From the Emergency Department to Vital Statistics: Cause of Death Uncertain

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Abstract

Vital statistics are widely used to evaluate trends in health and illness, inform policy, and allocate resources among health priorities. Literature comparing autopsies to clinical death certification has shown that the clinical ''cause of death'' certification is inaccurate or incomplete in many cases. Short of increasing autopsies, however, these studies have proposed few improvements. Using the case of death certification in the emergency department (ED), the authors analyzed the current approach to death certification. The authors propose the following to improve the quality of data: 1) acceptance of the declaration ''manner of death, natural; cause of death, uncertain''; 2) training for physicians in the selection of appropriate underlying causes of death and ''chains of causation''; and 3) participation of physicians with ongoing relationships to the patient in the certification process.

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When a person dies, we want to know why. Families and friends want both a practical and an existential answer. Physicians look for the mechanical or physiologic reason that circulation or neurologic function ceased. Statisticians look for patterns in populations, and public health officials and politicians propose programs or policies to prevent the next death.

After a 9-1-1 call, an ambulance brings the patient to the nearest hospital, where the resuscitation efforts are continued if promising and stopped if not. When an emergency physician (EP) declares a patient's death, he or she often then has to determine the cause. On the surface, this is a straightforward task, but the level of clinical detail necessary for accurate certification may or may not actually be available in emergency settings, especially for patients resuscitated in the field. One such patient illustrates the problem:

> A frail lady, 83 years old, came in on the overnight shift in the emergency department (ED). She had a history of diabetes; renal failure requiring dialysis; heart disease; peripheral vascular disease; and 2 days of nausea, vomiting, and diarrhea. Her daughters were initially most concerned about the gastrointestinal symptoms, but became much more alarmed on the way to the hospital when their mother seemed unable to talk. Her vital signs were stable. Her EP diagnosed a stroke and realized that she was in the time window for thrombolytics. She went to CT scan to rule out intracranial hemorrhage before thrombolytic therapy, but she coded in the scanner. After an hour of unsuccessful resuscitation efforts, the clinicians stopped the resuscitation, expressed their sympathy to her family, and left them to absorb the news.
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> The coroner's office was called, but declined her case for autopsy, since the death of an 83-year-old with known multisystem vascular disease was hardly considered mysterious. Although the family was shocked by her sudden death, they also declined an autopsy. The clinicians were then left to declare the immediate and underlying causes of death, with no prior knowledge of the patient, minimal knowledge of the patient's course of illness, and no postmortem examination.

Most of the components of the death certificate are straightforward, including the date and time of death,

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the facility where the death occurred, and whether an autopsy was performed (see Data Supplement S1, available online at http://www.blackwell-synergy.com/doi/suppl/10.1111/j.1553-2712.2008.00193.x/suppl_file/acem_193_sm_DataSupplementS1.pdf).[1] The problem that challenges EPs, and undermines those who would use vital statistics for surveillance purposes, is the cause of death. Based on international statistical standards, the death certification process requires the immediate cause of death and the "chain of events . . . that directly caused the death"[2] (see Data Supplement S2, available online at http://www.blackwell-synergy.com/doi/suppl/10.1111/j.1553-2712.2008.00193.x/suppl_file/acem_193_sm_DataSupplementS2.pdf). The examples provided on the standard death certificate suggest some prior knowledge of the patient, knowledge of the patient's course of illness, and postmortem anatomic knowledge, all of which are unknown to emergency providers when they complete death certificates.

In this article, we aim to discuss the epidemiologic and policy-related relevance of death certification, to review literature surrounding sudden death, and to discuss the death certification process from the perspective of the EP. We provide recommendations for revisions to the existing process in the United States.

THE USES OF DEATH CERTIFICATION

Accurate vital statistics are critical to understanding the causes of disease and death and the social, environmental, and physical conditions that place people at risk.[3] When death registration systems were first organized, problems quickly appeared in deciding how to attribute and classify causes of death.[4–6] A system created by Jacques Bertillon, chief statistician for the City of Paris, became the basis for the International Classification of Diseases, which has governed international mortality statistics since the early 20th century.[7–10]

In the first part of the 20th century, a particular effort was made to persuade physicians to stop using the traditional categories of "sudden death" and "old age," as well as clinical terms such as "meningitis," "paralysis," "convulsions," "pneumonia," and "peritonitis," that specified a disease process or outcome without qualifying its cause.[11–13]

In the past few decades, statisticians have focused on refining categories and in limiting the use of more generic categories like "cardiac arrest" that may be the final common pathways for a large variety of pathological processes. The 10th revision of the International Classification of Diseases (ICD-10) emphasized gathering more data about the circumstances of deaths, with the goal of classifying all deaths by underlying rather than immediate causes.[14] For example, the criteria for specifying pneumonia and respiratory failure as causes of death were narrowed to place some of those patients in the tallies for cancer, dementia, or other disorders in which their lungs are innocent bystanders.[15]

But epidemiologists, clinicians, and even historians have pointed out that the very goal of selecting one cause of death when multiple factors have contributed is part of the reason for disagreements and controversy.[5,16–18] The inclusiveness of the ICD-10 can introduce ambiguity in certification because it includes both proximate and distant causes of death and both clinical and pathological categories. For instance, a study designed to explore agreement between clinicians on a cause of death statement foundered in its very design, since it asked clinicians to distinguish between atherosclerosis, ischemic heart disease, and myocardial infarction as causes of death.[19] While this task may appear to make sense to a pathologist or a statistician, a clinician would see a patient with ischemic heart disease secondary to his or her atherosclerosis who presents to the ED with a myocardial infarction, a distinction without a difference. Other issues in certification, such as whether a particular patient's myocardial infarction was due to physical stress induced by a heat wave, may not be discernible at the time of death without detailed information about the environment in which the patient became ill and ultimately may be best answered not by individual death certifications but instead by epidemiologic determinations that a particular community had "excess deaths" in a given week.[20] Finally, the statistical requirements of certification may also conflict with clinical obligations, such as confidentiality of HIV status.[21]

Despite their shortcomings, death certificates have substantial real-world implications. Death certificate data are used to design public health programs, determine health care spending priorities, and predict future needs. When diabetes is not mentioned as an underlying cause of death on the death certificate of a patient who died of related heart or kidney disease, but only on those with diabetic ketoacidosis, the true risks and costs of diabetes to individuals and the population may be underestimated.[22] Similarly, it becomes difficult to understand the impact of chronic obstructive pulmonary disease (COPD) on mortality if the deaths of patients with the disease who present in respiratory distress are attributed to influenza without mention of COPD.[23] Rates of death from trauma were cited in the hearings and committee reports for the Trauma Care Systems Planning and Development Act of 2007, which provided grants to states to improve trauma centers and systems.[24] Mortality data from death certificates were also used in 2007 to support legislation to provide funding for stroke treatment and prevention systems[25] and treatment of traumatic brain injury.[26]

DEATH CERTIFICATION AND EPs

The emergency setting presents unique problems in certification of deaths. Some patients are already dead when they reach the ED and others actively dying. In the moment, precise diagnosis is much less important than emergent stabilization. Once death occurs, EPs are often in a difficult position when specifying the cause of death, and in many jurisdictions they may be pronouncing death in patients who present after out-of-hospital arrest. The shift from saving an individual's life to participating in the accurate recording of evasive details in the hope of contributing to the greater good can be a difficult transition. The practical matters associated with processing a death are also of importance. The body cannot be released to a funeral director to be buried without a death certificate. In each individual death, the

value of accuracy compared to a family moving on with their mourning process becomes questionable, but the aggregation of those deaths into statistics that guide policy then becomes problematic.

The *manner* of death—natural, accidental, homicide, or suicide—is a legal question with distinctions that go back centuries in British Common Law.[27–29] Patients who die in uncertain or unexpected circumstances are generally dealt with through medicolegal mechanisms requiring investigation and autopsy.[30,31] In elder patients with known diagnoses that could plausibly explain their deaths, the situation is murkier. Some jurisdictions will require autopsies in most or all sudden or unexpected deaths and all deaths occurring outside of hospitals, and other jurisdictions will leave greater discretion to certifying physicians. If a legal autopsy is not required, families may decline clinical autopsy for any of a number of reasons, even though it may be the only chance of learning the true cause of death.[32,33] In these cases, the attending physician is left with the uncomfortable choice between declaring a plausible cause (typically cardiac) and telling a traumatized family that their loved one will need to go for autopsy because he or she cannot be certain precisely why the patient died. However, what level of certainty or uncertainty is necessary to certify a death? If the choice is between two or three natural causes, the question has less legal or clinical significance and more statistical significance. It is one thing to put the family through a death investigation to determine whether a death was due to accidental or intentional trauma or poisoning and quite another to do so for purely epidemiologic reasons.

In 1990, EP Peter Cummings argued that physicians should accept the use of "'sudden death, cause uncertain,' as an honest act on the death certificate," both to generate further research into the phenomenon of sudden death and to make mortality statistics more accurate.[34] Cummings reiterated the possibility, supported by autopsy studies, that requiring an arbitrary cause certification overestimates cardiac deaths at the expense of stroke, pulmonary embolism, and other important but less clinically obvious causes of death.[35–41] A qualitative study of death certification by New Zealand General Practitioners came to the same conclusion—that a category of death that was "natural death of uncertain cause" would acknowledge uncertainty without leaving the family unsettled or the physician making a potentially inaccurate and arbitrary choice.[42] We need to find better ways of resolving this clinical uncertainty to improve clinical care, as autopsies have long done, making clinicians more comfortable with raising questions rather than coming to premature closure and reassuring families so that further investigation does not immediately raise concerns about the quality of care or unnecessarily delay the funeral preparations by the grieving family.

SUDDEN DEATHS AND EDs

What causes sudden or unexpected deaths in emergency settings? To explore which diagnoses may be over- or underestimated in death certificates, and look for systematic ways in which certain diagnoses may be missed or overestimated, we reviewed the literature on mortality in emergency settings. Multiple series of deaths in the ED from the United States, Europe, Australia, and Africa have been reported in the past 20 years. Series were identified by PubMed searches conducted in September 2007 and review of titles and abstracts for "emergency department death" (3,793 titles and abstracts); "cause of death unknown" (1,098 titles and abstracts); and other combinations of "sudden death," "emergency department," "cause of death," and "death certification," which captured only a few additional articles. All titles and abstracts were reviewed by one of the authors. Articles were included if they reported a series or cohort of deaths in emergency care settings using primary data or registries. Some studies reported on clinical determination of deaths, some reported on autopsy series, and some were validation studies comparing clinical to autopsy findings. Articles were excluded if they reported single cases, if the reported deaths were in out-of-hospital care (ambulance services), or after admission to or discharge from the hospital or were ED intervention studies designed to prevent deaths from a single condition.

In all series referenced in Table 1, cardiovascular disease and trauma were the most common causes of death in all age groups, with trauma deaths more common among younger patients and deaths due to chronic diseases more common among older patients.[34–41,43–45] The identified studies were heterogeneous in sampling strategy. In particular, some reported all deaths in the ED of one or more hospitals during a specified period, some reported only unexplained or unexpected deaths, and some reported only those that went to autopsy.

A series of deaths in emergency settings in southern Nigeria found similarly that trauma and cardiovascular disease were the leading causes of death, although they had a younger median age at death (33 years) than most of the first-world series.[46]

Across the case series in Table 1, traumatic and cardiac deaths were most readily and accurately classified, and stroke, pulmonary embolism, and a number of other internal diseases were most difficult to assess in an emergency setting and more likely to lead to discrepancies between clinical and autopsy findings. Stroke was particularly difficult; even on retrospective review, one series found only 46% agreement between two neurologists reviewing 200 consecutive deaths attributed to ischemic stroke or transient ischemic attack.[47]

POLICY SOLUTIONS

Given the policy importance placed on "cause of death" statistics, including use to direct local, state, and national disease prevention and treatment budgets, increasing the accuracy of death certification would be useful. Routine autopsy for older patients with multiple chronic illnesses that could reasonably cause death seems like an unwise use of resources when hospitals and public health agencies have more pressing demands. We offer the following suggestions for

Table 1
Causes of Sudden Death in Emergency Settings

Authors	Sample	Clinical Diagnoses (Percentages are of All Clinical Diagnoses)			Autopsy Findings (Percentages Autopsy Findings out of the Total Sample Unless Otherwise Specified)
		Clinical Diagnosis of Trauma	Clinical Diagnosis of Heart Disease	Other Clinical Diagnoses	
Cummings[34]	601 consecutive ED deaths	23%	29%	SIDS 2% Cancer 4.2% COPD 2.2% Drug overdose 2.0% Ruptured or dissecting aorta 1.7% Pulmonary embolus 1.5% Intracranial hemorrhage or stroke 1.5% Unknown 26%	No autopsies
Webb et al.[43]	186 trauma patients with complete clinical records	100%	0%	0%	Gunshot wounds 59% Motor vehicle collisions 11% Stab wounds 7% Pedestrian injuries 7% Falls 5% Motorcycle injuries 2% Other injuries 7%
Beckett et al.[44]	63 patients dying in 3 EDs	12.7%	55.6%	Chest infection 11.1% Carcinoma 3.2% Stroke 4.8% Aortic aneurysm 3.2% Pulmonary embolus 1.6%	No autopsies
Roller et al.[45]	57 patients with ''unexpected death'' in the ED (arrival with CPR in progress or DNAR orders excluded)	18%	40%	Carcinoma 12% Pulmonary etiologies 7% Aortic aneurysm 5% GI hemorrhage 4% Miscellaneous 14%	No autopsies
Kendall et al.[36]	325 deaths declared in the ED	13.5%	29.8%	Aortic dissection/rupture 2.5% Pneumonia 1.8% Asthma 0.62% Pulmonary embolus 0.92%	In 7/45 cases of ''medical arrest'' the working diagnosis was not confirmed at autopsy Five cases recorded as coronary disease were pneumonia (2 cases), ruptured AAA, and PE (2 cases) ''Of the 11 adult patients who suffered non-cardiac and non-traumatic causes of death only four were correctly diagnosed pre-mortem''

Table 1
Continued

Authors	Sample	Clinical Diagnoses (Percentages are of All Clinical Diagnoses)			Autopsy Findings (Percentages Autopsy Findings out of the Total Sample Unless Otherwise Specified)
		Clinical Diagnosis of Trauma	Clinical Diagnosis of Heart Disease	Other Clinical Diagnoses	
O'Sullivan[39]	1,000 consecutive autopsies on cases of sudden unexpected death	Clinical diagnoses not available	Clinical diagnoses not available	Clinical diagnoses not available	Major unsuspected findings at autopsy: MI 6% (40 of these 60 cases were myocardial rupture with tamponade) Intact aortic aneurysm 5.2% Ruptured aortic aneurysm 4% Bronchopneumonia 4.6% PE 4.2% Bronchial carcinoma 1.7% Malignant GI tumors 2% Active duodenal ulceration 1.3% Renal cell carcinoma 1% Recent CNS infarction or hemorrhage 1.7% Subarachnoid hemorrhage 08.%
Vanbrabant et al.[40]	196 deaths in a tertiary hospital ED	15.3%	19.4%	Cerebral (nontraumatic) 16.8% Unknown 13.3%	Of 29 cases with unknown clinical diagnosis who underwent autopsy: Cardiac, ischemic 41.4% Nontraumatic bleeding (AAA and esophageal cancer) 10.3% Sepsis 10.3% PE 10.3% SIDS 13.7% And one case each of myocarditis, massive liver necrosis, diffuse alveolar damage, and unknown
O'Connor et al.[38]	59 deaths in ED who went to autopsy	13.5%	37%	PE 7%	7% of cases had a condition found at autopsy which was previously undiagnosed and might have changed treatment: PE, MI, aortic dissection, ruptured diaphragm
Jayawardena et al.[35]	189 cases of death within 48 hours of admission via ED in which a complete autopsy and toxicology studies were performed	33.3%	27.5%	Intoxication with alcohol and/or drugs 13.8% Pulmonary thromboembolism 7.9% Pneumonia and asthma 7.4% Other 9% (including burns, GI hemorrhage and perforation, intestinal obstruction, incarcerated hernia, malignancy, sickle cell crisis, hypothermia, and sepsis)	Postmortem findings coincided with the antemortem diagnosis in 75.1% of cases
Mushtaq and Ritchie[37]	63 deaths reported to the procurator fiscal (Scottish coroner)	0%	74.6%	Respiratory failure 3.7% COPD 1.2% Asthma 1.2% Airway obstruction 1.2% Ruptured AAA 2.5% GI hemorrhage 1.2% Carcinoma 6.2% Intracranial hemorrhage 3.7% Septicemia 2.5% Old age 1.2%	39.7% were inaccurately predicted when compared to later autopsy. Agreement between autopsy and clinical diagnosis was 80% for cardiovascular disease and drug intoxication, but less than 50% agreement for intracranial events, pulmonary thromboembolism, airway obstruction, and carcinoma

Table 1
Continued

Authors	Sample	Clinical Diagnoses (Percentages are of All Clinical Diagnoses): Clinical Diagnosis of Trauma	Clinical Diagnosis of Heart Disease	Other Clinical Diagnoses	Autopsy Findings (Percentages Autopsy Findings out of the Total Sample Unless Otherwise Specified)
Virkkunen et al.[41]	91 deaths after resuscitation which initially showed pulseless electrical activity	0%	52.7%	Aortic dissection or rupture 19.8% PE 16.5% Intracranial hemorrhage 3.3% Other 7.7%	There were more diagnoses of AMI and less PEs, aortic dissections and ruptures among cases without autopsy compared with those including autopsy 15/91 patients died of PE, all determined by autopsy 18/91 patients died of aortic dissection or rupture, 17 diagnosed by autopsy and 1 clinically 30/91 died of AMI, 11 diagnosed at autopsy and 19 clinically

AAA = abdominal aortic aneurism; AMI = acute myocardial infarction; CNS = central nervous system; COPD = chronic obstructive pulmonary disease; CPR = cardiopulmonary resuscitation; DNR = do not resuscitate; ED = emergency department; GI = gastrointestinal; MI = myocardial infarction; PE = pulmonary embolism; SIDS = sudden infant death syndrome.

change in the process of death certification, with the expectation that they would streamline the process and improve the data quality:

1. Acceptance of a declaration: manner of death, natural; cause of death, uncertain. These cases could then undergo further review, either for the purpose of obtaining more information to demonstrate a more specific cause or as a class of deaths worthy of study to improve our understanding of population health.[34,42]

Acceptance of this category of death is of primary importance in improving death certificate quality. EPs would not tolerate a discrete list of cardiothoracic or abdominal ailments without ''chest pain NOS'' or ''abdominal pain NOS'' and yet are forced to select a cause of death on patients they may have never previously met. Analysis of deaths from the Framingham Heart Study cohort showed that death certificates overestimated cardiac deaths by 24.3% compared with detailed reviews by a physician panel that had access to the patient's longitudinal medical records.[48] Removal of the uncertainty from the denominator of all deaths may well change the distribution of causes of deaths, given the documented overestimation of cardiac death. This matter, however, is complex and would require changes in laws and legal review because of the role of death certification in separating suspicious from natural deaths. The multiple roles of death certification, as a clinical assessment of an individual patient, as a public health surveillance method, and as a medicolegal process to rule out suspicious deaths, require different kinds and standards of evidence to meet their purposes. The coroner's autopsy system is better designed to address the medicolegal aspect than it is to address the statistical demands of death certification. If accurate death certification for statistical (as opposed to clinical or legal) purposes has value to public health officials, epidemiologists, and other researchers, they need to join with EPs to design and implement systems for improvement that do not add to the burden of already overwhelmed EDs.

2. Training for physicians in the selection of appropriate underlying causes of death and ''chains of causation'' should be performed, either in medical school or early in residency, as most death certificates, at least in some jurisdictions, are completed by hospital-based interns.[49–52]

An important component of improving the utility of death certificate data is education of the physicians responsible for generating the data. Despite this, there is a paucity of data regarding educational curricula for completion of the death certificate,[47–49] and a literature review of four leading emergency medicine journals (*Academic Emergency Medicine*, *American Journal of Emergency Medicine*, *Annals of Emergency Medicine*, and *The Journal of Emergency Medicine*) demonstrate no educational trials attempting to quantify or improve knowledge regarding appropriate death certificate completion. Although formal training may be included in some residency programs, there is no explicit requirement for such, and the proportion of programs delivering effective educational programs is unknown.

3. Participation of primary care and specialist physicians with ongoing relationships to the patient. For deaths in the ED, the EP must be permitted to certify death and allow for the primary care physician or other treating physician to declare the cause of expected deaths.

Although the U.S. standard death certificate permits a physician to pronounce (certify) death without certifying the cause of death, use of this distinction is not universal. In addition, hospital policies restricting

transport of the patient out of the ED until the death certificate is completed may undermine the intent of this allowance. The degree to which this occurs is unknown.

CONCLUSIONS

While some of these suggested practices may have been adopted in individual jurisdictions, in others the dilemma we describe is all too common. Many of these suggested changes would require changes in hospital, local, state, or national policies. Changes in who completes death certificates for ED deaths would require collaboration between hospitals and their local coroners' offices, medical examiners, or other legal certifiers of death. Participation of outpatient physicians in specifying the cause of death of patients known to them requires health systems in which emergency providers can rapidly identify a patient's primary physician, as well as practical questions of willingness to participate, availability at the time of death, and modification of hospital policies requiring completion of the cause of death portion of the death certificate (as opposed to the declaration of death) before the body can be moved from the ED. The national agenda to develop a transferable and comprehensive electronic medical record would provide a great deal of insight into a patient's medical history and, notwithstanding the time pressures discussed, might allow for more accurate reporting. We believe that there is room for organized emergency medicine to participate in shaping decisions regarding the education of EPs and the public policy of the future in this arena.

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Supporting Information

The following supporting information is available in the online version of this paper:

Data Supplement S1. U.S. standard certificate of death (PDF file).

Data Supplement S2. Cause-of-death—background, examples, and common problems (PDF file).

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