length of stay in hospital for

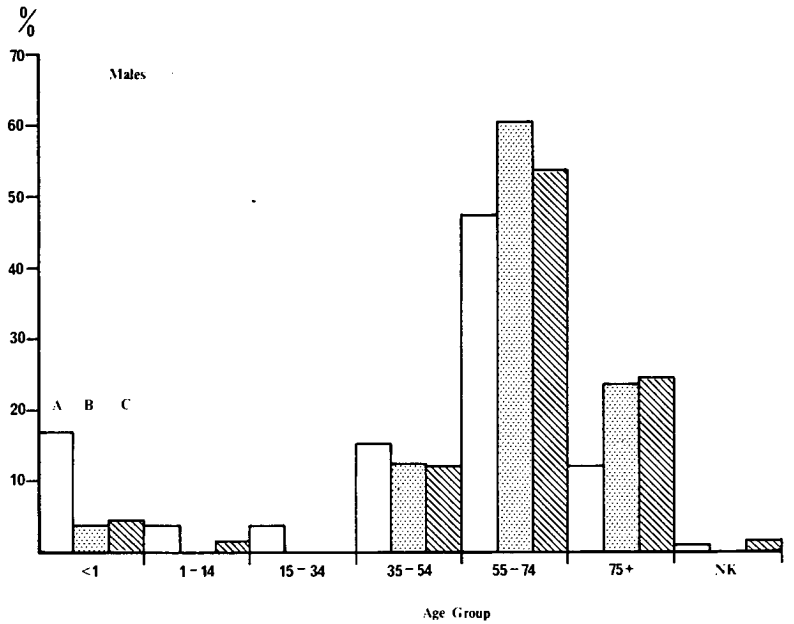

FIGURE 3. Percentage age-distribution of male patients in the three diagnostic categories. A = blank columns, B = dotted columns, C = shaded columns.

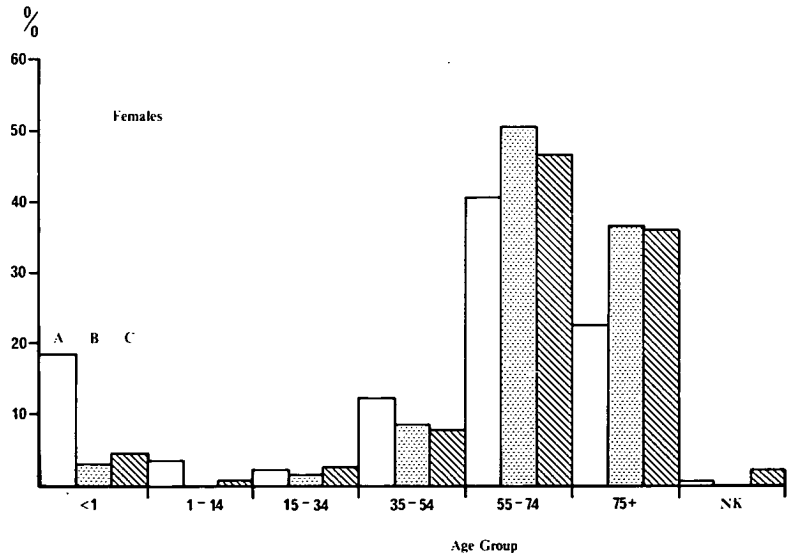

FIGURE 4. Percentage age-distribution of female patients in the three diagnostic categories. A = blank columns, B = dotted columns, C = shaded columns.

1049 of the 1117 possible cases (93.9%). These cases were distributed into two groups according as their length of stay was greater or less than 72 hours and it was found that length of stay did not significantly affect certainty of diagnosis or allocation into diagnostic category.

Patients with Cause of Death Undiagnosed Before Autopsy

Of the 1126 patients in the total sample, only 9 (0.8%) had no cause of death diagnosed before autopsy. The ages of these patients ranged from 0 to 92, four were females and five had been in hospital less than 72 hours prior to death. A positive diagnosis was made after autopsy in every case (see Table 7).

Re-distribution into ICD Groups After Autopsy

Re-distributing the forms into ICD groups according to the diagnosis made after autopsy resulted in the changes listed in Table 8. Groups I, VII, VIII and IX showed the most marked differences. After autopsy the changes were -11, +36, -23 and +13 cases respectively. The effects of these changes are seen in Figure 5, where the proportion of diagnoses in each of the ICD groups before and after autopsy is shown. For comparison the mean percentage distribution of all deaths in England for 1969-1973 to each group is also shown.

A more detailed list of these changes appears in Appendix 3, page 47. Some of these changes are particularly noteworthy. For example, the number of cases of ischaemic heart disease rose from the pre-autopsy 167, to a figure of 246 after autopsy, whereas deaths attributable to cerebrovascular disease fell from 87 to 48 after autopsy. Carcinoma of the bronchus was more frequently diagnosed after autopsy, 21 further cases being added, and there was also an increase in the number of tumours of the digestive tract (mostly pancreatic tumours). By contrast, fewer tumours of the brain and nervous system, and of the lymphatic and haematopoietic tissues were diagnosed after post-mortem. Before autopsy 34 patients were diagnosed as having malignant disease without a primary site being specified. The autopsy revealed the primary in all but five of these.

Amongst diseases of the respiratory system, the change in the diagnosis of pneumonia is striking, there being 83 deaths

TABLE 7. *Cause of death in patients in whom it was not known before autopsy.*

Age (years)	Sex	Length of stay	Autopsy diagnosis
0	Female	Short	Trisomy 13-15
8	Female	Short	Medulloblastoma
10	Male	Short	Diabetic coma
57	Female	Long	Lobar pneumonia
69	Male	Short	Carcinoma of the bronchus
70	Male	Long	Carcinoma of the kidney
78	Male	Long	Carcinoma of the pancreas
85	Male	Short	Carcinoma of the rectum
92	Female	Long	Septicaemia

Short = < 72 hours Long = > 72 hours

TABLE 8. *Distribution of cases into ICD groups before and after autopsy.*

ICD group	*Before autopsy*		*After autopsy*	
	n	%	n	%
I	24	2.13	13	1.15
II	244	21.67	240	21.31
III	24	2.13	21	1.87
IV	8	0.71	8	0.71
V	6	0.53	1	0.09
VI	7	0.62	14	1.24
VII	459	40.76	495	43.96
VIII	120	10.66	97	8.62
IX	87	7.73	100	8.88
X	33	2.93	31	2.75
XII	1	0.09	1	0.09
XIII	2	0.18	3	0.27
XIV	56	4.97	65	5.77
XV	43	3.82	37	3.29
XVI	3	0.27	0	0
Not known	9	0.80		
Total	1126	100.0	1126	100.0

ascribed to this cause by the clinicians, but only 44 following the post-mortem.

Changes in Diagnostic Categories for Individual Diseases
The diagnostic changes following post-mortem for the most numerous of the conditions within the four major ICD groups are shown in Tables 9-12.

Group II: Of the 244 diagnoses of malignant disease made by clinicians, only 122 were unchanged after autopsy. The cases in which the clinical diagnosis was altered included some in which the primary site of the neoplasm had been incorrectly stated and others in which a non-malignant disease was considered to be the underlying cause of death. The proportion of diagnoses which were changed after autopsy varied greatly from site to site (Table 8). Thus, 77.1% of the clinical diagnoses of bronchial carcinoma were sustained and so were 77.9% of cases of carcinoma of the breast. By contrast, only 37.5% of the clinical diagnoses of large bowel cancer were unchanged. These may be taken as the extremes of the percentage of unchanged diagnoses since the two values of 100% which appear in the table refer to a very small number of cases (two or less).

After autopsy, malignant disease was diagnosed as the underlying cause of death in 186 of the 244 cases (76.2%). Of the 58 cases to which a non-malignant cause of death was ascribed, by far the majority (20-34.5%) fell into the category of ischaemic heart disease. There were a further 11 cases in which other cardiovascular diseases were diagnosed as the underlying cause of death. In addition, 10 cases were said to have died from respiratory disease, 10 from disease of the digestive system, 4 from neurological disorders and 3 from endocrine diseases.

Group VII: The proportion of diagnoses which was unchanged by autopsy in this group overall, was 54.5% (Table 10). Of the individual diagnoses, pulmonary embolus was the one most likely to be changed, and in only 10.7% of cases was the clinician's diagnosis sustained at autopsy. The diagnosis of rheumatic heart disease, however, was agreed by both clinician and pathologist 10 times out of 12 (83.3%).

TABLE 9. *Post-mortem diagnoses of cases allocated to ICD group II on the basis of clinical diagnoses.*

Ante-Mortem Diagnosis \ Post-Mortem Diagnosis	Digestive tract	Stomach	Large bowel	Rectum	Respiratory tract	Bronchus	Bone, skin	Breast	Genito-urinary	Others	Non-specified	Brain & nervous system	Haematopoietic organs	Benign	VI	VII	Ischaemic heart disease	Other heart disease	Cerebrovascular disease	Diseases of arteries	Pulmonary embolus	Remainder	VIII	Pneumonia	Bronchitis	Remainder	IX	Gastric, duodenal, peptic ulcer	Liver disease	Pancreatic disease	Remainder	X	TOTAL	% unchanged after autopsy
1. Digestive tract (excl. 2-4)	*15*[*]					4			2	1							2				1			2					2				29	51.7
2. Stomach	2	*10*				2			1	1							1	2		1													20	50.0
3. Large bowel	1		6	2		1											2							1							2	1	16	37.5
4. Rectum				*7*													1				1			2							1		12	58.3
5. Respiratory tract (excl. 6)					*1*	1																											2	50.0
6. Bronchus				1		*37*			1				1				2	2			1				2	1							48	77.1
7. Bone, skin							*1*																										1	100.0
8. Breast						1		*7*									1																9	77.8
9. Genito-urinary	2					3			*13*	1							4					2		1		1							27	48.2
10. Others										*2*																							2	100.0
11. Non-specified	12	2	4	1		5			1				3				2											1	1	1		1	34	
12. Brain & nervous system		1				1				1		*7*			4				1														15	46.7
13. Haematopoietic organs	1					1			1	2			*16*				4													1		1	27	59.3
14. Benign																	1														1		2	0
TOTALS	33	13	10	11	1	56	1	7	19	8		7	20	0	4		20	4	1	1	3	2		6	2	2		1	3	2	4	3	244	50.0

[*] Includes 6 cases within the general category but with a different 3-digit code.

Figures in *italics* indicate the number of cases in which the ante-mortem and post-mortem diagnoses were unchanged.

TABLE 10. *Post-mortem diagnoses of cases allocated to ICD group VII on the basis of clinical diagnoses.*

Ante-Mortem Diagnosis \ Post-Mortem Diagnosis	Rheumatic disease	Hypertension	Ischaemic heart disease	Other heart disease	Cerebrovascular disease	Diseases of arteries	Pulmonary embolus	Remainder	I	II	Digestive tract	Stomach	Large bowel	Rectum	Bronchus	Breast	Genito-urinary	Others	Non-specified	Brain & nervous system	Haematopoietic organs	III	Diabetes	Remainder	IV	V	VI	VIII	Pneumonia	Bronchitis	Remainder	IX	Gastric, duodenal, peptic ulcer	Liver disease	Remainder	X	XV	Totals	% unchanged after autopsy
Rheumatic disease	*10*			2																																		12	83.3
Hypertension		*19*	7		4	3										1			1									1								2		38	50.0
Ischaemic heart disease	1	2	*128*[*]	7	1	5	7	1	1		1	1		1	1		1											1	6						1	1	167	76.7
Other heart disease	2	2	16	*20*[†]	1		1								2				3				1			1	4	6	1					1	3	64	31.3
Cerebrovascular disease	2	14	15	1	*33*[¶]	4	4	1				1			1			1		2					2	3		1		2							87	37.9
Diseases of arteries			4	2	1	*29*[§]									1		1										1						1	2		1	44	65.9
Pulmonary embolus			10		1	2	*3*	5							2						1						2	1	1								28	10.7
Remainder	1	1		2	1	1		*8*				1	1		1														1					1		19	42.1
TOTALS	16	38	180	34	42	44	15	15	1		1	3	1	1	8	1	2	1	4	2	1		1		2	4	9	14	3		2	1	4	7	1	459	54.5

[*] Includes 53 in same general category but with a different 3-digit code; [†] 4 in same category but different 3-digit code;

[¶] 7 in same category but different 3-digit code; [§] 3 in same category but different 3-digit code.

Figures in *italics* indicate the number of cases in which the ante-mortem and post mortem diagnoses were unchanged.

TABLE 11. *Post-mortem diagnoses of cases allocated to ICD group VIII on the basis of clinical diagnosis.*

	Pneumonia	Bronchitis	Remainder	I	II	Digestive	Stomach	Respiratory	Bronchus	Bone, skin	Genito-urinary	III	Diabetes	IV	VI	VII	Ischaemic heart disease	Other heart disease	Cerebrovascular disease	Diseases of arteries	Pulmonary embolus	IX	Liver disease	Pancreatic disease	Remainder	X	XIV	Heart and vessels	Total	% unchanged after autopsy
Pneumonia	*20*	2	3		1		3	2		2	1	1		3	1	2	19	4	3	2	4		3	1	1	4		1	83	24.1
Bronchitis	1	*16*	2						1	1							5	1	1		1				1	1			31	51.6
Remainder			*5*																						1				6	83.3
TOTALS	21	18	10		1		3	2	1	3	1	1		3	1	2	24	5	4	2	5		3	1	3	5		1	120	34.2

Figures in *italics* indicate the number of cases in which the ante-mortem and post-mortem diagnoses were unchanged.

TABLE 12. *Post-mortem diagnoses of cases allocated to ICD group IX on the basis of clinical diagnosis.*

Ante-mortem diagnosis \ Post-mortem diagnosis	Gastric, duodenal, peptic ulcer	Liver disease	Pancreatic disease	Remainder	II	Digestive tract	Stomach	Large bowel	Other sites	VII	Hypertension	Ischaemic heart disease	Other heart disease	Diseases of arteries	VIII	Pneumonia	Bronchitis	TOTAL	% unchanged after autopsy
Gastric, duodenal, peptic ulcer	16	1										2					1	20	80.0
Liver disease		*11**		2		1	1		1		1	2				2		21	52.4
Pancreatic disease		1	7			1												9	77.8
Remainder	2	1		*28*+		1		1				2	1	1				37	75.7
TOTALS	18	14	7	30		3	1	1	1		1	6	1	1		2	1	87	71.3

*Includes three within the *general* category but a different 3-digit code.

+Includes three within the *general* category but a different 3-digit code.

Figures in *italics* indicate the number of cases in which the ante-mortem and post-mortem diagnoses were unchanged.

Ischaemic heart disease was diagnosed most frequently by clinicians as the underlying cause of death in this group of patients and the pathologists agreed the diagnosis in 128 of the 167 cases (76.7%). There was a considerable difference in nomenclature, however, between the clinicians and pathologists. The clinicians had a clear preference for the terms, coronary thrombosis and myocardial infarction, whereas the pathologists had a predilection for terms such as coronary artery atheroma or arteriosclerosis. These differences are relatively trivial except that they accounted for the allocation of some clinical diagnoses into category B, since this was based on the 3 digit codes of the ICD classification.

After autopsy, 385 of the 459 cases remained within group VII (83.9%). Of the 75 cases which were allocated to other groups, 26 were diagnosed as having died from respiratory disorders (14 bronchitis, 9 pneumonia, 3 others), 25 from malignant disease, 7 each from diseases of the digestive tract and the genito-urinary system and 4 from neurological disorders. There were in addition, 2 cases where the underlying cause of death was a mental disorder, 2 where it was an endocrine disorder and 1 each where a perinatal or a dermatological cause was given.

Group VIII: Ante-mortem diagnoses in this group fared badly at autopsy, and only 41 out of 120 (34.2%) were unaltered (Table 11). The poor showing in this group was due in the main to the re-diagnosis of cases whose underlying cause of death was put down as pneumonia by the clinician. Only 20 of the 83 cases so diagnosed (24.1%) were unaltered at autopsy, the cause of death in a considerable number being changed to ischaemic heart disease. This diagnosis accounted in all for 24 of the 70 (34.3%) which were removed from group VIII on the basis of the autopsy findings, whilst a further 16 cases were attributed to other forms of cardiovascular disease. 11 cases were re-diagnosed as dying from malignant disease and 7 from gastro-intestinal disorders. Of the remaining re-diagnosed cases, 5 were considered to have genito-urinary disease, 3, endocrine disease, 2, neurological disorders, and there was 1 case each of dermatological, haematological and congenital disease.

Group IX: Agreement between ante-mortem and post-mortem

diagnoses was good in this group, 62 out of the 87 cases (71.3%) remaining unchanged at autopsy (Table 12). After autopsy 69 of the cases (79.3%) were kept in group IX, whilst of the other 18, 9 were diagnosed as cardiovascular disease, 6 as malignant diseases and 3 as disease of the respiratory tract.

Summary: A summary of the major changes appears in Table 13. This shows the number of patients in whom the diagnosis was unchanged after autopsy, the number re-allocated within the same ICD group and the number re-allocated to a different group.

TABLE 13. *Summary of changes in diagnostic allocation after autopsy.*

Group (AM)	No. of cases	Diagnosis unchanged after autopsy	
		n	%
II	244	116	47.5
VII	459	183	39.9
VIII	120	41	34.2
IX	87	56	64.4
Remainder	207	135	65.2
Total	1117	531	47.5

	Diagnosis changed in same group		Diagnosis changed to another group	
	n	%	n	%
II	70	28.7	58	23.8
VII	201	43.8	75	16.3
VIII	9	7.5	70	58.3
IX	13	14.9	18	20.7
Remainder	5	2.4	67	32.4
Total	298	26.7	288	25.8

CHAPTER 3

DISCUSSION OF RESULTS

In less than half the cases in this prospective study was the clinical diagnosis of cause of death confirmed at autopsy. The remaining cases were almost equally split between those in which there was only a minor difference of opinion, and those in which disagreement was total (see Table 1, p6).

COMPARISON WITH RESULTS OF RETROSPECTIVE STUDY

The results of this prospective study differ considerably from those of the retrospective study presented earlier(11). The major differences are set out in Table 14. Overall, the level of disagreement found in the prospective study is 2.4 times as high as that observed retrospectively, and a similar order of difference is seen when comparing the results from ICD groups II and VII (2.7 and 1.6 times respectively). For cases in group VIII, however, the results differ by a factor of 10.4.

TABLE 14. *Comparison of results from retrospective and prospective studies.*

	Percentage of disagreed cases			
	Total	ICD Group II	ICD Group VII	ICD Group VIII
Prospective	52.5	52.5	60.1	65.8
Retrospective*	21.7	19.3	36.9	6.3
Ratio P:R	2.4	2.7	1.6	10.4

*Data were obtained only from the Queen Elizabeth and General Hospitals in Birmingham.

These large differences were unexpected, although it must be remembered that the data are not strictly comparable, since on one hand we have results from two teaching hospitals and on the other, results from a large number of both teaching and non-teaching hospitals. We know that diagnoses made in teaching hospitals are more likely to be agreed at autopsy than those made in non-teaching hospitals and this undoubtedly accounts for some of the differences. The most important reason for the discrepancy, however, is likely to be observer error. In the retrospective study, there was probably an under-estimate of the level of disagreement, either because the information on which we made our judgement was inadequate or incorrect, or because there was an unconscious bias towards seeking agreement between the clinical and autopsy diagnoses.

Whatever the reason for the differences, however, one important point has emerged from these two sets of results, that is, results from studies in which the retrospective method is used to compare diagnoses should be viewed with some suspicion. We would strongly recommend that the prospective method be used in any similar studies undertaken in the future.

COMPARISON WITH RESULTS OF OTHER STUDIES

Although the level of complete disagreement found in this study seems high, it is, nevertheless, substantially less than that which has been found in other studies (Table 15). For example, Britton(39) found an error rate of 30% in a study in Sweden, and rates of 40% and 48% have been reported from America(38,40), whilst Heasman and Lipworth(13) found some measure of disagreement in 54.7% of cases in their study conducted in hospitals in Great Britain. When considering individual diseases, the frequency of disagreement may be even greater, as Prutting(7,8,41) has shown in his reviews.

THE SIGNIFICANCE OF THE LEVELS OF DISAGREEMENT

Mis-diagnosis of the disease which has caused the death of a patient has two important consequences. Firstly, the patient may thereby have received inappropriate treatment. The corollary of this is that had the patient's condition been recognised for what it was during his life, then he might have been given different treatment, which could conceivably

TABLE 15. *Percentage disagreement between ante-mortem and post-mortem diagnosis from various countries.*

No. of cases	Disagreement %	Type of study	Date of study	Country	Reference
25,066	24	R	1900-39	U.S.A	22
600	68	R	1919*	U.S.A	23
8,080	21	R	1933-37	U.S.A	24
1,000	49	R	1934-39	Norway	25
1,000	20	R	1940-49	Denmark	26
1,106	6	R	1947-53	U.S.A	27
1,889	48	R	1951-52	U.S.A	28
1,078	33	R	1952*	Germany	29
1,000	30	R	1952*	Czechoslavakia	30
1,132	48	R	1954-64	Germany	31
265	47	R	1958	U.S.A	32
1,000	30	R	1958-61	France	33
9,501	55	P	1959	Great Britain	13
327	28	R	1960	Sweden	34
4,315	11	R	1961-67	Germany	35
1,000	11	P	1966-67	Northern Ireland	36
4,652	52	R	1967	Germany	37
200	48	R	1970*	U.S.A	38
383	30	R	1970-71	Sweden	39
252	12	R	1973-75	U.S.A	9

* No dates of death were given in these studies, those which are shown are the dates of publication.

** Refers to deaths reported to the Coroner only.

P = prospective study; R = retrospective study.

have improved his chances of survival. The second consequence of mis-diagnosis of cause of death concerns mortality statistics. If the raw data on which these are based are inaccurate, then so are all the conclusions drawn from them.

THERAPEUTIC CONSEQUENCES

Just over half the patients whose cause of death was not correctly identified before autopsy were 70 years old or more (Table 16). Most of these patients were found to have multiple pathological conditions, any one of which was potentially lethal. It has been found that in patients with more than one disease, discrepancies often arise between ante-mortem and post-mortem diagnosis, usually because the clinician tends to stick to his original diagnosis, and overlooks new signs and symptoms which may arise(27,42). From a practical point of view, fitting our elderly patients into the 'correct' diagnostic box appears to have been relatively unimportant, since vigorous treatment would not have delayed death for long, and, as Baker(43) has so eloquently reminded us, the mere prolongation of life is not always in the patient's best interests.

TABLE 16. *Percentage distribution by age and sex of patients with disagreed diagnoses.*

Age	Males	Females	Total
0-9	5.9	5.1	5.5
10-19	0	0	0
20-29	0	0.6	0.3
30-39	0.7	2.5	1.7
40-49	5.2	1.9	3.4
50-59	14.2	11.5	12.7
60-69	29.1	20.4	24.5
70-79	32.2	35.7	34.0
80-89	11.2	19.8	15.9
90+	0	0.6	0.3
Not stated	1.5	1.9	1.7

Of the remaining patients, there was a reasonably clear indication that different treatment might have been advantageous in only 25. Thus on the evidence which we have, a misdiagnosis of cause of death was of clinical importance in about 8.6% of cases. This figure is similar to others which have been reported. For example, in the studies of Holler and de Morgan(38), Britton(39) and Burrows(9), the proportion of cases in which the correct diagnosis would have been significant to the patient was considered to be 5%, 7.3% and 11.9% respectively.

Our figure needs to be interpreted with considerable caution, however, and is not to be regarded as being in any sense exact. For example, the past medical history of the patient was not known to us, nor was his clinical state at the time he was first seen, nor do we know how quickly he deteriorated after his admission to hospital. All these factors could obviously have had an important bearing on the final outcome.

The clinician in charge of the patient, however, does have this knowledge, so any further studies of this kind ought properly to involve him directly. This could be achieved by referring back for his consideration any case in which the autopsy diagnosis disagreed with his own, assuming always that the clinician is unable to attend the autopsy in person. This system of referral could be undertaken routinely by departments of pathology, although this might cause undue delay in some cases. Alternatively, the task could fall to an intermediary who was working as part of a special research team.

Doctors have always suffered from the jibe that they bury their mistakes. So they do, but the good physician learns from them and he can best do so by being made aware of his diagnostic errors as rapidly as possible. In this way he can reflect upon a case when its details are fresh in his mind. Mona Britton(39) has outlined the benefit which both doctor and patient gain from the former knowing of his errors. "Disclosing of mistakes stimulates critical reasoning and increases the willingness to reconsideration, which should in turn improve future patient care."

EPIDEMIOLOGICAL CONSEQUENCES

The study of secular and geographical trends in disease rates depends upon accurate raw data, for if they are subject to error, then so are any conclusions based upon them. To take one recent case as an example. Burch(44) has suggested that the bulk of the enormous secular increase in death-rates from carcinoma of the bronchus recorded in this century has been due to wrongful diagnosis and not to the increase in tobacco smoking as the widely prevailing view maintains(45). There are many reports which show that lung cancer was commonly mis-diagnosed in the early part of the century(46,47) and that it has continued to be so down to the present(40,48-50). These (but not those who take a contrary position, e.g. Gilliam(51)), Burch cites in support of his case, and even though his view receives little support from the medical profession(52), it should remind us of the hazards which await those who may read too much into unreliable data. It is also important to bear in mind that mis-diagnosis is, as it were, bi-directional. Thus, in the present study, 11 of the 48 cases presumed on clinical grounds to have died from carcinoma of the bronchus were re-allocated, suggesting that the disease is over-diagnosed. To the 37 cases confirmed at autopsy, however, a further 22 were added so that the net result is an *under*-diagnosis (see Appendix 4, page 59).

THE EFFECTS OF AUTOPSY FINDINGS ON MORTALITY RATES

The general effect may be examined from a consideration of the following simple model.

Let D = the total number of patients diagnosed on clinical grounds as dying in unit time from any given disease; let
p = the proportion of these patients dying in hospital; let
q = the proportion dying outside hospital, and let
r_1 = the percentage of errors in the clinical diagnosis in hospitals and
r_2 = the percentage of errors in the clinical diagnosis outside hospitals.
If D' = the true number of patients dying with the disease in unit time, then

$$D' = \left[p + \left(\frac{p.r_1}{100} \right) \right] + \left[q + \left(\frac{q.r_2}{100} \right) \right] \quad (1)$$

The percentage change in the mortality rate

$$= \frac{(D' - D)100}{D} \quad (2)$$

Values of r_1 and r_2 may be positive or negative according as the disease is over- or under-diagnosed by the clinicians.

To establish the value of D' requires that an autopsy be performed on each person who dies (or at least on a statistically representative sample), and it requires that the cause of death be agreed by clinician and pathologist. The number of deaths in England and Wales in 1973 was approximately 590,000, of which 58% occurred in hospital and 42% outside. Less than a quarter of all deaths are followed by autopsy, and presumably most of the autopsies are performed on patients who die in hospital, although there are no readily available statistics to confirm this point. To undertake autopsies on all deaths (even if this were thought to be either desirable or necessary) would be a formidable undertaking, but some check on the accuracy of clinical diagnosis is required if the values of r_1 and r_2 in equation (1) above are to be obtained. Munan and Kelly(53) have suggested that autopsies on a 1% sample of cases would be adequate for this purpose, but this seems a low figure to set as a goal. The present national rate in England and Wales of about 25% would probably be adequate if it were universally achieved. That it is not the case is shown by the inter-regional differences which have been found(54).

The major difficulties which stand in the way of attaining a reasonable estimate of the error in certification are, firstly in ensuring that a truly representative sample of the population is taken and secondly, that all hospitals have the staff and the facilities to undertake the required number of autopsies. Furthermore, some means would have to be found to enable autopsies to be conducted routinely on persons dying outside hospital.

EFFECTS OF AUTOPSY FINDINGS ON PREVALENCE RATES

Three examples from the present study, pulmonary embolus,

malignant disease, and ischaemic heart disease are presented to illustrate how autopsy findings affect prevalence rates.

Pulmonary embolus: On clinical grounds, 28 patients were considered to have died from pulmonary embolus, but 3 only were substantiated at autopsy. On the other hand, after autopsy, the condition was given as the underlying cause of death in 25 patients altogether (Appendix 4, page 59). There were, however, many more patients in whom a pulmonary embolus was discovered at autopsy and in whom it was considered to be a contributory cause of death. Some of these were suspected clinically, but most were not (Table 17).

The effect of the autopsy findings on the prevalence of pulmonary embolus is shown in Table 18, page 30. There is little difference in the prevalence (cases/100) before or after autopsy when pulmonary embolus was considered as the underlying cause of death. When taking into account those cases in which it was also a contributory cause of death, then the autopsy findings increase the rate considerably. The final rate in the females is about three and a half times greater than the rate before autopsy; it is some six times greater in the males. In both sexes, the final rate is about twice as great as that obtained when the cases in which pulmonary embolus was suspected clinically as a contributory cause of death are included. Thus, the prevalence of pulmonary embolus in this population is found to be at least twice as great after post-mortem as was supposed on clinical grounds.

Malignant disease; In 37 patients, malignant disease was considered to be a contributory, but not the underlying cause of death. 22 of these tumours were suspected on clinical grounds (Table 19). The tumours occurred at several different sites, but for convenience they will all be considered together. The effect of the autopsy findings on the prevalence rates (cases/100) are shown in Table 20. Unlike the previous example, the autopsy findings affect the overall prevalence of malignant disease to only a small degree. After autopsy, slightly fewer patients were allocated to this group than before (240 as against 244), despite the fact that many individuals were re-allocated (Appendix 4, page 59). The final rate, including cases where malignant disease was both an

TABLE 17. *Number of cases of pulmonary embolus certified at autopsy as a contributory, but not the underlying cause of death.*

	Age-Group			
	35-54	55-74	75+	Not stated
Not suspected clinically				
Male	4	26	12	
Female	3	16	13	1
Suspected clinically				
Male	2	14	4	
Female		3	4	1
Total	9	59	33	2

TABLE 18. *Post-mortem diagnoses of cases allocated to ICD group VII on the basis of clinical diagnoses.*

	Age - Group				
	15-	35-	55-	75+	Total
Females					
Before autopsy	9.09	5.88	2.59	3.18	2.91
After autopsy (1)	9.09	0	2.59	3.18	2.33
After autopsy (2)	9.09	0	3.88	5.73	3.69
After autopsy (3)	9.09	5.88	9.48	11.47	8.54
After autopsy (4)	9.09	5.88	10.78	14.01	9.90
Males					
Before autopsy	0	0	2.22	4.42	2.01
After autopsy (1)	0	1.22	2.86	2.65	2.17
After autopsy (2)	0	3.66	7.30	6.19	5.52
After autopsy (3)	0	6.10	11.11	13.27	9.20
After autopsy (4)	0	8.54	15.56	16.81	12.54

Before autopsy: Cases in which pulmonary embolus was diagnosed clinically as the underlying cause of death.

After autopsy (1): Cases in which pulmonary embolus was diagnosed by pathologist as the underlying cause of death.

After autopsy (2): Cases in which pulmonary embolus was a contributory cause of death and was suspected clinically.

After autopsy (3): Cases in which pulmonary embolus was a contributory cause of death and not suspected clinically.

After autopsy (4): All cases in which pulmonary embolus was found by the pathologist to be either the underlying or a contributory cause of death.

TABLE 19. *Number of tumours certified at autopsy as a contributory, but not the underlying cause of death and suspected on clinical grounds.*

	Age-Group		
	35-54	55-74	Not stated
Not suspected clinically			
Male	1	13	3
Female	0	0	5
Suspected clinically			
Male	0	3	0
Female	1	8	3
Total	2	24	11

TABLE 20. *Prevalence of malignant disease (cases/100) with respect to autopsy findings.*[*]

	Age-Group						
	<1	1-14	15-34	35-54	55-74	75+	Total
Males							
Before autopsy	1.59	28.57	18.18	23.17	25.71	27.43	23.08
After autopsy (1)	0	28.57	18.18	21.95	23.49	29.20	21.91
After autopsy (2)	0	28.57	18.18	21.95	24.44	29.20	22.41
After autopsy (3)	0	28.57	18.18	23.17	27.62	31.86	24.75
After autopsy (4)	0	28.57	18.18	23.17	28.57	31.86	25.25
Females							
Before autopsy	3.70	20.00	18.18	17.65	25.43	16.56	19.42
After autopsy (1)	3.70	30.00	18.18	19.61	25.86	16.56	20.00
After autopsy (2)	3.70	30.00	18.18	21.57	29.31	18.47	22.33
After autopsy (3)	3.70	30.00	18.18	19.61	25.86	19.75	22.91
After autopsy (4)	3.70	30.00	18.18	21.57	29.31	21.66	23.30

* See Table 18 for explanation of autopsy categories.

underlying and contributory cause of death is only 1.1 times greater than the original clinical rate in men, and 1.2 times greater in females.

Ischaemic heart disease: On clinical grounds 167 patients were considered to have died from ischaemic heart disease, but after autopsy this figure rose to 246. The clinical diagnosis was confirmed in 128 of the 167 originals (see Appendix 4, page 59). There were relatively few cases in which ischaemic heart disease was considered as a contributory cause of death and in the majority of these, this was not suspected on clinical grounds (25 out of the total of 28 cases, see Table 21). The differences which the autopsy findings make to the prevalence of the disease are shown in Table 22, page 33. In cases in which ischaemic heart disease is the underlying cause of death, the effect of the autopsy is to increase the prevalence by 1.4 times in men and 1.7 times in women. Taking into account the cases in which it was also a contributory cause of death, the rate is increased after autopsy by 1.5 times and 1.9 times in the males and females respectively. In this instance, the increase in rate following the autopsy lies somewhere between those of the two previous examples.

It is interesting to note from these examples, that although there may be a considerable measure of disagreement between ante-mortem and post-mortem diagnoses, this does not necessarily affect the overall prevalence of a particular disease when it is considered solely as the underlying cause of death. Thus, the errors which are due to under-reporting and over-reporting by the clinicians, seem in some cases to cancel each other out, as Britton(39) has also noted to be the case.

The figures for malignant disease have probably been improved by considering all sites *en bloc*, but there were too few data to allow individual sites to be analysed separately. Certainly bronchiogenic tumours tended to be under-diagnosed before autopsy, whereas leukaemia and brain tumours were over-diagnosed (see Appendix 4, page 59). Grouping the results together tends to obscure the individual differences as Heasman and Lipworth(19) found when they made their survey.

When assessing the extent to which a condition is present in a population, either as a contributory or an underlying

TABLE 21. *Number of cases of ischaemic heart disease certified at autopsy as a contributory, but not the underlying cause of death.*

	Age-Group		
	35-54	55-74	75+
Not suspected clinically			
Male	2	11	4
Female	1	2	5
Suspected clinically			
Male	0	1	0
Female	0	1	1
Total	3	15	10

TABLE 22. *Prevalence of ischaemic heart disease (cases/100) with respect to autopsy findings.**

	Age - Group				
	15-34	35-54	55-74	75+	Total
Males					
Before autopsy	0	28.05	20.32	18.58	18.06
After autopsy 1	0	29.27	30.79	23.89	24.75
2	0	29.27	31.11	23.89	24.92
3	0	31.71	34.29	27.43	27.59
4	0	31.71	34.60	27.43	27,76
Females					
Before autopsy	0	3.92	14.66	14.01	11.26
After autopsy 1	9.09	7.84	22.85	26.75	19.42
2	9.09	7.84	23.28	27.39	19.81
3	9.09	9.80	23.71	29.94	20.97
4	9.09	9.80	24.14	30.57	21.36

* See Table 18 for explanation of autopsy categories.

cause of death, autopsy findings may profoundly alter figures based on clinical impressions. The data on pulmonary embolus show this with great force (Table 18).

RELATIONSHIP TO NATIONAL STATISTICS

The number of forms which were returned to us was not as great as we had hoped when we began the survey. Unfortunately, the time we chose to open the study coincided with a period of unrest within the profession and many of the consultants we approached were reluctant at that time to undertake any commitments beyond their normal clinical responsibilities. Those we lost from the survey did not return later, despite further appeals. In all, we received forms which we could use from an estimated 1.7% of all hospital deaths in the two regions we studied. We did less well in Trent than in the West Midlands, showing that action at a distance is not always effective. From Trent we received an estimated 0.7% return, from West Midlands, 2.8%. Despite this, however, our sample size is larger than most which have been reported (see Table 15, page 24).

It is impossible to estimate whether our sample is truly representative of all hospital deaths in the two regions, but it is obviously not representative of *all* deaths in the regions. For example, just under half of all deaths occur at home and it is known that domiciliary deaths have an older age-range than deaths in hospital(13). Since it is found that the accuracy of the diagnoses of cause of death decreases with age, there are likely to be more errors made in death certification in the domiciliary than in the hospital population. Moreover, the opportunity for amendment following autopsy is less than in hospital. It is not possible, therefore, to predict how far these results apply to general practice.

Heasman and Lipworth(13) considered that their sample was biased towards those cases in which the clinician was uncertain of his diagnosis. There is not much difference between the proportion of cases in which the clinical diagnosis was fairly certain, probable, or uncertain in their study and ours. The proportion in the three categories in Heasman and Lipworth's study were respectively, 55.6%, 29.7% and 11.9%, with 2.8% not stated. In our study the figures were: 50.4%, 33.1% and 11.5%, with 5.0% not stated.

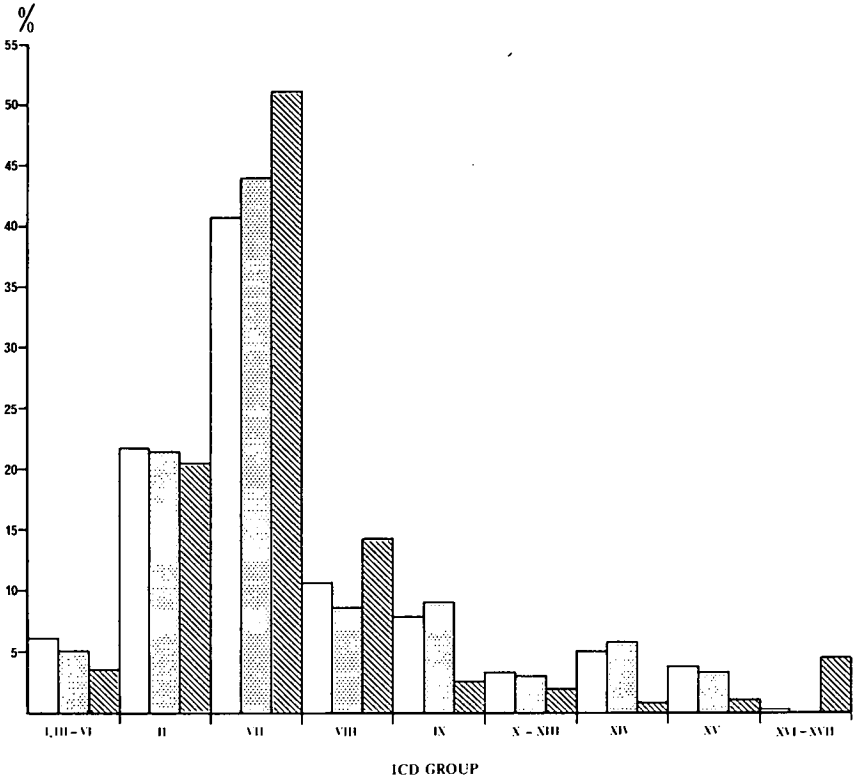

FIGURE 5. Percentage distribution of cases into ICD groups according to clinical and autopsy diagnoses, and mean percentage distribution of all deaths in England and Wales, 1969-1973. Blank column = clinical diagnoses, dotted column = autopsy diagnoses, shaded column = national deaths.

Finally, as is evident from Figure 5, some causes of death in this survey are over-represented to the detriment of others, so far as the national mortality data are concerned. It is clear that one cannot use the results of this study alone to make inferences about national statistics. However, we have shown that diagnostic errors are demonstrated with some regularity by routine post-mortem examination and that it would be a mistake to allow the critics of the autopsy to consign it to medical limbo.

CHAPTER 4

SUMMARY AND CONCLUSIONS

AUTOPSY RATES IN THE BIRMINGHAM TEACHING HOSPITALS

We have previously shown that the autopsy rate has fallen in the Birmingham teaching hospitals in recent years(11). In 1958 the rate was 74.4%, whereas in 1972 it was 46.0%, although even this rate is substantially above both the West Midlands regional and the national rates (27.3% and 25.8% in 1972 respectively). Over the years studied, 1958 and 1972, the national autopsy rate has been reasonably constant and so the experience of the Birmingham hospitals cannot be taken as typical of all hospitals in the country. It would be very interesting to compare autopsy rates in other hospitals, both in the West Midlands region and in other regions with those so far studied, so that a more complete picture of trends throughout the country can be established.

CLINICAL ATTITUDES TO THE AUTOPSY

The results of a questionnaire survey showed that for the majority of clinicians the autopsy still has an important part to play in their own practice, and virtually all consider it is a valuable teaching method for undergraduates(12). Most view the decline in the autopsy as a matter of concern. Reasons which they gave for the decline included an increased reluctance on the part of relatives to consent to the procedure, coupled with a change in attitude towards the autopsy by junior staff, increased confidence in the accuracy of ante-mortem diagnosis, and deficiencies in the service provided by the pathologists.

There was no means of corroborating the clinicians' impression that the attitude of junior staff towards the autopsy differed from their own, and this is an area which perhaps merits further study.

The grievances against the pathologist related either to

the quality of the autopsy, or to failure of communication. Many pathologists have expressed dissatisfaction with some aspects of modern autopsy practice and there does seem to be a need for an operational reassessment of the service. Of particular importance is the need to assess the desirability of changing the form and content of autopsy records and to test the efficiency of the feed-back loop from pathologist to clinician.

AGREEMENT BETWEEN ANTE-MORTEM AND POST-MORTEM DIAGNOSIS

A retrospective study made of the autopsy and clinical records from the Queen Elizabeth and General hospital showed that the underlying causes of death given by clinicians and pathologists disagreed in approximately a fifth of cases. The largest discrepancy was noted amongst patients diagnosed by the clinicians as having died from cardiovascular disease, due mainly to the under-diagnosis of pulmonary embolus.

To examine this disagreement between clinical and pathological diagnosis further, a prospective study was initiated which ran from January 1975 to April 1976, the results of which form the material for this report.

Information was obtained for roughly 1.7% of all hospital deaths in the regions studied. Of these, 114 (9.2%) were incomplete and had to be discarded, and in 9, the clinicians had not been able to make a diagnosis before death. In 531 of the remaining cases (47.5%), the clinical diagnosis agreed completely with the autopsy diagnosis. In 295 cases (26.4%) there was partial agreement and in 291 cases (26.1%), the clinical and pathological diagnoses disagreed.

There were considerable variations in the disagreement by sex, age, type of hospital, clinical diagnosis and certainty of diagnosis. The case in which disagreement was most likely to occur would be that of an elderly female in whom the clinical diagnosis of respiratory disease was uncertain and who died in a non-teaching hospital.

The measure of disagreement found in the retrospective study was higher than in the prospective study, probably because of observer error in the latter, and it is recommended that any investigation of ante-mortem and post-mortem diagnoses in the future should use a prospective method.

The consequences of errors in the clinical diagnosis of

death are twofold: firstly the patient may be denied the correct treatment and secondly, the reliablility of mortality data is rendered suspect. So far as therapeutic consequences were concerned, in the present study, more than half the disagreements were in patients over 70, with a multitude of pathological conditions, any of which might have been potentially lethal. It was not felt that *any* therapy would have prolonged life substantially in these patients. Of those remaining, in only 25 was there a reasonably clear indication that different treatment might have altered the outcome. This figure represents 8.6% of the total sample, but it is not likely to be exactly right, since we did not have details of previous admissions or of the patient's course in hospital. To get more accurate information on this point would require a study which directly involved the clinicians, and in which any disagreement could be immediately referred back to the clinician in charge of the case for an assessment as to whether a different therapeutic regime would have benefitted the patient in question.

From the epidemiological point of view, errors in certification of cause of death can affect both the apparent incidence and prevalence rates of a particular disease, depending on whether it is over- or under-diagnosed by the clinician. For example, the prevalence of pulmonary embolus in this study was shown to be twice as great after autopsy as was suspected on clinical grounds, whereas the prevalence of all malignant disease was little changed after autopsy even though many individual patients had their original diagnosis changed.

The autopsy is of great value in verifying clinical diagnosis, particularly if both pathologist and clinician agree on the final diagnosis, and there is a need to ensure that an autopsy is performed on a representative sample of all deaths so that mortality data are as free from error as possible. The major difficulty here is in checking the accuracy of the diagnosis in patients dying outside hospital. About 50% of all deaths occur outside hospital, and a higher proportion of elderly people die at home than in hospital. Since the diagnosis of cause of death becomes less accurate in the elderly, it is reasonable to suppose that the error rate amongst patients dying at home is greater than that

amongst those dying in hospital and it would be of great interest to try to establish the magnitude of this diagnostic error.

The results of the studies which are reported here lead us to conclude that the autopsy is still important for medical practice and that its decline is to be regretted.

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16. If the rules for completion have been properly followed, the underlying cause of death should normally be the last named condition in Part 1 of the dummy death certificate (see Appendix 1).

17. WORLD HEALTH ORGANISATION (1969). *International classification of diseases*, 8th revision, 2 vols Geneva.

18. The figures for all deaths are taken from the Registrar General's Medical Tables.

19. The conditions included within each of the ICD groups is shown in Appendix 2.

20. The results for all the ICD groups, and for certain sub-groups are to be found in Appendix 3.

21. It should be noted that some of the sub-groups in this and subsequent tables contain more than one three digit code.

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APPENDIX 1.

FORM USED IN PROSPECTIVE STUDY OF ANTE-MORTEM AND POST-MORTEM DIAGNOSES.

Name of Hospital No.

Patient's name

Sex

Age Date of birth

Date of admission

Date of death

A

CLINICIAN'S CERTIFICATE — to be completed before results of autopsy are known

Cause of Death

I

Disease or condition directly leading to death — a ..... due to (or as a consequence of)

Antecedent causes.

Morbid conditions, if any, giving rise to the above cause stating the underlying condition last — b ..... due to (or as a consequence of)

c .....

II **II**

Other significant conditions, contributing to the death, but not related to the disease or condition causing it. .....

.....

Differential diagnosis (or other notes) .....

.....

.....

.....

.....

.....

.....

.....

In my opinion the diagnosis given as the underlying cause is:

☐ Fairly certain ☐ Probable ☐ Uncertain

signature .....

B **PATHOLOGIST'S CERTIFICATE — to be completed after autopsy, with the use of clinical notes and after discussion with clinician, if possible.**

Cause of Death

I

Disease or condition directly leading to death

a ..... due to (or as a consequence of)

Antecedent causes.

Morbid conditions, if any, giving rise to the above cause stating the underlying condition last

b ..... due to (or as a consequence of)

c .....

II

Other significant conditions, contributing to the death, but not related to the disease or condition causing it.

II

.....

.....

List of principal lesions found (or other notes).....

.....

.....

.....

.....

.....

.....

.....

☐ Histological examination has been carried out and confirms cause of death

☐ Histological examination has not been carried out

☐ Histological examination is being carried out but results are not yet to hand

signature .....

any other comments

APPENDIX 2.

LIST OF CONDITIONS INCLUDED WITHIN EACH ICD GROUP.

ICD Group	Disease or conditions included
I	Infective and Parasitic Diseases
II	Neoplasms
III	Endocrine, Nutritional and Metabolic Diseases
IV	Diseases of the Blood and Blood-forming Organs
V	Mental Disorders
VI	Diseases of the Nervous System and Sense Organs
VII	Diseases of the Circulatory System
VIII	Diseases of the Respiratory System
IX	Diseases of the Digestive System
X	Diseases of the Genito-urinary System
XI	Complications of Pregnancy, Childbirth and the Puerperium
XII	Diseases of the Skin and Subcutaneous Tissue
XIII	Diseases of the Musculoskeletal System and Connective Tissue
XIV	Congenital Anomalies
XV	Certain Causes of Perinatal Morbidity and Mortality
XVI	Symptoms and Ill-defined Conditions
XVII	Accidents, Poisonings and Violence

APPENDIX 3.

ALLOCATION OF ANTE-MORTEM DIAGNOSES INTO DIAGNOSTIC CATEGORIES, BY CONFIDENCE OF DIAGNOSIS AND ICD GROUP.

I. INFECTIVE AND PARASITIC DISEASES (ICD 000-136).

	Total	A	B	C
Fairly certain	8	6	1	1
Probable	6	3	1	2
Uncertain	7	0	2	5
Not stated	3	1	0	2
Total	24	10	4	10

			Total	A	B	C
Fairly certain						
1.	150; 155-159	Digestive organs	13	7	4	2
2.	151	Stomach	9	7	1	1
3.	153	Large bowel	10	4	3	3
4.	154	Rectum	8	4	4	0
5.	160-163	Respiratory system	0	0	0	0
6.	162.1	Bronchus and lung	29	24	4	1
7.	170-173	Bone, connective tissue and skin	1	1	0	0
8.	174	Breast	7	6	1	0
9.	180-189	Genito-urinary organs	15	10	1	4
10.	190; 193-199	Other and unspecified sites	11	0	10	1
11.	191-192	Brain and other parts of the nervous system	10	6	2	2
12.	200-209	Lymphatic and haem-atopoietic tissue	18	9	6	3
13.	210-228	Benign	0	0	0	0
		Total	131	78	36	17
Probable						
1.	150; 155-159	Digestive organs	10	2	3	5
2.	151	Stomach	7	2	0	5
3.	153	Large bowel	6	2	1	3
4.	154	Rectum	2	2	0	0
5.	160-163	Respiratory system	0	0	0	0
6.	162.1	Bronchus and lung	15	10	2	3
7.	170-173	Bone, connective tissue and skin	0	0	0	0
8.	174	Breast	1	0	0	1
9.	180-189	Genito-urinary organs	8	2	2	4
10.	190; 193-199	Other and unspecified sites	15	2	12	1
11.	191-192	Brain and other parts of the nervous system	3	1	0	2
12.	200-209	Lymphatic and haem-atopoietic tissue	8	7	0	1
13.	210-228	Benign	2	0	1	1
		Total	77	30	21	26

			Total	A	B	C
Uncertain						
1.	150;					
	155-159	Digestive organs	5	0	0	5
2.	151	Stomach	3	0	1	2
3.	153	Large bowel	0	0	0	0
4.	154	Rectum	1	0	0	1
5.	160-163	Respiratory system	0	0	0	0
6.	162.1	Bronchus and lung	2	2	0	0
7.	170-173	Bone, connective tissue and skin	0	0	0	0
8.	174	Breast	1	1	0	0
9.	180-189	Genito-urinary organs	3	0	1	2
10.	190;	Other and unspecified				
	193-199	sites	10	0	7	3
11.	191-192	Brain and other parts of the nervous system	2	0	0	2
12.	200-209	Lymphatic and haem-atopoietic tissue	1	0	0	1
13.	210-228	Benign	0	0	0	0
		Total	28	3	9	16
Not stated						
1.	150;					
	155-159	Digestive organs	1	0	1	0
2.	151	Stomach	1	1	0	0
3.	153	Large bowel	0	0	0	0
4.	154	Rectum	1	1	0	0
5.	160-163	Respiratory system	2	1	0	1
6.	162.1	Bronchus and lung	2	1	1	0
7.	170-173	Bone, connective tissue and skin	0	0	0	0
8.	174	Breast	0	0	0	0
9.	180-189	Genito-urinary organs	1	1	0	0
10.	190;	Other and unspecified				
	193-199	sites	0	0	0	0
11.	191-192	Brain and other parts of the nervous system	0	0	0	0
12.	200-209	Lymphatic and haem-atopoietic tissue	0	0	0	0
13.	210-228	Benign	0	0	0	0
		Total	8	5	2	1
		Grand Total	244	116	68	60

III. ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES (ICD 240-279).

		Total	A	B	C
Fairly certain					
1. 250	Diabetes Mellitus	8	5	1	2
2. 240-246; 251-279	Remainder	4	4	0	0
	Total	12	9	1	2
Probable					
1. 250	Diabetes Mellitus	6	2	2	2
2. 240-246; 251-279	Remainder	4	0	1	3
	Total	10	2	3	5
Uncertain					
1. 250	Diabetes Mellitus	1	0	1	0
2. 240-246; 251-279	Remainder	0	0	0	0
	Total	1	0	1	0
Not stated					
1. 250	Diabetes Mellitus	0	0	0	0
2. 240-246; 251-279	Remainder	1	1	0	0
	Total	1	1	0	0
	Grand Total	24	12	5	7

IV. DISEASES OF THE BLOOD AND BLOOD FORMING ORGANS (ICD 280-289).

	Total	A	B	C
Fairly certain	3	2	1	0
Probable	3	2	1	0
Uncertain	2	1	1	0
Total	8	5	3	0

V. MENTAL DISORDERS (ICD 290-315).

Fairly certain	3	1	1	2
Probable	2	0	1	1
Not stated	1	0	1	0
Total	6	1	3	2

VI. DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS (ICD 320-389).

Fairly certain	5	3	2	0
Probable	2	1	0	1
Total	7	4	2	1

			Total	A	B	C
Fairly certain						
1.	390-398	Rheumatic disease	11	9	0	2
2.	400-4)4	Hypertensive disease	26	12	3	11
3.	410-414	Ischaemic heart dis.	92	48	35	9
4.	420-429	Other heart disease	29	10	11	8
5.	430-438	Cerebrovascular dis.	46	14	22	10
6.	440-448	Dis. of arteries etc.	22	13	7	2
7.	450	Pulmonary embolism	8	2	1	5
8.	451-458	Remainder	8	4	3	1
		Total	242	112	82	48
Probable						
1.	390-398	Rheumatic disease	1	1	0	0
2.	400-4)4	Hypertensive disease	9	4	1	4
3.	410-414	Ischaemic heart dis.	48	17	15	16
4.	420-429	Other heart disease	25	5	13	7
5.	430-438	Cerebrovascular dis.	30	8	10	12
6.	440-448	Dis. of arteries etc.	16	10	3	2
7.	450	Pulmonary embolism	9	1	4	4
8.	451-458	Remainder	7	4	1	2
		Total	145	50	47	48
Uncertain						
1.	390-398	Rheumatic disease	0	0	0	0
2.	400-4)4	Hypertensive disease	2	2	0	0
3.	410-414	Ischaemic heart dis.	16	6	4	6
4.	420-429	Other heart disease	7	0	1	6
5.	430-438	Cerebrovascular dis.	8	4	0	4
6.	440-448	Dis. of arteries etc.	3	2	0	1
7.	450	Pulmonary embolism	9	0	3	6
8.	451-458	Remainder	3	0	1	2
		Total	48	14	9	25

VII. DISEASES OF THE CIRCULATORY SYSTEM (ICD 390-458).

			Total	A	B	C
Not stated						
1.	390-398	Rheumatic disease	0	0	0	0
2.	400-4)4	Hypertensive disease	1	1	0	0
3.	410-414	Ischaemic heart dis.	11	4	5	2
4.	420-429	Other heart disease	3	1	1	1
5.	430-438	Cerebrovascular dis.	3	0	2	1
6.	440-448	Dis. of arteries etc.	3	1	0	2
7.	450	Pulmonary embolism	2	0	0	2
8.	451-458	Remainder	1	0	0	1
		Total	24	7	8	9
		Grand Total	459	183	146	130

VIII. DISEASES OF THE RESPIRATORY SYSTEM (ICD 460-519).

			Total	A	B	C
Fairly certain						
1.	460-474	Acute infections	0	0	0	0
2.	480-486	Pneumonia	33	10	12	11
3.	490-493	Bronchitis, emphysema and asthma	16	10	1	5
4.	500-519	Remainder	3	3	0	0
		Total	52	23	13	16
Probable						
1.	460-474	Acute infections	0	0	0	0
2.	480-486	Pneumonia	36	7	16	13
3.	490-493	Bronchitis, emphysema and asthma	9	4	0	5
4.	500-519	Remainder	2	2	0	0
		Total	47	13	16	18
Uncertain						
1.	460-474	Acute infections	0	0	0	0
2.	480-486	Pneumonia	9	2	4	3
3.	490-493	Bronchitis, emphysema and asthma	6	2	1	3
4.	500-519	Remainder	1	0	0	1
		Total	16	4	5	7
Not stated						
1.	460-474	Acute infections	0	0	0	0
2.	480-486	Pneumonia	5	1	2	2
3.	490-493	Bronchitis, emphysema and asthma	0	0	0	0
4.	500-519	Remainder	0	0	0	0
		Total	5	1	2	2
		Grand Total	120	41	36	43

IX. DISEASES OF THE DIGESTIVE SYSTEM (ICD 520-577).

			Total	A	B	C
Fairly certain						
1.	531-533	Ulcers of stomach, duodenum & peptic ulcers	7	5	2	0
2.	570-577	Diseases of liver & gall bladder	8	3	3	2
3.	577	Diseases of pancreas	3	3	0	0
4.	520-530; 534-569	Remainder	16	12	3	1
		Total	34	23	8	3
Probable						
1.	531-533	Ulcers of stomach, duodenum & peptic ulcers	12	10	0	2
2.	570-577	Diseases of liver & gall bladder	7	2	2	3
3.	577	Diseases of pancreas	4	3	0	1
4.	520-530; 534-569	Remainder	10	6	2	2
		Total	33	21	4	8
Uncertain						
1.	531-533	Ulcers of stomach, duodenum & peptic ulcers	1	1	0	0
2.	570-577	Diseases of liver & gall bladder	3	2	0	1
3.	577	Diseases of pancreas	1	1	0	0
4.	520-530; 534-569	Remainder	8	5	0	3
		Total	13	9	0	4
Not stated						
1.	531-533	Ulcers of stomach, duodenum & peptic ulcers	0	0	0	0
2.	570-577	Diseases of liver & gall bladder	3	1	1	1
3.	577	Diseases of pancreas	1	0	0	1
4.	520-530; 534-569	Remainder	3	2	0	1
		Total	7	3	1	3
		Grand Total	87	56	13	18

X. DISEASES OF THE GENITO-URINARY SYSTEM (ICD 580-629).

	Total	A	B	C
Fairly certain	13	6	4	3
Probable	12	3	3	6
Uncertain	6	2	1	3
Not stated	2	0	1	1
Total	33	11	9	13

XII. DISEASES OF THE SKIN & SUBCUTANEOUS TISSUES (ICD 680-709).

Probable	1	1	0	0

XIII. DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE (ICD 710-738).

Probable	2	1	1	0

XIV. CONGENITAL ANOMALIES (ICD 740-759).

		Total	A	B	C
Fairly certain					
1. 740-743	Congenital anomalies of the nervous system	5	5	0	0
2. 746-747	Congenital anomalies of heart	23	23	0	0
3. 744-745; 748-759	Remainder	11	11	0	0
	Total	39	39	0	0
Probable					
1. 740-743	Congenital anomalies of the nervous system	2	2	0	0
2. 746-747	Congenital anomalies of heart	10	10	0	0
3. 744-745; 748-759	Remainder	2	2	0	0
Uncertain					
3. 744-745; 748-759	Remainder	1	1	0	0
Not stated					
2. 746-747	Congenital anomalies of heart	2	2	0	0
	Grand total	56	56	0	0

XV. CERTAIN CAUSES OF PERINATAL MORBIDITY AND MORTALITY (ICD 760-779).

Fairly certain	19	16	3	0
Probable	15	11	2	2
Uncertain	6	5	0	1
Not stated	3	2	0	1
Total	43	34	5	4

XVI. SYMPTOMS AND ILL-DEFINED CONDITIONS (ICD 780-796).

	Total	A	B	C
Fairly certain	2	0	0	2
Probable	1	0	0	1
Total	3	0	0	3

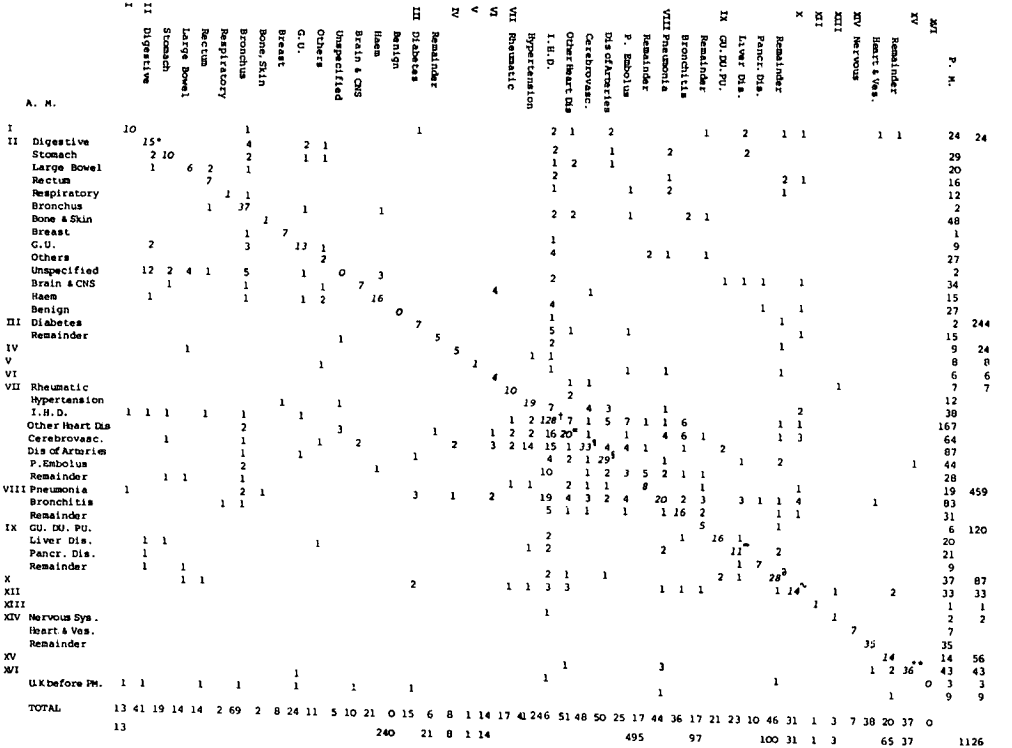
APPENDIX 4.

ANTE-MORTEM AND POST-MORTEM ALLOCATION OF UNDERLYING CAUSE OF DEATH.

Key to Appendix 4

Where superscript symbols are shown, the categories contain the following number of cases with different 3-digit codes:

*	6 cases
†	53 cases
α	4 cases
¶	7 cases
§	3 cases
∞	3 cases
∂	3 cases
~	3 cases
**	2 cases



Figures in *italics* indicate the number of cases in which the ante-mortem and post-mortem diagnoses were unchanged.

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