Pergamon

European Journal of Cancer Vol. 32A, No. 7, pp. 1102–1108, 1996

Printed in Great Britain
0959–8049/96 $15.00+0.00

PII: S0959-8049(96)00006-8

Special Paper

Accuracy of Admission and Clinical Diagnosis of Tumours as Revealed by 2000 Autopsies

B. Szende,[1] G. Kendrey,[2] K. Lapis,[1] F.J.C. Roe[3] and P.N. Lee[4]

[1]First Institute of Pathology and Experimental Cancer Research, Semmelweis Medical University, Budapest, Hungary; [2]Institute of Pathology, Imre Haynal University of Health Science, Budapest, Hungary; [3]19 Marryat Road, Wimbledon Common, London SW19 5BB, U.K.; and [4] P.N. Lee Statistics and Computing Ltd, Sutton SM2 5DA, U.K.

Admission, clinical and autopsy diagnoses of tumour were computed in 2000 consecutive cases, aged 30–80 years, using data collected in two university pathology departments in Budapest, Hungary. Based on diagnosis of tumour, regardless of site, as the underlying cause of death false-negative rates were 37.4% at admission and 8.8% clinically. Corresponding false-positive rates were 8.4 and 9.1%. General practitioners who correctly diagnosed a tumour as the cause of the terminal illness identified the primary site wrongly in 20.6% (90/436) of cases. Hospital clinicians did so in 20.4% (130/636) of cases. Overall, of site-specific tumours considered as the underlying cause of death at autopsy, 27.4% were incorrectly diagnosed clinically and 50.4% at admission. Diagnostic errors were particularly common for tumours of the lung, liver, ovary and gall bladder. Graduate and postgraduate education, planning of the health care system and quality of cancer care may benefit from statistical data derived from autopsy diagnoses. Copyright © 1996 Elsevier Science Ltd

Key words: tumours, diagnostic accuracy, false-positive rates, false-negative rates
Eur J Cancer, Vol. 32A, No. 7, pp. 1102–1108, 1996

INTRODUCTION

DEATH CERTIFICATE data are often used to study time-related trends in cancer mortality [1–3]. The most reliable information regarding the incidence of many internal cancers and other diseases is provided by autopsy [4–6]. Many studies have shown a high level of discrepancy between clinical diagnoses prior to autopsy and autopsy diagnoses [7–11]. Since autopsy rates are declining in most countries, the probability of diagnostic error is increasing. This trend is worrying insofar as public health policy makers rely heavily on mortality data derived from death certificates.

Hungary had the highest autopsy rate among 27 countries surveyed by the World Health Organisation [3]. This is partly because of tradition and partly because, according to Hungarian law, all patients who die in hospital are autopsied unless there are acceptable moral, religious or other grounds for objecting to autopsy. Hungary was, therefore, chosen for a study comparing admission diagnosis, pre-autopsy clinical diagnosis and post-autopsy diagnosis of the underlying and contributory causes of death in 2000 consecutive autopsies on persons aged 30–80 years dying in hospital [12]. Based on the major category of cause of death (e.g. diseases of circulatory system), 42.9% of admission and 37.2% of clinical diagnoses of the underlying cause of death were not confirmed as the underlying cause at autopsy. This paper investigates diagnostic discrepancies among cases where neoplasms were reported at admission, clinically or at autopsy.

Correspondence to F.J.C. Roe.
Received 17 Oct. 1995; accepted 30 Nov. 1995.

MATERIALS AND METHODS

Data were collected in respect of 2000 consecutive autopsies on patients, aged between 30 and 80 years, dying either in the Semmelweis University, Budapest (1000 cases) or in the Postgraduate Medical School, Budapest (1000 cases) between February 1988 and November 1991.

For each death, admission, pre-autopsy clinical and post-autopsy pathological diagnoses were coded according to the 9th Revision of the International Classification of Diseases (ICD). For clinical and autopsy diagnoses, the underlying cause of death, up to three causes leading directly to death and up to nine other contributory causes of death were recorded. Only a single admission diagnosis was recorded.

The accuracy of the admission and clinical diagnoses in the light of the autopsy findings has been reported elsewhere [12].

Neoplasms (ICD 140–239) constitute one major group of the ICD classification. Each three-digit code represents a disease entity, referred to in this paper as a 'site'. Certain combinations of sites, such as tumours of the pharynx (ICD 146 oropharynx, 147 nasopharynx and 148 hypopharynx), are referred to as a 'grouping'. Greater precision is catered for by using a fourth digit following a decimal point after the three digit code (e.g. ICD 188.4 malignant neoplasm of the bladder–posterior wall). Agreement between two diagnoses on four-digit code is referred to as agreement on 'location'.

The admission and clinical diagnoses were compared with the autopsy diagnosis. The extent of agreement on location, on site and on existence of a tumour was quantified overall and for 23 tumour groupings, where at least 10 cases were seen at autopsy. Diagnoses unconfirmed at autopsy are termed 'false-positives', the false-positive rate being expressed as a percentage of total diagnoses seen at admission or clinically. Diagnoses at autopsy that are undetected at admission or clinically are termed 'false-negatives', the false-negative rate being expressed as a percentage of total diagnoses seen at autopsy. Ninety-five per cent confidence limits of false-positive and false-negative rates were calculated using confidence interval analysis (CIA) [13].

RESULTS

The distribution of patients (total and with tumour) by age and sex is shown in Table 1. A tumour was considered the underlying cause of death at autopsy in 697 patients, all except 8 cases being malignant. Up to the age of 70 years, there were more autopsies in males than in females but the proportion dying from tumours was somewhat higher in females (40.0%) than in males (35.6%). The number of deaths from tumours was highest in both sexes in the seventh and eighth decades, and in the eighth decade the proportion of deaths from tumours was higher in males (34.5%) than in females (25.7%).

For 476 (23.8%) of the admission diagnoses and for 700 (35.0%) of the clinical diagnoses, a tumour was considered the underlying cause of death. Where a tumour was considered the underlying cause, there was mention of the tumour at the same site in the autopsy report for 372 (78.2%) admission diagnoses and for 554 (79.1%) clinical diagnoses. For the admission diagnoses, these 372 agreements could be divided into 313 (84.1%) where the underlying cause agreed exactly on location, 33 (8.9%) where it agreed on site but not location, and 26 (7.0%) where the tumour was mentioned, but not as the underlying cause. The division into these categories for the 554 clinical agreements was similar (location 453, 81.8%; site 53, 9.6%; mention 48, 8.7%). Fuller details of the confirmation of the admission and clinical underlying cause of death is shown in Table 2. Table 2 also shows that the admission diagnoses included far more cases, 261, than did the clinical diagnoses, 61, where there was a failure to detect a tumour considered to be the underlying cause at autopsy.

Detection, at admission and clinically, of tumours considered to be the underlying cause of death at autopsy, is considered further in Table 3. Of the 697 cases, just over half, 351 (50.4%) were not detected at admission. Detection of tumours was better clinically, only 29 of the clinical reports failing to report a tumour at all. A tumour of the correct site was detected clinically in 527 (75.6%) of cases, although in some of these the clinical report considered them to be only a direct or contributory cause and not the underlying cause.

Based on specific tumour site and on underlying cause diagnosis only, false-negative rates were 50.4% for admission and 27.4% for clinical diagnosis. False-positive rates were 27.3% for admission and 27.7% for clinical diagnosis.

Based on tumour, regardless of site, and again on underlying cause diagnosis, false-negative rates were 37.4% for admission and 8.8% for clinical diagnosis. False-positive rates were 8.4% for admission and 9.1% for clinical diagnosis.

Table 4 compares admission and autopsy diagnoses for the 23 specific most common tumour groupings, and Table 5 similarly compares clinical and autopsy diagnoses. These comparisons are all based on underlying cause of death. The tables show, for each grouping, the total numbers of cases diagnosed, the numbers of agreements by location, site and grouping, and the number of false-negative and false-positive diagnoses divided according to whether the erroneous diagnosis indicated a tumour as the underlying cause. For some sites, the total cases diagnosed at admission was substantially less than that at autopsy. This was most marked for lung, and gall bladder and bile duct tumours, but was also clearly evident for tumours of the oesophagus, stomach, colon, liver and kidney (Table 4), where only approximately half as many cases were diagnosed as the underlying cause at admission as at autopsy. Under-diagnosis was less marked clinically, but even here numbers of tumours of the gall bladder and bile ducts, and especially of the lung, were markedly underestimated (Table 5).

Comparability of total numbers of cases pre- and post-autopsy often conceals substantial false-negative and -positive rates, frequently because of difficulties in diagnosing the primary site of the tumour. Based on the data in Tables 4 and 5,

Table 1. Distribution by age and sex of the 2000 patients in the study and of the 697 patients with tumour as the underlying cause of death at autopsy

Sex	Patients	Age (years) 30–40	41–50	51–60	61–70	71–80	Total
Male	Total in study	45	101	216	371	351	1084
	With tumour (% of total)	11 (24.4%)	36 (35.6%)	77 (35.6%)	137 (36.9%)	121 (34.5%)	382 (35.2%)
Female	Total in study	36	64	134	324	358	916
	With tumour (% of total)	13 (36.1%)	31 (48.4%)	55 (41.0%)	124 (38.3%)	92 (25.7%)	315 (34.4%)

Table 2. Confirmation of admission and clinical diagnosis of underlying cause at autopsy

Source	Diagnosis	Confirmation at autopsy	Patients	% (95% CI)
Admission	Tumour	Underlying cause agrees on site	346	72.7 (68.7–76.7)
		— agreement on location also	313	65.8 (61.5–700)
		— location differs	33	6.9 (4.8–9.6)
		Underlying cause a tumour, site differs	90	18.9 (15.4–22.4)
		— tumour of same site mentioned*	16	3.4 (1.9–5.4)
		— tumour of same site not mentioned	74	15.5 (12.3–18.8)
		Underlying cause not a tumour	40	8.4 (6.1–11.3)
		— tumour of same site mentioned	10	2.1 (1.0–3.8)
		— tumour of same site not mentioned	30	6.3 (4.3–8.9)
		Total	476	100.0
	Not a tumour	Underlying cause a tumour	261	17.1 (15.2–19.0)
		Underlying cause not a tumour	1263	82.9 (81.0–84.8)
		Total	1524	100.0
Clinical	Tumour	Underlying cause agrees on site	506	72.3 (69.0–75.6)
		— agreement on location also	453	64.7 (61.2–68.3)
		— location differs	53	7.6 (5.7–9.8)
		Underlying cause a tumour, site differs	130	18.6 (15.7–21.5)
		— tumour of same site mentioned	28	4.0 (2.7–5.7)
		— tumour of same site not mentioned	102	14.6 (12.0–17.2)
		Underlying cause not a tumour	64	9.1 (7.1–11.5)
		— tumour of same site mentioned	20	2.9 (1.8–4.4)
		— tumour of same site not mentioned	44	6.3 (4.6–8.3)
		Total	700	100.0
	Not a tumour	Underlying cause a tumour	61	4.7 (3.6–6.0)
		Underlying cause not a tumour	1239	95.3 (94.0–96.4)
		Total	1300	100.0

*Mentioned as a direct or contributory cause. CI, confidence interval.

Table 3. Detection, at admission and clinically, of tumours considered to be the underlying cause of death at autopsy

Source	Detection	Patients	% (95% CI)
Admission	Tumour of same site detected	346	49.6 (45.9–53.4)
	— agreement on location also	313	44.9 (41.2–48.6)
	— location differs	33	4.7 (3.3–6.6)
	Tumour of different site detected	90	12.9 (10.4–15.4)
	Tumour not detected at all	261	37.4 (33.9–41.0)
Clinical*	Tumour of same site and location detected	466	66.9 (63.4–70.4)
	— considered to be underlying cause	453	65.0 (61.5–68.5)
	— considered to be direct or contributory cause	13	1.9 (1.0–3.2)
	Tumour of same site but not same location detected	61	8.8 (6.8–11.1)
	— considered to be underlying cause	40	5.7 (4.2–7.7)
	— considered to be direct or contributory cause	21	3.0 (1.9–4.6)
	Tumour of different site detected	141	20.2 (17.2–23.2)
	— considered to be underlying cause	109	15.6 (12.9–18.3)
	— considered to be direct or contributory cause	32	4.6 (3.2–6.4)
	Tumour not detected at all	29	4.2 (2.8–5.9)
	Total tumours detected as underlying cause at autopsy	697	100.0

* The distribution is exclusive; with patients satisfying two categories (e.g. direct cause agrees on location, underlying cause on site) assigned to the higher category.

Table 4. Comparison of admission and autopsy diagnosis of underlying cause of death for specific tumour groupings

	Total diagnoses		Agreements		False-negatives		False-positives	
Tumour groupings (ICD codes)	Autopsy	Admission	Location	Group only*	Other group	Not a tumour	Other group	Not a tumour
Oral cavity (140–145, 149)	34	22	10	8 (2)	2	14	2	2
Pharynx (146–148)	13	8	8	0 (0)	1	4	0	0
Oesophagus (150)	36	19	15	2	1	18	1	1
Stomach (151)	60	33	26	3	5	26	2	2
Colon (153)	51	26	18	2	5	26	6	0
Rectum (154)	38	33	29	0	2	7	3	1
Liver (155)	32	16	6	2	6	18	3	5
Gall bladder and bile ducts (156)	25	5	4	0	2	19	1	0
Pancreas (157)	31	20	9	6	5	11	3	2
Larynx (161)	15	17	14	0	1	0	3	0
Lung (162)	46	15	3	6	8	29	4	2
Breast (174, 175)	21	18	11	5 (5)	0	5	0	2
Cervix (180)	10	7	6	0	2	2	1	0
Uterus (182)	13	8	6	0	2	5	2	0
Ovary (183)	16	15	8	0	2	6	5	2
Prostate (185)	15	15	13	0	0	2	1	1
Bladder (188)	23	16	11	3	1	8	1	1
Kidney (189)	16	8	5	1	2	8	1	1
Hodgkin's disease (201)	11	9	7	0	0	4	2	0
Non-Hodgkin's lymphoma (200, 202, 203)	67	51	42	6 (1)	3	16	3	0
Lymphoid leukaemia (204)	15	11	11	0	2	2	0	0
Myeloid leukaemia (205)	42	32	28	0	7	7	2	2
Other leukaemia (206–208)	13	15	5	2 (0)	2	4	6	2

* For groupings involving multiple ICD codes, numbers in parentheses indicate agreement on site but not location.

Table 5. Comparison of clinical and autopsy of underlying cause of death for specific tumour groupings

	Total diagnoses		Agreements		False-negatives		False-positives	
Tumour groupings (ICD codes)	Autopsy	Clinical	Location	Group only*	Other group	Not a tumour	Other group	Not a tumour
Oral cavity (140–145, 149)	34	33	18	14 (5)	2	0	1	0
Pharynx (146–148)	13	13	13	0 (0)	0	0	0	0
Oesophagus (150)	36	34	30	3	2	1	1	0
Stomach (151)	60	57	43	3	6	8	6	5
Colon (153)	51	47	36	5	5	5	3	3
Rectum (154)	38	41	33	0	2	3	6	2
Liver (155)	32	32	15	2	9	6	6	9
Gall bladder and bile ducts (156)	25	19	13	3	7	2	1	2
Pancreas (157)	31	38	16	10	5	0	8	4
Larynx (161)	15	18	14	0	1	0	3	1
Lung (162)	46	26	8	8	18	12	5	5
Breast (174, 175)	21	22	14	5 (5)	1	1	0	3
Cervix (180)	10	10	7	1	2	0	1	1
Uterus (182)	13	11	9	1	3	0	1	0
Ovary (183)	16	20	9	0	6	1	8	3
Prostate (185)	15	18	14	0	0	1	3	1
Bladder (188)	23	25	19	4	0	0	1	1
Kidney (189)	16	12	8	1	4	3	0	3
Hodgkin's disease (201)	11	10	7	1	1	2	2	0
Non-Hodgkin's lymphoma (200, 202, 203)	67	63	52	6 (0)	8	1	4	1
Lymphoid leukaemia (204)	15	11	11	0	3	1	0	0
Myeloid leukaemia (205)	42	37	32	0	6	4	3	2
Other leukaemia (206–208)	13	19	8	1 (0)	4	0	7	3

* For groupings involving multiple ICD codes, numbers in parentheses indicate agreement on site but not location.

Table 6 summarises the sites showing the highest false-negative and -positive rates for admission and clinical diagnoses. Some comments should be made about specific tumours.

Gall bladder and bile ducts

Of 21 cases missed at admission (total autopsy diagnoses minus agreements), 2 were misdiagnosed as a liver tumour, with no tumour at all diagnosed in 19 cases. Of 9 cases missed clinically, only 2 were not considered to be a tumour, 3 being misdiagnosed as a liver tumour and 4 as tumours of other sites. False-positive diagnoses were relatively rare.

Liver

As for gall bladder and bile duct tumours, most (75%) of the 24 cases missed at admission were not diagnosed as a tumour at all. The corresponding proportion of the 15 cases missed clinically was lower (40%). False-positive diagnoses of liver tumours were much more common, forming about half of both admission and clinical diagnoses of this tumour. In most admission (63%) and clinical (60%) diagnoses of liver tumour, the autopsy diagnosis of underlying cause was not of a tumour at all. Except for the gall bladder and bile duct tumours, misdiagnosed as liver tumours (as note above), liver tumours were not commonly misdiagnosed as tumours of any one specific site.

Lung

In 29 of 37 (78%) cases missed at admission, and in 12 of 30 (40%) cases missed clinically, the underlying cause was not considered to be a tumour at all. In 2 of 6 (33%) cases of false-positives at admission and in 5 of 10 (50%) false-positives diagnosed clinically, the underlying cause at autopsy was not a tumour. Except for 3 cases, where the death was from a lung tumour but a larynx cancer had been considered to be the underlying cause both at admission and clinically, lung tumours were not commonly misdiagnosed as tumours of any one other specific site.

Ovary

There was substantial false-positive and -negative misdiagnosis of ovarian tumours, with all four rates in Table 6 around 50%. No tumour at all was detected at admission in 6 of 16 (38%) cases seen at autopsy, this proportion reducing to 7% for clinical diagnosis. Where ovarian tumours were misdiagnosed as other tumours, there was no other specific tumour that they were commonly misdiagnosed as.

Oral cavity

At admission, 14 oral cavity tumours seen at autopsy were not diagnosed as a tumour at all, 2 cases were diagnosed as a tumour but not of the oral cavity, and 6 were misdiagnosed as regards site within the oral cavity, mainly tongue tumours (ICD 141) being diagnosed as tumours of the floor of the mouth (ICD 144). Clinically, all oral cavity tumours seen at autopsy were considered to be a tumour, but in 2 cases, the tumour was not of the oral cavity, and in 9 cases there was disagreement as to the site within the oral cavity (again mainly due to over-use of ICD 144). In relatively few cases, an oral cavity tumour was considered to be the cause of death at admission or clinically, but not at autopsy. The false-positive rates shown in Table 6 arise mainly from inclusion of cases disagreeing on site within the oral cavity.

*Table 6. Sites showing highest false-negative and false-positive rates based on diagnosis of underlying cause**

Admission — false-negatives (%)		Admission — false-positives (%)	
Gall bladder and bile ducts	84.0 (63.9–95.5)	Other leukaemia	66.7 (38.4–88.2)
Lung	80.4 (66.1–90.6)	Liver	50.0 (24.7–75.3)
Liver	75.0 (56.6–88.5)	Ovary	46.7 (21.3–73.4)
Oral cavity	64.7 (46.6–80.3)	Oral cavity	45.5 (24.4–67.8)
Kidney	62.5 (35.4–82.8)	Lung	40.0 (16.3–67.7)
Other leukaemia	61.5 (31.6–86.1)	Pancreas	25.0 (8.9–49.1)
Colon	60.8 (46.1–74.2)	Colon	23.1 (9.0–43.6)
Oesophagus	52.8 (35.5–69.6)	Larynx	17.6 (3.8–43.4)
Stomach	51.7 (38.4–64.8)	Non-Hodgkin's lymphoma	15.7 (7.0–28.6)
Pancreas	51.6 (33.1–69.8)	Bladder	12.5 (1.6–38.3)
Ovary	50.0 (24.7–75.3)	Myeloid leukaemia	12.5 (3.5–29.0)
Clinical —false-negatives (%)		**Clinical — false-positives (%)**	
Lung	65.2 (49.7–78.6)	Other leukaemia	57.9 (33.5–79.7)
Liver	46.9 (29.1–65.3)	Ovary	55.0 (31.5–76.9)
Ovary	43.8 (19.8–70.1)	Liver	46.9 (29.1–65.3)
Kidney	43.8 (19.8–70.1)	Lung	38.5 (20.2–59.4)
Other leukaemia	38.5 (13.9–68.4)	Pancreas	31.6 (17.5–48.7)
Gall bladder and bile ducts	36.0 (18.0–57.5)	Oral cavity	30.3 (15.6–48.7)
Oral cavity	32.4 (17.4–50.5)	Kidney	25.0 (5.5–57.2)
Hodgkin's disease	27.3 (6.0–61.0)	Larynx	22.2 (6.4–47.6)
Lymphoid leukaemia	26.7 (7.8–55.1)	Prostate	22.2 (6.4–47.6)
Myeloid leukaemia	23.8 (12.1–39.4)	Cervix	20.0 (2.5–55.6)
Stomach	23.3 (13.4–36.0)	Hodgkin's disease	20.0 (2.5–55.6)

* False-negative and false-positive rates include cases with diagnoses agreeing on grouping but not on site; only rates with a denominator of at least 10 cases shown. 95% confidence intervals are shown with false-negative and false-positive rates.

Other leukaemias

Although, in some cases, the existence of a tumour was not suspected at admission, and, in a few, a diagnosis of leukaemia, at admission and clinically, had not been confirmed at autopsy, the major reason for the high false-negative and -positive rates was diagreement on type of leukaemia. For example, all 6 cases of the admission false-positives, and 6 of the 7 cases of clinical false-positive were due to a diagnosis in the other leukaemia grouping, when the autopsy diagnosis was lymphoid or myeloid leukaemia. For the leukaemias taken as a whole (ICD 204–208), the false-negative rates, ignoring site, were relatively low (admission 22.9%, clinical 12.9%) as were the false-positive rates (admission 6.9%, clinical 9.0%).

Colon, kidney, oesophagus, pancreas, stomach

For all these tumours, a susbtantial proportion, often around 50%, of cases seen at autopsy were not diagnosed as a tumour at all at admission. In additional cases, the admission diagnosis did not correctly specify the site. False-negative rates were always lower clinically, though still substantial for kidney tumours. False-positive rates were generally lower than false-negative rates. Where diagnoses agreed on the existence of a tumour, but not on the site, no clear pattern could be seen of one tumour being specifically misdiagnosed as another.

DISCUSSION

While we have studied a virtually complete sample of all deaths occurring in two hospitals in the given period, the representativeness of results from these two hospitals can be questioned. Both have high academic standing and the excellence of some departments selectively attracts patients with particular diagnoses. However, both hospitals act as district hospitals catering for a wide spectrum of diseases. Only for lung cancer is there reason to suspect the false-positive and -negative rates were unrepresentatively high. This is because there is, located in Budapest, a highly specialised Institute of Pulmonology to which cases of suspected lung cancer and/or chronic respiratory disease are transferred if they are fit and young enough to be moved. Consequently, a disproportionate number of such cases dying in the two study hospitals were too old or frail to withstand submission to a full range of available diagnostic procedures.

The high number of false-negative cases, not diagnosed as tumours at all by the general practitioner, points to the serious unreliability of morbidity and mortality statistics based on diagnoses entered on death certificates issued by general practitioners on patients that are not autopsied. The substantial differences between the diagnoses made at admission and those made at autopsy mean that in 261 out of 697 cases, where a tumour was considered to be the underlying cause of death, the presence of a tumour was not reported on the admission diagnosis. Although in some cases a general practitioner may have known that the patient had cancer but arranged the admission to hospital for a different reason, it seems certain that, in most instances, the general practitioner had missed the diagnosis completely.

There was good agreement between the number of patients considered to have a tumour as the underlying cause of death clinically (700) and at autopsy (697). However, this conceals the fact that there was agreement on the correct tumour site in only 506 cases and on a tumour being the underlying cause in only 636.

The proportion of tumours considered to be the cause of death at autopsy which were incorrectly diagnosed (either as to site or as to the existence of a tumour) was 27.4% by hospital clinicians and 50.4% by general practitioners. These figures appear rather higher than rates reported for other countries, for example 15% in Sweden [11], 22% in Japan [8] and 25.5% in India [9]. However, it is important to point out that clinically, false-positive and false-negative rates for existence of a tumour were both less than 10%. Most clinically incorrect diagnoses were wrong because the site of the primary neoplasm was wrong.

The identification of the correct site and type of malignant tumour is a matter of growing importance [7, 12]. Advances in surgical, radiotherapeutic and chemotherapeutic treatment have now developed to a level when the site and histological type of the primary tumour has a major influence on the choice and mode of therapy. It is well known that it can be difficult to locate correctly the primary site in the case of cancers of the gall bladder and bile ducts, pancreas, liver and kidney. However, the high false-positive and false-negative rates for lung and oral cavity cancers are alarming. Those responsible for the planning of health care systems, including prevention and screening, should be aware of the unreliability of mortality data derived from unautopsied deaths and should press for higher standards of diagnosis and higher autopsy rates [14–16]

To assess the consequences of clinical misdiagnosis, one needs to know when the error was made. For this purpose one would need access to records prior to those relating to the terminal admission of patients (for example, outpatient records and previous inpatient notes at the same and other hospitals). Such records were not always available to us, and it would have been difficult to extract from the, often handwritten, notes why and when various treatments were or were not given. Hopefully the present report will stimulate others to undertake more detailed studies of the consequences of clinical misdiagnosis of cancer.

1. Percy G, Stanek E III, Gloeckler L. Accuracy of cancer death certificates and its effect on cancer mortality statistics. *Am J Public Hlth* 1981, 71, 242–250.
2. Di Furia L, Piga R, Marmili S, *et al.* The value of autopsy in oncology. *Eur J Cancer* 1991, 27, 559–561.
3. World Health Organisation. 1992 *World Health Statistics Annual.* Geneva, WHO, 1993.
4. Kircher T, Nelson J, Burdo H. The autopsy as a measure of accuracy of the death certificate. *N Engl J Med* 1985, 313, 1263–2369.
5. Kajowara JK, Zucoloto S, Manco ARX, Muccillo G, Barbieri MA. Accuracy of clinical diagnoses in a teaching hospital: a review of 997 autopsies. *J Int Med* 1993, 234, 181–197.
6. Research after death (Editorial). *Lancet* 1994, 344, 1517–1518.
7. Mollo F, Bertaldo E, Grandi G, Cavallo F. Reliability of death certificates for different types of cancer. An autopsy survey. *Pathol Res Pract* 1986, 181, 442–447.
8. Hasuo Y, Ueda K, Kiyohara Y, *et al.* Accuracy of diagnosis on death certificates for underlying causes of death in a long-term autopsy-based population study in Hisayama, Japan, with special reference to cardiovascular diseases. *J Clin Epidemiol* 1989, 42, 577–584.
9. Sarode VR, Datta BN, Banerjee AK, *et al.* Autopsy findings and clinical diagnoses: a review of 1,000 cases. *Hum Pathol* 1993, 24, 194–198.
10. Lee PN. Comparison of autopsy, clinical and death certificate diagnosis with particular reference to lung cancer. A review of the published data. *APMIS* 1994, 102 (Suppl. 45), 1–42.
11. Veress B, Alafuzoff I. A retrospective analysis of clinical diagnoses

and autopsy findings in 3,042 cases during two different time periods. *Hum Pathol* 1994, **25**, 140–145.
12. Szende B, Kendrey G, Lapis K, Lee PN, Roe FJC. Accuracy of admission and pre-autopsy clinical diagnoses in the light of autopsy findings: a study conducted in Budapest. *Hum Exp Toxicol* 1994, **13**, 671–680.
13. Morris J, Gardner MJ. Calculating confidence intervals for relative risks (odds ratios) and standardised ratios and rates. *Br Med J* 1988, **296**, 1313–1316.
14. Bowman HE, Williems MJ. College of American Pathologists Foundation Conference VI. A profile of the pathologists in the year 2001—predictions and recommendations. *Arch Pathol Lab Med* 1992, **116**, 609–610.
15. Start RD, McCulloch TA, Silcocks PB, Cotton DWK. Attitudes of senior pathologists towards the autopsy. *J Pathol* 1994, **172**, 1–84.
16. Zanetto U, DoCampo JL. Post-mortem macroscopic examination, the clinician's missing practice (Letter). *J Pathol* 1994, **173**, 381–382.

Acknowledgement—The authors would like to thank Philip Morris Europe for financial support.