Manner of Death Certification After Significant Emotional Stress: An Inter-Rater Variability Study and Review of the Literature

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ABSTRACT

Not commonly seen, the risk of sudden death after significant emotional stress has been reported since antiquity and incorporated into folk wisdom, reflected by phrases such as “scared to death” and “broken heart.” A typical “victim” suffers from significant and often life-threatening natural diseases, making determination of the manner of death complicated, and at times controversial. The present study is designed to assess inter-rater variability and nonuniformity and controversy seen in manner of death certification in certain cases of death with significant stress involved in the circumstances of death.

Members of the National Association of Medical Examiner (NAME) were surveyed to assess differences in manner of death certification for eight sudden unexpected death scenarios in middle-aged men and women with underlying cardiac disease after significant stressful events including: being chased down a lonely road followed by a verbal confrontation, a roll-over motor vehicle collision (MVC) without injuries, a fall from a wheelchair in a MVC, an alleged armed robbery, an involuntary commitment, an arrest by police, sexual intercourse, and a severe panic attack with breathing problems. In all cases, the autopsy examination revealed hypertensive and arteriosclerotic cardiovascular disease. In all cases, natural diseases were identified as significant contributing conditions, including emphysema in six cases and diabetes mellitus in three.

Eighty-six responses were collected. The results show wide inter-rater variability, ranging from very good to poor (Kappa ranges from 0.16 to 0.94). One hundred fifty-five comments were collected. Most of the comments addressed more than one topic and were followed by discussions, open questions, and responders' experiences with previous cases and legal proceedings.

Our data show that cases of sudden death after significant stress have almost complete agreement in four cases and very high inter-rater variability in the other four. We propose that a detailed analysis of each case and an algorithmic approach could improve the predictability of the outcomes of death investigations for the legal system and for families. *Acad Forensic Pathol.* 2018 8(2): 692-707

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INFORMATION

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INTRODUCTION

It is well known that severe emotional stress is associated with dramatic neuroendocrine responses activating the sympathetic nervous system, the pituitary-adrenal axis, and the adrenal medulla. These activations result in excess secretion of cortisol and catecholamines, reportedly having cardiotoxic and arrhythmogenic effects (1, 2). The cases of acute cardiac events in susceptible individuals after events and emotional triggers are well described in the literature. A large epidemiological study of the influence of emotional/behavioral triggers on the incidence of cardiac events by reviewing published literature from 1970 to 2004 reported the incidence of an acute cardiac event within 24 hours after emotional or behavioral triggers varied from 10% to 67% (3). Myers et al. interviewed relatives regarding the circumstances surrounding the deaths of 100 men aged 70 years or less who died suddenly. They found that 23% of decedents experienced moderate or severe stress within 30 minutes before death (4). In a study involving 858 patients, Muller et al. showed that 9% of patients reported sexual activity in the 24 hours preceding myocardial infarction (MI), and 3% reported sexual activity in the two hours preceding onset of symptoms of MI (5). In a large population-based case study (Stockholm Heart Epidemiology Programme, SHEEP) of causes of myocardial infarction including all Swedish citizens 45–70 years of age living in Stockholm County with no previous myocardial infarction, researchers demonstrated that only 1.3% of the patients without premonitory symptoms had sexual activity within two hours of the onset of a myocardial infarction (6).

Establishment of causation between a stressful event such as a confrontation, a motor vehicle collision, or a robbery is the first and most important step in the certification of the manner of death. The question, “Would the person have died if the person were not injured (or chased, robbed, involved in a motor vehicle collision, assaulted, intoxicated, etc.)?” is a legal tool for the determination of causation in cases with concurrent pathologic causes and is referred to as the “but-for” test (7). Generally, an affirmative answer supports a natural death and a negative answer sup-

ports unnatural manners. Forensic cases tend to be grouped into large categories, sharing similar mechanisms of death. The majority of cases follow general rules for classifying manner of death based on over 800 years of practice, traditions, requirements of society, law enforcement investigations, and criminal justice standards (8). As there are no legal mandates, death certification is based on widely accepted definitions and assumptions of what is considered to be natural, homicidal, suicidal, or accidental deaths (9). The association between the precipitating event and death can be uncertain and complicated by underlying medical conditions or unusual circumstances. The determination of the manner of death in such cases is performed on a case-by-case basis (10). By the nature of the subject, the certification of death in such cases varies between certifiers and jurisdictions. Certification of the manner of death affects legal casework, public health programs, vital statistics, and families (11). Certification relies on the fundamental premise that the manner of death is mostly circumstance-dependent, not autopsy-dependent (10). The manner of death also relies on the association between the precipitating circumstances (e.g., injury, poisoning, hostile environment, natural disease, etc.) and death. The association ranges from uncertain to strong. If the association is uncertain (i.e., degree of certainty of less than 50%), the case may be certified as “undetermined.” Certification as “accident,” “suicide,” and “homicide” requires a higher degree of certainty (10, 12). A stricter burden of proof is required to decrease the risk of false convictions and to reduce the social costs of sanctions (12).

Certification of death after a significant stressful event is challenging and the literature on the topic is relatively sparse. In the paper “*Can sudden cardiac death be murder?*” published in 1978, J.H. Davis focused on the legal course of action in cases when “...a criminal act results in emotionally precipitated death in the absence of the physical injury or contacts” in order to develop “... medical criteria upon which such a homicide charge might be sustained” (13). The author prepared four synthesized situations in which middle-aged or elderly people with significant heart disease died shortly after burglary/robbery in the absence

of physical contact between the assailant and the victim. The cases were sent to 50 members of the Pathology-Biology Section of American Academy of Forensic Sciences (AAFS) and 39 replies were received. Responders acknowledged only five convictions of homicide in cases without physical contact during the past 15 years. Referring to contemporary studies demonstrating causal relationship between emotional stress and sudden cardiac death, J.H. Davis suggested five criteria to establish proof of causality between an emotional trigger and sudden death in cases where physical injury or contact does not occur (see **Table 1**) (13). Davis's criteria were revised in 2004 by S.A. Turner et al. in their paper "*Homicide by Heart Attack Revisited*" (14). In contrast to Davis's criteria dealing with situations where no physical injury occurs, the modified criteria are designed to be applied to situations where physical contact and/or nonlethal injury occurred (**Table 1**) (14).

The study of variability of the manner of death determination, "*Mind Your Manners II and III*", based on a "*Medical Examiner Manner of Death Questionnaire*" was performed by J. Goodin and R. Hanzlick in 1995, followed by the article "*Mind Your Manners*" by G.G. Davis, published in 1997 (9, 15). The study demonstrated that only three of 198 participants responded identically to each of 23 scenarios and the

majority of responders disagreed over most scenarios. The study results prompted "*A Guide for Manner of Death Classification*," completed in 2001 and posted on the NAME website for review and comments. The document was approved by the NAME Board of Directors in 2002 and since has been published on the NAME website (10). The document provides general principles and manner of death determination recommendations for 46 scenarios of adult death and four infant death scenarios. "*A Guide for Manner of Death Classification*" includes two scenarios similar to cases presented in this article including Scenario 28: "*Deaths resulting from fear or fright induced by verbal assault, threats of physical harm, or through acts aggression intended to instill fear or fright may be classified as homicide*" and scenario 45: "*Natural deaths occurring during the exertion of intercourse or other sexual activity such as masturbation may be classified as natural in manner*" (10).

Death certificates are a valuable source of statistical and medical information, as well as important legal documents. It was reported that disputed death certification can be a subject for litigation. The "*Medical Examiner Manner of Death Questionnaire*" revealed that 21% of certifiers experienced threats of lawsuit and 8% were sued in disputed manners on death certificates (15). Growing interest is developing within

Table 1: Criteria for Certifying Sudden Cardiac Death After Significant Emotional Stress

Criteria For Certifying Cardiac Death After Emotional Stress Where Physical Contact/Injury Did Not Occur (13)	Criteria For Certifying Cardiac Death After Emotional Stress Where Physical Contact/Non-Lethal Injury Did Occur (14)
The criminal act should be of such severity and have sufficient elements of intent to kill or maim, either in fact or statute, so as to lead logically to a charge of homicide in the event that physical injury had ensued.	The action of the perpetrator toward the victim should be of such severity and have sufficient elements of intent to frighten, injure or kill, either in fact or statute, so as to lead logically to a charge of homicide in the event that death resulted from physical injury.
The victim should have realized that the threat to personal safety was implicit. A logical corollary would be a feared threatening act against a loved one or friend.	The victim should have realized that the threat to personal safety was implicit. A logical corollary would be a feared threatening act against a loved one or friend.
The circumstances should be of such a nature as to be commonly accepted as highly emotional.	The circumstances should be of such a nature as to be commonly accepted as highly emotional.
The collapse and death must occur during the emotional response period, even if the criminal act had already ceased.	The collapse (and subsequent death, in most cases) must occur during the emotional response period, even if the criminal act had already ceased. In certain instances, death may be delayed, typically via medical intervention.
The demonstration of an organic cardiac disease process of a type commonly associated with a predisposition to lethal cardiac arrhythmia is desirable.	Autopsy should demonstrate an organic cardiac disease process of a type commonly associated with a predisposition to lethal cardiac arrhythmia. In the absence of a grossly or microscopically identifiable organic cardiac disease, the case may involve a functional cardiac disorder (such as a conduction system disorder) that has no anatomic correlation.

and outside of the forensic community in the matter of consistency in manner of death determination. The topic of manner of death certification repeatedly occurs during the meetings, professional discussions, and mailing lists. However, the certification of manner of death based on proximal causation remains difficult and at times controversial. This work intends to direct attention to challenges of certification, demonstrate the variety of approaches to manner of death certification by the contemporary forensic community, and propose a way to improve the uniformity and predictability of certification. The survey-formed questionnaire, including eight real scenarios of sudden death after significant stress, was used to assess the uniformity of certification. Six of these case scenarios are not included in the NAME Guidelines (10).

METHODS

All present cases were autopsied at the Eastern Regional Autopsy Center of the North Carolina Office of the Chief Medical Examiner by the Brody School of Medicine at University of East Carolina between 2009-2016. Complete autopsy and microscopy of major organs including brain was performed in all cases. Toxicological examinations were performed in specimens except for cases 3 (“Fall from a wheelchair during transport in a van”) and 6 (“Arrested by police, died in the patrol car”) with prolonged survival between the event and death.

The members of the NAME email list service were surveyed regarding determination of manner of death. The survey technique, a widely used method of scientific inquiry, was applied to collect professional opinions regarding manner of death certification. Using the survey technique, responses were collected from a relatively large group of professionals within a short time interval. The survey was created using the SurveyMonkey online tool (<https://www.surveymonkey.com>). The survey included a brief history (in which the decedents’ identities remained anonymous), investigative findings, and autopsy results. The responders were asked to choose between manners of death (natural, accident, suicide, homicide, and undetermined) and were given the opportunity to make comments. The link to

the survey was emailed to members of NAME participating in the NAME mailing list (NAME Listserv). Users of the mailing list include death investigators, forensic pathologists, medical examiners, coroners, retired medical examiners and forensic pathologists, and trainees. According to the NAME administration, at the time of the survey there were approximately 500 subscribers, but the number of active users is unknown. The survey was posted December 26, 2017 and the results were collected January 25, 2018.

Calculations of observer agreements, Free-Marginal Multi-rater Kappa (multi-rater κ_{free}) for nominal data, were performed according to J.J. Randolph (19, 20). The value of 0 indicates the level of agreement that could have been expected by chance. The value of Kappa of 0-0.20 is associated with no agreement and 0-4 % of reliability; 0.21-.39 is associated with minimal level of agreement and 4-15% of reliability; 0.40-0.59 is associated with weak level of agreement and 15-35% of reliability; 0.60-0.79 is associated with moderate level of agreement and 35-63% of reliability; 0.80-0.90 is associated with strong level of agreement and 64-81% of reliability; and above 0.90 is associated with almost perfect agreement and 82-100% of reliability (19).

Cases

Case 1: “Being chased along a road”

A 61-year-old female was found unresponsive in the driver’s seat of her car at an unattended rural fueling station by a patrol officer. A surveillance camera at the site recorded a verbal confrontation with a truck driver. Further investigation showed that the truck driver had followed the victim when she left a convenience store and chased her along isolated rural roads. She had a history of hypertension, congestive heart failure, and previous myocardial infarcts with angioplasty and stent placement. Autopsy revealed hypertensive and arteriosclerotic cardiovascular disease, a circumflex coronary artery stent, stenosis distal to the stent, severe myocardial fibrosis, and pulmonary emphysema. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 2: “Motor vehicle collision without injury”

A passenger in a small pick-up truck, a 48-year-old morbidly obese man, was found unresponsive in full arrest in the vehicle after a roll-over motor vehicle collision (MVC) without significant injury and with no indicators of positional asphyxia. The truck driver had no major injuries when emergency medical services arrived. Autopsy examination revealed scattered superficial abrasions on forearms, left upper back, and both shins. No bone fractures or injury of internal organs was seen. The internal examination showed severe hypertensive and arteriosclerotic cardiovascular disease with myocardial fibrosis, aortic atherosclerosis, and pulmonary emphysema. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 3: “Fall from a wheelchair during transport in a van”

A 58-year-old wheelchair-bound female fell out of her wheelchair during a sudden stop of a van in which she was being transported to her dialysis center. She was sitting in a wheelchair that was not secured. She was immediately taken to the emergency department where she refused treatment and was taken to the dialysis center. After dialysis, she returned to the emergency department because of the earlier fall and having developed a fever. She suffered cardiac arrest during X-ray evaluation. She had history of end-stage renal disease with dialysis, heart disease, deep vein thrombosis, obesity, peripheral vascular disease, bilateral lower leg amputations, multiple arteriovenous grafts, colon cancer, and a remote femur fracture. Autopsy revealed acute fracture of the 2nd – 5th left ribs, severe atherosclerotic cardiovascular disease, cerebrovascular disease, and diabetic nephropathy. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 4: “Death after an alleged robbery”

A 57-year-old man with a history of “heart issues” collapsed at the scene of an alleged armed robbery. The local medical examiner was informed that the in-

formation about the robbery could not be confirmed or denied and no one was with the decedent at the time of the collapse. Autopsy examination revealed significant hypertensive and atherosclerotic cardiovascular disease and pulmonary emphysema. No significant injuries were identified. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 5: “Involuntary commitment”

A 65-year-old man was taken to a hospital in anticipation of involuntarily commitment due to behavioral disturbances attributed to psychiatric illness. No physical restraints were used. He suffered a witnessed collapse at the hospital as the commitment papers were being served to him. He had a history of cardiac disease and cocaine abuse. Autopsy examination revealed significant atherosclerotic cardiovascular disease and pulmonary emphysema. Toxicologic examination revealed no evidence of recent cocaine use and only therapeutic concentrations of prescribed medications. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 6: “Arrested by police, died in the patrol car”

A 60-year-old man was arrested by police following a traffic stop when another (also nonviolent) violation was found. Investigation revealed no additional interaction between the man and law enforcement. He was a non-native English speaker. He suddenly collapsed while seated, unrestrained in the rear seat of the police car. Autopsy revealed severe atherosclerotic cardiovascular disease, severe peripheral vascular disease, and cerebrovascular disease with lacunar infarcts, pulmonary emphysema, and diabetes with pancreatic fibrosis. Gross and microscopic study of the brain did not reveal significant pathologic changes.

Case 7: “Death after sexual intercourse”

A 49-year-old female with hypertensive and arteriosclerotic cardiovascular disease and morbid obesity collapsed after sexual intercourse. The autopsy identified arteriosclerotic cardiovascular disease. Gross and

microscopic study of the brain did not reveal significant pathologic changes.

Case 8: “Severe panic attack with breathing problems”

A 55-year-old obese man suffering a severe panic attack with breathing problems collapsed in the ambulance. Initial vital signs: a blood pressure of 200/110 mmHg, heart rate of 148 beats per minute, and respiratory rate of 26 per minute. He had history of panic attacks, hypertension, diabetes mellitus, posttraumatic stress disorder, chronic back pain, and hyperlipidemia. Autopsy showed significant hypertensive and arteriosclerotic cardiovascular disease and pulmonary emphysema. Gross and microscopic study of the brain did not reveal significant pathologic changes.

RESULTS

The link to the survey was emailed to approximately 500 subscribers of the NAME email list service. Eighty-six members of the NAME mailing list service responded to the survey. Case 3 was skipped by one responder, thus eighty-six responders completed cases 1, 2, 4-8 and eighty-five responders completed case 3. This gave an overall response rate of approximately 17%, assuming that all NAME members actively use the email list service. The responses are shown in **Table 2**.

Cases 1-4 were associated with poor to moderate agreement between responders (**Table 3**). In case 1, natural manner of death was chosen by 37.21% of responders, accident by 1.16%, homicide by 37.12%, and undetermined by 21.42%. In case 2, natural manner of death was chosen by 34.88% of responders, accident by 59.30%, and undetermined by 5%. In case 3, natural manner of death was chosen by 25.88% of responders, accident by 61.18%, and undetermined by 12.94%. The Kappa for cases 1-4 were 0.16, 0.34, 0.31, and 0.55, respectively. Case 4 had undetermined manner of death selected by 68.60% of responders, natural by 29.07%, and homicide by 2.33%. Cases 5-8 were associated with very good inter-rater agreement (Kappa 0.94, 0.86, 0.94 and 0.91 respectively).

One hundred fifty-five comments were collected. Thirty-one responders commented on case 1, 23 on case 2, 29 on case 3, 29 on case 4, 12 on case 5, 14 on case 6, eight on case 7, and 13 on case 8. Most of comments addressed more than one topic and were followed by discussions, open questions, and responders' experiences with previous cases and legal proceedings. Several comments addressed similar problems while discussing manner of death certification. Representative citations addressing topics of discussion as well as individual points of view were identified and presented in **Tables 4** and **5**. Comments are presented in their original wording. As comments to the case 1 showed higher variety of topics than other cases, indicating complicated nature of the problem, we chose to present them in a separate table (**Table 4**). For systematic purposes, the comments were divided into four larger groups: “Homicide, pros and cons;” “Natural Death, pros and cons;” “Undetermined;” and “Evidence.” Comments to cases 2-8 are listed in **Table 5**.

DISCUSSION

Eight cases of sudden, unexpected cardiac death in middle aged men and women after a significant stressful event were presented. In all but one case, cardiac arrest occurred minutes after the precipitating event. In all cases, the autopsy examination revealed significant hypertensive and arteriosclerotic cardiovascular disease. Natural disease was considered contributory in all cases including emphysema in six cases, and obesity and diabetes mellitus in three cases each. The results of the survey showed significant inter-rater variability of manner of death certification for cases 1-4 and high agreement in cases 5-8 (**Tables 2** and **3**). Analyzing 155 comments to all cases, we identified nine major topics of discussion: vulnerability of the victim; establishment of causal relationship between stressful event and death; nature of stressor and individualized threshold; individualized perceiving of danger; time between stressful event and death; lack of evidence of physical injury while certifying unnatural death; rigidity using “undetermined” manner of death; doubt regarding adequacy of the investigational evidence; and consideration regarding other conditions (e.g., positional asphyxia, excited delirium, epilepsy,

Table 2: Manner of Death Determination By Medical Examiner In Cases of Death After Significant Emotional Stress, Assessed By Survey Completed By Members of the National Association of Medical Examiners Email List service (Listserve)

Cases	Manner of death
1 "Chased down a road"	<p>Q1</p> <p>Undetermined 25% Natural 37% Homicide 37% Accident 1%</p>
2 "Motor vehicle collision without injury"	<p>Q2</p> <p>Undetermined 6% Natural 35% Accident 59%</p>
3 "Fall from an unsecured wheelchair in a dialysis transport van"	<p>Q3</p> <p>Undetermined 13% Natural 26% Accident 61%</p>
4 "Death after an alleged robbery"	<p>Q4</p> <p>Undetermined 69% Natural 29% Homicide 2%</p>
5 "Death during involuntary commitment as papers served"	<p>Q5</p> <p>Accident 1% Undetermined 1% Natural 98%</p>
6 "Death while under arrest in a patrol car"	<p>Q6</p> <p>Undetermined 6% Natural 94%</p>
7 "Death after sexual intercourse"	<p>Q7</p> <p>Accident 2% Natural 98%</p>
8 "Death during a panic attack"	<p>Q8</p> <p>Accident 1% Undetermined 2% Natural 97%</p>

Table 3: Results of the Survey of Determination of Manner of Death By Members of the National Association of Medical Examiners. Absolute Number of Responses, Chosen Manner of Death and Percentage (in parentheses) Are Present

Cases	Natural	Accident	Suicide	Homicide	Undetermined
1 (n=86)	32 (37.21%)	1 (1.16%)	0 (0.00%)	32 (37.21%)	21 (24.42%)
2 (n=86)	30 (34.88%)	51 (59.30%)	0 (0.00%)	0 (0.00%)	5 (5.81%)
3 (n=85)	22 (25.88%)	52 (61.18%)	0 (0.00%)	0 (0.00%)	11 (12.94%)
4 (n=86)	25 (29.07%)	0 (0.00%)	0 (0.00%)	2 (2.33%)	59 (68.60%)
5 (n=86)	84 (97.67%)	1 (1.16%)	0 (0.00%)	0 (0.00%)	1 (1.16%)
6 (n=86)	81 (94.19%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	5 (5.81%)
7 (n=86)	84 (97.67%)	2 (2.33%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
8 (n=86)	83 (96.51%)	1 (1.16%)	0 (0.00%)	0 (0.00%)	2 (2.33%)

Participants were presented eight cases and asked to choose the appropriate manner of death. Eighty-six members of the National Association of Medical Examiners (NAME), participating in the NAME Listserv responded. Eighty-six members responded to cases 1,2,4-8 and eighty-five to case 3.

Table 4: Case 1 Comments (n=31)

Homicide Pros and Cons	Natural Death Pros and Cons	Undetermined	Evidence
<i>"Being chased is beyond the stress of daily living..."</i>	<i>"Even if we called it natural, by explaining what we mean, this sort of case is still prosecutable..."</i>	<i>"I don't think there is sufficient evidence to call this death a homicide. Still without knowing what happened between the assaults/chase and when she is found dead, I would be concerned about calling this a natural death"</i>	<i>"...not only a complete autopsy but toxicology, electrolytes" should be done.</i>
<i>"...intent of the other person to cause fear"</i>	<i>"Certified as natural but case summary attributes death to stress of confrontation. Cases like this can be prosecuted in (certain states)..."</i>	<i>"No linkage proven - could also go undetermined"</i>	<i>"Would like to know: duration of chase, nature of argument, the interval between her pulling into the station... and rough estimate of how long she sat at the station before found"</i>
<i>"...what the truck driver did seem to be illegal"</i>	<i>"If there is a time lag between the death and the incident, I would certify this death as natural. Since she is in the driver's seat of her stopped car, it seems like the latter is more likely."</i>	<i>"The information is insufficient. Need to know the time interval between confrontation and when body was found. May call it undetermined if truck driver followed her all the way to the fueling station"</i>	<i>"What did the video show about the truck driver?"</i>
<i>"The physiological stress of being pursued caused her death."</i>	<i>"I would not argue with my colleagues who would call this a homicide; either is reasonable"</i>	<i>"This case is in a solid gray area, and a reasonable argument could be made for natural or homicide. Going with undetermined because the timeline is not clear."</i>	<i>"Does chase mean follow in a vehicle aggressively, run after down the road or just slowly follow in a vehicle?"</i>
<i>"Assuming the incident occurred not long before shewas found, I would have no trouble making the link and certifying this as homicide."</i>	<i>"Exact nature of altercation and incident preceding it not elucidated. Otherwise, natural diseases sufficient to account for sudden death."</i>	<i>"Video camera seems to be the only evidence of an 'altercation'; to me, this makes determining the nature/severity of the incident too challenging."</i>	
<i>"He followed her, presumably to scare her..."</i>	<i>"No physical contact and no weapons brandished. No criminality..."</i>		
<i>"The confrontation was an assault."</i>	<i>"I would love to know - was her vehicle secure? Windows intact? Beyond that, given choices she would have had - natural."</i>		

Table 5: Cases 2-8 Comments

Case 2 n=23	<i>"Death associated with a vehicular accident even without anatomic lethal injuries must be accident related and could be associated with emotion-related dysrhythmia."</i>
	<i>"Why beat around the bush calling this a natural and then still saying that being in the crash 'probably contributed'?"</i>
	<i>"With the acute ischemic change I felt it was a little harder to definitely link his arrest to the collision. Otherwise I would've called it an accident."</i>
	<i>"Cardiac disease is up in the air, but it is unlikely his manner is anything but accident"</i>
	<i>"Passenger is dead of heart disease aggravated by accident. You take your victim as they are."</i>
	<i>"Comotio cordis vs. positional asphyxia depending on location of abrasions and photo examination."</i>
	<i>"...even if it is 'natural' with added stressor of being in a car ACCIDENT"</i>
	<i>"The temporal relationship is what pushes me to accident in this case, despite the superficiality of the injuries."</i>
Case 3 n=29	<i>"...for the MVC, he would not have died at the time. The MVC was an external, excitatory, efficient event."</i>
	<i>"She had no deviation from her baseline clinical status following the fall. The resultant rib fractures did not immediately cause respiratory compromise, and thus are of no consequence."</i>
	<i>"I need to know more about those rib fractures, and whether they might have been due to resuscitation. If they were not due to resuscitation, one could opine that the pain from the fractures caused by the fall could have precipitated arrest in this individual with severe natural disease. If the fractures are more consistent with resuscitation fractures, given that several hours elapsed from the fall to her arrest, I would probably call it natural or undetermined."</i>
	<i>"...rib fractures could be from CPR... I would certify this case as natural."</i>
	<i>"Too prolonged a time between fall and death."</i>
	<i>"for the MVC, she would not have died at the time. The MVC was an external, excitatory, efficient event—with injuries"</i>
	<i>"I call this an accident and explain in my summary and opinion that while probable, other causes/manners are not entirely excluded"</i>
	<i>"She has a number of natural reasons to be dead, but I think the rib fractures obtained in an "accident" so proximal to her death are at least contributory."</i>
	<i>"...the very minor vehicle-related fall. She would not have died when she did so I would call it an accident."</i>
	<i>"The rib fractures indicate that this was a significant injury. Pain would have potentiated a fatal cardiac arrhythmia."</i>
Case 4 n=29	<i>"...acute rib fractures reduced ability to effectively breath and played at least some role in her death."</i>
	<i>"In a debilitated person, even seemingly minor fractures can add to the physiological stresses needed to cause death."</i>
	<i>"I do not make this homicide from the driver's punching neither the brake nor the failure of restraint. This is an accident pure and simple in my book, even though the mechanism may be a cardiac arrhythmia or infarction."</i>
	<i>"If the robbery scenario is not backed up by anything, then undetermined. And why do we think it was armed robbery or any robbery type? And even if not armed, does not the stress of a robbery, even unarmed, rise to the level of stressor during a criminal act? I would give a lengthy discussion about the raised concern and say that if such details become evident then the manner may change. You could argue natural with same caveat or even homicide, but placing homicide with no objective evidence is a stretch in my opinion. Signing the manner as undetermined or cause with no explanation is not a good idea."</i>
	<i>"Because there is at least a possibility this decedent had his arrest during a threat to his physical well-being, I do not believe natural is appropriate here. However, an absence of any real clear supporting evidence, I do not believe one can call this a homicide either."</i>
	<i>"The alleged intervening issue is of uncertain reliability. About half the time I think about it I call it natural."</i>
	<i>"With insufficient information in a case like this I would defer to the underlying natural disease, rather than make it undetermined."</i>
	<i>"A useful manner classification for this type of death is 'C.U.P.I.' - circumstances undetermined pending police investigation - which means the case remains open and pending until additional investigative information is received."</i>

Table 5: Continued

Case 4 n=29	<i>"If this occurred during armed robbery then it's homicide, if not, then natural. Two equally plausible manners given unclear circumstances."</i>
	<i>"Pend the case for more information; if that is not fruitful, Undetermined is the way to go."</i>
	<i>"I assume some reason for the allegation of robbery. I would pursue further investigation. Further information might cause me to certify this as natural, but it also might justify a reason for a perceived robbery. What the decedent perceived is important here—regardless of the truth. I do not need to see the allegation in the police report, but then would need to see it in my MDI's report."</i>
	<i>"Based on the history, one is stuck between natural and homicide, a natural choice then would be undetermined."</i>
	<i>"Depending on the precise circumstances, this cause may fulfill Davis criteria; however, the absence of clear circumstances warrants an undetermined MOD in my opinion."</i>
Case 5 n=12	<i>"All stressors and conditions appear natural and expected outcomes of such conditions."</i>
	<i>"...he would likely not have died when he did so I would call it natural. Being served with papers is not an assault."</i>
	<i>"If there is no evidence of agitation, aggression or distress, then this is entirely a natural death."</i>
	<i>"...he would likely not have died at the time. The proceedings were external and excitatory but not efficient event."</i>
Case 6 n=14	<i>"Being arrested may have its stress but given the circumstances is an expected activity of daily living for this individual with severe heart disease, a detailed autopsy exam, I would very comfortably say natural. As a 'custody' death I would perform a complete autopsy..."</i>
	<i>"Not a lot of scene information is given here, and we must assume that all the pertinent negatives are indeed negative. With that being said, being arrested is a stressful event, and although there must be another human involved in an arrest, there is no intent to cause harm, fear, or death, and the actions of the other human in this case are not violent. Therefore, this is not a homicide."</i>
	<i>"Being scared without any violence or threat is just a risk factor not a factor changing manner."</i>
	<i>"...he would likely not have died when he did but I would call it natural. Being arrested as it is described is not an assault"</i>
	<i>"You fail to mention the decedent's emotional state and his response to the arrest, which suggests that this was a normal event and not one that involved and excited delirium-type adrenalin rush...that makes the difference."</i>
	<i>"Sufficient natural disease to account for sudden arrhythmic death. Circumstances were psychologically traumatic, but not outstanding."</i>
Case 7 n=8	<i>"Sex is a normal, albeit physiologically stressful, activity of daily living. Just like mowing the lawn, jogging, playing sports, etc..."</i>
	<i>"Sexual activity is a normal human activity. In the presence of significant natural disease, sudden death associated with this activity can not be regarded as accidental."</i>
Case 8 n=13	<i>"What triggered his panic attack? If another person's ill intentions did, then this would be a homicide. If something benign or if spontaneous, then this would be a natural."</i>
	<i>"Anatomical evidence of significant natural disease and history of psychiatric disorder support a purely natural cause for this death."</i>

MVC - Motor vehicle collision

CPR - Cardiopulmonary resuscitation

MDI - Medical death investigator

MOD - Manner of death

and diabetic ketoacidosis) causing death or contributing to death, that we systematized and addressed.

Sudden unexpected deaths due to natural causes occurring a short time after a significant stressful event are relatively uncommon but regularly seen in forensic practice. The determination of the manner of death in such cases is complicated and controversial. All presented “victims” suffered from significant and often life-threatening natural diseases, making the person “vulnerable.” According to current practice, the vulnerability or susceptibility of the victim does not absolve the assailant of criminal responsibility, “one takes the victim as one finds the victim,” as was commented by a large number of responders.

A stressful event may or may not hasten the death of one already vulnerable. The risk of sudden death correlates with the severity of the underlying condition and the nature and severity of the stressful event. By the nature of the subject, it is very difficult, if not impossible, to predict the risk of death triggered by a specified stressful event, but in the majority of cases it is possible to assess the retrospective association between precipitating stressful event and sudden death.

The certification of an unnatural manner of death requires the establishment of a causal relationship between the precipitating event and death. In a majority of cases, the causal relationship is obvious and can be easily assessed by the combination of professional knowledge, conventional wisdom, and common sense. However, there are some situations where causal relationships are unclear and controversial. Our results showed that in cases “Being chased along a road” (case 1), “Motor vehicle collision without injury” (case 2), “Fall from a wheelchair during transport in a van” (case 3), and “Death after an alleged robbery” (case 4) there were significantly differing opinions among certifiers. In comments, certifiers repeatedly used a statement “...the victim would not die if the victim were not...” as an argument for causal relationship between stressor and death of a vulnerable person—a good example of the usefulness of the “but-for” test in the context of death after stress (7, 21). One responder mentioned the criteria to establish proof of causality

between the emotional trigger and sudden death as suggested by J.H. Davis (**Table 1**) (13, 14).

Certification of an unnatural manner of death after a stressful event requires a strong association between an intense stressor and death. Conventional wisdom tells us that individuals can perceive the same stressors differently from one another and may even perceive the severity of an identical stressor differently under varying situations or physical conditions. No objective measurements for the intensity of stress exist as there are no meaningful predictors of severity individual’s physiological response to a stressor. While the association between sudden cardiac death and significant emotional stress is reported since antiquity, the intensity and nature of the stressor needed to trigger sudden cardiac death is unknown. Several responders suggested to differentiate between physiological stressors (e.g., sexual activities; stressors of daily living like mowing the lawn, jogging, playing sports, etc.) and stressors that are “*beyond the stress of daily living...*”, for example a criminal event. The differentiation is not sharp and may vary between social groups and individuals. For example, criminal activities can be a part of daily living for some just as jogging can be far beyond the stressors of daily living for others. The possible discrepancy between “real” and “perceived” danger is another major factor affecting certification. In the comments to the case “Death after an alleged robbery” (case 4), one responder wrote “*What the decedent perceived is important here, regardless of the truth*”. A similar problem occurred in the case “Severe panic attack with breathing problems” (case 8). Anxiety, panic, and perception of danger can occur for any reason or no reason at all. The subjective nature of danger perception requires interpretation of investigational evidence making certification controversial and unpredictable.

The establishment of the association between the precipitating event and death is the first and most important step of certification of manner. A short time interval between the stressful event and death strongly supports the causality. “*A Guide for Manner of Death Classification*” states that a “*close temporal relationship between the incident and death*” as short as “a

few minutes or less” is required to establish the causal relationship (10). The majority of cases of sudden death after significant stressful event, including cases “Motor vehicle collision without injury” (Case 2), “Involuntary commitment” (Case 5), “Arrested by police, died in the patrol car” (6), and “Death after sexual intercourse” (Case 7), obey the rule as cardiac arrest occurred during or within a few minutes after the significant stressful event. Comments “...the temporal relationship is what pushes me to ... in this case” were repeatedly used by survey participants, arguing for a causal relationship between stressor and death. However, there were exceptions from the “a few minutes or less” rule. Sixty-one percent of responders chose an accidental manner of death and 13% chose an undetermined manner in the case “Fall from a wheelchair during transport in a van” (case 3), where the cardiac arrest occurred a few hours after minor motor vehicle accident. According to the records, the decedent was seemingly unaffected after the accident. She returned to the scheduled dialysis and collapsed at the emergency department while being evaluated for the fall a few hours later. The discovery of acute rib fractures confirmed the “severity” of the fall, but the injury was not fatal on its own. Several responders found that “In a debilitated person, even seemingly minor fractures can add to the physiological stresses needed to cause death.” On the contrary, 26% of responders chose natural death due to “Too prolonged a time between fall and death.” The case “Being chased along a road” (case 1), where the woman was found in a driver’s seat of the car several hours after a recorded chase and verbal confrontation with a truck driver, showed the highest inter-rater variability (Tables 2 and 3) and highest number of comments (Table 4). The majority of responders mentioned the unknown time interval from altercation to death as a significant factor affecting their certification. However, 37% chose homicide and 25% chose undetermined manners of death. It was noted repeatedly that a longer time interval between the accident and death make the association between stressor and cardiac arrest weaker and a stronger investigational evidence required to establish causality.

The duration of time of being at risk of sudden death after a stressful event is unknown. The duration of

emotional and physical stress reaction and risk of sudden death after significant stress is unpredictable and varies between individuals (22). There is evidence that physical exertion (particularly by people who are not normally active), emotional stress, anger, and extreme excitement can trigger acute myocardial infarction and sudden cardiac death in susceptible individuals. Many triggers operate within one to two hours of symptom onset (3). An older study showed that during World War II, healthy US troops displayed symptoms of depression, anxiety, withdrawal, confusion, paranoia, and sympathetic hyperactivity after witnessing or experiencing traumatic events. The symptoms begin to diminish after 24–48 hours and were minimal after about three days (23). Psychiatrists define acute stress disorder as a complex of physical symptoms due to activation of the sympathetic system and emotional reaction after exposure for stressor lasting for at least three days after the acute traumatic event (24).

The investigational evidence can be unclear, incorrect, or both. Inadequate investigative findings limit the certifier’s ability to determine the correct manner of death. In the present case “Death after a robbery” (Case 4), law enforcement was not able to confirm or refute the allegation of robbery. Most of the responders (69%) chose “undetermined” as the manner of death followed by comments such as, “Unclear circumstances did not support the sufficient burden of proof for determination of the manner of death other than Undetermined”, “Pend the case for more information; if that is not fruitful, ‘Undetermined’ is the way to go.” or “Based on the history, one is stuck between natural and homicide, a natural choice than would be undetermined.” However, 29% of responders chose “natural” manner as “...insufficient information in a case like this I would defer to the underlying natural disease, rather than make it undetermined.” or “If this occurred during armed robbery then it’s homicide, if not, then natural. Two equally plausible manners given unclear circumstances.” These comments prompt interesting discussion regarding assessment and the relative weight of circumstantial evidence against autopsy-acquired evidence. The NAME guidelines state that manner of death determination is “circumstance dependent, not autopsy dependent” (10); however,

common sense indicates that significant evidence acquired at autopsy may, and should, be taken in consideration. The comments showed that the leveraging of investigational evidence and autopsy acquired evidence varies between certifiers and possibly rigidity using “undetermined” manner in the presence of obvious cardiac cause of death in the presence of unclear circumstances and the absence of injury.

The most common causes of death triggered by significant emotional stress are acute myocardial ischemia and arrhythmia in the context of atherosclerotic and hypertensive cardiovascular disease. However, as mentioned in several comments, some other conditions and diseases that may cause death triggered by significant emotional stress should be considered in a differential diagnosis. Some of them are listed here. For example, sudden death in people in significant acute distress and emotional and physical agitation, often associated with hyperthermia, stimulating drugs, and underlying mental disorders, are well described in the literature as excited delirium (other names included Bell’s mania, lethal catatonia, acute exhaustive mania, and agitated delirium). A significant number of deaths occur while individuals are being restrained by police or being taken into custody (25–27). Autopsy diagnoses in cases of sudden death after significant emotional stress are difficult because in the majority of the listed conditions, findings are sparse or absent. Another uncommon cause of death after significant emotional stress has only just been recently recognized, a rare acquired cardiomyopathy called takotsubo syndrome. The exact incidence is unknown. The disease presents as severe localized left ventricular wall dyskinesia (otherwise known as apical ballooning syndrome) identified by ventriculogram or echocardiography in the absence of hemodynamically significant coronary artery stenosis. In the majority of cases, the disease has a benign course with recovery of contractile function, but fatal cases occur. The diagnosis of takotsubo syndrome is challenging in the absence of ventriculogram or echocardiography as it may occur with coronary vasospasm, cardiac arrhythmia, and non-significant coronary disease and will have no postmortem anatomic correlate. Stress cardiomyopathy may also be a part of a sympathetic system mediated neurocardiogenic in-

jury, seen with subarachnoid hemorrhage, intracranial hypertension, and cerebral ischemia (28–31). Sudden unexpected death in epilepsy (SUDEP) is also a recently recognized cause of premature death. The incidence of SUDEP was reported to be 1.20 per 1000 people with epilepsy per year and it is significantly higher in younger individuals (32, 33). Macroscopic brain abnormalities were reported in 52% of cases and microscopic changes in 89% (32). The correlation of SUDEP with significant emotional or behavioral trigger needs to be studied (2). As mentioned in several comments, cases of such complexity require complete autopsy, preferably with histology, neuropathology, biochemistry, and complete toxicology. Resolving of such cases is time consuming, requires excessive investigational evidence, and may require good interaction with law enforcement. Despite all the effort, the determination of manner of death in a “vulnerable” victim exposed to a stressor of varying (or unknown) intensity is still difficult and controversial.

Some unrecognized unnatural deaths may be certified as “natural” by some physicians and medical professionals. While training in death certification is a part of forensic pathologists’ professional training, most death certificates are completed by busy general practitioners, hospital physicians, and non-physician medical professionals. According to the literature, physicians receive little or no training on death certification during their medical school and residency (15, 34). The accuracy of death certification is a topic of concern to public health authorities of many countries (16–18). An educational approach will improve the quality of death certification and increase the chance of “recognition” of potentially problematic cases and referral to appropriate medical examiner or coroner jurisdictions. As rules are not completely clear, do we need, as one responder mentioned, “...to step back and use common sense (i.e., what would a normal, indeed, non-”trained” human being think)” while identifying and certifying such cases?

The relatively small number of cases and unknown and probably low response rate are major limitations of our study. The response rate was of 17%, assuming all 500 subscribers received and read emails de-

livered on the Listserv. However, the proportion of subscribers reading emails coming from the Listserv is unknown and probably lower than expected. A British study on the burden of unfocused electronic communication received by emergency department (ED) physicians showed that during the 14-day study period, two ED attending physicians received 321 and 242 work-related emails and spent 14.8 and 10.3 hours, respectively, reading emails, attachments, and links. Private emails and spam were excluded from the count (35). Overload by emails, questionnaires, customer satisfaction assessments, and surveys presumably result in unwillingness to spend time responding to “non-urgent” emails, surveys, and questionnaires. According to a survey software developer, the 2014 average response rate for internal surveys (to employees) was 30–40%, and for external surveys was as low as 10–15% (36). Opinions on what constitutes “adequate” and “non-adequate” response vary greatly. While conventional wisdom tells us a higher response rate may be associated with lower non-responder bias and higher validity, research results tell us that a high response rate is not necessarily more accurate than a lower response rate. Visser et al. showed that surveys with lower response rates (near 20%) yielded more accurate measurements than did surveys with higher response rates (near 60 or 70%) (37). Similar results were reported by Choung et al. (38). Considering the response rate of 17%, the results of the survey are regarded as valid due to the varieties of manners of death certification among forensic professionals. A non-responder bias may not affect the variety of manners of certification as it probably would if the intention of the survey were to assess the true proportion of manners of death within a group of certifiers. The group of responders is relatively homogenous due to similarity of social status, education, licensing, practical experience, and exposure to the legal system. The homogeneity of the responders is believed to decrease the impact of non-responder bias as non-responders would most likely answer not significantly different from responders. The true inter-rater variability is difficult to assess as it will require very large number of cases and some form of “standardization” of cases, which are hard to make. However, even using the small number of cases, we were able to show signifi-

cant inter-rater variability in certain type of cases, for example the predictability of the manner of death certification for case 1 was close to being “by chance.”

CONCLUSION

The results of the survey show that despite the attention of the forensic community to the topic of manner of death certification, it remains far from uniform, at least for certain cases with competing causes. It raises the question “Do these cases need to be certified uniformly?” If yes, either the certification process or the educational procedure must be revised. A study of the usability of “*A Guide for Manner of Death Classification*” followed by an educational effort then a restudy of usability would be useful. An algorithmic approach can be considered.

REFERENCES

- 1) Appels CW, Bolk JH. Sudden death after emotional stress: a case history and literature review. *Eur J Intern Med*. 2009 Jul; 20(4):359–61. PMID: 19524173. <https://doi.org/10.1016/j.ejim.2008.09.010>.
- 2) Lathers CM, Schraeder PL. Stress and sudden death. *Epilepsy Behav*. 2006 Sep; 9(2):236–42. PMID: 16872908. <https://doi.org/10.1016/j.yebeh.2006.06.001>.
- 3) Strike PC, Steptoe A. Behavioral and emotional triggers of acute coronary syndromes: a systematic review and critique. *Psychosom Med*. 2005 Mar-Apr; 67(2):179–86. PMID: 15784781.
- 4) Myers A, Dewar HA. Circumstances attending 100 sudden deaths from coronary artery disease with coroner’s necropsies. *Heart*. 1975 Nov 1; 37(11):1133–43. <https://doi.org/10.1097/01.psy.0000155663.93160.d2>.
- 5) Muller JE, Mittleman MA, Maclure M, et al. Triggering myocardial infarction by sexual activity: low absolute risk and prevention by regular physical exertion. Determinants of myocardial infarction onset study investigators. *JAMA*. 1996 May 8; 275(18):1405–9. PMID: 8618365. <https://doi.org/10.1001/jama.1996.03530420033032>.
- 6) Möller J, Ahlbom A, Hulting J, et al. Sexual activity as a trigger of myocardial infarction. A case-crossover analysis in the Stockholm Heart Epidemiology Programme (SHEEP). *Heart*. 2001 Oct; 86(4): 387–90. PMID: 11559674. PMID: PMC1729949. <https://doi.org/10.1136/heart.86.4.387>.
- 7) Harvard Law School [Internet]. Cambridge (MA): Harvard College; c2018. Causation and tort liability (The New Palgrave Dictionary of Economics and the Law, Volume 1 (A–D), Peter Newman (editor). New York: Stockton Press; 1998, pages 211–214); [cited 2017 Sep 13]. Available from: http://www.law.harvard.edu/faculty/shavell/pdf/76_Causation_and_Tort_Liability_New_Palgrave.pdf.
- 8) Davis GG. Mind your manners. Part I: History of death certification and manner of death classification. *Am J Forensic Med Pathol*. 1997 Sep; 18(3):219–23. PMID: 9290867. <https://doi.org/10.1097/0000433-199709000-00001>.

- 9) Hanzlick R, Goodin J. Mind your manners. Part III: Individual scenario results and discussion of the National Association of Medical Examiners Manner of Death Questionnaire, 1995. *Am J Forensic Med Pathol.* 1997 Sep; 18(3):228-45. PMID: 9290869. <https://doi.org/10.1097/00000433-199709000-00003>.
- 10) Hanzlick, R., Hunsaker JC, Davis GJ; National Association of Medical Examiners. A guide for manner of death classification. 1st ed. Marceline (MO): National Association of Medical Examiners; 2002. 28 p.
- 11) Physicians' handbook on medical certification of death [Internet]. Hyattsville (MD): Centers for Disease Control and Prevention; 2003; [cited 2017 Aug 8]. Available from: https://www.cdc.gov/nchs/data/misc/hb_cod.pdf.
- 12) Kaplow L. Burden of Proof. *Yale Law J* [Internet]. 2012 Jan [cited 2017 Aug 8]; 121(4):738-859. Available from: http://www.yalelawjournal.org/pdf/1044_nzsbeogq.pdf.
- 13) Davis JH. Can sudden cardiac death be murder? *J Forensic Sci.* 1978 Apr; 23(2):384-7. PMID: 122751. <https://doi.org/10.1520/jfs10773j>.
- 14) Turner SA, Barnard JJ, Spotswood SD, Prahlow JA. "Homicide by heart attack" revisited. *J Forensic Sci.* 2004 May; 49(3):598-600. PMID: 15161183. <https://doi.org/10.1520/jfs2003343>.
- 15) Goodin J, Hanzlick R. Mind your manners. Part II: General results from the National Association of Medical Examiners Manner of Death Questionnaire, 1995. *Am J Forensic Med Pathol.* 1997 Sep; 18(3):224-7. PMID: 9290868. <https://doi.org/10.1097/00000433-199709000-00002>.
- 16) Lakkireddy DR, Gowda MS, Murray CW, et al. Death certificate completion: how well are physicians trained and are cardiovascular causes overstated? *Am J Med.* 2004 Oct 1; 117(7):492-8. PMID: 15464706. <https://doi.org/10.1016/j.amjmed.2004.04.018>.
- 17) Pritt BS, Hardin NJ, Richmond JA, Shapiro SL. Death certification errors at an academic institution. *Arch Pathol Lab Med.* 2005 Nov; 129(11):1476-9. PMID: 16253030. [https://doi.org/10.1043/1543-2165\(2005\)129\[1476:DCEAAA\]2.0.CO;2](https://doi.org/10.1043/1543-2165(2005)129[1476:DCEAAA]2.0.CO;2).
- 18) Ashworth TG. Inadequacy of death certification: proposal for change. *J Clin Pathol.* 1991 Apr; 44(4):265-8. PMID: 2030142. PMID: PMC496895. <https://doi.org/10.1136/jcp.44.4.265>.
- 19) Siegel S, Castellan NJ. Nonparametric statistics for the behavioral sciences. 2nd ed. Boston: McGraw-Hill; 2003. 399 p.
- 20) Randolph JJ. Free-marginal multirater kappa (multirater K[free]): an alternative to Fleiss' fixed-marginal multirater kappa [Internet]. Paper presented at: Joensuu Learning and Instruction Symposium; 2005 Oct 14-15; Joensuu, Finland; [cited 2018 Jan 25]. Available from: <https://eric.ed.gov/?id=ED490661>.
- 21) David H, McCague WP, Yaniszewski PF. Proving causation where the but for test is unworkable. *Advocates Q* [Internet]. 2003; 30:216-38[cited 2017 Sep 13]. Available from: http://mccagueborlack.com/uploads/articles/43/hd-pm-py_proving-causation.pdf?1299245845.
- 22) Cahill SP, Pontoski K. Post-traumatic stress disorder and acute stress disorder I: their nature and assessment considerations. *Psychiatry (Edmont).* 2005 Apr; 2(4):14-25. PMID: 21179648. PMID: PMC3004735.
- 23) Bryant RA, Harvey AG. Acute stress disorder: a handbook of theory, assessment, and treatment. 1st ed. Washington: American Psychological Association; 2000. 251 p.
- 24) Diagnostic and statistical manual of mental disorders. 5th ed. (DSM-5). Washington: American Psychiatric Association; 2013. 947 p.
- 25) Gill JR. The syndrome of excited delirium. *Forensic Sci Med Pathol.* 2014 Jun; 10(2):223-8. PMID: 24526411. <https://doi.org/10.1007/s12024-014-9530-2>.
- 26) Takeuchi A, Ahern TL, Henderson SO. Excited delirium. *West J Emerg Med.* 2011 Feb; 12(1):77-83. PMID: 21691475. PMID: PMC3088378.
- 27) Di Maio T, Di Maio VJM. Excited delirium syndrome: cause of death and prevention. Boca Raton: CRC/Taylor & Francis; 2006. 144 p.
- 28) Wybraniec M, Mizia-Stec K, Krzych L. Stress cardiomyopathy: yet another type of neurocardiogenic injury: 'stress cardiomyopathy'. *Cardiovasc Pathol.* 2014 May-Jun; 23(3):113-20. PMID: 24462197. <https://doi.org/10.1016/j.carpath.2013.12.003>.
- 29) Kurisu S, Sato H, Kawagoe T, et al. Tako-tsubo-like left ventricular dysfunction with ST-segment elevation: a novel cardiac syndrome mimicking acute myocardial infarction. *Am Heart J.* 2002 Mar; 143(3):448-55. PMID: 11868050. <https://doi.org/10.1067/mhj.2002.120403>.
- 30) Rotondi F, Manganelli F. Takotsubo cardiomyopathy and arrhythmic risk: the dark side of the moon. *Eur Rev Med Pharmacol Sci.* 2013 Jan; 17(1):105-11. PMID: 23329530.
- 31) Wittstein IS. The sympathetic nervous system in the pathogenesis of Takotsubo syndrome. *Heart Fail Clin.* 2016 Oct; 12(4):485-98. PMID: 27638019. <https://doi.org/10.1016/j.hfc.2016.06.012>.
- 32) Thom M, Michalak Z, Wright G, et al. Audit of practice in sudden unexpected death in epilepsy (SUDEP) post mortems and neuropathological findings. *Neuropathol Appl Neurobiol.* 2016 Aug; 42(5):463-76. PMID: 26300477. PMID: PMC4864133. <https://doi.org/10.1111/nan.12265>.
- 33) Sveinsson O, Andersson T, Carlsson S, Tomson T. The incidence of SUDEP: a nationwide population-based cohort study. *Neurology.* 2017 Jul 11; 89(2):170-7. <https://doi.org/10.1212/wnl.0000000000004094>.
- 34) Degani AT, Patel RM, Smith BE, Grimsley E. The effect of student training on accuracy of completion of death certificates. *Med Educ Online.* 2009 Sep 29; 14:17. PMID: 20165531. PMID: PMC2779619. <https://doi.org/10.3885/meo.2009.res00315>.
- 35) Hill DS, Cowling L, Jackson F, et al. ED, email, emess! *Emerg Med J.* 2013 Jan; 30(1):68-9. PMID: 22034537. <https://doi.org/10.1136/emered-2011-200741>.
- 36) Fryrear A. What's a good survey response rate? [Internet]. Boulder (CO): SurveyGizmo; 2015 Jul 27 [cited 2018 Jan 16]. Available from: <https://www.surveymzmo.com/survey-blog/survey-response-rates/>.
- 37) Visser PS, Krosnick JA, Marquette J, Curtin M. Mail surveys for election forecasting?: an evaluation of the Columbus Dispatch Poll. *Public Opinion Quarterly.* 1996 Jan 1; 60(2):181-227. <https://doi.org/10.1086/297748>.
- 38) Choung RS, Locke GR, Schleck CD, et al. A low response rate does not necessarily indicate non-response bias in gastroenterology survey research: a population-based study. *J Public Health.* 2013 Feb 1; 21(1):87-95. <https://doi.org/10.1007/s10389-012-0513-z>.