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Incident Reports Highlight Hazards in EMS Helicopter Operations

A study finds that communication difficulties, time pressure and distraction lead the list of human factors variables cited in incidents. A majority of incidents studied involved nonadherence to the U.S. Federal Aviation Regulations (FARs), and airspace violations and near-midair collisions were also among the most frequent anomalies reported. Most incidents occurred under visual flight rules (VFR) or no filed flight plan.

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Emergency medical service (EMS) aviation has improved the timeliness of response to medical emergencies and increased access to major medical centers that provide specialized patient-care facilities. The immediate availability of medical personnel in an emergency and fast patient transport following traumatic injury appears to reduce mortality by 35 percent to 52 percent.[1,2] Reflecting the growth in EMS aviation services, the annual number of aeromedical transports by helicopter has increased, for hospital-based operations, from 20,750 flight hours in 1980 to 134,912 flight hours in 1991.[3,4]

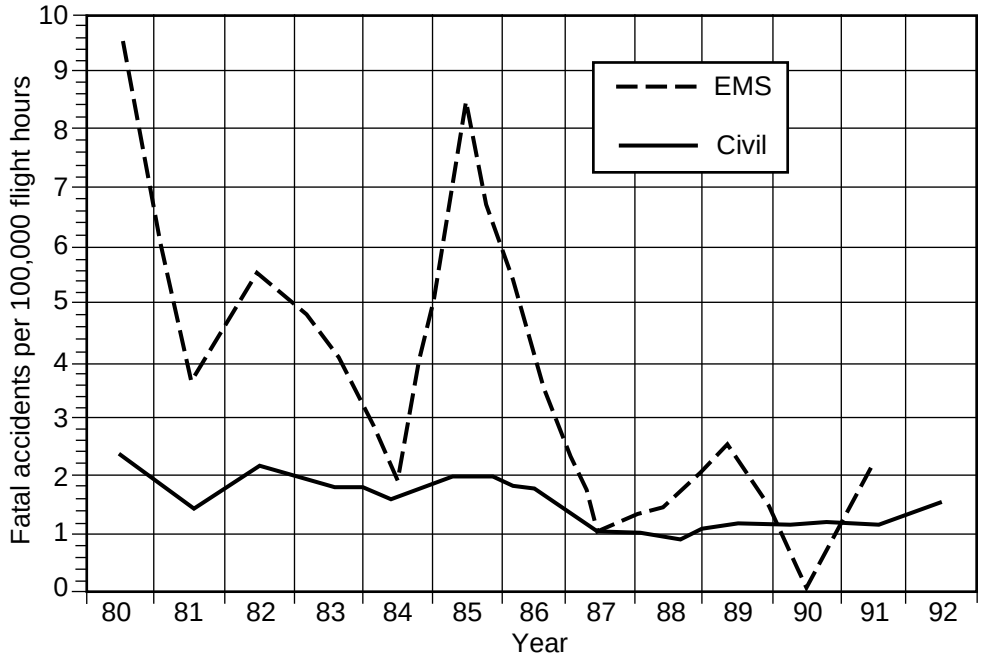
Although some emergency response programs provide both fixed-wing and rotary-wing capabilities, the helicopter has been recognized for its unique ability to reach remote areas, often in difficult terrain. Nevertheless, this capability has been associated with risk. After a series of fatal EMS helicopter accidents in 1985 and 1986, the safety record of EMS helicopter operations became a concern.

The U.S. National Transportation Safety Board (NTSB) studied 59 commercial EMS helicopter accidents occurring between 1978 and 1986.[5] Human error was attributed as the cause, directly or indirectly, of the majority of these accidents.[6] Weather was the second most common cause of these accidents. Despite a dramatic reduction in accident rates since the NTSB study,[7] the EMS helicopter remains a high-risk operation, with a fatal accident rate higher than the overall U.S. civil helicopter fatal accident rate (Figure l, page 2).

Because they frequently include pilot fatalities, fatal accidents often cannot provide investigators with complete information on the chain of events that led to the accidents. This obstacle is even more prevalent in EMS helicopter accidents, where it has been found that occupants are more likely to be seriously or fatally injured compared with occupants in non-EMS helicopters.[8] Therefore, there are advantages in supplementing accident investigation results with information from alternative perspectives.

One of these perspectives is reports of incidents that did not lead to accidents. The U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) has the world's largest data base on aviation incidents and is an important resource for this alternative perspective. In the study reported here, the ASRS data base was searched for reports related to EMS helicopter incidents. Eighty-one reports between 1986 and 1991 were obtained in full record form, which included the reporters' narratives of the incidents.

Fatal Accident Rates for Emergency Medical Service (EMS) and Civil Helicopter Operations, 1980–1992



Source: Helicopter Association International (HAI) *Helicopter Annual*, Association of Air Medical Services, *Journal of Air Medical Transport*

Figure 1

(Thirteen reports judged not to be relevant were excluded, leaving 68 reports for analysis.) These reports, voluntarily submitted by pilots, air traffic controllers and others, often included the crucial "chain of events" and the successful resolutions of the incidents.

The objectives of this study were to:

- Identify the types of safety-related incidents reported to ASRS in EMS helicopter operations;
- Describe the operational conditions surrounding these incidents, such as weather, airspace, flight phase and time of day; and,
- Assess the contribution to these incidents of selected human factors considerations, such as communication, distraction, time pressure, workload and flight/duty impact.

The ASRS incident reports and narratives were evaluated according to *incident variables* (reporter category, pilot's qualifications/ratings and incident anomaly reported); *operational variables* (flight phase, weather, flight plan, time of day and airspace); and *human factor variables* (communication, distraction, time pressure, workload and flight-duty conditions).

The ASRS data base contains voluntarily submitted incident reports, and therefore there are inherent statistical limitations in the use of these data because of a nonrandom sample and possible reporter and analyst biases. Nevertheless, the information derived from accounts of incidents from the people directly involved can be compelling. It is reasonable to assume that the reported levels of events found in the ASRS data base at least equal their actual incidence in flight operations.

Incident variables. The reporters who submitted the 68 ASRS incident reports included EMS helicopter pilots, air traffic controllers and pilots of other aircraft. The majority of reports (72 percent) were from pilots of single-pilot helicopters. There were no multiple reports from two-pilot helicopters, i.e., only one pilot submitted a report on any one incident.

Sixty-eight percent of the EMS pilot reporters were instrument-rated, and 66 percent of the pilot reporters mentioned in their narrative account that they were instrument flight rules (IFR)–current at the time of the incident.

In the ASRS data base, each incident report can involve up to six anomaly entries. Therefore, the total occurrences in each anomaly category are not mutually exclusive. Anomalies from the EMS helicopter data are presented both for total number in each category and percentage of the total number of incidents in Figure 2 (page 3).

Nonadherence to legal requirements/Federal Aviation Regulations (FARs) was evident in 53 percent of these reports. This

category includes all incidents in which a violation of a current FAR occurred, e.g., violations of flight/duty limitations or maintenance requirements. The third-ranked category is "Other," a category used to designate problems not specifically addressed by other incident categories. Excluding these two general categories, the three most prevalent safety-threatening anomalies found in this collection of ASRS incident reports were, in rank order: airspace violation, conflict or near-midair collision (NMAC) and in-flight encounter with instrument meteorological conditions (IMC).

Operational variables. These included flight phase, weather conditions, type of flight plan, time of day and type of airspace involved at the time of the incident. The EMS incidents occurred most frequently in the cruise phase of flight and during good weather. There were similar numbers of incidents on a visual flight rules (VFR) flight plan or no flight plan. None of the reported incidents were on an IFR flight plan, although 6 percent of the reports did not include the type of flight plan in use. (A Bell 412 EMS helicopter flight that crashed with four fatalities at Bluefield, West Virginia, U.S., in 1994 appears to have been the first EMS accident while operating under IFR. See *Helicopter Safety* Volume 21, May–June 1995).

The time of day most often reported for these incidents was between 1201 hours and 1800 hours. The reported incidents occurred in all types of controlled and uncontrolled airspace.

Human factors variables. These were communication, time pressure, distraction, workload and flight/duty conditions. The results are presented in Figure 3 (page 4). Communication difficulties were reported in 78 percent of the EMS incidents. Of these incidents, pilot-air traffic control (ATC) communication was mentioned most frequently (60 percent). The next highest proportion of these communication difficulties was between pilots and weather services (13 percent), where ambiguous weather reports or lack of accurate weather information became a major contributor to in-flight encounters with IMC. The third highest proportion of communication difficulties was between pilots and ground personnel such as police, ground crew and maintenance, where important information affecting the integrity of the EMS flight was not communicated to the pilot.

Time pressure, distraction and workload followed communication as frequent contributors to incidents. Time pressure reflects an indication by the reporter of lack of time as an important factor in the incident. The comments concerning time pressure revolved around four events: patient condition, rapid mission preparations, flight to the patient pick-up location and low fuel. Patient condition was reported as the most important contribution to time pressure (44 percent). One captain, who held an instrument rating and an airline transport pilot (ATP) certificate, was trapped above the clouds and forced to descend through the clouds in a noncertified helicopter while transporting a woman in high-risk labor.

"EMS accidents are extremely high," wrote one pilot, "and I feel that many, if not most, are the result of operating VFR in an IFR environment. … I allowed the patient's condition to

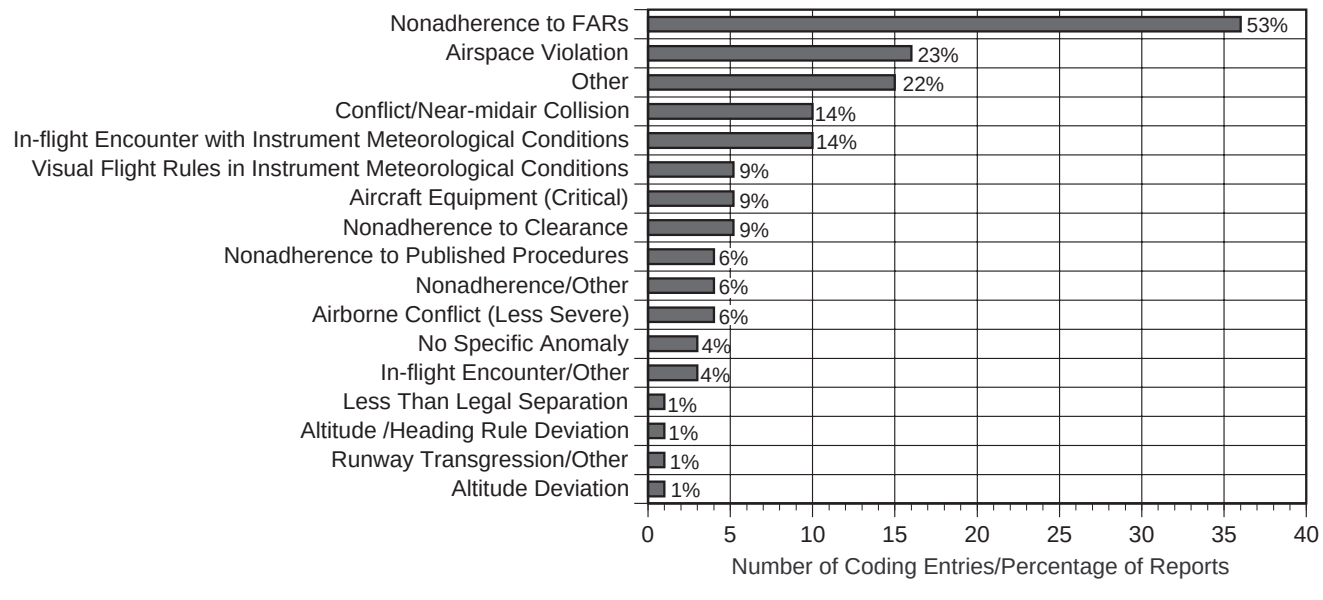
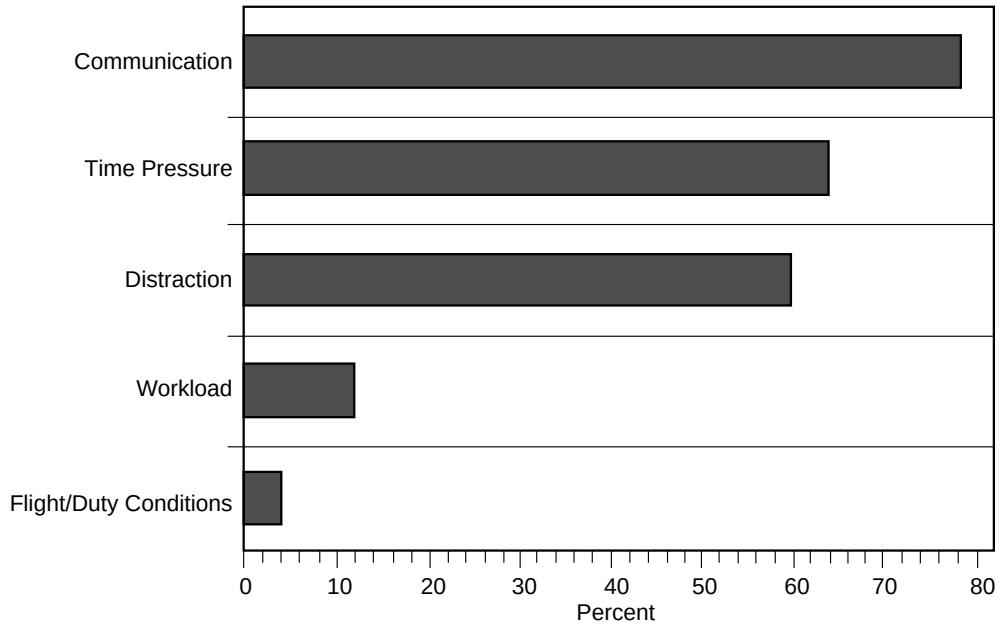


Figure 2

Contribution of Human Factors Variables in Emergency Medical Service (EMS) Incident Reports, 1986–1991



Source: U.S. National Aeronautics and Space Administration, Ames Research Center

Figure 3

influence my decision. … Weather was not available at XXX. … Should have refueled at YYY so more options were open."

Many external events helped create situations leading to distraction: aircraft equipment problems occurring in flight, monitoring of multiple radio frequencies, traffic avoidance in high-density traffic areas, radio frequency congestion, poor visibility caused by haze or night operations, and noise from medical equipment on aircraft. Events contributing to distraction were often also reported as time-pressure situations (e.g., impending bad weather, low fuel and patient condition).

The internal factors mentioned by some reporters that led to distraction involved concerns over family members, anxiety in the current situation, disorientation and general inattention. Distraction substantially contributed to the occurrence of the three most prevalent incidents in the EMS incident reports.

The proportion of incidents explicitly mentioning workload was fairly low at 12 percent. The concept of workload is complex and includes a wide variety of influences that can lead to overload and the shedding of important tasks. One reporter aptly described the complexity of the EMS operational demands contributing to workload:

"I was coordinating with dispatcher, medic command [flight following/status reports] and emergency vehicle on scene and broadcasting position reports and intentions on Unicom. … Approach Supervisor advised [me] that I entered his airspace and did not properly coordinate with his controller. … I was working four frequencies and receiving conflicting coordinates from the ground while searching for the landing zone."

The EMS incident reports were examined for comments concerning flight/duty considerations (i.e., flight/duty length, crew rest and number of duty days). Flight/duty conditions, although mentioned in a few reports, were not reported as a contributor to any safety-related incident despite representing violations of the FARs regulating Part 135 rest, flight and duty-time limitations. One reporter described a common reason why there are often difficulties complying with duty-time limits in EMS flight operations:

"I overflew the duty-time limits required under [FARs Part] 135.263d by 30 minutes. We received a request for an EMS patient transfer that would normally have been completed in a time frame that would not have violated any crew-duty times. Unplanned delay at the patient's originating hospital did not allow me to return in time to avoid working over my crew-duty time ... ."

Many of the variables in this collection of ASRS incident reports are known to have a significant impact in other aviation environments and are common topics in aviation human factors research.[9] The EMS helicopter reports from the ASRS incident data base were examined as an initial exploration of "real world"

events experienced by pilots, ATC operators and others dealing with EMS flight operations.

Several common patterns emerged in this study concerning airspace violations and NMACs. Both types of incidents tended to occur in airport traffic areas (ATAs) during midday. These results appear to reflect the complex airspace environment most commonly found around or near major medical centers, and a time of day when traffic density and interfacility patient transports would be expected to be high. In addition, according to the EMS pilot reporters, the ATC response to the Lifeguard call sign (by which EMS flights are designated) appears to be unpredictable and inconsistent, often encouraging a pilot to maneuver around the edges of controlled airspace to avoid any delays.

After the cruise phase of flight, the second most frequent phase reported for NMACs was descent and approach, a phase when initial entry into a confined airspace occurs and workload increases. NMACs occurred in uncontrolled airspace in two situations — high traffic density and lack of radio communication — that increased the likelihood of conflict between two aircraft. The "see-and-avoid" concept taught to every pilot is never more crucial than in these two situations. Billings et al. wrote, "The highest level of pilot vigilance must be maintained to avoid midair collisions, regardless of the airspace in which operations are being conducted and regardless of the ATC services being utilized."[10]

Degraded weather conditions are an extremely important consideration in the decision to fly an EMS helicopter mission. The 1988 NTSB investigation found unplanned entry into IMC as the single most common factor in fatal EMS helicopter accidents, with most occurring at night.[6] The findings of this ASRS incident study and those of the NTSB accident investigation were similar.

The differences between successfully resolved in-flight weather encounter incidents and accidents could possibly illuminate preventive strategies to be encouraged in the future.

Although tentative, a comparison of these two studies may be instructional. The conditions of weather, airspace and flight phase were similar in the two studies. The experience levels of the pilots were similar. The quality and interpretation of weather information was a concern in both studies. One difference, however, in the ASRS study, was the 68 percent rate of instrument rating and 66 percent rate of IFR currency for EMS pilots at the time of the incident. In the NTSB study, 86 percent of the pilots were IFR-rated, but only 6 percent were current. This finding appears to be a compelling reason to advocate IFR currency for EMS pilots, although additional research is necessary to reach this conclusion because of the limitations of the ASRS data. Nevertheless, in these real-life accounts, an IFR rating and currency were reported by these EMS reporters to be very helpful, if not invaluable.

As Lauber and Kayten wrote, "many factors can influence pilot judgment, such as the urgency of the mission, program competition, and management pressure (real or perceived)."[6] In the ASRS incident reports, time pressure and the influence of the patient's condition were frequent contributors to decisions to undertake a flight. There were no reports in these ASRS incidents concerning management pressure. Most of the pressure related in these ASRS incident reports arose from situational and self-imposed urgencies.

Two influential factors in EMS helicopter operations, one present in the current EMS incident study, were addressed by the 1988 NTSB study. These factors are the urgency of EMS mission requirements and the on-call nature of EMS operations contributing to fatigue.[6] The contribution of time pressure to the EMS incidents in this study has been discussed and was present in all three major types of incidents, although to a lesser extent in NMAC incidents. A common reason given by pilots for feelings of time pressure was rapid mission preparation, which led to errors, and the critical condition of a patient creating a sense of maximum urgency.

The acknowledgment of the pilot's role and membership in the EMS team is important in developing realistic expectations among all participants in the EMS operation.

The intense human response of pilots to injury and emergency was recognized in the NTSB study. One of the recommendations of the study was "to develop procedures to isolate flight operation decisions from medical decisions."[6] Whether this recommendation has been applied to the EMS operations reflected in this study's incident reports cannot be determined, but pilots continued to indicate a lack of "isolation from the medical decisions." But the goal of isolation may not be realistic when a pilot is faced with anxiety and expressions of urgency, both in speech and nonverbal signals, from medical staff.

The acknowledgment of the pilot's role and membership in the EMS team is important in developing realistic expectations among all participants in the EMS operation. The difficult balance among team membership, independent judgment and decision-making authority is a skill to be developed. The application of crew resource management (CRM) principles, prevalent in air carrier operations, might be effectively applied to the unique environment of EMS operations.

Also emerging from this study is an acknowledgment of the unique demands placed on the EMS pilot that lead to distraction, time pressure and heavy workload. These demands

can erode positive efforts toward good communication, thorough planning, cooperative teamwork and safe flight during patient transport.

The predominant findings of this study concern the need for definition of the pilot's role in the overall EMS team, and for ways to deal with the detrimental influences of communication/information transfer problems, distractions, time pressure and workload. Efforts need to be directed toward improving communication and transfer of crucial information, decreasing distraction, decreasing time pressure to realistic levels and assisting in workload management, thereby increasing safety.♦

Editorial note: This article is adapted from a NASA report, "Emergency Medical Service Helicopter Incidents Reported to the Aviation Safety Reporting System," a paper presented to the Ohio State University Seventh International Symposium on Aviation Psychology.

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