

## Forensic Science Investigation of a Balloon Accident

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**ABSTRACT:** This manuscript describes techniques undertaken to recreate the sequence of events that transpired after a hot air balloon made contact with an electrical power line. After the pilot's clothing was examined, the source of the fire in relation to the gondola and the pilot was established. Also determined through postmortem examination were the sequence of the three deaths, the probable heights from which two of the three passengers jumped, the setting where each body landed, and the causes of death for all three passengers. Finally, it was concluded, after correlating the autopsy findings with those of the scene investigation, that the proximate cause of the accident was pilot error.

**KEY WORDS:** pathology and biology, death, balloons

The idea of riding aloft on air was born when Archimedes, in the third century B.C., discovered the law of buoyancy. In 1783 balloon flying became a widely known entity. The first recorded hot air balloon flight, with animals as passengers, directed by Joseph and Etienne Montgolfier, was on 19 Sept. 1783. History was made on 15 Oct. 1783 when a man flew aboard a hot air balloon [1].

The first recorded fatality from a balloon accident occurred 15 June 1784 [1]. Ironically, the first balloon aeronaut, Jean Francois Pilatre de Rozier, was also the first balloon accident victim. He was attempting to reach England from France.

Every year between 1967 and 1978, with the exception of 1970, a balloon accident was reported to the National Transportation Safety Board (NTSB) [2]. From 1973 to 1978, the number of balloon accidents increased substantially, apparently associated with the increasing popularity of balloon flying as a sport. It has been estimated that between 1960 and 1975 the number of certified balloon pilots with a free balloon rating rose from 25 to about 700 [3].

There are few hazards in balloon flying, but of those that exist contacts with poles and power lines are the most dangerous [4,5]. The twelve-year NTSB statistics on balloon aircraft accidents from 1967 through 1978 disclose that collision with poles or wires accounted for 34.7% of the cases. Of the 72 cases of reported balloon accidents, pilot error was ruled by the NTSB as the proximate cause in 53 of the cases with 19 cases of pilot error resulting in the collision of the balloon with poles or wires.

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## Background Information

Three bodies (one female, two males) arrived at the morgue accompanied by the medical specialist on human factors from the Federal Aviation Administration (FAA) and an evidence technician from the Indiana State Police crime laboratory. The FAA representative reported that the decedents were from a balloon accident that had happened the previous day. He was unable to supply the forensic pathologist with any particulars except that the female was the pilot of the balloon. Neither the FAA representative nor the trooper knew the full name of any of the victims. Although the FAA was only interested in the outcome of the pilot's autopsy, the crew members were also autopsied, primarily because of the lack of investigatory findings. The postmortem examinations were intended to serve as a tool to determine the cause of the accident, the cause of death, the sequence of death, and especially the culpability of the passengers, if any. To accomplish these goals, extensive and meticulous dissection, full photographic recording, and toxicological analysis were done.

## Autopsy Findings

The female was autopsied first. The two male passengers, also autopsied, will be referred to as Passengers A and B.

The female pilot was wearing a green-stained pair of jeans and a yellow T-shirt with an iron-on picture of an airborne hot air balloon decorated with a marijuana leaf on the balloon envelope. An insignia on the gondola read "come fly with me." The T-shirt was incinerated along the right half of the back of the right shoulder and sleeve.

There were burns of the face, head, right ear, breasts, upper extremities, back, buttocks, and thighs. The burned skin from the right back, right upper extremity, and the right half of the head and face was scraped. Gross deformities of the right forearm and the left leg, resulting from traumatic fractures of the right radius and ulna and the left tibia and fibula, were immediately evident. Marked softening of the interscapular and lumbosacral regions was noted. Sections made at these areas revealed two independent pockets containing blood, crushed muscles, fat, and bone chips from the spinous processes of the thoracic, lumbar, and sacral vertebrae.

Internally, compressed fracture of the seventh cervical vertebral body, associated with crushing of the sixth and seventh cervical spinal cord segments, was noted. A gaping tear of the left anterolateral aspect of the fourth intercostal space, communicating with a vertical tear at the costochondral junction of the left fifth to the seventh ribs, was found. Fractures of the right first to the tenth ribs along the parasternal line, right fourth and fifth ribs at the costochondral junction, left first to the eleventh ribs along the mid-axillary line, and left first and second costal cartilage along the parasternal line were observed. The right lower and left upper lobes of the lung were lacerated by the rough fractured edges of the ribs. The laryngeal and tracheal mucosae were covered by blood-tinged mucus. Partial avulsion of the left upper pulmonary veins at their insertion was found together with a crush perforation of the right auricular tip. Multiple aortic intimal lacerations, bordering the insertion of the ligamentum arteriosum, were found. Multiple anteroposterior lacerations of the right lobe of the liver, rupture of the left leaf of the diaphragm, right renal hilar tear, and mesenteric lacerations were noted. Left sacroiliac separation and fractures of the right ischial tuberosity, ischial and pubic rami, and lumbar vertebral transverse processes were found. There was no remarkable organic disease process found.

Toxicologic analysis of the blood, urine, stomach contents, and tissue samples from the brain, liver, spleen, kidney, muscles, and lungs failed to show any evidence of drugs. The carbon monoxide level was less than 10% saturation. Analysis for marijuana by computerized gas chromatography/mass spectrometry [6] was negative.

*Passenger A*

There was no visible external evidence of back injury to this individual, who was wearing a blue T-shirt and denim pair of pants.

Areas of softening were found at the interscapular region and at the lumbar region. Pockets of crushed soft tissue with blood in the interscapular and the lumbosacral regions were noted. Fractures of the right second to the fifth ribs along the costochondral junction, right third rib along the midaxillary line, right first to the twelfth ribs along the interscapular line, left second rib lateral to the costochondral junction, left first eight ribs along the parascapular line, and the spinous processes of the first eight thoracic vertebrae were found. The manubriosternal joint was separated also. The fractured edges of the right first to the twelfth ribs caused deep laceration along the posterior half of the right upper and lower lobes of the lung. The mucosal surfaces of the trachea and larynx were unremarkable. Avulsion of the right main bronchus and the left pulmonary veins at their insertion was noted. Crushing injury of the left atrium and horizontal lacerations of the liver and hilum of the spleen were observed. The aorta showed horizontal laceration along the anterior wall of the ascending segment as well as in the descending segment below the ligamentum arteriosum. There was no observable organic pathology.

The blood, urine, bile, stomach contents, and pieces of tissue from the brain, liver, and kidney were negative for the presence of alcohol, carbon monoxide, and other drugs.

*Passenger B*

Externally, the body was grotesquely deformed because of burns involving approximately 90% of the body surface and associated with multiple skeletal fractures. The viscera showed evidence of blunt force trauma in the form of contusions, lacerations, and rupture of some of the hollow organs. Soot and flecks of carbonaceous material were found in the tracheobronchial tract as far down as the second bronchial segment. The mucosa of the respiratory tract showed evidence of burning. There was no underlying disease process noted.

Toxicologic analysis of the bile, stomach contents, and pieces of tissue from the brain, liver, kidney, spleen, and lung showed 425 mg/dL of ethanol in the stomach contents with trace amounts in the tissue. The carbon monoxide level in the spleen was less than 10% saturation.

**Investigatory Findings**

According to the official report of the NTSB [7] received several months after the post-mortem examination, the balloon, a Barnes Firefly AX-7, with a maximum gross weight capacity of 751 kg (1669 lbs), was on a pleasure flight without a flight plan. The balloon was the last of four balloons to lift off with the intention of photographing the maiden flight of the third balloon. It was late summer at approximately 6:25 p.m. on a clear bright day with scattered cloudiness at 1 km (3300 ft), 16 km (10 miles) visibility, and 8 km/h (5 mph) wind velocity without turbulence when the flight began. There were three passengers in the aircraft, making an approximate gross weight for the balloon of 423 kg (939 lbs). The female pilot had logged 50 h of actual flight time [7,8].

During the flight the pilot of the third balloon observed the balloon under discussion striking a power line. After two electrical flashes of light, the balloon caught fire. Witnesses on the ground claimed that prior to the collision the crash balloon had descended to an altitude of approximately 1.2 m (4 ft) above the ground, following the path of a balloon ahead of it. In an effort to cross over the power line, an increase in the amount of flame coming from the burner was observed. After the collision a man was observed jump-

ing out of the balloon at a height of approximately 15 to 22 m (50 to 75 ft). His body was later recovered beside a fence (Fig. 1). After the balloon ascended another 15 m (50 ft), a second individual was seen jumping out with clothes on fire. The body landed in a field of standing corn (Fig. 2). Having risen another 120 m (400 ft), the basket was observed to separate from the envelope. Found in a group approximately 9 m (30 ft) apart were three propane tanks, the burner unit, and a portion of the basket floor. Tank 1 showed the fuel gauge indicator frozen at  $\frac{3}{8}$  full, Tank 2 showed a large fragmentation hole and burns of the valves, and Tank 3 showed a fragmentation hole, melted metal, and burns and soot of the relief valve. The burner unit and the basket floor showed evidence of extensive burn damage. The third passenger was found 36 m (120 ft) north of the basket floor in a soy-bean patch. The envelope, which showed minimal damage, was found 2 km ( $1\frac{1}{4}$  miles) south of the point of impact.

### Discussion

The fire injury pattern on the victims demonstrates that there is not only a sequence in the deaths but also differences in the causes of death. When correlated with the structure of the aircraft, the fire can be shown to have started at the gondola floor rather than from the burner, which was located above the gondola (Fig. 3). The distribution of the burns of the pilot reveals that the flame was to one side of the gondola and to the back and right of the pilot. These findings correlate well with the eyewitness reports that the gondola while in flight caught fire immediately upon contact with the power line.

Passenger A died first, sustaining his injury by jumping from the gondola almost immediately after it contacted the power line. In spite of the rather flimsy clothing of the victim, the T-shirt was not damaged and the skin failed to show any evidence of blunt trauma. The absence of body burns further indicated that he jumped from the gondola before any significant fire developed in the structure. The extent of his injury was limited to the back, where dissection revealed a primary impact point. Fractures of the thoracic vertebral spinous processes and separation of the manubriosternal joint suggested that he fell from a relatively low height and struck a soft or yielding narrow structure that caused



FIG. 1—Impact site for Passenger A.



FIG. 2—*Impact site for the pilot.*

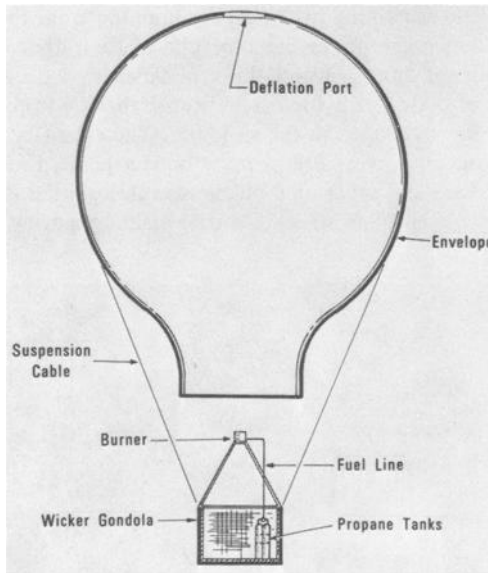


FIG. 3—*Schematic diagram of the hot air balloon.*

hyperextension of the thorax. These conclusions were supported by witness accounts that the victim jumped from the gondola approximately 15 to 22 m (50 to 75 ft) above the ground and landed on fencing wire (Fig. 1).

The second to die was the pilot. She was forced, because of the flames, to abandon her ship at a higher altitude since the aircraft was lighter after Passenger A jumped. Although the site of primary impact was essentially identical to that of Passenger A, the object with which the back of the pilot came in contact, although yielding, was broad and rough.

Because of the findings of a broken right forearm and left leg it was concluded that the body either bounced after the initial contact or was twisted before reaching its final position. It was thought that the surface which the body hit was rough because of characteristic scrapes superimposed on the burn lesions located on the right back, right half of the head and face, and right upper extremity. Further, because of the green stains noted on the T-shirt and the jeans, and the time of the year, the prosector suspected that she fell into a cornfield. The subsequent report showed that she did follow Passenger A in getting off the balloon but at the much higher elevation of approximately 30 to 38 m (100 to 125 ft) and that the body was recovered in a cornfield (Fig. 2).

Because the gross weight of the balloon was further lessened and since there was no defect on the envelope, the balloon continued to ascend and move farther from the initial site of the accident. Passenger B's autopsy showed that he remained in the balloon and died from the combined effect of flame inhalation and burning. The prosector believed that the victim was dragged or rolled as the gondola hit the ground because of the extensive soft tissue disruption and fractured bones. There was no primary impact point detected on the body.

It was concluded that the fault belonged to the pilot. Her attention was probably distracted while she was photographing the maiden flight of the third balloon and she underestimated the amount of heat necessary to give the balloon sufficient lift to cross over the high tension wire. According to the NTSB [2], the probable causes of the accident were improper in-flight decisions or planning and the misjudgment of the altitude and clearance by the pilot in command.

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