Regular Article

Autopsy Standardized Mortality Review: A Pilot Study Offering a Methodology for Improved Patient Outcomes

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Abstract

A standardized mortality review of hospital autopsies identified discrepancies between clinical diagnoses and autopsy findings, unexpected deaths, adequacy of diagnostic workup, presence of adverse event, and type of a quality issue if present. The standardized review elements were chosen based on a review of quality metrics commonly used by hospitals. The review was completed by the pathologist based on their initial autopsy findings. The final autopsy report was later reviewed to confirm the initial review findings. Major discrepancies in diagnosis were categorized as class I or II based on the modified Goldman criteria. Ninety-six hospital autopsy cases from January 2015 to February 2018 were included in the study. The overall major discrepancy rate was 27%. Class I discrepancies, where a diagnosis found at autopsy might have improved survival had it been made premortem, were identified in 16% of cases. Categories associated with increased discrepancy rates included unexpected deaths, inadequate workup, abnormal labs or imaging not addressed, and certain quality issues. Deaths not expected at admission but expected at the time of death, those with adverse events, those within 48 hours of a procedure, those within 48 hours of admission, those with physician-specific quality issues, and those with system or process issues were not significantly related to diagnostic accuracy.

Introduction

The rate of hospital autopsies has been declining in the United States in recent decades.[1] Estimated at only 8% in 2003, the autopsy rate has shown a dramatic drop compared to the estimated 30% to 40% in the 1960s.[1-3] Factors often cited for the decline include high cost and lack of direct reimbursement, lack of defined minimum rate standards for hospitals, overconfidence in diagnostic testing, and concerns over malpractice litigation.[4,5] Yet despite this decline, the autopsy has demonstrated its importance in quality improvement, medical education, identifying new diseases or new manifestations of known diseases, evaluating the effect of treatments such as immunotherapy in some cancers, and compiling accurate public health data.[6]

One way the autopsy serves as a quality control measure is by revealing incorrect or missed diagnoses. This clinico-autopsy discrepancy rate has been estimated to be as high as 30% in recent studies.[4,7] Analysis of pre- and postmortem discrepancies can be helpful for identifying areas of weakness in clinical diagnostic capability. For example, previous studies

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have identified pulmonary embolism as one of the most commonly missed diagnoses, suggesting that further prophylactic measures or lower threshold for suspicion may be indicated. Previous studies have also analyzed specific age groups, medical units (especially intensive care units), underlying diseases, and length of stay in order to identify groups with higher risk for significant discrepancy.

As autopsy rates continue to decline and missed diagnoses continue to be significant, proposals on how to firmly integrate the autopsy into hospital quality improvement processes and analysis of unexpected mortality, system errors, and clinical decision-making will be essential. This pilot study provides a means to achieve this integration through a standardized mortality review process.

Methods

Creating the Mortality Review Form

A mortality review form for hospital autopsies was created by an attending pathologist to address elements of the University Health System Consortium risk-adjusted mortality model using the following resource as a guide: https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/systems/hospital/qitoolkit/combined/d4n_combo_iqi-mortalityreview-bestpractices.pdf.

The 1-page form (Figure 1) includes demographic data, admitting diagnosis and diagnosis at the time of death, additional autopsy diagnoses, screening questions related to unexpected mortality, diagnostic workup, time of death related to admission, and adverse events. The form also identifies physician or system quality issues and the type of quality issue and, if the quality issue was related to patient evaluation, decision-making, communication, supervision, professionalism, or other factors. Unexpected death was defined as any mortality in a patient for whom, based on clinical findings at the time of admission, recovery and/or hospital discharge was the anticipated outcome.

The Pilot Study

The mortality review form was completed by board-certified pathologists based on medical record review and their preliminary findings at autopsy. Cases included in this study were adult hospital autopsy cases performed between January 2015 and June 2018 at Vidant Medical Center in Greenville, North Carolina. All cases had autopsy consent from the legal next of kin. Each autopsy was performed by pathology residents and/or attending pathologists, with supervision by the attending pathologist in each case performed by a resident. The study design was reviewed and approved by the institutional review board.

Identifying and Classifying Diagnostic Discrepancies

A review of the final autopsy report was conducted for each case to validate the initial mortality review, with adjustments made based on the microscopic findings, as well as to determine the rate of discrepancy between clinical diagnoses and autopsy findings. The medical chart was reviewed if the clinical history in the final autopsy report was unclear or insufficient. Discrepancies were classified using the modified Goldman criteria.[1,8-11] We focused only on major diagnoses, meaning those related to the primary cause of death or principal underlying disease. Major diagnostic discrepancies can be classified as class I or class II. Class I major diagnoses are those for which detection and adjusted therapy could have prolonged survival or cured the patient (eg, unsuspected myocardial infarction in a patient presenting with chest pain). Class II major diagnoses are those for which detection and adjusted therapy would not have prolonged survival or cured the patient (eg, unsuspected myocardial infarction in a patient presenting with cardiac arrest).

Statistical Methods

The χ^2 test of independence was used to investigate whether there was an association between each of the patient categories identified in the mortality review survey and the incidence of diagnostic discrepancies. In cases where the expected count was too small to use the χ^2 test, Fisher exact test was used instead. The SPSS program was used to run the tests. The α level used to determine statistical significance was .05.

Results

Mortality review forms were completed on 96 adult autopsies during the study period. Of the 96 autopsy cases that were analyzed, 51 were from male patients and 45 were from female patients. Ages ranged from 18 to 94 years, with a median age of 61 years. The demographics of the patients included are presented in Table 1. Two of the 96 patients died at home. The decision was made to include these 2 individuals because both had been admitted within 3 months of dying for reasons related to their primary cause of death. The remaining 94 patients died while admitted to Vidant Medical Center.

Major discrepancies were identified in 26 (27%) of the 96 total cases. Fifteen of these were categorized as class I discrepancies and 11 as class II discrepancies (16% and 11% of total cases, respectively). A comparison of major underlying diseases and primary causes of death as determined clinically and at autopsy for all cases with class I discrepancies is summarized in Table 2.

The relationship between expected or unexpected death and discrepancy rate was examined. Death in 57 of the 96 cases was expected (59%) and in 39 cases was unexpected (41%). The rate of major diagnostic errors for expected death was 8% (8 cases), and the rate for unexpected death was 19% (18 cases), which was statistically significant ($P = .001$). All but one of the discrepancies in expected death cases were class II errors, whereas the majority of errors in unexpected death cases (14/18 cases) were class I. Table 3 summarizes the patient mortality groups and the rate of major discrepancies for each category.

Confidential Review Mortality Review performed by Pathology							
PATIENT NAME:				**MRN:**		**AUTOPSY NUMBER:**	
AGE:	**SEX**	**EDP#**		**ADM DATE**	**D/C DATE**		**LOS**
ATTENDING PHYSICIAN				**CONSULTANTS**			

ADMITTING DIAGNOSES

ADDITIONAL DIAGNOSES AT TIME OF DEATH

ADDITIONAL DIAGNOSES BASED ON PRELIMINARY AUTOPSY FINDINGS

CAUSE OF DEATH

SCREENING		
yes	**no**	
		WAS THIS AN EXPECTED MORTALITY?
		WAS THIS AN UNEXPECTED MORTALITY?
		WAS MORTALITY NOT EXPECTED AT ADMISSION BUT EXPECTED AT TIME OF DEATH?
		WAS DEATH ASSOCIATED WITH AN ADVERSE EVENT OR DRUG REACTION?
		WAS THE DIAGNOSTIC WORK UP ADEQUATE?
		WERE ABNORMAL LAB, X-RAY, OTHER TEST RESULTS AND PHYSICAL FINDINGS ADDRESSED?
		WAS DEATH WITHIN 48 HOURS OF A SURGICAL OR INVASIVE PROCEDURE?
		WAS DEATH ASSOCIATED WITH DIAGNOSTIC FAILURE?
		WAS DEATH WITHIN 48 HOURS OF ADMISSION?

QUALITY ISSUES			COMMENTS
yes	**no**		
		WERE QUALITY ISSUES IDENTIFED	
		WAS A PHYSICIAN ISSUE IDENTIFIED	
		WAS A SYSTEM OR PROCESS ISSUE IDENTIFIED	
ISSUE IDENTIFIED RELATED TO			
yes	**no**		
		PATIENT EVALUATION/DATA ACQUISITION	
		CLINICAL DECISION MAKING	
		PERFORMING A TREATMENT OR PROCEDURE	
		DOCUMENTATION	
		COMMUNICATION AND COORDINATION	
		POLICY COMPLIANCE	
		SUPERVISION	
		PROFESSIONALISM	

ACTION

REFER TO (CIRCLE):

      CHIEF OF SERVICE

      QUALITY

      RISK MANAGEMENT

      OTHER (SPECIFY)

PATHOLOGIST SIGNATURE

Confidential Medical Review/Credentialing/Peer Review Committee Materials Pursuant to North Carolina General Statutes 131E-76, 131E-95, 131E-97.2 and/or 90-21.22A

Figure 1. Mortality review form.

The relationship between inadequate diagnostic workup and major discrepancies was evaluated and found to be significant. Eight (8%) cases were said to have had inadequate workup upon mortality review; the remaining 88 (92%) cases were considered to have adequate workup. The rate of major errors was 6% (6 cases) for cases with inadequate workup and 21% (20 cases) for those with adequate workup. The major discrepancy rate was found to be significantly higher for cases with inadequate workup ($P = .005$). Two-thirds of the discrepancies in cases with inadequate workup were due to class I errors.

Whether abnormal findings, laboratory test results, or imaging were addressed, premortem was also analyzed for

significance. Nine (9%) cases exhibited failure to address abnormal findings. Of these, 7 cases (rate of 7%) had a diagnostic discrepancy, and 5 of them were class I errors. Alternatively, the remaining 87 (91%) cases did not exhibit this failure, and 19 (20%) of these had a diagnostic discrepancy. The association between failure to address abnormal test results and major missed diagnoses was statistically significant ($P = .001$).

Of quality issues analyzed, the discrepancy rate for an issue not otherwise specified (not a physician or system issue) was identified in 6% of cases. Three of these were categorized as class I. The association between this group and major discrepancies was statistically significant ($P = .044$). System or process issues were the most common quality-type issue, present in 9 (9%) cases, and 3 of these had class I errors. This group was not statistically significant ($P = .058$). Least common were the physician-specific issues, present in only 3 (3%) cases. This group was also not significant ($P = 1.000$).

The patient quality issues identified were specifically related to patient evaluation/data acquisition in 5 (5%) cases, clinical decision making in 4 (4%) cases, performing a treatment or a procedure in 4 (4%) cases, and communication and coordination in 2 (2%) cases. No cases were identified as having issues related to documentation, policy compliance, supervision, or professionalism. Other elements including expected or unexpected mortality at the time of death, adverse events, death after a procedure, and death within 48 hours of admission did not show a statistically significant association with diagnostic discrepancy.

Table 1. Patient Demographics.

Item	No. (%), N = 96
Sex	
Male	51 (53.1)
Female	45 (46.9)
Age	
<18	0 (0)
18-30	4 (4.2)
31-40	7 (7.3)
41-50	10 (10.4)
51-60	22 (22.9)
61-70	34 (35.4)
71-80	15 (15.6)
81-90	3 (3.1)
>90	1 (1.0)

Table 2. Comparing Major Clinical Diagnoses and Autopsy Findings in Cases With Class I Discrepancies.*

Case No.	Age/Sex	Major Clinical Diagnoses	Major Autopsy Findings
A1	35/F	Septic shock, acute hemolytic anemia, thrombotic thrombocytopenic purpura	**Sickle beta plus (+) thalassemia; acute splenic sequestration crisis**
A4	63/M	Sepsis, diabetes, renal failure	Diabetes, renal failure, **pulmonary embolism (PE)**
A13	59/M	Cirrhosis, bronchitis	Cirrhosis, **ruptured broncho-aortic fistula**
A14	78/M	Heat exhaustion, shoulder pain	**Bacterial endocarditis**
A15	60/F	Mediastinal mass suspicious for malignancy, sudden cardiac death	**Ruptured thoracic aorta**
A41	18/F	Evan syndrome, acute kidney injury, pneumonia	Evan syndrome, **nonbacterial thrombotic endocarditis**
A42	48/F	Sepsis, necrotic uterine leiomyomata	**Pyelonephritis**
A49	53/M	PE, immobility secondary to severe depression and obsessive compulsive disorder	PE, **Parkinson disease**
A90	42/M	Influenza pneumonia complicated by intra-alveolar hemorrhage and PE	Influenza pneumonia complicated by intra-alveolar hemorrhage, PE, and **necrotizing acute pancreatitis**
A91	69/M	Sepsis, methicillin-resistant *Staphylococcus aureus* bacteremia, pneumonia	Pneumonia, **invasive candidiasis**
A69	62/F	Intracranial hemorrhage	Intracranial hemorrhage, **PE**
A75	70/F	Sepsis, right heart failure, biventricular thrombi	**Idiopathic pulmonary fibrosis** complicated by pulmonary hypertension, heart failure, and thromboembolic disease
A82	56/M	Ulcerative colitis status post proctocolectomy, gastrointestinal hemorrhage	**Small bowel obstruction complicated by perforation and hemorrhage**
A83	70/M	Altered mental status, congestive heart failure	**PE, pneumonia**, congestive heart failure
A101	58/F	Congestive heart failure, cardioembolic stroke	**Cardiac sarcoidosis**, cardioembolic stroke

Abbreviations: F, female; M, male.
*Unsuspected findings in bold.

Table 3. Relationship Between Mortality Categories and Incidence of Major Diagnostic Discrepancies.

	Cases With Major Discrepancies, No. (%), N = 26	Cases With No Major Discrepancies, No. (%), N = 70	P Value
Was this an unexpected mortality?			.001
Yes	18 (69%)	21 (30%)	
No	8 (31%)	49 (70%)	
Was mortality not expected at admission but expected at the time of death?			.618
Yes	13 (50%)	31 (44%)	
No	13 (50%)	39 (56%)	
Was death associated with an adverse event?			1.000
Yes	1 (4%)	4 (6%)	
No	25 (96%)	66 (94%)	
Was the diagnostic workup adequate?			.005
Yes	20 (77%)	68 (97%)	
No	6 (23%)	2 (3%)	
Were abnormal findings and test results addressed?			.001
Yes	19 (73%)	68 (97%)	
No	7 (27%)	2 (3%)	
Was death within 48 hours of a procedure?			.206
Yes	4 (15%)	4 (6%)	
No	22 (85%)	66 (94%)	
Was death associated with a diagnostic failure?			.000
Yes	10 (38%)	0 (0%)	
No	16 (62%)	70 (100%)	
Was death within 48 hours of admission?			.319
Yes	11 (42%)	22 (31%)	
No	15 (58%)	48 (69%)	
Were quality issues identified?			.044
Yes	4 (15%)	2 (3%)	
No	22 (85%)	68 (97%)	
Was a physician issue identified?			1.000
Yes	1 (4%)	2 (3%)	
No	25 (96%)	68 (97%)	
Was a system or process issue identified?			.058
Yes	5 (19%)	4 (6%)	
No	21 (81%)	66 (94%)	

Discussion

The decline in hospital autopsy numbers has been driven in part by the widely held belief among surveyed clinicians that advances in diagnostic and imaging modalities have rendered the autopsy obsolete.[4] Despite this popular notion, most studies on this topic have found no significant change over time in the frequency with which the autopsy reveals important, unsuspected findings.[4,7,12-15] A single notable exception is a meta-analysis study which found a decline in the rate of major errors detected at autopsy in recent decades.[2] However, the study concluded that although the rate was declining, it remained sufficiently high (8%-24% for major errors) to warrant continued use of the autopsy as a quality management tool.

Our pilot study demonstrates how an autopsy mortality review form may be used to correlate diagnostic discrepancies found at autopsy with important patient outcome and quality indicators. In our study, diagnostic discrepancies found at autopsy were found to be significantly associated with unexpected deaths, adequacy of diagnostic workup, whether abnormal laboratory values were addressed, and with quality issues.

Such information provides a basis for improving processes and patient outcomes. For example, pulmonary embolism and infections were the most common causes of class I errors in our study. Both are common complications in hospitalized patients that can often be prevented with vigilant precautions. Analysis of protocols and processes that are in place with an emphasis on early diagnosis and prophylaxis would be expected to improve outcomes. In a similar fashion, protocols and processes that might assure the adequacy of the diagnostic workup and follow-up on abnormal lab values would also be expected to decrease significant discrepancies. Interventions such as improved and standardized laboratory testing protocols, reflex testing, and automated prompts could be attempted. When such interventions are attempted, it would be important to continue to perform the standardized autopsy mortality review, in order to assess whether discrepancy rates were improving.

The most common class II findings in our study were perforated bowel, myocardial infarct, and malignancy. Knowing and analyzing this information in a standardized fashion allows identification of diagnoses that clinical examination, routine imaging, and standard laboratory protocols have not identified. A focused analysis could identify opportunities for premortem diagnosis or treatment and better outcomes.

Limitations of our study include small sample size, low autopsy rate, and the convenience sampling method. It has been suggested that selection bias may falsely elevate the discrepancy rate in autopsy studies, because clinicians are more likely to request an autopsy for difficult cases. This may be especially true for institutions such as ours with a low autopsy rate[9] (hospital autopsy rate at Vidant Medical Center was 6% in 2017). Interestingly though, studies have shown that clinicians are generally not able to predict which cases will reveal a missed diagnosis, therefore weakening this argument.[16]

In summary, use of a standardized autopsy mortality review form provides a means to correlate discrepancy rates with unexpected mortality, adequacy of laboratory testing, adequacy of abnormal test follow-up, and quality indicators. Such correlation could also be used to identify areas within the practice or diagnostic categories where there were increased numbers of discrepancies and to focus interventions in those areas, assuring that the autopsy regains its importance as an essential quality management tool.

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Declaration of Conflicting Interests

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