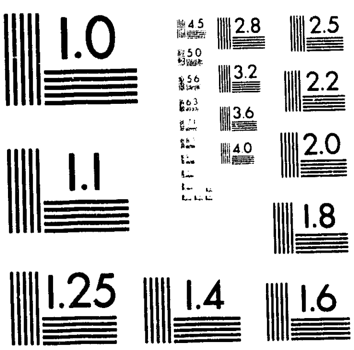
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FINAL REPORT

EPIDEMIOLOGY OF FATAL AND NONFATAL INJURIES IN THE AVIANCA PLANE CRASH
Avianca Flight 052 - January 25, 1990

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EXECUTIVE SUMMARY

On January 25, 1990 Avianca Flight 052 crashed without a conflagration after running out of fuel; 73 persons died, 85 survived. Epidemiological, biostatistical, and related analytical methods were used for the analysis of decedent and survivor injury patterns and for the purpose of examining selected EMS and hospital issues relative to disaster planning and incident management and response. Medical examiner and hospital records for all decedents and survivors were identified, abstracted, and coded using the International Classification of Diseases with Clinical Modifications, 9th Edition (ICD 9-CM) to determine the nature of injuries and comorbid conditions. Injury severity values were determined using the 1985 Abbreviated Injury Scale with Epidemiologic Modifications (AIS 85-EM). The paucity of crash site and prehospital information precluded its use in the analysis.

Survival patterns differed for crew members and passengers. Only one of the nine crew members survived (11%), whereas 84 of the 149 passengers survived (56%). Fatality rates increased with age. No one over 60 years of age survived (n=15) and only 37 percent in the 40-59 year (17/46) group survived. In sharp contrast, 64 percent in the 16-39 year (46/72) groups, 85 percent of those 5-15 years (11/13), and 92 percent of those under 5 years (11/12) survived. Nearly all fatalities resulted from chest and/or head trauma. Decedents had significantly higher cervical spine ($p=.02$) and thoracic spine ($p=.002$) fractures, while survivors had higher lumbar spine fractures ($p=.007$). Mean decedent Injury Severity Score (ISS) was 53 with 23 percent having the maximum ISS of 75. Mean survivor ISS was 18. Maximum Abbreviated Injury Scale (MAIS) Severity Score ranged from 4-6 for decedents and 1-5 for survivors. Twenty percent of the decedents had an upgraded MAIS based on blood loss (primarily from an MAIS of 4 to an MAIS of 5). To the extent that excessive internal blood loss could be attributed to delay in receiving definitive hospital treatment, compared to other factors, an additional 20 percent of the decedents may have survived.

Most survivors arrived at a hospital 2-6 hours post crash. Fifty-one and 24 percent of the survivors had MAIS 3 and 4 injuries, respectively, while two percent had an MAIS 5 injury. Among the survivors, 87 percent had one or more fractures (72 percent lower extremities, 42 percent upper extremities, 34 percent spinal, 25 percent skull, and 24 percent one or more ribs) and 31 percent had intracranial injuries.

These occurrence, severity and outcome data point to injury control policy, planning, and programs issues relevant to emergency services, disaster response and intermodal incident management. These issues include: delayed time to first hospital arrival, air transport decision making under adverse weather conditions and its regulatory implications, communications between crash scene and receiving hospitals, decedent location tagging, pre-hospital care documentation, identification of responders, command-control responsibilities, and roadway traffic management. There is also need for reconstruction and modeling of this crash with a focus on the relationship of age, type and severity of fatal and nonfatal injuries, and excessive bleeding to such factors as delayed response, mode of transportation, time to definitive treatment, seat type and restraint, and bracing position.

ACKNOWLEDGEMENTS

The authors wish to thank the administration and staff of the Nassau and Suffolk County Medical Examiners' offices for their extraordinary assistance and support needed to successfully complete the fatality data acquisition. We also thank the Nassau-Suffolk Hospital Council and the administration and medical record staffs of the participating hospitals for their time and dedicated efforts in obtaining the nonfatal data. We appreciate the assistance of the National Transportation Safety Board staff in providing us with documents related to the crash. Without the cooperation of these organizations and agencies, this initiative could not have been accomplished.

We would also like to thank Simona Heath and Alvin Hernandez of our medical record staff for their conscientious abstracting and coding.

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LIST OF ABBREVIATIONS

AIS	Abbreviated Injury Scale
AIS 85-EM	Abbreviated Injury Scale with Epidemiological Modifications
BNL	Brookhaven National Laboratory
CPR	Cardiac/Pulmonary Resuscitation
DAA	Dead after Arrival
DOA	Dead on Arrival
DOB	Date of Birth
EMS	Emergency Medical Services
ED	Emergency Department
ICD 9-CM	International Classification of Diseases 9th Revision with Clinical Modifications
IPAG	Injury Prevention and Analysis Group
ISS	Injury Severity Score
MAIS	Maximum Abbreviated Injury Scale
ME	Medical Examiner
NFS	Not Further Specified
NTSB	National Transportation Safety Board
PTS	Pediatric Trauma Score

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I. INTRODUCTION

On January 25, 1990 at approximately 9:34 P.M., Avianca Flight 052 crashed after running out of fuel. Because of the heavy rain and fog that evening, this flight along with many others, was placed in a holding position for landing. After three holding periods, the flight crew reported that it was running out of fuel and was unable to reach its alternate airport, Logan International in Boston (1). The plane was then given clearance to land but missed the initial approach to the airport, experiencing loss of power to all four engines due to fuel exhaustion, and crashed into a wooded residential area in Glen Cove, New York. There were 149 passengers and nine crew members on board. Of these 158 persons, 73 were fatally injured and 85 survived.

The Injury Prevention and Analysis Group (IPAG) at Brookhaven National Laboratory (BNL) conducted an in-depth evaluation of decedent and survivor injury patterns and their relationship to pre-hospital and other factors relative to adverse outcomes and disaster management. This study was initiated in accordance with an agreement between the Nassau County Health Department's Emergency Medical Services Committee and BNL/IPAG. Using well established scientific methodologies, IPAG medical and professional staff abstracted and coded hospital and Medical Examiner (ME) records of all persons who died or suffered nonfatal injuries in the Avianca crash.

Standardized epidemiological procedures already in use by IPAG for ongoing occupational injury and motor vehicle trauma studies were used for this project. Analyses focused on anatomic injury type, location, and severity, and on their relationship to other factors (e.g., time to treatment).

IPAG undertook this project with the intent of improving our understanding of Emergency Medical Services (EMS) issues, to better define EMS needs relative to disaster planning, triage, communications and coordination, and to address survivability issues for pediatric and adult patients.

II. OBJECTIVES

The overall objective of this analysis was to provide a scientific baseline to improve understanding of EMS issues and needs relative to disaster planning, coordination, communications, triage and survivability for both adult and pediatric populations.

The specific objectives were to: (1) describe the nature, extent, severity and outcome of both nonfatal and fatal injuries resulting from the Avianca crash, and (2) assess the relationship of EMS to other aspects of emergency management planning--including disaster planning, coordination, triage and survivability--within the context of the injuries resulting from the crash.

III. METHODS AND PROCEDURES

Hospital and/or Medical Examiner (ME) records were identified for each passenger and crew member. From each record, information on personal characteristics (e.g., age, sex, date of birth), time and date of arrival at the emergency department (ED) or ME office, cause and nature of injury, severity of injury, and hospital discharge status (e.g., treated and released, admitted, transferred to another facility, died) was obtained. If a patient received treatment at more than one facility, records from each facility were abstracted and coded whenever possible. The exception was for patients who were admitted to a hospital in the Long Island study region (Nassau, Suffolk, Queens Counties) and later discharged to a facility out of the region. Data on pre-hospital care and status was obtained from EMS computerized files when available.

Age was calculated using date of birth (DOB) as recorded on hospital or ME records. However, some medical records only had patient age with an approximation of DOB (e.g., 1/01/88 for a 2 year old child; 1/01/60 for a 30 year old adult). For these cases age was determined by age stated on medical record, rather than on actual DOB. When age differed between sources, records were reviewed and the "best" estimate of age was used (e.g., age on admission record instead of emergency department documents).

The cause of injury was coded using the International Classification of Diseases, 9th edition, with Clinical Modifications (ICD 9-CM) External (E) Cause of Injury codes E800-999 (2). The primary E code used was 840 ("Accident to powered aircraft at takeoff or landing") with 4th digit code to identify crew or passenger. However, if a statement appeared identifying other causes of injury (e.g., hit by falling object), this was also coded. The nature of injury and underlying medical conditions were coded using ICD 9-CM N codes to five digits (2). Anatomic injury location and injury severity were coded using the 1985 Abbreviated Injury Scale (AIS 85) (3) and the AIS 85 with Epidemiologic Modifications (AIS 85-EM) (4) [Figure 1]. For each body region injured, a maximum AIS (MAIS) severity score was determined. This determination was based on defining the highest AIS severity level for all injuries in an AIS 85-EM body region.

For this analysis, ICD was used primarily to describe the nature of injury and AIS to describe the anatomic location and severity of injury. Because of different degrees of specificity within each coding system and some injury assignation to different anatomic locations in each system (i.e., facial, spinal, and pelvic fractures), slight variations in the number of cases with AIS and ICD coded injuries resulted. For example, in ICD sacral/coccyx fractures are coded as spinal fractures, and facial fractures are coded to the broad skull fracture category. AIS considers sacral/coccyx fractures as lower extremity fractures and facial fractures as part of the facial structure, separate from the head.

The overall (i.e., whole body) severity of injuries was calculated using the Injury Severity Score (ISS). The ISS is calculated by totaling the sum of the squares for the highest severity level in each of the three most severely injured body regions (3,5). An ISS of 75 is the highest possible score. AIS 6 level (incompatible with life) injuries are automatically assigned an ISS value of 75 (3,5). For ISS calculations the body is divided into 6 regions: 1) head, neck, ears, cervical spine; 2) face; 3) chest and thoracic spine; 4) abdominal, pelvic contents, lumbar spine; 5) extremities, pelvic girdle; and 6) external (3).

For internal injuries AIS severity levels can differ by volume of blood loss or extent of anatomic damage. For example, by AIS 85 methodology a cerebral epidural hematoma =<100cc is assigned a severity of 4, while hematoma >100cc has a severity of 5. Lung lacerations involving multiple lobes with =<1000cc hemothorax have an AIS severity of 4, but with >1000cc blood loss it is an AIS 5 level injury. ME and hospital records rarely specified blood loss by volume. Rather, words such as mild, moderate, severe, acute, and extensive were used to define the amount of blood loss. Direct communications with the pathologists performing the autopsies indicated that if terminology was used such as extensive or severe, the blood loss was "definitely" within the upper limits. Therefore, for all ME cases, the higher severity levels ("upgraded" severity codes) were assigned when such descriptive terms were used. The lower severity level was assigned when the blood loss was not specified or when terminology such as mild or moderate was used.

For hospitalized cases, however, it was not possible to contact each physician for terminology interpretation. Therefore, when terminology was non-specific regarding volume of blood loss, the lower severity level designations were assigned to survivor injuries. Two cases in the ME data base had diagnoses of heart and major vessel lacerations/transection without specificity regarding extent of laceration/transection (e.g., partial, total). In the "non-upgraded" data base they were coded to the lesser severity of laceration/transection NFS and in the "upgraded" data base they were coded as complex laceration and/or total transection.

All medical record(s) for each case were inspected to identify all injuries sustained. For hospital records this included, but were not limited to, discharge summaries, ED diagnoses, physicians' and nurses' notes, radiological results, surgical reports, and test results. For the ME cases this included death certificate information, full autopsy reports, radiology and toxicology screening results. Because of the extent of trauma, most of the medical records were voluminous in size. For example, a number of the coded records contained more than 75 ICD diagnoses.

Once all abstracting and coding was completed, the data were key entered into IPAG computers, subjected to internal quality control checks and analyzed. Quality control procedures included visual scanning of completed abstracting forms, selected independent double coding, computer editing, and selected independent reabstracting. Statistical significance was tested at the $p \leq .05$. As part of the analysis, potential confounding factors, such as chronic or acute conditions/illnesses which may affect injury outcome, were identified.

IV. RESULTS

A. Overall Patterns

Among the 158 persons on board Avianca Flight 052 (passengers and crew), 46 percent died and 54 percent survived (Figure 2). Males and females comprised 53 and 47 percent of the passengers, respectively. Age distributions for males and females were similar (Figure 3). Ninety three persons were transported to 14 hospitals in Nassau, Suffolk, and Queens County. Seventy-four persons (80 percent) were admitted to the initial treatment hospital, nine (10 percent) were given emergency treatment and then transferred to another hospital, two (2 percent) were treated and released from the emergency department and eight (9 percent) were pronounced dead on or after hospital arrival at a hospital (Figure 4). All of those who died after hospital arrival succumbed within 48 hours post crash (Figure 5).

B. Fatal/Nonfatal Comparisons

Survival patterns differed for crew members and passengers. Only one of the nine (11 percent) crew members survived; whereas 84 of the 149 (56 percent) passengers survived (Figure 6). The following analyses are for passengers and crew members combined unless otherwise identified.

There were no significant gender differences by survival status for those on board (passengers and crew combined); 56 percent of the males and 51 percent of the females survived (Figure 7). Fatality rates increased as age increased (Figure 8). There were no survivors in the 60 and over age group (all were passengers). This group comprised 10 percent of all passengers on board the aircraft. Over half of the persons in the 40-59 year age groups died. In sharp contrast, for those age 15 and under and 16-39, 88 and 64 percent, respectively, survived.

1. Nature of Injuries

Statistically significant differences ($p < .05$) were seen when comparing intrathoracic, intracranial, and intra-abdominal injuries for survivors and decedents (Figure 9). Concussion was not diagnosed in any of the decedents, since this is a diagnosis usually based on clinical signs and symptoms. However, decedents had significantly higher intracranial lacerations and hemorrhages (Figure 10). Decedents also had significantly higher skull (primarily to the base of the skull) and thoracic fractures rates (Figure 11). Rib fracture patterns differed among decedents and survivors. Over half of the decedents had multiple rib fractures and lung injuries (e.g., lung lacerations and contusions), whereas only 20 percent of the survivors were diagnosed with multiple rib fractures (Figure 12). Sharply higher rates of cervical and thoracic spine fractures were seen in decedents, while lumbar fracture rates were significantly higher in survivors (Figure 13).

2. Anatomic Injury Severity

a. Maximum Abbreviated Injury Scale (MAIS) Score

MAIS scores ranged from 1-5 for survivors and 4-6 for decedents (Figure 14). Eight survivors (9 percent) incurred only MAIS 1 (minor) injuries; these were primarily multiple contusions, abrasions, lacerations, and sprains and strains. Twelve survivors (14 percent) had MAIS 2 injuries (moderate); primarily concussive injuries without neurologic deficit, simple fractures, and extensive lacerations, contusions, and abrasions. Forty-three survivors

(51 percent) had MAIS 3 (serious) injuries. MAIS 3 lower extremity injuries were seen in nearly half of the decedents; these were primarily compound fractures.

Five decedents (7 percent) and 20 survivors (24 percent) had MAIS 4 (severe) level injuries; most of these were to the thoracic and head region for both groups. MAIS level 5 injuries (critical) were incurred by 71 percent of the decedents and 2 percent of the survivors. These included major intracranial, spinal cord, and intrathoracic injuries such as extensive cerebral hemorrhages, multiple rib fractures with hemopneumothorax, and major vessel lacerations. Twenty-two percent of the decedents had MAIS 6 injuries, defined as virtually unsurvivable injuries. These included severance of major thoracic vessels (e.g., the aorta), massive head trauma (deformation of both skull and brain), and laceration of the upper cervical spinal cord.

b. Injury Severity Score (ISS)

ISS ranged from 2-43 for survivors and from 21-75 for decedents (Figure 15). As previously described in Methods, any person incurring an MAIS level 6 injury was automatically assigned an ISS score of 75.

C. Fatalities

Seventy-three persons died in the crash, including 65 who were pronounced dead at the scene and eight who died at or enroute to a hospital. For the persons who died after arrival, five arrived at a hospital within the first 2 to 3 hours post crash and two arrived more than 4 hours after the crash. One person was pronounced DOA at a hospital about 2.5 hours after the crash (Figure 5).

1. Nature of Injuries

Nearly all decedents had one or more documented internal injuries to the head and/or thorax (Figure 16). Forty-five percent had skull fractures, 48 percent sustained spinal fractures (figure 17); the majority of these spinal fractures were to the cervical and thoracic spine (Figure 13). Six decedents had fractures to more than one area of the spine. Over 80 percent of the decedents had rib/sternum/trachea fractures (Figure 17); half of these had eight or more fractured ribs (Figure 12). Eighty-five percent of the decedents incurred one or more injuries to the lungs; 26 percent had one or more cardiac injuries (Figure 12). Intracranial injuries were diagnosed in nearly 90 percent of the decedents (Figure 10). One or more abdominal injuries was found in half of the decedents; 30 percent sustained liver injuries (Figure 18).

2. Anatomic Injury Severity

Using the "upgraded" AIS severity protocol (see Methods and Procedures), 93 percent of the fatalities had one or more AIS 5 or greater injuries (Figure 19). All fatalities had at least one MAIS injury of 4 or greater (Figure 20). Of the cases with thoracic injuries, 44 percent were MAIS 5 and 18 percent were MAIS 6 injuries. For cases with intracranial injuries, 48 percent were MAIS 5 and five percent were MAIS 6. There was no significant difference in the distribution of AIS 5 or greater injuries to decedents by either gender or age. Five decedents (7 percent) had an MAIS 4 (brain and/or thorax) and 16 (22 percent) an MAIS 6 (Figure 20).

Most of the fatalities had ISS scores between 25 and 66 and 23 percent had the maximum ISS of 75 (Figure 21); the mean ISS was 53 for all decedents.

There was no difference in average decedent MAIS or ISS by age.

MAIS and ISS levels were also calculated using conservative estimates without taking into account the nonspecific terminology to upgrade severity. Based on these estimates, 1 decedent would have had an MAIS 3 injury, 18 (25 percent) an MAIS 4 injury, 40 (55 percent) an MAIS 5 injury, and 14 (19 percent) the maximum level 6 injury (Figure 22). The mean ISS for the non-upgraded fatality cases was 48.

3. Underlying Medical Conditions

Neoplasms were diagnosed in 23 percent of the decedents (Figure 23); over 80 percent of the neoplasms were in the 40 and over age groups. Over 60 percent of the fatalities had circulatory or respiratory problems diagnosed on autopsy. However, it is not known how many of these were secondary to the injury. For example, pulmonary edema could have existed as an underlying chronic medical condition, or may have been secondary to the trauma.

D. Survivors

1. Arrival Time

Time of arrival at a hospital was documented in the records of 92 percent of the 85 survivors. Of the cases with documented times, 65 percent arrived at a hospital for initial treatment within four hours of the crash; 13 percent arrived within the first 2.5 hours (Figure 24). Most of the remaining cases arrived within six hours after the crash.

The 17 survivors who arrived within 3 to 3.5 hours after the crash had the highest proportion (65 percent) of internal injuries. Time differences among the groups were not statistically significant.

According to EMS data, 49 percent of the cases were known to be transported to hospitals by fire/rescue squads, 34 percent had no transporting agency listed, and 16 percent were transported by helicopter (Figure 26). Of the 14 survivors who were transported by helicopter, three had an MAIS 1 or 2, eight an MAIS 3, and 3 an MAIS 4 (Figure 27). In addition, one decedent with two MAIS 5 injuries was transported by helicopter and died after hospital arrival. No clear triage patterns were demonstrated for helicopter runs, when analyzed by age and injury type.

Mode of transportation was not specified on the hospital records for 41 percent of the cases taken to hospitals, including those who died on or after hospital arrival. Ambulance run sheets could not be found with hospital records.

2. Body Regions Injured

Forty-four percent of the survivors sustained intracranial (including concussive) injuries; 35 and 27 percent, respectively, sustained thoracic and abdominal injuries; and 36 percent had one or more spinal injuries (Figure 28). Over 80 percent had non-external lower extremity injuries, primarily fractures. Male intracranial injury rates were significantly higher than female rates (Figure 29).

3. Nature of Injuries

ICD defined internal injuries (chest/abdomen/pelvis) were sustained by 40 percent of the survivors (Figure 30). Lung injuries were identified in 18 percent of the survivors; two survivors had cardiac injuries (Figure 12). Abdominal/ pelvic injuries were diagnosed in 25 percent of the survivors

(Figure 31). Intracranial injuries were seen in 30 percent (Figure 30); 22 percent were concussions with no other documented intracranial injury (Figure 10). Eight percent of the survivors had skull fractures with no mention of an intracranial injury.

One or more fractures were sustained by 87 percent of the survivors (Figure 30). Lower extremity fractures were diagnosed in 72 percent (Figure 32); over half were to the lower part of a leg (Figure 33). Of all survivors, 22 percent had fractures to the pelvis and 34 percent to the femur. Forty-two percent of the survivors had upper extremity fractures (Figure 32); most were to the upper arm and shoulder region (Figure 34).

Over 20 percent of the survivors had one or more rib fractures, four percent had sternal fractures, and two percent had flail chest (Figure 12). Spinal fractures were seen in 34 percent of the survivors; 80 percent of these were to the lumbar spine (Figure 13). Seventeen percent of the survivors had one for more facial fractures, primarily to the jaw region (Figure 35).

Statistically significant differences for fractures was observed by gender: 98 percent of the females sustained fractures compared to 78 percent of the males (Figure 36). This was primarily due to females having a significantly higher rate of lower extremity fractures (Figure 37).

4. Severity Levels

Of all survivors 24 percent had only "minor" or "moderate" severity injuries (MAIS 1 and 2), 51 percent had serious injuries (MAIS 3), 23 percent had "severe" injuries (MAIS 4), and two percent had "critical" (MAIS 5) injuries (Figure 38). Nearly half of the survivors had ISS scores ranging from 1-15, and approximately one quarter had scores 16-24 or 25-43 (Figure 39).

5. Age Distributions

Statistically significant trends across age groups were seen in the proportion of survivors with non-external injuries. Thoracic, abdominal, spinal, and lower extremity injuries were significantly higher for the 16 year and older age groups than for those under age 16 (Figure 40). Three survivors (14 percent) under age 16 had thoracic injuries which included single rib fractures, lung and cardiac contusions, and hemopneumothorax; whereas, 27 survivors (43 percent) 16 years or older sustained thoracic injuries, primarily multiple rib fractures, and lung contusions and lacerations. Of all survivors under age 16 nine percent were diagnosed with abdominal injuries. In contrast, 21 survivors (33 percent) 16 years or older had abdominal/pelvic injuries. Only one survivor under age 16 sustained a spinal injury, an acute cervical strain. In sharp contrast 48 percent of the survivors 16 years or older sustained one or more spinal injuries.

Persons under age 16 had significantly lower fracture rates than those 16 or older. (Figure 41). Half of the survivors under age three and 71 percent of those ages 3 through 15 sustained fractures, whereas 95 percent of those 16 or older had fractures to one or more body regions. No survivor under age 16 had a spinal or pelvic fracture. For those 16 years or older, 46 percent had one or more spinal fractures and 27 percent had pelvic fractures. Except for upper limb and skull fractures, the age group differences were statistically significant.

For extremity fractures, persons 16 years or older were more likely to have complex (AIS-3) fractures (open/displaced/comminuted) rather than simple fractures (AIS-2) (Figure 42). However, statistical significance ($p<.05$) in fracture severity between these groups was only observed for tibia fractures, while fibula fractures approached this significance level ($p=.06$).

Mean survivor MAIS and ISS were slightly lower for survivors under age 16 (Figures 43 and 44). However, this finding was not statistically significant.

6. Length of Stay

Length of initial hospital stay generally increased as MAIS scores increased. For those with an MAIS of 1, the mean days hospitalized were 2; those with MAIS scores of 4 had a mean hospitalization of 64 days (Figure 45). Both patients with an MAIS 5 injury were hospitalized for extended periods and then transferred to rehabilitation facilities outside of the region. It should be noted, however, that many of the survivors required extensive outpatient rehabilitation, some were transferred to hospitals outside the study region for further care and rehabilitation, and some had subsequent hospital admissions for orthopedic, reconstructive and/or other surgical procedures.

Mean length of initial hospital stay was shortest for those in the youngest age group and highest for those in the 40-59 group (Figure 46). For survivors under age three the mean length of stay was one week, whereas for those in the 40-59 group it was slightly over 2 months.

V. DISCUSSION

This event presented a unique opportunity to conduct an extensive study of the injuries incurred in an airplane crash without the confounding problem of burns and toxic fume inhalation associated with conflagration. Most of the decedents and survivors incurred multiple injuries within a broad spectrum of severity. ME and hospital records were often voluminous with some cases having more than 75 diagnoses identified in various parts of the hospital charts or medical examiner records. Thus, in order to obtain the level of detail needed to classify and code injuries, IPAG staff thoroughly reviewed all documents in hospital charts and medical examiner records.

Because some plane occupants were extricated from the wreckage and the crash site was heavily wooded, it is possible that some of the injuries may have been caused by the extrication process or by surrounding debris. The National Transportation Safety Board (NTSB) indicated that interior furnishings from the plane (e.g., seat units, overhead bins) were found scattered in the wreckage (1). Rescuers commented that some of the occupants may have been crushed by survivors trying to get out of the plane.

The high fracture rates (particularly to lower limbs) seen in this analysis have also been recognized in previous studies of plane crashes (11, 19-21). Various mechanisms that can contribute to these and other injuries have been identified by Hill (21). For example, being struck by loose objects can cause penetrating injuries, fractures, lacerations, and contusions; and absence or failure of restraint systems have been linked with injury caused by flailing or flying bodies. However, because of the paucity of information at the Avianca crash scene, it was not always possible to determine mechanism of injury causation.

Pre-hospital EMS information was sketchy at best. Multiple trauma was the diagnosis listed on EMS run sheets for over 90 percent of the cases. Vital signs were missing for all but one case, and information regarding post crash occupant location, condition of the occupant, and treatment rendered at the crash scene or during transportation was missing or unavailable for all cases. For example, it was not known how many received CPR or other potential injury producing procedures (e.g., intubation). A number had sternal fractures and many sustained rib fractures. It is possible that some of these injuries could have been caused by administration of CPR; however, this could not be ascertained because of lack of documentation.

Passengers were not warned of an imminent crash and had not been instructed to assume a brace position. It is possible that the distribution and severity of injuries would have been different if a brace position had been assumed prior to impact.

Identification of patients who were initially treated at one facility and admitted to another created some difficulties. Because of general confusion, language barriers, and children too young to communicate, names were often missing from initial ED documents and ages were often approximated in ED records. Therefore, matching ED cases with some of the hospital admission cases required the use of additional analytical procedures.

One survivor of the crash had an arrival time specified on the hospital ED record as being 20 minutes after the crash. Discussions with hospital staff indicated that this time was probably in error, since no one could remember any crash survivor arriving within that time period. Conversations with EMS staff also indicated that it was doubtful whether a transport was made by EMS within 20 minutes of the crash since the first rescue vehicle did not leave the crash scene until approximately one hour after the crash.

A comparison of decedent to survivor fractures was not conducted since full body x-rays were not taken on most of the decedents; therefore, only obvious fractures were noted on autopsy findings. It should be noted, however, that while a comparison of internal injuries between decedents and survivors was conducted, autopsy information regarding internal injuries was likely to be more extensive than information available for survivors.

According to the NTSB final official report (1), the 149 passengers on board the flight, consisted of 61 adult males and 61 females ranging in ages from 19-77 years, 8 male and 8 female children ages 3-15 years, and 8 male and 3 female infants ages 4 months to 27 months. However, data from the IPAG investigation differed as to age and gender distributions for these 149 persons (Table 1). Because the IPAG investigation was conducted after the initial hospitalizations of all survivors, allowing access to more complete medical records, the opportunity to achieve accuracy and precision in abstracting and coding was maximized. On the other hand, NTSB had to conduct their investigation under considerable time pressure; their primary objective was to determine the cause of the crash as distinguished from the IPAG objectives, which focused on the meticulous documentation of injury characteristics, quantitative severity measurements, and other outcomes. At the time of the investigation NTSB did not have access to complete medical records for each case. This could have contributed to the observed differences in gender, age, and MAIS distributions. It should be noted that IPAG and NTSB total counts of passenger and crew were in agreement.

Unfortunately, seating position for many of the passengers was unknown.

According to the NTSB report a number of passengers were not assigned seats and some of those with assignments were not in their assigned seats when the plane crashed (1). During the NTSB investigation, some seating positions were defined; however, persons in those seats were not identified in the published reports. Rather, the seating position (when known), age, injury type, and MAIS sustained was published. An initial attempt was made to match NTSB cases with IPAG cases by age, gender, injury description, and MAIS. However, only 20 percent of the cases could be matched using these key variables because of discrepancies between NTSB and IPAG data. While it might be possible to match virtually all cases using "fuzzy" searching techniques, the time and costs involved were beyond the scope of this project.

Surviving infants and children under age 16 years generally had more favorable outcomes when compared to survivors in all other age groups. In a study conducted on blunt trauma seen in a Minnesota metropolitan hospital over a 10 year period, statistically significant higher rates of chest trauma were seen in adults compared to children (6). Children under 15 years of age rarely presented with flail chests, diaphragm rupture, and cardiac and great vessel injuries. Instead, thoracic injuries in children were usually less severe, primarily hemopneumothorax requiring closed thoracotomy tube drainage. Pulmonary contusions and single rib fracture were the most common thoracic injuries seen in children. The authors concluded that "greater elasticity and improved compliance of the chest, diaphragm, and mediastinal structures" probably contributed to the more favorable outcomes observed in children when compared to adults. The aforementioned study also found that vertebral fractures were significantly lower in children than in adults. This Avianca analysis corroborated the Minnesota findings.

The use of TRISS (combination of ISS, and systolic blood pressure, Glascow Coma Scale, and respiratory rate) and the Pediatric Trauma Score (PTS) were considered (7,8,9). However, physiologic components necessary for using these scales were for the most part not available. Documentation regarding age and vital signs was missing from most of the EMS data and was often incomplete in initial hospital assessment information. In addition, Glascow Coma Scale and/or central nervous system function parameters, a criteria for TRISS and PTS determination, were for the most part not documented as part of the initial patient assessment. Instead, general statements such as alert, lethargic, or non-responsive appeared as first-cut patient assessments in the ED. The magnitude of the event, the crowded ED conditions, and the inability of many survivors to communicate in the English language made it difficult for EMS and hospital staff to obtain and document the detailed information needed for these assessments.

A number of research articles in the field of aviation trauma have addressed the issue of poor documentation at crash scenes or in the ED (10,11). The use of pre-numbered case note tear-off slips or tags which can be attached to the patients at the scene has been recommended as a way to address the issue of poor documentation (10). Based on the Avianca findings, there is also a need to affix another part of a pre-numbered slip, tag, or bracelet to the site from which a patient is extricated. This would be useful for a number of reasons. First, such a system would enable documentation at the site that would stay with the patient and could be updated as necessary in the field, regardless of who provides treatment. Second, it would assist investigators in reconstructing crashes and in identifying occupant seating position or other location. This multiple tagging approach could have similar applicability to motor vehicle crashes and other multiple casualty situations.

Helicopters were used to transport 14 survivors (16 percent). Exhaustive analysis by age, severity (MAIS and ISS), and injury type failed to reveal a pattern for triage relative to air transportation. Seventy-three percent of those transported by helicopter had an MAIS of 3 or less. Of the 20 survivors with an MAIS 4, only three were transported by helicopter and one person with an MAIS 5, who died after hospital arrival, was transported by air. According to EMS staff, only a few "windows" were available for take off and landing because of the poor weather conditions (rain and heavy fog). Therefore, air transportation decisions were based largely on patient availability at the time; for the most part these patients were less seriously injured. Given the danger inherent in air transportation on the night of the crash, the use of helicopters for evacuation purposes under adverse weather conditions must be scrupulously reexamined.

Whether the lack of triage or delay in obtaining definitive medical care contributed to deaths or injury severity is not certain. Hospitals did not start receiving patients until approximately two hours after the crash. Studies have identified the need for treatment during the first hour post trauma, the "golden hour", to reduce mortality (12-16). Medically aggressive patient management in the first hour could be critical in saving lives. Rouse determined that reduction of on-scene treatment time from 28 minutes to 15 minutes increased hospital arrival time during the "golden hour" from 48 to 72 percent (16). It is recognized that the time it took EMS units to arrive at the scene and begin extrication efforts made it difficult to transport patients during the "golden hour".

Improved time to hospital coupled with early surgical intervention have been linked to increased probability of survival in a number of studies conducted on multiple trauma events (13,17). Some investigators suggest the need for trauma teams at disaster sites which include anesthesiologists and surgeons (18), particularly in rural areas where transport time may be prolonged and EMS staff may be inadequately trained. They claim that this would enable aggressive management of airway problems and would allow for more sophisticated resuscitative techniques. Cad and colleagues found that the use of anesthetists at the crash scene was valuable in providing fluid replacement, analgesia and sedation, and ensured that severely injured patients received early treatment by experienced medical personnel (10).

At the crash scene there was no clearly defined command hierarchy, no person assigned who was officially authorized to delegate jobs or responsibility, and no name tags worn which identified personnel and their affiliation/qualifications (e.g., EMT, AEMT, physician, nurse). In addition, numerous persons responded to the scene who wanted to offer assistance (22). Communications between the scene and receiving hospitals were poor. Therefore, hospitals were neither aware of the number of cases to expect, nor did they have prior knowledge of the nature and extent of injuries. Some hospitals overestimated the number of cases they would receive while others received numerous patients at one time. In addition, some hospitals received patients that they were not equipped to handle, while trauma centers received some of the less severely injured persons. Information from some of the receiving hospitals indicated a lack of orthopedic specialists because they did not anticipate the high volume of fracture cases. Also, no protocol was in place at the time of the crash for pediatric trauma referral. The collective contribution of these conditions to survivability and injury outcome needs to be further examined.

Nassau County EMS now has a Pediatric Trauma protocol that was implemented in late 1990 and has recently released a disaster control plan which addresses a number of other issues. The plan presents a clearly defined scene management strategy starting with establishment of a command post and triage staging center and culminating with a plan for hospital assignment based on type and severity of injuries.

Based on the finding that children had higher survivability and generally less severe injuries, there is a need to fully review and consider countermeasures for passenger protection which address the sharp differences in outcome observed between younger and older passengers. Age-specific physiologic differences (tissue elasticity, bone fragility) may play a greater role in survivability and injury tolerance than previously thought. Further crash reconstruction would contribute to a better understanding of this finding. Developing injury countermeasures to address such differences may require alternative strategies to those currently under consideration.

Autopsy reports reviewed by IPAG staff for this analysis were exceptionally thorough and well organized. Every decedent had extensive examination data documented for all organ systems, including organ systems not injured. Autopsy and other notes were neatly typed and legible. Considering the magnitude of the event and the number of autopsies performed in a relative short period of time, the Nassau County Medical Examiner's Office deserves recognition for a "job well done".

Injury severity is often determined in AIS by a numeric value, such as volume of blood loss or extent of damage. However, hospital and ME records often used terminology such as slight, moderate, acute, or severe rather than specific volume estimates. Since all but one of the autopsies were performed at the Nassau County ME's office, statements such as acute or severe hemorrhage were coded to the greatest blood loss (for head => 100 cc and chest => than 1000 cc) after confirming interpretation of these definitions with the ME office. It was not possible, however, to classify blood volume based on terminology in hospital records. Numerous physicians were involved and it was beyond the scope of this study to contact each hospital and physician to determine their interpretation of terminology.

Twenty percent of the decedents with head and/or thoracic injuries had severity upgraded based on blood loss (one from an MAIS 3 to an MAIS 4 and 14 from MAIS 4 to MAIS 5). It was not possible to determine if the blood loss would have been less, thereby potentially increasing the chance of survival, if immediate definitive care had been rendered or if hospital treatment had begun within the first hour post-crash. Based on these findings, however, one could argue that some of the deaths related to excessive blood loss may have been prevented. Further crash reconstruction and modeling have the potential to address this and related issues, even with missing crash scene information, such as when a passenger or crew member expired or unknown seating positions.

The nature of injuries was analyzed using ICD N categories. AIS was used for analysis of severity and anatomic location of injury. When comparing ICD and AIS diagnoses, distributional differences were observed in the analysis of concussive, spinal, and pelvic injuries. Using ICD, 17 survivors had a diagnosis of concussion; by AIS criteria 35 had symptoms that could be associated with head trauma and were therefore coded to the AIS concussive codes. ICD specifies concussion as intracranial injury and assigns a code based only on level of consciousness, while AIS defines a concussive injury as known head trauma with associated symptomatology, (e.g., headache, dizziness, lethargy, loss of consciousness). ICD assigns symptomatology that may be associated with a head injury, such as headache, dizziness, or nausea, to the ICD symptom codes, if there was loss of consciousness and concussion was not stated in the record. When ICD head symptom codes were added to cases with concussive codes, they equalled the number of cases assigned concussive codes in AIS.

It should be noted that it is possible to assign an AIS concussive code to a patient who does not have a concussion. For example, a person with a head contusion may complain of headache or dizziness, yet this symptom could be associated with another problem, such as anxiety, hunger, or shock from other injury. While AIS has the potential of overreporting concussive injuries, ICD could result in underreporting, since some of the above symptomatology can be associated with a concussion. Other ICD and AIS coding differences (e.g., skull, lower extremity, and spine fractures) are discussed in Methods.

VI. CONCLUSIONS

Based on the findings presented herein, the following EMS and hospital issues merit consideration for disaster planning and management:

1. A major limitation in conducting this analysis was the lack of pre-hospital EMS documentation and the paucity of ED documentation.
2. The multiple tagging approach suggested herein is also applicable to motor vehicle crashes and other multiple casualty situations.
3. Some of the delays to hospital treatment were due to roadway congestion, numerous responding agencies, inadequate perimeter control to direct the flow of traffic, lack of a single command post, and poor access to the crash scene which had only one road leading to it.
4. No defined command hierarchy was identified, and no person was officially authorized to delegate responsibility.
5. Responders were not identified with name tags or affiliation/ qualifications (e.g., EMT, AEMT, physician, nurse).
6. Lack of adequate communications between the crash scene and the receiving hospitals may have contributed to adverse injury outcomes, but the extent was unknown.
7. A significant number of the fatal injuries were related to massive chest and head trauma and associated hemorrhage.
8. Medical records often lacked specificity regarding volume of blood loss.
9. Lower limb fractures, primarily to long bones of the lower leg, were common, an outcome consistent with lack of assuming a "brace position".

10. Crash reconstruction information that can be linked with injury type, severity, and anatomic location is necessary to develop an enhanced understanding of injury mechanism.

11. Infants and children 15 years and younger had higher survivability with fewer internal injuries and fractures; their injuries were also generally less severe than those on board who were older.

12. As aviation technology progresses to the point of reducing the potential for plane crashes with fire, occupant protection issues will merit additional consideration. Findings from this and other studies indicate a high probability of survival in the absence of fire and toxic fumes.

13. To the extent that excessive internal blood loss could be attributed to delays in receiving definitive hospital treatment, rather than to other factors, an additional 20 percent of the decedents may have survived.

VII. RECOMMENDATIONS

The following recommendations are based on the findings of this investigation:

- Reexamine countermeasure strategies to protect passengers of all ages because of higher survivability of children compared to adults.
- Use vehicles that can respond to a mass casualty scene which are equipped with adequate splinting and other materials needed for treating mass trauma.
- Use pre-numbered tags/bracelets/note slips which can be affixed to the patients and site of extrication and/or seating location within a wreckage.
- Require crash respondents to wear name tags stating affiliation and training status (e.g., EMT, AEMT, M.D., R.N.).
- Improve pre-hospital/hospital coordination and communications for hospital readiness.
- Further examine crash and injury data to resolve differences between NTSB and IPAG findings, including age, gender, and AIS values.
- Review full medical records for accurate and reliable injury outcome measurements. Ideally, this should be done after initial hospital discharge when all medical reports and records are complete.
- Retain back-up documentation from official crash investigations, including medical records, for research purposes.
- Include specialists in injury epidemiology on official investigation teams.
- Incorporate procedures which allow for blood loss descriptors routinely found in medical records, such as minor, moderate and severe to standardized severity coding systems.

- Conduct a follow-up study on crash survivors to determine long-term (post hospital discharge) adverse health and economic effects.
- Initiate crash reconstruction and modeling studies focusing on the relationship of adverse outcomes to such factors as blood loss, delayed response and transport time, seating location, seat type and restraint, bracing position, and nature, distribution and severity of injuries.
- Use reconstruction and modeling of this crash to provide valid and more reliable information needed for efficacious decision making to implement strategies for injury prevention or severity reduction in aircraft crashes.

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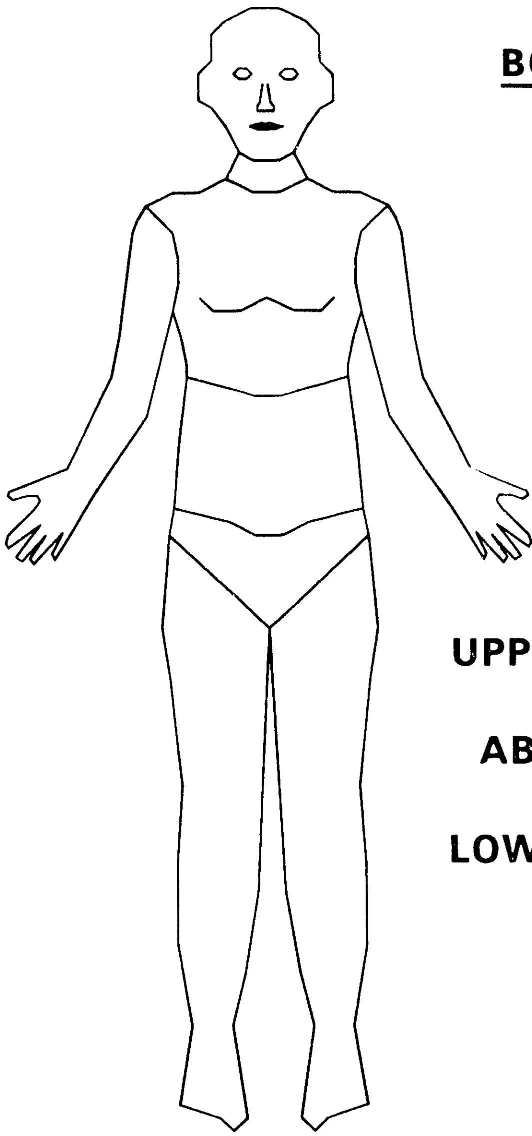
FIGURES

FIGURE 1

AIS 85-EM



BODY REGIONS

HEAD

FACE

NECK

THORAX

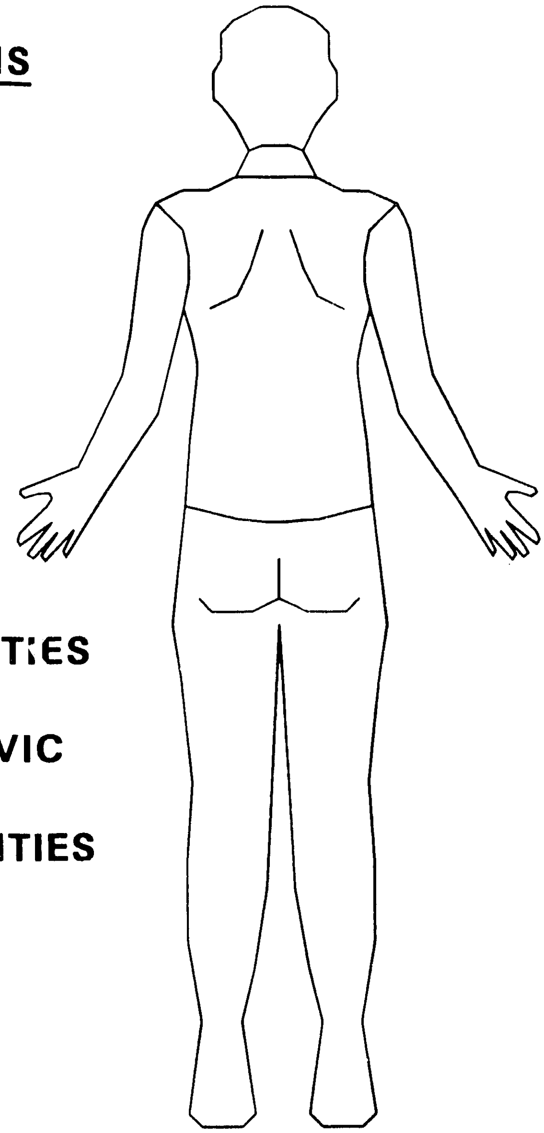
SPINE

UPPER EXTREMITIES

ABDOMEN/PELVIC

LOWER EXTREMITIES

EXTERNAL



SEVERITY CODES

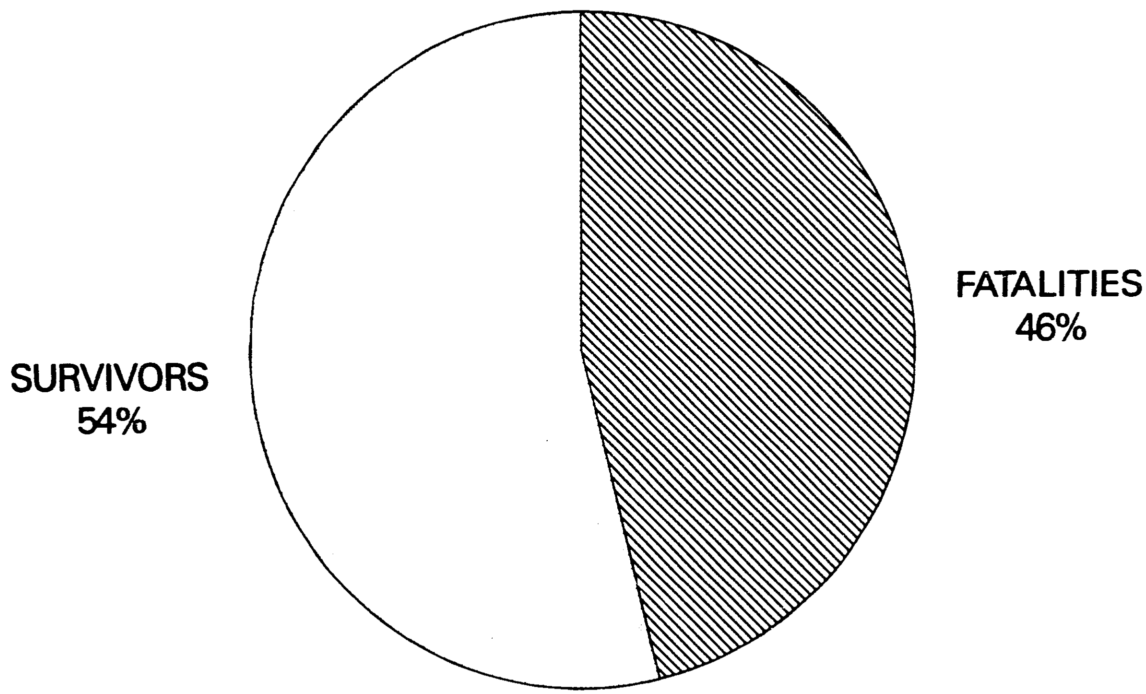
1 MINOR
2 MODERATE
3 SERIOUS
4 SEVERE
5 CRITICAL
6 MAXIMUM INJURY, VIRTUALLY UNSURVIVABLE

0 NO INJURY
7 PAIN
8 RULE OUT
9 CONTACT

FIGURE 2

OVERALL SURVIVAL DISTRIBUTION OF OCCUPANTS

AVIANCA CRASH 1/25/90



(n=158)

FIGURE 3

AGE DISTRIBUTION BY GENDER

AVIANCA CRASH 1/25/90

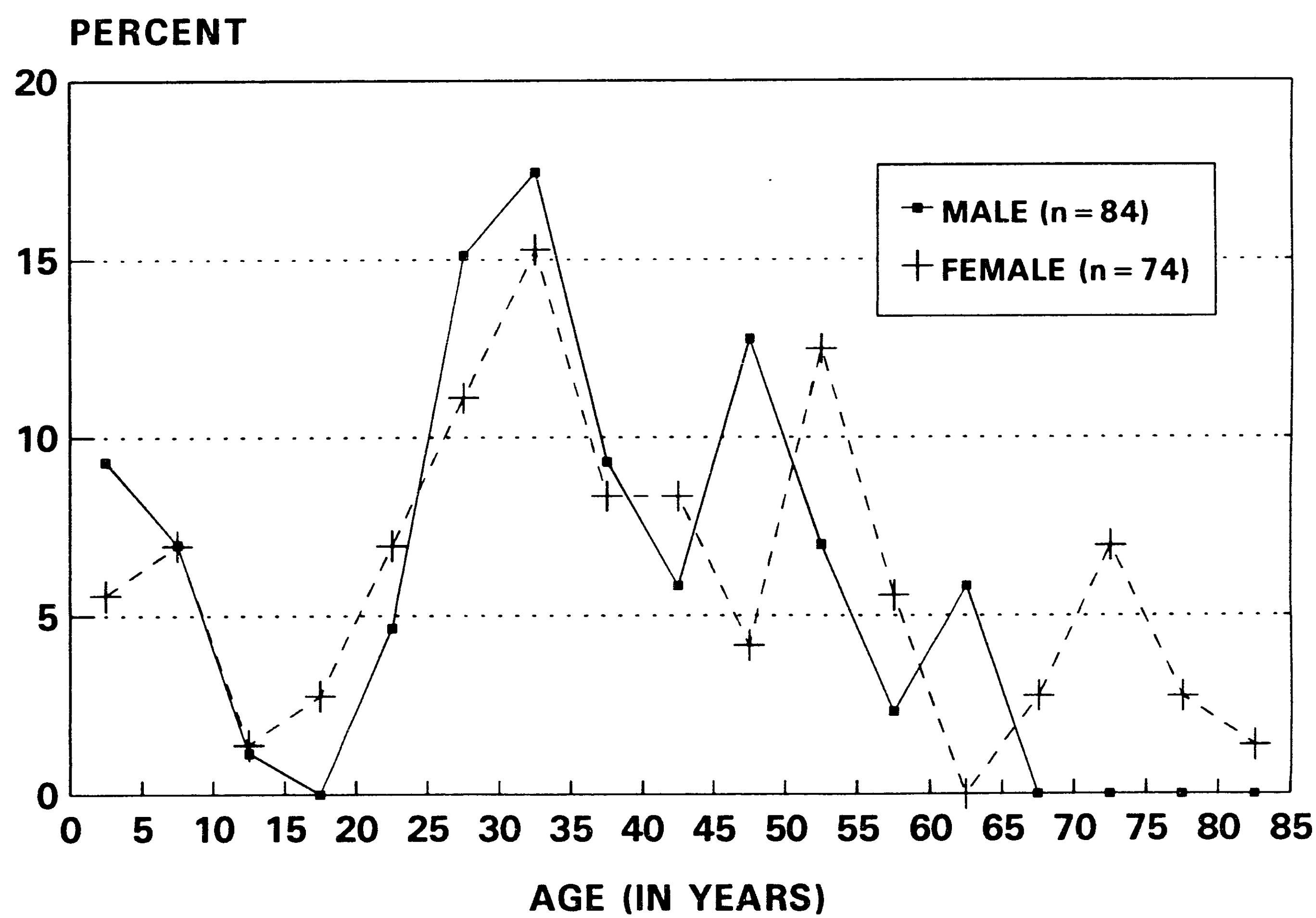
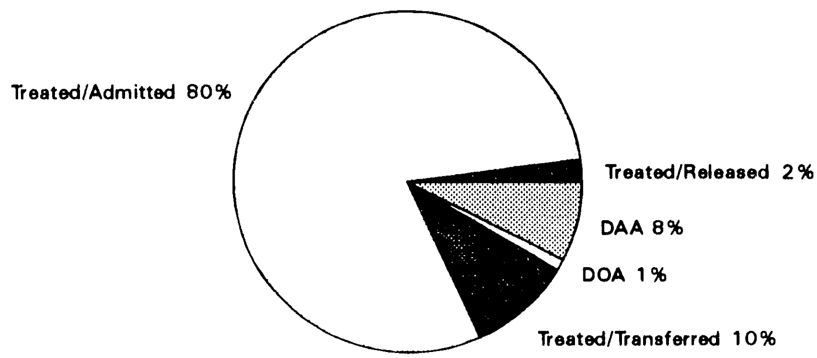


FIGURE 4
DISCHARGE STATUS FROM FIRST HOSPITAL FOR ALL CASES TRANSPORTED TO HOSPITALS
AVIANCA CRASH 1/25/90



(n=93)

FIGURE 5
TIME TO DEATH FOR FATALITIES OCCURRING AFTER HOSPITAL ARRIVAL
AVIANCA CRASH 1/25/90

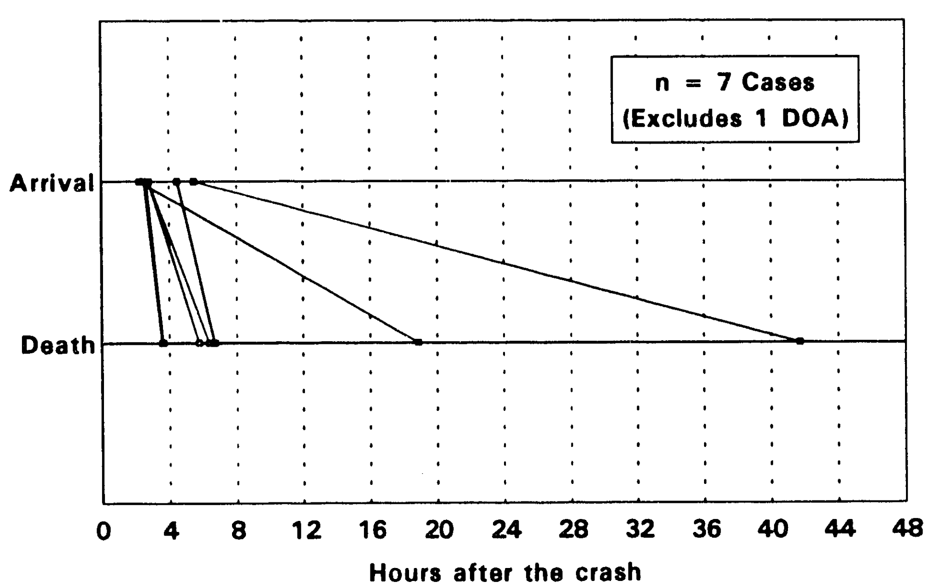
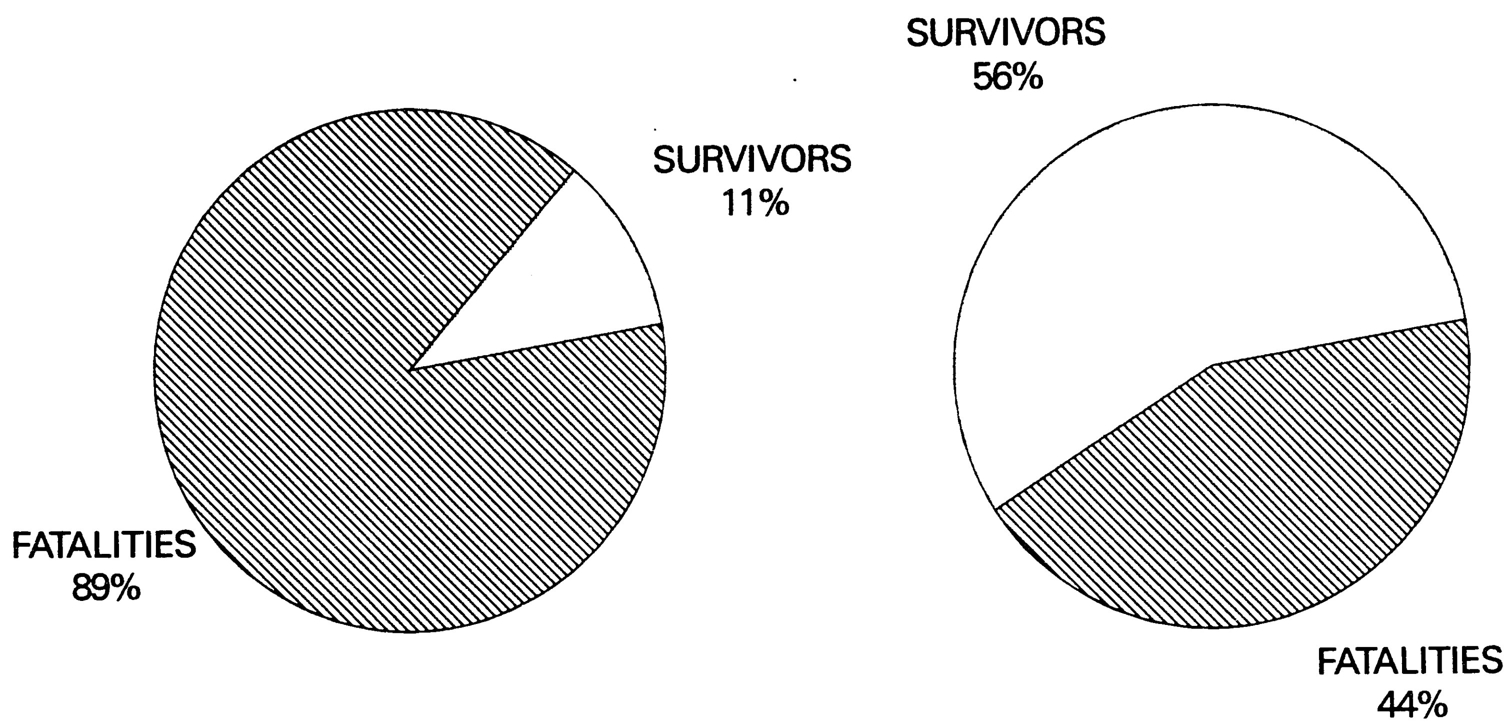


FIGURE 6
SURVIVAL DISTRIBUTION BY OCCUPANT STATUS
AVIANCA CRASH 1/25/90



CREW (n = 9) | **PASSENGERS (n = 149)**

FIGURE 7
CASE FATALITY RATIOS BY GENDER
AVIANCA CRASH 1/25/90

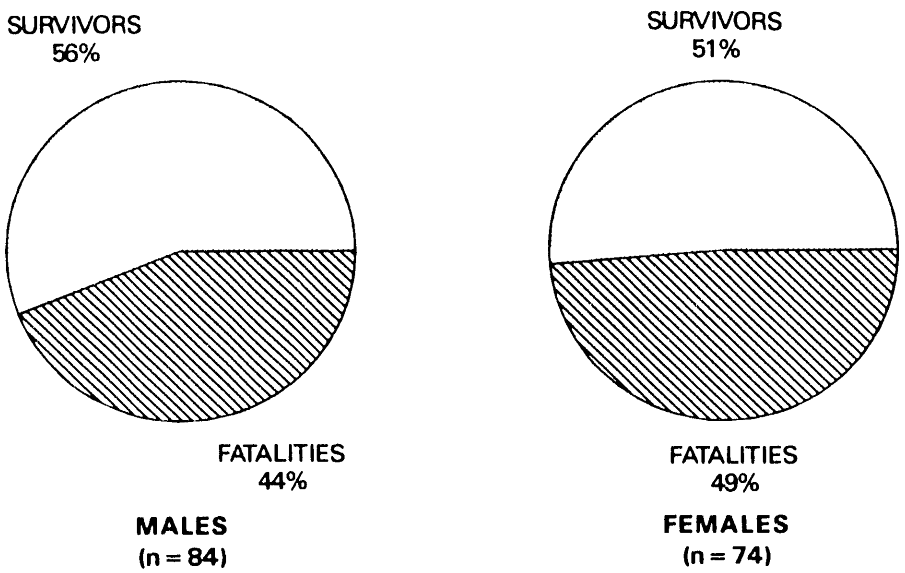


FIGURE 8
CASE-FATALITY RATIOS BY AGE
AVIANCA CRASH 1/25/90

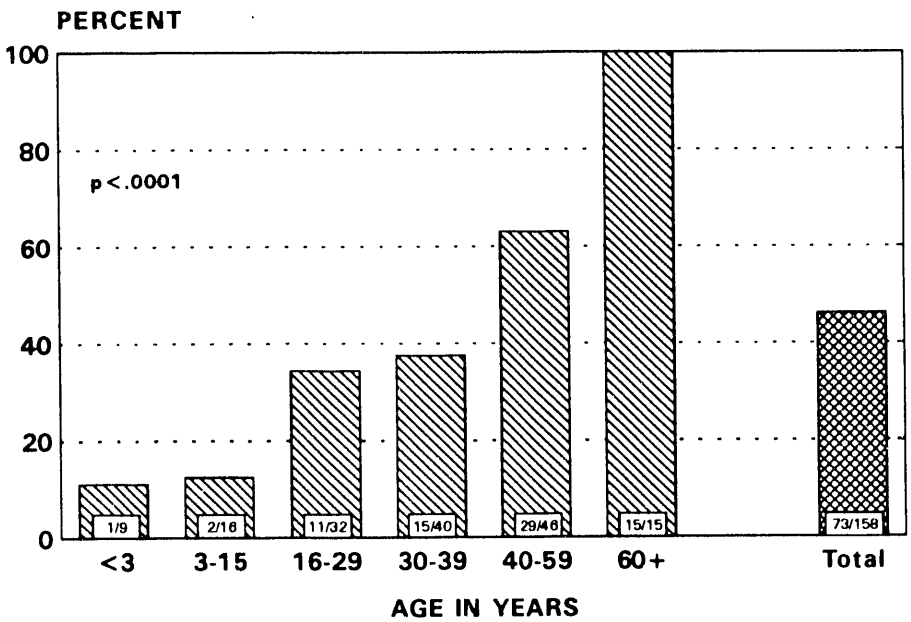


FIGURE 9

PERCENT CASES WITH ONE OR MORE INTERNAL INJURIES BY SURVIVAL STATUS

AVIANCA CRASH 1/25/90

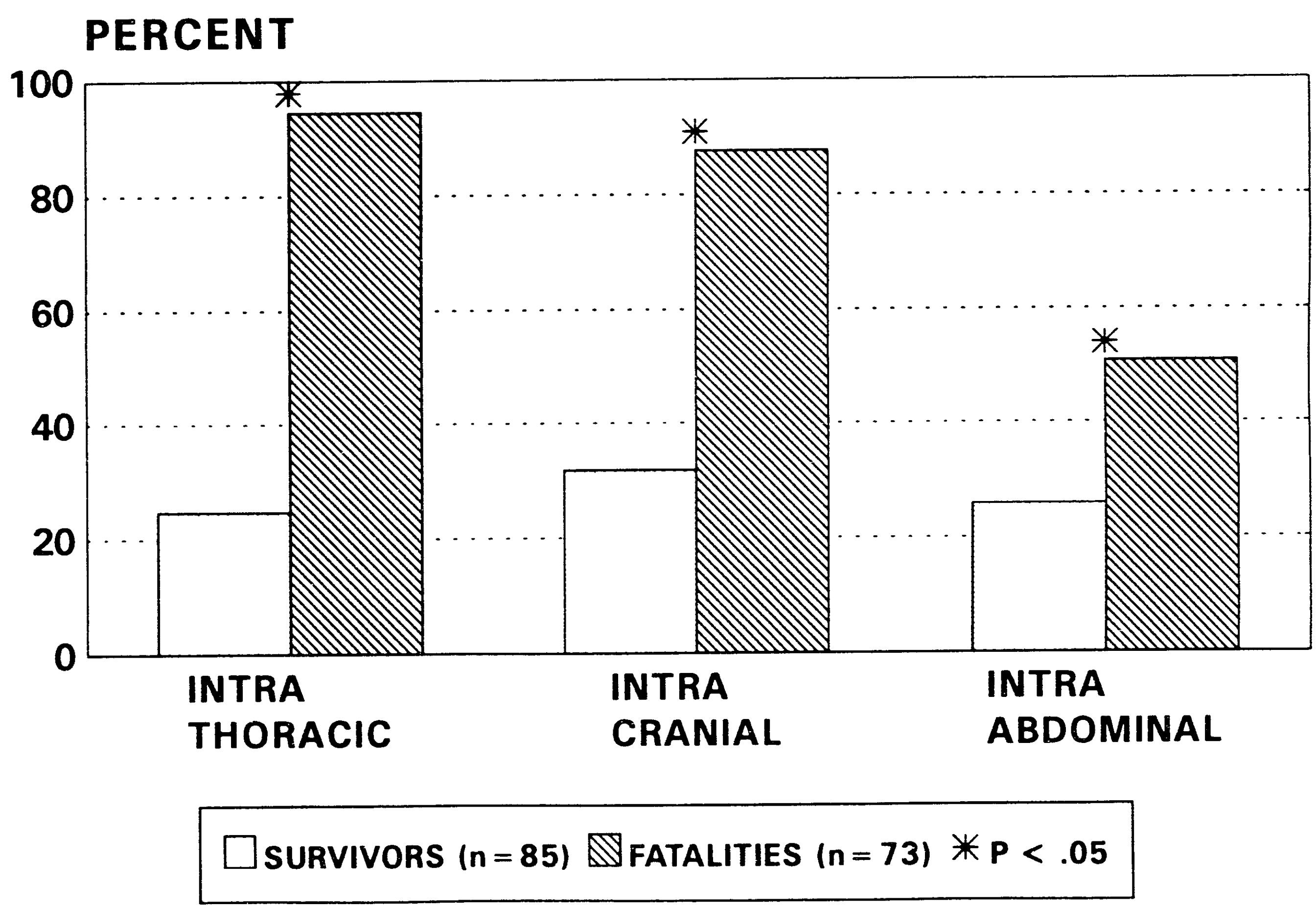


FIGURE 10
PERCENT CASES WITH INTRACRANIAL INJURIES BY TYPE AND SURVIVAL STATUS
AVIANCA CRASH 1/25/90

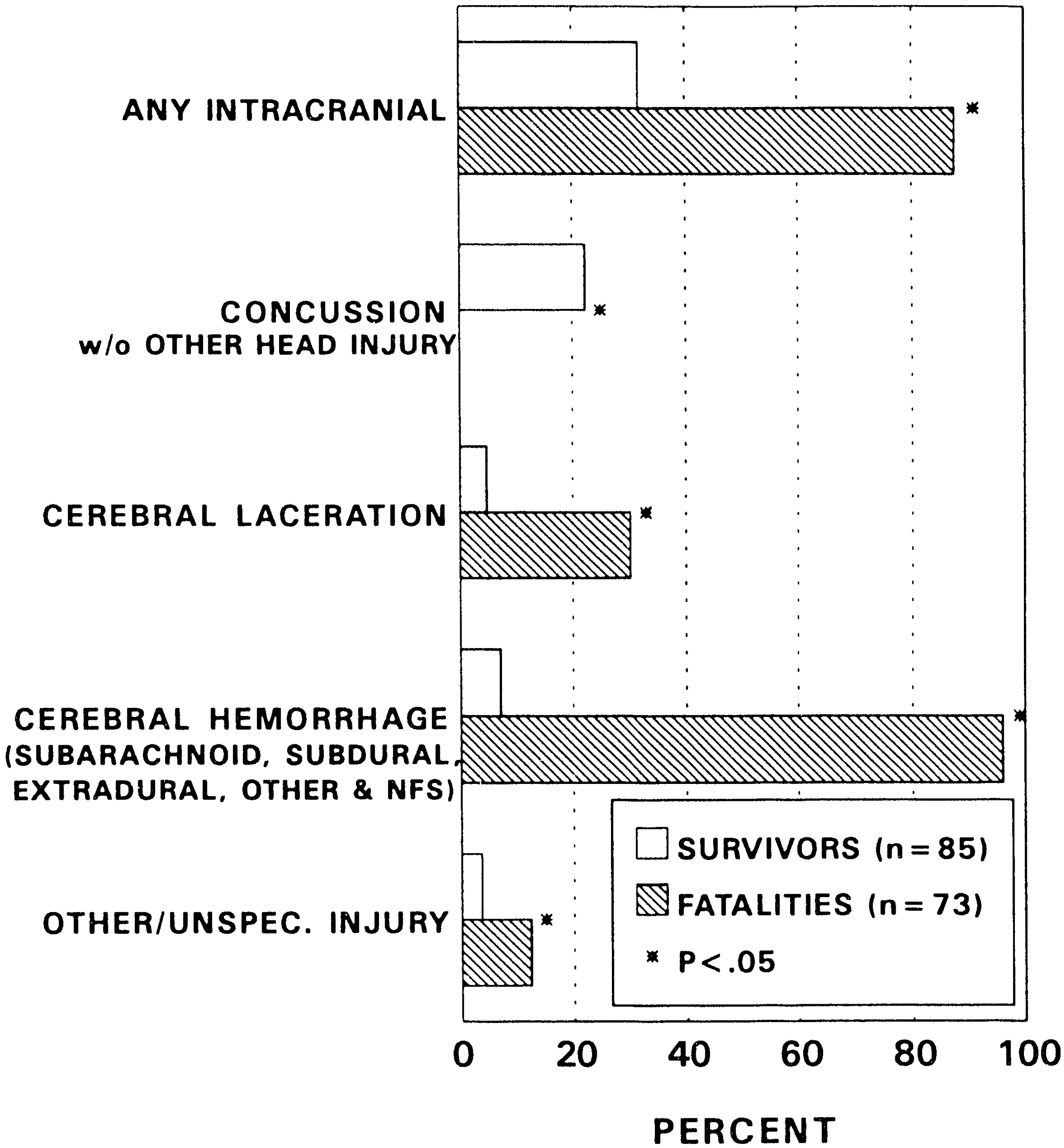


FIGURE 11
PERCENT CASES WITH FRACTURES BY LOCATION AND SURVIVAL STATUS
AVIANCA CRASH 1/25/90

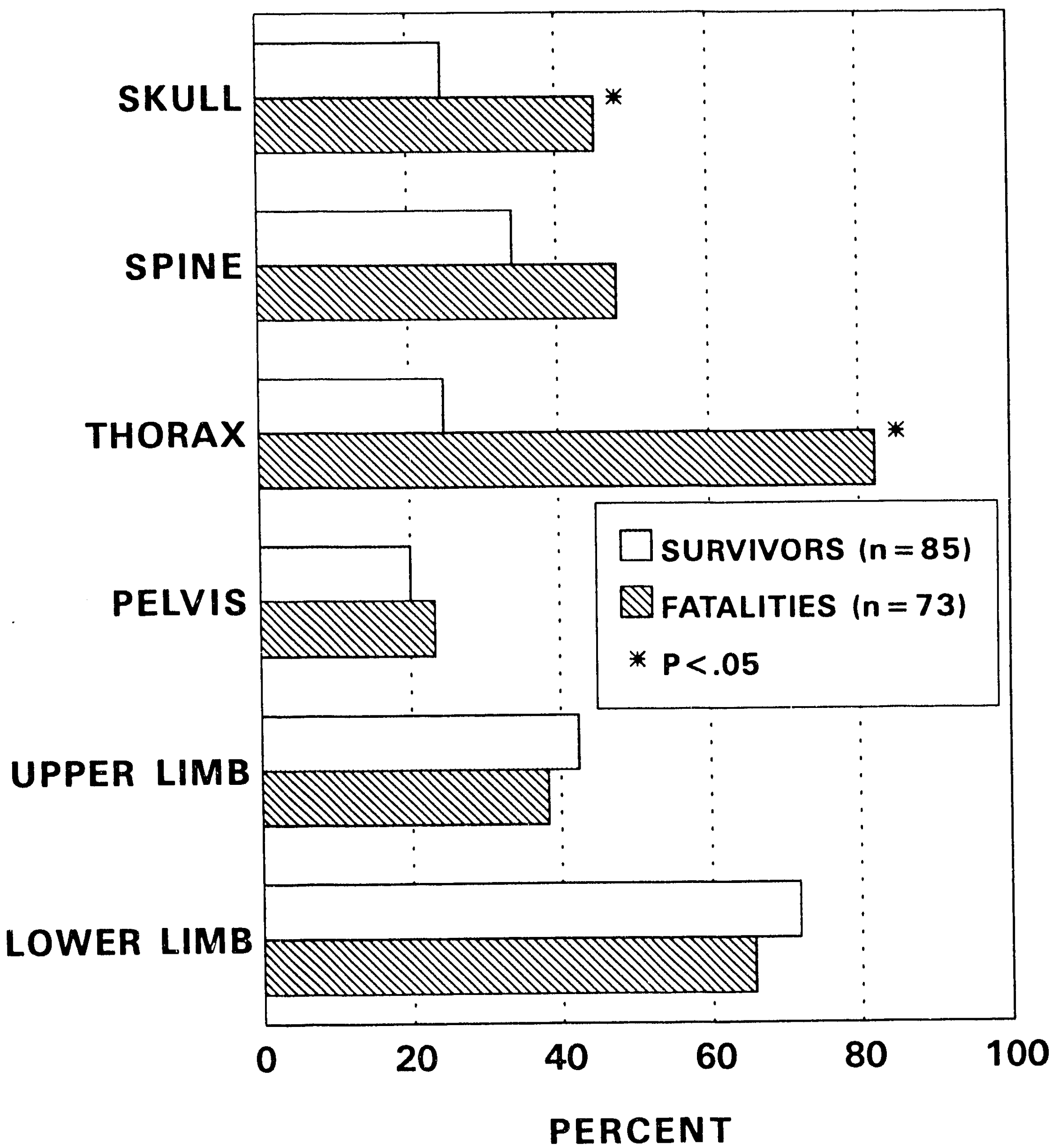


FIGURE 12
PERCENT CASES WITH THORACIC INJURIES TO SPECIFIED ORGANS BY SURVIVAL STATUS
AVIANCA CRASH 1/25/90

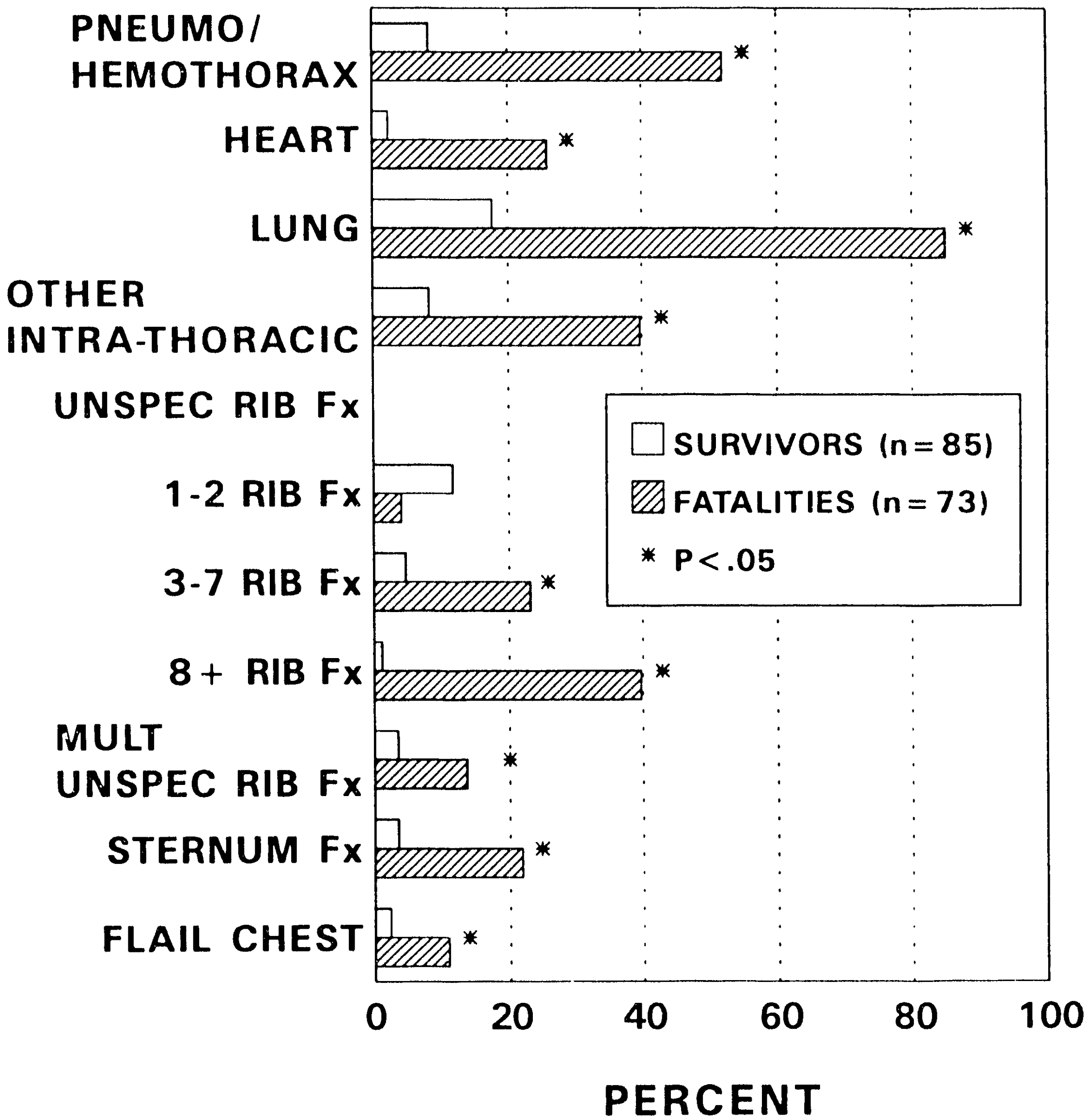


FIGURE 13

PERCENT CASES WITH ONE OR MORE SPINAL Fx BY LOCATION AND SURVIVAL STATUS

AVIANCA CRASH 1/25/90

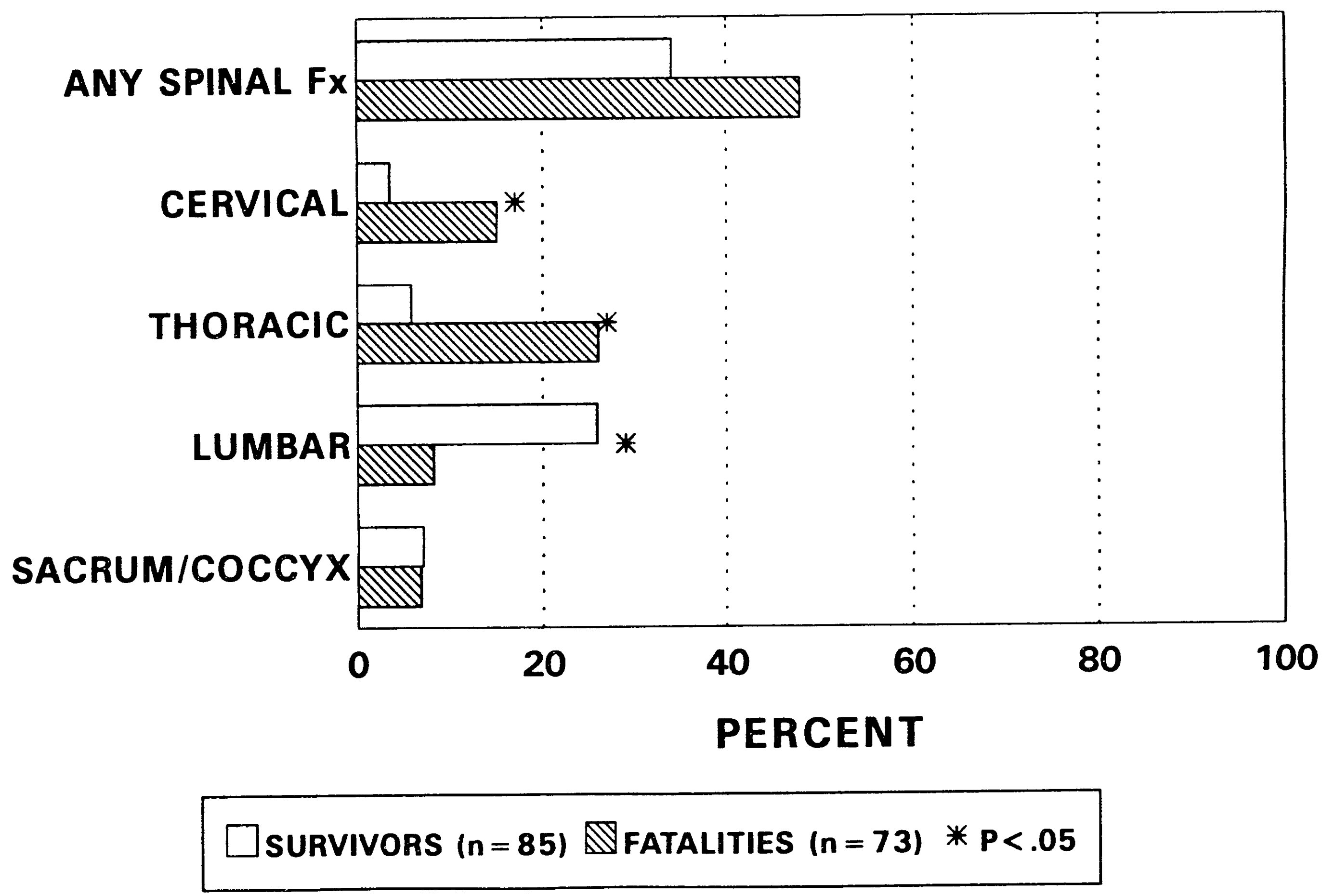


FIGURE 14
DISTRIBUTION OF MAXIMUM AIS SCORE BY SURVIVAL STATUS
AVIANCA CRASH 1/25/90

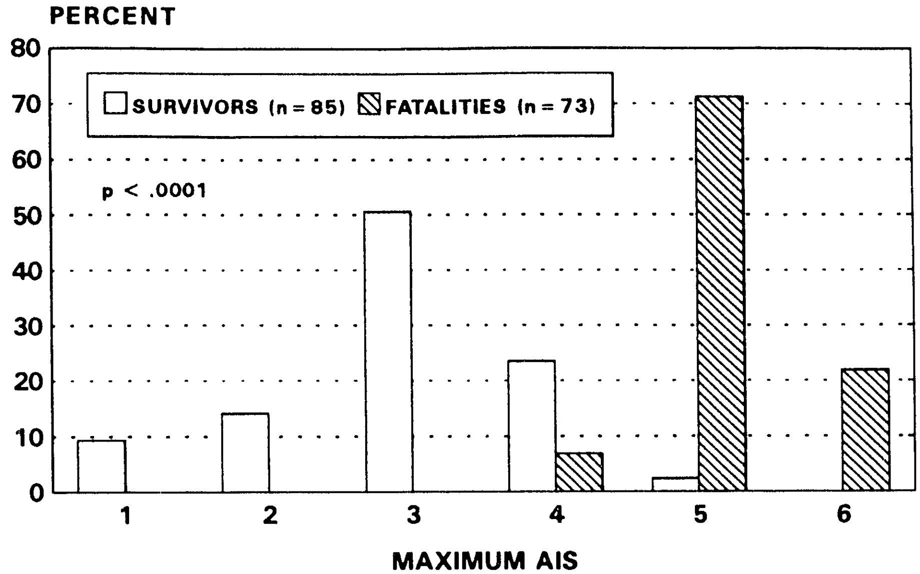


FIGURE 15
CUMULATIVE DISTRIBUTION OF INJURY SEVERITY SCORE BY SURVIVAL STATUS
AVIANCA CRASH 1/25/90

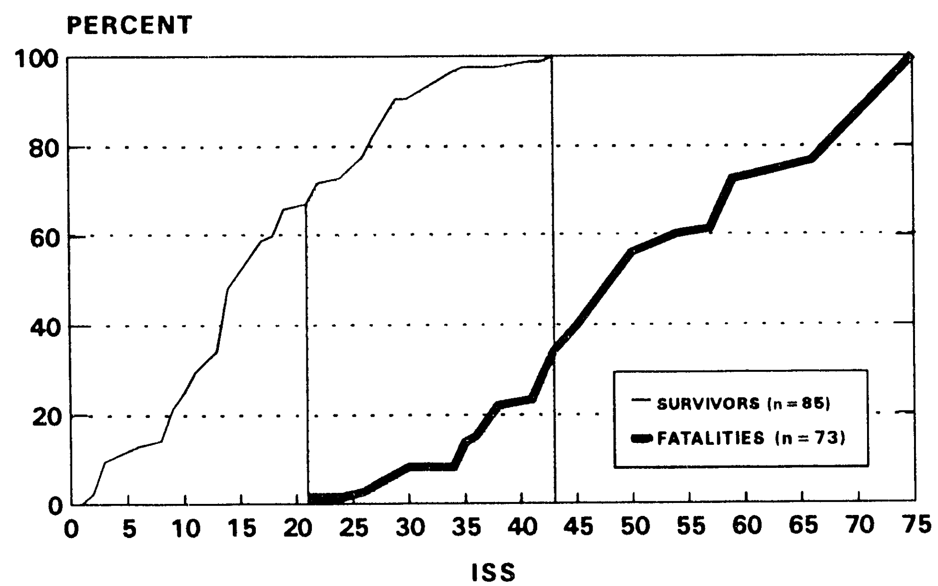
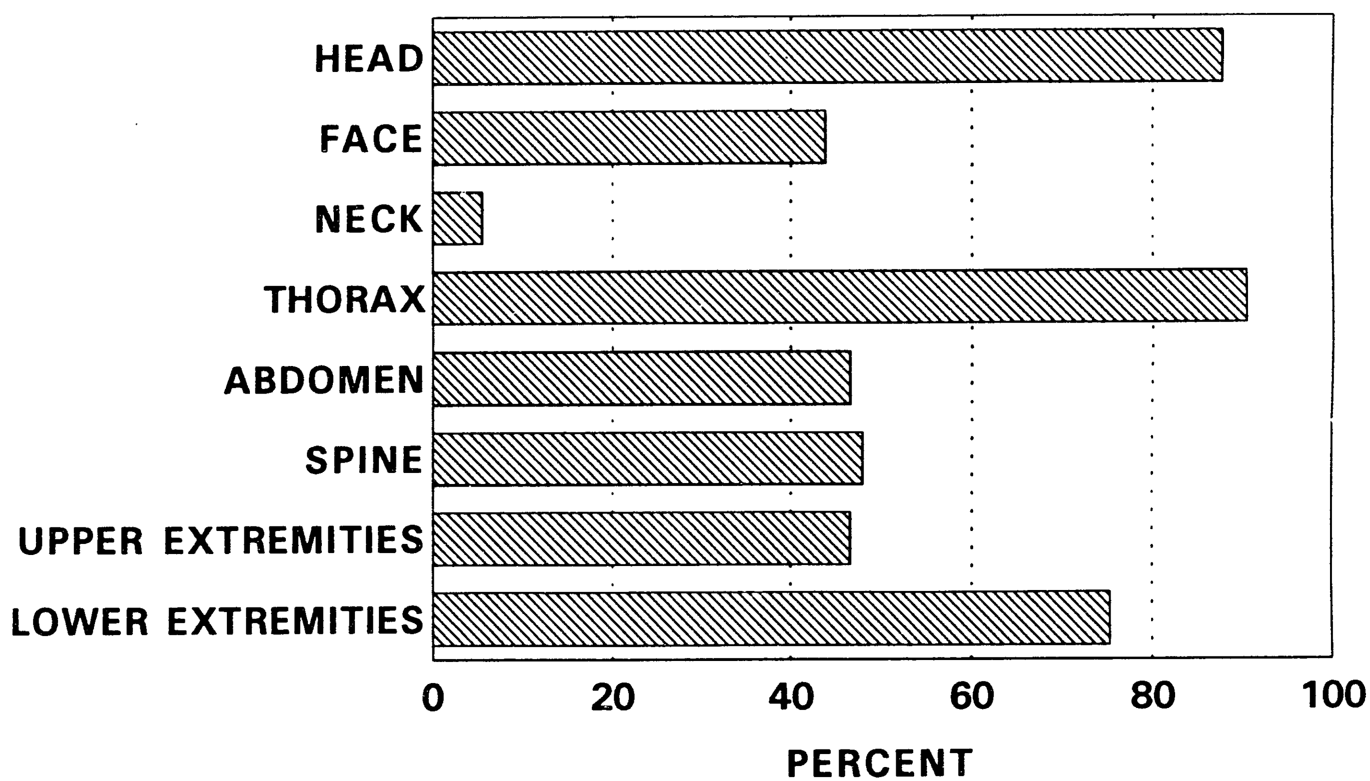


FIGURE 16

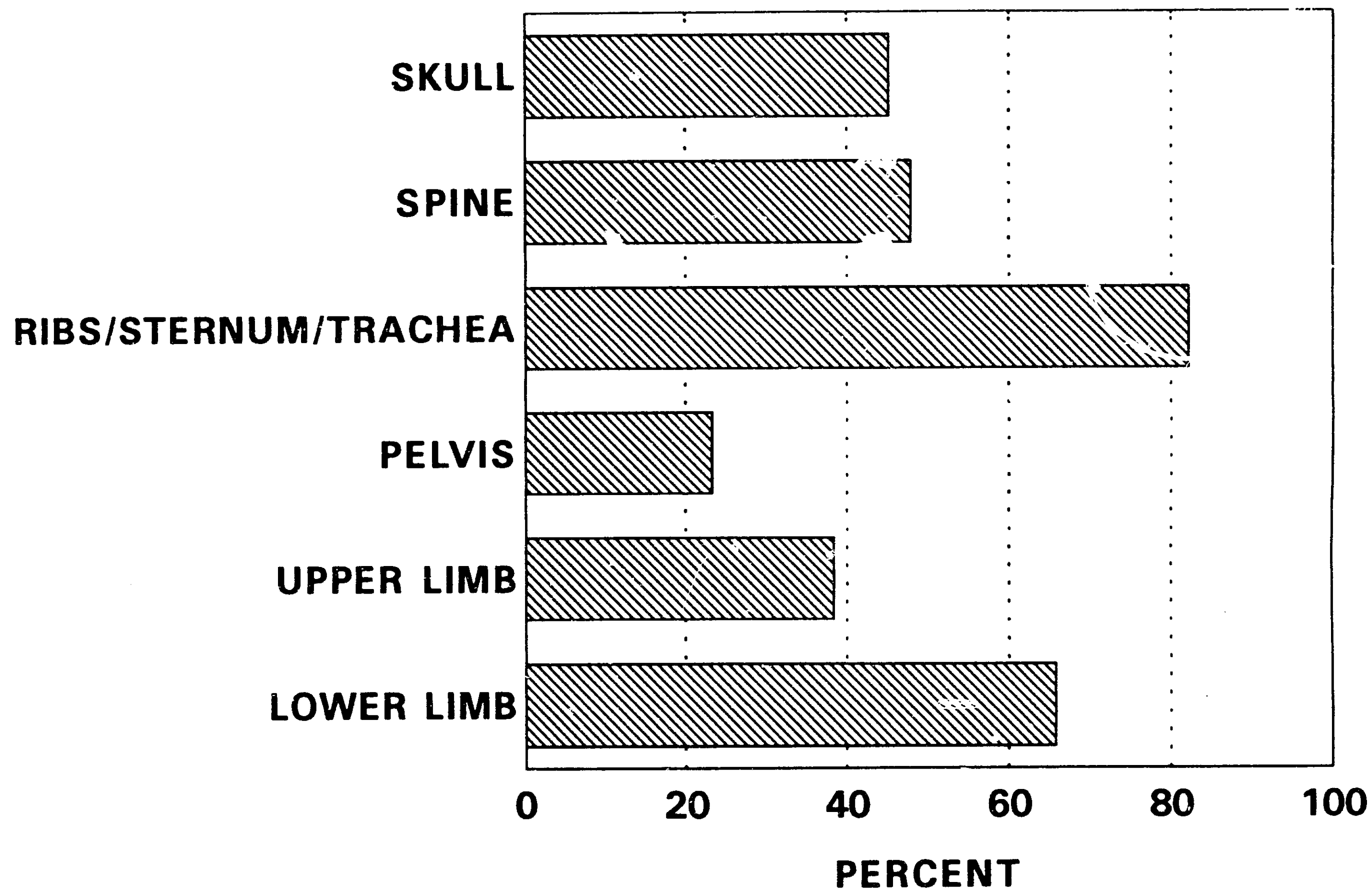
PERCENT FATALITIES WITH ONE OR MORE NONEXTERNAL INJURIES TO A SPECIFIED BODY REGION

AVIANCA CRASH 1/25/90



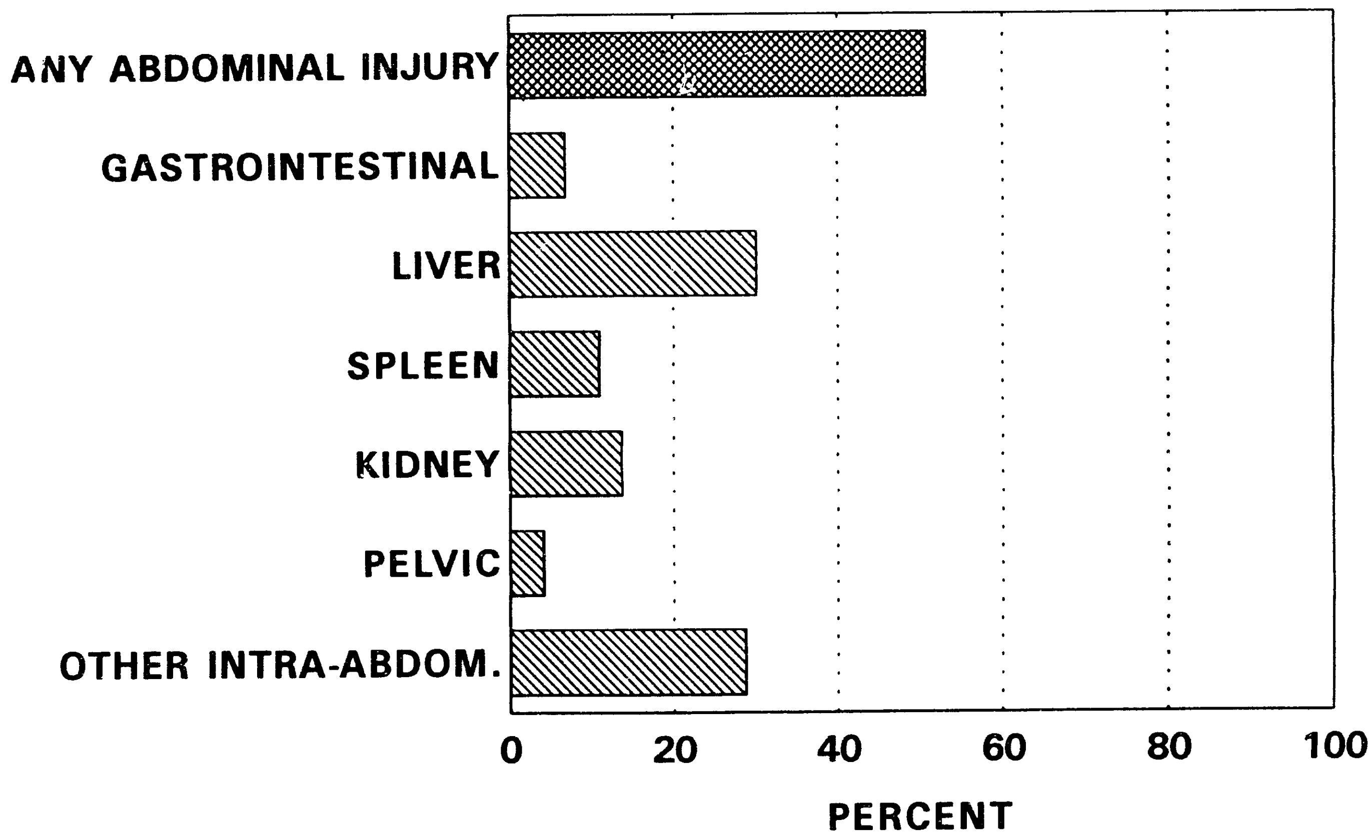
(n = 73)

FIGURE 17
PERCENT FATALITIES WITH FRACTURES BY LOCATION
AVIANCA CRASH 1/25/90



(n = 73)

FIGURE 18
PERCENT FATALITIES WITH ABDOMINAL INJURIES TO SPECIFIED ORGAN
AVIANCA CRASH 1/25/90



(n = 73)

FIGURE 19

PERCENT FATALITIES WITH MAXIMUM AIS 5+ BY BODY REGION

AVIANCA CRASH 1/25/90

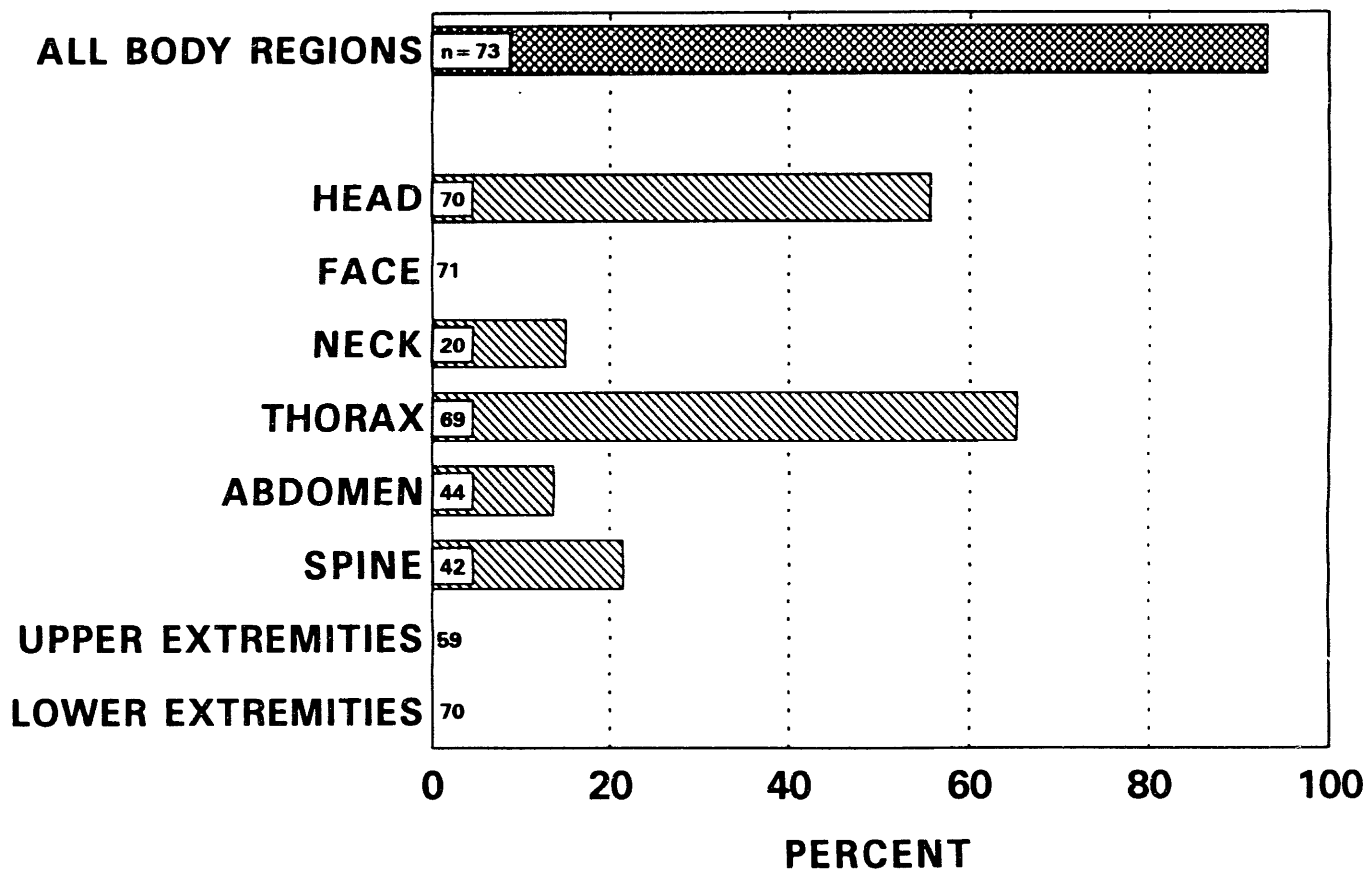
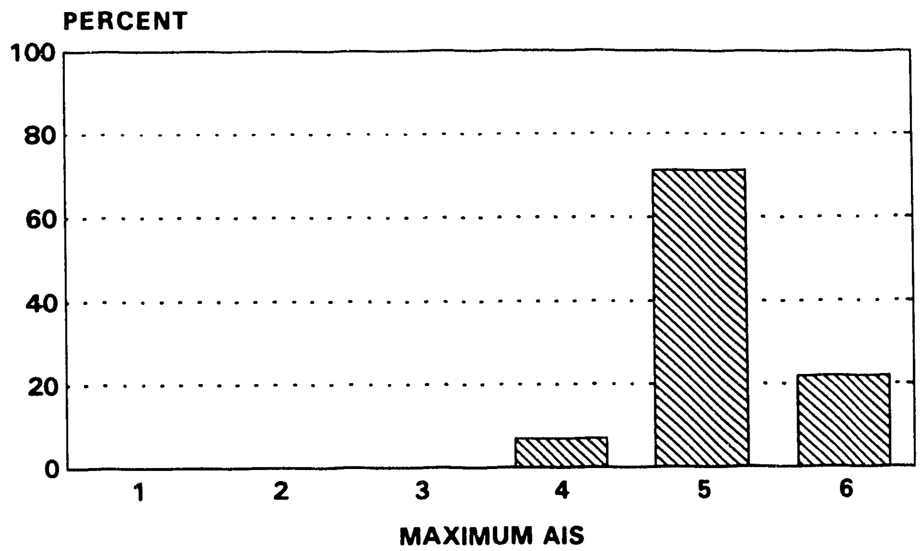
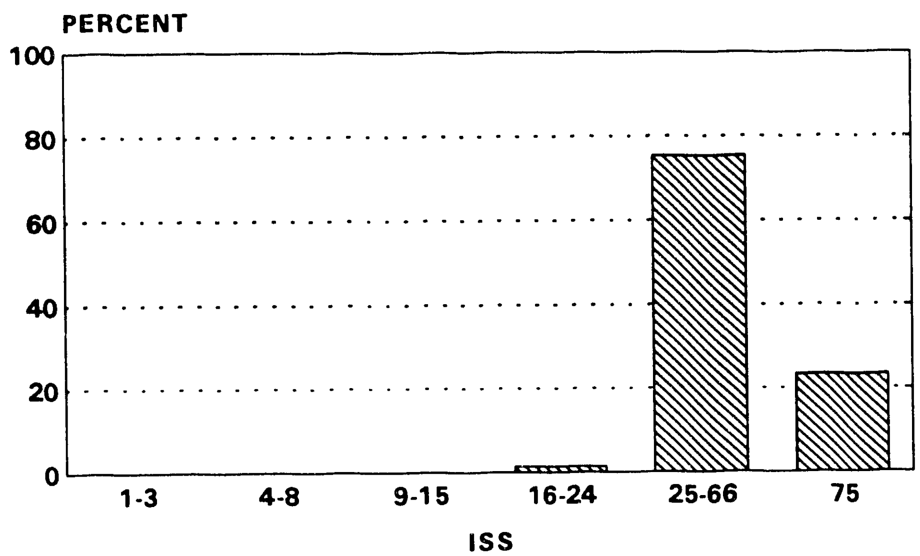


FIGURE 20
DISTRIBUTION OF MAXIMUM AIS SCORE AMONG FATALITIES
AVIANCA CRASH 1/25/90



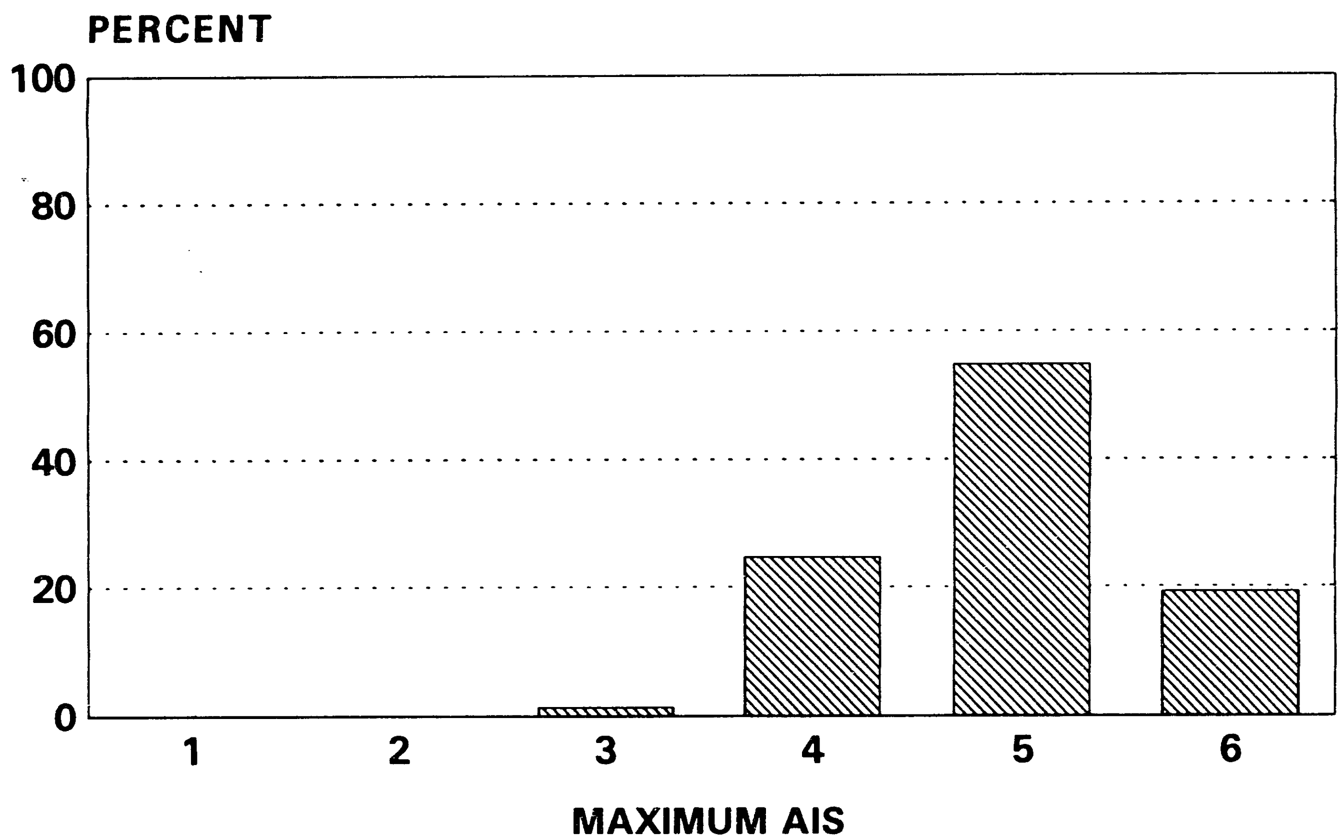
(n = 73)

FIGURE 21
DISTRIBUTION OF INJURY SEVERITY SCORE AMONG FATALITIES
AVIANCA CRASH 1/25/90



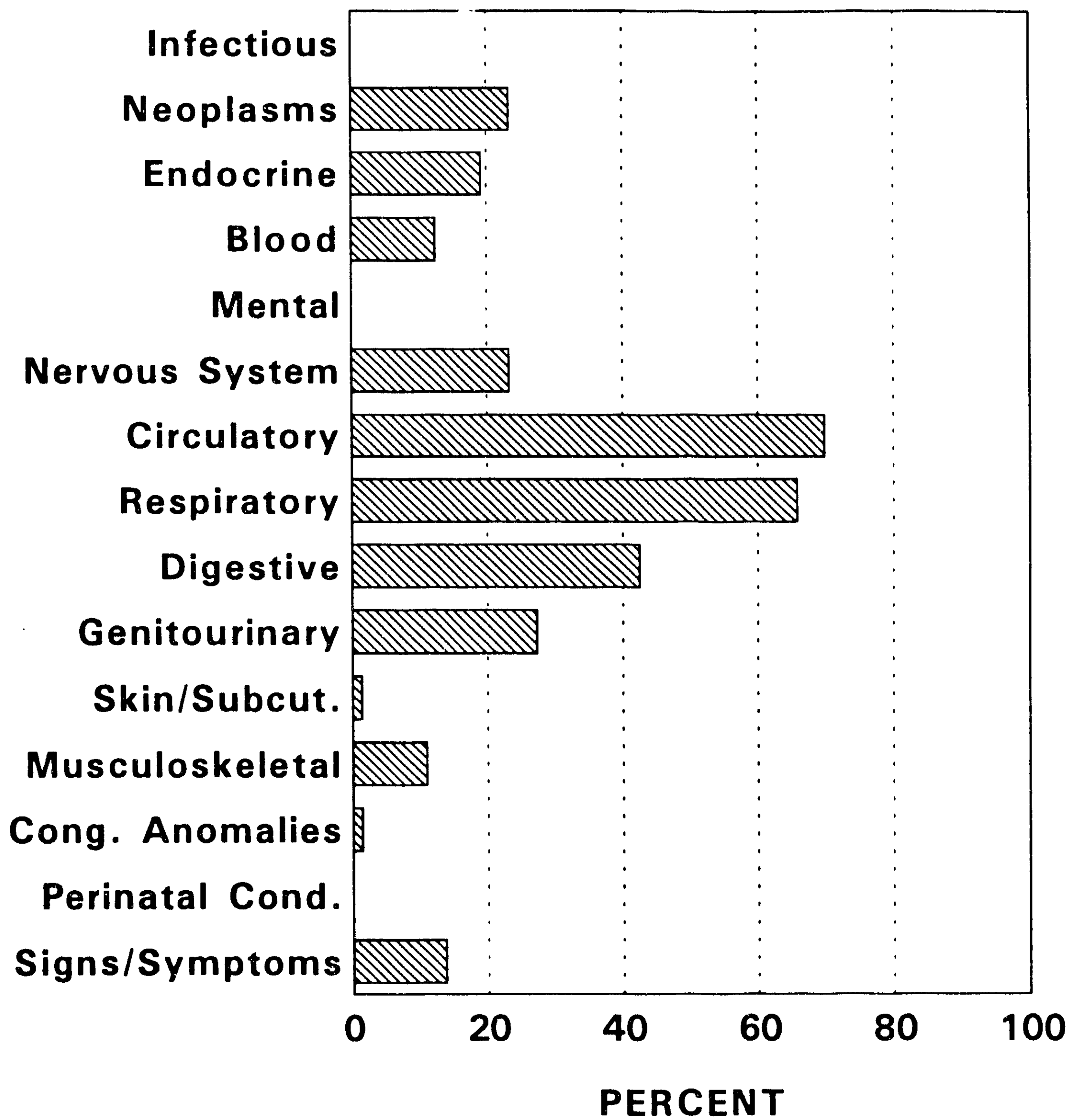
(n = 73)

FIGURE 22
DISTRIBUTION OF NON-UPGRADED MAXIMUM AIS SCORES AMONG FATALITIES
AVIANCA CRASH 1/25/90



(n = 73)

FIGURE 23
PERCENT FATALITIES WITH ONE OR MORE DIAGNOSES BY MAJOR ICD-N GROUPS
AVIANCA CRASH 1/25/90



(n = 73)

FIGURE 24
CUMULATIVE DISTRIBUTION OF HOSPITAL ARRIVAL TIMES FOR SURVIVORS
AVIANCA CRASH 1/25/90

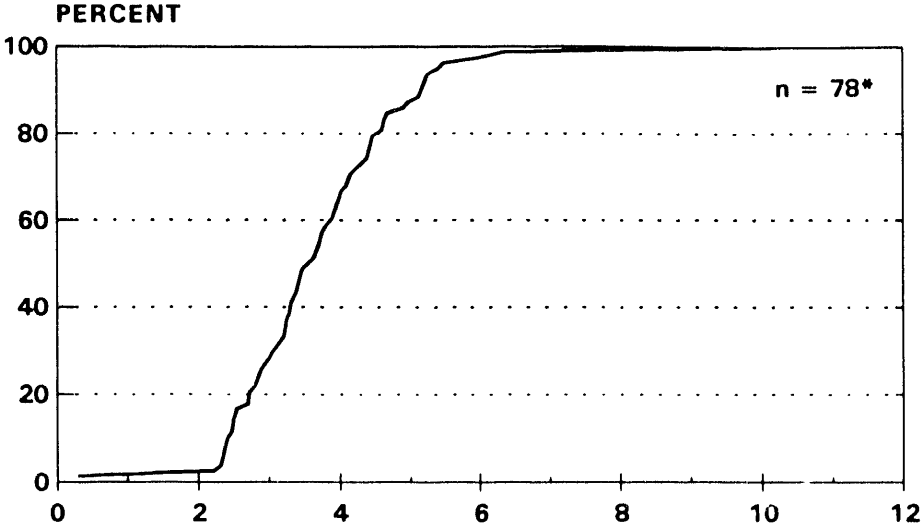
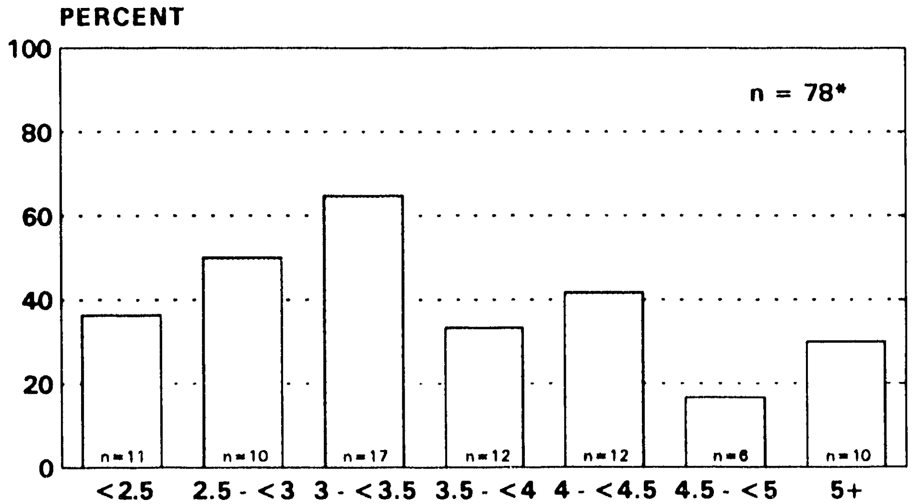


FIGURE 25
PERCENT SURVIVORS WITH INTERNAL INJURIES BY TIME OF HOSPITAL ARRIVAL
AVIANCA CRASH 1/25/90

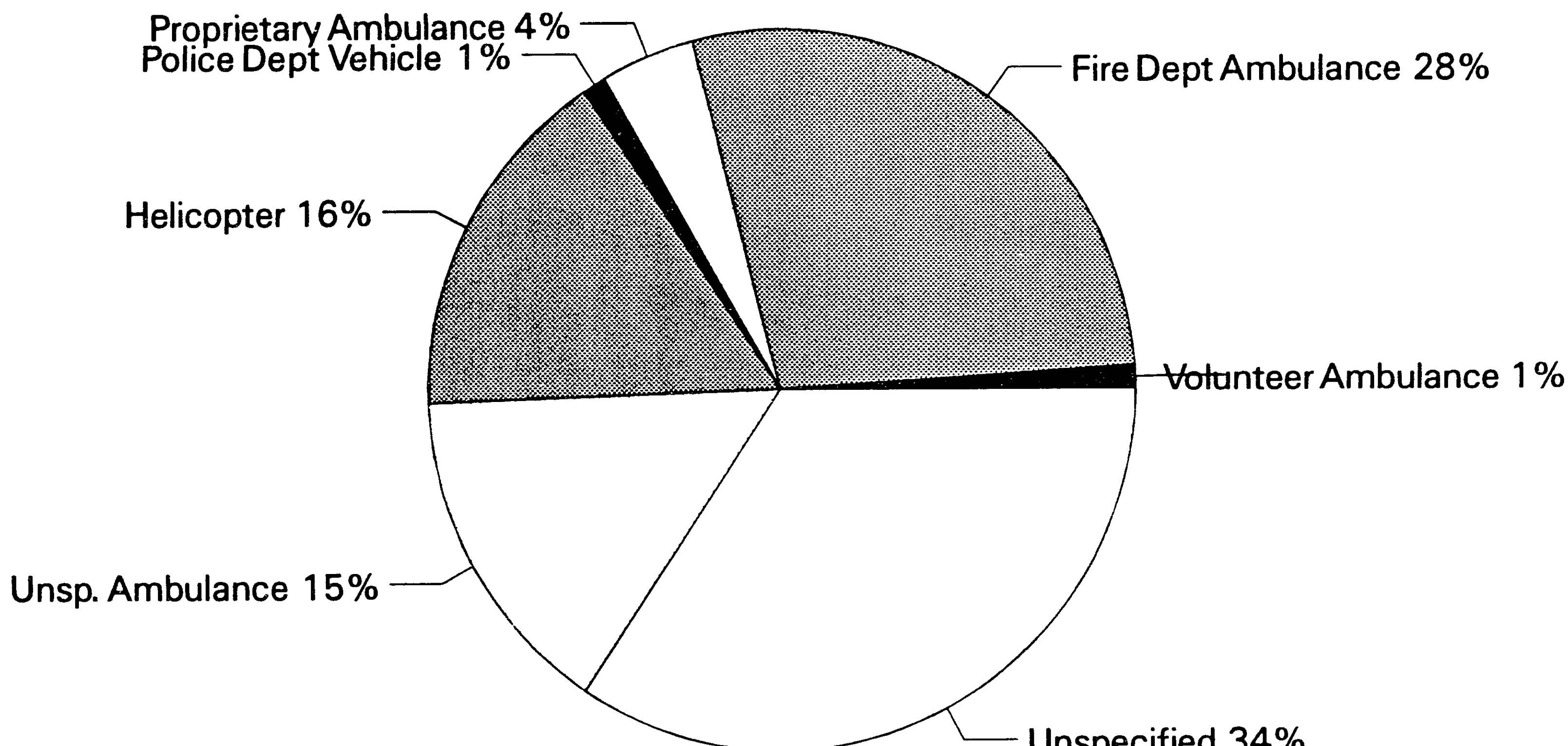


* EXCLUDES: 7 SURVIVORS WITH MISSING HOSPITAL ARRIVAL TIME.

FIGURE 26

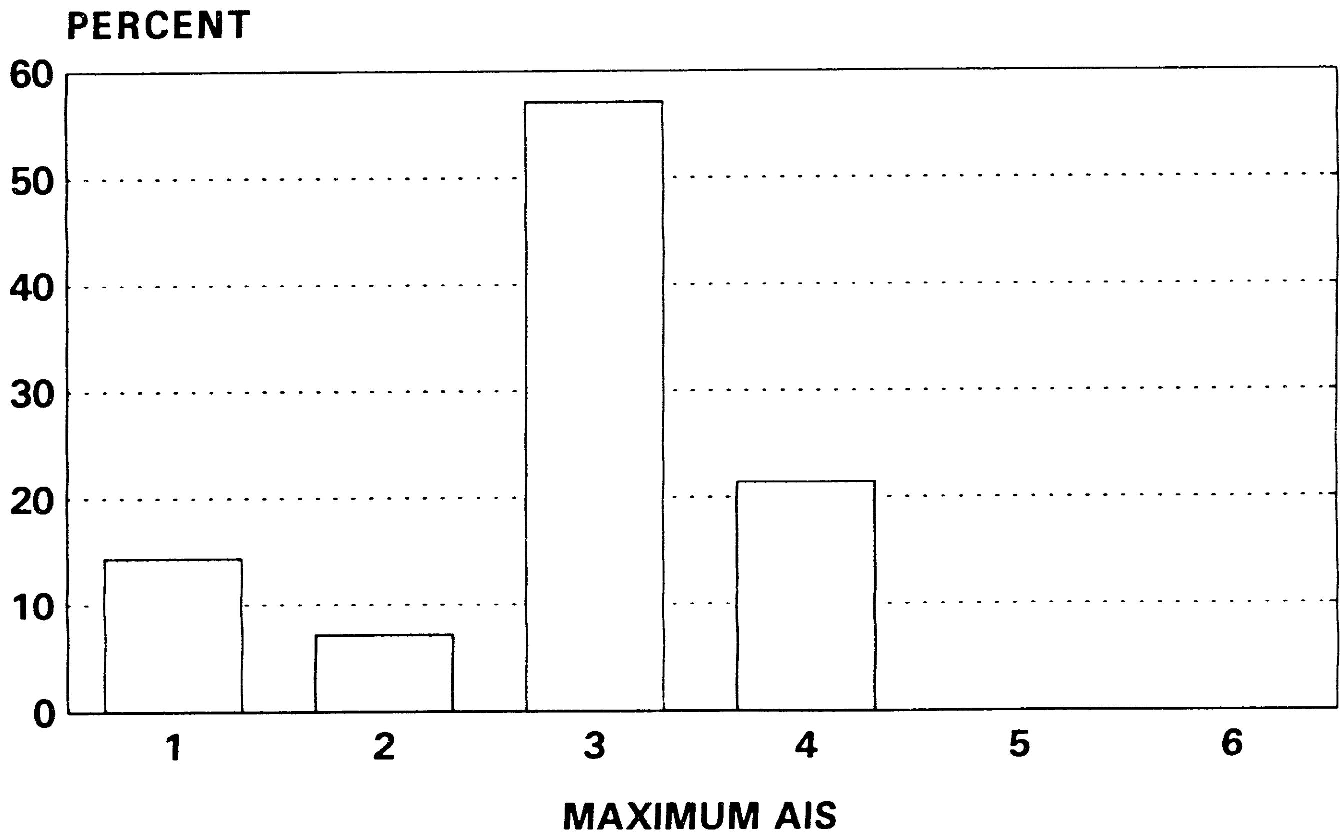
MODE OF TRANSPORTATION TO HOSPITAL BASED ON EMS DATA

AVIANCA CRASH 1/25/90



(n = 93)

FIGURE 27
DISTRIBUTION OF MAXIMUM AIS SCORE AMONG AIR-LIFTED SURVIVORS
AVIANCA CRASH 1/25/90

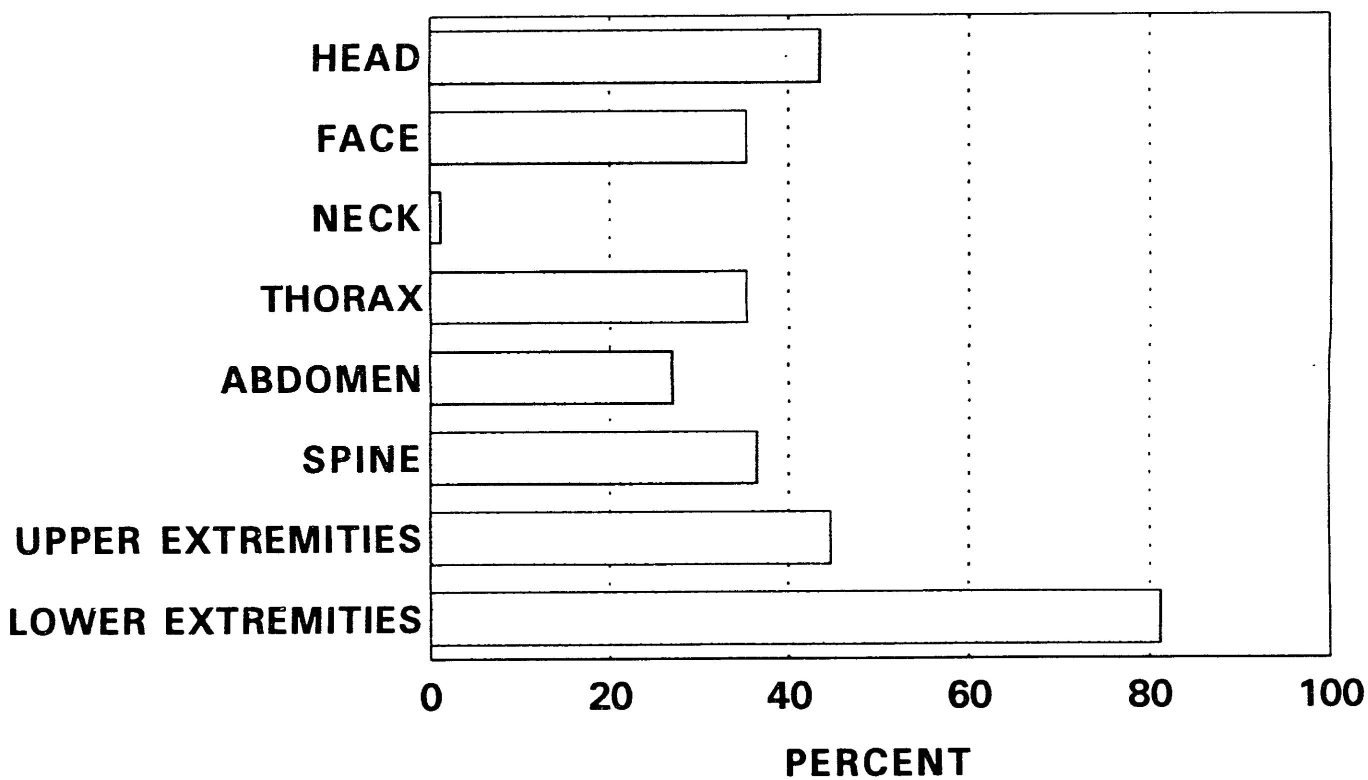


(n = 14)

FIGURE 28

PERCENT SURVIVORS WITH ONE OR MORE NON-EXTERNAL INJURIES TO A SPECIFIED BODY REGION

AVIANCA CRASH 1/25/90



(n = 85)

FIGURE 29
PERCENT SURVIVORS WITH ONE OR MORE INJURIES TO SPECIFIED BODY REGION BY GENDER
AVIANCA CRASH 1/25/90

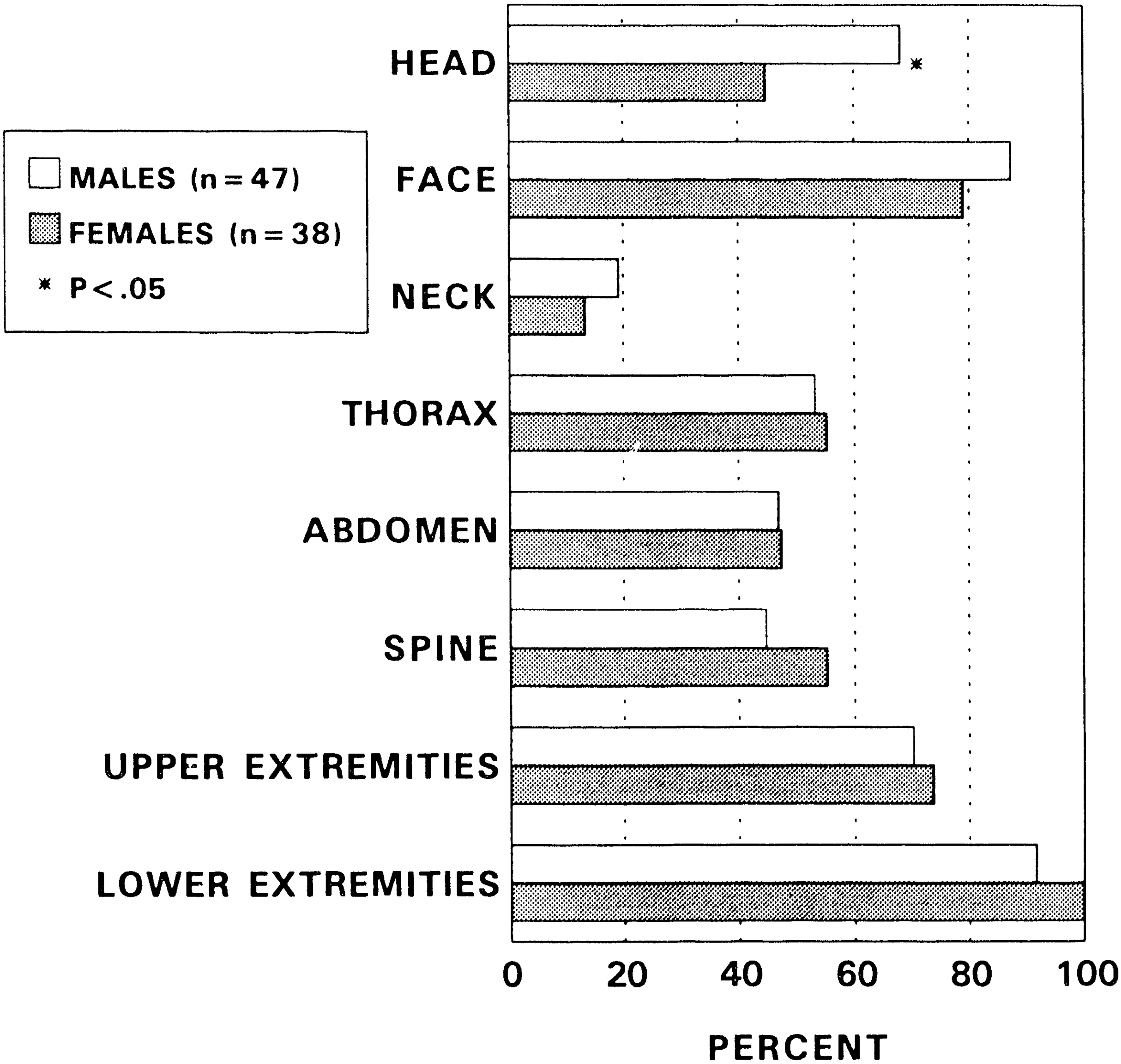
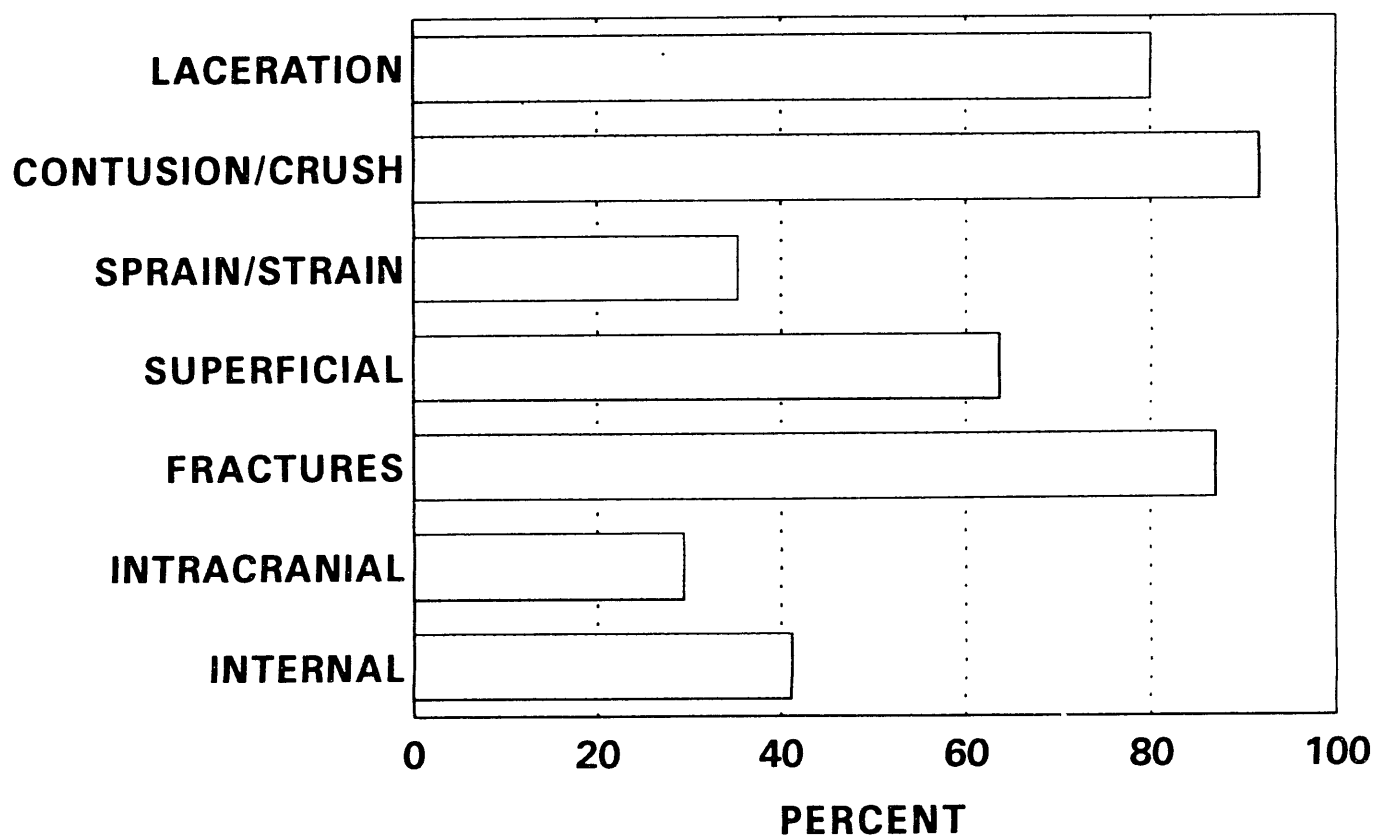
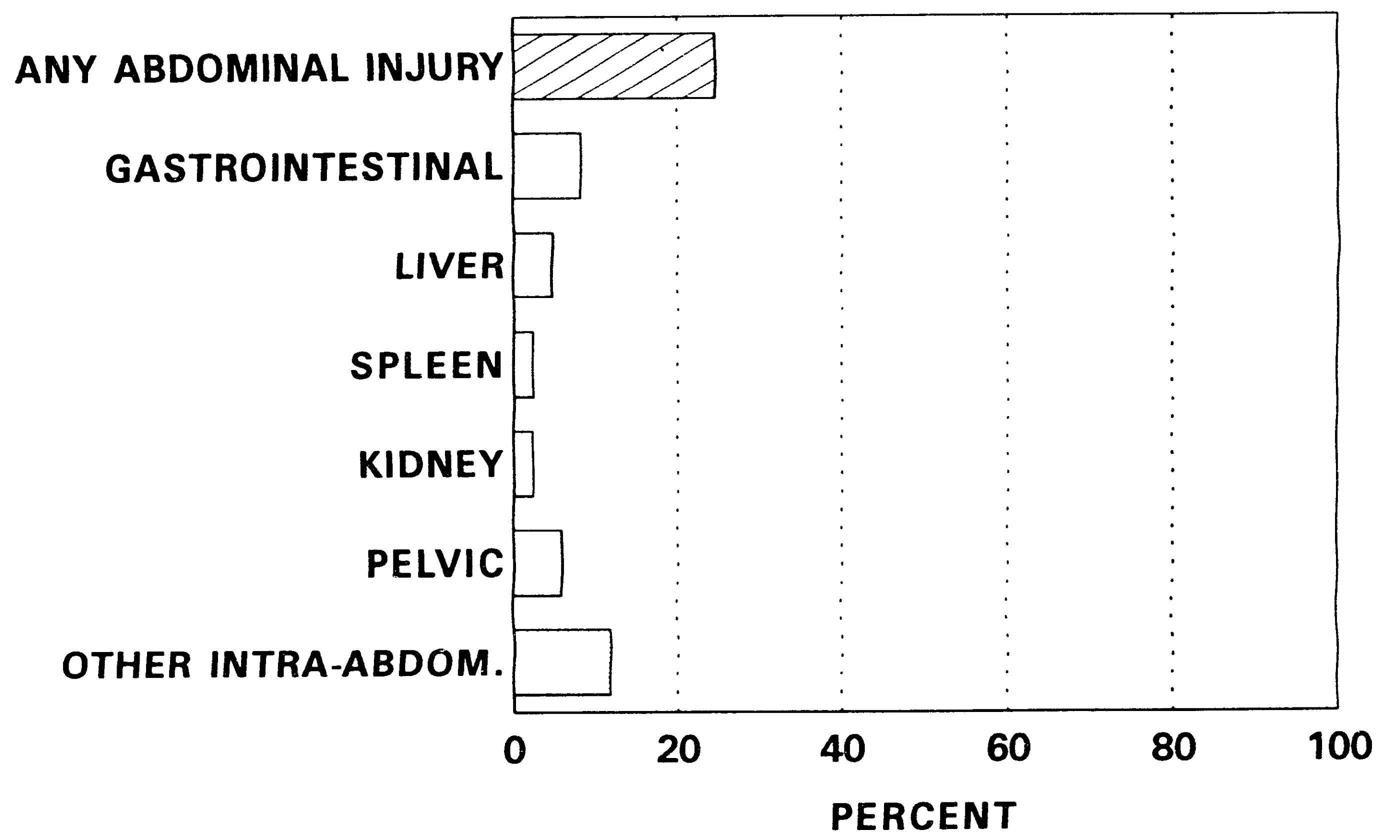


FIGURE 30
PERCENT SURVIVORS WITH ONE OR MORE INJURIES BY SPECIFIED TYPE
AVIANCA CRASH 1/25/90



(n = 85)

FIGURE 31
PERCENT SURVIVORS WITH ABDOMINAL INJURIES TO SPECIFIED ORGAN
AVIANCA CRASH 1/25/90

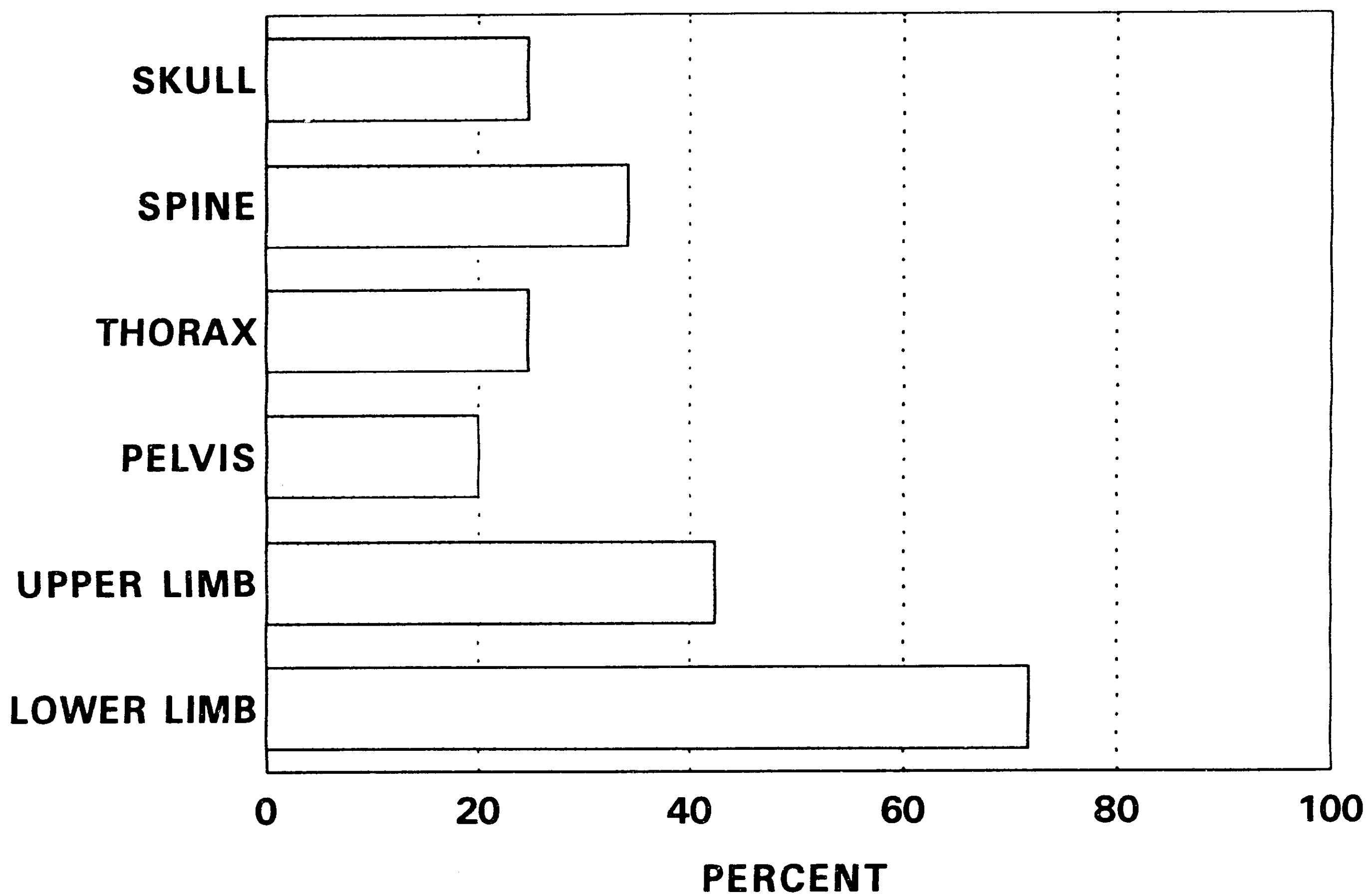


(n = 85)

FIGURE 32

PERCENT SURVIVORS WITH FRACTURES BY LOCATION

AVIANCA CRASH 1/25/90

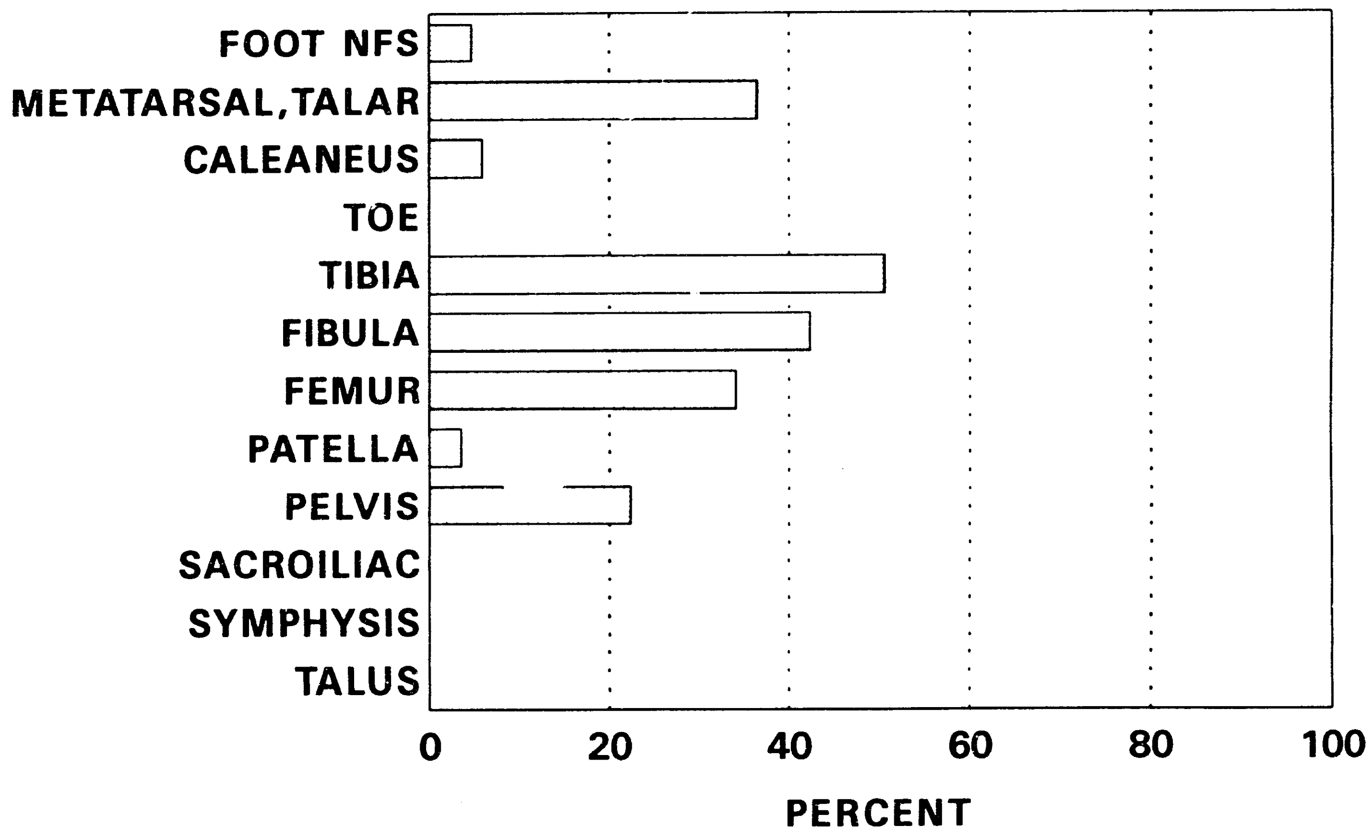


(n = 85)

FIGURE 33

PERCENT SURVIVORS WITH ONE OR MORE LOWER EXTREMITY FRACTURES BY LOCATION

AVIANCA CRASH 1/25/90

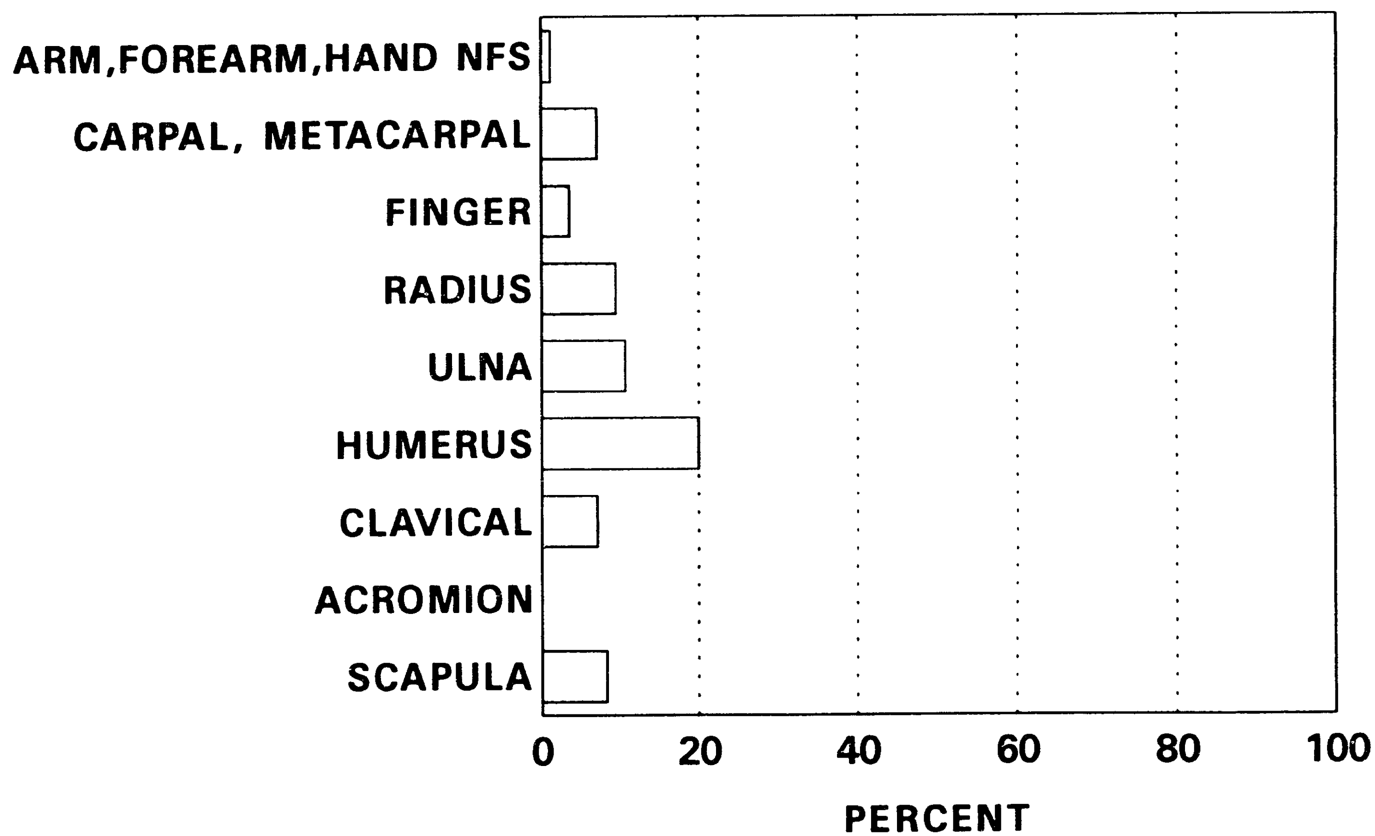


(n = 85)

FIGURE 34

PERCENT SURVIVORS WITH ONE OR MORE UPPER EXTREMITY FRACTURES BY LOCATION

AVIANCA CRASH 1/25/90

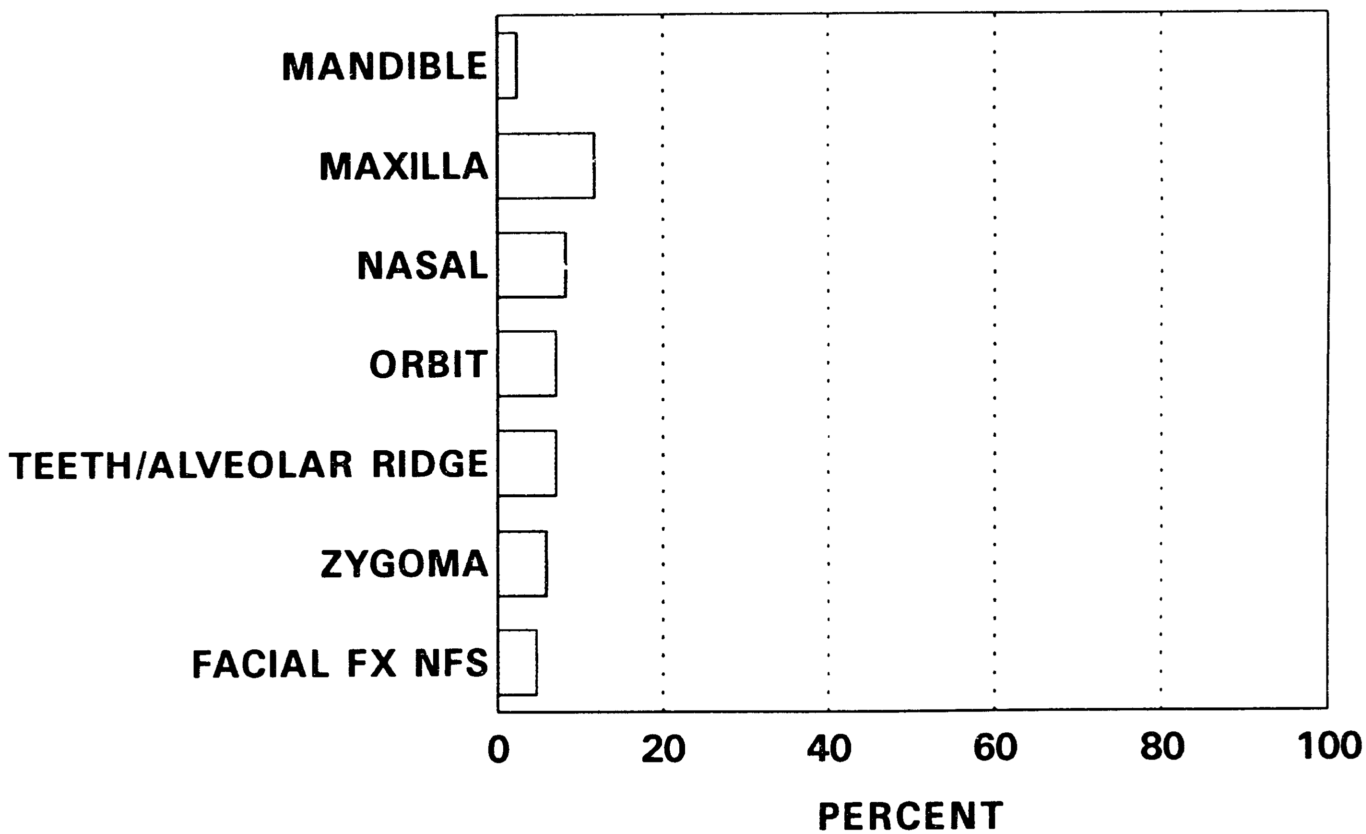


(n = 85)

FIGURE 35

PERCENT SURVIVORS WITH ONE OR MORE FACIAL FRACTURES BY LOCATION

AVIANCA CRASH 1/25/90



(n = 85)

FIGURE 36
PERCENT SURVIVORS WITH ONE OR MORE SPECIFIED INJURIES BY TYPE AND GENDER
AVIANCA CRASH 1/25/90

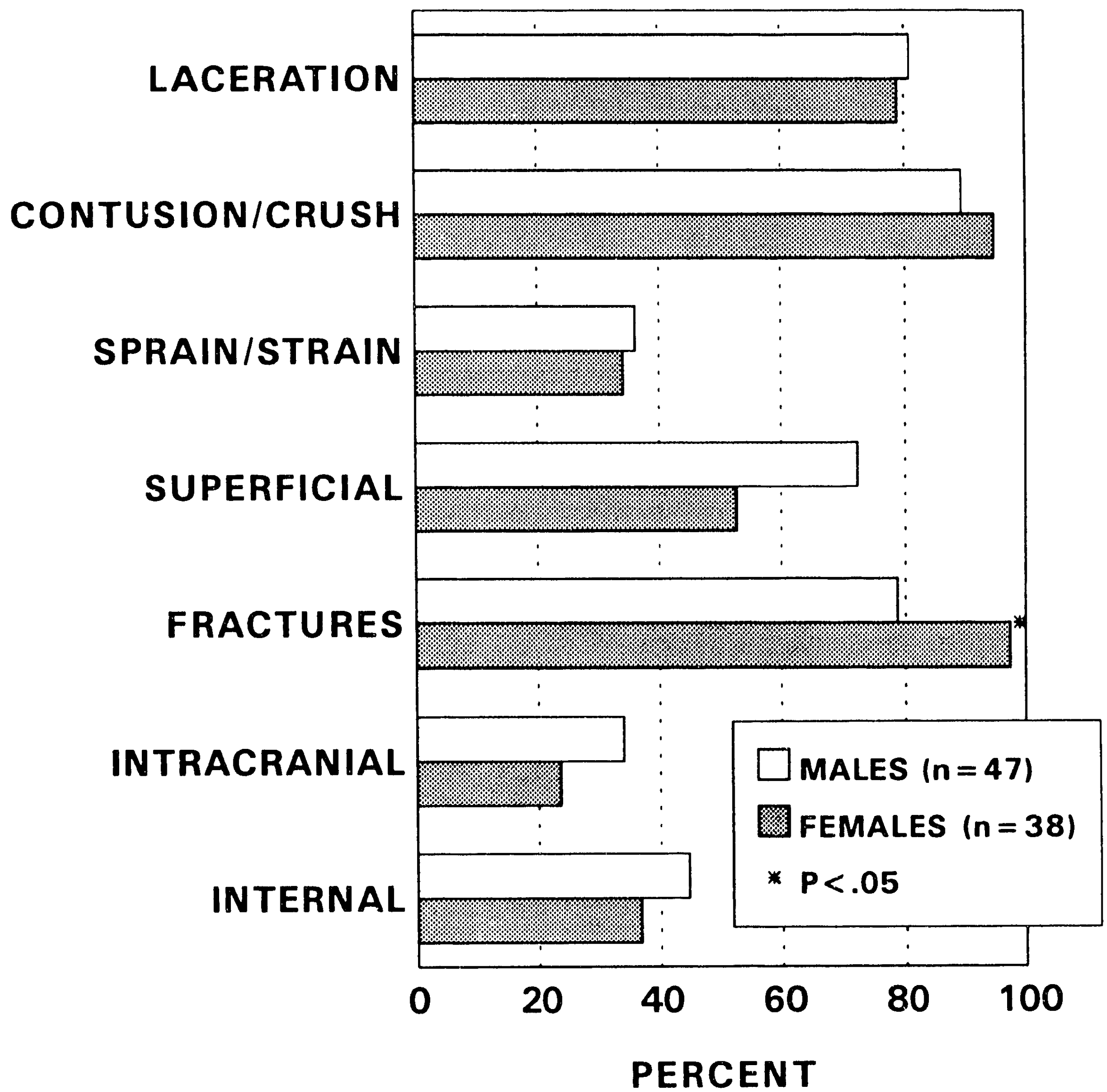


FIGURE 37
PERCENT SURVIVORS WITH FRACTURES BY LOCATION AND GENDER
AVIANCA CRASH 1/25/90

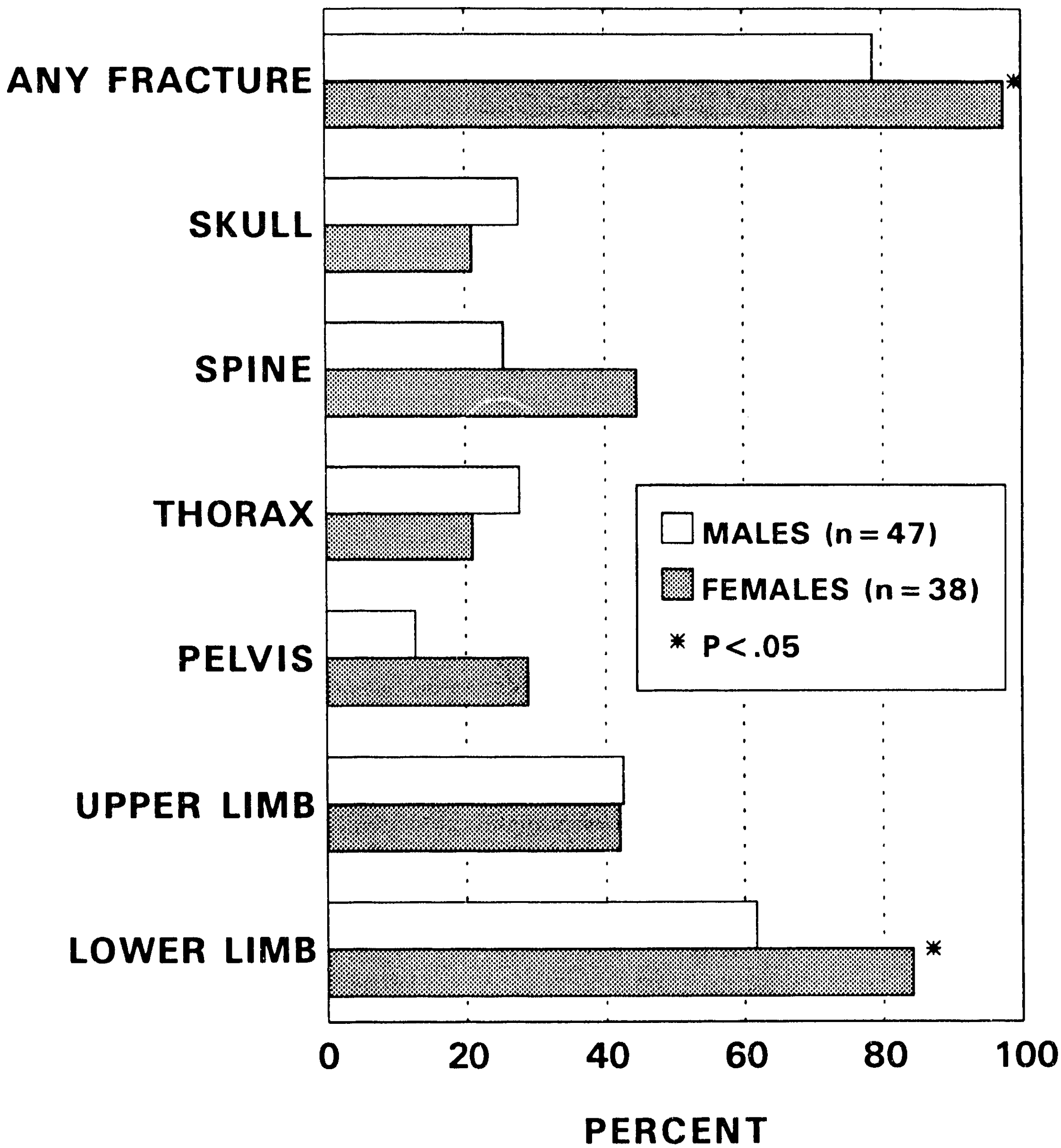
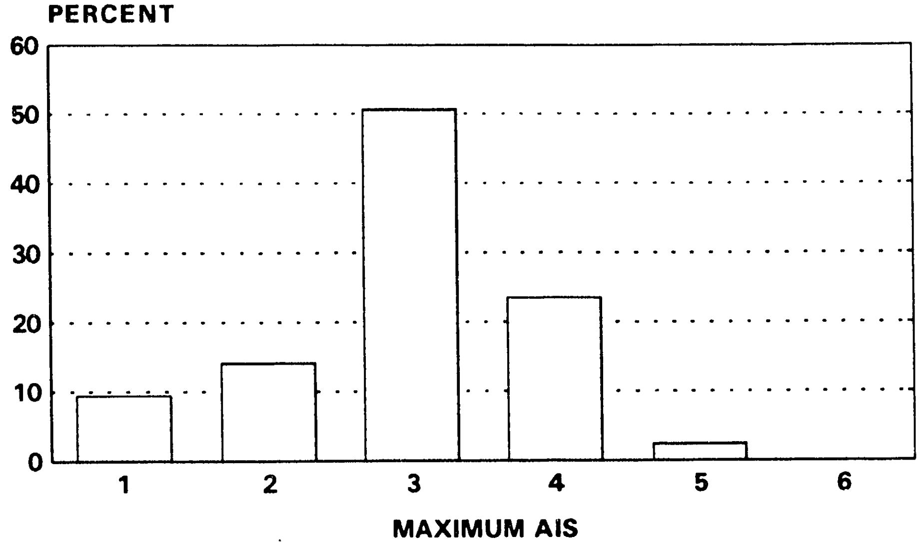


FIGURE 38

DISTRIBUTION OF MAXIMUM AIS SCORE AMONG SURVIVORS

AVIANCA CRASH 1/25/90

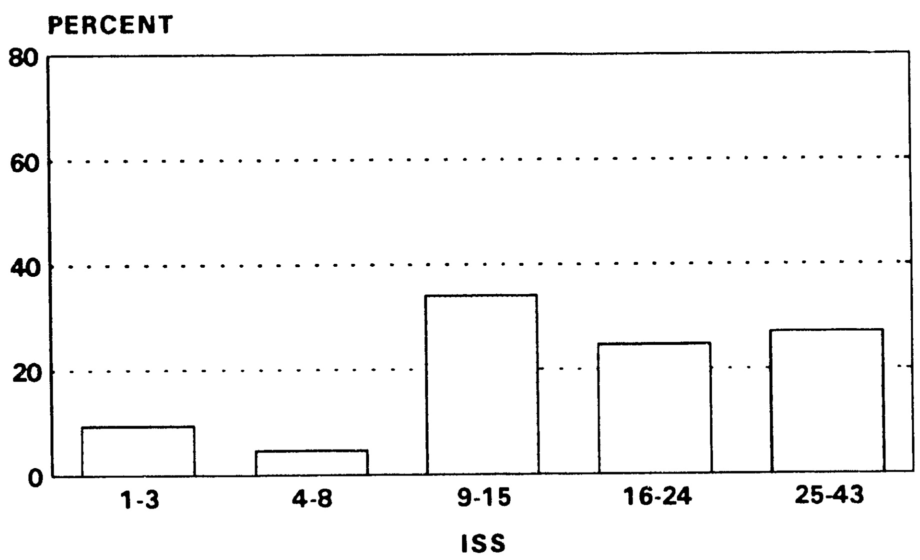


(n = 85)

FIGURE 39

DISTRIBUTION OF INJURY SEVERITY SCORE AMONG SURVIVORS

AVIANCA CRASH 1/25/90



(n = 85)

FIGURE 40
PERCENT SURVIVORS WITH ONE OR MORE NON-EXTERNAL INJURIES BY BODY REGION AND AGE
AVIANCA CRASH 1/25/90

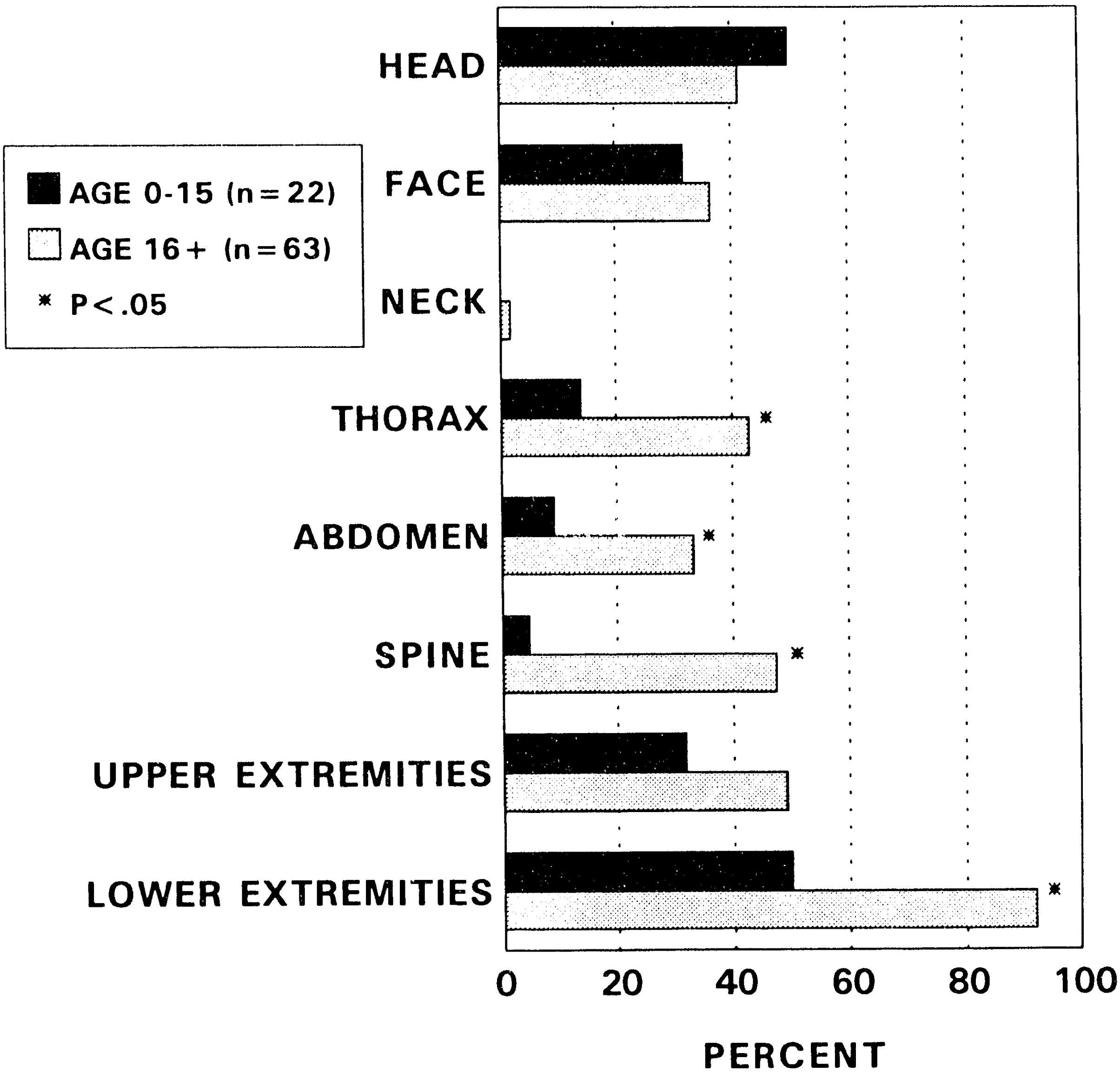


FIGURE 41
PERCENT SURVIVORS WITH FRACTURES BY LOCATION AND AGE
AVIANCA CRASH 1/25/90

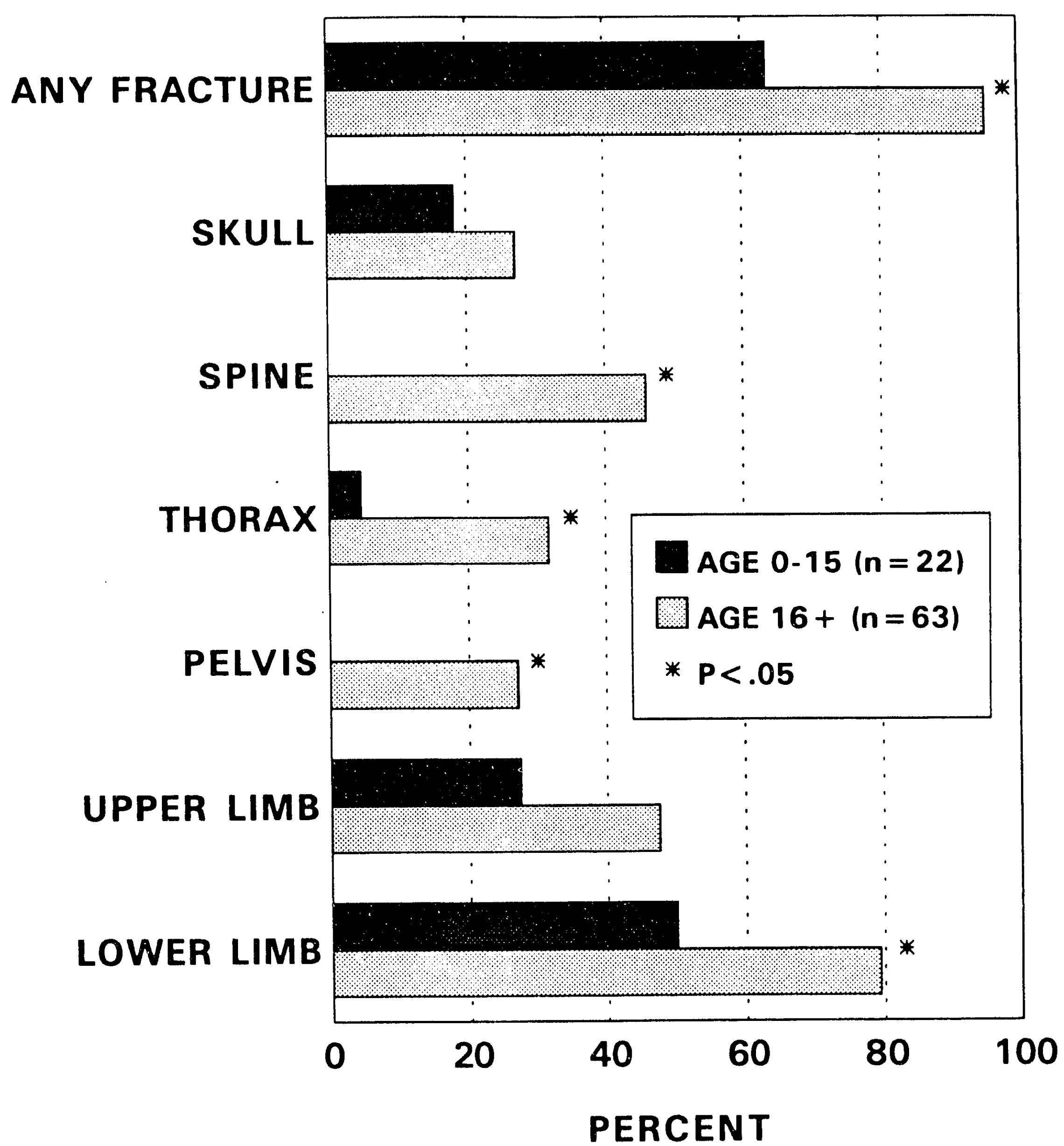
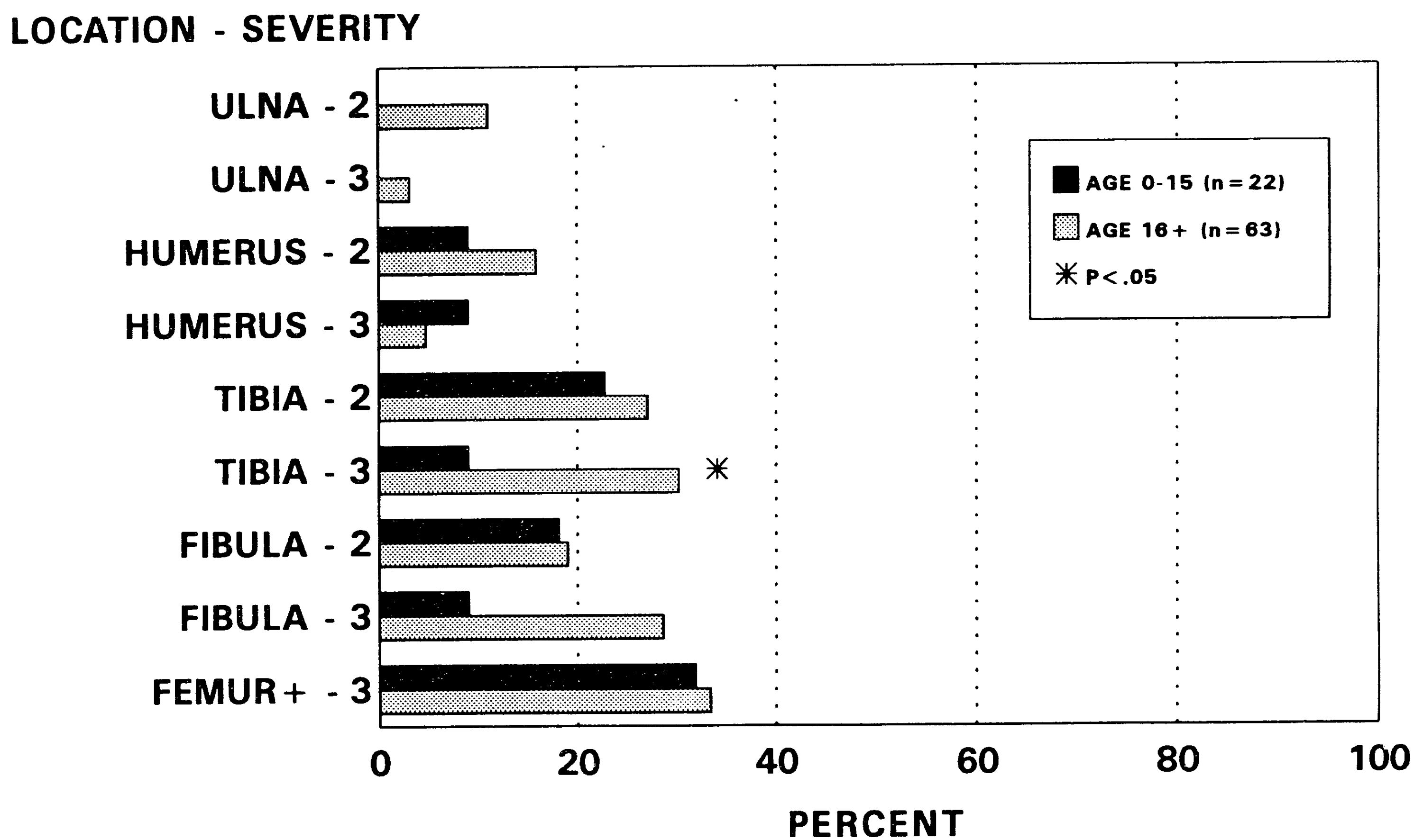


FIGURE 42

PERCENT SURVIVORS WITH ONE OR MORE EXTREMITY FRACTURES BY LOCATION, SEVERITY AND AGE

AVIANCA CRASH 1/25/90



+ NOTE: ALL FEMUR Fx ARE SEVERITY 3

FIGURE 43

MEAN MAXIMUM AIS SEVERITY BY AGE FOR SURVIVORS

AVIANCA CRASH 1/25/90

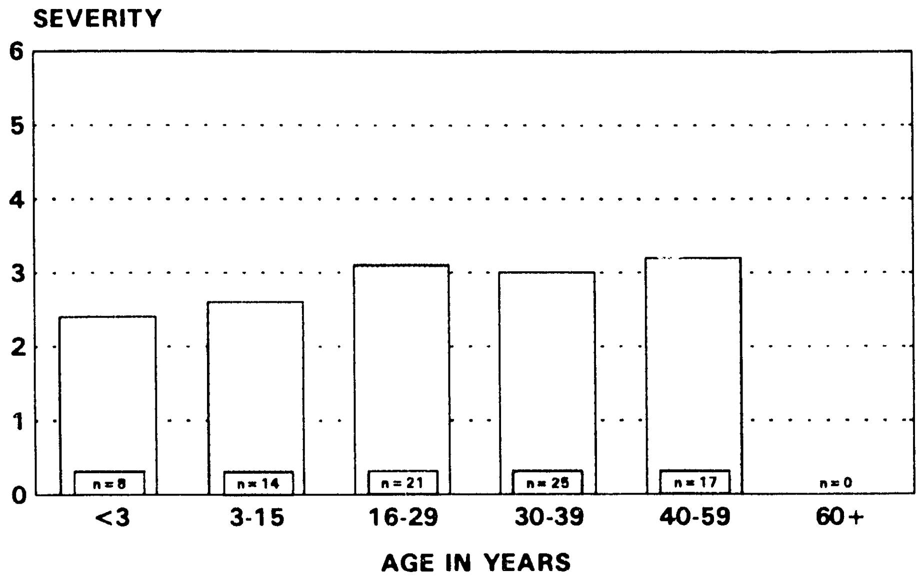


FIGURE 44

MEAN INJURY SEVERITY SCORE BY AGE FOR SURVIVORS

AVIANCA CRASH 1/25/90

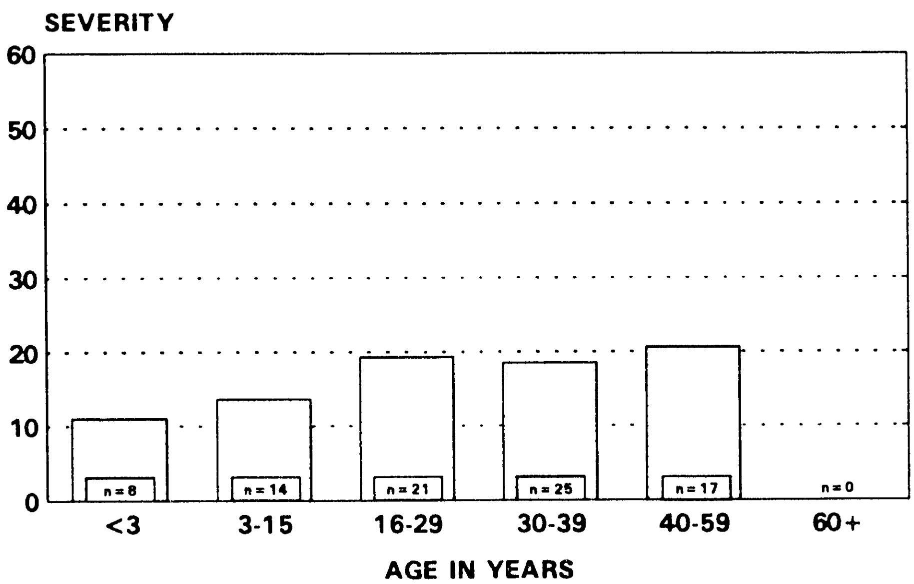
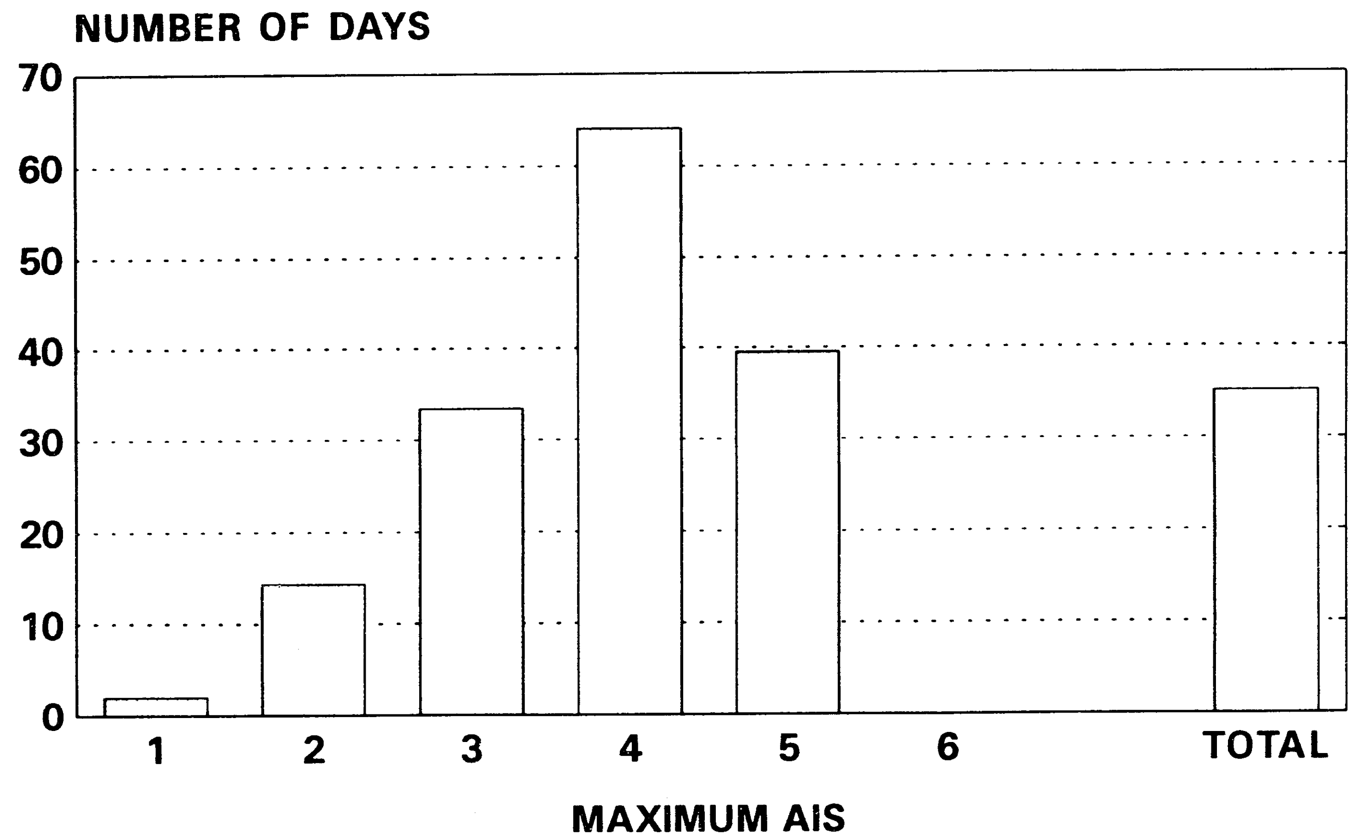


FIGURE 45

AVERAGE LENGTH OF INITIAL HOSPITALIZATION BY MAXIMUM AIS SCORE AMONG SURVIVORS

AVIANCA CRASH 1/25/90

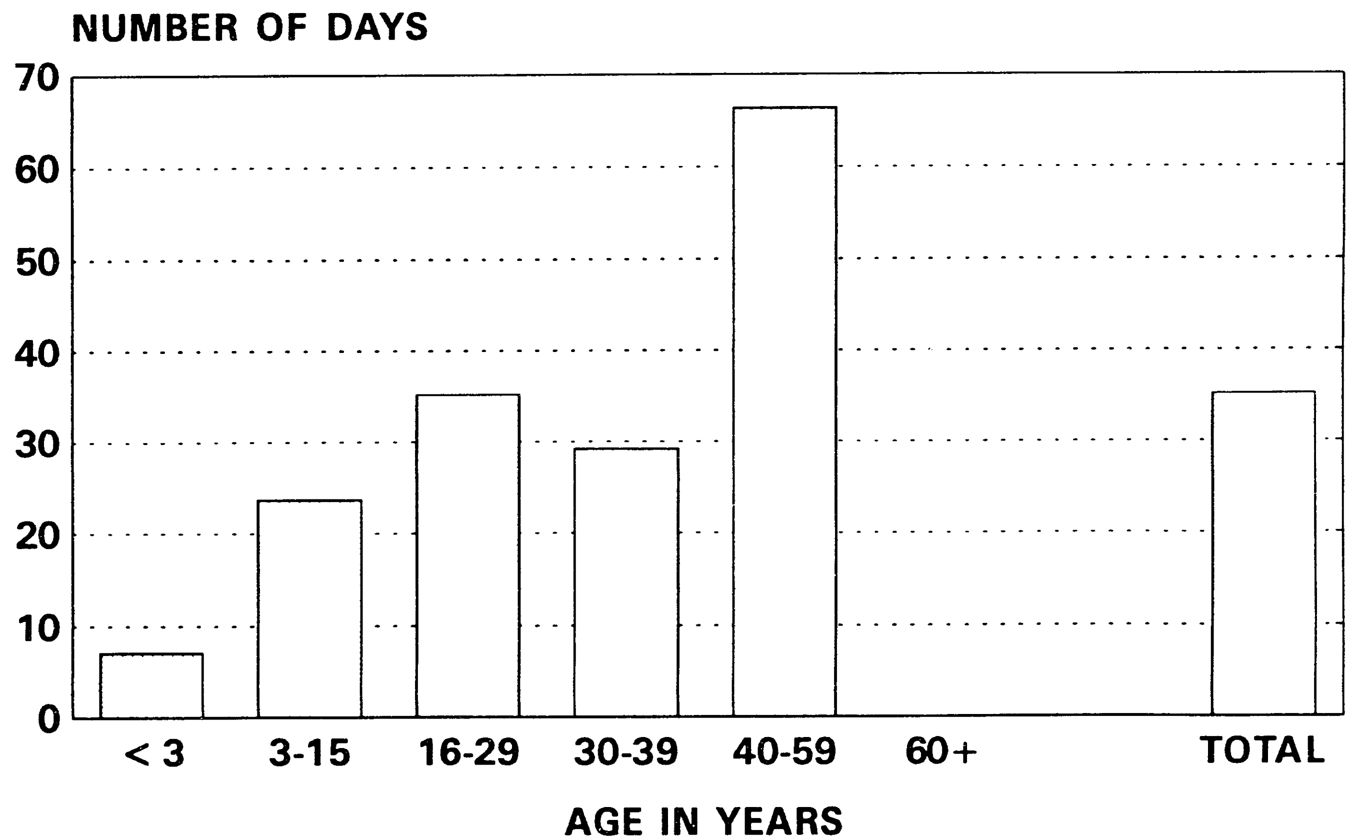


(n = 85)

FIGURE 46

AVERAGE LENGTH OF INITIAL HOSPITALIZATION BY AGE AMONG SURVIVORS

AVIANCA CRASH 1/25/90



(n = 85)

TABLE

TABLE 1

NTSB and IPAG Age Group Distributions by Gender for Passengers
Avianca Crash 1/25/90

Age Groups (in years)	NTSB*			IPAG		
	Male	Female	Total	Male	Female	Total
< 3	8	3	11	7	2	9
3-15	8	8	16	8	8	16
16-18	0	0	0	0	1	1
19-77	61	61	122	63	59	122
78+	0	0	0	0	1	1
Total	**77**	**72**	**149**	**78**	**71**	**149**

From: National Transportation Safety Board. Aircraft Accident Report: Avianca, the Airline of Columbia Boeing 707-321B, HK 2016. Fuel Exhaustion. Cove Neck, New York January 25, 1990. PB91-910404. NTSB/AAR-91/04. Washington, DC. April 30, 1991, Page 14.

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11/8/93

END