Significance of inaccuracies in vital statistics

Mortality data, such as those contained in death certificates[225, 226] or large administrative databases,[224, 255] are commonly used in outcomes research.[256-266] Moreover, major decisions related to the allocation of healthcare research funds derive in part from estimates of disease burden.[267-271] The degree of correlation between disease burden and research funding depends on the specific measure—prevalence, incidence, mortality, disability-adjusted life-years and economic costs.[269, 271] Nonetheless, all of these measures depend on accurate vital statistics and other epidemiologic data derived from clinical diagnoses, both of which are known to contain major inaccuracies.

Given the prevalence of major errors in clinical diagnoses among deceased patients (Appendix Table 3), improvements in autopsy rates would be expected to produce substantial improvements in mortality data. These improvements would provide multiple tangible benefits to researchers and funding agencies.

Use of the Autopsy as a Surveillance Tool

One epidemiologic application of the autopsy consists of the use of incidental findings or 'necropsy surprises' in routine autopsies to gauge the prevalence of important chronic diseases. For instance, patients who die of conditions unrelated to gallstones or an abdominal aortic aneurysm provide a quasi-random sample of the general population from the perspective of attempting to measure the prevalence of these conditions. This approach to using the autopsy as an epidemiologic tool has been applied to diseases of the biliary tract and abdominal aorta, as well as several common forms of cancer.[17-19, 21, 22, 272, 273, 274]

Another epidemiologic application of the autopsy is in identifying or helping to characterize new and emerging diseases. Prominent examples of this role of the autopsy have consisted of infectious diseases,[275] such as Legionnaire's disease, AIDS, and pulmonary hantavirus.[23-26, 276-281] Outbreaks, such as the West Nile virus epidemic, and, more recently the use of anthrax a biological weapon, emphasize the importance of surveillance. Routine autopsies may detect cases that would otherwise escape investigation.

Table 1 – Sensitivity of Clinical Diagnosis Comparing Theoretic True Diagnosis with Autopsy Results as the Diagnostic Standard

		"True Diagnosis" (Observed Autopsy Diagnosis)		
		Lung Cancer	**Other Major Diagnosis**	**Total**
Clinical Diagnosis	**Lung Cancer**	180 (182)	90 (88)	270 (270)
	Other Major Diagnosis	20 (54)	1710 (1676)	1730 (1730)
	Total	200 (236)	1800 (1764)	2000 (2000)

Adapted from Saracci[58]

Table 2 – Inter-rater Agreement for Pathologists Assessing the Presence or Absence of Pneumonia at Autopsy

Observer pair	Observed Kappa (95% CI)*	Maximum possible Kappa†
A,B	0.72 (0.49-0.95)	0.83
A,C	0.65 (0.39-0.91)	0.65
A,D	0.52 (0.22-0.82)	0.52
B,C	0.81 (0.59-1.0)	0.81
B,D	0.66 (0.38-0.94)	0.66
C,D	0.84 (0.63-1.0)	0.84
D,D (6 months later)	0.82 (0.59-1.0)	1.0

* Cohen's kappa,[112, 113] with 95% confidence-interval limits calculated according to the Wilson efficient-score method, corrected for continuity

† Maximum possible kappa, given the observed marginal frequencies

Table 3 - Mean Error Rates and Correlations with Time, Autopsy Rates

Error Classification	Error rate* (95% CI)	Change in error rate with time**	Change in error rate with increased autopsy rate†
Class I	10.2% (6.7-15.3%)	26.2% relative decrease per decade (p=0.1)	7.8% relative decrease for each 10% increase in autopsy rate (p=0.2)
Major errors	25.6% (95% CI: 20.8-31.2%)	28% relative decrease per decade (p=0.0006)	12% relative decrease for each 10% increase in autopsy rate (p=0.0003)
Discrepant ICD Disease Categories	11.7% (9.7 -13.9%)	28% *increase* per year (p<0.0001)	1.4% decrease for each 5% increase in autopsy rate (p=0.1)

* The error rates listed here represent the probability of a diagnostic error at time zero (1980 for Class I and major errors, 1975 for ICD discrepancies), with the referent case mix category (general inpatients or adult inpatients), reference country (U.S.) and unweighted mean autopsy rate (44.3%) for included studies.

† Changes are all relative to the value for the base year and mean autopsy rate.

Table 4 - Class I Error Rates Computed for Varying Autopsy Rates in 4 Different Years

Autopsy Rate	1970	1980	1990	2000
5%	17.6%	13.6%	10.4%	7.9%
10%	17.0%	13.1%	10.0%	7.6%
20%	15.9%	12.2%	9.3%	7.1%
40%	13.9%	10.6%	8.0%	6.1%
80%	10.4%	7.9%	5.9%	4.5%
100%	9.0%	6.8%	5.1%	3.8%

Table 5 - Major Error Rates Computed for Varying Autopsy Rates in 4 Different Years

Autopsy Rate	1970	1980	1990	2000
5%	44.3%	36.4%	29.2%	22.9%
10%	42.7%	34.9%	27.9%	21.8%
20%	39.6%	32.1%	25.4%	19.7%
40%	33.7%	26.8%	20.8%	15.9%
80%	23.3%	17.9%	13.6%	10.2%
100%	19.0%	14.5%	10.8%	8.1%

Table 6 – Autopsy Rate Stratified by Formally Assessed Levels of Diagnostic Certainty for Deaths in a Neonatal Intensive Care Unit (as reported by Dhar et al [124])

Diagnostic Certainty	Autopsy Rate (95% CI)
Completely Certain (Level 1)	53.1% (41.7-64.1%)
Almost Certain (Level 2)	61.3% (56.2-66.2%)
Probable or suspected (Level 3)	73% (62.4-81.6%)

Table 7 – Autopsy Rate and Diagnostic Disagreements Stratified by Clinical Confidence (from Heasman and Lipworth[127])

Clinical Confidence	Total Number of deaths	Autopsy rate	Disagreement rate
Fairly certain	9,248	57%	16%
Probable	3,694	76%	33%
Uncertain	1,282	88%	50%
Not stated	393	67%	28%
Total	14,617	65%	25%

Table 8 – Number of Autopsies and Percent Diagnostic Errors Stratified by Clinical Confidence and Patient Age (from Britton[121, 122])

Clinical Diagnosis	Age < 70	Age≥ 70	Total
Fairly certain - # (% erroneous)	91 (15%)	91 (34%)	182 (25%)
Probable - # (% erroneous)	60 (33%)	91 (53%)	151 (45%)
Total - # (% erroneous)	151 (23%)	182 (43%)	333 (34%)

Table 9 – Autopsy Rates and Diagnostic Confirmation Rates Stratified by Clinical Confidence (from Cameron and McGoogan[155, 156])

Clinicians' Assessments of Principal Diagnosis	Percent of Cases	Confirmation of Principal Diagnosis at Autopsy
Fairly certain	47%	75%
Probable	35%	55%
Uncertain	16%	30%

Table 10 – Diagnostic Confirmation Rates Stratified by Clinical Confidence Before and After Intervention to Increase Autopsy Rate (from Cameron et al[123])

	Number of cases (Percent of cases with autopsy confirmation of principal clinical diagnosis %)	
	5/75-6/77 (Autopsy rate 30%)	6 months in 1978 (Autopsy Rate 63%)
Total # of autopsies	326	154
Main diagnosis "certain" or "fairly certain"	168 (52%)	144 (94%)
Autopsy confirmation of main diagnosis	182 (56%)	131 (85%)
Autopsy confirmation of causes of death	60 (18%)	90 (58%)
Autopsy would normally NOT be requested	-----	44 (86%)
Autopsy would normally be requested	-----	110 (85%)

Table 11 – Clinicians Assessment of Necessity in Cases Sent for Autopsy and Stratified by Clinical Confidence (from Hartveit[293])

Confidence in clinical diagnosis	Clinicians' Assessments of Autopsy Necessity		
	Essential	Desirable	Little Interest
Certain	22%	70%	8%
Uncertain	45%	54%	1%

Table 12 – Diagnostic Errors Detected by Autopsy in the Single Study Including Discharge Diagnoses for Patients who did not Die (from Cameron & McGoogan[155,156])

	Principal diagnoses and causes of death as determined by autopsy in 1975-7			Principal discharge diagnoses from same hospitals in 1976	
	Confirmed	Overturned	Missed	Alive	Died
Pulmonary TB	7	8	7	138	5
PE	44	35	99	140	18
Acute appendicitis	3	1	1	441	4
Bowel obstruction	6	3	0	159	13
Acute MI	198	58	51	1452	258
Cirrhosis	22	5	13	125	12

TB – tuberculosis; PE – pulmonary embolism; MI – myocardial infarction