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Accuracy of Admission and Pre-autopsy Clinical Diagnoses in the Light of Autopsy Findings: a Study Conducted in Budapest

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Pre- and post-autopsy diagnoses of underlying cause of death were compared in consecutive autopsies on persons aged 30 to 80 years; 1000 from each of two pathology departments in Budapest. Data on admission diagnoses and on contributory causes of death were also analysed. At autopsy, the percentages of deaths by underlying cause were neoplasms (any site) 34.9%, diseases of the circulatory system 40.2%, digestive system 13.8%, endocrine, nutritional, metabolic or immune systems 2.7%, and respiratory system 2.2%.

For these five disease groupings, the percentages of cases diagnosed clinically as the underlying cause of death which were confirmed at autopsy were, respectively, 90.9%, 84.0%, 82.9%, 55.2% and 32.5%. Although, out of 697 cases with an autopsy diagnosis of neoplasia as the underlying cause, there were only 61 (8.8%) where neoplasms were not diagnosed clinically as the underlying cause, this conceals the fact that in 130 (18.7%) the two diagnoses differed as to the site of the primary neoplasm (ICD 3 digit code).

The fact that 43% of post-mortem diagnoses (ICD major category) of underlying cause are missed on admission, and that 19% are missed clinically, indicates that improved clinical diagnostic procedures have not diminished the need for high autopsy rates. Morbid anatomy needs to be better resourced.

Introduction

Mortality data based on death certificates are widely used in medico-scientific research, *inter alia* to discern health trends and determine the health policies of Governments and international organisations concerned with human health and the quality of the environment. It is therefore important to assess the reliability of such data. Autopsy, sometimes combined with the results of certain in-life diagnostic procedures, provides the most reliable information on underlying and contributory causes of death. However, autopsy rates have been declining universally so that death certificates are increasingly being completed solely based on clinical diagnoses, often without the benefit of the application of modern diagnostic techniques such as are only available for use in hospitals and/or by medical specialists.

Many investigators have assessed the reliability of death certificate data by comparing clinical diagnoses prior to autopsy with autopsy diagnoses.[1–4] High level of discrepancy have been found in most such studies. In line with this a recent joint report by the Royal Colleges of Pathologists Surgeons and Physicians,[5] citing the results of a study by Mollo *et al.*,[6] stated that 'In autopsies performed on patients thought to have died of malignant disease there was only 75% agreement that malignancy was the cause of death and in only 56% was the primary site identified correctly'. The report concluded, *inter alia*, that 'Such high levels of discordance mean that mortality statistics which

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are not supported by autopsy examinations must be viewed with caution' and cited Gobbato *et al.*[7] in support of this conclusion.

The main reason for death certificate unreliability is clearly that no autopsy is carried out. However, additional reasons are that certificates are incorrectly completed – sometimes by clinicians who have not been specifically trained in how to complete them – and that certificates are completed before the full autopsy findings are known and are not subsequently corrected. Another reason for inaccuracy is that the relatives of deceased persons are more distressed by some causes of death than by others and certifying doctors take this into account when they complete certificates.

Of 27 countries surveyed by the World Health Organisation,[8] Hungary was found to have the highest autopsy rate. This is partly determined by tradition and partly by the fact that, according to Hungarian law, all patients who die in hospital must be autopsied unless there are acceptable moral, religious or other grounds for objecting to autopsy. In consequence, some 49% of 140,000 deaths per year among the 10.5 million population of Hungary are subjected to autopsy.[9] The total of over 68,000 autopsies per year places a heavy burden on the departments of pathology of the seven university and 70 district hospitals in Hungary.

In the case of each autopsy, a report is prepared which includes demographic information, a clinical summary, a description of the gross and histologic autopsy findings, results of any special tests and the concluding pathologic diagnoses. In addition to the underlying cause of death, the latter include the immediate cause of death, complications of the underlying illness and contributory causes of death.

Materials and methods

Data were collected from 1000 consecutive autopsies on patients aged between 30 and 80 who died in the Semmelweis Medical University, Budapest, between February 1988 and November 1991 and from another 1000 consecutive autopsies on patients in the same age range who died during the same period in the Postgraduate Medical School, Budapest. The autopsies were performed, respectively, in the First Institute for Pathological Anatomy and Experimental Cancer Research of the Semmelweis Medical University and the Department of Pathological Anatomy of the Postgraduate Medical School. At each Institute, virtually all patients within the specified age range who died during the specified period were autopsied.

In the case of each death, one real and one theoretical death certificate was prepared. The *post autopsy certificate* (i.e. the real death certificate) was prepared in the light of the autopsy findings. The theoretical death certificate was prepared on the basis of what the clinicians who looked after and investigated the patient during his/her terminal illness, thought the diagnoses were prior to autopsy. This *'clinician's pre-autopsy death certificate'* was taken to represent what would have gone on the death certificate had the patient died in hospital but had not been subjected to autopsy. The entries on these two death certificates could be compared with admission diagnoses.

Table 1 Distribution of subjects by age, sex, year of admission and hospital

	Postgraduate Medical School		*Semmelweis Medical University*		
	Male	*Female*	*Male*	*Female*	*Total*
Age group					
30–40	19	18	26	18	81
41–50	60	26	41	38	165
51–60	92	72	124	62	350
61–70	183	165	188	159	695
71–80	180	185	171	173	709
Year of admission					
1988	165	118	208	141	632
1989	137	139	100	90	466
1990	124	97	170	141	532
1991	108	112	72	78	370
Total	534	466	550	450	2000

The same rules were applied to the preparation of the two death certificates. All diagnoses were coded according to the 9th Revision of the International Classification of Diseases (ICD). Clinicians' death certificates and real death certificates recorded (i) the underlying cause of death, (ii) up to three causes leading directly to death and (iii) up to nine other contributory causes of death.

The ICD Classification (9th Revision) consists of Major Groups (e.g. Neoplasms = ICD 140–239; Infectious and parasitic diseases = ICD 001–139; etc.). These major groups can be subdivided into minor groups (e.g. Malignant neoplasms of the respiratory and intrathoracic organs = ICD 160–165; intestinal infections = ICD 001–009) and within these minor groups each three digit code represents a disease entity (e.g. pulmonary tuberculosis = ICD 011). Even greater precision is catered for by the use of 4 digit codes with the additional digit appearing following a decimal point after the 3 digit code (e.g. Malignant neoplasm of bladder/posterior wall = ICD 188.4).

For the purposes of the analyses undertaken in the present study, a disease was only considered to be an *'underlying cause of death'* if it appeared as such on the real death certificate as completed; a disease was categorised as *'underlying or direct cause of death'* if it was shown either as an underlying cause, or as one of the up to three direct causes on the death certificate; and the category

Table 2 Distribution of underlying causes of death (ICD major categories) by sex and hospital

		Postgraduate Medical School		*Semmelweis Medical University*		
		Male	*Female*	*Male*	*Female*	*Total*
Post-mortem ('Post autopsy death certificate')						
1–139:	Infectious and parasitic diseases	2	2	2	3	9
140–239:	Neoplasms (any site)	226	171	156	144	697
240–279:	Endocrine, nutritional and metabolic diseases and immunity disorders	15	14	8	16	53
280–289:	Diseases of blood and blood forming organs	0	4	6	4	14
290–319:	Mental disorders	5	2	0	0	7
320–389:	Diseases of the nervous system and sense organs	5	1	0	1	7
390–459:	Diseases of the circulatory system	192	181	243	188	804
460–519:	Diseases of the respiratory system	15	9	11	9	44
520–579:	Diseases of the digestive system	57	62	98	59	276
580–629:	Diseases of the genitourinary system	16	10	10	11	47
680–709:	Diseases of the skin and subcutaneous tissue	0	0	1	1	2
710–739:	Diseases of the musculoskeletal system and connective tissue	0	4	1	5	10
740–759:	Congenital anomalies	1	3	2	5	11
780–799:	Symptoms, signs and ill-defined conditions	0	1	3	1	5
800–999:	Injury and poisoning	0	1	9	1	11
E800–E999:	External causes of injury and poisoning E code	0	1	0	2	3
Clinician ('Clinician's death certificate')						
1–139:	Infections and parasitic diseases	0	0	3	2	5
140–239:	Neoplasms (any site)	240	174	151	135	700
240–279:	Endocrine, nutritional and metabolic diseases and immunity disorders	14	23	6	15	58
280–289:	Diseases of blood and blood forming organs	2	4	5	5	16
290–319:	Mental disorders	6	4	2	3	15
320–389:	Diseases of the nervous system and sense organs	3	2	5	2	12
390–459:	Diseases of the circulatory system	192	179	248	183	802
460–519:	Diseases of the respiratory system	8	7	14	11	40
520–579:	Diseases of the digestive system	51	52	78	64	245
580–629:	Diseases of the genitourinary system	15	10	10	6	41
680–709:	Diseases of the skin and subcutaneous tissue	0	0	1	1	2
710–739:	Diseases of the musculoskeletal system and connective tissue	0	5	2	6	13
740–759:	Congenital anomalies	1	2	2	1	6
780–799:	Symptoms, signs and ill-defined conditions	1	2	20	10	33
800–999:	Injury and poisoning	0	1	3	6	10
E800–E999:	External causes of injury and poisoning E code	0	1	0	0	1
Not given		1	0	0	0	1
Admission diagnosis						
1–139:	Infectious and parasitic diseases	0	0	1	0	1
140–239:	Neoplasms (any site)	139	114	116	107	476
240–279:	Endocrine, nutritional and metabolic diseases and immunity disorders	18	13	12	11	54
280–289:	Diseases of blood and blood forming organs	5	8	6	5	24
290–319:	Mental disorders	7	7	1	2	17
320–389:	Diseases of the nervous system and sense organs	16	12	7	0	35
390–459:	Diseases of the circulatory system	109	80	215	151	555
460–519:	Diseases of the respiratory system	3	7	16	9	35
520–579:	Diseases of the digestive system	41	41	98	79	259
580–629:	Diseases of the genitourinary system	12	9	6	10	37
680–709:	Diseases of the skin and subcutaneous tissue	1	0	0	1	2
710–739:	Diseases of the musculoskeletal system and connective tissue	0	4	2	11	17
740–759:	Congenital anomalies	1	2	0	1	4
780–799:	Symptoms, signs and ill-defined conditions	178	165	65	57	465
800–999:	Injury and poisoning	1	1	3	4	9
E800–E999:	External causes of injury and poisoning E code	0	1	0	0	1
1200—1:	Supplementary classification V code	0	0	2	1	3
Not given		3	2	0	1	6

Table 3 Underlying, direct and contributory causes of death by sex

	Clinician's death certificate		*Post autopsy certificate*	
	Male	*Female*	*Male*	*Female*
Underlying cause	1083	916	1084	916
Direct cause - 1	1059	883	1082	914
- 2	950	787	1047	880
- 3	677	565	784	639
Other contributory cause - 1	699	581	1016	865
- 2	493	401	954	812
- 3	303	256	858	719
- 4	152	133	722	599
- 5	66	67	590	463
- 6	17	32	435	332
- 7	7	12	301	219
- 8	4	3	192	137
- 9	2	2	118	71
Subjects	1084	916	1084	916
Total diagnoses	5512	4638	9183	7566
Mean per subject	5.08	5.06	8.47	8.26

Table 4 Numbers of post-mortem diagnoses of underlying cause (ICD major categories) detected clinically

		Detected clinically as				*Percent missed clinically*	
Post-mortem diagnosis Underlying cause	*Total cases*	*Underlying cause*	*Direct cause only*	*Contrib. cause only*	*Not detected at all*	*as underlying cause*	*Totally*
140–239: Neoplasms (any site)	697	636	24	8	29	8.8	4.2
240–279: Endocrine, nutritional and metabolic diseases and immunity disorders	53	32	5	10	6	39.6	11.3
280–289: Diseases of blood and blood forming organs	14	8	1	–	5	42.9	35.7
390–459: Diseases of the circulatory system	804	674	89	19	22	16.2	2.7
460–519: Diseases of the respiratory system	44	13	16	6	9	70.5	20.5
520–579: Diseases of the digestive system	276	203	40	13	20	26.4	7.2
580–629: Diseases of the genitourinary system	47	29	11	4	3	38.3	6.4
Other ICD major categories*	65	28	9	4	24	56.9	36.9
Total*	2000	1623	195	64	118	18.8	5.9

*Detections within same specific ICD major category

'any mention' was applied to any diagnosis shown on the death certificate as the underlying cause, as a direct cause or as a contributory cause.

Results

Table 1 shows the distribution of subjects by age, sex, year of admission and hospital. Overall 54.2% of the subjects were male with the sex ratio being similar at the two institutes. The mean age of the 1084 males was 63.9 years and that of the 916 females was 65.8 years.

As expected, the distribution of underlying causes of death varied between the three sources of data. Table 2 shows the distributions by sex and hospital as indicated by the post-autopsy death certificate, the clinician's pre-autopsy death certificate and the admission diagnosis. Diseases of the circulatory system were shown as the underlying cause of death in about 40% of the post-autopsy and clinicians' death certificates as compared with 27.8% of the admission diagnoses. Neoplasms of any site were shown as the underlying cause of death in 34.9% of the post-autopsy certificates, 35.0% of the clinicians' certificates and 23.8% of the admission diagnoses. The percentages for diseases of the digestive system as the underlying cause of death were 13.8, 12.3 and 13.0 respectively. A 23.3% incidence of 'Symptoms, signs and

Table 5 Numbers of clinical diagnoses of underlying cause (ICD major categories) confirmed at post-mortem

Clinical diagnosis of underlying cause	Total	Confirmed at post-mortem as				Percent unconfirmed	
		Under-lying	Direct only	Contrib-only	Not detected	as under-lying	Totally
140–239: Neoplasms (any site)	700	636	9	17	38	9.1	4.6
240–279: Endocrine, nutritional and metabolic diseases and immunity disorders	58	32	1	7	18	44.8	31.0
280–289: Diseases of blood and blood forming organs	16	8	1	2	5	50.0	31.3
390–459: Diseases of the circulatory system	802	674	110	14	4	16.0	0.5
460–519: Diseases of the respiratory system	40	13	15	9	3	67.5	7.5
520–579: Diseases of the digestive system	245	203	16	19	7	17.1	2.9
580–629: Diseases of the genitourinary system	41	29	1	8	3	29.3	7.3
780–799: Symptoms, signs and ill-defined conditions	33	1	5	6	21	97.0	63.6
Other ICD major categories*	64	27	7	4	26	57.8	40.6
Total*	1999	1623	165	86	125	18.8	6.3

*Confirmations within same specific ICD major category

Table 6 Accuracy of admission diagnoses of underlying cause of death in terms of clinical and post-mortem diagnoses

ICD major category	Number of clinical diagnoses		Number of post-mortem diagnoses	
	Total	% Missed at admission	Total	% Missed at admission
140–239: Neoplasms (any site)	700	35.1	697	37.4
240–279: Endocrine, nutritional and metabolic diseases and immunity disorders	58	48.3	53	49.1
280–289: Diseases of blood and blood forming organs	16	25.0	14	50.0
390–459: Diseases of the circulatory system	802	41.6	804	42.7
460–519: Diseases of the respiratory system	40	75.0	44	86.4
520–579: Diseases of the digestive system	245	33.1	276	40.6
580–629: Diseases of the genitourinary system	41	61.0	47	61.7
Other categories*	97	56.7	65	69.2
Total*	1999	40.2	2000	43.1

*% Missed are within same specific category

ill-defined conditions' (ICD 780–799) given as the admission diagnosis fell to 1.7% as an underlying cause of death in the clinician's certificate and to only 0.3% in the post-autopsy certificate. Despite the higher incidence of ICD 780–799 diagnosed at the time of admission, diseases of blood and blood-forming organs (ICD 280–289), diseases of the nervous system and sense organs (ICD 320–389) and diseases of the musculoskeletal system and connective tissue (ICD 710–739) were overdiagnosed in terms of what were found at autopsy to be underlying causes of death at the time of admission.

Table 3 indicates a tendency for greater numbers of direct and contributory diagnoses to appear on the post-autopsy death certificates than on clinicians' death certificates, this being equally true for the two sexes.

Table 4 shows, in the case of eight major disease categories, the numbers of post-autopsy diagnoses of underlying cause of death that appeared on the clinicians' death certificate as an underlying cause, a direct cause only, a contributory cause only or not at all! The last two columns of this table show percentages ranging from 8.8 to 70.5 for the clinician failing to identify the post-mortem diagnosis as the underlying cause of death, and percentages ranging from 2.7 to 36.9 for the clinician failing to record at all on the death certificate the underlying cause of death as recorded after post-mortem examination. The discrepancy rate was particularly high in the case of diseases of the respiratory system (ICD 460–519) and the overall discrepancy rate for all disease categories was 18.8%. At first sight the difference between the clinician's certificate and the post-autopsy certificate in the case of neoplasms of any site (ICD 140–239) appears quite small at 8.8%, but as will be seen below (see Table 8) this low percentage conceals the fact that although the

Table 7 Confirmation of admission diagnosis clinically and a post-mortem

ICD major category	Total Admission Diagnoses	Percent unconfirmed			
		Clinically		At post-mortem	
		Underlying cause	Any cause	By underlying cause	Any cause
140–239: Neoplasms (any site)	476	4.6	1.7	8.4	5.0
240–279: Endocrine, nutritional and metabolic diseases and immunity disorders	54	44.4	13.0	50.0	31.5
280–289: Diseases of blood and blood forming organs	24	50.0	29.2	70.8	37.5
390–459: Diseases of the circulatory system	555	15.7	2.7	16.9	0.4
460–519: Diseases of the respiratory system	35	71.4	37.1	82.9	8.6
520–579: Diseases of the digestive system	259	36.7	11.6	36.9	9.7
580–629: Diseases of the genitourinary system	37	56.8	21.6	51.4	16.2
780–799: Symptoms, signs and ill-defined conditions	465	97.4	52.7	99.6	66.0
Other categories*	89	60.3	44.9	79.8	61.8
Total*	1994	40.0	18.7	42.9	22.5

*% Unconfirmed are within same specific category

clinician was usually right in identifying neoplasia as an underlying cause of death, he/she was very frequently wrong in the identification of the site of the primary neoplasm.

Table 5 displays the same data from the opposite viewpoint, showing the numbers of and percentages of cases where clinicians' diagnoses of underlying cause of death were confirmed at autopsy, were found only to be direct or contributory causes or were not found at all. That autopsy provided diagnoses for conditions which the clinician was unable to diagnose (ICD 780–799) is not surprising. However, several of the high discrepancy rates in respect of clinical and post-autopsy diagnoses of underlying cause of death illustrate the continuing need for high autopsy rates if mortality data based on death certificates are to be used meaningfully in some kinds of epidemiological studies.

Table 6 displays the relationship between admission diagnoses and underlying causes of death given on pre- and post-autopsy death certificates. Just over 40% of clinical diagnoses of underlying cause of death were seemingly not recognised at the time patients were admitted to hospital and just over 43% of post-autopsy underlying causes of death were seemingly not recognised at the time of admission. The discrepancy rates were high for all the major classes of disease. Table 7 looks at the accuracy of admission diagnosis from the opposite viewpoint, i.e. in terms of percentage confirmation first after clinical investigation and then at autopsy.

Table 8 displays the underlying causes of death data for the more commonly occurring minor groups of diseases and it is the data in this table which provide the most poignant evidence of the continuing need for high rates of autopsy. In the case of primary neoplasms of internal organs and tissues, high rates of clinical misdiagnosis were particularly evident. Thus of 276 cancers of the digestive organs (ICD 150–159) found at post mortem to be the underlying cause of death, 10.9% were completely missed clinically and of 287 clinical diagnoses of cancers of the digestive system as the underlying cause of death, no such cancer was found at necropsy in 15.0%. For cancers of the respiratory and intrathoracic organs (ICD 160–169), the comparable percentages were 38.1 and 24.5, respectively and for cancers of lymphatic and haemopoietic tissue (ICD 200–209) the percentages were 8.1 and 41.2. In addition to these examples of clinically completely missed diagnoses and clinical diagnoses that were completely unconfirmed at autopsy there were appreciable percentages of cases of discrepancies between diagnoses of underlying causes of death and direct or contributory causes of death. Discrepancy rates were even higher for many diagnoses of diseases of the circulatory system and of non-neoplastic diseases of the respiratory, digestive and genitourinary system.

It should be noted that even where there is agreement between clinical and post-mortem diagnosis in the underlying cause of death as classified by ICD minor category, this does not necessarily imply complete agreement. Thus, of 697 cases of neoplasia diagnosed at post-mortem, there was agreement that a neoplasm was the underlying cause in only 636, that it was in the same minor category in only 562, and that it had the correct 3 digit ICD code in over 506. Data on agreement by 3 digit code are too extensive to present here but are available on request.

Arguably, the matter of greatest interest in a study of this kind is the extent to which death certificates for patients who die in hospital, but are not subjected to autopsy, are reliable. In the present study a comparison of underlying causes of death

Table 8 Percentage of post-mortem diagnoses detected clinically and percentage of clinical diagnoses confirmed at post-mortem (commoner ICD minor categories)

Diagnosis	Total underlying at PM	Percent detected clinically			Total underlying clinical	Percent confirmed at PM		
		Underlying	Direct/ contrib.	Not at all		Underlying	Direct/ contrib.	Not at all
Malignant neoplasms								
140–149: Lip, oral cavity and pharynx	47	95.7	0.0	4.3	46	97.8	0.0	2.2
150–159: Digestive organs and perineum	276	84.4	4.7	10.9	287	81.2	3.8	15.0
160–169: Respiratory and intrathoracic organs	63	54.0	7.9	38.1	49	69.4	6.1	24.5
170–178: Bone, connective tissue, skin and breast	33	81.8	3.0	15.2	33	81.8	9.1	9.1
179–189: Genitourinary organs	95	84.2	1.1	14.7	99	80.8	7.1	12.1
200–209: Lymphatic and haemopoietic tissue	148	88.5	3.4	8.1	140	35.3	23.5	41.2
Diseases of the circulatory system								
393–400: Chronic rheumatic heart disease	59	79.7	10.2	10.2	55	85.5	1.8	12.7
401–409: Hypertensive disease	29	89.7	10.3	0.0	94	27.7	18.1	54.3
410–414: Ischaemic heart disease	93	44.1	31.2	24.7	151	27.2	50.3	22.5
415–419: Diseases of pulmonary circulation	9	22.2	11.1	66.7	23	8.7	47.8	43.5
420–429: Other forms of heart disease	35	60.0	25.7	14.3	63	33.3	60.3	6.3
430–439: Cerebrovascular disease	44	22.7	36.4	40.9	57	17.5	61.4	21.1
440–450: Diseases of arteries, arterioles and capillaries	529	46.3	17.2	36.5	342	71.6	16.4	12.0
Diseases of the respiratory system								
480–489: Pneumonia and influenza	4	25.0	25.0	50.0	17	5.9	52.9	41.2
490–499: Chronic obstructive pulmonary disease and allied conditions	32	31.3	34.4	34.4	17	58.8	35.3	5.9
Diseases of the digestive system								
530–539: Diseases of oesophagus, stomach and duodenum	50	54.0	20.0	26.0	41	65.9	14.6	19.5
570–579: Other diseases of digestive system	197	76.1	17.8	6.1	172	87.2	11.0	1.7
Diseases of the genitourinary system								
580–589: Nephritis, nephrotic syndrome and nephrosis	13	53.8	46.2	0.0	15	46.7	13.3	40.0
590–599: Other diseases of urinary system	25	56.0	24.0	20.0	20	70.0	20.0	10.0

according to clinicians' death certificates with underlying causes of death according to post-autopsy death certificates, provides information about this. Provided that one restricts such comparisons to major groups of diseases then the percentages of cases where the clinician underdiagnoses or overdiagnoses underlying cause of death, appear to be relatively small (e.g. neoplasms (all sites) — ICD 140–239 — 0.4% overdiagnosis; endocrine, nutritional and metabolic diseases and immunity disorders — ICD 240–279 — 9.4% overdiagnosis; diseases of the blood and blood-forming organs — ICD 280–289 — 14% overdiagnosis; diseases of the circulatory system — ICD 390–459 — 11% underdiagnosis; diseases of the digestive system — ICD 520–579 — 11% underdiagnosis; diseases of the genitourinary system — ICD — 580–629 — 13% underdiagnosis). However, as shown in Table 8, if one breaks the major groups down into minor groups, the extent of clinical underdiagnosis, overdiagnosis and misdiagnosis is seen to be very high, and in terms of correctness of individual 3 digit ICD codes, inaccuracy rates are higher still.

Discussion

Ideally, we would have liked to be able to construct a random sample of all persons within the chosen age range who died anywhere in Hungary, or within a geographically defined area of Hungary (e.g. the city of Budapest) and to carry out the study described in this paper on that sample. However, this was not possible and so the best we could do was to confine the study to two large Institutes, each with a high annual throughput of autopsies and both located in Budapest. Special advantages of the involvement of these two particular Institutes, i.e. the Semmelweis Medical University and the Postgraduate Medical School is that they both have high academic standing and both use the same autopsy procedure and method of entering and storing data. Also, although, as in the case of academic Institutes generally, the excellence of some departments selectively attracts patients with particular putative diagnoses, both the Semmelweis and the Postgraduate Medical School act as district hospitals and accordingly cater for a wide spectrum

of diseases. The contents of Table 2 illustrate the broad coverage of diseases dealt with in the two hospitals. They also indicate a similarity between the two Institutes in the spectra of kinds of disease catered for. Taking these various facts into account, we are satisfied that the 2000 autopsies that we have reviewed are reasonably representative of hospital deaths in Budapest generally and in Hungary generally.

A continuing need for autopsy examinations has been stressed in numerous publications. The needs are not only scientific, educational and statistical but extend into social aspects of modern everyday life.[10–18] Notwithstanding these needs, for economic and other reasons autopsy rates have been declining in most developed countries.[15–19] In the case of deaths from internal diseases, one might have expected that the increased availability of modern diagnostic techniques would have enabled clinicians to achieve such high rates of diagnostic accuracy that autopsy would not be needed in relation to establishing the underlying cause of death. The results of the present study show that for various reasons, this expectation is not currently being realised for persons of ages ranging from 30 to 80 dying in hospital in Hungary. One reason is that by the time terminally ill patients are admitted to hospital they are too ill to withstand the available diagnostic procedures, or there is insufficient time before they die for the use of such procedures. A further problem is that, in the case of some very ill patients, clinicians understandably attach less importance to the accuracy of diagnosis than to the quality of the terminal care.[2–4,20] For instance, in the case of a patient known to be riddled with metastatic cancer, the physician may feel that precise location of the primary cancer is of no more than academic interest, e.g. in terms of the patient's immediate welfare. Added to these explanations of imprecision in clinical diagnosis are genuine errors made by clinicians because diagnoses are difficult and/or because the diagnostic procedures available are not fully reliable. Such explanations partly explain the differences between 'clinician's death certificates' and 'post-autopsy death certificates' found in the present study.

It is reasonable to assume, in the case of the present study, that the details recorded in the 'clinician's death certificate', are those that would have gone forward for inclusion in national mortality tables had no autopsy been performed. It is much less certain, however, whether the details recorded at the time of admission would have been the ones that went on the death certificate if the patient had not been admitted to hospital and had not been submitted to autopsy. When general practitioners arrange for patients to be admitted to hospital, they do not necessarily provide diagnoses of the conditions from which patients subsequently die. Thus, a patient admitted for repair of a hernia but who dies of an unanticipated heart attack whilst in hospital would not in reality be an example of misdiagnosis of underlying cause of death by the doctor arranging the admission. Therefore, in the present paper, we attach much more importance to the differences between the 'clinicians' death certificates' and the 'post-autopsy death certificates' than to those between the 'admission diagnoses' and the 'post-autopsy death certificates'. Notwithstanding the multiplicity of reasons for differences between admission diagnoses and underlying causes of death as appearing on the 'clinicians' death certificates' it is clear from the data displayed in Tables 6 and 7 that, as one would expect, there was a closer relationship between clinicians' death certificates and post-autopsy death certificates than between admission diagnoses and post-autopsy death certificates. This, no doubt, reflects *inter alia* the benefits of the special diagnostic techniques available to hospital-based clinicians as distinct from general practitioners.

Mortality statistics are often used to estimate the frequency of occurrence (i.e. prevalence) of individual diseases or groups of diseases, and in the investigation of factors that are associated with their occurrence and may be involved in their aetiology.[21,22] They are also used to investigate possible relationships between different diseases and to compare the susceptibilities of different sub-groups of populations to fatal diseases. In turn, the results of studies based on the use of mortality statistics are used to guide public health policy and planning. It is obvious, therefore, that it is a matter of considerable importance that data for underlying cause of death should be as accurate as possible.

In addition to the underlying causes of death, a series of other diagnoses are established at autopsy as contributory causes of death. These may or may not have been apparent to the clinician and may or may not have been considered by him/her as contributing to death. At the same time there may have been diagnoses made clinically that gave rise to serious symptoms at the time and involved the use for medical care but which were not contributory to death. Hopefully in the way in which the present study was designed, such diagnoses would not have appeared on either the 'clinician's death certificate' or the 'post-autopsy death certificate'.

The results of our studies indicated that diseases of the respiratory, circulatory, digestive and genitourinary systems were underdiagnosed as underlying causes of death fairly commonly by clinicians. In the case of the respiratory, digestive and genitourinary systems our findings matched those reported by Modelmog *et al.*[23] By contrast, the total number of clinical diagnoses of neoplasia of any site was remarkably accurate in our study whereas this was not the case in the studies by

Modelmog *et al.*[23] and Stevanovic *et al.*[24] If this reflects an improvement in methods of tumour diagnosis, then it is clear that the improvement does not yet extend to increased accuracy in diagnosis of the primary site of neoplasia (see Table 8).

The immense amount of data obtained from our autopsy study will enable us to go into further details in relation to diagnostic errors in minor groups of diseases or in specific diseases. Further publications in this respect are in preparation.

The case for pressing for high autopsy rates assumes that diagnoses made at autopsy are more accurate than those made clinically.[1] However, there are some situations in which diagnoses may be more easily and accurately diagnosed clinically than at routine autopsy. Overdose of insulin or adrenalin for instance, would be easy to overlook at autopsy. Wilson[25] wrote 'in justice and honesty it must be admitted that in a certain number of patients — about 20% — more or less mystery and confusion still prevailed after post-mortem examination'. This suggests that the autopsy room is not the 'Palace of Truth' that some pathologists would claim it to be. Nevertheless, the findings in the present study strongly suggest that, in the absence of autopsy, diagnoses of underlying cause of death of internal diseases are often remarkably and seriously wrong. This can only mean that, for such diseases, the reliance that epidemiologists often place on human mortality data may be unjustified and that public health policies developed in the light of epidemiological studies of mortality data may be misguided.

Another matter which needs to be faced relates to the significance of contributory as distinct from underlying causes of death. How can and should such data be taken into account in the assessment of, say, disease trends and environmental health risks? Where malignant neoplasms are considered not to be underlying causes of death, but contributory causes, how should such findings be taken into account in the assessment of trends in cancer incidence?

Pathologists are physicians providing quality control of clinical work, diagnoses serving as basis of therapy.[26] Every society and country, rich or poor has to deal with the problem; how to train, how to educate pathologists for the next century? – One fact seems to be basic: a good autopsy practice can serve as the best springboard for a highly effective surgical pathology activity.[27]

The high rate of autopsies in Hungary cannot be achieved without well trained and qualified pathologists. To keep up this rate is unequivocally of national and international value and interest.[28]

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