

Vincent J. M. Di Maio,¹ M.D. and Dominick J. M. Di Maio²

Natural Death as Viewed by the Medical Examiner: A Review of 1000 Consecutive Autopsies of Individuals Dying of Natural Disease

REFERENCE: Di Maio, V. J. M. and Di Maio, D. J. M., "Natural Death as Viewed by the Medical Examiner: A Review of 1000 Consecutive Autopsies of Individuals Dying of Natural Disease," *Journal of Forensic Sciences*, JFSCA, Vol. 36, No. 1, Jan. 1991, pp. 17–24.

ABSTRACT: A study of 1000 consecutive autopsies of individuals dying of natural disease was conducted. Cardiovascular disease was responsible for 60.9% of all deaths with coronary artery disease—not only the main cause of cardiovascular death but also the main cause of all natural deaths—accounting for 45.1% of such cases. Diseases of the central nervous and respiratory systems accounted for 8.7 and 8.6%, respectively, of the natural deaths. Seizure disorders and pneumonia were the main causes of death in these organ systems. There were 124 deaths of children less than one year in age, 91 of which were due to sudden infant death syndrome (SIDS). All of the SIDS deaths were in children less than 10 months old.

KEYWORDS: pathology and biology, symposium, cardiovascular disease, postmortem examination, natural death, autopsy, medical examiner, sudden death

One of the most common misconceptions held by both the public and medical personnel in regard to medical examiner offices is that the cases handled by these offices are exclusively traumatic in origin. In fact, the largest category of deaths seen in medical examiners' offices are natural deaths. Over an eight-year period in San Antonio, Texas, natural deaths constituted from 42.3 to 47.7% of all cases handled. In a ten-year period in Dallas, natural deaths made up 51.2% of all deaths [1].

Natural deaths are referred to the medical examiner for a variety of reasons: the death is sudden or unexpected or both; an individual is found dead; there is no medical history of any significant disease to explain death; no physician is in attendance at the time of death; an attending physician cannot determine a cause of death; or the death is suspicious or mislabeled as due to trauma. For a number of reasons, many such deaths are not autopsied. Medical examiner's offices, like virtually all organizations, have limited resources, both personnel and material. These resources have to be directed first to violent deaths; this is because the primary duty of medical examiners' offices, as viewed by their funding agencies (state, county, or local government), is to investigate traumatic death. Thus, such deaths have a higher priority than natural deaths.

While autopsying every case may seem commendable, in many instances, it may so strain the capacity of the system that it results in a decrease in the quality of work generated. The National Association of Medical Examiners recommends, in its *Standards*

¹Chief medical examiner, Office of the Medical Examiner, Bexar County, Texas.

²Student, Trinity University, San Antonio, TX.

for *Inspection and Accreditation of a Modern Medicolegal Investigative System*, that a forensic pathologist perform a maximum of 200 autopsies per year [2]. In most offices, the number of cases performed is much greater. As the case load per physician progressively increases, there is an increased tendency to make errors and to take shortcuts which can lead to mistakes.

The factors that determine whether a death apparently due to natural disease is autopsied are most often the circumstances surrounding the death (sudden collapse, found dead, symptoms or the lack of, death at work, and other circumstances), the presence or lack of a medical history, the age and sex of the victim, whether there was a physician in attendance, suspicious circumstances indicating that the death was possibly not a natural death, the possibility of civil litigation, the staffing of the medical examiner's office, and the case load of the medical examiner's office. An example of a case that will always be autopsied as opposed to a case that is virtually never autopsied would be a 25-year-old white female with no past medical history and no symptoms who collapses and dies at work, whereas a 72-year-old white female, with a history of metastatic breast cancer, dying at home, in bed, with the family in attendance, will virtually never be autopsied.

In deaths in which there is sudden collapse or an individual is found dead, that is, sudden or unexpected deaths, in which the circumstances surrounding the death and the presence or absence of medical history calls for examination, many offices use an age limit in determining which cases should be autopsied. In San Antonio, we use 60 years of age as the limit. Thus, when the case is an individual 60 years of age or older who collapses or is found dead while not at work, whether or not he or she has a medical history, where there are no suspicious circumstances, and when on external examination he or she shows no evidence of trauma, this type of case is generally not autopsied. It is still our policy, however, to perform a complete toxicological examination in virtually all such cases. In a few instances, we have found a death to be due to a drug overdose. Some offices use a lower age cutoff point. This is often determined by the staffing of the office.

In a study by Vanatta and Petty on the limitations of external examinations in determining the cause and manner of death, in 88 cases in which the manner of death was certified as natural by external examination, and in which the bodies were subsequently autopsied by other agencies, in all instances, the manner of death was still found to be natural though the cause of death was erroneous in 29% of the cases [3]. The majority of the errors were a result of over-diagnosis of arteriosclerotic cardiovascular disease, hypertensive cardiovascular disease, and cancer.

Since natural deaths constitute the largest group of cases investigated by medical examiners and in many instances the largest group autopsied, the authors decided to conduct a study of 1000 consecutive autopsies of individuals dying of natural diseases in Bexar County, Texas. In all instances, a full autopsy was conducted. A complete toxicological screen for alcohol and for acid, basic, and neutral drugs was conducted in virtually all cases. Analyses for narcotics were performed in select cases. The purpose of this study was to find out what diseases are the principal causes of natural death presenting to the medical examiner's office.

Results

Table 1 groups causes of death by organ system for the 1000 autopsies. Cardiovascular disease was responsible for 609 (60.9%) of the deaths, followed in frequency by diseases of the central nervous system (8.7%) and of the respiratory system (8.6%). Deaths due to sudden infant death syndrome (SIDS) constituted 9.1% of the cases.

TABLE 1—*Causes of death by organ system for 1000 autopsies.*

Cardiovascular	609
Central nervous	87
Respiratory	86
Hepatic	42
Gastrointestinal	30
Pancreas/diabetes mellitus	12
Urogenital	12
SIDS ^a	91
Other	31
Total	1000

^aAlthough SIDS is not an organ system, the authors have included it here because of its prominence.

Cardiovascular Disease

Table 2 gives a breakdown of the 609 deaths due to cardiovascular disease. Four hundred and fifty-one deaths were attributed to coronary artery disease (CAD). In 54 of the CAD cases (11.9%), significant disease (70% narrowing of the lumen or greater) was confined to a single vessel. This vessel was the left anterior descending coronary artery in 40 instances, the circumflex in 4, and the right coronary artery in 10 (Table 3).

Of the 451 CAD cases, 157 (34.8%) showed gross scarring of the myocardium, with 38 cases (8.4%) giving evidence of an acute myocardial infarction, grossly. The actual incidence of acute myocardial infarction and scarring of the myocardium was higher because microscopic sections were not taken in all cases.

Of the 60 CAD cases (13.3%) in which there was thrombosis of a coronary artery, the main left coronary artery was involved in 6 instances, the left anterior descending coronary artery in 19, the circumflex in 6, and the right coronary artery in 29 (Table 3). In eight (13.3%) of the 60 cases, only the thrombosed vessel showed evidence of significant coronary atherosclerosis. Thirty (50%) of the 60 cases showed evidence of myocardial scarring grossly and 15 (25%) evidence of acute myocardial infarction on gross examination. The second largest category of deaths due to cardiovascular disease is cardiomyopathy, 78 cases. Here, males predominated, 56 to 22. Three individuals, ages 2½ months, 16 years, and 32 years, had hypertrophic subaortic stenosis. In 20 of the cases,

TABLE 2—*Deaths due to cardiovascular disease.*

Coronary artery disease	451
Cardiomyopathy	78
Hypertensive cardiovascular disease	13
Valvular heart disease	13
Congenital heart disease	12
Myocarditis	10
Other cardiac conditions	9
Dissecting aortic aneurysm	16
Rupture of atherosclerotic aortic aneurysm	7
Total	609

TABLE 3—Deaths due to coronary artery disease: distribution of lesions in cases with single-vessel disease or coronary thrombosis.

	Single-Vessel Disease	Coronary Thrombosis
Main left coronary artery	0	6
Left anterior descending coronary artery	40	19
Circumflex coronary artery	4	6
Right coronary artery	10	29
Total	54	60

the cardiomyopathy was associated with a history of alcoholism. This is undoubtedly an underestimation of this etiology.

Thirteen deaths ascribed to cardiovascular disease were attributed to hypertensive cardiovascular disease unassociated with significant atherosclerosis. All the individuals had less than 25% coronary atherosclerosis in all vessels. Males predominated 8 to 5 over females. The average weight of the heart for males was 580 g and for females 544 g. The mechanism of death in these cases is an arrhythmia.

The next category was valvular heart disease. Mitral stenosis accounted for 3 deaths, aortic stenosis for 4, and floppy mitral valve for 6. Deaths were certified as due to floppy mitral valve only when all other causes of death had been ruled out. In all such cases, a complete microscopic examination and toxicological screen for alcohol and for acid, basic, and neutral drugs, as well as narcotics in the younger individuals, was performed. In the deaths attributed to floppy mitral valve, 4 individuals were female and 2 were males. The oldest individual was a 58-year-old male with a clinical history of a floppy valve and arrhythmias associated with it.

Congenital heart disease accounted for 12 deaths: 2 adults, ages 34 and 36 years; a teenager (14 years); a 9-year-old; a 10-year-old; and 7 children less than a year in age. Both of the adults died of coronary artery anomalies, with no medical history for one individual and a vague unsubstantiated history of "heart disease" in the other. The 9-year-old, 10-year-old, and the teenager had histories of congenital heart disease. Of the 7 infants, 1 (age 4 months) had a history of heart disease. The other 6 children, all without any history, were 36 h to 2 months old. Three had a single ventricle, and there was one case each of transposition of the great vessels, coarctation of the aorta, and cardiomyopathy.

There were 10 cases of myocarditis with the individuals varying in age from 6 weeks to 52 years. Miscellaneous cardiac conditions causing death were the Wolfe-Parkinson-White syndrome, acute and subacute rheumatic fever, primary arrhythmias, and a dissecting aneurysm of the left anterior descending coronary artery in a 40-year-old woman 1 month postpartum.

There were 7 deaths due to rupture of an atherosclerotic aneurysm of the aorta, 6 involving the abdominal aorta and 1 the thoracic aorta; the average age was 69 years, and all the victims were male. Sixteen individuals had dissecting aortic aneurysms; the average age was 54 years, with males predominating 10 to 7 over females. Two cases showed both acute and old dissections. Ten of the 16 cases had the typical dissection pattern beginning in the ascending arch and running down to the abdominal aorta. In 3 cases, there was only dilatation of the ascending aorta with rupture, while in another 3, the dissection was confined to the arch of the aorta.

Diseases of the Central Nervous System

Diseases of the central nervous system caused 87 (8.7%) of the natural deaths (Table 4). Seizure disorders accounted for the largest number (36) of these deaths. Thirty-two of the seizure deaths were due to epilepsy; 4 were due to alcoholic seizures. Of the 32 epileptics, 29 had idiopathic epilepsy. Of the others, in 2 instances the seizures were related to vascular malformations and in 1 to a consequence of hypoxic brain injury occurring at birth. In the individuals with idiopathic epilepsy, males outnumbered females 16 to 13.

Intracerebral hemorrhage accounted for 23 deaths. Males predominated 16 to 7. A history of hypertension could be obtained in 9 of the individuals. In one instance, the intracerebral hemorrhage was due to a vascular malformation. (Most deaths secondary to intracerebral hemorrhage do not become medical examiner cases. This is because these individuals usually do not die immediately, living long enough for a clinical diagnosis to be made.)

Berry aneurysms accounted for 19 deaths, females predominating 12 to 7. Other causes of death were meningococcal meningitis, agenesis of the corpus callosum, hydrocephalus, Huntington's chorea, presenile dementia, and Dandy-Walker syndrome.

Diseases of the Respiratory System

Deaths due to disease of the respiratory system were almost as common (8.6%) as those due to the central nervous system (Table 4). Pneumonia accounted for 40 deaths, 16 of which were of children 12 years or less in age. Of the 24 adults, 11 had a history of alcoholism, 4 had neurological impairment of some sort, 2 had psychiatric histories, and 1 had chronic obstructive pulmonary disease.

Asthma accounted for 12 deaths, which were equally divided between males and females. The age distribution was random, from young children to individuals 50 years of age.

There were 11 deaths due to massive pulmonary emboli, 4 to tuberculosis, 7 to primary malignant tumors, and 1 to epiglottitis.

TABLE 4—*Deaths due to central nervous system and respiratory diseases.*

CENTRAL NERVOUS SYSTEM DISEASE	
Seizure disorder	36
Intracerebral hemorrhage	23
Rupture of berry aneurysm	19
Primary tumor	3
Other conditions	6
Total	87
RESPIRATORY SYSTEM DISEASES	
Pneumonia	40
Asthma	12
Tuberculosis	4
Primary malignant tumor	7
Pulmonary emboli	11
Other	12
Total	86

Diseases of the Hepatic System

There were 42 deaths due to diseases of the liver (Table 5). Thirty-seven deaths were a consequence of chronic alcoholism with cirrhosis, hepatic failure, fatty metamorphosis, or some combination of these. In 2 cases, there was massive nontraumatic intraabdominal hemorrhage due to alcoholic cirrhosis. This entity has been described by Di Maio [4].

Diseases of the Gastrointestinal System

Thirty deaths were due to disease of the gastrointestinal (GI) system (Table 5). Twenty-one deaths were due to massive hemorrhage, with 18 of these a consequences of chronic alcoholism with resultant cirrhosis and esophageal varices. Two other individuals had massive bleeding from gastric ulcers and 1 from a duodenal ulcer. Males predominated 15 to 6. Three individuals died of primary GI tumors and 3 others as a result of peritonitis due to a ruptured bowel following a small bowel obstruction. One individual died of complications of spontaneous rupture of the esophagus, secondary to vomiting.

Pancreas/Diabetes Mellitus

There were 12 deaths in this category (Table 6). Nine individuals died of diabetic ketoacidosis. They ranged in age from 31 to 60 years. The vitreous glucose levels ranged from 648 to 791 mg/dL.

Urogenital Disease

There were 12 deaths in this category (Table 6). The most interesting was that of a woman who died during labor of an amniotic fluid embolism.

Deaths in Infants

There were 124 deaths of children less than a year in age (Table 7). The 91 deaths ascribed to sudden infant death syndrome (SIDS) were all children less than 10 months

TABLE 5—Deaths due to disease of the hepatic system and GI system.

HEPATIC DISEASES	
Cirrhosis, fatty metamorphosis, hepatic failure due to chronic alcoholism	37
Peritonitis secondary to cholecystitis	2
Primary tumor	1
Primary intraabdominal hemorrhage due to cirrhosis	2
Total	42
GI DISEASES	
Hemorrhage	21
Primary tumor	3
Small bowel obstruction with peritonitis	3
Other	3
Total	30

TABLE 6—Deaths due to diseases of the pancreas and the urogenital system.

PANCREATIC DISEASE	
Diabetic ketoacidosis	9
Pancreatitis	2
Primary tumor	1
Total	12
UROGENITAL DISEASE	
Uremia	6
Acute pyelonephritis	3
Primary tumor	1
Amniotic fluid embolism	1
Peritonitis	1
Total	12

TABLE 7—Causes of death in children less than one year of age.

SIDS	91
Infection	20
Congenital defects	10
Other	3
Total	124

of age (the oldest was 9 months old) (Table 8). Of the 10 children with congenital defects, 7 involved the heart. The 3 "other" causes of death listed in Table 7 were prematurity, seizures, and cardiomyopathy. Twenty children died as a result of infections; pneumonia/bronchitis accounted for 10 of these cases.

Discussion

As expected, cardiovascular disease accounted for the greatest number of natural deaths (60.9%). Coronary atherosclerosis was not only the main cause of cardiovascular deaths, but also of all natural deaths, accounting for 45.1% of such cases. In 11.9% of deaths due to coronary artery disease, the disease was confined to a single vessel. Also, not unexpectedly, this vessel was the left anterior descending coronary artery in 74.1% of the cases. Thrombosis of a coronary artery was present in only 13.3% of our cases. Coronary thrombosis appears to be associated with a higher incidence of myocardial scarring and acute myocardial infarction than in coronary artery deaths as a whole.

After coronary artery disease, the frequency of other causes of death drops off dramatically, that is, cardiomyopathy was 7.8%; seizure disease, 3.6%; pneumonia, 4%; and so forth. Chronic abuse of alcohol took a heavy toll, accounting for 9.4% of the deaths, if one adds up all causes of death due to this condition. Thus, cirrhosis was the cause of 37 deaths; intraabdominal hemorrhage complicating cirrhosis, 2 deaths; GI hemorrhage, 18 deaths; pancreatitis, 2 deaths; alcoholic seizures, 4 deaths; pneumonia complicating alcoholism, 11 deaths; and cardiomyopathy due to alcoholism, 20 deaths. In actuality, this last cause of death is understated in that more of the cardiomyopathy deaths were probably due to alcoholism.

TABLE 8—SIDS deaths.

Age, months	Number
1	17
2	29
3	20
4	9
5	9
6	2
7	3
8	0
9	2
Total	91

In children less than a year old, the most common cause of death was SIDS (91 cases), followed by infection (20 cases), and congenital defects (10 cases). In deaths attributed to SIDS, 66 of the 91 cases occurred in the first 3 months of age, 18 in the 4th and 5th months, and only 7 in the 6 to 9-month age group. Half of the deaths due to infection were due to pneumonia/bronchitis. Six children dying suddenly of congenital heart disease were undiagnosed prior to autopsy. Three of these had a single ventricle, and one each had transposition of the great vessels, coarctation of the aorta, and cardiomyopathy.

References

- [1] Petty, C. S. and Di Maio, V. J. M., "The Medical Community and the Medical Examiner," *Dallas Medical Journal*, Vol. 65, 1979, pp. 288-294.
- [2] *Standards for Inspection and Accreditation of a Modern Medicolegal Investigative System*, 2nd ed., National Association of Medical Examiners, 1988.
- [3] Vanatta, P. R. and Petty, C. S., "Limitations of the Forensic External Examination in Determining the Cause and Manner of Death," *Human Pathology*, Vol. 18, 1987, pp. 170-174.
- [4] Di Maio, V. J. M., "Sudden Unexpected Death Due to Massive, Nontraumatic Intra-abdominal Hemorrhage in Association with Cirrhosis of the Liver," *American Journal of Forensic Medical Pathology*, Vol. 8, No. 3, 1987, pp. 266-268.

Address requests for reprints or additional information to
 Vincent J. M. Di Maio, M.D.
 Chief Medical Examiner
 Bexas County Medical Examiner's Office
 600 North Leona
 San Antonio, TX 78207