Jeffrey Salomone III,[1] B.S., M.S.; Anton P. Sohn,[1] M.D.; Roger Ritzlin,[1] M.D.; Joseph H. Gauthier,[1] M.D.; and Vernon McCarty,[2] B.S.

Correlations of Injury, Toxicology, and Cause of Death to Galaxy Flight 203 Crash Site

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ABSTRACT: This report details the medical investigation of the crash of Galaxy Flight 203, on 21 Jan. 1985, near Reno, Nevada. Sixty-eight persons died at the scene, two died during hospitalization, and one victim survived. After completion of autopsies on all victims, pathologists determined causes of death based upon injuries, evidence of smoke inhalation, and toxicologic results. Our research shows that the majority of victims survived the impact only to succumb to toxic gas and fire. We correlated the causes of death, various injuries, and toxicologic findings to body location at the crash site to aid in reconstructing the events surrounding the accident and to address medicolegal problems and safety considerations. Our experience clearly supports the need for thorough medical investigation, including autopsy of each victim and determination of the precise cause of death for all fatalities.

KEYWORDS: pathology and biology, postmortem examinations, aircraft, human identification, disaster investigation

While 1984 marked one of the safest years on record for commercial air travel, in 1985 fatalities resulting from commercial aircraft disasters surpassed those of all previous years. In the past, many authors have stressed the need for proper forensic medical investigation of aviation disasters, including autopsy of all victims [*1,2*]. Cullen and Turk have noted that Annex 13 to the Convention on International Civil Aviation recommends that careful postmortem examination, including autopsy, be conducted on those killed [*3*]. In spite of these recommendations, a review of the medical literature reveals that articles detailing methods used in identification of commercial airliner crash victims are fairly common, but articles describing careful postmortem examination of the victims are surprisingly rare [*4-6*]. In the decade preceding 1985, some 30 commercial airliners crashed, claiming more than 2500 lives [*7*]; yet research located only 2 reports discussing autopsy findings and injury patterns [*8,9*].

Prudent investigation of aircraft disasters demands thorough forensic medical investigation, including autopsy of each victim and determination of the precise cause of death for all fatalities. After highlighting the background information regarding the crash of Galaxy

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[1]Medical student, professor and chairman, assistant professor, and assistant professor, respectively, Department of Pathology, University of Nevada School of Medicine, Reno, NV.
[2]Washoe County Coroner, Reno, NV.

Flight 203, we will discuss our rationale for conducting internal autopsies on all victims, the protocol followed by each pathologist working in the temporary morgue, and how cause of death was resolved. Correlations of injuries, toxicology levels, and causes of death to the crash scene will be examined. Such correlations are useful to gain further insight into the events surrounding the crash and to pinpoint areas where future research may improve commercial airline travel—aspects all too frequently overlooked in aircraft crash investigations. Using Galaxy Flight 203 as an example, we conclude that mere identification and external examination of victims stops far short of the proper medical investigation for these tragedies.

The Crash

The first aircraft disaster of 1985 occurring in the United States involved a Lockheed L-188 turboprop, operated by Galaxy Airlines, which crashed soon after takeoff on 21 January south of Reno, Nevada. Returning to the Minneapolis-St. Paul area, this chartered plane carried tourists on a combination Superbowl and gambling junket. A crew of six, including three stewardesses, operated the plane carrying sixty-five passengers. The craft took off at 1:04 a.m. from Reno-Cannon International Airport, and almost immediately the pilot radioed to the tower that there was an unusual vibration in the plane. He requested clearance for an emergency landing and airport rescue equipment.

Though approved for a "left-downwind" landing, the plane banked slightly to the right (west), lost altitude, and initially impacted in a field to the east of U.S. Highway 395, approximately 2 miles (3 km) from the runway. From there, the plane skidded across the frosty field in a southwesterly direction. Upon impacting the embankment of an irrigation ditch, the craft broke apart, ejecting numerous passengers and hurling debris approximately 200 ft (61 m). The aircraft continued a short distance, crashing through a recreational vehicle (RV) display lot adjacent to the highway, and finally came to rest with a portion of the fuselage in the two northbound lanes. Fire rapidly engulfed the wreckage and nearby RVs.

The Rescue

Within 5 min, rescue and fire personnel reached the scene. Five victims were initially discovered; the three living victims were quickly transported to local hospitals. Still belted to their seats, a 17-year-old male and father, age 42, had been catapulted to the middle of the highway. The son unbuckled his seat belt and ran from the fire as the fuel and RVs exploded. He suffered several minor soft tissue injuries and a few small second-degree burns. His father, found by rescue personnel at the point at which he had landed, was comatose. His injuries included facial and skull fractures, brain trauma, a hemothorax, extremity fractures, and third-degree burns over approximately 15% of his body. He died on his eighth hospital day. Witnesses reported that the third victim, a 45-year-old male, emerged from the burning wreckage. Having suffered third-degree burns over 85% of his body, he died of infectious complications in a hospital burn unit after two weeks. Rescuers located a husband and wife, over 120 ft (36.5 m) from the fuselage, still strapped to their seats, in a field across the highway. Both victims were in cardiac arrest and had significant trauma. Triage personnel considered their condition nonviable. Only the young male survived. The remaining victims were later located in or near the fuselage, and virtually all the bodies were extensively charred. Though firefighters controlled the flames in less than 30 min, the aircraft was incinerated.

Autopsy

The three reasons cited by Cullen and Turk [3] for performing autopsies on commercial aviation fatalities included addressing medicolegal problems, evaluating safety equipment and reconstructing events surrounding the accident. Forensic science experts have identified several medicolegal reasons for conducting postmortem examinations and toxicological screening on these victims. Mason [*1*] noted that some life insurance policies contain clauses excluding payment to beneficiaries when the victim was intoxicated at the time of death, regardless of whether or not alcohol contributed to the death. Such exclusion clauses are infrequent and this issue has not been raised in the Galaxy investigation. Cullen and Turk [*3*] also discuss the problems of identifying sequence of death when several members of a family die in a single crash. Survivorship, even for a brief time period, may affect disposal of estates, especially when each spouse has children from a previous marriage. In fact, determination of the cause of death settled at least one such question raised by the attorney handling the estate of one couple killed in the crash of Flight 203.

While alcohol exclusion clauses and survivorship constitute valid reasons to perform internal autopsies on crash fatalities, Nevada law provides the single factor most influencing the decision to autopsy all 68 bodies from the Galaxy accident: Nevada law permits recovery for pain and suffering experienced before death when negligence and wrongful death are proven. Survivors suing on behalf of the victim may be awarded a larger settlement if expert testimony demonstrates that the victim experienced a slower death from toxic gas inhalation and incineration as opposed to rapidly fatal injuries.

Once the decision was made to autopsy all victims, attention turned to the coordination of this task. The bodies were transported to the temporary morgue for identification and postmortem examination. Before autopsy, three different teams inventoried any personal effects, removed dentition, and obtained fingerprints. Details of body recovery at the scene, identification procedures, and temporary morgue operations have been described elsewhere [*10*]. To ensure consistent and high-quality postmortem examination, three forensic pathologists agreed to perform all the autopsies and to follow a common protocol. Each autopsy report would contain a description of property, the extent of external charring, evidence of external trauma, identifying features, and internal traumatic lesions. Autopsy on passengers included an external examination, removal of the calvarium and examination of intracranial structures, and examination of thoracic and abdominal cavities. Acute trauma, prior surgery, and gross evidence of pregnancy could thus be identified. Autopsies on the pilot, copilot, and engineer included all of the above plus removal and dissection of organs, and full body X-rays. The pathologists performed the first eighteen autopsies on January 23. Twenty-eight autopsies were completed the following day and the last twenty-two on 25 January.

During the autopsies pathologists collected samples of blood, liver, lung, kidney, psoas muscle, and, if present, urine. The samples forwarded to the Federal Aviation Administration (FAA) Toxicology Laboratory in Oklahoma City, underwent analysis to determine hemoglobin (Hgb), carbon monoxide (CO), cyanide (CN), and blood-alcohol (BA) levels. The FAA lab chose not to measure CN levels in blood samples of victims whose CO levels were considered to be equivocal; that is, less than 10% saturation. Laboratory workers checked for bacterial contamination in all samples having elevated BA levels. Specimens from the cockpit and cabin crew were also examined for presence of drugs.

Cause of Death

Final determination of each victim's cause of death was made by the pathologists and the coroner after receipt of the toxicology results. They reviewed autopsy findings for severity of trauma, presence of soot in the airway, and hemorrhagic edema of the tracheal mucosa, consistent with inhalation of superheated gases. Three major categories of cause of death emerged. The first category, those dying of blunt force trauma, included twenty-seven victims (40% of the fatalities) with lethal injuries, negative or equivocal CO and CN levels and little, if any, airway soot or edema. The next group, those dying of flashfire, exemplified the picture of rapid incineration: no lethal trauma, negative or equivocal CO and CN levels, mild to moderate airway soot, and occasional airway edema. Eight victims (11%) comprised this group. The final category included the thirty-three victims (49%) who succumbed to smoke inhalation and thermal injury. These victims lacked lethal injuries, had markedly elevated CO and CN levels and, at autopsy, demonstrated moderate to extensive soot in the airways. The smoke inhalation/fire group contained a subclass of six victims, including the pilot and copilot, who had serious but nonfatal injuries. Because of elevated CO and CN levels and evidence of heat injury or airway soot, they were included among those dying of toxic inhalation and burns. The pathologists assigned cause of death to each case without knowledge of the victims' body location at the crash site. Table 1 illustrates representative cases from each of the three major categories.

Methodical investigation and careful record keeping by the teams responsible for body recovery at the scene permitted analysis for patterns in the injuries, toxicologic levels, and causes of death. Workers divided the area into grids and, as each body was removed from the wreckage, tagged it with an alphanumeric symbol indicating the grid where found, assigned it a body number, and measured and recorded its exact location. Using this information, we plotted the location of each victim on diagrams of the site. When the outline of the fuselage, approximated from photographs of the scene, and causes of death were superimposed on the charts, several patterns emerged. Figure 1 established that all persons dying from traumatic injuries were found in the wreckage along the west (highway) side of the scene. Those dying of smoke inhalation and burns were found in the remains of the cockpit and fuselage. The eight flashfire victims were scattered amongst the bodies along the west side of the crash

TABLE 1—*Representative cases from cause of death categories.*[a]

Finding	Cause of Death (Number of Cases) trauma (36)	flashfire (21)	smoke/fire (47)
Head injury	+	—	—
basal skull fracture	+	—	—
vault skull fracture	+	—	—
brain trauma	+	—	—
Chest injury	+	+	—
major rib fractures	+	—	—
minor rib fractures	—	+	—
cardiac trauma	+	—	—
lung trauma	+	—	—
hemothorax	+	—	—
Abdominal injury	+	—	—
hemoperitoneum	+	—	—
hepatic trauma	+	—	—
splenic trauma	+	—	—
Extremity fractures	+	+	+
upper-unilateral	—	—	+
upper-bilateral	+	+	—
lower-unilateral	+	+	+
lower-bilateral	—	—	—
CO level (% sat)	1%	5%	27%
CN level (mcg/ml)	not run[b]	not run[b]	1.34
Blood alcohol	0	0	0.068
Tracheal edema	—	—	—
Tracheal soot	—	moderate	extensive

[a]+ = injury present; — = injury absent.
[b]CN levels determined only when CO was greater than 10% saturation.

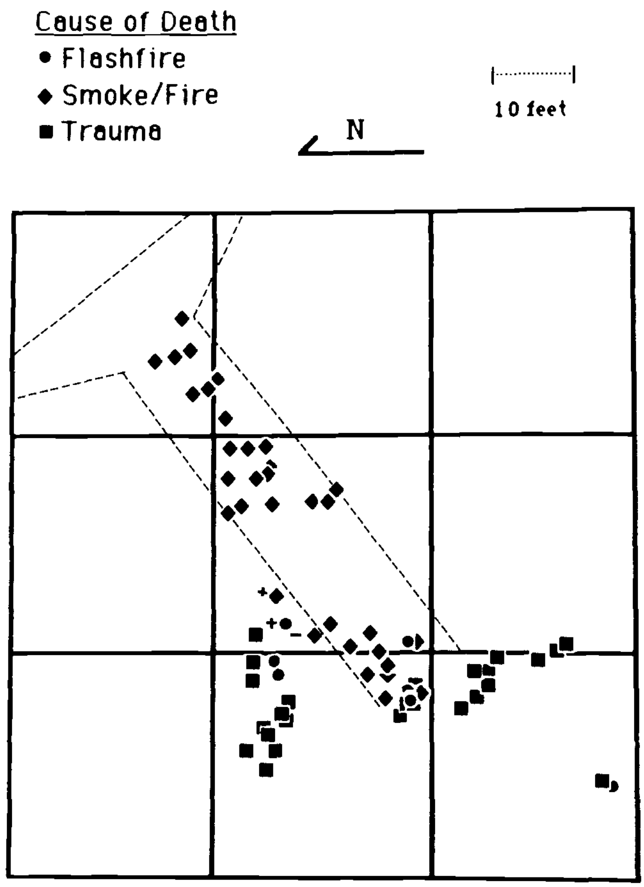

FIG. 1—*Diagram of crash site showing body location and cause of death. Each symbol represents one body: circle = flashfire; diamond = smoke inhalation and burns; square = trauma; distorted symbols indicate overlapping of bodies. Rear portion of the aircraft fuselage indicated by broken line; unable to locate, with certainty, the exact location of the forward section of fuselage. The flight crew are marked by crosses to the left of the symbol representing the body (lower portion of central grid).*

scene. Figure 1 includes neither the two victims thrown across the highway nor the three passengers transported to the local hospitals.

The autopsy reports were reviewed to determine the incidence of specific physical findings, namely, selected injuries and presence of airway burns or soot, and elevated alcohol, CO and CN levels. Table 2 summarizes the results.

For selected findings, additional diagrams of the crash site illustrate the locations of victims having that finding. In Figs. 1 through 5 each symbol represents a single body. A "+" indicates a victim without the specific finding illustrated by each figure, while a circle, diamond, or square represents a victim in the flashfire, smoke inhalation/fire, or trauma category, respectively, who sustained that finding. In some figures symbols overlap, revealing the close proximity of bodies.

Victims who suffered head injuries are shown in Fig. 2. This group includes those with fractures of the cranial vault, basilar skull fractures, craniofacial fractures, intracranial hemorrhages, and brain trauma. Twenty-eight victims suffered head injuries, the majority of which (70%) died from trauma. Only eight of these victims were in the smoke inhalation/

TABLE 2—*Autopsy findings of crash victims by cause of death.*

	Trauma		Flashfire		Smoke/Burns		Total	
Finding	#	(%)	#	(%)	#	(%)	#	(%)
Skull: vault fracture	19	(70%)	...	...	6	(18%)	25	(37%)
Skull: basal fracture	15	(56%)	...	...	2	(6%)	17	(25%)
Skull: facial fracture	2	(7%)	...	...	1	(3%)	3	(5%)
Brain trauma	14	(52%)	...	...	4	(12%)	18	(26%)
Chest: major rib fracture	23	(85%)	3	(38%)	4	(12%)	30	(44%)
Chest: minor rib fracture	1	(4%)	1	(13%)	1	(3%)	3	(5%)
Chest: sternal fracture	4	(15%)	...	...	1	(3%)	5	(8%)
Chest: cardiac injury	11	(41%)	...	...	1	(3%)	12	(18%)
Chest: pulmonary injury	7	(26%)	1	(13%)	1	(3%)	9	(13%)
Chest: hemothorax, bilateral	6	(22%)	...	...	...	...	6	(9%)
Chest: hemothorax, unilateral	4	(15%)	1	(13%)	2	(6%)	7	(10%)
Chest: aortic tear	3	(11%)	...	...	...	...	3	(5%)
Chest: diaphragmatic rupture	2	(7%)	...	...	...	...	2	(3%)
Abdomen: hepatic trauma	7	(26%)	...	...	...	...	7	(10%)
Abdomen: splenic trauma	5	(19%)	...	...	...	...	5	(8%)
Abdomen: hemoperitoneum	7	(26%)	...	...	...	...	7	(10%)
Pelvis: fracture	1	(4%)	...	...	...	...	1	(2%)
Upper extremity: unilateral fracture	8	(30%)	...	...	6	(18%)	14	(21%)
Upper extremity: bilateral fracture	2	(7%)	...	...	1	(3%)	3	(5%)
Lower extremity: unilateral fracture	11	(41%)	2	(25%)	6	(18%)	19	(28%)
Lower extremity: bilateral fracture	6	(22%)	1	(13%)	5	(15%)	12	(18%)
Burns: Avg. % body surface area	79	...	92	...	95	...	89	...
Trachea: heat injury	4	...	2	(25%)	5	(15%)	11	(16%)
Trachea: no soot	23	(85%)	4	(50%)	3	(9%)	30	(44%)
Trachea: mild soot	4	(15%)	1	(13%)	...	...	5	(8%)
Trachea: moderate soot	...	...	2	(25%)	14	(42%)	16	(24%)
Trachea: extensive soot	...	...	1	(13%)	16	(49%)	17	(25%)

fire category and were recovered from inside the fuselage. Six (18%) of those in the smoke inhalation/fire group sustained a fracture to the cranial vault, compared to nineteen (70%) of those in the trauma group.

Figure 3 shows the distribution of chest injuries comprised of rib and sternal fractures, hemothoraces and injuries to the heart, lungs, aorta, and diaphragm. Many of those who suffered chest injuries were found along the western side of the crash site. We classified rib fractures as either minor, those with less than four rib fractures and no underlying cardiac or pulmonary trauma, or major, having five or more fractures, often bilateral, and commonly associated with underlying injuries to the heart or lungs. In the trauma category, twenty-three victims (85%) suffered major rib fractures, while only four of the smoke inhalation/fire victims had rib fractures in this classification. The pulmonary injury group listed in Table 2 contains both pulmonary contusions and pulmonary lacerations, while myocardial contusions and lacerations to the myocardium or pericardium were included in the group of cardiac injuries.

Abdominal injuries, including hepatic trauma, splenic injury, or hemoperitoneum, were found less frequently than thoracic injuries. The distribution of these injuries closely resem-

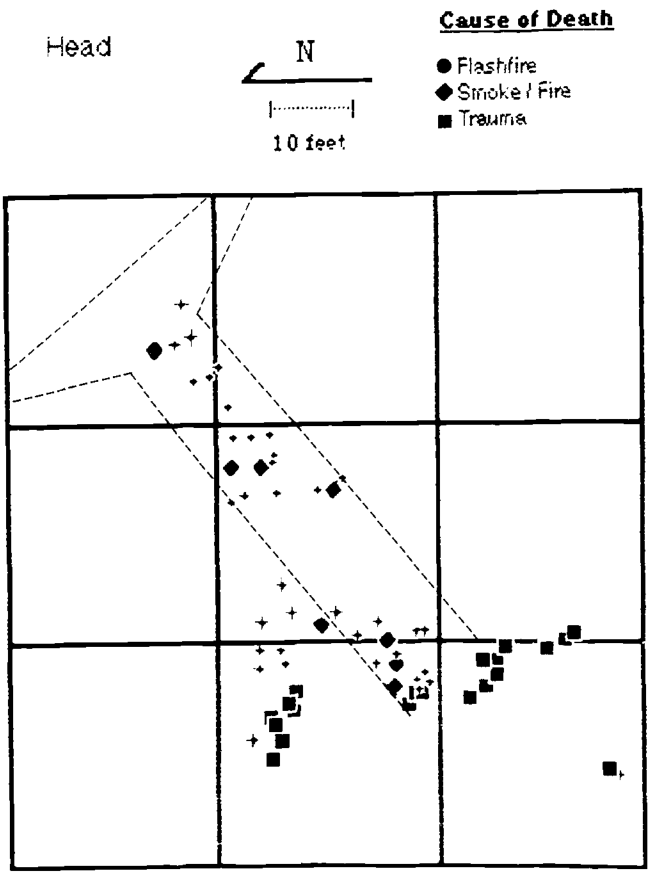

FIG. 2—*Body location of victims with head injuries. Each cross represents the location of a body. Crosses which have been replaced with a circle, diamond, or square represent a body having a head injury. Symbols correspond to cause of death as in Fig. 1. Some overlapping of bodies is obvious.*

bles that of the chest trauma shown in Fig. 3. Since no victims in the flashfire or smoke inhalation/fire categories suffered these injuries, all abdominal injuries were located along the west side of the crash site in the trauma victims. Seven trauma victims (26%) sustained injury to their liver, while five experienced a ruptured spleen.

Extremity fractures were more frequently found among those in the trauma category. The victims who remained inside the fuselage and died from smoke inhalation and fire suffered fractures in their extremities nearly half as often as those in the trauma group. Of the trauma victims, ten (37%) suffered a fracture to at least one upper extremity, and seventeen (63%) suffered a fracture to at least one lower extremity. In contrast, only seven (21%) of the smoke inhalation/fire victims experienced a fracture to at least one upper extremity and eleven (33%) sustained a fracture in at least one lower extremity.

Victims in the flashfire category were found to have tracheal mucosa appearing frothy, edematous, and hemorrhagic more often than those in the two other groups. This injury, consistent with burning from inhalation of superheated air, was found in two (25%) of the flashfire fatalities, while 15% of victims in both the trauma and smoke inhalation/fire groups had this finding. Victims dying of flashfire, presumed to have been in areas readily exposed to flame, would suffer tracheal burning more frequently than those protected by the fuselage from fire or those killed instantly from trauma.

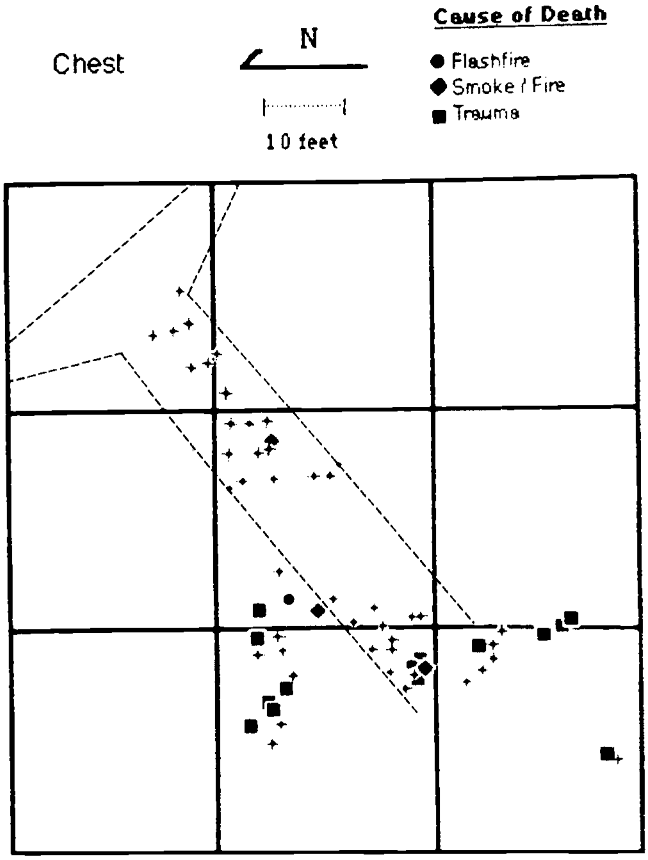

FIG. 3—*Body location of victims with chest injuries.*

Slightly more than half of those dying in the crash were found to have some amount of soot in their large airways. Most victims in the trauma group lacked tracheal soot, and of the four (15%) having soot deposits, all were described as having mild amounts. Of the 30 (91%) smoke inhalation/fire victims having airway soot, 14 (42%) had soot deposits described as moderate while the remaining 16 (49%) had extensive soot deposits. Figure 4, the distribution of the bodies exhibiting tracheal soot, illustrates that this finding was almost exclusively limited to those remaining inside the fuselage and suffering smoke inhalation.

Carboxyhemoglobin (carbon monoxide) levels were measured from blood samples of all victims. Table 3 summarizes these results, as well as cyanide and blood-alcohol levels. Nineteen (70%) of the trauma victims exhibited CO in their blood. Of these, levels ranged from 1 to 12% saturation, with a mean level of 6.1% saturation. In sharp contrast to this are the results from those succumbing to smoke inhalation and fire; analysis demonstrated carboxyhemoglobin in the blood of all thirty-three victims, ranging from 12 to 44% saturation. The mean level among this group was 24.3% saturation, a fourfold increase over those dying of trauma. Figure 5 demonstrates the distribution of elevated CO levels. Cause of death is not indicated in this diagram; however, the increasing size of the squares corresponds to increasing CO levels. The distribution clearly shows that the higher levels were found among those in the smoke inhalation/fire victims, located in the fuselage.

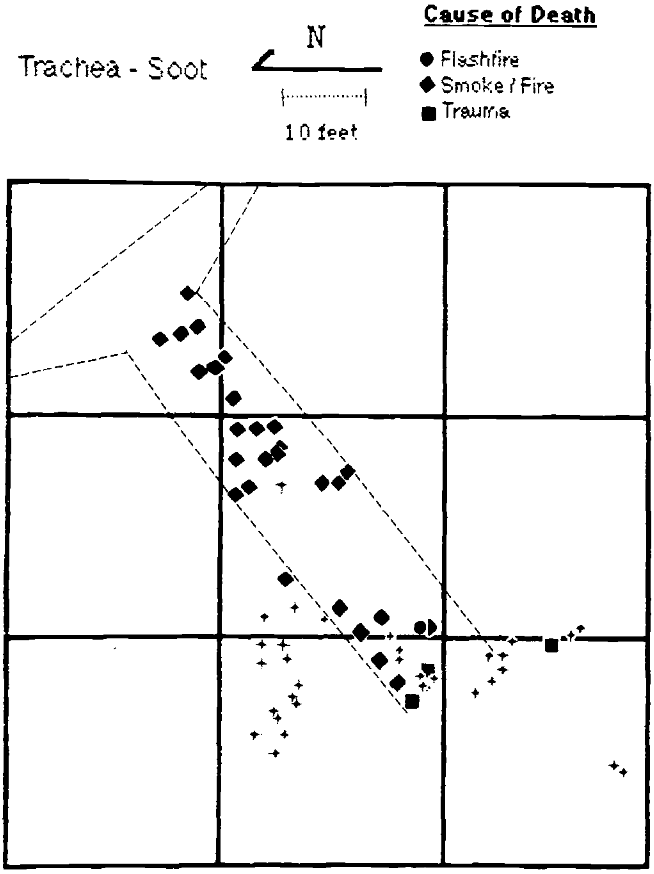

FIG. 4—*Body location of victims with deposition of soot in airways.*

Cyanide gas is produced from combustion of nitrogen containing organic compounds, including silk and wool, as well as by many plastics. As noted above, CN levels were determined on samples having CO levels greater than 10% saturation. Three trauma victims had positive CN levels, with a range of 0.03 to 0.18 μg/mL and a mean level of 0.08 μg/mL. All but one of the smoke inhalation/fire victims had positive CN levels; these results ranged from 0.03 to 1.34 μg/mL. The mean CN level among members in this category having positive levels was 0.56 μg/mL, seven times that of the trauma group. The lethal CN level has been estimated to be 3.0 μg/mL [*11*], but it is presumed to be lower in a victim suffering from trauma, extensive burning, or carbon monoxide poisoning. The distribution of victims with positive CN levels closely resembles Fig. 5, again supporting the smoke inhalation/fire cause of death for those trapped in the burning aircraft.

Sixteen victims had positive blood alcohol (BA) levels. The eight in the trauma group with positive levels averaged 0.098 mg/dL. Close behind this were the six smoke inhalation/fire victims, averaging a BA of 0.080 mg/dL.

The flight crew had no organic lesions which may have contributed to the accident, and blood-alcohol levels and screening tests for acidic, neutral, and basic drugs were all negative. This speaks against crew incapacitation as a contributing factor in the cause of the crash.

TABLE 3—*Toxicology results by cause of death.*

Toxicology	Trauma $n = 27$	Flashfire $n = 8$	Smoke/Burns $n = 33$	Total $n = 68$
Carbon monoxide:[a]				
number of victims with levels >0	19	6	33	57
average levels >0 (% sat)	6.1	4.8	24.3	16.3
average levels, all victims (% sat)[b]	4.3	3.6	24.3	14.0
range, levels >0 (% sat)	1-12	1-6	12-44	1-44
Cyanide:[c]				
number of victims with positive levels	3	...	32	35
average positive levels (μg/mL)	0.08	...	0.56	0.52
average level, tested samples (μg/mL)[d]	0.05	...	0.56	0.48
range, positive levels (μg/mL)[c]	0.03-0.18	...	0.03-1.34	0.03-1.34
Blood alcohol[e]				
number of victims with positive levels	8	2	6	16
average positive levels (mg/dL)	0.098	0.057	0.080	0.085
average level, tested samples (mg/dL)[f]	0.029	0.014	0.015	0.020

[a]CO levels determined on all victims.
[b]Average includes all samples analyzed, including levels of zero.
[c]Cyanide levels determined only on those samples with a CO greater than 10% saturation: cyanide not determined on 22 trauma cases, all flashfire cases and 1 smoke/fire case. Positive levels are those greater than zero.
[d]Average includes all samples analyzed, including negative levels.
[e]Blood alcohol determined on all victims.
[f]Average includes all samples analyzed, including negative levels.

Accident Reconstruction

Information obtained from the medical investigation of this airliner crash, including internal autopsies on all victims and plotting diagrams correlating findings to body distribution at the crash scene, has provided clues advantageous in reconstruction of the accident. From the scene evidence, accident investigators have determined that the tail portion of the plane first impacted the ground. One may conclude that all victims survived this initial impact because the tail section of the fuselage lacked victims who had sustained rapidly fatal injuries. Only scattered extremity injuries and a few linear skull fractures were found in the bodies recovered from the rear of the fuselage. If the plane plummeted to the ground from the estimated 100- to 200-ft (30- to 60-m) altitude, impacting at its aft section, autopsies of those in the rear of the aircraft should include basilar skull fractures, ruptured diaphragms, and distal femoral fractures [9]. The absence of such a pattern among victims seated in the aft of the aircraft implies that the traumatic injuries were received during forward motion impact rather than downward plummeting.

After initial impact, the plane skidded forward approximately 1/4 mile (0.4 m). The medical findings and body locations support the conclusion by investigators that the plane broke apart upon impacting the ditch embankment. The row of victims having trauma along the

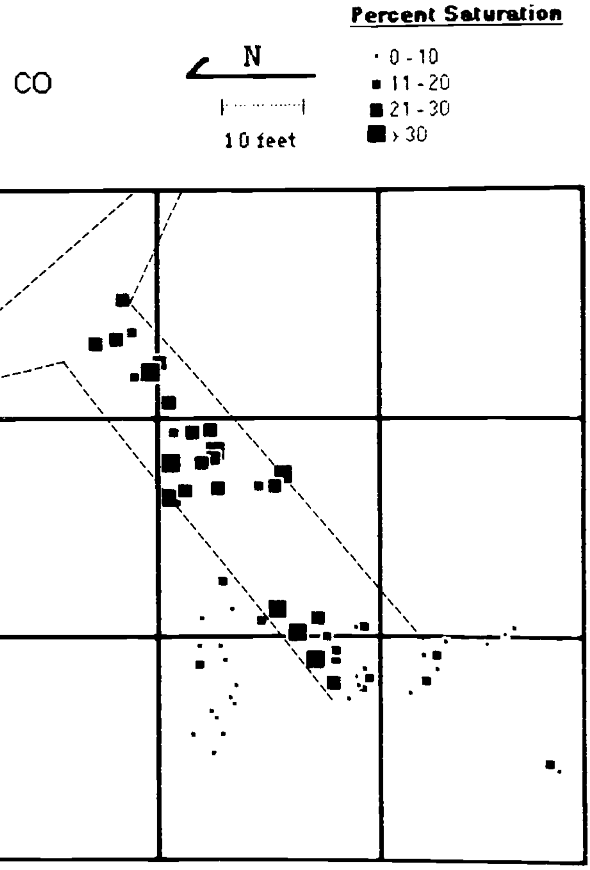

FIG. 5—*Body locations showing various CO levels. Unlike Figs. 1-4, this figure does not indicate cause of death; increasing size of symbol corresponds to greater CO levels.*

western aspect of the crash site can be explained by the ejection and subsequent impact of the passengers as the fuselage ruptured. Several victims, including the husband and wife found across the highway, were catapulted along a trajectory above the RVs. The seating configuration for an Electra includes twenty rows of seats, usually five across, separated by an aisle. According to the survivor, he and his father were seated in seats 6A and 6B, the row just behind the lavatories. Evidence indicates that the plane ruptured forward to this location, at the forward third of the fuselage. The bodies of the husband and wife found across the highway apparently were seated in seats 6C and 6E, and debris from the aircraft lavatories was scattered nearby.

After impacting the ditch, the fuselage slid forward, coming to rest among the ejected victims and the RVs. Approximately the forward one third of the fuselage, containing the cockpit, appears to have rotated to a position along the starboard side of the remaining fuselage. While virtually all victims ejected from the fuselage died from injuries, the victims who remained inside the cabin suffered significantly less trauma. Elevated CO and CN levels with the absence of life-threatening trauma show that those trapped in the fuselage survived the crash only to succumb to smoke inhalation and fire. The high density of bodies at the open end of the main section of the fuselage poses the question of whether some victims in the cabin were thrown forward upon impact with the ditch and RVs or whether those with minor trauma were attempting to escape from the cabin when the fire engulfed the debris.

Because this flight was chartered, the airline permitted passengers to select their seats. The absence of seating assignments greatly limits further reconstruction of the accident. For example, those victims dying of trauma would be expected to have been seated in the rows nearest the point where the aircraft ruptured.

Discussion

Our analysis raises important issues involving commercial airline safety. First, nearly 25% of the passengers had positive blood-alcohol levels. Though stomach contents were not analyzed for alcohol and because blood cultures showed no evidence of alcohol producing bacteria, we conclude these passengers had ingested alcohol before boarding the aircraft. Had the circumstances surrounding the accident been less violent, the threat that these passengers pose is apparent—not only the threat to themselves, but also to other passengers—when an emergency demands rapid evacuation.

Fire remains the most significant safety problem associated with the crash of Flight 203. The victims comprising the trauma category suffered significant, life-threatening injuries and could have expired regardless of whether or not the craft was engulfed in fire. Those in the flashfire and smoke inhalation/fire groups, some 60% of the victims and those who survived the impacts, became fatalities because of the conflagration. Certainly this crash demonstrates the need for continued research into technologies that minimize the threat of fire in aircraft crashes. Another potential area for improvement of airline safety centers upon the need to decrease the use of materials which produce cyanide gas when burned. Recent FAA regulations will soon require, in planes for 30 or more persons, slow-burning seat coverings and illumination or escape path markings on or near the cabin floor. The FAA has also considered requiring smoke detectors in galleys and lavatories, as well as automatic fire extinguishers in airplane lavatories [*12*]. In short, methods of preventing fires or minimizing damage resulting from them has been and will continue to be an area in which advances will lead to increased air safety.

Conclusion

In summary, this paper demonstrates the importance of careful forensic medical investigation of airline crashes. Incomplete examination of crash victims' bodies, without an attempt to determine accurately the precise cause of death for each victim, fails to address major issues where the forensic scientist can play an important role. Representatives of the National Transportation Safety Board and other governmental agencies believe fire to be responsible for 65% of the 1040 U.S. aircraft disaster fatalities occurring between 1965 and 1982 [*12*]. Our evidence demonstrates that CO and CN have a significant role in determining cause of death. Analysis of injuries relative to body location at the crash site provides information valuable in pinpointing circumstances surrounding the accident, as well as the accurate sequence of events. Our experience indicates that inquiry into the cause of death is beneficial in not only settling medicolegal questions arising out of aircraft disasters, but also in identifying safety concerns. Forensic medical investigators should review crash data and voice their concerns on safety issues requiring further study. By addressing these issues, the forensic scientist can assist those in the aviation industry to improve commercial airline safety.

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Address requests for reprints or additional information to
Anton P. Sohn, M.D.
Professor and Chairman, Department of Pathology
University of Nevada School of Medicine
Reno, NV 89557