

# Quality of Death Certificate Diagnoses of Arteriosclerotic Heart Disease

LEWIS KULLER, M.D., Dr.P.H., ABRAHAM LILIENFELD, M.D., M.P.H., and RUSSELL FISHER, M.D.

**E**PIDEMIOLOGIC STUDIES of arteriosclerotic heart disease (ASHD) based on death rates are numerous. Differences in death rates between ethnic, racial, and social groups have stimulated further prospective and cross sectional studies of cardiovascular disease. The differences between urban and rural areas and among different geographic areas of the United States have generated many hypotheses, a number of which remain unclear at present. The accuracy of the reporting of the underlying cause of death on a death certificate may be poor, and therefore the reliability of reported death rates may be questionable. Differences among geographic areas and between various racial, social, and ethnic groups within communities can be caused by variations in certification of the underlying cause of death by physicians.

However, adequate studies to determine whether the large differences in death rates be-

tween areas of the United States actually reflect a difference in the incidence of the disease or are only due to artifacts of certification of cause of death practices or diagnostic methods of physicians have not been completed.

Several types of studies have attempted to determine the accuracy of the underlying cause of death on the death certificate. These studies can be divided into three categories.

1. A query of physicians who signed the death certificates to determine the criteria of diagnosis, followed by a comparison between the underlying cause reported on the death certificate and a diagnosis made by another physician using the information provided by the physician signing the certificate (1).

2. An evaluation of the cause of death statement by reviewing available medical information and comparing the cause of death as determined independently by two or more physicians. The second method differs from the first only in that records are reviewed rather than using information supplied by the physician who certified the cause of death (2-4).

3. A comparison of pathology observed at autopsy with the underlying cause of death (5, 6). This type of study is limited by the selectiveness, according to the circumstances of death, with which autopsies are performed and by the lack of correlation between certain clinical diagnoses and pathological observations.

Studies that attempt to measure the accuracy of arteriosclerotic heart disease as the underlying cause of death are difficult for several reasons.

1. A high proportion of deaths attributed to arteriosclerotic heart disease are sudden and

---

*Dr. Kuller is assistant professor of chronic diseases, and Dr. Lilienfeld is professor of chronic diseases, Johns Hopkins University School of Hygiene and Public Health, Baltimore. Dr. Fisher is chief medical examiner of the State of Maryland.*

*The study was supported in part by Public Health Service training grants Nos. HE 5297 and HE 5082, National Heart Institute, general research support grant No. GS 1501-FR 5445-04, National Institutes of Health, and by a Public Health Service research career program award, No. K6-GM-13,901 from the National Institute of General Medical Services.*

*The Computing Center of the Johns Hopkins Medical Institutions did part of the computations for the study.*

unexpected, and frequently both the clinical and pathological information are meager.

2. Because of the association of several cardiovascular diseases in the same person, the choice of a single underlying cause of death is frequently arbitrary.

3. A high proportion of deaths attributed to arteriosclerotic heart disease are certified by the medical examiner or coroner. Changing patterns as well as variations in certification by medical examiners among communities may influence both geographic differences in rates and trends in mortality attributed to arteriosclerotic heart disease.

As part of an epidemiologic study of sudden and unexpected death, we determined the clinical criteria for the diagnosis of arteriosclerotic heart disease as reported on the death certificate and whether arteriosclerotic heart disease was a principal cause of death or an associated disease.

#### Method of Study

A stratified systematic sample of all deaths from nontraumatic causes of Baltimore residents aged 20–64 years who died between June 15, 1964, and June 14, 1965, was obtained from the records of the Baltimore City Health Department. A total of 1,857 deaths, or 49.6 per-

cent of all deaths of Baltimore residents during the study period, comprised the sample (table 1).

Included in the 1,857 deaths were the following groups: (a) all deaths of persons less than 40 years old, (b) all deaths occurring outside a hospital, (c) 25 percent of deaths in hospitals of persons aged 40–64 that were certified by the medical examiner, (d) 33 percent of deaths in hospitals not so certified, and (e) all deaths of Baltimore residents aged 20–64 occurring outside the city, except those occurring in State hospitals.

After death certificates had been obtained, the deaths were classified into a high and a low probability of sudden death before further review. The high and low probability of sudden death was determined from information on the death certificate, including estimated length of treatment, cause of death, and interval from the onset of the disease until death.

The group of deaths that were classified as low probability were not reviewed further, and only the information on the death certificates was obtained for this group. A total of 408 (25.4 percent) of all deaths in Baltimore City were in this low probability category. However, all deaths in which the death certificates mentioned cardiovascular disease were thoroughly reviewed, as well as the remaining deaths

**Table 1. Deaths in sample and deaths attributed to arteriosclerotic heart disease before and after adjustment for sampling, by age group, Baltimore, June 15, 1964–June 14, 1965**

Age group, place of death, and certification	Number Baltimore residents	Sample		Deaths in sample from arteriosclerotic heart disease		
		Number	Percent	Number before adjustment	After adjustment for sampling fractions	
					Number	Percent of all deaths of Baltimore residents
20 to 39 years.....	322	322	100.0	29	29	9.0
40 to 64 years.....	3,421	1,535	44.9	524	1,098	32.1
Medical examiner, hospital.....	608	151	24.8	80	320	52.6
Medical examiner, nonhospital.....	140	140	100.0	72	72	51.4
No medical examiner, hospital.....	2,098	669	31.9	167	501	23.9
No medical examiner, non-hospital.....	390	390	100.0	140	140	35.9
Outside city.....	185	185	100.0	65	65	35.1
Total.....	3,743	1,857	49.6	553	1,127	30.1

classified as being a high probability of sudden death. Available information was reviewed in order to determine the causes of death and the accuracy of the diagnosis.

For deaths certified by the medical examiner of Baltimore City, his records were reviewed including a report by a nonmedical investigator employed by the medical examiner's office who determines the date and place of death, the circumstances associated with the death, and obtains information from the next-of-kin, hospital, and physicians about the medical history of the dead person. The medical examiner's report also includes results of an investigation conducted by the police department.

For all inhospital deaths, the hospital record was abstracted by a physician and the admitting diagnosis, length of hospitalization, diagnostic information, and causes of death were obtained. The results of the electrocardiogram in the hospital record were accepted as the diagnosis, and no attempt was made to reinterpret the electrocardiogram. When there was more than one electrocardiogram, the most abnormal recording, excluding a terminal arrhythmia such as asystole and fibrillation, was selected as the diagnosis.

In the deaths occurring outside of a hospital and not certified by the medical examiner, a letter was sent to the certifying physician requesting information about the cause of the person's death, degree of disability, and medical history. In these deaths the physicians' records, such as electrocardiograms, were not reviewed so that only the physicians' interpretations of clinical findings were the basis of our classifications.

## Results

*Distribution of arteriosclerotic heart disease deaths.* In 553 (29.8 percent) of the 1,857 deaths in the original sample arteriosclerotic heart disease was considered to be the principal cause of death. After we had adjusted for sampling by multiplying by four the deaths in the hospital of persons aged 40-64 certified by the medical examiner and by multiplying by three the deaths of those aged 40-64 not so certified (the inverse of the sampling fractions), 1,098 deaths of persons aged 40-64 and 29

deaths of those 20-39 were estimated as having been caused by arteriosclerotic heart disease. In table 1 the distribution of these 1,098 deaths is presented by place of death before and after adjusting for sampling.

*Criteria for the diagnosis of arteriosclerotic heart disease.* Because of the difficulty of obtaining detailed information about deaths outside of Baltimore, the discussion is limited to deaths in Baltimore City only. In 452 of the 488 deaths in which we decided that arteriosclerotic heart disease was the principal cause of death, ASHD was also stated to be the underlying cause of death on the certificate (rubrics 420 and 422, International Classification of Diseases, 7th revision) while for the remaining 36, arteriosclerotic heart disease was either the immediate or contributing cause on the death certificate (table 2).

In 170 of the 488 deaths we attributed to arteriosclerotic heart disease, the death had been certified by the medical examiner. In 69 (40.6 percent) of the 170 deaths, the diagnosis was based on an autopsy examination, and in the remaining 101 deaths the diagnosis was

**Table 2. Underlying cause of death as reported in vital records of 488 deaths determined to be due to arteriosclerotic heart disease,<sup>1</sup> Baltimore City deaths only, unadjusted sample**

Underlying cause of death	ICD rubric 7th revision	Number attributed to ASHD	Percent of all ASHD deaths
Neoplasms.....	140-239	1	0.2
Diabetes.....	260	22	4.5
Rheumatic fever and heart disease.....	400-416	1	.2
Arteriosclerotic heart disease....	420 and 422	452	92.7
Chronic endocarditis and other diseases of heart.....	421, 430-434	4	.8
Diseases of arteries.....	450-456	1	.2
Remaining.....	-----	7	1.4
Total.....	-----	488	-----

<sup>1</sup> Arteriosclerotic heart disease deaths includes deaths attributed to myocardial infarction, coronary insufficiency, coronary thrombosis, atherosclerotic heart disease, arteriosclerotic heart disease, coronary artery disease, and angina pectoris.

based either on a past history of arteriosclerotic heart disease or on the rapidity of the death.

Of the 170 deaths, 122, of persons aged 40-64 years, were considered sudden deaths. Sudden death was defined in this study as "An individual who died due to natural causes and who was not restricted to his house, hospital, or other institution and who was able to function in the community 24 hours prior to death. The time interval for the onset of the fatal event until death was less than 24 hours."

In table 3 the frequency of autopsy of the sudden deaths certified by the medical examiner is presented according to the final diagnosis and history of arteriosclerotic heart disease. Clearly, if the dead person had a history of heart disease, the medical examiner would certify the cause of death as arteriosclerotic heart disease or hypertensive heart disease, usually without an autopsy examination; if the dead person had no history of arteriosclerotic heart disease, then an autopsy examination and another diagnosis (other than arteriosclerotic heart disease) would be much more likely. Whether or not the medical examiner would find a cause of death other than arteriosclerotic heart disease if the bodies of persons with a history of arteriosclerotic heart disease were autopsied cannot be determined. A study of autopsy observations of all sudden deaths or an unbiased sample of sudden deaths is needed.

Approximately 35.7 percent (174) of the 488

deaths before adjusting for sampling were listed on the death certificate as having occurred in a hospital and were not certified by the medical examiner (table 4). However, 57 (32.0 percent) of the 174 deaths in hospitals were of persons dead on arrival at the hospital. In 57 (32.0 percent) of the 174 deaths in a hospital attributed to arteriosclerotic heart disease and not certified by the medical examiner, an autopsy examination had been performed. In no instance did the pathologist report that a diagnosis other than arteriosclerotic heart disease was the principal cause of death.

Although many of the persons were found to have had a recent myocardial infarction, in others the observations were of severe atherosclerosis. Because of the considerable variation of autopsy reports among hospitals, no attempt was made to enumerate the specific manifestations of coronary artery disease reported on each autopsy protocol. In 63 of the remaining 69 deaths without autopsy and of persons not dead on arrival, the electrocardiogram was interpreted as showing a myocardial infarction or another abnormality suggestive of coronary artery disease (table 4). In three of the five deaths in which no EKG report was available, the person had died after a few hours in the hospital, and it is quite possible that the EKG was not reported on the clinical record. In the other two deaths in which the EKG was normal, the person had been admitted to the hospital

**Table 3. Final diagnosis of sudden deaths, medical examiner-certified, of persons 40-64 years (unadjusted sample), by history of arteriosclerotic heart disease and by autopsies performed**

Category	Final diagnosis of cause of death						Total	
	Arteriosclerotic heart disease		Hypertensive heart disease		Other			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
History of ASHD.....	49	79.0	9	14.5	4	6.5	62	100.0
Autopsies performed.....	8	16.3	0	-----	3	75.0	11	17.7
No history of ASHD.....	73	46.2	32	20.3	53	33.5	158	100.0
Autopsies performed.....	41	56.2	21	65.6	43	81.1	105	66.5
Total certified by medical examiner.....	122	55.5	41	18.6	57	25.9	220	100.0
Total autopsies performed.....	49	40.2	21	51.2	46	80.7	116	52.7

with another diagnosis and had died suddenly in the hospital, apparently of acute coronary disease.

There were 144 deaths that had occurred outside of a hospital and 57 persons that were dead on arrival at the hospital (table 4). The majority of these were medically unattended just before death, and the diagnosis of arteriosclerotic heart disease was based on either a history of arteriosclerotic heart disease, the rapidity of death, and the absence of other significant diseases that may have caused the death. As noted in table 5, 120 (62 percent) of these 192 deaths in which no autopsies were performed

were considered sudden deaths, and 72 not-sudden deaths. In the 120 sudden deaths, 95 (79 percent) of the persons had a history of heart disease while for the remaining 25 the diagnosis of arteriosclerotic heart disease was based principally on the rapidity of death. Also, in about three-fourths (55) of the 72 not-sudden arteriosclerotic heart disease deaths there was a history of heart disease.

*Deaths outside of Baltimore City.* There were 42 sudden and 23 not-sudden deaths attributed to arteriosclerotic heart disease that had occurred outside of Baltimore City. Although we were successful in most cases in ob-

**Table 4. Evaluation of the diagnosis of arteriosclerotic heart disease deaths of Baltimore City residents aged 20-64 years, unadjusted sample**

Place of death and certification status	All deaths	Diagnostic criteria <sup>1</sup>									
		Autopsies performed		Abnormal EKG's		History of ASHD		Sudden death with no history of ASHD		Not-sudden death with no history of ASHD	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Not certified by medical examiner:											
Hospital, excluding those dead on arrival.....	117	48	41.0	63	53.9	43	75.4	2	1.7	4	3.4
Hospital, dead on arrival.....	57	9	15.8	-----	-----	-----	-----	2	3.5	3	5.3
Nonhospital.....	144	-----	-----	-----	-----	107	74.3	23	16.0	14	9.7
Certified by medical examiner.....	170	69	40.6	-----	-----	63	37.1	28	16.5	10	5.9
Total.....	488	126	25.8	63	12.9	213	43.6	55	11.3	31	6.4

<sup>1</sup> All diagnostic categories are mutually exclusive.

**Table 5. Criteria for diagnosis of arteriosclerotic heart disease deaths outside a hospital,<sup>1</sup> Baltimore residents aged 20-64 years**

Diagnostic criteria	Sudden death		Not-sudden death		Total	
	Number	Percent	Number	Percent	Number	Percent
History of heart disease.....	95	79.2	55	76.4	150	78.1
No history of heart disease, interval between onset of symptoms and death:						
Less than 2 hours.....	15	12.5	-----	-----	15	7.8
2-24 hours.....	3	2.5	-----	-----	3	1.6
Less than 24 hours, unwitnessed.....	7	5.8	-----	-----	7	3.6
More than 24 hours.....	0	-----	17	23.6	17	8.9
Total.....	120	100.0	72	100.0	192	100.0

<sup>1</sup> Includes deaths outside a hospital and those dead on arrival and not autopsied.

taining information as to whether or not the death was sudden and obtaining summaries of hospital records, the inability to review available clinical records in their entirety limited our interpretation of the accuracy of these death certificates.

*Deaths in which arteriosclerotic heart disease was not the principal cause of death.* On 478 death certificates, arteriosclerotic heart disease was listed as the underlying cause of death. In 452 of these deaths, we decided that arteriosclerotic heart disease was the principal diagnosis (table 2). In another 26 in which arteriosclerotic heart disease was listed as an underlying cause, additional information suggested another diagnosis as the most likely cause (table 6). In 19 of these 26 cerebrovascular disease was the principal cause of death. The physician usually certified cerebrovascular disease as the immediate cause or, in several instances, had attributed the death to "CVD" which was classified by the health department coder as cardiovascular rather than cerebrovascular disease. Of the 43 deaths in which arteriosclerotic heart disease was a contributing cause, 26 were attributed to hypertensive heart disease (table 6). Most of these deaths were certified by the medical examiner and were sudden deaths. It is likely that in this age group,

deaths attributed to hypertensive heart disease are probably caused by a combination of hypertensive and arteriosclerotic heart disease.

In six deaths cancer was considered to be the principal diagnosis. All patients had terminal metastatic cancer, and there was little doubt that cancer rather than heart disease was the principal cause of death.

*Deaths with no mention of arteriosclerotic heart disease on the death certificate.* We attempted to determine whether any deaths in which the diagnosis of arteriosclerotic heart disease did not appear on the death certificate may have had significant clinical coronary artery disease. This was done in several ways.

1. In deaths of persons aged 40-64 years certified by the medical examiner, autopsy protocols were reviewed to see if arteriosclerotic heart disease might be a cause of death. The medical examiner's reports were also examined for mentions of a history of arteriosclerotic heart disease. Autopsies were performed in 46, or 80.7 percent, of the 57 sudden deaths not attributed to arteriosclerotic or hypertensive heart disease and in 14, or 44 percent, of the 32 not-sudden deaths. Review of the autopsy and examiner's reports revealed no evidence that any of these deaths should have been attributed to arteriosclerotic heart disease.

2. For 316 deaths in hospitals not certified by the medical examiner and in which the diagnosis of arteriosclerotic heart disease or hypertensive heart disease was not listed on the death certificate, autopsy protocols and clinical records were reviewed. Autopsy protocols were available in 66 (20.9 percent) of the 316 deaths. The pathologist did not consider arteriosclerotic heart disease as the most likely cause of death of any of these persons. A review of the 316 hospital records also failed to reveal instances of death attributable to arteriosclerotic heart disease not reported on the death certificate.

3. In 54 deaths outside of a hospital not certified by the medical examiner and not due to arteriosclerotic heart disease, hypertensive disease, or cerebrovascular disease, the physician had reported a history of heart disease in 7, but in 5 of the 7 the diagnosis of arteriosclerotic heart disease was also listed on the death certificate. Also, in 14 (36 percent) of 39

**Table 6. Reclassification of cause of deaths in which the death certificate listed arteriosclerotic heart disease as underlying or contributing cause**

More likely cause of death	Arteriosclerotic heart disease listed as—		Total
	Underlying cause	Contributing cause	
Cancer.....	0	6	6
Pulmonary disease.....	0	4	4
Gastrointestinal disease.....	0	3	3
Pulmonary embolism.....	2	0	2
Alcoholism.....	1	0	1
Hypertensive heart disease.....	0	26	26
Cerebrovascular disease.....	19	4	23
Peripheral vascular disease.....	1	0	1
Uremia.....	3	0	3
Total.....	26	43	69

deaths outside of a hospital due to cerebrovascular disease, the physician had reported a history of arteriosclerotic heart disease. In 4 of these 14 the diagnosis of arteriosclerotic heart disease did not appear on the death certificate.

### Discussion

We have previously reported that 60 percent of arteriosclerotic heart disease deaths that had occurred to Baltimore residents during a 1-year period were sudden (7). Because of the rapidity of these deaths clinical data to support the diagnosis of arteriosclerotic heart disease as listed on the death certificate are meager. Even in those deaths in which autopsies were performed the pathological information may not be conclusive. A recent myocardial infarction or coronary thrombosis may be noted in only a small percent of the sudden cardiac deaths (3, 8-11). Frequently, the only pathological finding reported is a significant degree of atherosclerosis.

After adjusting for sampling we found that only 33.3 percent of all those whose deaths were attributed to arteriosclerotic heart disease including both sudden and not-sudden deaths survived long enough to be admitted to the hospital, and only 19 percent survived longer than 24 hours in a hospital (7). Therefore clinical information at the time of the fatality is available in only a small number of the deaths.

Many of the sudden deaths were either unwitnessed or occurred with great rapidity (7), so that it was not possible to obtain detailed information about symptoms before death.

Actually, we are left with only two criteria that determine why many of the deaths are certified as being caused by arteriosclerotic heart disease; a history of heart disease as reported in 50 percent of the sudden and 65.3 percent of the not-sudden deaths and the rapidity of death (7).

If we accept the evidence from autopsy studies that most deaths of healthy persons that are rapid and occur within 1 or 2 hours after onset of symptoms were due to arteriosclerotic heart disease, and that individuals with a history of heart disease who died suddenly had most likely succumbed because of their heart disease, then a basis for the diagnosis of the arteriosclerotic

heart disease deaths does exist. However, if we are skeptical of the adequacy of the autopsy studies and believe that persons with a history of arteriosclerotic heart disease also die suddenly because of a cerebrovascular accident, ruptured abdominal aneurysm, or pulmonary embolism, then the criteria for the certification leave much to be desired.

It is possible that geographic differences in arteriosclerotic heart disease death rates may reflect differences in the frequency with which sudden deaths are certified as caused by arteriosclerotic heart disease. If a diagnosis other than arteriosclerotic heart disease was stated as the cause of death in the unwitnessed and less than 2-hour categories, then the death rate in white males in this study aged 40-64 would be 60 percent lower. Also, within any geographic area, the relationship of arteriosclerotic heart disease death rates to such factors as socioeconomic status, race, and occupation may be affected by the proportion of sudden deaths certified as having been due to arteriosclerotic heart disease.

Much of the knowledge of the pathogenesis of coronary artery disease and its distribution in different geographic areas is based on observations at autopsy; since many of these studies are limited either to deaths occurring in hospitals or deaths certified by the medical examiner, but rarely both, an unknown bias exists. We do not know whether the pathology of coronary disease is similar in those that survived long enough to reach a hospital and in those who died suddenly outside of a hospital or were dead on arrival at the hospital. We found that deaths in which autopsies were performed were different in several ways from deaths without a subsequent autopsy, especially in the frequency of a history of heart disease, so that the deaths which were followed by autopsy may not be a representative sample of all deaths.

Arteriosclerotic heart disease deaths of Negroes and whites of lower socioeconomic class were more likely to be certified by a medical examiner (12). This factor must be considered in comparing the prevalence of arteriosclerotic heart disease in various racial and social groups when studies are based on autopsies performed in hospitals.

Further exploration of arteriosclerotic heart disease mortality in different communities is clearly indicated. Whether the differences in death rates between geographic areas of the United States can be substantiated by careful study should be determined. Our understanding of the pathogenesis of arteriosclerotic heart disease may be considerably enhanced if the factor or factors responsible for differences in mortality rates can be delineated. However, investigators should be wary of attempting to set rigid criteria for the diagnosis of deaths from arteriosclerotic heart disease. Consider that in a large metropolitan community with two medical schools, several other affiliated teaching hospitals, and a very active medical examiner's office, we still have based our diagnoses of deaths caused by arteriosclerotic heart disease on what many believe to be minimal criteria.

### Summary

Nontraumatic deaths of Baltimore residents aged 20–64 years, occurring between June 15, 1964, and June 14, 1965, were investigated. The accuracy of the diagnosis listed on the death certificate was determined by reviewing available medical information and from interviews of next-of-kin or other relatives or friends of the dead person.

A stratified sample of approximately 50 percent (1,857) of the total deaths was reviewed. In 553 (29.8 percent) of these 1,857 deaths arteriosclerotic heart disease was considered to be the principal cause of death. Of the 553 deaths due to arteriosclerotic heart disease 488 (88.4 percent) occurred within Baltimore City. In 452 (92.6 percent) arteriosclerotic heart disease (rubrics 420 and 422) had been considered as the underlying cause of death and in the other 36 (7.4 percent) as either an immediate or contributing cause. Because of the rapidity of the events leading up to the deaths attributed to arteriosclerotic heart disease, the accuracy of the diagnosis is often based only on a history of heart disease, suddenness of the death, and the absence of other significant diseases.

### REFERENCES

- (1) Moriyama, I. M., Baum, W. S., Haenszel, W. M., and Mattison, B. W.: Inquiry into diagnostic evidence supporting medical certifications of death. *Amer J Public Health* 48: 1376–1387, October 1958.
- (2) Garcia-Palmieri, M. R., et al.: Coronary heart disease mortality—a death certificate study. *J Chronic Dis* 18: 1317–1323, December 1965.
- (3) Skyring, A., Modan, B., Crocetti, A., and Hammerstrom, C.: Some epidemiological and familial aspects of coronary heart disease: report of a pilot study. *J Chronic Dis* 16: 1267–1279, December 1963.
- (4) Gearing, F. R., Caron, L. P., and Schweitzer, M. D.: Data in support of death certificate diagnosis of coronary artery disease in New York City. Presented at American Public Health Association meeting, New York, Oct. 5, 1964.
- (5) James, G., Patton, R. E., and Heslin, A. S.: Accuracy of cause-of-death statements on death certificates. *Public Health Rep* 70: 39–51, January 1955.
- (6) Beadenkopf, W. G., Abrams, M., Daoud, A., and Marks, R. U.: An assessment of certain medical aspects of death certificate data for epidemiologic study of arteriosclerotic heart disease. *J Chronic Dis* 16: 249–262, March 1963.
- (7) Kuller, L., Lilienfeld, A., Fisher, R.: An epidemiological study of sudden and unexpected deaths due to arteriosclerotic heart disease. *Circulation* 34: 1056–1068, December 1966.
- (8) Baroldi, G.: Acute coronary occlusion as a cause of myocardial infarct and sudden coronary heart death. *Amer J Cardiol* 16: 859–880, December 1965.
- (9) Crawford, T.: Thrombotic occlusion and the plaque. *In* Evolution of the atherosclerotic plaque, edited by R. J. Jones. University of Chicago Press, Chicago, 1963, pp. 279–290.
- (10) Spain, D., and Bradess, V.: Relationship of sex, age and physical activity to sudden death from coronary occlusion. *In* Work and the heart, edited by F. F. Rosenbaum and E. L. Belknap. Paul B. Hoebner, Inc., New York, 1959, p. 283.
- (11) Weinberg, S. B., and Helpert, M.: Circumstances related to sudden and unexpected death in coronary heart disease. *In* Work and the heart, edited by F. F. Rosenbaum and E. L. Belknap. Paul B. Hoebner, Inc., New York, 1959, p. 288.
- (12) Kuller, L., Lilienfeld, A., and Fisher, R.: Sudden and unexpected deaths due to natural causes in adults. A comparison of deaths certified and not certified by the medical examiner. *Arch Environ Health* 13: 236–242, August 1966.