Closing the Loop: Facilitating the Use of Autopsy Information in Medical Decision Making and Managed Care

Peter N. Nemetz

Strategy and Business Economics, Sauder School of Business, University of British Columbia.

Abstract: This paper advances the somewhat paradoxical hypothesis that the emergence of managed care which threatens to accelerate the decline of the autopsy may, in fact, offer an opportunity for its re-emergence as an important tool of quality and cost control. A simplified autopsy-based management information structure is proposed to close the loop where information currently gleaned from the autopsy is frequently unused or underutilized in medical decision making and managed care.

Introduction

The national autopsy rate fell steadily from 19.1% in 1972 (the first year that the U.S. National Center for Health Statistics (NCHS) began regular compilation of these data) to 9.4% in 1994, at which point the NCHS stopped collecting national data.[1–2] A survey of all state autopsy rates by this author found a continuing decline, with the national average in 2003 of only 8.3%.[3] Based on additional state-specific data, there is every reason to believe that the national rate has continued its gradual decline to this day. There is no apparent reversal in this trend in prospect, as the complex and interdependent explanatory factors for this decline remain valid today. These include, inter alia: (1) the emergence of powerful new diagnostic imaging technologies such as MRI, CT, PET and ultrasound; (2) the low medical profile and remuneration associated with autopsy activities; (3) increasing cost of the autopsy; (4) reduced interest in the cause of death among elderly patients; (5) concern over the transmission of diseases such as AIDS and hepatitis; (6) concerns over legal liability from the disclosure of findings; (7) the decision by the Joint Commission on the Accreditation of Hospitals (now the Joint Commission on the Accreditation of Healthcare Organizations) in 1971 to eliminate a minimum autopsy rate for hospital accreditation; and (8) the emergence of the nursing home as a new locus of death in modern American society.[4–5]

It is unlikely that the practice of autopsy will completely disappear in the near to mid term future, however, as this procedure is still vital to the conduct of medico-legal investigation of accidents, homicides and suicides.[6–8] Nevertheless, if the current trend were to continue, the autopsy would cease to make any significant contribution to the three traditional consumers of its information: outcome assessment, quality control and epidemiology.

One additional and powerful factor contributing to the decline of the national autopsy rate is the emergence of managed care systems in the United States. Medical care delivery organizations in this new environment, such as HMOs, have been singularly devoted to the provision of quality care at minimal cost—there is no apparent rationale for investment in a procedure which is of no benefit to the patient who has just died.

The frequently intangible benefits and longer-term payoff of autopsy-generated information is critical to understanding its continuing demise.[9] There is a large and persuasive literature championing the cause of the autopsy. It is not the purpose of this paper, however, to restate these arguments; but instead to focus on the potential strategic value of the autopsy in today's health system. This paper advances the somewhat paradoxical hypothesis that the emergence of managed care which threatens to accelerate the decline of the autopsy may, in fact, offer an opportunity for its re-emergence as an important tool of quality and cost control.

The Autopsy and Managed Care

The essence of managed care has been the delivery of cost-effective medical services. The successful achievement of this goal requires quality management—as assessment system which identifies ineffective,

Correspondence: Peter N. Nemetz, Ph.D., Strategy and Business Economics, Sauder School of Business, University of British Columbia.

incorrect or counterproductive diagnoses and medical treatment, and ultimately brings about change. The autopsy has been termed the ultimate instrument of quality control in the practice of medicine and it is here that hope may lie for its revival.

The question remains as to why managed care institutions—in need of continuous quality improvement—should embrace the autopsy. The critical goal is for information to drive process improvement. Unfortunately, the autopsy has not been recognized as a measure for strategic advantage. The essential feedback loop between autopsy information and clinical practice has remained unclosed[10–11] for a variety of reasons: long lag times in the generation of autopsy information and a mind-set among many clinicians that such information, when available, would contribute little to the practice of clinical medicine. The potential exists to overcome these principal impediments to the utilization of autopsy-generated information because of the emergence of computer-based management information systems (MIS) and the gradual adoption of the electronic patient record.

The Autopsy and Management Information Systems

The emergence of management information systems has had a profound effect on the conduct of business in general and can have an equally major impact on the practice of modern medicine. Linking the autopsy to the managed care system requires that the information from this procedure be intimately linked to a system-wide MIS. The following sections briefly outline how such a system might be designed and implemented.

While medical-based MIS is only in its infancy; the basic components of such a system are presented in Figure 1 and include:

1. patient demographic data
2. laboratory test data
3. surgical procedures data
4. outpatient visit data
5. tissue storage and retrieval (including DNA analysis)
6. diagnostic data
7. pharmaceutical data
8. biopsy and autopsy results.

Epidemiologists recognize these interrelated components as the building blocks of a linked medical record system. In order to implement such as system, the following additional components are essential:

a. a unit record system which assigns a unique and invariant patient identifier number,
b. a consistent and comprehensive diagnostic coding system,
c. a consistent and comprehensive surgical procedures index, and
d. a drug coding system.

Finally, in a fully functioning medical, computer-based MIS, this information must be on-line or electronically archived, easily retrievable and in a consistent and comparable format. Through the emergence of modern computer-based information storage and retrieval systems and the increasing relevance of such data, components of this type of system have already been put in place in many medical centers. The full integration of autopsy data into such systems will require one further step, however, as outlined below.

A Simple Autopsy MIS

An effective autopsy-based MIS requires most of the components depicted in Figure 1. This is a necessary but not sufficient prerequisite to an autopsy-MIS functioning as a tool for quality management. The additional element required to establish this system is linkage to a series of modifiable databases which encode acceptable and unacceptable (or flaggable) values for a variety of diagnostic variables. This concept is best illustrated through reference to the flow chart in Figure 2 which outlines the logical branching and outputs of a possible autopsy-related MIS.

As stated above, the prerequisite for operationalizing this concept is a system for coding all diagnostic test values, ICD or equivalent diagnoses, and surgical procedures. How would such a system differ from common current procedures? At present, in many medical centers, ante-mortem diagnoses are available in hard copy in the patient record (unified or dispersed), and cause of death diagnoses (assuming no autopsy) are listed on the death certificate in a prescribed format[12] and may or may not also be available in part of the patient record.

If an autopsy occurs, the findings from this procedure are used to revise the cause of death
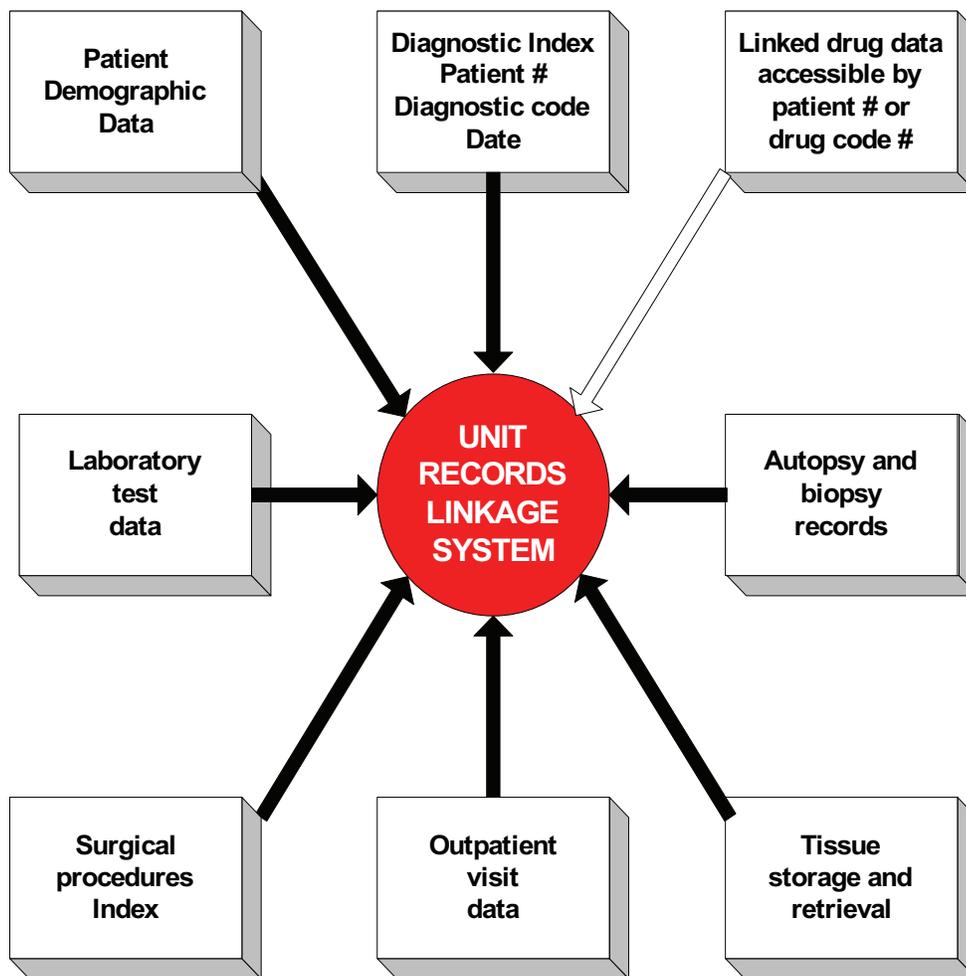
Figure 1. Unit Record System.

information to be entered on the death certificate, and the more detailed results of the autopsy may or may not be placed in the patient record and communicated to the decedent's physician. The uncertain availability of this information and its degree of utilization represent a major unclosed feedback loop in the medical system. The proposed autopsy-MIS would replace much of the initial human effort in interpretation and communication and produce a series of flags alerting medical system personnel and administrators to various discrepant results with differing degrees of medical, and ultimately economic, significance through cost containment. The advantage of such a system is not only its signaling of individual discrepant results, but also the ability to create time series data which could signal trends in medical outcomes or particular aggregations of significant medical results associated with medical procedures, diagnostic tests or equipment, pharmaceuticals, or even individual medical practice skills.

Such an autopsy-MIS would entail a multistage system which would function as follows:

1. major and minor diagnoses made at autopsy would be coded by ICD category and automatically compared with diagnostic codes (Dxi) on the patient's electronic record.
2. any major Dxi on the patient record not verified at autopsy would generate a Flag A, alerting the medical system administrator to a diagnostic discrepancy due to either human error or diagnostic machinery malfunction. The algorithm must also include a component which recognizes the existence of certain chronic or acute conditions which may not be observed at autopsy. For example, the early stages of diabetes mellitus will usually have no obvious morphological manifestations at autopsy.
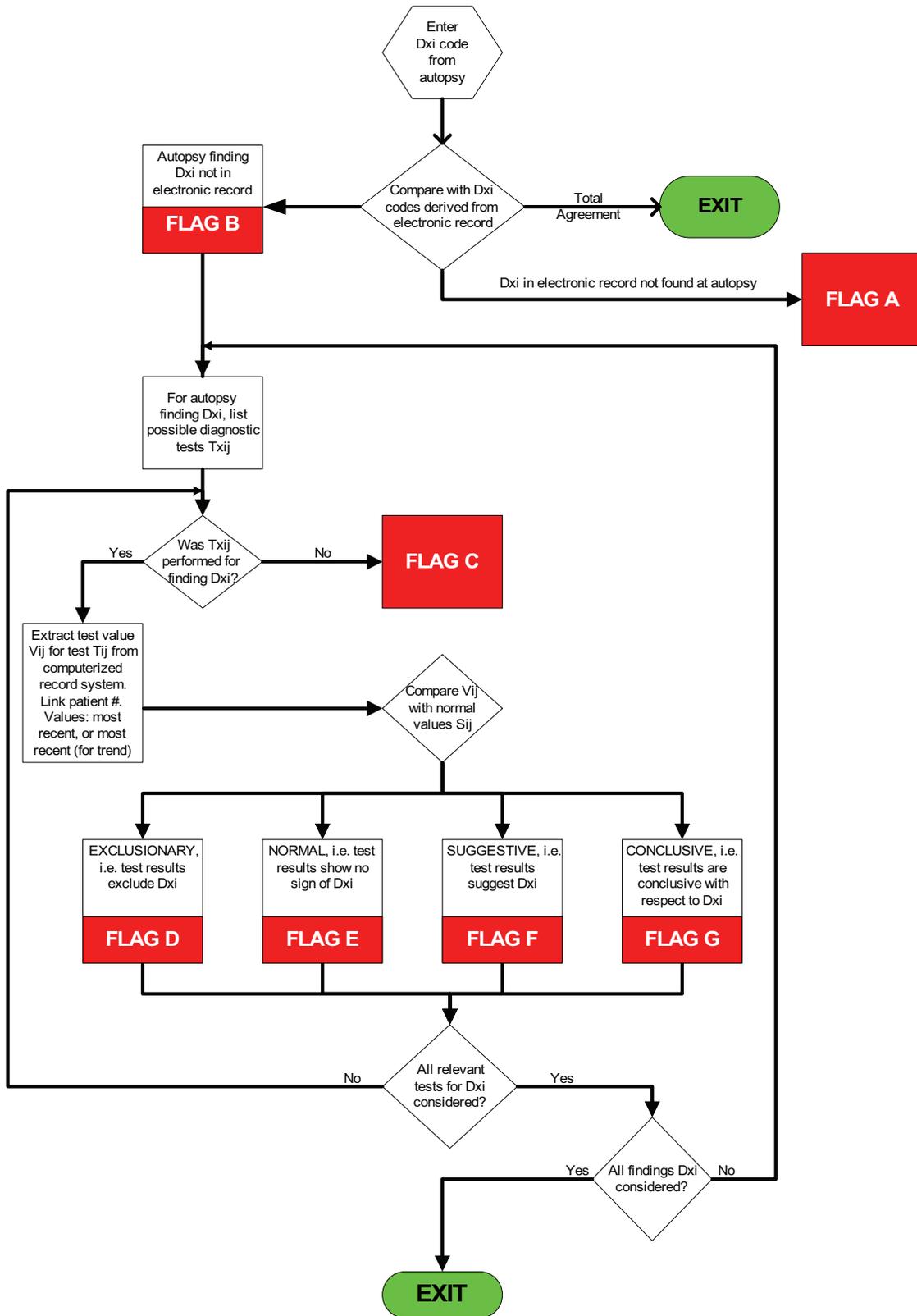3. Perhaps, more important, is the presence of an autopsy Dxi not already in the patient record.

Figure 2. Autopsy-MIS Dxi Routine.

Not all such new findings will be equally relevant and, as such, a potentially useful filter for these data is Goldman et al.'s[13] classification of the value of autopsy-generated information (See Table 1). Class I (discrepancy of a primary diagnosis with an adverse impact on the patient's survival) is of greatest importance, but is clearly dependent on patient co-morbidity. This presents the greatest challenge for the development of this AI system as, for example, the undetected presence of a fatal pulmonary embolism in a terminally ill cancer patient is of significantly less medical importance than such an embolism in an accident victim. To address this problem, it would be necessary to construct a series of conditional "if" statements—for example:

NO flag A, if pulmonary embolism AND terminal cancer,
YES flag A, if otherwise.

4. Where a Dxi made at autopsy is not found in the patient record, the system would generate a Flag B.

5. For finding Dxi at autopsy not found in the patient electronic record, the MIS lists possible diagnostic procedures which could have detected such a condition (including radiology, blood, urine, microbiologic, etc.). The absence of such a test would generate Flag C.

6. If one or more of such tests were performed, the test values would be extracted and compared with electronic dictionary-based normal values. This extraction could be performed from one of two possible sources—either the patient's electronic record, or the electronic files of diagnostic laboratories which are part of the linked medical records system. Four possible flags could result from this process:

Flag D would be generated if the test results excluded finding Dxi,
Flag E would be generated if the test results showed no signs of Dxi;
Flag F would be generated if test results were suggestive of Dxi; and
Flag G would be generated if the results were conclusively positive with respect to Dxi.

Each of these flags represents a different problem in the medical system: flags D and E indicating an error in the diagnostic technology; flags F and G signaling an error in the interpretation of the diagnostic output, each requiring a distinct remedial response (See Table 2). The underlying linked database dictionaries and interpretative rules required for such a system of diagnostic evaluation are presented in Figure 3. Clearly, the example flow chart of Figure 2 is only part of a more complex system of heuristics which could track other important variables such as surgical outcomes and adverse drug reactions.

## Cost Constraints and Autopsy Targeting Strategies

It is extremely unlikely that adopting a policy of universal autopsy would be cost-effective under any circumstances, as the marginal cost of the autopsy would exceed the marginal benefit of the information generated at a rate significantly less than 100 percent. Determining an appropriate rate of autopsy for process improvement within a managed care setting is initially a subjective assessment, but movement toward an appropriate rate will be guided by the information yield of autopsies conducted over time. Inherent in this process is tracking disease frequency and related data, and using this information for continuous

Table 1. Goldman et al.'s classification of value of autopsy-generated information.

Class	Information Yield
Class I	Discrepancy of a primary diagnosis, with an adverse impact on the patient's survival
Class II	Discrepancy of a primary diagnosis but with equivocal or no adverse impact on survival
Class III	Discrepancy of a secondary diagnosis that should have been recognized by the patient's physician, not related to the cause of death
Class IV	Discrepancy of a secondary diagnosis that could not have been made from the information available before death

Table 2. Definition of errors flagged by one possible autopsy-MIS.

Flag	Interpretation
A	A diagnosis listed on the patient's electronic medical record is not found at autopsy. This represents a false positive finding. With the exclusion of certain chronic or acute conditions with no observable morphological features at autopsy (such as early stage diabetes mellitus), this finding represents the possibility of unnecessary diagnostics or medical treatments.
B	A diagnosis made at autopsy is not found in the patient record. This represents a false negative finding.
C	If a false negative finding [Flag B], a flag is generated after the MIS finds that a diagnostic test capable of presaging the autopsy result was not performed prior to the patient's death.
D	A false negative finding as in B, but an appropriate diagnostic test was undertaken prior to the patient's death and the results of this test *exclude* the diagnosis made at autopsy. This is suggestive of test error.
E	A false negative finding as in B, but an appropriate diagnostic test was undertaken prior to the patient's death and the results of this test *do not confirm* the autopsy diagnosis. Again, this is suggestive of test error.
F	A false negative finding as in B, but an appropriate diagnostic test was undertaken prior to the patient's death and the results of this test are *suggestive* of the autopsy diagnosis. This suggests inadequate clinical follow-up.
G	A false negative finding as in B, but an appropriate diagnostic test was undertaken prior to the patient's death and the results of this test are *conclusive* with respect to the autopsy diagnosis. This is suggestive of either a failure in test result transmission or interpretation.
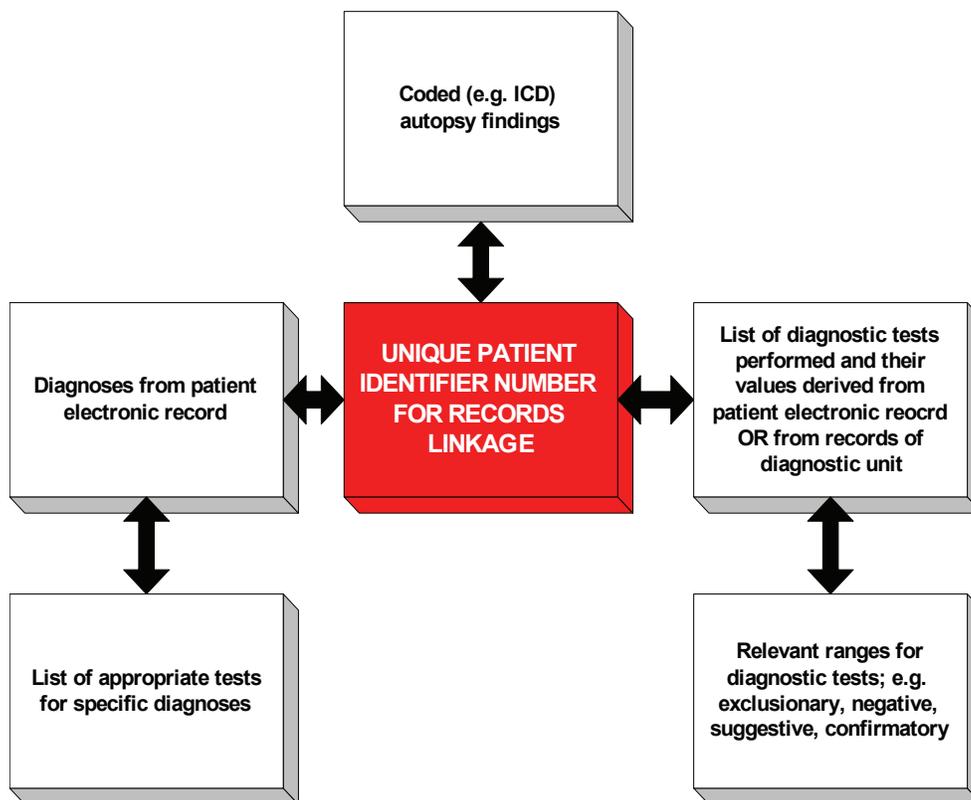
Figure 3. Linked Data Modules in Autopsy MIS.

improvement initiatives and quality planning in the clinical environment.

An enduring lesson from research conducted on autopsy findings is the absence of any consistent methodology for predicting which autopsies will have the highest information yield—specifically ex ante prediction of important discrepant results.[14–16] This is in fact a fundamental attribute of the autopsy, for without the discovery of new or unexpected results, the value of the autopsy would decrease substantially.

With no a priori information for the design of an autopsy targeting strategy, the most appropriate avenue to follow is one of stratified random sampling, where the choice of strata, or categories, is mandated by the demographic and medical characteristics of a targeted patient population, a specific diagnostic technology in heavy use, and surgical or other therapeutic procedures performed at higher cost than competitors. Specific autopsy-targeting strategies will emerge, however, in response to autopsy signals suggestive of a pattern of discrepant results and the creation of control charts and benchmarks. Table 3 summarizes possible institutional responses to signals from an autopsy MIS.

Conclusions

The confluence of two recent major developments in medical care delivery—the emergence of managed care and a growing consumer demand for cost-effective, quality medicine, and the development of linked, computerized medical database systems—present an unusual opportunity to reverse the decline in the national rate of autopsy. An autopsy-MIS system providing critical quality control information for the organization and delivery of clinical medicine may also partially meet the needs of epidemiological research in those circumstances where distinctive and identifiable subsets of the population are receiving medical care. In this way, the autopsy may survive and continue to serve the needs of its three traditional markets: epidemiological data for public health policy, quality management for process improvement and cost control, and outcome assessment for clinical decision making.

Table 3. Possible institutional responses to signals from an autopsy-based MIS.

Realm	Signal	Autopsy Response	Clinical Response
Quality Control	excessive error rates in diagnosis or surgical and other therapeutic interventions	increase rate in category of concern in order to identify further cases, monitor trends, and establish statistical significance	attempt to identify and remove cause of errors
Quality Control	differing error rate detection by type of autopsy	adjust mix of autopsy types (i.e. extent) to maximize detection of Class I errors, given budget constraint	n.a.
Outcome Assessment	suggests high positive or negative outcomes associated with specific interventions	set minimum autopsy number in specific clinical studies in order to establish statistical significance	adjust treatment protocols in response to data on outcomes
Epidemiology	incidence and prevalence rate determination and other epidemiologic studies	set minimum number of autopsies for statistical significance, and set minimum extent of autopsy which will satisfy study-specific data needs	n.a.

Disclosure

The author reports no conflict of interest.

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