

REVIEW ARTICLE

Assessing the Autopsy

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This study outlines the role of autopsies in medical practice and health policy, details the nature and reason for declining rates, including those in Rochester, Minnesota, and suggests possible remedial measures to halt or reverse this trend. It is concluded that one of the principal impediments to reversing the declining rate of autopsies is what is referred to in Economics as "market failure." In particular, the nature of the spatial and temporal distribution of costs and benefits has

precluded the existence of an incentive structure which can lead to a realization of the major net social benefits from the autopsy. Ultimately, it is only the explicit recognition by the medical profession, government agencies, corporate insurers, and the general public of the nature and significance of this market failure and foregone benefits which can lead to remediation. (Am J Pathol 1987, 128:362-379)

THE AUTOPSY plays a critical and multifaceted role in modern medicine, not the least of which is its function as a quality control and verification mechanism in diagnostics with its ultimate salutary impact on clinical practice. From the viewpoint of public health policy, the autopsy offers a valuable instrument for achieving cost-effective health care and the efficient allocation of resources. From an epidemiologic perspective, autopsies provide accurate information on cause of death and thus facilitate the process of hypothesis generation and testing concerning the temporal and spatial prevalence of disease. The availability of autopsy data is of particular relevance to the Rochester Project at the Mayo Clinic in guaranteeing the accuracy of the data base and permitting the continuation of extensive epidemiologic research of national and international importance.^{1,2}

Despite the crucial and continuing role of autopsies, not only directly in medicine but also indirectly in important resource allocation decisions in the public health sector, there has been a significant decline in the autopsy rate in the United States since the Second World War. Even in Rochester and surrounding Olmsted County, there has been a parallel, although less pronounced decline in these rates.

The purpose of this study is to outline the role of autopsies in medical practice and health policy, detail

the nature and reason for declining rates, including those in Rochester, Minnesota, and to suggest possible remedial measures to halt or reverse this trend. It is concluded that one of the principal impediments to reversing the declining rate of autopsies is what is referred to in Economics as "market failure." In particular, the nature of the spatial and temporal distribution of costs and benefits has precluded the existence of an incentive structure which can lead to a realization of the major net social benefits from the autopsy. Ultimately, it is only the explicit recognition by the medical profession, government agencies, corporate insurers, and the general public of the nature and significance of this market failure and foregone benefits which can lead to remediation.

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The Role of the Autopsy

The role of the autopsy is both broad and multifaceted. Listed below are the most important of its contributions to medical practice and health policy.

1. Autopsies provide confirmation, clarification, and correction of antemortem clinical diagnoses and, as a consequence, an "opportunity for clinicians to enhance their medical knowledge and diagnostic skill and apply this to all patients under their care."³ In this regard, a recent British study found that an increasing necropsy rate produced a higher rate of confirmation of clinical diagnoses.⁴ The essential issue is one of quality control.⁵⁻⁸ Mayo surgeons have expressed "a continuing interest in the very real value of knowing (and seeing) the operative site to be satisfactory or unsatisfactory; a continuing interest in the surprise findings at postmortem which clarify a different post-operative course, [and] an overlooked condition or lesion."⁹

Table 1 summarizes the results of research published since 1980 on the extent of inaccurate or missed clinical diagnoses discovered at autopsies. The results of Table 1, and additional work in this area dating from the immediate postwar period,⁴¹⁻⁷³ are contentious, for in some respects, they can be used to draw both optimistic and pessimistic conclusions concerning the diagnostic process. What is clear from these data and their supporting research is that the capability of the autopsy to identify clinically important missed diagnoses has remained remarkably robust over the past six decades. The principal explanation for this phenomenon is the disclosure by autopsy of different missed diagnoses in successive eras. To quote a study on this subject by Goldman: "Therapeutic advances may bring us to yet another era of even newer and more unusual causes of death. Thus it is likely that the autopsy will be a perpetual cornerstone of the auditing of the quality of medical care."^{74, see also 20}

In addition, however, this extensive body of research demonstrates the continuing difficulties inherent in the antemortem diagnosis of such important diseases or conditions as pulmonary embolism.^{98-11,51,53,56,69,75,76} The significance of this type of diagnostic anomaly was stressed by Heasman and Lipworth⁶¹ in a study conducted in 75 British hospitals. While in the aggregate, "the effect of post-mortem examinations on mortality statistics . . . would be small . . . , there were, however, one or two conditions where it appeared that the published statistics are very much in error."

Research conducted at the Mayo Clinic in Rochester, Minnesota, has revealed numerous initial diag-

noses at autopsy, including 12% of colon cancers,⁷⁷ 19% of gliomas,⁷⁸ 38% of primary intraspinal neoplasms,⁷⁹ 45% of pheochromocytomas,⁸⁰ and 66% of meningiomas.⁷⁸

In a majority of cases documented in Table 1, antemortem knowledge of this massive body of autopsy findings would have had little effect on disease outcome. Nevertheless, the impact of these data is significantly greater with respect to the expenditure of society's scarce resources on the medical treatment of individuals, and the distribution of such resources nationwide on medical research, training, and disease prevention and control. This conclusion applies with equal force to false-positive as well as false-negative results revealed at autopsy.

2. Autopsies aid in discovery of new or previously unrecognized diseases. These include Legionnaires' disease, toxic shock syndrome, the carotid artery syndrome in strokes, rheumatoid disease of the aorta and aortic valve, scleroderma kidney, Kwashiorkor, veno-occlusive disease, protein-losing enteropathy, protein loss from villous adenoma and carcinoma of the colon, chloride loss with gastric mucosal hypertrophy, aldosteronism, gastric perforation from congenital muscular defects of the stomach, and the Zollinger-Ellison syndrome.^{81,82}

3. Autopsies provide essential information on disease manifestation which cannot be provided by living subjects.^{83,84}

4. Autopsies assist in the evaluation of new surgical techniques.

5. Autopsies play an important role in the evaluation of the efficacy of new drugs and their potential adverse effects.⁸⁵

6. Autopsies facilitate the investigation of environmental, occupational, and lifestyle-related diseases, including both inter- and intra-cultural and geographic comparisons.^{47,86-94} Of particular importance in this category are the detection of chronic, long-term, delayed, and/or subclinical effects of ingestion, inhalation or absorption of new chemicals in the workplace or the general environment, including soil, air, and water pollutants, and new commercial products, food additives, and contaminants. In this last category are a broad range of chemicals and elements, associated with modern industrial production processes, which are characterized by high levels of toxicity. These include such substances as chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, polychlorinated biphenyls and terphenyls, organochlorine pesticides, and transuranics such as plutonium.⁹⁵⁻¹⁰¹

7. Autopsies provide reassurance and potentially critical information for members of the family of the

Table 1—Inaccurate or Missed Clinical Diagnoses (Discovered at Autopsy)

Author(s)	Year	Number of deaths	Diagnoses	
Stevanovic ¹⁰	1986	2145	Overall rate of major discrepancies	29%
Anderson ¹¹	1986	2067	Discrepancy rates between autopsy results and clinical diagnosis—total	40.8%
			Major diagnosis, adverse impact	7.0%
Kircher et al ¹²	1985	272	Major disagreement on underlying cause of death between autopsy and death certificate	29%
Heller et al ¹³	1985	64	Different principal diagnoses	31.3%
Gibinski et al ¹⁴	1985	217	False-negative diagnoses	22.1%
			False-positives	10.1%
Gough ¹⁵	1985	46	Missed major diagnosis, where diagnosis before death: would probably have resulted in longer survival or cure,	13%
			would probably not have changed management	22%
McGougan ¹⁶	1984	1152	Autopsy failed to confirm main clinical diagnoses	39%
			Failed to confirm other conditions which contributed to death	66%
Gambino ¹⁷	1984	428	Diagnoses missed or erroneous	15.6%
Friederici and Sebastian ¹⁸	1984	2537	Primary disease not clinically diagnosed	10%
			Autopsy disclosed one or more unexpected important findings	64%
Berthrong ¹⁹	1984	1846	182 carcinomas of the prostate, of which 101 occult	55.5%
Goldman et al ²⁰	1983	300	Autopsies revealed major missed diagnosis that would have prolonged survival	10%
			Showed missed diagnosis with no treatment change	12%
Pounder et al ³	1983	100	Antemortem diagnoses not confirmed	16%
Puxty et al ²¹	1983	461	Autopsies revealed undiagnosed contributory factor to death	27–31%
Scottolini and Weinstein ²²	1983	100	Major clinical diagnoses not confirmed	13%
			Cause of death not in clinical diagnosis	24%
Zarling et al ²³	1983	100	Incorrect antemortem diagnoses of actual acute myocardial infarction	47%
Asnaes et al ²⁴	1983	266	Clinician's diagnosis confirmed as incorrect	18%
Stemmermann ²⁵	1982	1376	First diagnosis at autopsy of tumors in elderly Hawaiian Japanese (327/813)	40%
Gobbato et al ²⁶	1982	1405	Malignant neoplasm undiagnosed	27%
Clark and Whitfield ²⁷	1982	471	Major discrepancies between clinical diagnoses and autopsy findings	4.2%
Schottenfeld et al ²⁸	1982	575	Death certificates required recoding of underlying cause of death	15%
Bobrowitz ²⁹	1982	527	Sample includes all patients where TB was primary or secondary cause of death; diagnosis made only at autopsy	4%
Clark ³⁰	1981	1076	Death due to natural disease independent of disease under treatment or, less commonly, due to clinically undiagnosed condition	5.1%
Horwitz et al ³¹	1981	8998	Not diagnosed endometrial cancer	0.3%
Thurlbeck ³²	1981	200	Error rate in diagnosis of major disease	12–24%
			Error rate in cause of death	10–36%
Cameron and McGoogan ³³	1981	1152	Main diagnosis not confirmed	39%
Mandard et al ³⁴	1981	111	Discovery of second primary tumor in cases of esophageal cancer	21%
Colby et al ³⁵	1981	80	Proportion of patients who died with clinically unsuspected Hodgkin's disease in series of patients with HD	5%
Busuttill et al ³⁶	1981	182	Disagreement between clinician and pathologist on underlying cause of death	23.6%
Asnaes and Paaske ³⁷	1980	807	Differences in mode of death	4%
			Not diagnosed—malignancies	4%
			—syphilitic aortitis	1%
			—pulmonary TB	0.7%
Cameron et al ⁴	1980	154	Main diagnoses not confirmed	15%
			Causes of death not confirmed	42%
Sandritter et al ³⁸	1980	1096	Inadequate diagnosis	16.1%
			False diagnosis	2.6%
Engel et al ³⁹	1980	257	Improper recording of underlying cause of death in autopsied cases	42%
			Error in confirmation of original death certificate diagnoses	11%
Cechner et al ⁴⁰	1980	415	Bronchogenic carcinoma	
			False-negatives	28%
			False-positives	9%

deceased.^{102–105} These are detailed further in this paper.

8. Autopsies make significant contributions to medical and epidemiologic research. Of particular importance are studies on the incidence rates of wide-

spread and important diseases such as Alzheimer's where differential diagnosis presents a singular challenge to the clinician. For example, potential confounding diagnoses include related degenerative brain disorders (eg, Pick's disease), cerebrovascular

disorders (eg, multi-infarct dementia), infections (eg, Creutzfeldt–Jakob disease), increased intraventricular pressure (eg, normal pressure hydrocephalus), exogenous toxins and drugs (eg, anticholinergics), delirium, memory loss as benign senescent forgetfulness, focal neurologic disease (eg, Wernicke's aphasia), depressive illness, poor adaptive social behavior, and angular gyrus syndrome.^{106–112}

Autopsies occasionally generate unexpected information on the continuing incidence of diseases no longer considered of major significance. A case in point is provided by recent research in Broward County, Florida, verified by the Centers for Disease Control, suggesting no real decrease in the local incidence of syphilis (0.96%) in the past three decades despite advances in diagnosis and treatment.¹¹³

In addition to facilitating the generation of accurate incidence rates in epidemiology, autopsies make an essential contribution to the identification of prevalence trends¹¹⁴ and hypothesis testing for risk factors in disease etiology.

With respect to the publication of medical research, at Mayo as well as elsewhere, it is recognized that a lack of corroborative autopsy studies has sometimes led to difficulties with publication.¹¹⁵ This is indeed a potentially serious problem, because a critical element in the advancement of scientific inquiry is the dissemination and exchange of research results through the medium of scholarly publication.

The availability of external research funding is, under certain circumstances, partially influenced by the existence of sufficiently high autopsy rates. By way of example, a recent "Request for Cooperative Agreement Application" from the National Institute of Aging on the creation of an Alzheimer Disease Patient Registry (ADPR)¹¹⁶ specifically asks applicants to "indicate expected autopsy rates and plans for incorporating data from autopsy confirmation of diagnosis in the ADPR." In light of the aforementioned problems of differential diagnosis with Alzheimer's disease, the conduct of such research and continued attraction of external funding is dependent upon an extensive autopsy system. "An autopsy and detailed neuropathologic examination remains the most reliable way to diagnose Alzheimer's disease."¹¹⁷

9. Autopsies assist in the evaluation of new prostheses in cardiac and orthopedic surgery.^{118,119}

10. Autopsies facilitate the evaluation of intentional and unintentional effects of treatment in the newly developing area of genetic engineering.

11. Autopsies assist in the evaluation of diagnostic technologies and tests.^{19,120–124} The autopsy can play a special role in the assessment of major new diagnostic technologies such as computer-based axial tomogra-

phy (CAT scan), nuclear magnetic resonance (NMR), and positron emission tomography (PET). While these new technologies offer major opportunities for increasing diagnostic accuracy of living subjects,¹²⁵ they entail significant resource commitments and hence social opportunity costs. Their effective utilization requires, among other factors, a precise assessment of their diagnostic accuracy. It has been maintained by some physicians that these advanced diagnostic technologies cannot replace autopsies. Instead, CAT scans, NMR, and PET should act in concert with autopsies to raise the overall level of diagnostic accuracy. By way of example, Jacobs et al,⁴⁴ in an autopsy-based verification study of CT scans, found 11 false-negatives in 79 cases (13.9%) of brainstem infarction, brainstem hemorrhage, and small metastasis.

Goldman et al,²⁰ in a recent article in the *New England Journal of Medicine*, conclude:

The modern explosion in diagnostic procedures is illustrated by the dramatic increase in 1980 of ultra-sound, nuclear medicine, and computerized tomographic procedures. . . . Although these new procedures are useful and probably contributed to the improved ante-mortem diagnosis of tumors in 1980, they sometimes contributed directly to a missed diagnosis. . . . Our findings suggest that the current very low autopsy rate in many hospitals is inappropriate and that the autopsy will continue to uncover many shortcomings in both medical and surgical diagnoses.

Gambino, in a 1984 paper,¹⁷ found that 4.4% of autopsy studies "disclosed errors in the results of a variety of diagnostic tests including ultrasound, roentgenogram, nuclear scan and blood chemistry analysis."

Clearly it would be unrealistic to expect the achievement of 100% accuracy in the broad range of diagnostic technologies and techniques. The principal goals of the autopsy in this regard are, first, to help achieve, through the process of constructive feedback, an acceptable minimum level of diagnostic error and, second, to identify nonrandom characteristics of error, whether attributable to specific diagnostic technologies, particular pieces of equipment, or certain diseases. Some general evidence on this last point is provided by Kircher et al¹²⁶ in a study of Connecticut autopsies in 1980. The authors found that

deaths due to neoplasms were most accurately diagnosed. . . . Deaths resulting from diseases of the respiratory or digestive system were associated with the highest rates of disagreement. Diseases most commonly overdiagnosed were circulatory disorders, ill-defined conditions, and respiratory diseases. Diseases most commonly underdiagnosed as the cause of death on the death certificate were specific traumatic conditions and gastrointestinal disorders.

With respect to the accuracy of diagnosis as a function of age, Cameron concludes from a study of autopsy data in Scotland that "confirmation of clinical diagnoses at autopsy was in inverse proportion to the patient's age."¹²⁷

12. Autopsies provide essential tissues for research and transplantation in such areas as ophthalmology, otorhinolaryngology, and orthopedics.¹¹⁵ Most frequently used tissues include dura, pituitaries, diaphragm, psoas muscle, middle ear, eye, and trachea. Particularly critical has been the role of autopsy eyes in corneal transplantation, in research, and for the instruction of residents in microsurgical techniques and pathology.

13. Autopsies are an indispensable source of primary or corroborative information in cases of sudden, suspicious, or unexplained death. This is not only the case for legally mandated necropsies to investigate possible homicides, but also to identify medical conditions with frequently no antemortem manifestations, such as those associated with sudden infant death syndrome [SIDS] and various adult cardiogenic disorders.^{128-133; see also 134-137}

14. Autopsies furnish valuable information concerning potential risks associated with specific therapeutic techniques such as radiation.¹³⁸

15. Autopsy findings can lead to more effective supportive care in cancer cases and could prolong patient survival.¹³⁹

16. Finally, autopsies can play a crucial role in the identification and potential control of new epidemic diseases. One of the foremost examples of this process is found in the study of acquired immune deficiency syndrome (AIDS) where autopsies have provided verification of antemortem diagnoses; generated first diagnoses of clinically unidentified infections and malignancies, leading in turn to greater accuracy in incidence and prevalence rates as well as a more complete description of AIDS-related disorders; extended the knowledge base concerning the specific manifestations and course of opportunistic infections; and identified related pathologic conditions in the brain, intestines, adrenal cortex and medulla, lymph nodes, spleen, lungs, eyes, and other organs.¹⁴⁰⁻¹⁵⁶

In light of the numerous and persuasive arguments for the autopsy, it would be reasonable to expect a steady or indeed increasing rate for a procedure which has been labelled "a most important peer review mechanism of medical and surgical care. . . . [and] an unrivalled teaching exercise and very important research tool."¹⁵⁷ In fact, the trend in autopsy rates has been the exact opposite, as witnessed by declining national and Mayo rates. The nature and reason for this decline are detailed in the next section.

The Nature of and Reason for Declining Autopsy Rates

The national autopsy rate has fallen from approximately 50% of all deaths in the immediate postwar period to a level of 14.7% in 1980. The extent of necropsies varies by cause of death and is heavily skewed toward a relatively small number of legally mandated categories such as homicide, where approximately 94% of all deaths are followed by autopsy.^{81,158} While there is a significant number of autopsies in the United States for such inferred causes as cardiovascular disease (87,917) and malignant neoplasms (35,836), these represent rates of 8.9% and 8.6% of those diseases, respectively.¹⁵⁹ Autopsy rates also differ markedly by age grouping¹⁶⁰ and place of occurrence of death. A study in Connecticut for the period 1970-1980 found an average total autopsy rate of 14%, but widely divergent rates across various categories. Fifty-six percent of all deaths occurred in hospitals, which, in turn, had an average autopsy rate of 21%. In contrast, nursing homes, which accounted for 20% of all deaths, had an average autopsy rate of 1%.^{12,21}

Figure 1 includes the limited data available from the U.S. National Center for Health Statistics.¹⁶¹ The gradually declining trend exhibited here is corroborated by independent data reported by the Commission on Professional and Hospital Activities.^{162,163; see also 164} Also presented in Figure 1 are three time series specific to the Mayo Clinic and its environs: 1) Olmsted County since 1964, 2) the city of Rochester for the same period, and 3) the Mayo hospitals since 1911. These Mayo trends exhibit a decline parallel to the national data, although their levels remain far above that of the United States as a whole. The disaggregated data for Rochester also appeared skewed, although in this case it is more by type of patient than disease *per se*. There is an abnormally low autopsy rate for elderly citizens. The rates for all Olmsted County residents 65 years and older at time of death are presented in Figure 2 and compared with the national average. These limited data demonstrate a sharp increase over the period 1964/65, in response to the initiation of the Rochester Epidemiological Program Project (REPP), and a gradual decline since that time. Detailed cross-section time series autopsy data for Olmsted County residents (see Figure 3) confirms, with the exception of the very youngest age groupings, the generally declining trend of autopsies both temporally and across age groupings.

While exceedingly useful in detailing the important temporal shifts in aggregate autopsy rates, these data provide little guidance for remedial decision-making

Figure 1—Autopsy rates for the United States, Olmsted County, Rochester, and the Mayo Hospitals.

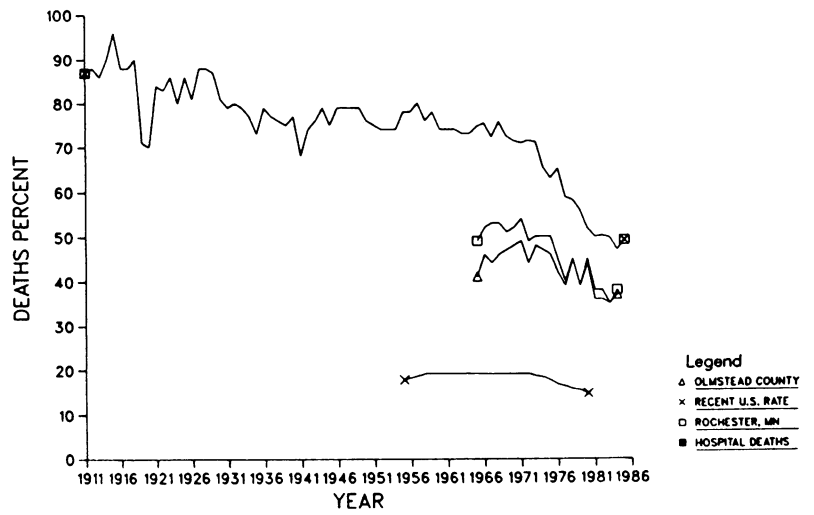


Figure 2—Autopsy rates of elderly population of Olmsted County and the United States.

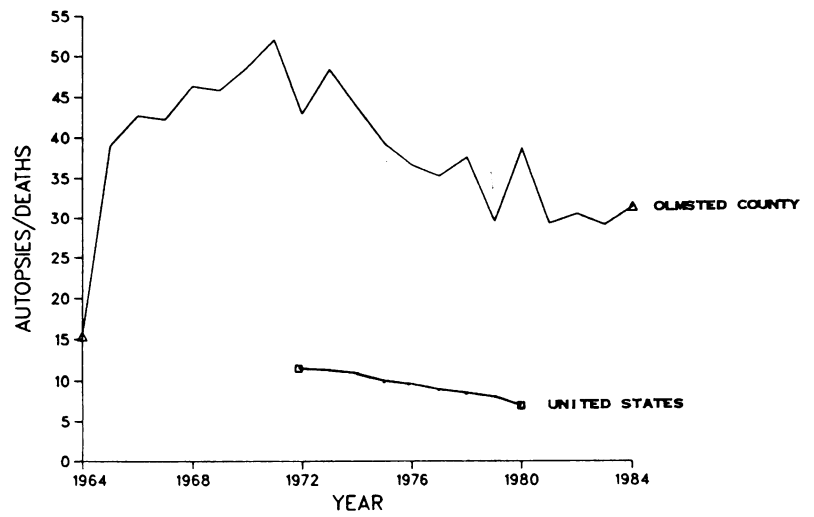
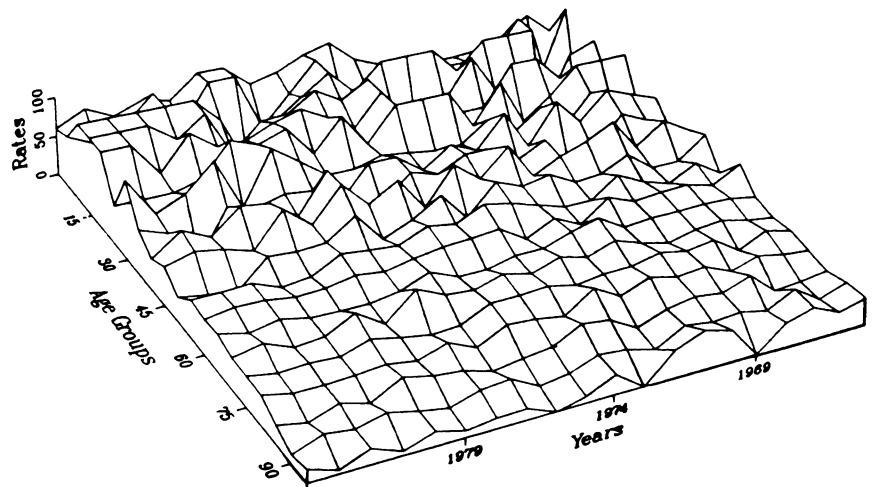


Figure 3—Cross-section times series autopsy data for Olmsted County, 1965–1984.



because they provide only a suggestion of the disparate factors that bear upon autopsy rates for particular population subgroupings. In an attempt to remedy this deficiency, the author generated a profile of autopsies by locus of death in both 1970 and 1984, which revealed several critical shifts in the pattern of autopsy activity. The decline in autopsy rates for Rochester and other Olmsted County residents occurred across virtually all categories (including deaths in residences, hospitals, and nursing homes) with the exception of homicides and accidental deaths followed by a coroner's inquest. Perhaps most important from a national perspective was the pronounced decline in autopsy rates (from 43% to 16%) in nursing homes. With the significant "first diagnoses" made at autopsies on the elderly,¹²⁷ and the projected increases in the elderly population of the United States over the next several decades, this autopsy pattern presents a particularly challenging problem.

Several general reasons have been advanced to explain the steady decline in autopsy rates in the United States. These include a decision by the Joint Commission on the Accreditation of Hospitals in 1971 to eliminate the requirement for a minimum 20% autopsy rate¹⁶⁵; the general lack of a high medical profile associated with such activities; a lower interest in the cause of death in elderly patients¹⁶⁶; recent concern over the potential transmission of certain diseases such as AIDS; the unfavorable economics of autopsies; the potential embarrassment or legal liability associated with misdiagnosis or malpractice; and the presence of nonmedical personnel in the decision-making structure surrounding the disposition of the deceased's body. Of these postulated and diverse explanations, the last three seem the most important and are addressed in turn.

Economic Considerations

As documented in this paper, there are persuasive arguments which suggest a major net social benefit from autopsies. Nevertheless, there exist few economic incentives to undertake this medical procedure because of the nature and distribution of its costs and benefits. The costs¹⁶⁷ include 1) facility maintenance, including space, overhead, personnel, supplies, and equipment; 2) body transportation; 3) professional fees for performing the autopsy; 4) documentation, photography, etc.; 5) laboratory tests, including histopathology, toxicology, chemistry, bacteriology, and serology, if relevant; 6) postmortem X-rays, if needed; and 7) fees for consultation time and court appearances, if required. In contrast, the benefits fall into two general and somewhat amorphous categories:

1) the psychologic well-being of relatives of the decedent from knowing the cause of death; and 2) the potential for the creation of healthier and longer lives.

Policy-making within the public and private sectors concerning a socially desirable rate of autopsies is hampered by several interrelated economic factors. First, the costs are immediate, focused and direct, averaging \$900 to \$2000 per autopsy in the late 1970s and early 1980s, depending on the procedures performed.^{30,165,168,169} As of 1986, the average cost of the approximately 750 autopsies performed at the Mayo Clinic was estimated at \$1900 independent of associated educational activities. This figure is composed of approximately 47% direct personnel expenses, 40% for supplies and services, including photography, audiovisual requirements, tissue laboratory tests, etc.; and 13% for space, equipment, depreciation, and indirect costs.¹⁷⁰

Because autopsies can only infrequently be paid for as a physician's service, they usually must be covered by hospital overhead, which may or not be reimbursable. With regard to Medicare coverage, Alex MacMahon of the American Hospital Association is quoted as stating:

The pathologist's fee or professional component for autopsy service is not included under Part B Medicare payment because autopsies are not performed as a service to individual patients. The full cost of pathology service including a professional and facilities component is currently reimbursed under Part A. As such, the professional component falls under the reasonable compensation equivalents (RCE) limits. The RCE was created under TEFRA [Tax Equity and Fiscal Responsibility Act]. Under prospective pricing the cost of autopsy will not be passed through. These costs must be covered by the DRG [diagnosis-related group]-based pricing system (as a cost of doing business). Therefore, the price paid for patients in a given DRG should be adequate to cover autopsies (including costs) performed for medical, legal, education, and research purposes.¹⁷¹

The impact of the Diagnosis-Related Group Classification system (DRG) under Medicare on both the number of autopsies and the related level of remuneration remains contentious. There has been concern expressed that the ultimate effect of the new reimbursement system on autopsy rates will be negative.^{172,173} While opinions differ, it has been suggested that in light of the range of institutional impediments already in existence, the DRG may have only a modest negative impact on already low autopsy rates. With respect to the level of DRG reimbursement, it has been postulated that autopsy data may have a positive effect by increasing the complexity of the groups classification¹⁷⁴; but this conclusion is controversial¹⁷⁵ and has not been verified elsewhere.¹³

From an economic point of view, a critical factor in

determining the appropriate rate of autopsies is marginal cost; and, in this regard, Guariglia and Abrahams state:

Virtually all of the cost of an autopsy service is fixed and unrelated to volume, within the limits of allocated space and staff. The actual cost of a few autopsies (more than zero) is not much less than that of many autopsies (again, within limits) when determined on an incremental basis, since the variable costs associated with each case are low.¹⁷⁴

In contrast to autopsy-related costs, the benefits are generally long-term, diffuse, indirect, and occasionally intangible. The creation of healthier and longer lives is a very broad benefit and, from an economic viewpoint, represents the aggregation of a number of disparate but important variables, including 1) the reduced cost of hospitalization or other treatment due to a generally improved process of disease detection; 2) the reduction in work productivity loss due to earlier detection and possible disease cure across the entire population; 3) the reduction in work productivity loss due to the development of more effective prosthetic devices and organ transplants; and 4) a reduction in the spread of disease due to improved systems of diagnosis and treatment. These are all critical potential social cost savings whether they accrue directly to the individual or indirectly through insurance coverage, employer contributions, or reduced governmental expenditures.

Despite the apparent magnitude of these benefits, the incentives for their realization may be absent or distorted. As indicated above, the loci of costs and benefits are usually different. In particular, the autopsy, in many respects, has the characteristics of a public good—its benefits are widely distributed, non-appropriable, and indivisible. For all these reasons, the net social benefit from a high autopsy rate may not be realized because of an absence of a relevant market-based incentive structure. Under these types of circumstances, the traditional economic response has been some form of government regulatory activity. The current interest in deregulation in the United States may hamper the passage of appropriate legislation and, therefore, nongovernmental policy options must receive greater scrutiny.

The rate of autopsies and the medical information resulting therefrom have an intimate relationship with health policy decision-making in both the private and public sectors. This is particularly the case in the context of social investment allocation decisions with respect to both imminent and immediate threats to human health and longer-term widespread societal disease patterns. It is usually the case that health policy conclusions and resource allocation decisions are based on epidemiologic studies of death certificates

and their associated vital statistics. Yet the quality of statistically based measures of confidence and significance, which form the foundation for such decisions, may be seriously compromised if no explicit recognition is given to the error rate in death certification without autopsy.*

Epidemiologic information, verified by autopsy data, is the *sine qua non* of sound “investment” decisions in the allocation of scarce resources in the area of public health. The inherent market failure associated with autopsies implies that the information derived therefrom will be undervalued in the decision-making process. Yet without the statistical accuracy resulting from verified epidemiologic data, there is no guarantee that correct inferences will be drawn concerning disease incidence and prevalence rates and etiologic risk factors. Such information, in the form of high levels of both sensitivity and specificity, is an essential prerequisite to the efficient and effective allocation of scarce societal resources between the health sector and other sectors of the economy, among diseases, and between prevention and treatment.

Quality control is one of the best routes to efficiency, or cost minimization. It should be viewed as a highly productive investment at a time when the total cost of medical care is of great social concern. Effective quality control will lead to cost reduction through several mechanisms, especially by avoiding unnecessary medical expenses and by assuring high quality care—which implies the greatest level of care per dollar spent.^{176,177}

Finally, there is a potential role for the necropsy in risk-benefit analysis concerning the effects of new drugs and diagnostic and therapeutic technologies. While the almost universal effect of medical intervention is salutary, there are frequently non-zero risks associated with such activities. These risks can vary markedly across medical activities, and risk-benefit theory mandates that a careful weighing of risks and expected benefits be conducted, especially in those cases where risks are considered nontrivial. Potential adverse effects of diagnostic technologies have been

*In an attempt to identify the specific role of autopsies in the first diagnoses of AIDS, the Centers for Disease Control conducted a file search and analysis, on behalf of the author, on the 26,875 cases reported as of October 31, 1986. Unfortunately, this experiment established more convincingly the well-documented deficiencies of death certification than it did an autopsy/AIDS nexus. This was forcefully demonstrated by a record-by-record check of 18 anomalous AIDS cases which revealed at least two rather remarkable instances: one patient reported to have produced a sputum sample, and another to have run a high temperature, in the month following their deaths.

documented, for example, in the use of computed tomography.^{178-185, see also 186} In some of these cases, the exact mechanisms of adverse reactions remain unknown.

The autopsy can contribute useful information to the risk analysis of the effects of prescription and non-prescription drugs, as well as chemotherapeutic agents.¹⁸⁷⁻¹⁹⁸ In addition, the necropsy can play an especially important role in helping to weigh the risks of radiation for both diagnostic and therapeutic purposes. Burger et al¹³⁸ conducted a morphologic study "in order to investigate the incidence, character, and pathogenesis of radiation-associated changes, as well as the possible modifying effects of adjunctive therapy" (p 1256). They found that "radiation-induced tissue alterations in patients with intracranial gliomas are manifold in character . . . and not consistently predicted by formulae based on dose, dose rate, and post-irradiation survival."

Burger et al also speculated on possible synergistic effects of therapeutic agents, because "three of the four cases of radiation necrosis in the brain surrounding the neoplasm occurred in the groups treated with both chemotherapy and irradiation" (p 1270). The issue of synergy, because of its inherent complexity, has been only cursorily addressed in the literature of environment and health. There is clearly a potential role for the autopsy in this area where univariate dose-response functions may provide a poor guide to ultimate medical risks. Although the discipline of risk-benefit analysis remains fraught with theoretic and empiric difficulties,^{199,200} it does offer a promising opportunity to increase the efficiency of resource use in the medical sector.

Legal Liability

It has been suggested that improved quality control will ultimately lower the number of malpractice awards.¹⁶⁵ This issue is of particular note as it is possible that fear of litigation may unnecessarily influence clinicians' views of the autopsy. In a recent survey of 183 hospitals with medical school pathology residency affiliations, Valaske²⁰¹ found widespread support for the increased use of autopsies to reduce the risk of financial loss from malpractice suits. Five specific reasons were provided to support this conclusion:

1. Autopsies eliminate suspicion. ("Performance of autopsies tends to exculpate the institution from any suspicion of concealment.")
2. Autopsies provide reassurance to families. ("Autopsies clarify situations of [apparent] negligence, stopping many claims which were unfounded, and

providing impetus for equitable settlement of claims which are valid.")

3. Autopsies substitute facts for conjecture. ("Autopsy tends to uncover findings that may explain an unfavorable outcome of a procedure [otherwise] possible leading to a suit." "Ten or 15 times a year we are asked by clinicians before autopsy to rule out possible complication carrying liability. . . . More often than not, we rule them out.")
4. Autopsies construct a better defense. ("We have been able to prepare a much better defense when autopsy information is available than when we have had to rely on clinical information alone." "The objective documentation of findings plus the active and informed participation of the pathologist in negotiation or litigation can be a significant contributing factor in negating plaintiff claims.")
5. Autopsies reduce the number of claims. ("Autopsy findings prevent capricious malpractice actions. . . ." "Autopsy findings have usually enabled the pathologist to furnish information which proved supportive of the hospital staff. In some cases, the evidence was damning and dictated quick settlement of claims." ". . . the epidemiology of hospital death is surprisingly full of supposition and speculation. [In the absence of autopsy], claims are brought against this murky background.")

Issues of legal liability and their economic consequences also affect the pharmaceutical industry. It is in the interest of drug manufacturers to encourage and perhaps help in the funding of an increased autopsy rate in order to provide an enhanced data base on adverse drug reactions. By either verifying or disproving adverse drug reactions as expeditiously as possible, the pharmaceutical industry can protect itself from unnecessary financial losses as well as continue to provide society with essential and efficacious medications.²⁰²

Nonmedical Decision-Makers

Aside from medical personnel and relatives of the deceased, two other groups may influence the decision concerning the disposition of the deceased's body. These include nursing home operators and funeral home directors. It would be naive to assume an enthusiastic response by all nursing home operators to the encouragement of autopsies among their residents. The quality of care could vary among nursing homes and it is possible that those homes with below average care might be disinclined to encourage autopsies lest they reflect negatively upon their performance.

There appear to be no direct or indirect incentives for funeral homes to participate in the autopsy process or advise families of the deceased to do so. In fact, the medical literature suggests that morticians have a strong disincentive because of "the inconvenience in transporting the body to the hospital when the death occurs elsewhere and the delay in the preparation of the body for funeral services."²⁰³

The Rochester Project as a Special Case

The Rochester Epidemiological Program Project (REPP) represents a partial and particularly important exception to the lack of an appropriate incentive structure for autopsies at the national level. A sufficiently high autopsy rate (ranging between 65% and 100%, depending on target population) is essential to preserving the accuracy of the REPP's unique data base, which has virtually complete coverage of a geographically defined population since the beginning of the century. While the extensive medical benefits from this project accrue both nationally and internationally, some of these effects are in fact directly appropriable by the Mayo Clinic and its personnel. In the 22 years since its inception, the REPP has led to the publication of over 380 scientific research papers by Mayo staff, graduate students, and visiting scientists.²⁰⁴ The significant contribution to medical knowledge represented by this scholarly output would not have been possible without the unique opportunity afforded to this group of scientists by the Rochester Project. The benefits directly accruing to these individuals are also shared in the form of positive externalities for other Mayo activities. The benefits of high autopsy rates and their impact on epidemiologic research and clinical practice at Mayo provide an additional contribution to Mayo's international reputation for excellence.

Remediation

A necessary prerequisite to remediation is the identification of points of influence where an increase in the rate of autopsies may be encouraged. Figure 4 is a representative schematic which delineates 1) potential targets for autopsy encouragement, such as elderly citizens, children and other relatives of the elderly, parents of infants, and others; 2) potential delivery personnel for this information, such as the medical community, nursing home staff, and morticians; and 3) points of influence within the chart of basic locations of death. This figure can be easily generalized to describe any social agglomeration encompassing residences, nursing homes, physicians' offices, clinics,

and hospitals. The principal arguments which could be used to encourage increased autopsies should be directed at target groups—those that would receive autopsy information—and delivery personnel—those who might be expected to deliver information concerning autopsies to the target groups.

Targets

In general, the arguments used on the potential decedent should have two foci: 1) a stress on the specific benefits to his/her family and 2) broader benefits to society. With respect to societal benefits, one of the principal arguments is based on the fact that the more autopsies that are performed, the greater is the probability that the subject's disease can be treated, or that some nonapparent disease of medical significance can be diagnosed and cured.

The greatest opportunity for influence appears to be relatives of potential or actual decedents who may respond to direct arguments based not only on social altruism, but more particularly, on self-interest associated with identification of contagious disease, settlement of insurance claims, recognition of genetic disorders, potential organ availability, and peace of mind associated with knowledge of the cause of death and consequent relief from potential feelings of guilt.

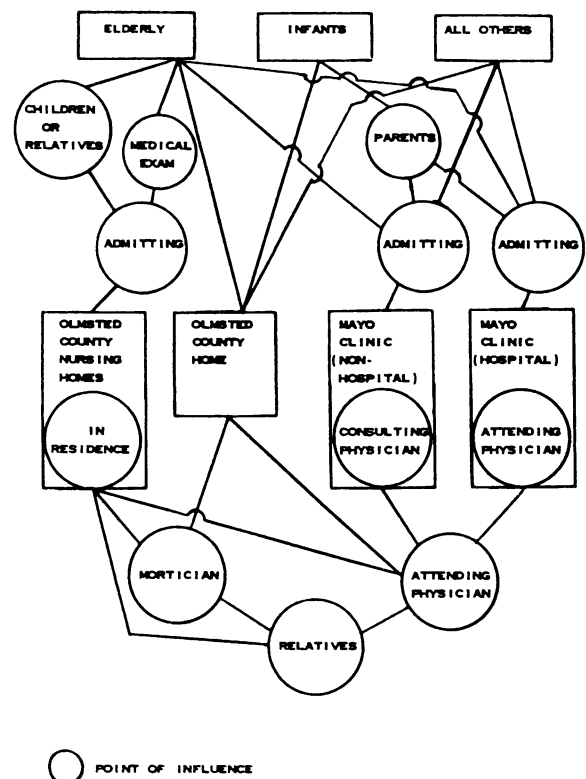


Figure 4—Points of influence on autopsy rates.

Delivery Personnel

In general, the medical community seems best able to deliver this advice to potential decedents and/or their relatives for two reasons: 1) there are compelling, although not universally accepted, reasons why a high autopsy rate is in the best interests of the medical community; and 2) the potential decedent and/or relatives are most likely to trust the medical profession as a relatively unbiased source of advice.

An important delivery route is through the process of public education, and publications produced by medical institutions, as illustrated by the *Mayo Clinic Health Letter* and *Harvard Medical School Health Letter*, may significantly aid this goal over the longer term.

With regard to nursing homes, where autopsy rates are unacceptably low, there are several additional arguments that can be used as incentives for nursing home staff to encourage a higher autopsy rate: 1) the increased probability of detecting contagious diseases which might affect other residents; and 2) increased knowledge concerning cause of death and, conversely, those factors which did not contribute to death. This latter factor may be important in alleviating concerns of other residents and/or their relatives about the quality of care and general safety of the immediate environment with respect to pathogens or other potential life-threatening factors. Where nursing home operators are particularly reticent to cooperate, there may be an avenue for moral suasion under these circumstances. In a community such as Rochester, Minnesota, it might be expected that the level of autopsies on deceased residents would increase *if* the Mayo Clinic decided, as a matter of policy, to request cooperation from nursing homes in this endeavor. The prospects for influencing the autopsy rate of residents of Olmsted County nursing homes are also promising in light of the fact that the Mayo Division of Community Internal Medicine "has been instrumental in placing Mayo Clinic staff physiatrists as consultants at each one of [the] local nursing homes and three . . . [Division members] are contract nursing home medical directors."²⁰⁵ It is unclear, however, whether the special opportunities to influence autopsy rates in Olmsted County nursing home residents can be realized in larger, less isolated communities with a more heterogeneous system of medical care and delivery.

In either case, a central issue is the manner and form of eliciting autopsy approval. This process should be the result of both oral and written encouragement. It must be clear in any permission form that no disfigurement is entailed under normal autopsy

procedures, because this is a concern frequently voiced by relatives of the deceased.²⁰⁶ In addition, there must be no ambiguity regarding organ donation. Some subgrouping of the population can be expected to approve of autopsy for themselves, but not organ donation, and, consequently, their agreement to autopsy could be jeopardized by any lack of clarity between autopsy *per se* and organ donation in the consent form.

The avenue of least promise may be the attempt to influence the attitudes of morticians. The only possible leverage, even in Rochester, might be moral suasion where every mortician has been formally requested by the Mayo Clinic to participate, and each knows that all competitors have received a similar request. Again, the prospect of this type of coordinated initiative on the part of the medical community seems less likely in a larger urban center.

In sum, arguments to delivery personnel should stress the benefits to the community and special interest groups and include *inter alia* the capability to reveal the presence of contagious disease; the potential source of organs for transplantation; the monitoring of community medical care (especially quality control for cost minimization); the opportunity to study the natural history of disease processes; help in planning local health care; establishing causes and non-causes of death; assistance in determining the manner of death; producing vital statistics; monitoring public health; providing medical education, research material, and knowledge; and ultimately improved disease detection and treatment.

Summary Observations and Conclusions

In conclusion, it appears that there are a number of promising avenues for increasing the autopsy rate. Included among these are public education through such vehicles as medical health letters and direct counseling of potential decedents and their relatives by the medical profession and, to a lesser extent, by nursing home staff. This is clearly a long-term process, and the reversal of declining autopsy rates will take time. Some short-term benefit might be achieved by focusing efforts in areas which are particularly deficient, such as nursing homes.

It appears that the principal focus of attention must be on the medical profession. Without their active agreement and participation, the effort to reverse declining autopsy rates will inevitably be frustrated. The *Hospital Procedure Guide for Mayo Clinic Physicians*²⁰⁷ instructs each physician in the event of a patient's death to

Request spouse or next of kin for permission for complete postmortem examination, including the brain in all cases.

Explain the advantages of such an examination and make certain it is understood there is no charge or undue delay because of necropsy. (pp 10–8)

While it is clear that there are no major disincentives for consultants to recommend autopsy, Tangalos²⁰⁸ states that

a number of fundamental changes have occurred over the past 15 years. A generation ago when most deaths occurred in hospital, it was the pathology resident's responsibility to respond to all deaths and secure autopsy permission. At present, the physician primarily responsible for the patient is responsible for the autopsy.

Logistically and legally the nursing home death is much more difficult to handle. There is often no death vigil with next of kin close at hand. There is great reluctance on the part of the physician to attend the body that has been essentially abandoned by family and it is an onerous task to ask the resident physician to proceed to the nursing home to pronounce a body he has never seen nor cared for. Over the phone it is psychologically difficult to ask for autopsy permission and even more difficult when one considers that these calls must be conferenced to record by permanent tape the agreement to proceed with post-mortem examination.

Another practice that has met with disfavor is the inclusion by the pathologist of a request for a letter by the primary care physician explaining to the family the autopsy results. This procedure is now a matter of routine whereas in the past it was the responsibility of the primary care doctor to ask if a letter was in order. The consulting staff objects to this practice as a routine, as the wording must be delicate and carefully chosen.

It has been suggested that the declining rate has been due to institutional inertia, and that a change in governing board policy, at Mayo or any other medical center, may be neither necessary nor sufficient to effect an autopsy rate reversal. What may be required is a process of consultation with each resident physician that stresses the positive benefits of increased autopsy rates for the patient's family, for other patients who may benefit directly from transplant tissue or indirectly from increased medical knowledge, for the physician himself, for the Clinic, and for the many general scientific and practical reasons already enumerated in this report.²⁰⁹

Where an institution such as Mayo has spare capacity to perform autopsies, it may be possible to increase the rate at little additional expense because of the relatively low level of marginal cost.²¹⁰

It is suggested here that emphasis also be placed on the role of autopsies as a verification mechanism for important new diagnostic technologies, such as PET, NMR, and CAT scans, which have attracted so much attention and popularity within the medical community.

It is recommended that further efforts be made to explore the possibility of the Mayo Clinic, and other

medical institutions throughout the country, taking a more active role in promoting a positive attitude toward autopsies by nonaffiliated physicians, nursing home staff, and morticians.

With regard to legislative activity, it is instructive to note past practice in Scandinavia: "It [is] understood, when a patient enters a hospital in those countries, that if death ensues, there will be an autopsy unless the family signs a form within 12 hours of death specifying that one is not desired."²¹¹ Unfortunately, recent legislative changes in Sweden have reversed the onus in this decision, and specific permission must be received from the decedent's family prior to autopsy. The negative impact of this policy change on the autopsy rate is already apparent. In the United States, a positive spillover effect on the rate of autopsies may ensue as a result of recent legislation in 15 states requiring hospitals to solicit organ donations from families of dead or dying patients.²¹²

Nevertheless, the role of government intervention, either directly or indirectly, in the activities of the medical sector remains contentious. The medical profession should give serious consideration to increasing the autopsy rate to preserve the independence of the profession and to protect itself from hasty and potentially ill-conceived regulations in response to highly charged and emotive public issues, such as the emerging fear of an AIDS pandemic.²¹³

Major new studies have recently been undertaken by the College of American Pathologists and the American Medical Association with the goal of reexamining the continuing contribution of the autopsy to modern medicine. In addition, the Joint Commission on Accreditation of Hospitals is in the process of reconsidering an autopsy standard.²¹⁴ All three of these initiatives and related activities will focus renewed attention on what has been termed "the ultimate audit" of medical practice¹⁷ and the "ultimate medical consultation."²¹⁵

This resurgence of interest in the autopsy among segments of the medical community has led to a series of proposals that may help alleviate the problem of low rates. These diverse recommendations include, *inter alia*, suggesting that research grants require a minimum autopsy rate,²¹⁶ tying autopsies more closely to functional problems in educational programs and linking the necropsy to the risk/quality assurance role of the DRG system,¹⁷³ seeking a specific DRG descriptor for the autopsy,²¹⁷ and negotiating on a hospital-by-hospital basis direct cash incentives for pathologists to conduct autopsies.²¹⁸

Finally, the role of autopsies in quality control, cost minimization, and the efficient allocation of resources offers a great potential for influencing insur-

ance companies, governmental health departments, and even individual hospitals in an era when rapidly increasing costs of medical care threaten to jeopardize government budgeting processes and the availability of a decent minimum standard of medical care for all Americans.

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