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Death on the Railway

Deaths of medicolegal interest occurring or discovered on railroad property have received little or no attention in the recent literature. While studies of deaths associated with other means of transportation, particularly road vehicles and aircraft, have been reported at length and in depth, railroad-related deaths have been accorded only cursory study.

This is true particularly in the American medical and medicolegal literature. A review of the *Cumulated Index Medicus* for 1968–1974, inclusive, yielded numerous foreign references in the "Railroad" category, with those from Russia and India predominating. It must be noted, however, that most of these articles dealt with the environmental, preventive medicine, and occupational aspects of railroading, although several articles did report medicolegal aspects of specific railway accidents or railroad-related injuries and deaths.

In contrast, this review yielded very few references from the American literature. The most recent is, however, a most welcome and instructive study of a high-speed passenger train derailment which resulted in eleven deaths and numerous injuries to passengers [*1*].

The paucity of published work in this area stands in sharp contrast to the numerous types of railroad-related deaths seen by the pathologist in a busy forensic practice, and to the often difficult questions of cause, responsibility, and interpretation which they present.

It is for these reasons, and because of the author's lifelong interest in railroading, that a series of cases is presented here illustrating common problems faced by the forensic pathologist in the study of railroad-related deaths.

Procedure

The term "railroad-related death" is used in this paper to indicate a death either occurring on railroad property, including railroad cars, tracks, and right of way, or in which the decedent's body was first discovered either on or very near railroad property.

Twenty-seven such cases from the period 1971–1974, inclusive, were selected from the files of both the Office of Coroner-Montgomery County, Ohio and the Office of Chief Medical Examiner-State of Maryland, in Baltimore.

The Montgomery County, Ohio cases represented all deaths for this period coded in the office under the heading "Railroad," as well as all other uncoded railroad-related deaths which the author found reported during that period. The author personally performed the autopsy or examination in six of these 22 cases, and in the other 16 personally reviewed all of the histories and autopsy findings. The author personally performed the autopsy in four of the five Maryland cases, and personally reviewed the fifth, all during the period November 1972 to July 1973, inclusive.

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This series, encompassing railroad-related deaths of individuals in both a county coroner's jurisdiction and a busy state medical examiner's office, is believed to be the first of its kind reported in the medical or medicolegal literature.

Scope of Study

The modern railroad and its immediate environment encompass a great variety of geographic settings, factors of enormous mechanical and electrical motive power and speed, and numerous temptations to individuals both to disregard railroad rules and to inflict harm on railroad property and personnel.

Railroads traverse barren and lonely country, bodies of water, small towns, and great cities. Railroad trains and tracks thus provide a continuing and sometimes fatal temptation for children at play, a convenient line of travel for transients and some pedestrians, and at times a convenient place for disposal of decedents' bodies. Many grade crossings of roads and railroads are unprotected by warning devices, with the ever-present potential for fatal vehicle-train collisions, but even at those protected crossings drivers frequently ignore or bypass the warning lights and gates in the face of an approaching train, often with resulting fatality.

Finally, and perhaps in keeping with the growing disregard for human life in America, individuals with increasing frequency intentionally damage or pillage railroad property and assault or kill persons riding or working on trains.

With these considerations in mind, the 27 railroad-related deaths were conveniently grouped for study into five categories (Table 1).

TABLE 1—*Categories of railroad-related deaths.*

Category	Cases, no.
1. Vehicle-train collision	
a. Automobile	
Driver	5
Passenger	4
b. Truck	
Driver	1
c. Motorcycle	
Operator	1
Passenger	1
2. Individual afoot on railroad tracks	
a. Walking	6
b. Sitting or asleep	2
3. Fell from train or vehicle	
a. From train	1
b. From truck	1
4. Found on or near railroad property	
a. Ruled "accident"	1
b. Ruled "homicide"	2
c. Undetermined	1
5. Killed while riding on train	
a. Ruled "homicide"	1
TOTAL	27

This series does not include any individuals killed in the collision or derailment of a railroad freight or passenger train. This type of accident, while fortunately infrequent, does often result in serious physical harm or death. The injuries involved are usually of the blunt and sharp force types, although sometimes they are of thermal or electrical variety. Medicolegal contributions to the study of railroad mass disasters may be found

in the literature. In the recent article by Braden previously noted [*1*], he reported that crash investigation techniques previously utilized by human factors teams in investigating commercial airline crashes are for the first time applied to the study of a railroad accident.

For each of the five categories, a brief discussion will serve to indicate the particular conditions or problems pertinent to the specific category of deaths and the investigative and medicolegal approaches which may lead to the clarification or solution of these problems. One or more particularly instructive cases from each category will be presented as examples.

Vehicle-Train Collision

This type of death occurs almost invariably at a railroad crossing when a motor vehicle is driven into the path of an oncoming train or into the stationary or moving train itself. In some cases there is apparent wanton disregard by the driver for crossing warning signals, while in others the driver for some reason apparently does not see the approaching train. A motor vehicle may stall on the tracks, especially if the driver panics or attempts to shift gears while actually on the crossing or tracks. It must always be ascertained by those investigating the fatal collision whether crossing warning devices, if any, were in fact functioning at the time of the collision, and whether the train engineer was sounding his warning whistle or bell, or both, as required.

The twelve fatalities in this category include individuals killed in nine separate accidents, in three of which two persons were killed, and in one of which three persons were killed. In the latter accident, however, the deaths of the driver and one passenger did not fall under the jurisdiction of the Montgomery County Coroner's Office. The seven drivers ranged in age from 18 to 60 years. The youngest passenger was 22 months of age; the oldest could not be ascertained, for in the single motorcycle-train collision it could not be determined with certainty which of the two motorcycle riders was the operator and which the passenger. Rural and suburban railroad crossings were the sites of three fatal collisions each, while two occurred in towns and only one in a city. In all cases there was at least a crossing warning sign in place at the crossing where the fatal collision occurred.

Case 1—A 60-year-old man was seen at night driving his automobile toward a suburban railroad crossing at which flashing signals were warning of an approaching freight train. A driver following immediately behind stated after the accident that the subject's brake lights did not flash as he neared the crossing. Despite the functioning crossing signals, and the sounding of the locomotive horn and its bright headlight, the subject drove his car into the path of the locomotive. He died of multiple severe blunt force injuries. A blood ethanol determination at autopsy was negative. The subject's wife stated after the accident that her husband had recently been feeling poorly. He, however, had no known significant natural disease, and none was demonstrated at autopsy.

Case 2—At a rural grade crossing in daylight a dump truck operated by a 29-year-old man was struck and demolished by a passenger train traveling on time at about 70 mph (about 115 km/h). The truck driver died of multiple severe injuries. He had begun driving this route only recently, and had reportedly been warned by the owner of the truck to expect this high-speed train there at about that time each day. The locomotive engineer felt that the truck may have stalled on the tracks as the train approached.

Case 3—A 25-year-old man was driving his car in daylight on an icy rural road in winter. Near a grade crossing he applied his brakes on sighting an approaching freight train, but as he did so the car slid into the path of the train and was struck by it. All four occupants of the car were thrown from the vehicle, the driver and a son dying

almost immediately, and an infant daughter five days later. Witnesses stated that the train bell, horn, and lights were operating at the time of the collision.

These examples indicate most of the important factors in vehicle-train collisions which are worthy of consideration by the forensic pathologist. Needless to say, an autopsy must always be performed in cases of railroad-related deaths, for only it will enable the pathologist to determine the exact cause of death and any preexisting physical diseases or conditions which may have caused or contributed to the fatal accident.

Case 1 raises the question of why the driver did not heed the warning signals and the approach of the train. At autopsy in such a case the pathologist must look especially for lesions which may have impaired the driver's vision or hearing and resulted in his failing to notice the oncoming train. A blood ethanol determination, and a search for other drugs, if pertinent, must also be performed. In a case with a history such as this one the possibility of suicide must also be considered.

In Case 2 the driver may have forgotten about the scheduled train, or his vehicle may have malfunctioned or stalled on the crossing. Worth considering in similar circumstances is the observation that natives, particularly of rural areas, may become so accustomed to the passage of a particular train at a given crossing at a set time that they fail to look for it there at other times, a fatal collision thus sometimes occurring at that crossing when the train is unexpectedly running late.

As seen in Case 3, weather conditions may play a role either in obscuring the driver's view of an oncoming train or in causing him to lose control of his vehicle at a crossing while attempting a sudden stop.

Both drivers and passengers in all Category 1 cases died of multiple, severe, and usually blunt force injuries. In deaths of vehicular occupants discovered after vehicle-train collisions, particularly those where the driver is not seen driving onto the crossing, or in which the deceased suffers disfiguring injuries or burns, or both, it is mandatory that the possibility of the individual's being already dead or unconscious from other causes when struck by the train be considered and, if possible, established or ruled out by autopsy. It may also be necessary to specifically establish the identity of the individual at autopsy. Cases have been reported in which an individual has been subdued or killed for various reasons, then placed in a vehicle on or at a railroad crossing in an attempt to camouflage the homicide by simulating a fatal vehicle-train collision.

Individual Afoot on Railroad Tracks

Four of the eight subjects were children or adolescents, their ages ranging from six years to the teens. Two children were walking with companions on railroad tracks, one on a bridge and the other on an open trestle, at the time they were struck and killed by trains. The two teenagers were walking close beside the tracks at the time of their accident. The other four subjects were adults, ranging in age from the mid-20s to middle age. One was struck by a train while sitting on the tracks, and another while lying on the tracks. The third was struck by a train while crossing the tracks, and the fourth under unknown circumstances. He remained unidentified for more than three weeks after the accident. Three of the accidents were known to have occurred at night.

Case 4—Three youths were riding their bicycles across a rural railroad trestle when a freight train arrived there traveling at about 20 to 25 mph (about 32 to 40 km/h). Two of the youths gained the opposite end of the trestle safely, but the third fell or jumped about 28 ft (8.5 m) to the rocky creek bottom below, sustaining multiple injuries from which he died two days later after surgery.

Case 5—A man known to be a chronic alcoholic was seen by the engineer of a freight train lying motionless on the tracks in front of the approaching train. The engineer was unable to stop the train before it struck the subject, inflicting multiple injuries, including

partial traumatic amputation of three of his four extremities. The deceased's blood ethanol at autopsy was 0.39 g/100 ml.

Case 6—A 24-year-old man on a summer family outing beside a river tried to cross mainline railroad tracks at the nearby river trestle. As he did so an oncoming Metroliner train struck and killed him. At autopsy a patterned abrasion matching part of the train structure was seen on one forearm. There were multiple fractures and multiple pulmonary bone marrow emboli were seen in microscopic sections taken at autopsy. Blood ethanol at autopsy was 0.13 g/100 ml.

Case 4 is of a type all too frequently seen, that in which one or more individuals are surprised by an approaching train while walking or riding on a bridge, trestle, or other elevated structure. They are often unable to escape the structure without being either first struck by the train or being injured or killed while leaping or running from it.

The advent of the new high-speed trains such as the Metroliner has introduced new hazards to those on foot on railroad tracks traveled by these trains. The Metroliner, for instance, travels in relative quiet and at speeds exceeding 100 mph (160 km/h). At least one case has been reported in which several children at play on the tracks were struck and killed by one of these trains [2]. They, and perhaps the subject in Case 6, were either entirely unaware of the train's quiet, rapid approach, or though they saw or heard it approaching, underestimated its great speed.

Ethanol likely played a contributory role in Case 6, and was in Case 5 likely largely responsible for the deceased's comatose and unresponsive condition immediately prior to the accident.

Cases 7 and 8—Two youths walking along mainline railroad tracks at night were seen by crewmen to wave at their passing train, but the noise of its passing apparently resulted in the youths' failure to hear a second train approaching in the opposite direction on an immediately adjacent track. The engine of the second train struck and killed the two youths, unbeknown to the engineer. Their bodies were discovered beside the tracks the next morning. It was only when this engine was traced by railroad police to another city after the completion of its run, and tissue matching that of one of the boys was found on it, that the true sequence of events was made known.

Pedestrians and trespassers on railroad property face additional hazards, only one of which is death by electrocution resulting from their contacting electrified third rails or high voltage trackside or overhead train electric power transmission lines [3].

Fell from Train or Vehicle

Individuals climbing, riding, or playing on railroad cars in yards or on open track may receive serious or fatal injuries when they are either crushed between moving cars or fall from cars to be run over by their wheels. Those individuals are often children or transients, although not infrequently railroad workers are also involved. This type of accident also occurs, although less frequently, with motor vehicles on railroad property.

Case 9—A five-year-old boy climbed on the rear framework of a semitruck trailer stopped for a crossing warning flasher at a city crossing. At that time the truck began to cross the tracks, causing the subject to fall, catching his leg in the rear bumper framework. He was then dragged for some distance across the tracks and along the street, where he finally became dislodged and fell from the vehicle. The truck driver was unaware of the accident until later stopped by police; he was not cited. The child was dead on arrival at a hospital of multiple severe blunt force injuries.

Even though railroad crews and police patrol railroad trains and yards, discouraging trespassers, railroad equipment and crossings still present a strong attraction particularly for children and youths, often with unfortunate results such as the above.

Found On or Near Railroad Property

In this category are found perhaps the most challenging and puzzling cases confronting the pathologist in the area of railroad-related deaths. For the fact that an individual is found dead on railroad property, or even in a railroad car, by no means guarantees that he died there or that his death was in any way caused by, or associated with, the railroad itself. The very fact that the body is found dead under unknown circumstances makes each of these deaths immediately suspect. The four example cases in this category, all unique, will make this abundantly clear.

Case 10—An adolescent boy was found lying beside rural railroad tracks, unconscious, with external evidence of blunt force injuries to the head, trunk, and limbs. He was hospitalized, and remained in the same condition until his death two days later. At that time he had still not been identified. Autopsy revealed a youth appearing to be twelve to fourteen years old and apparently of Spanish extraction. There was evidence of blunt force injury in the occipital scalp, and contrecoup cerebral cortical contusion hemorrhages were present anteriorly in the brain. Pictures and descriptions of the boy were published by news media in the area.

Ten days postmortem, persons from a large city 110 miles (177 km) to the west identified the boy on this basis. Further investigation revealed that he had run away from home, traveling east on a freight train. The autopsy findings indicated a fall on the back of the head, resulting in the eventually fatal craniocerebral injuries. He had apparently jumped or fallen from the train, although an assault by another individual in which the boy was knocked to the ground could not absolutely be ruled out.

Case 11—At a large city bakery, railroad tank cars containing corn syrup were parked on an adjacent railroad track overnight. When an employee went to one of the cars on a winter morning to turn on car-heating apparatus he noticed one of the top hatches ajar. Looking down into the tank car he discovered a man's body therein, immersed in the corn syrup. Tubes of tire cement and tire patches were found near the tracks.

The body was that of a fully clothed young white man. He for some time remained unidentified. Autopsy revealed only a faint apparent needle puncture wound in one antecubital fossa. There was no corn syrup in the mouth or respiratory passages. He was subsequently indentified, and was found to have been released from jail at about noon on the day prior to his being found. He was last seen alive that night. The history also suggested past use of narcotics. Postmortem toxicology revealed only a blood ethanol of 0.08 g/100 ml. Tests for narcotics and solvents were negative. Still, it was concluded on the basis of the entire case history that the most likely cause of death was narcotism, or solvent inhalation, or both. It was also concluded that associates of the deceased had placed his body in the tank car after his death.

Case 12—A white man was found one afternoon lying on the ground about 90 ft (27 m) from a box car sitting on a city railroad spur track. He was fully clothed and had died of blunt force craniocerebral injuries. Blunt force injuries were also found upon the face and extremities. A piece of wood bearing apparent blood, and hairs, was found nearby. The deceased had apparently been living in a boxcar on the siding, as various items of clothing were found therein. His blood ethanol at autopsy was 0.24 g/100 ml. The death was ruled a homicide.

Case 13—Two men were walking along rural mainline railroad tracks in the early afternoon. They made a habit of doing so at that time to check the trackside ground for animal dens. As they did so a patch of freshly turned earth caught their eyes, and on digging into it they found a human lower extremity. Law enforcement and coroner's personnel were called to the scene, and further digging revealed in a shallow grave the body of a young man, buried face down, his hands and ankles bound together behind his back with rope. The body remained unidentified until the next morning.

An autopsy showed that death had resulted from multiple blunt force injuries, particularly to the face, head, and neck. The death was ruled a homicide. Further investigation suggested a motive for the incident.

It is apparent from these unusual cases that an individual found dead on railroad property may well not be the victim of a true accident, but that he may actually have been the victim of homicidal violence. He certainly also may have died of natural causes, and suicide by jumping or lying in front of oncoming trains or intentionally contacting electrified third rails has also been reported [*4*].

Thus it behooves the forensic pathologist to maintain a high degree of both skepticism and objectivity when dealing with such a railroad-related death. It must not be assumed that the death was caused by, or in fact had anything directly to do with, the railroad itself.

Confronted with blunt force injuries in the body at autopsy, the pathologist must distinguish between injuries sustained as a result of the individual having fallen from or having been struck by a train, and those sustained by other means. Usually this important differentiation is not difficult. However, often only a thorough study of the history, the scene, and the autopsy findings, along with follow-up will bring the true story to light and make possible a definitive ruling. And, in some cases, the latter is not possible even after all of the data have been thoroughly evaluated.

Killed While Riding on Train

Trains are not generally considered to be a dangerous or risky mode of transportation. However, deaths of accidental, suicidal, and homicidal nature have been reported in those on board stationary or moving trains.

Homicidal deaths are being seen with increasing frequency. This is particularly distressing because most of the victims are apparently entirely innocent and apparently unknown to the killer, who usually shoots at or toward a train as a sniper from some distance away. Metroliner engineers report that frequently missles are thrown at their trains and that sniping attacks are directed at trains. Some of the resultant killings are apparently intentional [*2*]. In some, the assailant may bear a grudge or ill will against the particular railroad, or against railroads in general, for some real or imagined injustice—perhaps the loss of a job. This possibility must be considered by those investigating such a death. In some other cases the assailant may be shooting only at the train, or at another target, and may not actually intend to kill anyone.

Yet, several homicidal shootings involving railroad personnel have been reported recently [*5*]. Another form of homicide involving train riders occurs when an individual intentionally causes the wrecking or derailment of a train, with resultant loss of life. Railroad police and other law enforcement authorities are charged with investigating cases of this type.

Case 14—A 50-year-old railroad brakeman, riding in the side bay window of a freight train caboose at night, was struck by a shotgun blast fired through the window from trackside as the train passed a rural crossing. It took some time to stop the train and to bring help to the scene, and the brakeman was pronounced dead in the caboose 30 minutes after being shot. He died of hemorrhagic shock resulting from multiple pellet wounds of thoracic and abdominal viscera. A suspect was eventually apprehended. He was charged and brought to trial accused of involuntary manslaughter, but he was not found guilty.

The evaluation and solution of this type of case requires cooperation between the railroad and civil police in pinpointing the location of the shooting and apprehending those responsible, and the pathologist in demonstrating the cause of death and, if possible, the trajectory of the lethal missile(s) for correlation with the scene investigation.

An unusual type of accidental death occurring on moving trains is that in which an individual leaning out the window of an English or European compartmented railway car to

spy on individuals in an adjacent compartment is killed when his head strikes a fixed obstacle located close beside the tracks [6].

Discussion

The proper study of railroad-related deaths and the reaching of accurate conclusions and rulings about them requires of the forensic pathologist both general and specialized knowledge, as well as the willingness and ability to cooperate with other investigative agencies.

He must first approach each railroad-related death as in any other case, that is, by obtaining an accurate history and thorough scene investigation, the latter including photographs and measurements and augmented by the pathologist's personally visiting the scene if possible. A thorough, complete, and accurate autopsy must then be performed, and the findings meticulously documented.

But railroad-related deaths produce special problems as well, and it is to these that the pathologist must also address himself if future questions and problems are to be answered, and justice done, if need be.

The pathologist must have some familiarity with, if not interest in, the basic mechanics and operating rules of railroads. This is necessary so that he fully understands, appreciates, and places in proper perspective various accidents, injuries, and other findings such as have been presented above. If he lacks this knowledge and ability to correlate, the pathologist must seek counsel from railroad personnel or police, or other agencies.

It has been made amply clear that a railroad-related death, although initially presented or presenting as an accident, may be of other types as well, including homicide. The pathologist must remain objective in his examination and not be surprised at unexpected findings.

In performing his examination he must also realize that many of these cases will result in either civil or criminal litigation. This may be in the form of a civil suit filed by relatives of a grade crossing collision victim against a railroad, alleging the latter to have been negligent in not providing warning devices or in operating a train improperly. It may be a civil suit against a railroad in a case where an individual is killed while working for the railroad or otherwise on railroad property. Criminal proceedings may be brought against individuals charged with the shooting of a train crewman.

Thus, all case findings must be very thoroughly documented, and findings and conclusions must be stated in such a fashion that they will be both intelligible and useful in court, perhaps months or years later.

In this regard also, the pathologist through his studies may be able to provide definitive answers to questions regarding the cause of or responsibility for some of these deaths. Here it is vital that the presence or absence of natural or traumatic disease antedating the railway death be thoroughly documented at autopsy.

Toxicology studies must also be done. Even if the body is severely injured or dismembered and near exsanguination has occurred, accurate ethanol levels closely approximating premortem blood ethanol levels may be obtained by the analysis of vitreous humor [7].

It is interesting to note that in this series, blood ethanol determinations were not done in all victims who died acutely. Of those drivers tested, only one driver in Category 1, a motorcycle operator, had a positive blood ethanol determination. However, three subjects in Category 2 and two of four in Category 4 had ethanol in their blood at the time of death.

Finally, the exact cause of death, although most often multiple blunt traumatic injuries, must nonetheless be demonstrated without question.

Before, during, and after the autopsy the forensic pathologist must engage the cooperation of other investigative agencies—railroad, law enforcement, and laboratory—in solving

many of these often difficult cases. In this regard it is worth noting that one subject in Category 2 and three of four subjects in Category 4 remained unidentified for periods ranging from less than one day to three weeks postmortem, thus demonstrating the frequent need for cooperation with fingerprint experts, trace evidence technicians, and the public media in these cases as well.

Conclusions

Railroad-related deaths, those occurring or discovered on railroad property, have received scant attention in the medical and medicolegal literature, particularly when compared to that accorded deaths associated with other means of transportation. This report, believed to be the first case study of this subject, presents 27 railroad-related deaths occurring over four years in two widely separated medicolegal jurisdictions.

The largest category of deaths was that of individuals killed in vehicle-train grade crossing collisions. The causative factors in these deaths were varied; alcohol did not play a role in those drivers tested for it. Individuals killed while afoot on railroad property and on falling from railroad or other vehicles were most often children or youths. Cases of bodies found dead on railroad property present the most complex problems encountered in this area; a number will be found to be victims of homicide. Most of these individuals in this series remained unidentified for various periods after their bodies were found. Assaults on, and homicides of, train crewmen are an increasing problem.

The forensic pathologist must confront railroad-related deaths using standard techniques of thorough and meticulous history, scene and autopsy examinations, and employing as well special knowledge of problems unique to railroad operations. Cooperation with railroad and other investigative agencies is mandatory. It must be expected that a significant number of these cases will result in civil or criminal litigation.

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References

[1] Braden, G., *Aerospace Medicine,* Vol. 45, No. 7, July 1974, pp. 772–779.
[2] Carmody, J. J., *Trains,* Vol. 31, No. 4, Feb. 1971, p. 23 (article reprinted with permission from the 28 June 1970 issue of *Washington Post's Potomac* magazine).
[3] Fisher, R. S., in *Medicolegal Investigation of Death,* W. U. Spitz and R. S. Fisher, Eds., Charles C Thomas, Springfield, Ill., 1973, p. 314.
[4] Gonzales, T. A., Vance, M., Helpern, M., and Umberger, C. J., *Legal Medicine Pathology and Toxicology,* 2nd ed., Appleton-Century-Crofts, Inc., New York, 1954, p. 188.
[5] "Arrivals and Departures," *Trains,* Vol. 35, No. 3, Jan. 1975, p. 10.
[6] Camps, F. E. in *Gradwohl's Legal Medicine,* 2nd ed., F. E. Camps, Ed., John Wright and Sons Ltd., Bristol, 1968, Chapter 16, pp. 303–304.
[7] Coe, J. I. and Sherman, R. E., *Journal of Forensic Sciences,* JFSCA, Vol. 15, No. 2, April 1970, pp. 185–190.

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