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Natural Death While Driving

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ABSTRACT: Of sudden natural deaths while driving, 126 occurred during 1980 through 1985 in the northern half of Sweden. The mean age of the 69 car driver victims was 59 years, considerably higher than that of traumatic car deaths, and all but 2 were males. The mean age of 57 operators of other vehicles was 66 years, and of these, 6 were women. Seven car drivers were stricken during commercial employment. Most accidents occurred during daytime and the distribution of the weekdays was fairly even. Ischemic heart disease accounted for 112 deaths, and other cardiovascular diseases for an additional 9 deaths. Only 1/5 of the victims experienced previous symptoms of disease. Out of at least 31 other persons at risk in the car deaths, only 2 passengers suffered minor injuries. The trauma in the deceased was in most cases minor in both car and other vehicle deaths. Property damage was also minimal. At least 1/3 of the drivers were able to stop the car before becoming unconscious. In none of the car cases was alcohol detected in the blood, while alcohol was identified in at least 2 of the other vehicle victims. The findings here agree with previous studies that natural deaths at the wheel are fairly uncommon, and that the risk for other persons is not significant. The value of adequate postmortem examinations of drivers dying in traffic is stressed—natural deaths can otherwise be overlooked.

KEYWORDS: pathology and biology, motor vehicle accidents, deaths, cardiovascular system, postmortem examinations

Sudden death is always dramatic, and this is particularly so when the victim is operating a vehicle, especially a motor vehicle, as other people may then be involved and injured. This has prompted some to urge restrictions of driving privileges of persons with heart disease. Such restrictions are, however, useless unless they result in greater safety. Attempts have been made to identify persons at risk of sudden cardiac death, but so far these efforts have not been successful enough for practical application.

Information is thus needed about the epidemiology and characteristics of natural deaths while driving. As recognized natural deaths are not included in the traffic statistics, we here present a study of such deaths in northern Sweden.

Material and Methods

All 126 cases of sudden natural death of persons while driving that were autopsied at the State Institute of Forensic Medicine in Umeå during the 6-year period 1980 through 1985 were included in the study. The district collects medicolegal autopsies from the 4 northern counties forming the northern half of Sweden. The district has about 900 000 inhabitants. Cases were included only if the individual died during or immediately after car driving, pedal

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cycling, motorcycling, and so forth, including 1 person who became unconscious and never regained consciousness. Pedestrians were not included. In each case, a complete necropsy was performed, including in most cases histological and toxicological analyses. All available police, social, and hospital records were scrutinized.

Injuries were classified according to the Abbreviated Injury Scale [*1*], where MAIS denotes maximum AIS, that is, the highest AIS value in an injured person.

Results

Of the 126 deceased 69 were car drivers, 35 bicyclists, 11 riders of snowmobiles, 6 mopedists, 4 riders of kick-sleds, and 1 motorcyclist.

Age and Sex

The mean age of the 69 car driver victims was 59 ± 12 years (mean ± SD) (range 29 to 81). There were only 2 females, aged 38 and 48 years (Fig. 1). The mean age of the other 57 victims was 66 ± 13 years, and among these, 6 were women (Fig. 1).

Circumstances

The car fatalities occurred most frequently on the urban road network (22 cases, 32%). County roads accounted for 17 cases (25%), parking lots and terminal areas for 12 cases (17%), forest roads for 9 cases (13%), and highways for 7 cases (10%). Working areas accounted for only 2 cases. In 7 cases (10%), the vehicles were in commercial traffic (2 taxis, four lorries, and one bus). Passengers were present in the 2 taxis and in 1 of the lorries.

Bicyclists died most frequently on the urban road network (13/35). County roads accounted for 11 cases, forest roads for 5 cases, parking lots and terminal areas for 3 cases, cycle tracks for 2 cases, and highways for 1 case.

Distribution by Months, Days, and Hours

The car accidents were evenly distributed per month except for a slightly higher incidence during November and December. There was an even distribution over the days of the week (M 19%, T 16%, W 10%, T 14%, F 9%, S 14%, S 17%), but there was a tendency that more deaths occurred at midday (Fig. 2).

The other 57 deaths seemed to be randomly distributed over the week (M 19%, T 4%, W 23%, T 11%, F 11%, S 23%, S 11%). In these cases, most of the deaths as well occurred during the daylight hours (Fig. 2). As a result of the nature of the vehicle, there was a strong seasonal variation of these other vehicle deaths.

Causes of Death

Cardiovascular disease was the primary cause of death in 67 of the 69 car deaths. Coronary atherosclerosis with recent or old myocardial infarctions or both were the predominant findings (49 cases, 71%). The mean age in cases with recent infarction only (19%) was 64 years, and 66 years in cases with old infarction only (35%). The mean age in cases with coronary atherosclerosis and myocardial fibrosis only (9%) was 48 years, and where coronary atherosclerosis only was present (13%), the victims had a mean age of 57 years. Cardiomyopathy, severe calcific aortic valve stenosis, and rupture of abdominal aortic aneurysm each accounted for 1 additional case. The 2 women were the only deaths caused by rupture of an intracranial berry aneurysm with subsequent subarachnoid hemorrhage (Fig. 3).

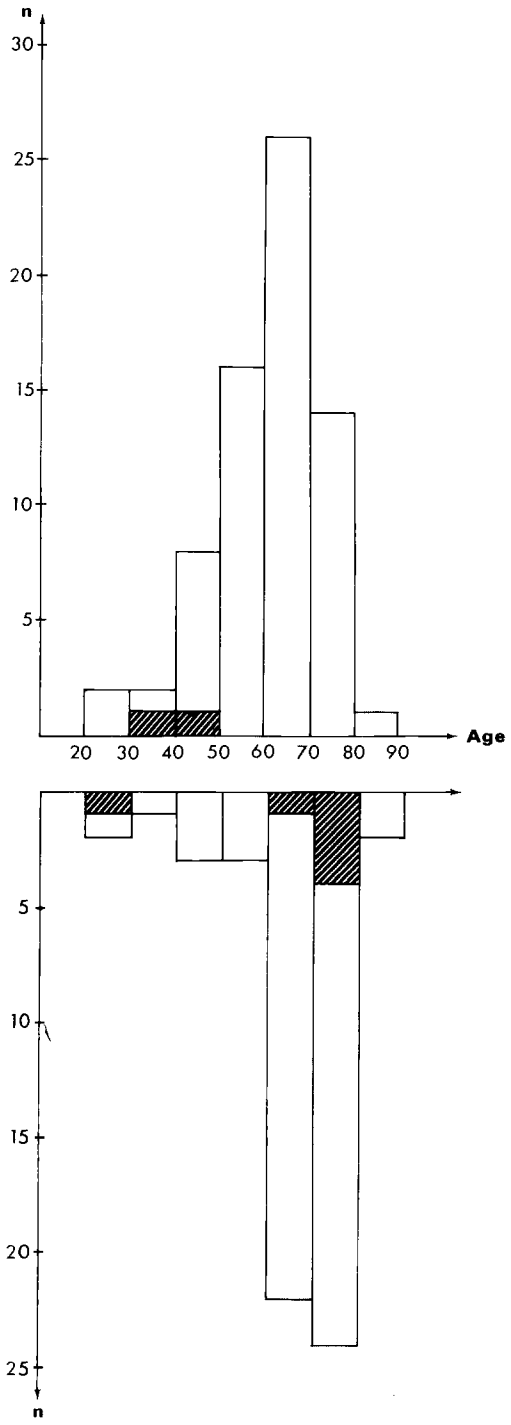

FIG. 1—*Age and sex distribution of 69 natural deaths in car traffic* (upper part) *and of 57 other vehicle deaths* (lower part). □ = *males*, ■ = *females*.

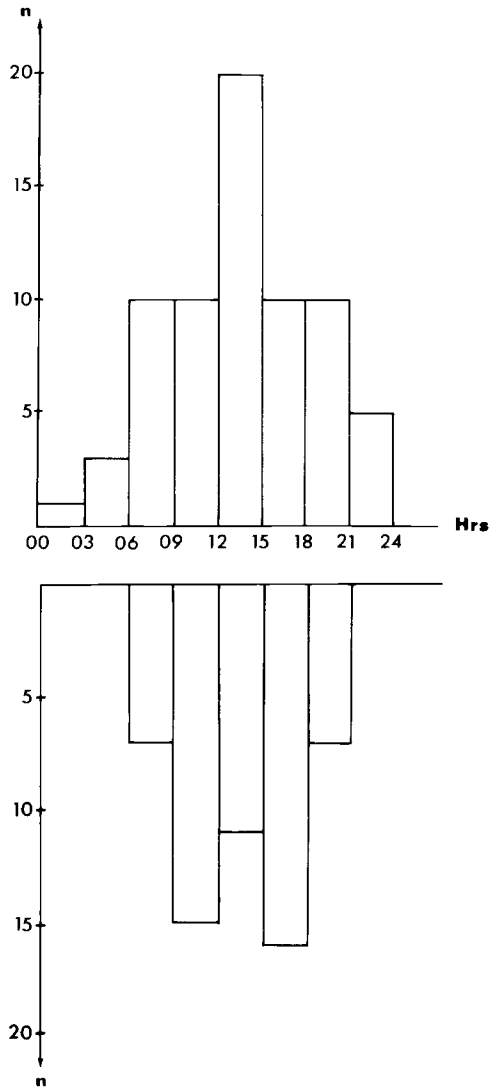

FIG. 2—*Distribution by 3-h intervals of 69 natural deaths in car traffic* (upper part) *and of 56 other vehicle deaths* (lower part). *(In one of these latter deaths the time was unknown.)*

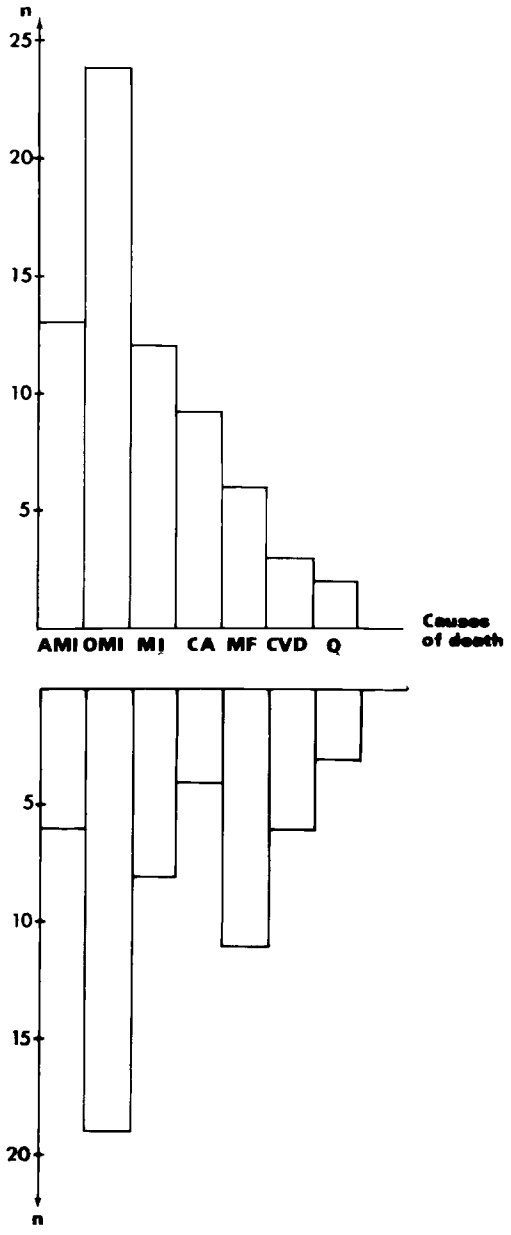

FIG. 3—*Causes of death in 69 natural deaths in car traffic* (upper part) *and of 57 other vehicle deaths* (lower part). AMI = *acute/recent myocardial infarction (with coronary atherosclerosis).* OMI = *old myocardial infarction (with coronary atherosclerosis).* MI = *acute/recent and old myocardial infarction (with coronary atherosclerosis).* CA = *coronary atherosclerosis without myocardial infarction or fibrosis.* MF = *diffuse myocardial fibrosis (with coronary atherosclerosis).* CVD = *cardiovascular disease of other types.* O = *other causes of death.*

Among the other 57 cases, coronary atherosclerosis with recent or old myocardial infarction or both accounted for 14 deaths, coronary atherosclerosis with old infarction only for 19 deaths, coronary atherosclerosis with myocardial fibrosis for 11 deaths, and coronary atherosclerosis only for 4 deaths. Cardiac malformation (3 cases), cardiomyopathy (1 case), rheumatic valve disease (1 case), dissecting aneurysm of the thoracic aorta (1 case), pulmonary embolization (2 cases), and bronchopneumonia in an alcoholic (1 case) were the other causes of death.

Symptoms of Disease

Of the car deaths, the victim had premonitory symptoms before the accident in 17 (25%) cases (Table 1). In 27 (39%) cases the victim had not mentioned any symptoms, and in 25 cases (36%) it was not recorded if the victims had expressed any symptoms. In the other 57 cases, the corresponding figures were 8 (14%), 26 (46%), and 23 (40%) (Table 1).

Personal Injuries

The number of "persons at risk" in the car deaths were 69 drivers, and at least 26 passengers, 2 pedestrians, and 3 persons in 3 separate impacted vehicles. Physical injuries were totally absent in 87% of the driver victims, while 13% had signs of trauma (5 cases MAIS = 1, 2 cases MAIS = 2, 2 cases MAIS = 3). Passengers were present in 20 cases, but only 2 of these suffered minor injuries. None of these were passengers in commercial traffic. Of the car deaths, 66 were single-vehicle incidents (96%), while in 3 cases vehicular collisions resulted. Other road users were not injured in any of these cases.

Of the bicyclists, 18 (51%) exhibited personal injuries, in most cases restricted to minor excoriations (14 cases MAIS = 1, 3 cases MAIS = 2, 1 case MAIS = 3). Additional other vehicle deaths suffered minor excoriations in a few cases (4 cases MAIS = 1, 1 case MAIS = 3). The 2 cases with MAIS = 3 both exhibited skull base fractures resulting from the fall from the vehicle and were considered to be without significance as a cause of death. In only 1 case was a road user other than the deceased injured—this was a bicyclist who ran over the deceased.

Car Damages

There was no damage to the car in 51 cases (74%) and minor damage in 14 cases (20%). In 4 cases (6%), the vehicular damage was extensive, as judged from the police records.

Danger in Traffic

The victim was classified as a danger in traffic if he/she was unable to stop his/her vehicle, or if the vehicle crossed over to the wrong side of the road. This happened in 16 (23%) of the car cases, but there was only 3 head-on collisions with other passenger cars and 1 collision

TABLE 1—*Symptoms before the incident.*

	Car Deaths	Other Vehicle Deaths
Angina pectoris	11	3
Weakness	4	3
Nausea	2	1
Abdominal pain	...	1

with a parked car. One collision was considered serious, but no other person was injured in any collision.

In 25 of the car deaths (36%), witnesses testified that death (or unconsciousness) probably occurred before the car stopped. It was proved that the victim was alive up to a few minutes after the car was stopped in 24 cases (35%). The 38-year-old woman with subarachnoid hemorrhage remained alive for 8 days without regaining consciousness. In 19 cases (28%) it was not known if the victim died before or after the car was stopped. In at least 44 cases (65%), the victim was able to slow down the speed considerably before unconsciousness or death occurred.

Nineteen of the thirty-five bicyclists, three of the six mopedists, and none of the five snowmobile riders in motion were unable to stop their vehicle before collapsing. In the rest of the non-car cases, the dying driver did not fulfill our definition of danger to other persons in the traffic. In twenty cases (35%) the driver/rider was alive after the vehicle had been stopped, in twenty-two (39%) he/she was not alive, and in fifteen cases (26%) viability was not known.

Alcohol

None of the motor car victims was found to be under the influence of alcohol while driving, but one had 0.3 g/L ethanol in the urine. In nine cases (13%) blood analyses were not performed.

One snowmobile rider had 1.3 g/L of ethanol in the blood and 2.0 g/L in the urine. One bicyclist had 0.6 g/L in the blood and 0.2 in the urine and another bicyclist had 0.3 g/L in the urine only. In 32 of the other vehicle death cases (56%) no blood toxicology was performed.

Discussion

Traffic accidents killed approximately 800 persons and injured approximately 20 000 persons each year in Sweden during the period under investigation according to official statistics. This mortality and morbidity constitute some of the largest unsolved health problems in our country. Since the human factor is the most important single aspect responsible for traffic accidents, research designed to determine the relationship between physical and mental factors and the etiology of accidents seems important.

As modern man spends a considerable time behind the wheel, it should not be surprising that a number of drivers die from disease processes while driving. Driving a vehicle often constitutes a significant emotional stress. In subjects with coronary artery disease, physical exertion as well as mental stress can result in an increasing degree of myocardial ischemia. It has been shown that substantial electrocardiographical changes and increases in blood pressure occur among drivers with manifest coronary insufficiency in relation to healthy drivers [*2,3*]. Obviously, the operation of a vehicle constitutes a stress factor for the driver with ischemic heart disease that not only endangers the driver's own health, but the safety of others on the road as well. In addition, other types of stress may be associated with the driving of a vehicle. In our own material, six out of eleven natural deaths during snowmobile driving were connected with heavy physical exertion—three had just tried to lift their snowmobile, and three died during the loading of timber. Of the bicycle deaths, only three were documented to have occurred on an uphill slope, but this is obviously a minimum figure.

Epidemiology

The scarcity of reports on sudden natural death in traffic suggests, however, that it is not frequent. Peterson and Petty [*4*] reported that the collisions that resulted from natural

deaths constituted less [5] than 6/10 000 accidents reported (that is, less than 0.1%). Also, a few Swedish studies [6, 7] indicate that natural death at the wheel is a rare event. Out of 635 medically unattended fatal cases of ischemic heart disease in males, and 332 similar female cases, only 6 males (that is, less than 1%) were driving a car at the onset of the attack [6]. Herner et al. [7] reported that only 41 of 44 255 (that is, less than 0.1%) road accidents reported to the police in 1 region of Sweden were caused by sudden illness of the driver of a motor vehicle. The illness was most often due to epilepsy or myocardial infarction, and 8 drivers died at the wheel from their disease.

Although the statistics have been collected in different ways in separate investigations, they agree in general that sudden natural deaths play only a minor part in road accidents and seldom occur while driving. In our region, it can be estimated that about 7000 sudden unexpected deaths occurred during the period under investigation (compare Ref 8), meaning that about 1% occurred at the wheel. On the other hand, severe injuries to a driver may make it impossible to determine whether a pathologic condition actually precipitated the collision, and concern has been expressed that serious crashes may have been caused by unrecognized natural disease (see Ref 5).

Age and Sex

Sudden natural deaths at the wheel are primarily a male problem. According to Myerburg and Davis [9], 16% of unexpected deaths from coronary heart disease were women. Other authors have reported that 2 to 5% of natural or coronary heart deaths at the wheel were in women [4, 10]. In the present study, we found no women at all dying at the wheel from coronary disease. The only two women in the car death category died from subarachnoid hemorrhage. The underrepresentation of female cardiac deaths at the wheel may be explained because (1) they die less frequently from coronary heart disease; (2) when they do, they are less likely to die suddenly and unexpectedly; or (3) when they do die suddenly and unexpectedly, they are less likely to be at the wheel (compare Ref 10). This latter hypothesis is partly corroborated by our finding that of the other vehicle traffic deaths in our material 11% were women.

The mean age of natural deaths in our material of car deaths was 59 years, in the material of West et al. [10] 60 years, and in the material of Peterson and Petty [4] 56 years. This should be compared with a median age of 34 years of drivers suffering traumatic deaths [4] and a median age of 30 years of deceased drivers in single-vehicle accidents in our own district [11]. Obviously, sudden natural deaths while driving affects a different population of drivers than traumatic deaths. This is also true for other vehicle natural deaths, where we found a mean age of 66 years (compare, for example, Refs 12 and 13).

Time and Circumstances

Our finding that about 10% of accidents occurred during commercial driving corresponds very well with the figure of 9% published by West and coworkers [10]. According to these authors, this figure is of the same magnitude as that for noncommercial driving if driving distances are considered.

As previously demonstrated by West et al. [10], most natural deaths at the wheel occurred during daytime. This finding is significantly different from other types of single-vehicle accidents, which mostly occur during the night and during weekends [14].

Causes of Death

Our finding that the great majority (112/126) of natural deaths in traffic were caused by ischemic heart disease correlates well with previous investigations. West et al. [10] stated

that 94% of natural deaths at the wheel died from heart disease, and Peterson and Petty [*4*] found that of 105 sudden natural deaths among motor vehicle drivers and passengers, 73% were caused by arteriosclerotic cardiovascular disease with (19/105) or without (58/105) myocardial infarction. Hypertensive cardiovascular disease, rheumatic heart disease, myocarditis, aortic aneurysm, intracerebral hemorrhage, and subarachnoid hemorrhage from ruptured berry aneurysm accounted for most of the additional cases, which is in fair agreement with our findings.

Kerwin [*15*] pointed out that sudden cardiac death is seldom due to a recent myocardial infarction—less than 20% of sudden cardiac deaths are due to recent infarction (see also Ref *8*). In our material, the proportion of recent myocardial infarction in all 119 cardiac deaths at the wheel was 33%.

Symptoms of Disease

In the comprehensive study of Myerburg and Davis [*9*], 6% of the victims were known to have coronary heart disease. West et al. [*10*] found that about 60% of single-vehicle accident drivers dying from heart disease knew that they had a heart disease, and in the study by Peterson and Petty [*4*], about 50% of drivers who died at the wheel of an automobile with or without an accident had known cardiovascular related symptoms. Myerburg and Davis [*9*] found that 62% of fatally stricken automobile drivers had known of symptomatic heart disease.

Our own findings indicate that at least one fifth of the victims had premonitory symptoms before the incident. This does not mean, of course, that it would have been possible to prevent any or all these fatalities [*7*].

Personal Injuries

Peterson and Petty [*4*] described 81 cases of sudden natural death at the wheel. Of these, 36 drivers were involved in accidents, but there were no fatalities or serious injuries resulting from collisions. The slow rates of speed involved would possibly account for this favorable result. More than half of the 81 drivers were apparently able to stop the automobile before an accident occurred. Only 1 of the total of 10 passengers received an injury requiring hospitalization.

Eight drivers died at the wheel from their disease in 44 255 traffic accidents reported to the police (that is, 0.02%) in Sweden. A total of seven drivers with myocardial infarction died at the wheel, but no one else was injured as a result, and in only four cases did any damage to property ensue. These seven apparently had time to take precautions with their care before they died [*7*].

Our own results also show that when sudden death at the wheel occurs, it almost never results in injuries to others and often not even to the victims themselves nor in property damage, in agreement with the above mentioned previous investigations. The consensus is therefore that sudden death at the wheel does not pose a serious risk to other persons. Accidents caused by drivers incapacitated by cardiovascular disease are uncommon, and it is even more rare for persons other than the driver to be injured or killed as a result of the accident (see Refs *10* and *16*). Only 1 passenger was killed in 155 collisions as a result of natural deaths [*10*]. A second report where passengers have been killed as a result of sudden death at the wheel described a commercial bus where 7 persons died from drowning after a crash into a river [*17*].

It seems that the sudden cardiac dysfunction does not immediately effect the function of the brain—instead the victim has often sufficient warning to drive to the side of the road and stop in time. Sudden death of cardiac origin is a process that begins with minor irregularities in electrical impulse generation. This phase usually lasts a few minutes or more, but even if

the sequence of arrhythmias evolves in a shorter time period, there is probably time for warning symptoms to occur and time to react [*15,16*].

Alcohol

We found no car victim who had been under the influence of alcohol while driving. This finding can be compared with that of Peterson and Petty [*4*] who found that only 4 out of 36 driver deaths resulting from natural causes were associated with alcohol intoxication, while 86 out of 156 driver deaths resulting from traumatic injuries were alcohol involved. In a study of 155 natural deaths at the wheel in California [*10*], about 20% were under the influence of alcohol. This difference probably reflects legal and social factors. Of the other vehicle deaths in our material, 2 were found to be under the influence of alcohol in spite of the regrettable fact that a majority of these deaths had not been analyzed toxicologically. As it can be assumed that operators of vehicles other than cars may have a higher frequency of alcohol intoxication than car drivers (see, for example, Refs *12* and *13*), blood alcohol analysis should be performed in the former group as well as in the latter.

Disease and Trauma

Peterson and Petty [*4*] described six driver fatalities where death was attributed to trauma but where a disease process may have been a causative factor in the accident. In such cases, the actual cause of death may be an important consideration from the point of view of proper insurance adjustment and other litigative considerations. The same authors found that 19% of all motor vehicle driver fatalities where the driver was at fault and where an accident occurred were the result of disease processes and trauma. Again, the need for autopsy of drivers dying behind the wheel is illustrated. Of course, there may exist difficulties in interpreting cases with both disease and traumatic lesions, but this is even more so if no autopsy has been performed.

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