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AUTOMOBILE ACCIDENTS AND AUTOPSY PROTOCOL: SOME REFLECTIONS OF A FORENSIC PATHOLOGIST

Charles E. Black*

An article on the integrated scientific and medical aspects of automobile crash deaths is timely and compelling. This increasingly critical problem involves a vast area of both criminal and civil law and a great responsibility on the part of the lawyer. An attempt will be made in this article to erect some helpful directional guideposts to assist the lawyer in the investigation and discovery of facts important in the preparation and trial of cases involving highway deaths. The rôle of the pathologist in connection with highway crash deaths deals with two types of factual evidence: physical evidence, involving the collection of blood, bullets, vehicle fragments, etc.; and direct evidence, covering the medical aspects of the autopsy. A report of a rather typical crash highway death is included to illustrate some of the problems that are presented in the investigation of automobile accident cases, and the use of the autopsy protocol.

The rôle of the pathologist as a member of the team investigating highway accident deaths was presented at the last annual meeting of the Tri-State Hospital Assembly in Chicago.¹ In a recent article, Dr. Russell S. Fisher,² of Baltimore, a leader in forensic pathology and a member of the committee on medico-legal problems of the American Medical Association, emphasized the rôle of the pathologist and the need for the use of scientific developments in pathology in the solution of medico-legal problems, particularly in sudden and violent deaths to which there are no eye-witnesses. The American Medical Association has expressed concern over the number of highway deaths; the Association regards this as the nation's number one public health problem.³ This concern is evidenced in a symposium dealing mainly with the medical aspects of automobile crash injuries.⁴ These efforts have been followed by the recent appearance of a comprehensive book on crash injuries by Dr. Jacob Kulowski,⁵ who is a member of the committee on the medical aspects of automobile injuries and deaths of the American Medical Association. This book covers the integrated medical aspects of highway casualties, including the biomechanics and pathomechanics of automobile injuries. The bibliography contains 51 pages of references on the various medical aspects of the problem. In the final chapter Dr. Kulowski notes that the objective of forensic medicine is equal justice through a better understanding of the medical aspects of crash injuries and deaths.

The steadily growing number of highway deaths and injuries is shown by statistics released by the National Safety Council, the press, radio and tele-

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1 Address by the author, Tri-State Hospital Assembly, May 4, 1960.

2 Fisher, *Recent Developments in Forensic Pathology*, 172 J.A.M.A. 896 (1960).

3 Editorial, *Death on the Highways*, 163 J.A.M.A. 262 (1957).

4 Symposium, *General Medical Aspects of Automobile Crash Injuries and Deaths*, 163 J.A.M.A. 225 (1957).

5 KULOWSKI, *CRASH INJURIES—THE INTEGRATED MEDICAL ASPECTS* (1960).

vision. The Council, in 1959, reported 37,800 fatal automobile accidents and approximately 2,870,000 persons injured,⁶ including 395 motor vehicle deaths for the Fourth of July week end, 1959, and an estimated 595 deaths for the Fourth of July week end, 1960.⁷ The Council estimates total economic loss from all highway accidents over the last 10 years at \$45 billion.⁸ If the best interests of justice are to be served, the lawyer must develop his talents as a scientific investigator and tireless sleuth—to the end that law may bring order out of chaos on the nation's highways.

Not infrequently the lawyer may be required to seek a rapid education in some highly specialized field. He may even have to obtain a special ruling of the court in order to obtain facts in medical reports. The thorough understanding of scientific and medical facts, if tedious and time-consuming, is also rewarding—and it results in a trial lawyer with the investigating expertise of Sherlock Holmes and the fact-finding acumen of a television defense counsel.

ACCIDENT INVESTIGATION

The investigation of the average highway accident death requires a team of investigators. This team may consist of traffic and law enforcement officers, detectives, photographers, the prosecutor, toxicologists, chemists, coroners, medical examiners, and the pathologist. The purpose of the team is to reconstruct the facts surrounding the accident and the death. The team's investigation includes carefully assembled written reports and drawings on the details of the accident, photographs of the scene and the damaged vehicles, and scientific and medical reports. The physical facts should show any defects in the operation of the motor vehicle, including mechanical failures such as faulty brake lights, failure of brakes, failure of wheel bearings, defective or frosty windshields, damaged or defective tie-rods, drive-shafts and other mechanical details that may have played a role in the cause of the accident. The autopsy report enumerates the injuries, determines the cause of death and frequently reconstructs circumstances such as time and manner of death. It incorporates other medical information on the victim that may be directly related to the accident—all facts which may be crucial in the trial of a case. The physical facts gathered by the investigating team fall into several categories: statements obtained from witnesses;⁹ weather factors such as rain, climatic temperature, snow, sleet, ice and fog;¹⁰ factors that obscure vision such as physical obstructions, fog, smoke, darkness, unusual brightness, light reflections and eye defects; camouflaging factors such as blending of colors of vehicles with surroundings; unusual designs

6 ACCIDENT FACTS, NATIONAL SAFETY COUNCIL 41 (1960).

7 *Ibid.*

8 *Ibid.*

9 State or local police will give the investigating attorney a photostatic copy of the accident report, containing driver statements, witness identification, physical facts and other essential accident detail. The accident report may also indicate that police photographs were taken of the accident, and these will be available to the alert investigator.

10 Precise weather information for a particular date and locality may be obtained from the nearest weather bureau office, or it may be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. There is a nominal charge, e.g., 20 cents for climatological data, 10 cents for hourly precipitation data, etc.

of cars, small compact car hazards, and the almost invisible thin glass tops of some models. It is pertinent to know all of the extenuating circumstances of a particular automobile accident, including the health and medical status of the drivers, before assessing the blame.¹¹

Another category of physical evidence, speed, is a particularly important question in death cases. It is important to know that the alleged speed has been accurately determined; speedometers and speed computers may be defective or their use controversial. It is equally important to know to what extent speed was a contributing factor in the accident and how the alleged speed was determined, whether by witnesses, speed computing devices, by skid-marks, or other means.

The currently popular means of estimating speed is through the study of skid-marks. This technique, according to White,¹² has certain limitations, several of which may render an estimation of speed invalid. Information such as the length and width of the tire marks should be supplemented with data on weather conditions; type, character, dryness and smoothness of roadways; presence of gravel or sand deposits; type, character, make, mechanical differences, age, smoothness and defects of tires; size, weight, length, model, year and make of automobile; defects of brakes, brake-drums and brake-lines; and defects of wheels and bearings, tie-rods, and other possible variables. Skid-mark enthusiasts discount many of these factors; for this reason, the trial lawyer must know the limitations of the procedure. He may have to seek the help of a skid-mark expert.

The counterpart to the speeder, as a primary cause of highway accidents, is the slow driver. The automobile crash injury research of Cornell University, in a study of 3,000 car accidents,¹³ showed that over 74 per cent had been moving at speeds of less than 60 miles an hour. Obviously, efforts devoted exclusively to speed regulation will not solve the problem of automobile accident fatalities. All of the factors, both mechanical and human, must be considered.

The pathologist frequently plays a part in the collection of physical evidence for these cases. He may be able to find various items in the open wounds of the victim: glass, metal parts, paint, fragments of clothing, gravel, etc. These facts are identifying evidence, connecting the contact vehicle and the victim. The proper collection, identification and transmission of this evidence is so important that instructions on wound analysis are included in standard manuals for crash investigators. Physical evidence is especially valuable in hit-and-run fatal accidents.¹⁴

Dr. C. W. Muehlberger, Director of the Michigan Crime Detection Laboratory, has written an instructive chapter in Snyder's book on homicide investigation, *Death Due to Highway Accidents*.¹⁵ He shows a series of photographs

11 Federal rules concerning discovery procedures are FED. R. CIV. P. 26-37.

12 WHITE, TIRE DYNAMICS 62 (1956).

13 Lader, *Crash Injury Research, Cornell University*, Better Homes & Gardens, June, 1960, p. 139, col. 2.

14 A leading civil case basing a verdict for damages in a hit and run accident entirely on circumstantial evidence of the nature above discussed, is *Zolton v. Rotter*, 321 Mich. 1, 32 N.W.2d 30 (1948). In this case, circumstantial evidence prevailed over positive testimony to the contrary.

15 SNYDER, HOMICIDE INVESTIGATION 297-320 (1959).

on automobile accidents, along with a discussion of the investigation of deaths due to highway accidents and the collection of physical evidence.

MEDICAL ASPECTS

The first portion of this discussion has been arbitrarily confined to the physical aspects of crash accident death investigation. An attempt will be made now to peer into the medical aspects of the death driver. It seems advisable at this point to discuss these through an autopsy protocol, the general outline of which will be utilized merely as a guide. Elucidations on various parts of this protocol will be made to show how the forensic pathologist arrives at some of his deductions and conclusions. The procedure of the pathologist in determining the factual cause, the proximate cause, and manner of death is similar to the determinations used by the physician in making a difficult diagnosis on a patient suffering from an obscure disease. In both instances the physician has to use both subjective and objective findings which include personal history, physical examination, laboratory studies, etc. The one great contrasting difference is that the pathologist has the obstacle of a still subject, which shrouds many of the pertinent medical facts. The subjective information or the information known as a medical history utilized by the pathologist has to be secured from entirely objective sources: the attending physician, medical reports, police, witnesses—from friend and from foe.

The examination of the crash victim's body is known as the autopsy examination, post mortem examination or necropsy examination. This examination is necessary for several reasons. First, it is important to determine as accurately as possible the primary or proximate cause of death. Secondly the autopsy reconstructs the events occurring at the scene of the fatal accident. Combined with a visit to the scene by the pathologist, it is often a means of determining the manner of production of the injuries and the force producing death.

It goes without saying that autopsies should be performed on fatal accident cases as often as possible. There are several problems involved in obtaining autopsies. The first problem is to convince officials and the public that autopsies on accident victims where violence is involved are necessary, a goal which can be attained in one of two general ways. In instances of criminal violence or suspicion of criminal violence, the coroner, medical examiner, or district attorney may order an autopsy, in which case the county bears the cost.

In general, when a patient dies in a hospital, there is no charge made for the autopsy. In addition to the permission of county officials, the investigator may go to the next of kin. The family, insurance companies or friends in this case assume the responsibility of the cost of the examination. Autopsies will occasionally be refused by the prosecutor for fear of offending local families. The defense attorney may then be obliged to press the relatives for an autopsy in order to protect his client.

Although an autopsy cannot be ordered in every crash death, where there is criminal violence involved, or where there is a personal injury issue, an autopsy is strongly recommended. It then becomes imperative to employ an experienced forensic pathologist, one not only able to correlate the medico-

legal details of crash deaths, but also able to present this material effectively to a jury.

The investigator may often have to double-check if he is to be certain an autopsy has not been performed. The death certificate—particularly if, as in many cases, it is made out before the autopsy—will not always reflect this information.

AUTOPSY PROTOCOL

Part I: General Information¹⁶

The first part of the autopsy consists of general information such as the name of the decedent, autopsy number, age, race, prosector or pathologist, sex, marital status, occupation, name of coroner or medical examiner, the attending physician, persons attending the autopsy, time of death, time and place of the autopsy, and the name of the person who authorized or gave permission for the autopsy.¹⁷

Part II: History

A vivid picture of the scene of the accident is vitally important to the pathologist in making his determination of the cause of death and the manner of death. The picture should, if possible, be supplemented by a visit to the scene for first hand information. This history should include how, when, and where the accident occurred, whether or not the victim was conscious and suffered painful injuries, if he slowly lost consciousness prior to death, or whether death was immediate. He should know the type of collision and type and size of vehicles involved, along with the estimated speed of each. For example, the characteristic type of injury produced in head-on collisions is the crushing of the chest. Rear-end collisions produce hyperextension of the upper cervical spine, causing such injuries as the so-called whip-lash injury or sudden death from fracture dislocation of the upper cervical vertebra.¹⁸ It is also essential to know whether the impact was from the right side or left side and whether or not the victim was thrown from the car. The pathologist should inquire about possible previous visits to the doctor, or visits to taverns, etc. It is essential to know as much as possible of the victim's medical history and particularly any *symptoms* which the decedent may have manifested immediately prior to the fatal crash. Some of these symptoms that the pathologist should stress are drowsiness, pain, headache, dizziness, vomiting, convulsions, "black-outs," fainting, narcolepsy, unusual euphoria, or a marked variation in judgment and other pertinent medical manifestations. It is the sensory neurological disturbances¹⁹ that frequently impair the driver's ability most in the operation of the motor vehicle; these may lead to the discovery of medical conditions of the decedent driver, such as alcohol influence, drug intoxication, and heart and

¹⁶ The autopsy protocol consists of seven parts.

¹⁷ Proper identification is one of the most important features of this information. It is best to have the body identified by a friend or relative in addition to having the body identified by the coroner or medical examiner and the officer who attended the scene.

¹⁸ See CECIL AND LOEB, *TEXTBOOK OF MEDICINE* 1476 (1956); and MACBRYDE, *SIGNS AND SYMPTOMS* (1947).

¹⁹ Organization Section, *Medical Guide for Physicians in Determining Fitness to Drive a Motor Vehicle*, 169 J.A.M.A. 1195 (1959).

kidney disease, brain pathology, and diabetes mellitus. There are in addition about a hundred medical conditions that may appear to be alcohol intoxication.

Symptoms — Drowsiness

Drowsiness is a driver hazard manifested by pathologically demonstrable conditions, including carbon monoxide, alcohol, drugs and some disease conditions. Alcohol and drugs are widely used alone and in combination for the purpose of improving a sense of well being and to relieve anxiety and tensions. Drugs, employed to promote sleep, relieve anxiety, produce central nervous system stimulation and prevent motion sickness, may produce drowsiness. Even aspirin, digitalis, anti-histamines and anti-infective drugs may produce unexpected drowsiness in some individuals. Barbiturates, tranquilizers, antihistamines, and amphetamines (nervous system stimulants such as “pep pills”) are used in these situations in such small amounts that detection by ordinary chemical analysis is impractical.

Pain

Pain is the most frequent sensory symptom presented by the patient to the physician. It may come from any of the sensory cranial nerves, relaying pain paresthesias and numbness from the sensory portion of the trigeminal nerve. Symptoms of pain from the heart, lungs, pancreas, liver and gastro-intestinal tract are relayed through the vagus cranial nerve. Pain is also relayed from the end organs of the skin to the brain over peripheral nerves. The distribution of the sensory organs of the skin is arranged in definite bands known as dermatomes. These sensory dermatomes help determine the level in the spinal cord of traumatic lesions, for example. Severe sudden pain as experienced in coronary insufficiency or coronary occlusion can be a significant factor in producing crash accidents.

Headaches

Headaches are the commonest type of pain symptom encountered in the general practice of medicine. In most cases the origin of headache can be determined from the details of the history, often indicating conditions such as acute alcoholism, carbon monoxide poisoning, sensitivity to certain drugs (histamine), lesions of the cervical disc, cervical arthritis, hypertension, head injuries, brain tumors, abscesses of the brain, and other medical states. Any of these conditions may be a significant factor in an accident or an important clue indicative of some disease process causing death.

Euphoria and impaired judgment

Euphoria and impaired judgement follow the influence of alcohol, drugs, and combinations of certain drugs and alcohol. Barbitol preparations, tranquilizers, certain nervous system stimulants (amphetamines), and marijuana may cause euphoria and impaired judgment serious enough to cause driving hazards and obscure danger signals. The feeling of self-confidence and well-being caused by these drugs tends to contribute to poor driving.

Family history

In certain instances it may even be important to probe into the family history. Convulsive disorders, headaches of the migraine type, some mental disorders, diabetes, cardio-vascular disease, and some tumors may result from a hereditary predisposition.

Dizziness

The sensory symptom of dizziness is produced from a variety of conditions, including toxicities from carbon monoxide, alcohol, drugs, hypertension, hemorrhages of the brain, brain tumors and severe anemia. Inflammatory conditions, trauma and tumors affecting the vestibular portion of the eighth nerve may produce dizziness and unsteadiness of gait.

Vomiting

Episodes of nausea and vomiting occur in many toxic and medical states, including acute alcoholism, acute carbon monoxide poisoning, toxicity from many drugs, head and spinal cord injuries, fourth ventricular brain tumors and injuries to the upper spinal cord. They are also commonly associated with gastro-intestinal disturbances, liver disease and pancreatic disease.

Convulsions

Convulsions are common manifestations of inflammatory lesions of the brain, toxic states of the brain, such as carbon monoxide, or marked alcoholism, degenerative changes of the brain, and tumors of the brain. Convulsive disorders such as the so-called petit mal and the grand mal types of epilepsy occur suddenly, creating a special hazard to the safe operation of a motor vehicle.

Narcolepsy

Narcolepsy is an uncommonly encountered disease. It is reported following certain inflammatory states of the brain, traumatic injuries of the brain and tumors of the brain. Attacks are apt to occur in surroundings favoring sleepiness, such as driving on turnpikes, or in poorly ventilated automobiles. Small amounts of carbon monoxide in the atmosphere can be a precipitating factor in the development of one of these episodes.

Psychological and emotional states

Temporary emotional conditions may cause the driver to be unalert to various traffic problems. Certain depressive states slow reflexes to the point of making driving hazardous. Anxiety states, undue fatigue, psychoneurotic conditions and other psychopathic aberrations may make driving difficult, as well as dangerous.

Alcohol

The symptoms of acute intoxication by ethyl alcohol are first characterized by euphoria and exhilaration. As more alcohol is taken and absorbed, muscular incoordination, ataxia, incoherence of speech, nausea, and vomiting result. In the final stage the patient may pass into a stupor of complete relaxation, with partial anesthesia, profound shock and death. On the other hand, drugs,

particularly the barbiturates and tranquilizers and many natural disease states, especially when combined with small amounts of alcohol, may be confused with alcoholic intoxication. One of the most serious alcoholic problems that confronts the physician, and the lawyer, is the vehicle accident connected with death and a driver presumed to be under the influence of alcohol. These are problems usually involving the health, happiness, economy and freedom of persons far removed from both accident and alcohol. About half of the states have enacted statutes similar to the Uniform Vehicle Code,²⁰ which reads:

Sec. 11-902. Persons under the influence of intoxicating liquor or of drugs.

(a) It is unlawful and punishable as provided in subsection (d) of this section for any person who is under the influence of intoxicating liquor to drive or be in actual physical control of any vehicle within this state.

(b) In any criminal prosecution for a violation of subsection (a) of this section relating to driving a vehicle while under the influence of intoxicating liquor, the amount of alcohol in the defendant's blood at the time alleged as shown by chemical analysis of the defendant's blood, urine, breath or other bodily substance shall give rise to the following presumptions:

1. If there was at that time five-hundredths per cent or less by weight of alcohol in the defendant's blood, it shall be presumed that the defendant was not under the influence of intoxicating liquor;

2. If there was at that time in excess of five-hundredths per cent but less than fifteen-hundredths per cent by weight of alcohol in the defendant's blood, such fact shall not give rise to any presumption that the defendant was or was not under the influence of intoxicating liquor, but such fact may be considered with other competent evidence in determining the guilt or innocence of the defendant;

3. If there was at that time fifteen-hundredths per cent or more by weight of alcohol in the defendant's blood, it shall be presumed that the defendant was under the influence of intoxicating liquor;

4. The foregoing provisions of this subsection shall not be construed as limiting the introduction of any other competent evidence bearing upon the question whether or not the defendant was under the influence of intoxicating liquor.

(c) It is unlawful and punishable as provided in subsection (d) of this section for any person who is a habitual user of or under the influence of any narcotic drug or who is under the influence of any other drug to a degree which renders him incapable of safely driving a vehicle to drive a vehicle within this State. The fact that any person charged with a violation of this subsection is or has been entitled to use such drug under the laws of this State shall not constitute a defense against any violation of this subsection.

(d) Every person who is convicted of a violation of this section shall be punished by imprisonment for not less than 10 days nor more than 1 year, or by fine of not less than \$100 nor more

²⁰ UNIFORM VEHICLE CODE § 11-902.

than \$1,000, or by both such fine and imprisonment. On a second or subsequent conviction he shall be punished by imprisonment of not less than 90 days nor more than 1 year, and, in the discretion of the court, a fine of not more than \$1,000. The Commissioner shall revoke the operator's or chauffeur's license of any person convicted under this section.

The Code, in summary, makes three presumptions based on the evidence of alcohol in the blood. All persons having 0.05 per cent alcohol or less in their blood are presumed to be not influenced. All persons having 0.15 per cent or more are presumed to be under the influence; for those in the zone between 0.05 and 0.15 per cent, no presumption exists. These presumptive limits are recommended by the National Safety Council and the American Medical Association.

Dr. Muehlberger²¹ poses three pertinent medico-legal questions on the subject:

1. Had the person been drinking alcoholic liquor, and, if so, about how much alcohol did he have in his body at the time in question?
2. How seriously intoxicated was he at the time in question? Did the extent of alcohol intoxication bear any causal relationship to the difficulty which arose?
3. Was acute alcohol intoxication the sole direct cause of death?

Dr. Muehlberger further points out "that the toxicological evidence merely sets up a presumption" in those states that have enacted chemical test statutes. He states that it would be grossly unfair to set up a chemical test as the last word concerning a driver's guilt. Any presumption may be overcome by competent contrary evidence. The criteria used in the Uniform Vehicle Code on alcohol is most controversial in the range of 0.05 to 0.15 per cent blood alcohol. Chemical tests should not constitute the sole basis for determining guilt or innocence, any more than any other laboratory test—or even an autopsy examination.

In realization of this problem and to assist the physician, the American Medical Association has prepared a comprehensive manual entitled, "Chemical Tests for Intoxication."²² This manual covers the psychological action of alcohol, the pharmacology and toxicology of alcohol, alcohol and accidents, various chemical testing procedures, interpretation of tests, limitations, waivers, statutes, court decisions and references. It is available to physicians both for advising patients on alcohol and to assist in preparing medical testimony.

The manual also places emphasis on the precautions to be used in the collection of the specimen in order to avoid errors of chemical contamination. The blood alcohol determination is a useful means of differentiating alcohol intoxication from drugs and from natural diseases that closely simulate alcoholic

21 Muehlberger, *Medicolegal Aspects of Alcohol Intoxication*, MICH. ST. B.J. (1956).

22 CHEMICAL TESTS FOR INTOXICATION, AMERICAN MEDICAL ASSOCIATION (1959). See also: Smith, *Drinking and Driving*, 3 CRIM. L.Q. 1 (1960); Freimuth, *Alcohol and Highway Fatalities*, 3 J. FOR. SCI. 65 (1958); Kursh, *The Highway Killer They Don't Talk About*, 65 SCI. TEMP. J. 3 (1957); and Shupe and Dubowski, *Ethyl Alcohol in Blood and Urine: Simple Photometric Method for its Forensic Determination*, 22 AM. J. CLIN. PATH. 901 (1952).

influence. The toxicologist should check carefully for possible contaminating agents such as alcohol, acetone, ether, or other volatile organic substances in his testing procedures. Proof of identity of specimen and proof of identity of subject are both essential. Individual variations in tolerance after imbibing alcoholic beverages create problems for both bartender and police officer in estimating the degree of intoxication. Because of these variations, and other factors present when the imbiber has visited several taverns, the burden of proof of the place of intoxication may be difficult to sustain.

Carbon monoxide

Carbon monoxide in the exhaust gases of automobiles is a frequent cause of highway deaths. It is important even in minimal amounts in the atmosphere. Johnstone²³ found that a carbon monoxide concentration of over 0.01 per cent, if inhaled for a period of six hours, could cause headache, drowsiness, faulty judgment, and impaired driving ability. These minimal amounts of carbon monoxide concentration may be even more serious in cases where the driver has some impairment of the circulation to the brain, the heart, or of other vital organs. The exhaust gases from internal combustion engines contain an average of about seven per cent carbon monoxide; this amount tends to increase if the combustion is incomplete. Occasionally in closed automobiles and in the cabs of trucks, carbon monoxide escapes through defective exhaust systems.

Acute carbon monoxide poisoning produces sensory symptoms of headache, drowsiness, faintness, motor weakness, stupor, coma, and death. Death may occur suddenly from high concentrations, or slowly from a longer period of exposure to lower concentrations. If a person breathes a low concentration for a considerable length of time, especially during sleep, acute poisoning can occur and can cause death, which usually requires at least 50 per cent saturation in the blood. The susceptibility of different individuals varies. In cases of severe coronary insufficiency, I have seen death occur in the range of 20 to 30 per cent saturation in the blood. During low concentrations of carbon monoxide in the atmosphere a state of complete motor helplessness may intervene.

The hazard of breathing low concentrations of carbon monoxide over a prolonged period is illustrated by the case of a trucker who lived with his wife and several children in Battle Creek. He and his wife, on a cold afternoon in mid-winter, left Battle Creek in their semi-tractor-trailer combination for an overnight trip to Cleveland. During this all-night trip they made several stops for coffee and lunch. In the meantime, the truck motor was allowed to run with the cab tightly closed — a common practice among truckers during winter months. On the outskirts of Cleveland, in Cuyahoga County, the couple became violently ill; both manifested the typical symptoms of carbon monoxide poisoning, such as headache, drowsiness and extreme weakness. They stopped the truck, sought aid, and were both taken into a local hospital by ambulance. The physician in the area was called to the emergency room of the hospital, where he made a diagnosis of acute carbon monoxide poisoning and immediately administered oxygen. The wife was revived, but the trucker died. His

²³ JOHNSTONE AND MILLER, OCCUPATIONAL DISEASES AND INDUSTRIAL MEDICINE 108, 114 (1960).

body was taken to the local coroner's office where an autopsy was performed. Apparently without previous history or consultation with the attending physician, a pathological diagnosis of a heart attack was made following the autopsy examination.

Because of this autopsy report the trucking company felt disinclined to pay compensation, believing that there was no causal relationship between his employment and his death. The family employed a lawyer, who in turn employed me to assist as pathologist to show that there was a relationship between this man's employment and his death.

Our first step in the investigation of this case was to establish, by means of a second autopsy, a causal connection between death and carbon monoxide poisoning, and to confirm the attending physician's diagnosis. Upon examination of the body after exhumation, the skin and skeletal muscles disclosed a typical cherry-red color. The absence of internal organs curtailed further internal examination. We then requested the tissue and slides from the coroner's office of Cuyahoga County, but were refused. We were given the opportunity to visit the county morgue and there examined the tissue and selected material for preparation of slides. The family's lawyer and his pathologist also quickly accepted this offer and proceeded to examine these tissues in Cleveland. As the attendant picked the jar containing the tissue portions taken from the internal organs he observed that the tissues appeared to be unfixed, noting their undue pinkness. I responded by stating that the organs were fixed, but that the cherry-red color was due to carbon monoxide poisoning. (Incidentally, this characteristic pinkness or cherry-red color will remain in the internal organs for a long time even after the body has been buried.) Gross and microscopic studies, combined with history, confirmed the local physician's diagnosis of carbon monoxide poisoning. No evidence of natural disease was found; checks were made for heart disease, lung disease, brain disease, kidney disease and acute trauma. At the hearing, before a referee of the compensation commission, the pathologist who was responsible for the original autopsy held to his position that a heart attack was the cause of death. The case was appealed to the Workmen's Compensation Commission of the State of Michigan, which found for the widow;²⁴ the evidence supported a conclusion of compensable death due to acute carbon monoxide poisoning, causally related to the driver's employment. This case clearly shows the importance of the victim's history. If the original pathologist had had a detailed history of this case, or had consulted with local physicians, or had taken blood for carbon monoxide determination and then had performed the autopsy personally, I am confident that he would have arrived at the conclusion of acute carbon monoxide poisoning.

(Incidentally, I had the additional obstacle of having a local fellow pathologist testify that he felt that the pathologist doing the first autopsy was right in his diagnosis of a heart attack purely on the basis of an outstanding reputation.)

²⁴ Meyers v. Emmerson Truck & Storage Co., Michigan Workmen's Compensation Comm'n, July 29, 1953.

This case not only stresses the need for an autopsy on highway accident victims but also points to a need for greater attention to the circumstances of each case. The heavy responsibility connected with the autopsy should not be delegated to some junior lieutenant. In no other area of medical science are the faculties of observation and discrimination more vigorously required to achieve the medico-legal objective than in the post-mortem examination. If the autopsy is performed in a merely routine matter, details of the greatest importance may be completely overlooked.

Influence of drugs and other medical aspects of the driver

The increased use of drugs to produce sleep, to relieve anxiety and tension and to stimulate, has had its effect on the accident driver. The Committee on Medical Aspects of Automobile Injuries and Deaths of the American Medical Association has prepared a guide known as the "Medical Guide." This booklet is recommended as a criterion for determining fitness to drive by the examining physician. It has been prepared and is available to assist physicians in examining patients and advising them on their ability to operate a motor vehicle safely, and to caution them on the use of drugs when driving.

The medical, physical, mental and emotional states or disabilities that may impair driving ability are carefully enumerated in the "Medical Guide," along with the problems of temporary impairment from medications, alcohol and carbon monoxide. This same committee has also prepared a brief graphic pamphlet entitled "Are You Fit To Drive?" It can be obtained from the Association of Casualty and Surety Companies, 60 John Street, New York 38, New York.

Rehling²⁵ stresses that it requires a very small quantity of drugs to produce a pronounced effect on the driver's skill; it requires several ounces of alcohol to yield comparable intoxication. He forewarns the unsuspecting individual of the hazard in combining alcoholic beverages with sedative drugs or tranquilizers; this combination may increase the sedative effects of the drug four or five times. The synergistic effect of alcohol and drugs is commonly termed a "cheap drunk." The degree of intoxication may be considerably out of proportion to the amount of alcohol determined in the circulating blood. When such inconsistencies appear, the possible influence of drugs has to be considered.

Barbital

Barbiturates are widely used to control nervousness and to produce sleep. The effects may vary; even with barbiturates, a period of excitement and other symptoms of acute alcoholism may be manifested. Barbiturate preparations also have promiscuous uses, often creating a problem for law enforcement officers; these preparations are known as "Blue-birds," "Yellow jackets" or "Goof-balls."²⁶ Rehling concludes that the intoxicating effects of these various barbiturates are second only to those of alcohol in producing intoxicating influences on the driver. To avoid confusing these drugs and alcohol, the pathologist and toxicologist should lean heavily on the history of drug administration.

²⁵ Address by C. J. Rehling, Alabama State Toxicologist, National District Attorneys' Association in Miami Beach, Florida, March 18, 1960.

²⁶ *Ibid.*

Tranquilizers

Tranquilizers are used especially for the relief of nervous tension and anxiety. The fact that they produce drowsiness becomes a problem to law enforcement officers, pathologists and toxicologists. Some of the tranquilizing drugs commonly used are Meprobramate, Chlorpromazine, Valmid, Parsidol, and Reserpine.²⁷ Anti-histamines have enjoyed great popularity in the relief of symptoms of the common cold, and the relief of allergic states; like tranquilizers, antihistamine drugs may cause drowsiness and impairment of judgment and dizziness. Here again, the investigator must depend heavily upon information gained through a history of the use of drugs.

Marijuana

Marijuana²⁸ is classed as a hallucinogen because of its singular ability to produce unusual emotional states. The person under the influence of marijuana may suffer a complete loss of responsibility, even to the point of becoming disoriented. Many fatal accidents have occurred from the untoward effects of this narcotic.

Fatigue

The experienced pathologist frequently encounters fatalities in accident cases following instances where undue fatigue, drowsiness, and sleepiness are involved. This drowsy state, whatever its cause, impairs reasoning, slows mental reactions and alertness and diminishes sensory faculties such as vision and hearing. Fatal accidents occur especially after inadequate rest and the so-called "highway fatigue." Minimal amounts of carbon monoxide, alcohol or drugs may hasten this sort of fatigue.²⁹

Coma

Coma or complete unconsciousness may be due to carbon monoxide, alcohol, toxic drugs, traumatic injuries of the brain, with or without fractures of the skull, spontaneous cerebral hemorrhage, cerebral thrombosis, inflammatory conditions or tumors of the brain. Certain diseases, such as kidney or Bright's disease and diabetes mellitus, are important causes of coma. The condition may exist for some time prior to death from traumatic injuries or profound shock. It becomes important in the case in which the pathologist is asked to determine which of two persons in an accident died first. The proximate cause of death is divided into three general categories: coma, syncope, or asphyxia, all vital functions dependent upon the brain, the heart, the lungs. The arrest of any one of them quickly causes death. The pathologist can usually determine from his examination which vital process ceased first.

Syncope

The term syncope is used to indicate a sudden cessation of the heart action resulting in death. Syncope is caused by shock, emotional stresses, violent blows to the thorax or upper abdomen and shock associated with a sudden

²⁷ *Ibid.*

²⁸ Organization Section, *Medical Guide for Physicians in Determining Fitness to Drive a Motor Vehicle*, 169 J.A.M.A. 1195 (1959).

²⁹ See Brachi and West, *Sleep Deprivation*, 171 J.A.M.A. 11 (1959).

fall in blood pressure. Alcohol and drugs can induce either primary or secondary shock, which in turn is often a causative factor in the production of sudden syncope.

Asphyxia

Asphyxia is defined as a series of conditions induced by a diminished oxygen supply. Compressive traumatic injuries to the chest or neck may produce obstructions to the respiratory tract. Fractures of the larynx or lungs can produce hemorrhage and asphyxia. Sometimes the neck or chest is compressed against the steering wheel, or the body falls beneath an overturned car. Asphyxia also results from suffocation through a low oxygen tension, poorly ventilated cars and cabs, or from carbon monoxide poisoning. It may also result from paralysis of the respiratory centers in the brain stem following excessive alcohol, injection, morphine, barbiturates and trauma to head and neck.

Hypoglycemia

Hypoglycemia is a rather commonly encountered transient state; it is particularly prevalent among patients under insulin for diabetes mellitus. In patients who are receiving large doses of insulin, an occasional fatal insulin reaction occurs which is due to hypoglycemia and shock. The condition also occurs in persons going without breakfast or undergoing rigid dietary regimens. The symptoms of severe hypoglycemia (insulin shock) are nervousness, profuse sweating, pallor, rapid pulse, weakness, impaired memory, disorientation, confusion, delusions, ataxia, loss of consciousness, generalized convulsions, shock, and death. These symptoms can easily be confused with alcohol intoxication and drugs. In general the blood sugar level in these cases of hypoglycemia taken during the hypoglycemic episode is 70 milligrams per 100 cubic centimeters of blood or lower, an important factor of laboratory diagnosis.

Part III: External Examination

The external examination of the crash victim includes a general description of the body as to height, weight, bony frame, deformities, stature, muscular development, whether athletic or obese, nutrition, and identification marks. In addition, in accident death victims, it is important to note injuries of the head, trunk and extremities, such as abrasions, contusions (bruises), lacerations and perforation wounds of the skin, and evidences of fractures of the bones. When external injuries of the head occur, they may suggest internal head and neck injuries. When these injuries occur to the chest, particularly when fractured ribs can be palpated, it may indicate a "stove-in" type of chest injury. Chest injuries are the most common causes of death in accident cases. Head injuries are next in frequency, especially in pedestrian fatalities. Chest and head injuries are combined in most crash deaths. It is essential that the pathologist note all of the various external injuries of the body, including such things as the presence of foreign material, car fragments, dirt or gravel. Occasionally characteristic marks occur on the skin, such as tire burns, gravel burns and characteristic contact wounds. These various superficial exterior wounds should

be accurately described, measured and recorded in the autopsy protocol. Often it is desirable to photograph some of the external and internal traumatic lesions for purposes of trial. As an example, peri-orbital hematoma (blackeyes) and bleeding from the external auditory canals are suggestive of basal skull fractures.

The careful study of abrasions and lacerations which show bevelled edges may be helpful in determining the direction and type of the scraping force. Lacerations of neck may suggest broken windshield injuries. Multiple fractures of the bones of the legs may suggest bumper injuries; these are common in pedestrian accidents. Notations of post mortem cyanosis indicate an excess of carbon dioxide in the red blood cells; this produces a dusky purplish-blue or plum color to the skin and internal organs. On the other hand a pink livid cherry-red color of the skin and internal organs suggests acute carbon monoxide poisoning.

In summary, the external examination of the autopsy, in addition to determining the cause of death, is particularly useful in reconstructing the events at the scene of the accident. The experienced pathologist, through a visit to the scene, can usually determine which injuries are primary impact injuries and which are secondary impact injuries.

Part IV: Internal Examination

The internal examination of the body involves a systematic examination of the various cavities of the body, including contents of them. A record of the morbid changes of the various internal organs is made as they are removed. This consists of measurements — carefully written descriptions as to color, appearance, and consistency — along with any special pathological lesions, such as traumatic contusions, lacerations, hemorrhages, perforating wounds, and other significant pathological changes. A lesion found in one part of the body may indicate the existence of some pathological condition in another organ. For example, a concentric hypertrophy and enlargement of the cardiac muscle of the left heart may indicate hypertension. This hypertension may be due to one of two principal things:

1. An obstruction lesion, such as a calcific valvulitis of the aortic valve, which is often due to an old rheumatic heart condition. This condition, incidentally, is a common cause of sudden death.
2. A generalized circulatory hypertension of some duration.

The presence of foamy blood in the heart chambers suggests the entrance of air into the circulation; this occasionally occurs following certain perforating traumatic wounds. The exudation of foamy blood from the nose and mouth are suggestive of hemorrhage into the lungs, frequently associated with traumatic chest injuries. Antemortem clots in the lining of the ventricles of the heart may be due to several causes, including coronary occlusions, circulatory failure and trauma. These clots sometimes lodge in vital areas such as the lungs or brain.

Because injuries of the chest are a common cause of death in accident cases, particular attention is paid to the heart, the aorta and its branches, in the internal examination of the chest, which is usually the first area exposed.

Chest

Examination of the chest includes examination of the bony frame for fractures and dislocations. This includes the sternum, or breast plate, the clavicles or collar bones, the ribs, and spinal vertebra. The amount and character of fluid found in the pleural cavities is to be measured and described. If this fluid is watery and of low specific gravity, it may indicate circulatory failure. If it is inflammatory and of a high specific gravity, it may be due to some inflammatory or neoplastic process, while if it is unclotted blood, it is more likely to be associated with trauma, especially when accompanied by other injuries. In the presence of hemorrhage the pathologist immediately looks for the source. In chest injury cases fractured ribs often perforate the larger vascular channels, such as the aorta or lungs.

Heart

The heart is weighed, described and observed as to general outline. Any lesions due to natural disease or trauma are carefully described. Moritz³⁰ has covered this subject in a very comprehensive manner. Cardiac injuries most frequently follow steering wheel impacts and are classified as primary impact injuries. Injuries to the heart may occur without any external evidence of injury to the overlying skin or thoracic cage. The injuries inflicted to the heart usually consist of cardiac contusions due to the application of blunt force. This force may damage the heart wall or valve leaflets in one of two ways. The myocardium may be injured by contusion of the heart muscle, causing sudden or somewhat delayed death. This damage to the heart muscle may be delayed, leading to a lesion that may resemble an infarct or cardiac tamponade (rupture), and result later in sudden death. The contused area of the heart muscle may be replaced by scar tissue and be interpreted later as an old infarct and attributed to an occlusion, a coronary heart disease, when the infarct is the result of trauma. The heart is sometimes impinged against the vertebral column in compressive injuries of the chest; particularly when the heart is in a rigid state of contraction, causing a tearing of the heart muscle or valve leaflets and papillary muscles. The heart may be perforated by the sharp ends of fractured ribs. Bleeding may occur into the pericardial sac, thereby producing cardiac tamponade and death. In addition to these traumatic injuries of the heart, the pathologist looks further for lesions of natural disease. These may be recent or old infarctions of the myocardium, recent or old evidences of inflammatory disease, neoplasm and congenital defects. The coronary arteries also ought to be inspected for evidences of occlusion either by emboli, thrombi, or chronic occlusion due to obturating arteriosclerosis.

Lungs

The pathologist makes a general inspection of the pleural cavities, noting whether or not the lungs are inflated or collapsed. A fractured rib perforating the lung may cause an increased negative pressure in one of the pleural cavities. This condition is known as tension pneumothorax and is occasionally the cause of sudden death if not relieved medically. Cases of tension pneumothorax pro-

³⁰ MORITZ, *PATHOLOGY OF TRAUMA* (1954). See also, GOULD, *PATHOLOGY OF THE HEART* (1953).

duce lung collapse. The pathologist then looks for a fractured rib which may have punctured a portion of the lung. The attachments of the lung, known as the hilum, ought to be inspected for evidence of lacerations or tearing of the great vessels. The hilar regions are often contused and are frequently associated with lacerations and hemorrhage into the chest cavities. Occasionally death occurs from generalized contusions of the lungs associated with hemorrhages and edema of the lungs, which produce virtual drowning by means of one's own fluids. Certain types of head injuries also produce this overwhelming pulmonary edema when the respiratory center is embarrassed by the effects of trauma. Not infrequently, with these lung injuries, the thoracic aorta shows evidences of trauma and perforation which can also be due to injuries by sharp ends of broken ribs. Fracture dislocations of the thoracic spine are associated with fractures of the aorta, which also cause hemorrhage and death.

In certain types of crash injuries, the ribs will be fractured over a localized area of the chest. This type of injury may occur when the victim is violently thrown from the colliding automobile and strikes some stationary object.

Abdomen and contents

The abdomen is opened and examined subsequent to examination of the thorax. The abdominal cavity, lined by peritoneum, is examined for the presence of inflammatory fluid, excess air and blood. The fluids and blood present are measured and described. Then a search is made for their sources. Air most often enters the abdominal cavity through perforating gastric or duodenal ulcers, or traumatic perforations. The inflammatory fluid is usually due to a peritonitis from a perforation of the gastro-intestinal tract, such as a perforating ulcer of the stomach or duodenum, a perforated appendix, perforating diverticuli of the large intestine and traumatic perforations. Also, perforations of the gastro-intestinal tract occur from violent trauma applied to the abdomen or from perforating wounds following automobile accidents, especially where the stomach is over-dilated with fluid or food.

The pathologist carefully examines the stomach for the presence of erosions, ulcers, perforations, and trauma. He records the character, amount and consistency of food in the stomach. He notes whether there are aromatic odors of alcoholic beverages in the stomach contents.

Liver

The liver is removed, weighed, measured and described. In fatal accidents, it is carefully observed for hemorrhages of the capsule, with lacerations of the capsule. The pathologist also notes fractures, hematomas of the internal portion of the liver. He also looks for injuries of the liver about its attachment as a source of hemorrhage, and for any inflammatory or neoplastic process connected with the liver or gall bladder. The liver is frequently damaged when there are crushing or violent forces applied to the lower right chest.

Spleen

The spleen is systematically removed, weighed and described. Here again, the capsule and parenchyma are carefully noted for fractures or hemorrhage,

which may be evidence of trauma. The spleen is frequently injured when violent traumatic blows are applied to the lower left thorax.

Kidneys

The kidneys are removed, weighed and described. These organs may be injured by violent blows to either flank, blows which will also frequently result in injury to the adrenal glands. When the kidneys are removed, the abdominal aorta is inspected for evidences of traumatic injury or hemorrhage, and the spinal cord is examined at the site of dislocations or fractures of the spine.

Head and spine

Internal examination of the head is made for evidence of spontaneous hemorrhage, softening, inflammatory disease, tumor, trauma and fractures of the skull. Symptoms following trauma to the head may not appear for hours, days or weeks; when they do appear, they may result in sudden death. Particular types of force applied to the head produce characteristic results in the brain. Examples are the contracoup type of injury, in which the damage to the brain is most severe on the side opposite the impact, and tearing of the commissures in cases where extreme velocity has occurred or generalized focal hemorrhage with necrosis where a sudden deceleration is involved.

An autopsy is particularly necessary in cases where death has been caused by head and spinal injuries combined with fractures of the thoracic aorta. There may be no evidence of injury; as in many types of head, neck and chest injuries, an autopsy may be the only means of determining the cause of death.

The importance of skull and brain injuries lies in the biomechanics of their production. Violent head injuries may be due to primary impacts, such as the head striking a flat surface, like a windshield or a dash. The head injuries more often are due to some secondary impact, for example from striking the roadway. The high velocity of the head striking some resistant object produces innumerable injuries to the brain, and not infrequently death. Violent transmitted force applied to the lower jaw can produce serious head and neck injuries, including fracture of the base of the skull, similar to the injuries inflicted by a blow of the fist to the jaw.

The biomechanics of spine, spinal cord and spinal nerve root injuries occur in four mechanical ways: hyperflexion, hyperextension, compression and hyperelongation. The most serious injuries to the spinal cord commonly follow fracture dislocations of the vertebra of the spine. Some of these dislocations of the spine may undergo spontaneous reduction and may not be discernible by X-ray.

Hyperflexion of the spine, the so-called "Jackknife" type of injury, commonly produces crushing fractures of the bodies of vertebra anteriorly, and spinal cord injuries. Comminuted fragments of bone may be displaced in the spinal canal or into the cord itself. Severe hyperextension of the spine following crash accidents causes a crushing of the posterior portion of the body and the vertebral arch with or without dislocation. The spinal cord may be damaged from the fractured arch or dislocation.

The neural arch may be fractured and collapsed by means of the body

being thrown violently against some resistant object at the time of the accident; this will produce damage to the cord, nerve roots, or ligaments. Sometimes a careful dissection of the spine is necessary at autopsy, to disclose localized injuries of the spine or cord, particularly in cases where there was a transient dislocation at the moment of impact. Symptoms and findings of nerve root injury may be immediate, or may not appear until later, following cicatricial (scar) tissue or callus (new bone) formation. Walker³¹ points out that another late complication of head and neck injuries is that of post traumatic epilepsy. The post traumatic convulsions usually begin within two years after the initial cerebral injury.

Spinal cord and sensory nerve root injuries are significantly important, both from a medical management standpoint and from a medico-legal viewpoint.

Schneider³² emphasizes that trauma to the spine and spinal cord does not carry such a high mortality rate as formerly because of the development of newer methods of treatment after World War II. Better attitudes and newer methods of transporting the injured to the hospital increase chances of survival. Kulowski³³ points out that concussions of the cord or mild contusions have been converted into irreversible transections by neglect of careful examination, and above all by careless transport. A careful history of the patient should be taken on admission to the hospital to show how, when and where the accident occurred. One should know particularly if there has been progression of sensory and motor neurological symptoms, and whether the spine injuries occurred during hyperflexion or hyperextension. The time of onset and progression of symptoms should be carefully noted; these include numbness, burning, pain, bladder and bowel symptoms or any loss of motor power. Upon admission to the hospital, the injured patient should be checked carefully for the presence of surgical shock.

Schneider³⁴ feels that examination of the patient with trauma to the spine is one of the most neglected problems in medicine. He thinks there is a tendency on the part of many physicians simply to check the patient's motor power and level of hypalgesia and neglect the remainder of the evaluation. A thorough neurological examination is imperative initially as this is a base line with which all future observations are compared. This neurological examination must be repeated frequently — every six to 12 hours — to determine any neurological change.

The question of laminectomy and its timing is the number one problem in these cases of spinal cord compression. This must be established immediately from neurological examination of motor, sensory, or visceral paralysis (urinary bladder and rectum). This information can be obtained by determining the status of the reflexes of the knee, ankle, and abdominal muscles. Next, a

31 WALKER, POST TRAUMATIC EPILEPSY (1949).

32 KAHN AND SCHNEIDER, CORRELATIVE NEUROSURGERY 327 (1955). See also, SPURLING, PRACTICAL NEUROLOGICAL DIAGNOSIS (1960); and RAMSAM AND CLARK, THE ANATOMY OF THE NERVOUS SYSTEM (1959).

33 KULOWSKI, CRASH INJURIES—THE INTEGRATED MEDICAL ASPECTS (1960).

34 KAHN AND SCHNEIDER, *op. cit.* *supra* note 32.

thorough X-ray examination is in order for the purpose of determining the site of the lesion, degree and type of dislocation, deformity of the spinal canal or presence of bony fragments in the spinal canal and fractures of the lamina, pedicles and articular processes.

The generally recognized³⁵ medical indications for immediate laminectomy are:

1. Displacement or protrusion of a bony fragment into the spinal canal and in compound fractures.
2. Progression of motor and sensory paralysis in incomplete lesions of the spinal cord.
3. Partial or complete spinal block regardless of the X-ray findings of the spinal cord as demonstrated by the Queckenstedt test.

The generally recognized³⁶ contraindications to laminectomy are as follows:

1. Traumatic shock or associated injuries to some other system.
2. Fracture-dislocation at C-3 and C-4 vertebral level.
3. Immediate complete paralysis without any spinal fluid block.

In summary, the gross internal examination of the autopsy enumerates factual and objective information whether due to natural causes, from injury, or congenital malformations. In addition to detailed descriptions, it includes the collections of physical evidence, sketches, diagrams, photographs and representative pieces of tissue for microscopic study.

Part V: Microscopic Examination

The representative sections of the various organs prepared for microscopic examination include significant lesions, such as occluded coronary arteries, or of traumatic lesions, including capillary hemorrhages of the brain, traumatic fat emboli of the lungs, or hemorrhages in the margins of external and internal wounds. These hemorrhages are indicative of injury while the subject was alive. The degree of inflammatory organization seen and described is an aid in estimating the time of injury. Occasionally this systematic microscopic examination may serve to change the whole interpretation of the gross internal examination. The diagnosis of a milliary chronic infective granuloma may be changed to a milliary carcinomatosis of the lungs, as I experienced the other day in examining a 22-year-old boy with no apparent primary tumor lesion in the gross.

Part VI: Final Summary Of Autopsy

The final summary consists of a statement of the pathological conditions disclosed by the autopsy. In medico-legal autopsies they are listed in the order of their importance as factors in the causation of death.

³⁵ See TARLOV, SPINAL CORD COMPRESSION (1957). See also I DePALMA, SPINAL INJURIES (1959).

³⁶ KAHN AND SCHNEIDER, *op. cit. supra* note 32.

As an example, shock is arbitrarily listed first, due to hemorrhage from a fractured thoracic aorta caused by a violent crushing injury of the chest following a head-on collision. The accuracy of the conclusions, of course, will depend upon the amount of care and observation of the many details of the autopsy.

Part VII: Interpretation Of The Autopsy

The cause, time, manner and circumstances of death as determined by the pathologist are based on his training and experience, upon information gained from circumstances of the accident and on medical information derived from other sources. The validity of his opinions are dependent upon the correctness of the facts as ascertained. The pathologist may or may not write out this section of the autopsy protocol. In accident cases he often will not, since he may not know all of the circumstances, or be aware of the medico-legal objectives of the autopsy.

APPENDIX

A Typical Autopsy Case*

I: General Information

Name:	Autopsy Number:
Age: 19 Race: White	Prosecutor:
Sex: Female Status: Married	Charles E. Black, M.D.
Attending autopsy:	Coroner: Local coroner
Coroner	Place of Autopsy:
Sheriff officers	Local Funeral Home
Autopsy authorized by:	Time Expired:
Prosecuting Attorney	Approximately 2:00 a.m.
Permission for autopsy given by:	Time of Autopsy: 9:00 p.m.
Husband	Identification: Mortician

II: History

Early in the evening, a married woman, aged 19, went in her own 1956 Ford automobile to a dance pavilion, which was a short distance from a trunkline highway. She was accompanied by her first brother, then aged 26, and by her second brother, then aged 16. She (hereinafter referred to as "the sister") and her two brothers spent the evening at the dance pavilion, leaving there about 1:30 a.m. She was driving, with her second brother sitting in the middle of the front seat, and her first brother sitting to his right. There was some fog, but not a continuous, complete blanket of fog. It was a drifting high fog, obscuring the highway intermittently. When they had gone a mile or two west on the trunkline highway and were about opposite a restaurant, an oncoming car, operated by a neighbor, came across the center line of the highway onto the north or right side of the highway, and struck the sister's car. As a result of this first impact, she was believed to have suffered an injury to the right knee, but otherwise her injuries were not deemed to have been serious. The interior of the car was not damaged except for a slight bend in the steering wheel.

After this impact, her car was on the north side of the pavement headed west with the left side approximately two or three feet from the center line of the pavement. The neighbor's car was headed in a northeasterly direction with the greater portion across the center line to the north, with the front end in close proximity to the front of the sister's car, and part of the rear across the south side of the pavement.

After the first impact, the sister got out of her car and stood near the left front door on the driver's side. The door was open, the tail lights and the dome light in the car were burning. The first brother stood by his sister, assisting her. Her second brother started east from the point of impact to warn oncoming traffic from the east. When he had gotten about 200 feet east of the point of the first impact, the defendant in this case, who was driving a 1956 Ford automobile in a westerly direction on the highway at a speed of

* Presented by the author at the 31st Annual Convention of Prosecuting Attorneys Association, Mackinaw Island, Michigan, July 25, 1958.

from 50 to 55 miles an hour, passed the second brother, who was waving his hands. When the defendant approached the sister's car, when about 30 feet from her, he applied his brakes. The right side of the defendant's car scraped the left side of the sister's car and also the right side of the neighbor's car. He finally stopped at a point on the south side of the highway opposite the place of impact.

The defendant had spent the evening at the same dance pavilion and, when his condition was called to the attention of a deputy sheriff, the defendant said, "You don't need to watch me; my stepson is driving tonight."

The trim from the right side of the defendant's car was caught on the trim of the sister's car. Parts of clothing were found on the defendant's car; matching paint from the defendant's car was found on the sister's car; and matching paint from the sister's car was found on the defendant's car.

Certain skid marks were discernible after the accident; these were testified to by the sheriff's deputies and were shown in photographs.

After the impact, the sheriff's deputies and sheriff came to the scene. Sometime after 2:00 a.m., the defendant was allowed to leave the scene to return to his home. Before the defendant arrived home, it was ascertained that the sister was dead. The deputy sheriff was then requested to go to the defendant's home. He informed the defendant of the death of the sister, and asked for a sample of his blood to determine whether or not he was under the influence of intoxicating liquor. The defendant went to the sheriff's office, whereupon a sample of his blood was taken with his consent and co-operation. Blood was drawn by a physician and sent to the state laboratories; it was determined that his blood had an alcoholic content of 0.12 per cent, by weight, of ethyl alcohol. This blood was drawn approximately two hours after the accident.

Both the decedent and the defendant were reportedly in good health prior to the accident.

III: External Examination

General description: The body is that of a well-nourished, well-developed adult white female, appearing the stated age of 19.

Head: A laceration which measures 2 inches in length is found over the outer portion of the left eyebrow, which measures 4 centimeters in diameter. Multiple lacerations and ecchymoses are found over the chin. A laceration of the scalp is found measuring 3 inches in length.

Thorax: Fractured ribs can be palpated over the right chest.

Abdomen: Bruises and excoriations of the upper portion of the abdomen and of the right lower quadrant. An extensive area of ecchymosis is found over the left hip.

Extremities: A bumper-type injury is found about both legs. A compound comminuted fracture of the left ankle is seen. Comminuted fractures of the upper portion of the left tibia and fibula are found. The right patella shows a compound fracture.

IV: Internal Examination

Head: The head was not opened.

Heart: Weight — 325 grams. The heart is normal in size, shape and development. No evidence of injury is seen to the heart.

Lungs: Right — weight 550 grams. Left — weight 550 grams. The pleural cavities contain approximately 500 cc of clotted blood. Extensive hemorrhages are found into the lower lobe and lower portion of the upper lobe of the right lung. The lower lobe of the right lung is completely replaced by hemorrhage.

Spleen: Weight — 150 grams. No fractures are found.

Liver: Weight — 1400 grams. The entire liver shows virtual crushing with numerous fractures. The internal portion of the liver is virtually macerated.

Pancreas: Not remarkable. The pancreas is normal in size, shape and appearance. No evidence of injury is found.

Gastro-intestinal tract: The stomach is empty. The appendix is present.

Kidneys: Neither kidney shows evidences of fracture. Hemorrhage into Gerota's capsule is found about both kidneys.

Ureters: Patent.

Adrenals: No evidence of injury is found.

Reproductive organs: A portion of placenta is found in the fundus of the uterus which measures $2.5 \times 2.5 \times 2$ centimeters.

V: Microscopic Examination

Heart: The myocardium shows no significant changes. The coronary arteries are negative.

Lungs: Shows extensive hemorrhage and edema. The lower lobes of both lungs show sharply defined fissures due to trauma.

Spleen: No evidence of injury is seen.

Liver: Shows marked edema. Extensive fractures are found throughout with hemorrhage.

Pancreas: Shows a normal glandular architecture.

Gastro-intestinal tract: Shows no unusual changes.

Adrenals: Shows marked edema.

Reproductive organs: *Uterus:* The decidua and chorion shows no evidence of degenerative change. The endometrium shows a marked decidual reaction. *Cervix:* Shows a papillary type of endocervicitis. *Ovaries:* A hemorrhagic corpus luteum verum is seen. Follicular cysts are numerous.

VI: Final Summary

1. Shock following extensive crushing injuries of right side of trunk.
 - A. Fractures of the 4th, 5th, 6th, 7th, 8th, and 9th ribs on the right.
 - B. Lacerations and contusions of both lungs with bilateral hemothorax.
 - C. Extensive fractures of the liver with hemorrhage.

2. Comminuted fractures of the left tibia and fibula.
3. Compound comminuted fractures of the right patella.
4. Compound comminuted fractures of the left ankle.
5. Multiple lacerations and ecchymoses of the face, scalp, trunk, and extremities.
6. Pregnancy of approximately 6 weeks gestation.
7. Bumper-type of injuries of both legs.

VII: Interpretations

The purpose of the autopsy was to determine the cause of death and to determine if possible which injuries were produced by the first impact and which ones were produced by the second impact. Further, it was important to be able to show whether first impact injuries were serious enough to have caused death. These determinations were vital since there were no credible eye-witnesses to the second accident.

One of her brothers was rendered unconscious as a result of the second impact and had no memory of the first impact. The second brother was not able to testify with any certainty as to his sister's condition after the first impact nor was the driver of the car who caused the first accident. For that reason it was important that the cause of death be determined from the autopsy; then it was necessary to show whether the first impact could have caused the serious injuries which resulted in death.

The history showed that she was conscious following the first crash, and that she spoke a few words. Her legs were not fractured at that time as she stood on the pavement beside her car. If she had had the lethal injuries from which she died, she would not have been able to do these things. The principal injury sustained by the decedent from the primary impact was the injury of the right patella of her right knee, which played no significant part in the death. This is a common type of dash injury in head-on collisions.

The autopsy, combined with the statement of fact and photographs of the cars, showed that the second crash impact produced the lethal injuries from shock and crushing injuries of the right chest and liver. It further indicated that this blow was directed from the right as she was standing beside her automobile.

The presence of bumper-type fractures of both legs shows that these were inflicted while she was standing. The presence of considerable blood in each chest cavity and in the abdominal cavity showed that she was alive following the second impact and died primarily of shock as a result of internal hemorrhage.