

Air Ambulance Operations: Enhancing Public Safety or Causing Unnecessary Tragedy?

By

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Introduction²

In the early morning darkness of June 5, 1998, AirCare One, a Eurocopter AS350BA, departed the Harlingen Emergency Medical Services (EMS) facility in Harlingen, Texas, en route to the scene of a vehicle accident about 60 miles northwest in Brooks County. AirCare One had been requested by a trooper at the scene who had called the local “911” service. Onboard were the pilot, a flight nurse and a flight paramedic.

About 15 minutes after departure, the pilot advised his dispatcher that he was 16 minutes from the emergency destination. Ten minutes later, the pilot radioed that AirCare One was “five minutes” from the destination and that he would be changing frequencies. That was the last contact anyone had with AirCare One. Thirty hours later, the burned wreckage was found in remote, brushy ranch land in northern Starr County, Texas. All aboard had been killed.

AirCare One was not the only EMS helicopter program to experience tragedy in 1998. In January, 1998, an injured skier and three flight crew members were killed in the crash of a helicopter ambulance near Sandy, Utah. Two months later, in March, 1998, three were killed and

two critically injured in the crash of a police helicopter being used for medical transport. The crash of AirCare One was followed by an August 20, 1998, crash in Iowa that killed three.

To make matters worse, recent experience has unfortunately demonstrated that 1998 was not an unusual year for fatal EMS helicopter crashes.³ Three fatal helicopter EMS crashes occurred in 1999 and four in 2000. Since January 1, 1998, EMS helicopter crashes have accounted for 11 fatal occurrences with 32 pilots and medical support personnel being killed, two sustaining critical injuries and two patients being killed.

Despite a comprehensive study by the National Transportation Safety Board (NTSB) in 1988, with specific recommendations for reducing the incidence of EMS helicopter crashes, recent experience suggests reappearance of serious safety issues. This paper examines recent developments in helicopter EMS (HEMS)⁴ operations with an emphasis on significant developments since 1988.⁵ In particular, operational and medical issues are examined in an attempt to highlight the factors that govern the risks and benefits of HEMS operations. The paper concludes with recommendations for improving the safety of HEMS operations.

Emergence of HEMS Operations

The first air transport of a patient occurred sometime around 1870 in Paris, France. Balloons were used to transfer soldiers wounded in the Franco-Prussian war. In the early 1950's, helicopters were successfully used to evacuate soldiers wounded in the Korean conflict. The use of helicopters was expanded during the Vietnam War with significant decreases in mortality.⁶ In 1968 the use of civilian helicopters to transport patients was suggested, based upon the military experience. The first commercial helicopter EMS program focusing on patient transports was commenced in Denver, Colorado, in 1972.⁷

Since 1972 helicopter EMS programs have dramatically increased in number worldwide. By 1987 there were 155 commercial emergency helicopter EMS programs in the United States, increasing from 42 programs in 1981.⁸ By 1995 there were an estimated 300 HEMS programs⁹ operating in the U.S.

From 1980 to 1986¹⁰ the HEMS accident rate was an astonishing 13.42 per 100,000 flight hours.¹¹ Stansbury states in his article that “[t]he storm peaked in 1986 with 14 helicopter and three airplane accidents that left 13 people dead.” In retrospect, the storm may have merely abated for a few years. The storm appears to have returned with a vengeance in the mid 1990's, accounting for 13 deaths in 1998, ten in 1999 and 11 in 2000.¹²

The 1988 NTSB Safety Study

The NTSB was moved to conduct its study of the commercial emergency helicopter industry after exponential growth in the early 1980's was accompanied by a fatal accident rate almost twice that of nonscheduled Part 135 air taxi helicopter operations.¹³ The NTSB

concluded that weather, particularly unplanned flight in instrument meteorological conditions (IMC), was the single greatest hazard to HEMS operations.¹⁴ Other operational risks were also identified, including the influence of the mission on pilot judgment, competitive pressures to fly in unsafe conditions, pilot proficiency, pilot fatigue and minimum HEMS equipment.¹⁵

As noted above, unplanned entry into IMC was the most significant factor associated with fatal HEMS operations. One-fourth of the 59 crashes analyzed in the NTSB Safety Study involved reduced visibility and/or spatial disorientation. Almost three-fourths of these crashes were fatal. All of the reduced visibility crashes occurred during a patient transfer mission.¹⁶

Based upon the study results, the NTSB issued recommendations to the Federal Aviation Administration (FAA) and the HEMS industry. The NTSB directed the FAA to better train their inspectors to review pilot training procedures, especially those dealing with the implications of operation in degraded weather conditions. The FAA was also asked to amend the Federal Aviation Regulations to restrict HEMS operations to a day-visibility minimum of one mile.¹⁷ Industry was asked to create safety committees with HEMS programs and to develop visual flight rules (VFR) weather minimums for each program based upon local terrain and weather patterns. The NTSB also recommended that programs communicate their weather minimums to pilots in writing and prohibit deviations.¹⁸

The NTSB Safety Study was an industry “wake up” call. Facing increased government pressure and prospective rule making the HEMS industry initiated its own system of self-regulation. A positive development for the HEMS industry has been the creation and growth of the Commission on Accreditation of Air Medical Services¹⁹ (CAAMS), now known as the Commission on Air Medical Transport Systems (CAMTS).²⁰ Founded in 1990, the CAMTS

has developed a comprehensive set of voluntary standards and an accreditation process based upon site visits to prospective HEMS programs. The CAMTS voluntary standards apply to both helicopter and fixed wing aircraft.²¹

Having highlighted the root causes of HEMS crashes and provided a roadmap for recovery, there was optimism that the industry had reversed the trend. The accident rate between 1987 and 1993 decreased to 3.14 per 100,000 flight hours, less than the accident rate among civilian turbine helicopters.²² Remarkably, there were no fatal HEMS crashes reported by the NTSB between 1990 and 1992. By 1998, however, it became apparent that the lessons learned 10 years ago were being ignored and familiar patterns began to reappear.

Fatal Crashes Since 1988

Table 1 lists fatal HEMS crashes since 1988. The synopses for these occurrences are contained in Appendix A.

Of the 21 crashes, 11 have occurred since January 1, 1998. Eleven of the 21 crashes involved adverse weather with and eight involved unplanned flight into IMC. These data closely resemble the pre-1988 data referenced in the NTSB Safety Study.

Table 1

Fatal EMS Helicopter Crashes since January 1, 1988

Date	Location	Make/Model	Reg. No.	Crew Fatalities	Patient Fatalities	Circumstances
4/17/88	Cajon, CA	AS355F	N5777P	2	6	Inclement wx; collided with power lines
12/22/88	Cape Girardeau, MO	Bell 206L	N119CG	2	1	Unplanned flight into IMC Spatial disorientation/night
2/13/89	Tyler, TX	BK-117	N7025L	3		Unplanned flight into IMC Non-proficient IMC pilot
6/1/89	Big Timber, MT	Bell 206L	N76KM	3	1	Night/disorientation Lack of familiarity with area
8/27/89	Blanchard, ID	AS350D	N132SH	3	1	Mechanical failure Maintenance
5/27/93	Cameron, MO	AS350B	N782LF	1	1	Mechanical failure Engine/material failure
11/19/93	Portland, ME	Bell 206L	N911ME	2	1	Unplanned flight into IMC Night conditions
12/12/96	Penn Yan, NY	BO-105	N90750	2	1	Low ceiling; terrain, high winds
3/14/97	Lena, LA	BO-105	N7161J	1		Unplanned flight into IMC Spatial disorientation
12/14/97	Littleton, CO	Bell 407	N771AL	3	1	Night/nearby obstructions Lighting in LZ
1/11/98	Sandy, UT	Bell 222	N222UH	3	1	Unplanned flight into IMC Terrain/night/winds
3/23/98	Van Nuys, CA	Bell 205	N90230	3	1	In-flight emergency
6/5/98	La Gloria, TX	AS350BA	N911VA	3		Unplanned flight into IMC Night/IMC proficiency
8/20/98	Spencer, IA	Bell 222	N30SV	3		Mechanical/Defective part
4/3/99	Indian Springs, NV	BO-105	N105HH	3		Unplanned flight into IMC Spatial disorientation
6/14/99	Jackson, KY	S-76A	N2743E	4		Collided with terrain in IMC
7/17/99	Fresno, TX	BK-117	N110HH	3		Catastrophic structural/ mechanical failure
3/10/00	Dalhart, TX	BO-105	N335T	3	1	Unplanned flight into IMC Night/icing

Date	Location	Make/Model	Reg. No.	Crew Fatalities	Patient Fatalities	Circumstances
4/25/00	St. Petersburg, FL	BK-117	N428MB	3		Collision with radio tower
7/24/00	Sumner, GA	AS350B	N911AM	3		Collision with terrain
10/16/00	Burlington, NC	AS355	N355DU	1		Mechanical/maintenance

The Crash of AirCare One

The flight and demise of AirCare One are a textbook example of how the NTSB findings have not been applied and enforced within HEMS programs.

The pilot of AirCare One was hired approximately six months before the crash. His previous helicopter experience, consisting of 2,750 hours at the time of employment, was primarily in Bell helicopters. He had no prior experience, before being hired by Valley Air Care's Part 135 contractor, in Eurocopter equipment. Most significantly, he only possessed 45 hours of instrument time, 30 hours of night experience, of which 25 was logged as night cross-country. The contractor's own standards called for an instrument rated commercial pilot with a minimum of 3,000 total commercial flight hours.

The flight departed at night, with no moon, at 5:14 a.m. local time. For several weeks, Valley Air Care's service area, like the rest of Texas, had experienced haze and reduced visibility from extensive smoke being brought into the state from Mexican forest fires. Witnesses at various points along the route of flight and in the vicinity of the crash described the visibility as extremely poor. One rancher, located about five miles from the crash site, said that on first light he could not see his mailbox less than 100 yards from his house. The helicopter departed from an urbanized area and proceeded northwest. Along the route of flight towards the emergency

destination, the availability of ground reference lighting decreased substantially. There was virtually no ground reference lighting in the vicinity of the destination. A local constable described the unpopulated ranch land to the west of the aircraft's intended route as a "black hole" with "no horizon."

The elevation at the departure helipad was 36 feet, the elevation at the intended destination was 420 feet and the elevation at the crash site was 550 feet. The helicopter's base was located in Harlingen, Texas, which is just inland from the Gulf of Mexico. Figure 1 shows the departure point, the intended destination and the crash site. While most of the area serviced by Valley Air Care is relatively flat, the terrain rises rapidly along the western extremities of the service area. Figure 2 illustrates the change in terrain elevation.

Figure 1.
Location of Significant Events

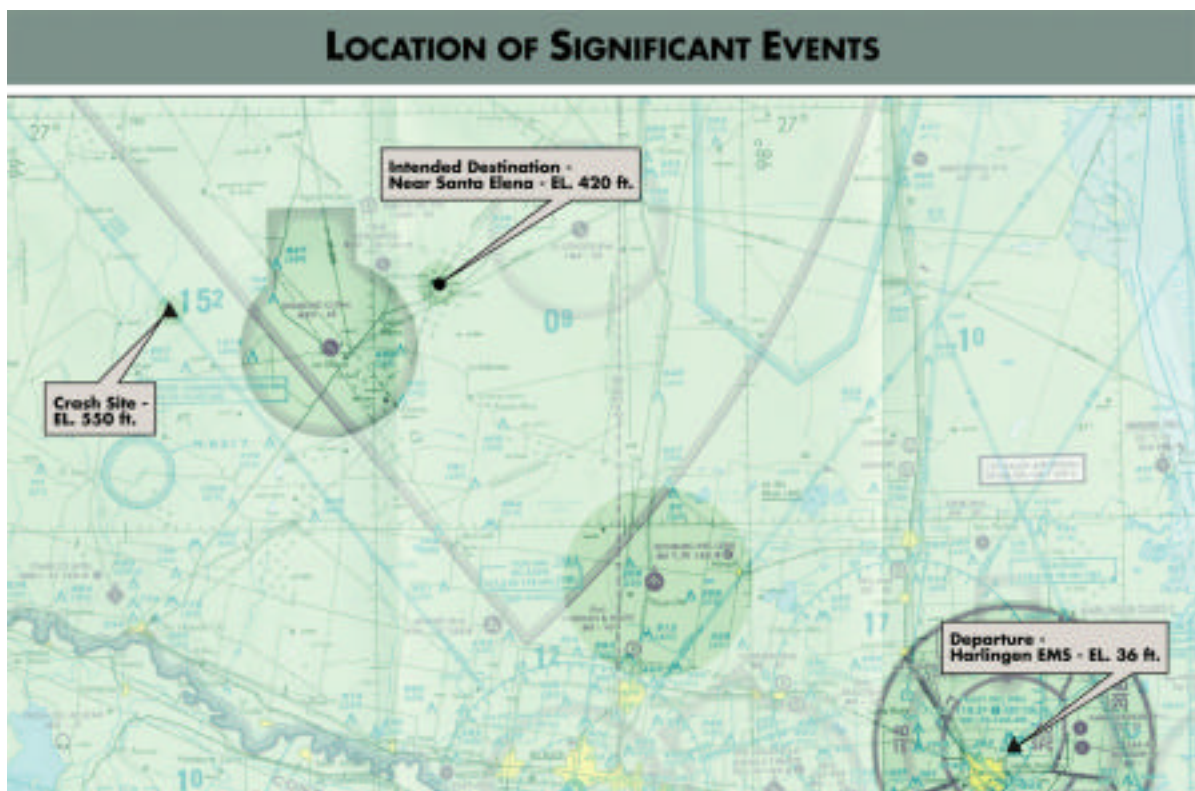
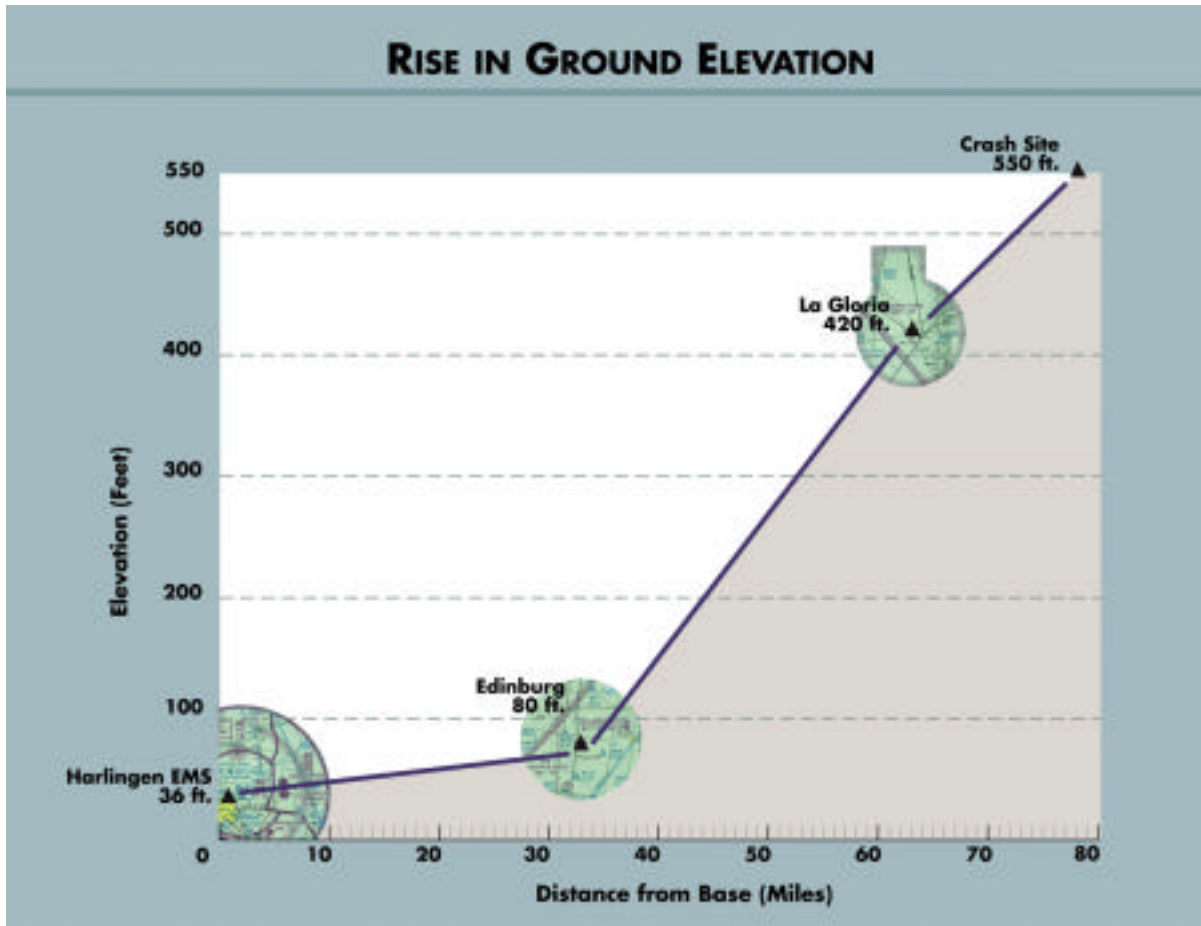


Figure 2.

Rise In Ground Elevation



The call for assistance came to Harlingen EMS by way of its “911” service. The request came from a trooper attending a tractor-trailer wreck about 60 miles northwest of Harlingen. Although emergency service was requested, it was later determined that the injuries to the driver of the tractor-trailer rig were minor and he was transported by ground ambulance to a care facility. The pilot accepted the mission, based upon the request for HEMS service, and the flight departed.

Consider the flight of AirCare One in the context of the NTSB Safety Study:

- (1) The pilot had limited experience in the make/model aircraft being flown;
- (2) The pilot had very limited night and instrument flying experience;
- (3) The service area had widely varying terrain with limited horizon references;
- (4) The aircraft took off at night in questionable VFR weather with IMC prevailing in the vicinity;
- (5) The pilot accepted a mission involving questionable HEMS necessity.

Of the factors which contributed to the crash of AirCare One, all had been highlighted ten years earlier by the NTSB, as being common threads in a number of HEMS crashes. Unfortunately, AirCare One typifies a recently recurring pattern of night crashes in which a non-proficient instrument pilot disregards VFR-only standards and operates the aircraft in IMC or adverse weather conditions. Despite a significant reduction in fatal crashes between 1989 and 1993, the last three years' experience begs for immediate and serious attention from government and industry. Had the recommendations made by the NTSB been followed by the pilot of AirCare One and his employer, the crash would not have occurred.

Operational and Medical Issues

With the expansion of HEMS service worldwide in recent years, there has been much greater scrutiny in the literature of various operational and medical issues applicable to HEMS operations. Writers have critically examined the medical necessity for and efficacy of helicopter ambulance operations. Prehospital evaluation, dispatch and flight acceptance issues have also

been addressed, as have human factors and cockpit resource management issues. Additionally, voluntary standards have been created and self-regulation of the industry is ongoing.

Crash statistics, compiled over the last two decades, tell us that HEMS operations are, at best, risky. When assessing HEMS programs, consideration must be given to the safety of the HEMS crew as well as the medical welfare of the patient being transported.²³ The appropriate threshold inquiry in attempting to balance the medical necessity of helicopter transport against its demonstrated risks is: under what circumstances, if any, is HEMS a medically superior means to transport patients?

While results are mixed²⁴, recent studies have raised serious questions concerning the efficacy of helicopters in improving the outcome of transported patients. We start with the proposition that HEMS programs are both expensive²⁵ and dangerous.²⁶ With the safety of the patient and crew being paramount, the decision to utilize HEMS must be predicated upon thoughtful analysis of medical necessity and efficacy, not mere convenience.

In the realm of trauma injuries, several studies have concluded that HEMS has very limited medical benefit to the vast majority of patients transported. A retrospective three and one-half (3½) year study of trauma patients transported by helicopter and ground ambulances, 62% of which had sustained major trauma, demonstrated that patients transported by helicopter did not enjoy a statistically significant improvement in outcome over those transported by ground.²⁷ A study which assessed response time of helicopter and ground ambulances, concluded that activation times, response times and on-scene times for helicopter transports were longer, on average, than ground ambulances in the service area analyzed.²⁸ The same study also concluded that prevailing triage practices result in over usage of helicopters in approximately

85% of transports.²⁹ The Cunningham study analyzed trauma data compiled for patients transported by helicopter and ground ambulances. The expected outcomes for patients transported by helicopter were no better than those transported by ground except among a very small subset of very seriously injured patients. When analyzed for mortality rates, there were no significant differences between the two groups of patients. The beneficial effects of helicopter transfer were statistically better in only the minority of very seriously injured patients. This study, which involved a very large patient population and covered a five-year period, emphasized the need to better identify patients who would benefit medically from “this expensive and risky” mode of transport.³⁰ Most recently, the Brooke Army Medical Center study³¹ of 792 trauma patient transported by helicopter and ground ambulance concluded that there was no statistically significant difference between mortality rates for either group when compared with national mortality rates.

The long-assumed benefits of helicopter transport have fared better in the realm of pediatric transports. A 1996 retrospective study of 3,861 admissions to a pediatric trauma center concluded that helicopter transport was associated with better survival rates among urban children.³² An empirical pediatric study, where cases were categorized as surgical, medical or neonatal, concluded that complicated deliveries and children with respiratory complications or serious illnesses benefit from HEMS.³³

Writers, analyzing the assumed benefits of HEMS, have suggested more precise guidelines for determining which calls for assistance should be dispatched to ground versus helicopter transport.³⁴ In a position paper by the National Association of Emergency Medical Services Physicians (NAEMSP), the group noted that “there is no well-established body of clinical

literature that delineates the best criteria for dispatching a helicopter to an emergency scene”.³⁵ While many guidelines have been proposed³⁶, no definitive criteria have been established to cover pediatric, neonatal, medical and traumatic etiologies. Although progress has been made with respect to developing trauma criteria³⁷, pediatric and general medical issues have not been addressed.³⁸ Significantly, the current CAMTS standards do not contain any medical response guidelines or criteria; they merely suggest a periodic utilization review of transports.³⁹ Once concise criteria are established, EMS facilities can train their dispatchers to direct the call, as appropriate, to a ground ambulance or a helicopter. Training the pilots and medical team on the criteria will result in more efficient utilization of the helicopter and substantially reduce inappropriate usage.

Some cases have been identified as inappropriate for HEMS transport. One study concluded that “air medical transport for the injured patient without signs of life following pre-hospital intervention appears futile.”⁴⁰ Another study of in-flight cardiac arrest resulting from cardiac, traumatic or respiratory etiologies reported a zero survival rate.⁴¹ Yet another study reported by Stansbury concluded that inter-hospital transfer of cardiac patients by air offered no benefit to the patient.⁴²

The staffing and coordination of HEMS teams has also been the subject of study. In Europe, it is common for HEMS units to be staffed with physicians. In one study, several variables related to an emergency transport were analyzed to determine if the specialty of the attending physician influenced the injury outcome. After reviewing 2,139 cases, flight time to the scene and original specialty of the HEMS physician did not have a statistically significant effect on patient outcomes.⁴³ A Norwegian study examining the professional interactions among

members of the HEMS team, which in that country typically consist of a pilot, paramedic and physician, emphasized the importance of the team having a common set of rules and guidelines that are accepted as their own without question and exception.⁴⁴

The NTSB Safety Study identified pilot instrument proficiency as an important factor that affected the safety of HEMS missions.⁴⁵ The NTSB stated, "...[i]t is clear that a noncurrent instrument rating significantly increases the possibility of a pilot experiencing a spatial disorientation or loss of control when unplanned entry into IMC occurs."⁴⁶ This subject was addressed in a 1997 study which sought to determine whether instrument-proficient pilots would manage flight into unplanned IMC better than their non-proficient counterparts.⁴⁷ The study involved 28 pilots with a median experience of 6,300 hours in helicopters of which 13 were instrument-proficient and 15 were not. The statistically significant results were that instrument-proficient pilots lost control less often, maintained instrument standard more often and entered IMC at a higher altitude compared to the non-proficient group. The study clearly demonstrated that instrument-proficient pilots could more safely manage an unexpected IMC encounter even though the non-proficient pilots were very experienced helicopter pilots.

Weather is the single most significant factor affecting the safety of HEMS flight. The CAMTS standards provide for ceiling and visibility weather minimums which are a function of day versus night operation and local versus cross country flights. Examination of HEMS crash reports suggests that minimums should be increased. Since the likelihood of encountering adverse weather is equally probable within the entire service area, it seems logical to eliminate the local versus cross country distinction. Eliminating the geographical variable and collapsing the weather minimums into single day and night minimums would add certainty and reduce the likelihood of

pilot confusion. CAMTS should strongly consider the advisability of single day and night weather minimums, discarding the local versus cross-country distinction. A single set of day and night weather minimums coupled with mandatory instrument proficiency would greatly improve the safety of HEMS operations.

Recommendations

- (1) HEMS operators should hire only instrument proficient pilots and require all pilots to maintain instrument proficiency. Even though all operations should be restricted to VFR, all aircraft should be equipped to permit flight in unexpected IMC. There should be no exceptions to this requirement.
- (2) CAMTS and the HEMS operators should adopt more stringent experience requirements for their line pilots. Specifically, CAMTS should consider adopting more stringent experience requirements in its 12.04.02 standard. A minimum of 3,000 hours total commercial helicopter experience with 1,500 hours as pilot-in-command of helicopters is recommended. Of this total, a minimum of 250 hours of night experience is suggested.
- (3) CAMTS should consider adopting a standard which requires pilots to demonstrate instrument proficiency in each make and model of helicopter to be flown before being assigned to the line.
- (4) The FAA should adopt more stringent and concise minimum weather standards applicable to HEMS operations. Day minimums of 1000' ceilings and one mile visibility and night minimums of 1500' ceilings and three miles visibility should be implemented. A single standard for day operations and a single standard for night operations would eliminate potential confusion among pilots and make enforcement of violations easier.
- (5) The HEMS operators and CAMTS should, prior to rule making by the FAA or in the absence of rule making, adopt more stringent weather minimums such as those

suggested above. CAMTS should eliminate the alternative weather minimum of 800 foot ceilings and two miles visibility and opt for a single standard. The alternative simply gives rise to potential confusion and ambiguity. Given the role of unplanned entry into IMC in HEMS crashes, the more certain and exact the minimum standards, the better. The minimum standards set forth above are suggested.

- (6) HEMS operators should implement a continuing educational program concerning the role deteriorating weather plays in HEMS crashes using examples of prior crashes as a teaching tool. CAMTS should consider adopting a comparable standard.
- (7) CAMTS and the HEMS industry should incorporate forecast weather into their minimums. A mission should not be accepted unless it can be safely completed within applicable minimums. The CAMTS standard 11.01.04 should be revised to read: “Recommended minimums to ~~begin~~ complete a transport shall be no less than:” This change will force the pilot to consider forecast conditions against minimum before accepting a flight.
- (8) CAMTS and the HEMS industry should work to develop concise medical criteria to ensure that HEMS is being appropriately utilized. In all but a few cases, ground transport is an equally effective, yet significantly safer, means of transport. The industry must develop meaningful standards for HEMS transport or governmental regulation will follow.

Conclusions

The premise that helicopter EMS is a superior means of transporting patients to care facilities cannot be supported except in a very small population of severely injured trauma patients, complex deliveries and some neonatal circumstances. In all but a few cases, ground transport is an equally effective, yet significantly safer, means of transport. Until concise guidelines are developed, excessive and inappropriate usage of helicopters to transport patients will continue, thus exposing the vast majority of these patients to unnecessary risks. In many instances, the risks of being transported by helicopter may exceed the mortality risks associated with the original injury or illness.

Following the NTSB Safety Study in 1988, key safety factors were identified, and the industry safety record improved dramatically for almost four years. Since 1998, however, there has been a substantial increase in fatal HEMS crashes which has continued, unabated, through this year. The recent fatal crashes have involved the same factors that the NTSB identified over a decade ago. Unless the industry acts aggressively and immediately, increased governmental scrutiny will result. Until and unless significant changes are made which preclude unplanned encounters with IMC, sponsoring care facilities should consider discontinuing helicopter EMS operations. The HEMS industry will face a crisis unless dramatic and sweeping changes are made soon. In the current state of affairs, transport by helicopter affords little chance of improving the patient's medical outcome while imposing an unnecessary, yet preventable risk to the patient and crew.

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Lawyers of America and is listed in Best Lawyers in America. Mr. Slack has handled numerous air crash cases for passengers and their families since beginning his practice in 1983. Notable clients have included the families of Stevie Ray Vaughan, Walter Hyatt (Valujet Flight 592), and the medical team aboard AirCare One. Mr. Slack is currently serving as a member of the plaintiffs' steering committee in multi-district litigation arising from the crash of American Airlines Flight 1420. Mr. Slack holds B.S. and M.S. degrees from Texas A&M University in Aerospace Engineering and a J.D. from the University of Texas School of Law. From 1974 to 1980 Mr. Slack was a senior aerospace engineer with the National Aeronautics and Space Administration Johnson Space Center, Houston, Texas.

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2. This paper is dedicated to the memory of AirCare One Senior Flight Paramedic Brenda Leinweber and Flight Nurse Carlos De La Fuente.

3. The occurrences referenced in this paper can be found in the NTSB Aviation Accident Synopses database at <http://www.nts.gov/aviation/Accident.htm>. Additional information on the occurrences may be found at the database maintained by the Air & Surface Transport Nurses Association at <http://www.nfna.org/concern.html>.

4. The terms "helicopter EMS" will be used to describe medical helicopter operations in this paper. Various authors also refer to them as "helicopter ambulances," "paramedic helicopters," "MEDEVAC," "aerovac," "flying intensive care units," "emergency helicopter" and "helicopter medical transports."

5. While the term "air ambulance" as used in the paper title includes both fixed-wing and rotor wing aircraft, this paper will deal exclusively with rotor wing or helicopter operations.

6. See Col. Spurgeon Neel, *Army Aeromedical Evacuation Procedures in Vietnam & Implications for Rural America*, 204 J. OF THE AM. MED. ASS'N 309, 309 (1968)

7. See NATIONAL TRANSPORTATION SAFETY BOARD, SAFETY STUDY, COMMERCIAL EMERGENCY MEDICAL SERVICE HELICOPTER OPERATIONS 3 (NTSB/SS-88-101) (1988) (hereinafter "NTSB Safety Study")

8. See *id.*, at 4.

9. See Dave Stansbury, *Turbulent Times Persist for Air Medical Transport* 21 J. EMERGENCY MED. SERVICES 51, 51 (1996).

10. For the period 1980-1985, the NTSB Safety Study estimated 12.34 accidents per 100,000 flight hours, almost twice the rate of 6.69 experienced by the broader nonscheduled Part 135 helicopter fleet. Most HEMS accident statistics are merely estimates since HEMS data are not separately compiled and maintained by the NTSB.

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11. *See Stansbury, supra* note 8.
 12. Appendix A. NTSB synopses of fatal HEMS crashes since January 1, 1988.
 13. *See NTSB Safety Study, supra* note 6, at 7.
 14. *See id.* at 9.
 15. *See id.* at 9-57.
 16. *See id.* at 58.
 17. *See id.* at 61(directing the FAA to amend 14 C.F.R. §135.205 to require EMS helicopters to operate with at least 1 mile of visibility during the day. This section has not been amended as requested by the NTSB).
 18. *See id.* at 64.
 19. Constituents of CAAMS/CAMTS include the American College of Emergency Physicians (ACEP); National Association of Air Medical Communication Specialists (NAACS); National Association of EMS Physicians (NAEMSP); National EMS Pilots Association (NEMSPA); National Flight Nurses Association (NFNA)/Air & Surface Transport Nurses Association (ASTNA); American Academy of Pediatrics (AAP); American Association of Respiratory Care (AARC); National Association of Neonatal Nurses (NANN); National Association of State EMS Directors (NASEMSD); Air Medical Physician Association (AMPA) and the National Air Transport Association (NATA).
 20. *See Eileen Frasier, CAAMS: Summary of Progress and Potential 1990-1994*, 13 AIR MED. J. 398, 398 (1994)
 21. COMMISSION ON ACCREDITATION OF MEDICAL TRANSPORT SYSTEMS, *Accreditation Standards of CAMTS*, Preamble (4th ed. 1999), (hereinafter “CAMTS standards”).
 22. *See Stansbury, supra* note 8, at 52.
 23. *See Merv Letts et al., An Analysis of an Air-Ambulance Program for Children*, 19 J. PEDIATRIC ORTHOPAEDICS 240, 244 (1999).
 24. *See id.* at 244; *See also Paul Cunningham et al, A Comparison of the Association of Helicopter and Ground Ambulance Transport with the Outcome of Injury in Trauma Patients Transported from the Scene*, 43 J. TRAUMA 940, 943 (1997).
 25. *See J.P. Nicholl et al., A comparison of the costs and performance of an emergency helicopter and land ambulances in a rural area*, 25 INJURY 145, 150 (1994); Susan Budassi Shehey, *Justifying the cost of your air medical transport program*, 21 J. EMERGENCY NURSING 564, 564-65 (1995).

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26. See Stansbury, *supra* note 8; Letts, *supra*. note 23; Appendix A; NTSB Safety Study, *supra* note 6
 27. See P.A. Cameron et al., *Helicopter Retrieval of Primary Trauma Patients by a Paramedic Helicopter Service*, 63 AUST. N.Z. J. SURGERY 790, 796 (1993)
 28. See Nicholl, *supra* note 25, at 149.
 29. See Matthew L. Moront et al., *Helicopter Transport of Injured Children: System Effectiveness and Triage Criteria*, 31 J. PEDIATRIC SURGERY 1183, 1185 (1996).
 30. See Cunnginham, *supra* note 24, at 945.
 31. See James L. Owen et al., *One Year's Trauma Mortality Experience at Brooke Army Medical Center: Is Aeromedical Transportation of Trauma Patients Necessary?*, 164 MILITARY MED. 361, 365 (1999).
 32. See Moront, *supra* note 29, at 1185.
 33. See Letts, *supra* note 23, at 245.
 34. See e.g., Richard E. Burney & Ronald P. Fischer, *Ground Versus Air Transport of Trauma Victims: Medical and Logistical Considerations*, 15 ANNALS OF EMERGENCY MED. 1491, 1494 (1986).
 35. Nicholas Benson, National Assoc. of Emergency Med. Services Physicians, *Air Medical Dispatch: Guidelines for Scene Response*, 13 AIR MEDICAL J. 315, 315 (1994).
 36. See *id.* See also Moront, *supra* note 32; Johannes Bonatti et al., *Predictors of short-term survival after helicopter rescue*, 30 RESUSCITATION 133, 137-39 (1995); Eric Savitsky & Howard Rodenberg, *Prediction of the Intensity of Patient Care in Prehospital Helicopter Transport: Use of the Revised Trauma Score*, AVIATION, SPACE, AND ENVIRONMENTAL MED. 11, 13-14 (1995); Benson, *supra* note 34; Catherine C. Carrubba, National Assoc. of Emergency Med. Services Physicians *Criteria for Prehospital Air Medical Transport: Nontrauma and Pediatric Considerations*, 13 AIR MED. J. 317, 318 (1994).
 37. See Savitsky, *supra* note 35, at 11.
 38. See Carrubba, *supra* note 35, at 317.
 39. See CAMTS standards, *supra* note 21, at 41.
 40. Stansbury, *supra* note 8, at 56 (quoting from RE, Varon J: "Air Medical Transport" *The Journal of Family Practice*, 36(3): 313-318, 1993).
 41. See *id.*

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42. *See id.*
43. *See Bonatti, supra* note 35, at 135, 37.
44. *See* Vivianne M. Fonne, *The Effect of Occupational Cultures on Coordination of Emergency Medical Service Aircrew*, 67 AVIATION, SPACE, AND ENVIRONMENTAL MEDICINE, 525, 529 (1996).
45. NTSB Safety Study, *supra* note 6, at 19.
46. *id.*
47. Richard C. Wuerz & Rick O’Neal, *Role of Pilot Instrument Proficiency in the Safety of Helicopter Emergency Medical Services*, 4 ACADEMIC EMERGENCY MED. 972, 972 (1997).