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ROLE OF THE PATHOLOGIST IN ARSON INVESTIGATION

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EDITOR.

While arson is an offense against property, it may involve an offense against persons if someone is injured, killed, or dies as a result of a feloniously set fire. In many states the arsonist has committed a capital offense when a fatality occurs as a result of his crime. In deaths resulting from a fire, as in all deaths which are due or presumably due to violence, the investigation of the cause and manner of death and the signing of the death certificate are the responsibility of the Coroner or Medical Examiner. This introduces the medico-legal phase of the subject.

This presentation is predicated on the thesis that the pathologist can contribute to the solution of some of the problems arising in connection with many fires which are investigated by the arson squad and by the police. Post-mortem examination of a body recovered from the scene of a conflagration may yield to the pathologist information which has a direct bearing on the origin of the conflagration and the identification of those responsible for the fire.

Approximately 10,000 deaths each year in the United States are caused by fires. In almost a quarter of these, the victim is found dead at the scene. Although the majority of deaths due to fire are accidental, this is not *always* the case. Some fire deaths which appear accidental have been carefully planned and involve suicide or homicide. There are several explanations other than accident for the presence of bodies at a fire scene.

DESTRUCTION OR MUTILATION OF A DEAD BODY BY FIRE TO CONCEAL A HOMICIDE

The criminal is rarely successful in this effort. A great deal of heat and fuel are required to completely consume a human body. Even after prolonged exposure to extreme heat, portions of the body will remain identifiable as human in origin. It is frequently possible to establish the cause and mechanism of death by careful post-mortem examination of the body even though there is extensive damage from heat and flame.

CASE: After a fire in a blazing shed had been extinguished, search of the interior of the almost completely destroyed structure disclosed the severely burned body of a young woman. Internal examination of the head revealed a fractured skull, subdural

and subarachnoid hemorrhages and contusion of the brain which were responsible for death. There was no smoke or soot in the air passages, and the blood contained no carbon monoxide, indicating that death had occurred before the victim had been exposed to the fire. Further investigation by the police disclosed that the victim had been killed in an altercation during which a cement building block had been dropped on her head. The murderer then sought to destroy the evidence of his act by placing the body in the shed, which he set on fire. Arrest and conviction followed.

INDIVIDUALS BURNED OR INCINERATED WITH HOMICIDAL INTENT

Usually the victims of homicidal burning are unconscious as a result of the effects of alcohol or hypnotic drugs (barbiturates, chloral hydrate, etc.) or are disabled by injuries.

CASE: The charred body of a young man was found in a burned auto after the fire had been put out. Autopsy disclosed that death was the direct result of the fire. The blood alcohol was 0.09%. Interrogation by the police revealed that a "friend" of the victim had thrown gasoline over him as he lay sleeping in the auto and then set him and the car on fire by tossing a lighted "comic book" into the interior of the vehicle. The motive behind the crime was jealousy concerning the attentions of a mutual female acquaintance. The defendant was tried and found guilty of murder in the first degree.

DESTRUCTION OR MUTILATION OF A DEAD BODY BY FIRE TO PERPETRATE AN INSURANCE FRAUD

After first destroying by fire and heat the identifying characteristics of the deceased (facial features, fingerprints, scars, etc.), the criminal purposely misidentifies the mutilated body so that a claim may be entered for the collection of the life insurance of the supposed victim. Such fraudulent claims must be watched for with mass catastrophes where large numbers of badly burned or mutilated bodies are involved. Taking advantage of the confusion and haste which may attend the claiming and disposal of many unidentified and partially identified dead, purposeful misidentification is made, and the body is claimed and buried under the name of a confederate on whose life there is an insurance policy.

SUICIDE BY SPRINKLING OR SOAKING HIS CLOTHING WITH A FLAMMABLE SUBSTANCE AND THEN IGNITING HIMSELF

Thorough investigation must be carried out in all such cases to eliminate the possibility of a "torch murder". By the same token, the community should not be alarmed with rumors of a "torch murder" when the manner of death is actually suicide.

CASE: The body of a 61 year old woman was found lying on the floor of her bedroom with her clothing almost completely burned off. A partially empty container of a flammable liquid was beside her bed together with six unburned and one burned match. None of the furnishings in the room was damaged. Interrogation of the victim's family revealed that she had been despondent and had repeatedly threatened to commit suicide.

CASE: A 62 year old was discovered in his garage with his clothing ablaze. The fire was extinguished, and he was rushed to a hospital where he died of severe burns shortly

after arrival. The body of the victim, his clothing, and his shoes (which were not burned) smelled strongly of gasoline, and search of the garage yielded two empty pint bottles which had contained gasoline. The family stated that the victim had been under medical care for severe melancholia.

A SUICIDE VICTIM HIDING EVIDENCE OF HIS ACT BY FIRST SETTING FIRE TO THE SURROUNDINGS

In some instances the motive behind the fire setting is an attempt to perpetrate an insurance fraud. In other situations the victim may wish to spare himself and his family the stigma of suicide.

CASE: The body of an elderly man was recovered from a burned building. Autopsy revealed that death was due to carbon monoxide asphyxia from the fire. Both wrists of the deceased presented multiple incised wounds with the hesitation marks characteristic of a suicide. Investigation of the burned building revealed the fire had been deliberately set by the victim.

AN INDIVIDUAL TRAPPED IN A STRUCTURE SET AFIRE BY AN ARSONIST AND PERISHED AS AN UNFORESEEN RESULT OF THE FIRE

The presence of a potential victim within the building may be completely unknown to the arsonist, or the fire set by the arsonist may spread further than had been originally intended with resultant unexpected fatalities. Such a situation occurred in Cleveland when a feloniously set fire in a barber supply house went on to involve a neighboring apartment building. Nine dwellers in the apartment perished as a result.

Whether the fire is started by a pyromaniac, a psychotic, or a calculating criminal is immaterial to the present discussion. The investigation of a fire goes beyond establishing or disproving the element of criminality in the origin of the conflagration. Hazards to health and life must be checked and eliminated. The human failings of carelessness, negligence, and ignorance can lead to consequences as serious or fatal as those arising from a criminal act.

Illegal or improper storage and disposal of fuels and flammable materials is always a source of potential disaster. A recent explosion in a sewer in Cleveland which resulted in one death, many casualties, and widespread property damage was traced to the presence in the sewer of products of industrial wastes from neighboring factories. Carelessly performed amateur electrical work or improperly installed gas appliances are additional sources of danger.

Given a body recovered at the scene of a fire, what can the pathologist discover or establish by his examination that may be useful to those who are charged with the responsibility of investigating the fire? Answers to the following questions can almost always be obtained by careful study of the body and correlation of the anatomic findings with other data:

1. When did death occur, before or during the fire?
2. What was the cause of death?
3. Who is the dead body? . . . the problem of identification.
4. What contributing or ancillary factors are involved in the death . . . alcohol, drugs, injuries or natural disease?

5. What was the manner of death . . . accident, suicide, homicide, or natural causes?

Before discussing the answers to these questions, a broad basic generalization should be stated. *No matter how badly burned, incinerated, or charred a body may be, a great deal of useful information can be gained by a careful examination of the remains.*

PROOF THAT THE VICTIM WAS ALIVE IN THE FIRE

In the post-mortem investigation of a body recovered from a fire, it is essential to determine whether or not death was due to the fire. The victim may have been moribund or unconscious from other causes (alcohol, drugs, poisons, injuries, natural disease) and died as a result of the fire.

Deposits of Smoke and Soot in the Air Passages (larynx, trachea and bronchi). The presence of black or gray-black carbonaceous material on the mucous membrane lining of the air passages indicates that smoke has been inhaled and thus proves that active respiration occurred while the fire was in progress. Whether there is much or little soot in the air passages depends on the type of fire and the amount of soot in the smoke. Failure to find evidence of smoke inhalation should arouse the suspicion that death may have occurred before the individual was exposed to fire and smoke. However, it is possible for the victim of a fire to die so rapidly in an extremely hot blaze that he has little opportunity to inhale smoke or soot.

Presence of Carbon Monoxide in the Blood. Although the composition of smoke varies widely and is dependent on the interaction of several factors (e.g., type of fuel, amount of oxygen available to support combustion, temperature attained by the fire, extent to which smoke has been diluted by air, etc.), almost invariably smoke contains a dangerous amount of carbon monoxide. In a smoke-filled room, the concentration of carbon monoxide may be so great as to cause loss of consciousness and death within a few minutes.

The presence of carbon monoxide in the blood in excess of 10% saturation indicates that the individual breathed smoke and therefore was probably alive in the fire. (A small amount of carbon monoxide may be "normally" present in the blood of garage workers or smokers.) Carbon monoxide can reach the blood only by active respiration. *It is not absorbed through the skin after death.* When carbon monoxide is inhaled, it combines with hemoglobin, the red coloring matter of the blood, and produces a compound called carboxyhemoglobin which has a characteristic "cherry-red" color. The skin, mucous membranes, and organs of a fire victim will have a livid cherry-red color if a sizable quantity of carbon monoxide is inhaled prior to death.

Carboxyhemoglobin can be readily demonstrated by chemical tests and its exact concentration determined. Even if the blood is coagulated by heat, the coagulum can be broken up under oil, and the chemical tests carried out.

With flash fires or with intensely hot, rapidly-spreading fires there may be little or no carbon monoxide in the blood. The victim may die too rapidly to inhale the gas in appreciable quantities.

Erythema (Reddening) and Edema Around Skin Burns and Blisters. The presence of a border of localized reddening at the edge of a burn is a vital reaction which depends on active circulation of the blood. The heart must be beating if this phenome-

non is to be produced. Hence it is an indication that the victim was alive when the burn was sustained.

If the skin, alive or dead, is super-heated, it may develop blisters which contain steam. Such blisters either rupture immediately or collapse when the skin cools. Burns which are sustained before death may be completely masked or obscured by the continued application of heat after death.

Hemorrhage Beneath the Endocardium of the Left Ventricle. Blood may escape under the lining of the heart as a result of hyperthermia. This reaction is not specific for heat but is seen with a variety of fatal mechanisms. It is readily demonstrable at autopsy. In the burned victim it indicates active circulation when the fatal exposure to heat took place. It furnishes additional evidence that the individual was alive in the fire.

Thus, when death has *preceded* a conflagration, one does *not* find smoke in the air passages, carbon monoxide in the blood, water-filled blisters, or hemorrhages beneath the lining of the heart.

CAUSE OF DEATH

The basic purposes of the autopsy are to establish the cause and manner of death and to acquire and to preserve whatever medical evidence may be present to aid in the overall investigation of the case. By performing a *complete* post-mortem examination of the body (including microscopic and toxicologic studies), the pathologist can usually determine the cause of death. The degree of burning and the quantity of carbon monoxide in the blood must be carefully evaluated to determine whether they are lethal factors, contributory factors, or incidental findings.

There are numerous injurious possibilities in most fires. Any one or several acting together may be the actual means of death.

A. Falling walls, floors, beams, and the like can result in fatal mechanical and crushing injuries.

B. Excessive heat may be fatal, in and of itself. Hot gases or flame can lead to severe shock and cardio-vascular collapse. It is possible for death to occur as a result of heat without visible burning of the skin. This requires relatively long exposure to heat below the ignition temperature. Such a death is a form of acute heat stroke.

C. Lack of oxygen (anoxia) rarely causes death in a fire. If there is enough oxygen to keep the fire alive, there will be enough oxygen to support life. Fire dies out at a concentration of oxygen which will maintain life. If a mouse and a lighted candle are placed in an air tight container, the candle will be extinguished by lack of oxygen while the mouse is still active.

D. Noxious gases, smokes, and fumes are commonly produced by many fires. Some cause death by interfering with vital body reactions while others irritate the respiratory organs, causing severe and fatal pulmonary edema.

Carbon Monoxide. Death from carbon monoxide may occur with little or no burning of the body. This colorless, odorless, and tasteless gas first incapacitates and then asphyxiates. Carbon monoxide causes death by uniting with the hemoglobin of the blood and preventing the uptake and transport of oxygen. This lethal product of combustion does not cause irritation of the air passages.

Carbon Dioxide. Rarely does a fire produce sufficient carbon dioxide to cause fatal asphyxia solely on this basis.

Hydrogen Cyanide and Hydrogen Sulfide. These poisonous gases are formed in large quantities when wool is burned.

Oxides of Nitrogen. Toxic compounds of oxygen and nitrogen ("nitrous fumes") may be formed in lethal amounts when certain materials containing nitrogen are burned. In the Cleveland Clinic fire large quantities of X-ray film were involved, and the great majority of the deaths in this disaster resulted from the inhalation of the poisonous fumes produced by the combustion of the plastic base (nitrocellulose) of the X-ray films.

Acrolein. This is an extremely toxic substance which is produced when fats or oils are superheated.

Chemicals and Refrigerants. These present special problems and include such materials as ammonia, freon, methyl chloride, phosgene (from the decomposition of carbon tetrachloride), etc.

Delayed Deaths. The victim of a fire may be found alive and die subsequently hours, days, or weeks later. In these cases, as in those found dead at the scene of the fire, the determination of the exact cause of death is a prime consideration. Criminal responsibility for death is the same whether the victim dies immediately or later.

A. Pulmonary Edema. Large quantities of watery fluid may pass from the blood vessels of the lungs into the lung spaces as a result of irritation of the lungs by toxic gases, and the victim literally drowns in his own secretions. Such deaths usually occur within a few hours to a day or two after the individual has been removed from the fire.

B. Laryngeal Edema. As a result of the inhalation of hot air and gases, the victim may develop edema (swelling) of the larynx with resultant respiratory obstruction and asphyxia.

C. Shock. The victim of severe injuries (burns, fractures, etc.) frequently succumbs to irreversible circulatory shock.

D. Pneumonia. Pneumonia may occur as a complication of burns or other injuries. Inhalation of irritating smokes and gases damages the lungs and predisposes them to bacterial infection.

E. Lower Nephron Nephrosis. This is a variety of serious kidney damage which results in failure to form urine (anuria). It is also called "crush kidney" and "hemoglobinuric nephrosis" and is a sequela of severe injuries of many types.

F. Infection at the Burned Site. This complication is now relatively rare. The antibiotic drugs are excellent weapons against this complication.

ARTEFACTS IN BURNED AND INCINERATED BODIES

The examiner must not be misled by some changes produced in the dead body by heat and fire which may be confused with ante-mortem injuries.

Splits of the Skin. The continued application of heat to the skin after death causes the skin to contract and split. The resultant defects closely resemble slashes made by a knife, and may create the impression of a homicidal attack with a sharp instru-

ment. The heat splits are not accompanied by evidence of bleeding and can be readily differentiated from ante-mortem cut and stab wounds.

Postmortem Blisters. Heat applied to a dead body may produce steam between the epidermis and dermis. The resultant "pseudo-blisters" contain only gas. They lack the circumferential reddening of ante-mortem blisters, and the skin beneath is yellow or gray rather than red as is found in true blisters.

Skull Fractures. Steam will form within the skull if the head is exposed to sufficient heat. If the heating is continued, enough pressure may be built up inside the skull to eventually cause it to explode. The explosion will result in fractures of the skull which may simulate ante-mortem injury.

Extreme heat, even without internal explosion, can lead to desiccation of the skull and the production of post-mortem linear fractures. Neither in such an instance nor in the situation outlined in the previous paragraph will the fractures be accompanied by such brain injury or hemorrhage as would reasonably be expected if the bony injuries were the result of ante-mortem mechanical violence. When the fractures are the result of steam explosion, the fracture lines are separated.

Post-mortem skull fractures and brain injury can occur in burned bodies as a result of crushing impacts from falling beams, walls, etc. In such instances the fractures and brain trauma are not accompanied by evidence of hemorrhage, a vital reaction.

Epidural Hemorrhages. Blood may accumulate between the skull and dura as a result of heat and mimic an ante-mortem epidural hemorrhage. Such a collection of blood can be differentiated from the ante-mortem traumatic variety inasmuch as the blood clot in the latter is unilateral and does not extend across the midline.

Fractures of the Extremities. Extreme heat may make the long bones so brittle that playing a hose on the body can result in fractures. Examining or moving such a body can also result in fragmentation of the bones.

Pugilistic Posture. Many bodies recovered from fires are found in the so-called "pugilistic posture" or "pugilistic attitude", with the arms, wrists, and legs flexed or semi-flexed. The bending of the limb is due to heat rigor, a situation where the muscles stiffen and shorten due to protracted exposure to high temperature. This change can occur even though the victim did not die as a result of the fire. The contraction of the muscles is so strong that the muscles are torn if the limbs are forcibly extended.

IDENTITY OF THE DECEASED

It is usually possible to establish the identity of a burned body if all available avenues are explored and utilized. Even though the body is apparently burned beyond recognition, careful internal and external examination may yield data which permit absolute identification.

The values of identification are manifold.

Humanitarian. Human decency and morality require that every effort be made to establish the identity of the deceased so that family and friends may be apprized of the death and properly dispose of the remains.

Civil Affairs. The collection of insurance, probating of wills, settling of estates,

and legal remarriage of a surviving spouse are dependent on establishing the identity of the deceased.

Criminal Investigation. Homicide investigation begins with the identity of the deceased, and proper prosecution in a case of homicide requires that the identity of the deceased be unquestionably established.

The subject of identification is too broad for a complete discussion at this time. A few brief pertinent observations with special reference to burned bodies are in order.

The interior of the body is frequently well preserved when the outer surface is badly charred or destroyed. In situations where the hair, facial features, clothing, and external genitalia have been completely destroyed, examination of the interior of the body will often yield sufficient data to permit the determination of age and sex. The presence of internal changes resulting from previous disease, injury, or surgery may provide additional specific facts to aid in identification.

Teeth and dentures are resistant to heat, and resort to dental techniques of identification may be rewarding. Vitallium dentures are practically indestructible and are extremely valuable in helping to establish identity where the remains are severely charred. In a recent case in Cleveland identity was established in a body burned beyond recognition by finding a strip of paper with the victim's name embedded in the plastic portion of an upper denture.

Jewelry (signet rings, fraternity rings, etc.) may be the key which unlocks the riddle of the identity of the deceased. X-ray examination of the hands of a severely burned body may reveal the presence of rings which would have gone unnoticed because they are hidden by the charred skin and crumpled contracted fingers. X-ray examination of other portions of the body may also prove useful in establishing identity.

CONTRIBUTORY AND ANCILLARY FACTORS IN DEATHS

A complete autopsy and toxicologic studies will, in many instances, demonstrate how and why the victim was rendered vulnerable to death in a conflagration. A high level of alcohol in the blood may explain why the victim was unable to find his way out of a burning building with adequate fire escapes. Moreover, many fires result from the careless acts of alcoholics. The presence of a barbiturate in the blood or urine casts some light on a possible explanation for death in a burning building. Incapacitating natural disease discovered at autopsy provides a ready explanation why the individual was unable to save himself.

MANNER OF DEATH

After all facts dealing with the fire are collected and assembled, a decision can be made as to the manner of death—homicide, suicide, accident, or natural causes. This verdict will depend on the results of many avenues of investigation. The anatomic findings of the pathologist, the chemical analytic results of the toxicologist, the study of the scene of the fire by the arson investigator, and the results of the interrogation of witnesses and suspects by the arson investigator and police, taken

together, give a comprehensive picture of what has transpired. A sound ruling is based on all facts.

CONCLUSIONS

The pathologist may contribute valuable data to the investigation of a known or suspected case of arson by careful examination and evaluation of the findings in the bodies of any victims. The autopsy will not only establish cause of death, but will also furnish, in many instances, answers to questions relating to the identity of the victim and the source and origin of the fire. Thorough study of a burned body or even parts of a burned body will frequently yield information which illuminates many of the problems confronting the arson investigator and the police.

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