The Certification of Fatalities Related to Diabetes Mellitus: A Shot in the Dark?

James R. Gill

ABSTRACT

Worldwide, an estimated 415 million people have diabetes mellitus, which results in extensive morbidity and mortality. In order to track the effect of diabetes on mortality statistics, deaths in which diabetes mellitus caused or contributed to death must be recognized, included on the death certificate, and then properly coded for vital statistic purposes. For public health policy, this will help determine the extent of the disease and follow whether deaths increase or decrease. There is variation among death certifiers for when and how diabetes is included on the death certificate and among vital records bureaus as how to code diabetes-related deaths. Case scenarios are presented to highlight the certification issues that arise with deaths related to diabetes mellitus. This area of death certification may benefit from a consensus effort to standardize and enhance certification and coding of deaths due to diabetes in order to improve the reliability of these mortality statistics. *Acad Forensic Pathol. 2016 6(2): 184-190*

AUTHOR

James R. Gill MD, Connecticut Office of the Chief Medical Examiner

Roles: Project conception and/or design, data acquisition, analysis and/or interpretation, manuscript creation and/or revision, approved final version for publication, accountable for all aspects of the work.

CORRESPONDENCE

James R. Gill MD, 11 Shuttle Rd, Farmington CT 06032, jgill@ocme.org

ETHICAL APPROVAL

As per Journal Policies, ethical approval was not required for this manuscript

STATEMENT OF HUMAN AND ANIMAL RIGHTS

This article does not contain any studies conducted with animals or on living human subjects

STATEMENT OF INFORMED CONSENT

No identifiable personal data were presented in this manuscsript

DISCLOSURES & DECLARATION OF CONFLICTS OF INTEREST

The author, reviewers, editors, and publication staff do not report any relevant conflicts of interest

FINANCIAL DISCLOSURE

The author has indicated that he does not have financial relationships to disclose that are relevant to this manuscript

KEYWORDS

Forensic pathology, Death certification, Cause of death, Diabetes mellitus

INFORMATION

ACADEMIC FORENSIC PATHOLOGY: THE OFFICIAL PUBLICATION OF THE NATIONAL ASSOCIATION OF MEDICAL EXAMINERS
 • (ISSN: 1925-3621) • https://doi.org/10.23907/2016.020
Submitted for consideration on 3 Apr 2016. Accepted for publication on 6 May 2016

INTRODUCTION

According to the Centers for Disease Control and Prevention, 29.1 million people or 9.3% of the U.S. population have diabetes mellitus (1). Diabetes was the seventh-leading cause of death in the United States in 2010 based upon 69 071 death certificates that listed diabetes as the underlying cause of death. However, diabetes mellitus was mentioned as a cause or contributing cause of death on 234 051 certificates. Given the public health aspects of diabetes mellitus, it is imperative that diabetes role in causing death is identified and when appropriate, included on the death certificate. Variations exist among physicians for when and how diabetes is included on the death certificate (2-11). This disparity is further compounded by vital statistic coding rules, which may result in the selection of diabetes as the underlying cause of death when cardiovascular disease is mentioned as a consequence (7) or an under-recognition of diabetes when diabetes mellitus is listed on Part II on the death certificate (10). For national mortality statistics, the coded underlying "cause of death" is based on the cause of death in Part I of the death certificate.

A rule of thumb for death certification is "one cause of death per person." This rule may be broken as death is a complex process and there are instances with two competent causes of death in which one cannot be favored over the other (e.g., atherosclerotic and hypertensive cardiovascular disease). In addition, the use of Part II allows the death certifier to list other conditions that contribute to death. How these multifactorial deaths are ultimately coded by vital statistic bureaus is determined by the registrar of vital statistics using national/international rules. Multiple-cause-of-death (MCOD) data has been suggested to complement the underlying-cause-of-death (UCOD) data as it captures other contributing disease (12). The use of MCOD detects more diabetic-related deaths than the UCOD and may better reflect the extent of diabetes death burden (10).

Diabetes may be classified in three main types: type 1 is due to a failure of the pancreas to produce enough insulin (previously called insulin-dependent diabetes mellitus or juvenile diabetes); type 2 is due to insulin resistance in which cells fail to respond to insulin and sometimes followed by a lack of insulin (previously called noninsulin-dependent diabetes mellitus or adult-onset diabetes); and gestational diabetes occurs in pregnant women without a previous history of diabetes who develop high blood-sugar levels. In some instances, other disease processes may damage the pancreas (e.g., chronic pancreatitis) and it may denoted by this disease process (see below).

If diabetes causes or contributes to death, one also needs to consider its etiology. Diabetes usually is a competent proximate cause of death but there are instances in which the insulin-requiring condition was caused by another disease (e.g., chronic alcoholic pancreatitis, hemochromatosis) that damaged the pancreas, or by medications (e.g., antipsychotic medications) that resulted in a hyperglycemic condition (13-15). The ultimate question is when and how to include diabetes mellitus on the death certificate. Is it best included as the proximate cause or as a contributing condition? These opinions vary among physicians and even by country depending upon the general practice and the specific medical circumstances for a particular death (2, 5, 6, 8, 9). Diabetes has been shown to be underreported on more than 50% of death certificates in New Zealand (2). These certification issues will be discussed based on case vignettes (**Table 1**) to highlight different concepts about diabetes mellitus and death certification.

CASE VIGNETTES

Case 1

A 66-year-old man with insulin-dependent diabetes for ten years died of an acute myocardial infarct due to atherosclerotic cardiovascular disease with a normal blood glucose. He had a history of hypercholesterolemia and hypertension. There was no coronary artery thrombosis and toxicology was negative.

This death can be explained solely by the atherosclerotic cardiovascular disease. So it raises the question of whether diabetes mellitus should be included on the

death certificate. Coronary artery atherosclerosis is a multifactorial process. Diabetes mellitus, smoking, high blood pressure, and hyperlipidemia are known risk factors. In the above patient, it may appear arbitrary to select diabetes mellitus (and not hyperlipidemia, for example) as the etiology of the atherosclerosis and list diabetes. Including diabetes mellitus in Part II, however, is another option. Part II is for conditions that contribute to death but do not result in the underlying cause in Part I. As such, to include diabetes in Part II may appear to break this rule because diabetes does contribute to the atherosclerosis listed in Part I. Part II of the death certificate, however, also may be used for "risk factors" (16) and so diabetes mellitus may be included. Disagreements among clinical subspecialist (e.g., endocrinologists versus cardiologists) of what should be listed as the underlying cause of death in a patient with diabetes have been reported. A survey on whether to invoke diabetes mellitus as the underlying cause of death in a patient with diabetes who died from an acute myocardial infarction found that more endocrinologists (56%) than cardiologists (41%) would invoke diabetes as the underlying cause of death (6).

Case 2

A 37-year-old man with juvenile-onset, insulin-dependent diabetes died of an acute myocardial infarction due to atherosclerotic cardiovascular disease with a normal blood glucose. He had no history of drug abuse. There was no coronary artery thrombosis and toxicology was negative.

It would be unusual for a 37-year-old to develop fatal atherosclerotic coronary artery disease absent a history of chronic cocaine abuse or familial dyslipidemia. In this instance, the use of diabetes mellitus as the proximate cause of death in Part I as opposed to Part II may better reflect the primary role of diabetes mellitus in this death. Patients with juvenile-onset diabetes mellitus have a high risk of premature coronary artery disease with the earliest heart-related deaths occurring in the late third decade of life (17).

Case 3

A 26-year-old man with long-standing, insulin-dependent diabetes was found dead at home. His vitreous humor had a glucose concentration of 980 mg/dL. Acetone was detected in his blood. His autopsy was otherwise unremarkable.

This is a classic instance of diabetic ketoacidosis. The cause of death may be certified as hyperglycemia and ketoacidosis due to diabetes mellitus or simply diabetic ketoacidosis (DKA) (18). The manner of death would be natural as the diabetes was following its natural "untreated" course.

Table 1: Case Vignettes

1.	A 66-year-old man with diabetes with a myocardial infarct due to atherosclerosis
2.	A 37-year-old man with juvenile-onset diabetes with a myocardial infarct due to atherosclerosis
3.	A 26-year-old man with long-standing, insulin-dependent diabetes dies of diabetic ketoacidosis
4.	A 26-year-old man with no history of diabetes dies of hyperglycemia and ketoacidosis
5.	A 36-year-old man with schizophrenia recently started on olanzapine dies of diabetic ketoacidosis
6.	A 46-year-old man with insulin-dependent diabetes with diabetic cardiomyopathy
7.	A 19-year-old woman dies of hypoglycemia due to an intentional insulin overdose
8.	A 47-year-old chronic alcoholic with chronic pancreatitis dies of diabetic ketoacidosis
9.	A 47-year-old woman with diabetes dies of kidney failure due to diabetic nephropathy
10.	A 47-year-old woman dies of sepsis due to a chronic foot ulcer with osteomyelitis

Case 4

A 26-year-old was found dead at home. He had no history of diabetes but his roommate had noted him drinking large volumes of soda the past few days and he had been in bed for the past two days. In his bedroom were numerous soda bottles filled with urine. His autopsy was otherwise unremarkable. His vitreous humor had a glucose concentration of 980 mg/dL. Acetone was detected in his blood. His autopsy was otherwise unremarkable.

This is a patient with new onset diabetes who died from DKA (19). The cause of death may be certified as in Case 3. One may add a modifier of "new onset diabetes mellitus" or "undiagnosed diabetes mellitus" for further clarification. Forensic pathologists are the physicians to make the initial diagnosis of diabetes mellitus in some patients when the initial presentation is death.

Case 5

A 36-year-old man with schizophrenia was recently started on olanzapine. He was found dead at home and had no history of diabetes mellitus. His vitreous humor had a glucose concentration of 980 mg/dL. Acetone and a therapeutic concentration of olanzapine were detected in his blood. His autopsy was otherwise unremarkable.

Hyperglycemia and new onset diabetes have been described with certain antipsychotic medications and some initial presentations are fatal diabetic ketoacidosis (20). As these deaths may be complications of therapy, the death certification is more complex (15). The immediate cause of death is hyperglycemia and ketoacidosis and some certifiers may use DKA as the proximate cause of death. Others may invoke the medication and underlying disease (15, 21-23) for the proximate cause. If available, a therapeutic complication manner of death may be invoked otherwise a natural manner would be appropriate as this was not an inadvertent ingestion that would favor a manner of accident (15).

Case 6

A 46-year-old man with long-standing, insulin-dependent diabetes had a history of diastolic cardiac dysfunction and congestive heart failure. A recent cardiac catheterization revealed widely patent coronary arteries. An echocardiogram revealed normal cardiac valve function, a decreased ejection fraction, and thickened left ventricle. He had no history of hypertension and had regular visits to his medical internist. His autopsy revealed moderate cardiac hypertrophy with slight myocardial fibrosis. His vitreous humor had a glucose concentration of 70 mg/dL.

These clinical and pathologic findings are diagnostic of diabetic cardiomyopathy (24). The proximate cause of death is diabetes mellitus. Diabetic cardiomyopathy describes diabetes-associated changes in the structure and function of the heart resulting in ventricular dysfunction that occurs independently of coronary artery disease and hypertension.

Case 7

A 19-year-old woman was found dead in her bedroom with a suicide note. There are three empty 10 mL vials of human insulin (100 u/mL) that were prescribed to her father, who had diabetes mellitus. She did not have diabetes or other medical problems. Her autopsy revealed superficial cuts on her wrist that did injure major vessels. Her remaining autopsy and toxicology analysis were negative. Her vitreous glucose was 20 mg/dL.

The cause of her death is hypoglycemia due to insulin intoxication and the manner of death is suicide (25). The "how injury occurred" line on the death certificate may state: "nondiabetic who intentionally self-injected another person's insulin." Homicide is in the differential diagnosis but unlikely (26-29). In rare instances, children with diabetes who die from medical neglect may result in criminal charges for the caregivers (30).

The diagnosis of hypoglycemia cannot be made on the postmortem vitreous glucose as it naturally decreases with increasing postmortem interval (31). A normal or

elevated postmortem glucose may exclude hypoglycemia or help diagnose diabetic ketoacidosis.

Case 8

A 47-year-old chronic alcoholic with a history of numerous bouts of pancreatitis was found dead at home. His vitreous humor had a glucose concentration of 980 mg/dL. Acetone but no ethanol was detected in his blood. His autopsy demonstrated a steatotic liver and a fibrosed pancreas with calcifications and a large pseudocyst.

These finding are consistent with DKA but in this instance it is a complication of chronic pancreatitis due to chronic alcoholism. Chronic alcoholism is the disease that initiated the lethal chain of events (14, 32-35). One may or may not include "diabetes" in the cause of death statement. For example, the cause of death may be listed as: hyperglycemia and ketoacidosis due to chronic pancreatitis due to chronic alcohol abuse. Another certification option would be: diabetic ketoacidosis due to chronic alcoholic pancreatitis, particularly if the patient was on insulin therapy for this known complication of chronic pancreatitis. Some may refer to this form of diabetes as pancreatic diabetes mellitus to distinguish it from type 1 and type 2 diabetes. This is another example in which the use of the MCOD may provide more information about the nature of the death but to certify (and code the death) as due to diabetes mellitus would result in an underestimation of deaths due to chronic alcoholism.

Case 9

A 47-year-old woman with diabetes died of kidney failure due to diabetic nephropathy. She decided not to undergo hemodialysis treatment. At autopsy, her kidneys had extensive Kimmelstiel-Wilson nodules in the glomeruli.

The kidney failure is the immediate of cause of death and the etiology is diabetes mellitus. Therefore, the underlying cause of death is diabetes mellitus. A common mistake on death certificates is to list the immediate cause without the proximate cause of death (e.g., "end stage kidney disease" or "end stage liver disease" without an etiologically specific cause) (36). The manner of death is natural.

Case 10

A 47-year-old woman with diabetes died of sepsis due to a chronic foot ulcer with osteomyelitis. Recent lower extremity angiograms revealed no atherosclerotic stenosis.

The immediate cause of death is the sepsis and osteomyelitis due to the infected foot ulcer, which is a well-described complication of diabetes mellitus. Diabetes mellitus is the proximate cause of death.

DISCUSSION

Diabetes may cause or contribute to death by a variety of pathways, including acute and chronic mechanisms. These include disruptions of glucose metabolism, causing or exacerbating renal and cardiovascular disease, increasing the risk of infection, and by secondary trauma from neurologic compromise. In 2011, approximately 282 000 emergency room visits for adult patients with diabetes had hypoglycemia as the first-listed diagnosis and there were approximately 175 000 emergency room visits for people of all ages with a hyperglycemic crisis. In 2010, among adults aged 20 years or older, a hyperglycemic crisis caused 2361 deaths (1) and some of these, as medical examiners/coroners can attest, occurred as the initial presentation of the disease (19). From 2009–2012, among adult patients with diabetes, 71% had blood pressures greater than or equal to 140/90 mmHg or used prescription medications to lower high blood pressure (1).

Some clinicians may default to cardiovascular disease for the cause of death and either disregard an important diagnosis or include it as a contributing condition (37). For national mortality statistics, the coded "cause of death" is based upon the cause of death in Part I of the death certificate. This singular view potentially misses disease processes that contribute to the death and would warrant public health scrutiny. Tardon et al. showed that more than 80% of the certificates studied contained more

than one cause of death and stressed the importance of including MCOD coding and not just UCOD data (12).

A study by Adair and Rao examined cause of death data in Australia and the United States to examine trends in the ratio of diabetes reported in Part I (underlying cause) and Part II (associated cause) of the death certificate in deaths due to cardiovascular disease (4). They reported that the underlying cause of death statistics masked the magnitude of diabetes-related mortality. From 1999 to 2006, there was an increase in the ratio of diabetes deaths in Part I vs. Part II in cardiovascular deaths. They noted that in Australia, diabetes reported in Part I would be 12% lower in 2006 if the ratio from 1999 were applied. They concluded that this increased likelihood of physicians reporting diabetes in Part I reflected the subjectivity of diabetes death certification and that specific guidelines on death certification of diabetes relating to its reporting as an underlying or associated cause are needed.

A study by Lu et al. conducted a survey of endocrinologists, cardiologists, and nephrologists regarding the underlying cause of death for seven hypothetical case scenarios in diabetic patients. They found variations by specialty and only one case (a diabetic patient who died from hyperglycemic hyperosmolar nonketotic coma) had a nearly 100% agreement that diabetes mellitus was the underlying cause of death (6).

CONCLUSION

This area of death certification may benefit from a consensus effort, similar to the National Association of Medical Examiners' and American Medical College of Toxicology's position paper on opioid certification (38). As clinicians may have professional biases and not as much death certification experience as forensic pathologists, a survey of forensic pathologist's certification practices may be interesting. It appears that the variation in certification occurs when considering the chronic effects of diabetes mellitus when there is confounding atherosclerotic or hypertensive cardiovascular disease. Deaths due to acute diabetic glucose disruptions (e.g., DKA) are generally correctly certified as due to diabetes mellitus.

REFERENCES

1) CDC. National diabetes statistics report 2014. Atlanta: Centers for Disease Control and Prevention; 2014 [updated 2014; cited 2016 Mar 27]. 12 p. Available from: http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf.

2) Chen F, Florkowski CM, Dever M, Beaven DW. Death Certification and New Zealand Health Information Service (NZHIS) statistics for diabetes mellitus: an under-recognised health problem. *Diabetes Res Clin Pract*. 2004 Feb; 63(2):113-8. PMID: 14739051. http://dx.doi.org/10.1016/j.diabres.2003.09.002.

3) de Faire U, Friberg L, Lorich U, Lundman T. A validation of cause-of-death certification in 1,156 deaths. *Acta Med Scand*. 1976; 200(3): 223-8. PMID: 970229. http://dx.doi.org/10.1111/j.0954-6820.1976.tb08223.x.

4) Adair T, Rao C. Changes in certification of diabetes with cardiovascular diseases increased reported diabetes mortality in Australia and the United States. *J Clin Epidemiol*. 2010 Feb; 63(2):199-204. PMID: 19664902. http://dx.doi.org/10.1016/j.jclinepi.2009.04.002.

5) Nojilana B, Brewer L, Bradshaw D, et al. Certification of diabetes-related mortality: the need for an international guideline. *J Clin Epidemiol*. 2013 Feb; 66(2):236-7. PMID: 23159105. http://dx.doi.org/10.1016/j.jclinepi.2012.07.017.

6) Lu TH, Kwok CF, Ho LT. Whether to report diabetes as the underlying cause-of-death? a survey of internists of different sub-specialties. *BMC Endocr Disord*. 2010 Jul 23; 10:13. PMID: 20653939. PMCID: PMC2912904. http://dx.doi.org/10.1186/1472-6823-10-13.

7) Lin YP, Lu TH. Trends in death rate from diabetes according to multiple-cause-of-death differed from that according to underlying-cause-of-death in Taiwan but not in the United States, 1987-2007. *J Clin Epidemiol*. 2012 May; 65(5):572-6. PMID: 2226933. http://dx.doi.org/10.1016/j.jclinepi.2011.09.010.

8) Balkau B, Jougla E, Papoz L. European study of the certification and coding of causes of death of six clinical case histories of diabetic patients. EURODIAB Subarea C Study Group. *Int J Epidemiol*. 1993 Feb; 22(1):116-26. PMID: 8449631. http://dx.doi.org/10.1093/ije/22.1.116.

9) Lu TH, Shih TP, Lee MC, et al. Diversity in death certification: a case vignette approach. *J Clin Epidemiol*. 2001 Nov; 54(11):1086-93. PMID: 11675159. http://dx.doi.org/10.1016/s0895-4356(01)00383-3.

10) Wier LM, Gjelsvik A. Diabetes mortality in Rhode Island: comparing underlying cause of death versus any listed cause of death. *Med Health R I*. 2008 Mar; 91(3):86-7. PMID: 18438099.

11) Andresen EM, Lee JA, Pecoraro RE, et al. Underreporting of diabetes on death certificates, King County, Washington. *Am J Public Health*. 1993 Jul; 83(7):1021-4. PMID: 8328597. PMCID: PMC1694790. http://dx.doi.org/10.2105/ajph.83.7.1021.

12) Tardon AG, Zaplana J, Hernandez R, Cueto A. Usefulness of the codification of multiple causes of death in mortality statistics. *Int J Epidemiol*. 1995 Dec; 24(6):1132-7. PMID: 8824854. http://dx.doi.org/10.1093/ije/24.6.1132.

13) Creighton Mitchell T, McClain DA. Diabetes and hemochromatosis. *Curr Diab Rep*. 2014;14(5):488. PMID: 24682660.

14) Gill JR. Pancreatitis and the forensic pathologist. *Acad Forensic Pathol*. 2016 Jun; 6(2):237-48.

15) Ely SF, Neitzel AR, Gill JR. Fatal diabetic ketoacidosis and antipsychotic medication. *J Forensic Sci*. 2013 Mar; 58(2):398-403. PMID: 23278567. http://dx.doi.org/10.1111/1556-4029.12044.

16) Hanzlick R, editor. The medical cause of death manual. Northfield (IL): College of American Pathologists; 1994. 109 p.

17) Krolewski AS, Kosinski EJ, Warram JH, et al. Magnitude and determinants of coronary artery disease in juvenile-onset, insulin-dependent diabetes mellitus. *Am J Cardiol*. 1987 Apr 1; 59(8):750-5. PMID: 3825934. http://dx.doi.org/10.1016/0002-9149(87)91086-1.

18) Umpierrez GE, Kitabchi AE. Diabetic ketoacidosis: risk factors and management strategies. *Treat Endocrinol*. 2003; 2(2):95-108. PMID: 15871546. http://dx.doi.org/10.2165/00024677-200302020-00003.

19) DiMaio VJ, Sturner WQ, Coe JI. Sudden and unexpected deaths after the acute onset of diabetes mellitus. *J Forensic Sci*. 1977 Jan; 22(1):147-51. PMID: 263933. http://dx.doi.org/10.1520/jfs10379j.

20) Liebzeit KA, Markowitz JS, Caley CF. New onset diabetes and atypical antipsychotics. *Eur Neuropsychopharmacol*. 2001 Feb; 11(1): 25-32. PMID: 11226809. http://dx.doi.org/10.1016/s0924-977x(00)00127-9.

21) Koller EA, Doraiswamy PM. Olanzapine-associated diabetes mellitus. *Pharmacotherapy*. 2002 Jul; 22(7):841-52. PMID: 12126218. http://dx.doi.org/10.1592/phco.22.11.841.33629.

22) Meyer JM, Leckband SG, Loh C, Moutier CY. Quetiapine-induced diabetes with metabolic acidosis. *Int Clin Psychopharmacol*. 2004 May; 19(3):169-71. PMID: 15107661. http://dx.doi.org/10.1097/00004850-200405000-00009.

23) Miller EA, Leslie DL, Rosenheck RA. Incidence of new-onset diabetes mellitus among patients receiving atypical neuroleptics in the treatment of mental illness: evidence from a privately insured population. *J Nerv Ment Dis*. 2005 Jun; 193(6):387-95. PMID: 15920379. http://dx.doi.org/10.1097/01.nmd.0000165292.11527.16.

24) McGuire AR, Gill J. Diabetic cardiomyopathy: a forensic perspective. *Acad Forensic Pathol*. 2016 Jun; 6(2):191-7.

25) Winston DC. Suicide via insulin overdose in nondiabetics: the New Mexico experience. *Am J Forensic Med Pathol*. 2000 Sep; 21(3): 237-40. PMID: 10990283. http://dx.doi.org/10.1097/00000433-200009000-00010.

26) Uezono T, Shiono H, Shimizu K, et al. Simultaneous analyses of hypoglycemic agents and C-peptide are essential in a homicide case with the combined dosing insulin and insulin-releasing drug. *Leg Med (Tokyo)*. 2002 Mar; 4(1):34-6. PMID: 12935689. http://dx.doi.org/10.1016/s1344-6223(01)00042-6.

27) Benedict B, Keyes R, Sauls FC. The insulin pump as murder weapon: a case report. *Am J Forensic Med Pathol*. 2004 Jun; 25(2):159-60. PMID: 15166770. http://dx.doi.org/10.1097/01.paf.0000127383.69760.72.

28) Hess C, Musshoff F, Madea B. Disorders of glucose metabolism-post mortem analyses in forensic cases: part I. *Int J Legal Med*. 2011 Mar; 125(2):163-70. PMID: 20878417. http://dx.doi.org/10.1007/s00414-010-0509-6.

29) Marks V. Insulin murders. *Med Leg J*. 2009; 77(Pt 2):39-47. PMID: 19731478. http://dx.doi.org/10.1258/rsmmlj.77.2.39.

30) Dyer O. Parents jailed after child dies of diabetes. *BMJ*. 1993 Nov 13; 307(6914):1232-3. PMID: 11643196. PMCID: PMC1679383.

31) Coe JI. Use of chemical determinations on vitreous humor in forensic pathology. *J Forensic Sci*. 1972 Oct; 17(4):541-6. PMID: 4680755. http://dx.doi.org/10.1520/jfs10142j.

32) Lin YK, Johnston PC, Arce K, Hatipoglu BA. Chronic pancreatitis and diabetes mellitus. *Curr Treat Options Gastroenterol*. 2015 Sep; 13(3):319-31. PMID: 26084759. http://dx.doi.org/10.1007/s11938-015-0055-x.

33) Malka D, Hammel P, Sauvanet A, et al. Risk factors for diabetes mellitus in chronic pancreatitis. *Gastroenterology*. 2000 Nov; 119(5): 1324-32. PMID: 11054391. http://dx.doi.org/10.1053/gast.2000.19286.

34) Sarles H. Chronic pancreatitis and diabetes. *Baillieres Clin Endocrinol Metab*. 1992 Oct; 6(4):745-75. PMID: 1445167. http://dx.doi.org/10.1016/s0950-351x(05)80164-8.

35) Sprague RG. Diabetes mellitus associated with chronic relapsing pancreatitis. *Proc Staff Meet Mayo Clin*. 1947 Nov 26; 22(24):553-8. PMID: 18896454.

36) Cambridge B, Cina SJ. The accuracy of death certificate completion in a suburban community. *Am J Forensic Med Pathol*. 2010 Sep; 31(3):232-5. PMID: 20512028. http://dx.doi.org/10.1097/paf.0b013e3181e5e0e2.

37) Agarwal R, Norton JM, Konty K, et al. Overreporting of deaths from coronary heart disease in New York City hospitals, 2003. *Prev Chronic Dis*. 2010 May; 7(3):A47. PMID: 20394686. PMCID: PMC2879979.

38) Davis GG, National Association of Medical Examiners and American College of Medical Toxicology Expert Panel on Evaluating and Reporting Opioid Deaths. National Association of Medical Examiners position paper: recommendations for the investigation, diagnosis, and certification of deaths related to opioid drugs. *Acad Forensic Pathol*. 2013 Mar; 3(1):77-83.