Souls on Board: Helicopter Emergency Medical Services and Safety

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In this issue of *Annals*, Professor Sue Baker and colleagues explore a problem with which many of us are familiar and, I presume to say, are unsure how to solve: fatal crashes of air medical helicopters. It is a subject that is seldom missed by journalists in the lay press and quite often results in a sensational front-page story. It's understandable. Who hasn't marveled at a medevac helicopter swooping down onto a busy highway, just closed because of a serious crash, to whisk off the critically injured? Who is not aware of air ambulances standing ready to transport, at a moment's notice, the most seriously ill and injured from remote locations to the most capable and appropriate medical centers? So when an air emergency medical services (EMS) helicopter crashes, killing the crew and sometimes the patient they were summoned to save, who would argue that it's not noteworthy or sensational? The subject is further fueled by the ongoing public debate about the efficacy of air medical transport, allegations of overuse, the competitive business practices of some air EMS vendors, and severely stretched federal regulatory oversight.

Baker et al performed a retrospective review of 22.3 years of helicopter EMS operations (1983 to 2005) not simply to identify contributors to the occurrence of helicopter EMS crashes but also specifically to explore what factors contribute to the survival of crew and patient when a crash does occur. Their study revealed that crashes in darkness are associated with more than triple the risk of fatalities, bad weather increases the risk 8-fold, and postcrash fire results in a 16-fold increase in the risk of fatalities. In addition to their concern for the risk posed to patients, the authors note that helicopter EMS crewmembers face an elevated occupational risk as well: a rate of 16 times the mean occupational death rate for US workers during the same period.

This article is notable for several reasons. The lead author, perhaps better recognized in the public health community than by emergency medicine clinicians, is a nationally respected epidemiologist who specializes in injury prevention. A pilot herself, she has served on Federal Aviation Administration (FAA) expert panels, she advises the assistant secretary of defense on occupational health issues as a member of the Armed Forces Epidemiological Board, and she is author of more than 170 refereed publications. She is perhaps best known for development of the Injury Severity Score. In short, these findings are the work of an accomplished scientist and advocate for safety and therefore warrant our attention. Second, publication of this article follows 16 helicopter EMS crashes in 2005 (6 fatal) and 13 in 2004 (6 fatal), the highest number of fatal crashes in 2 consecutive years experienced in the industry's history. These crashes were accompanied by a plethora of critical articles in the *New York Times*,[1] the *Wall Street Journal*,[2] and *USA Today*.[3] Finally, the article discusses specific recommendations for improved safety of air ambulance occupants. Many have been debated for years and will likely be debated anew.

Let's put some of this into perspective. There are more helicopter EMS crashes in the news today because there have been more helicopter EMS crashes per year in the last 7 years than in the previous 7 years, roughly 13 per year (1998 to 2005) compared with 5 per year (1988 to 1997),[4] which has resulted in a lot more front-page stories and public scrutiny of the issue. But these headlines seldom explore the denominator. The industry has grown tremendously since the mid 1990s. The Atlas and Database of Air Medical Services (ADAMS) reports that there are between 650 and 700 EMS helicopters operating in the United States today, compared with approximately 300 in the mid 1990s.[4] There are nearly twice as many flight hours logged and twice as many patients flown. The industry estimates that more than 300,000 patients per year are now transported by helicopter EMS. So is the industry flying less safely or is it just flying more? The fatal crash rate for helicopter EMS has remained less than 2 per 100,000 miles flown since 1992 (Figure).[5] Twenty-two years (1980 to 2002) of helicopter EMS operations with a staggering 2,745,207 patients transported resulted in 21 patients losing their lives because of helicopter EMS crashes, a death rate of 0.76 per 100,000 patients flown. Compared with 131 to 292 deaths caused by medical error per 100,000 hospitalized patients, as reported by the Institute of Medicine's *To Err is Human: Building a Safer Health System*,[6] the risk to patients seems less daunting.

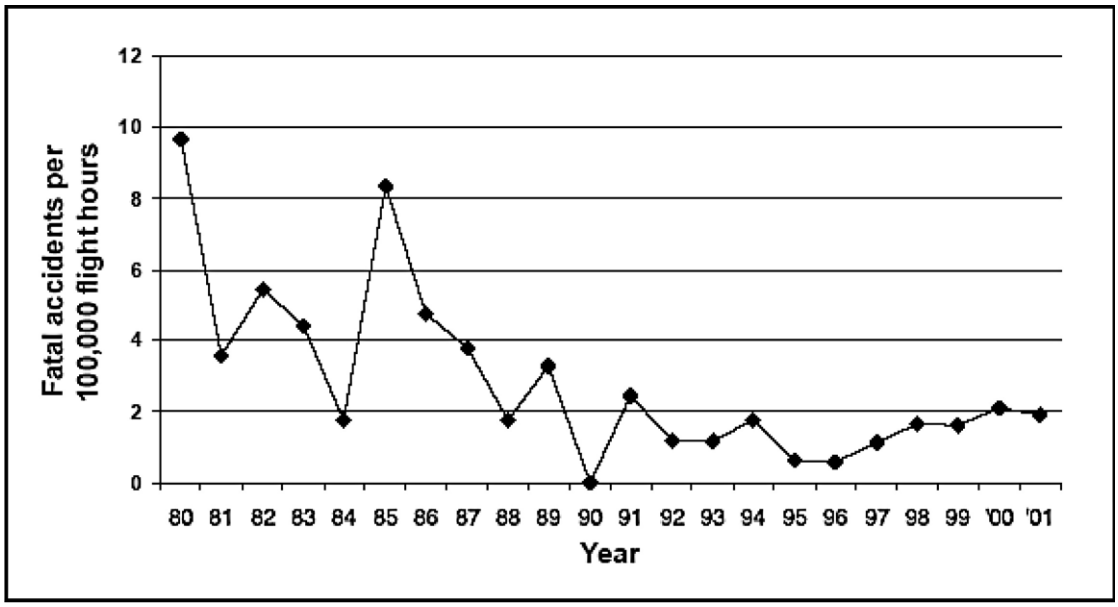

Figure. Fatal accident rates for helicopter EMS operations, 1980-2001. From Blumen IJ, UCAN Safety Committee. A safety review and risk assessment in air medical transport. *Supplement to the Air Medical Physician Handbook*. Air Medical Physicians Association. Salt Lake City, 2002, p. 23.

The risk helicopter EMS poses to flight crews, including pilots, paramedics, flight nurses, and physicians, is palpable. During the same 22-year study period, there were 144 crew deaths. Still, the 22-year average annual odds of a helicopter EMS crewmember experiencing a fatal crash were 1 in 1,158.[5] Incidentally, *The Book of Risks*[7] has published a number of activities that generate a 1 in 1,000 risk of death. By their numbers, 33 hours of helicopter EMS flight time compares with 25 hours of rock climbing, 50 hours of skydiving, and 55 hours of riding a motorcycle.[5]

The dedicated crewmembers of the air medical industry *do* expose themselves to an appreciable level of risk in their profession, greater than that of any other profession tracked by the National Safety Council. And many have lost their lives in the line of duty. We owe them a debt of gratitude on behalf of the patients for whom helicopter EMS makes a difference.

But are the risks faced by helicopter EMS crews and their patients greater than they need to be? Can the industry be made safer for the benefit of these dedicated crews and their patients? The authors certainly believe so, and the air medical industry and the FAA agree.

The authors propose several technologic interventions to improve the safety of helicopter EMS: the introduction of night-vision goggles and helicopters equipped for night-vision flight (at an estimated cost of >$100,000 per aircraft), energy-absorbing seats and landing gear, and crash-resistant fuel systems. Recommendations for improved decisionmaking are also offered, which include improved medical-necessity algorithms to ensure appropriate use, alternatives to flights at night, and standardized fly/no-fly decision protocols for pilots. What the authors and the FAA lack are the cost-effectiveness and feasibility studies required to determine the best selection of interventions to decrease the fatal crash rate.

At an Air Medical Safety Summit convened in 2000 by industry and safety experts, the effectiveness and feasibility of 56 individual issues related to helicopter EMS safety were categorized[8] (Table). Included on this list were technologic applications and, perhaps more important, interventions intended to raise the level of critical thinking among pilots, crew members, and corporate management about helicopter EMS operations and safety. The Air Medical Safety Summit reached consensus on recommendations, but they too lack effectiveness and feasibility studies, which makes sweeping regulatory mandates challenging. The FAA is working with industry to find tenable solutions.

What is the emergency physician's role in all this? Most of us have little input into how research funding is allocated, whether FAA regulators will more closely scrutinize the industry's compliance with its operating instructions, or whether the industry will adopt the voluntary initiatives recommended by the FAA to mitigate crash risk factors. What we *can* influence is appropriate use of air medical units.

The stories of crews walking a patient with shoulder pain to board a medevac helicopter must stop.[9] The exposure of flight crews and patients to any risk must be outweighed by the expected benefit to the patient. A recently published abstract concludes that a majority of patients (60%) transported by helicopter to trauma centers have minor injuries; 26% were discharged within 24 hours.[10] Before chiding the flight crews for ferrying low-acuity patients, we must recognize that approximately 70% of helicopter EMS transports are interfacility transports, meaning that in the majority of transports, the sending physician has input about

Table. Interventions to improve aviation safety matrix, organized to indicate effectiveness and feasability.

FEASIBILITY \ EFFECTIVENESS	High	Moderate	Low
High	• Enhance the training for night flying operations • Enhance the training for mountain flying operations • Equip aircraft with Terrain Avoidance Warning Systems (TAWS) • Equip aircraft with radar altimeters • Provide aircraft with mission-essential equipment • Improve the content of weather briefings	• Enhance the awareness of accident causes • Improve physiological training • Improve training with avionics equipment: usage, capabilities, etc. • Improve weather radar • Encourage greater utilization, interaction with and assistance from Air Traffic Management • Improve/enhance training of ATC personnel in rotorcraft operations and capabilities • FAA to enhance training elements of Biennial Flight Reviews and Pilot Training Standards	• Readily available crew/passenger briefing cards • Fuel flow indicators • Simplify calling FSS • Publish a mountain flying advisory circular • Publish a "flat light/whiteout" advisory circular • Require flight plans • Provide more UNICOM frequencies
Moderate	• Conduct/enhance annual IFR proficiency checks • Conduct/enhance training to improve the understanding of weather briefings • Enhance overall training: recurrent, professional knowledge, etc. • Conduct/enhance training in ADM • Establish an integrated and structured Pilot Training Program • Conduct/enhance mission-oriented training • Conduct/enhance CRM training • Equip aircraft with Moving Map Displays to provide weather, obstacle, and terrain data • Equip aircraft with avionics to provide a vertical awareness display or warning • Standardize cockpits of similar make/model used in similar operations • FAA to enhance/improve contents of annual IFR proficiency checks • Establish national criteria for the marking of wires and towers	• Operators to enhance training for Biennial Flight Reviews and Pilot Training Standards • Develop helicopter-specific, mission-specific computer-based emergency procedures simulators • Develop satellite-based Communications, Navigation and Surveillance (C/N/S) technology • Increase the rate of commissioning of new AWOS/ASOS (Automated Weather Observing System/Automated Surface Observing System) facilities • Improve aeronautical charts (symbology, data, etc.)	• Improve pilot handbooks • Data link technology • Require annual calibration of fuel quantity gauges
Low	• Horizontal Awareness From Terrain • Synthetic vision • Heads-up display • Night vision devices • Full-motion simulators • Enhance visibility/detection of wires and towers • Change corporate mind-set • Improve safety culture • Improve safety program	• ADS-B (Automatic Dependant Surveillance-Broadcast) Technology • Automated voice call-outs • Over-bank warnings • Excess terrain closure warnings • improve equipment with state-of-the-art technology • Prohibit night flying by non-IFR rated pilots • Require human factors/ergonomics in cockpit designs	• Increase dual-pilot time prior to solo PIC • Increase time requirements for "mission certification" • Obstacle database • Enhanced ice detection equipment • Raise minimums for night instrument approaches • Require ATC monitoring of instrument approaches • Prohibit night VFR • Update FAR Part 135 requirements • Require crashworthy fuel tanks for certification

From Blumen IJ, UCAN Safety Committee. A safety review and risk assessment in air medical transport. *Supplement to the Air Medical Physician Handbook*. Air Medical Physicians Association. Salt Lake City, 2002, p. 17.
FSS, Flight service station; *ATC*, air traffic control; *UNICOM*, Universal Integrated Communications; *IFR*, instrumental flight rules; *ADM*, aeronautical decision making; *CRM*, crew resource management; *PIC*, pilot-in-command; *VFR*, visual flight rules; *FAR*, Federal Aviation Regulations.

appropriate use. For the 30% of helicopter EMS operations that are scene calls, physicians providing medical oversight can affect use by ensuring that appropriate regional triage guidelines for helicopter EMS activation are in place, as well as mechanisms to provide quality assurance of the process. The steady evolution of energy-absorbing construction techniques for automobiles, side-curtain air

bags, and other safety enhancements suggests that the criteria for airlifting patients based on injury mechanism should be formally reviewed.

There are patients and physicians both who benefit from appropriate use of air medical transport. Approximately 28% of the US population has access to Level I or Level II trauma center care, within an hour, only by helicopter.[11] Discontinuation of helicopter EMS services was found to have a detrimental impact on mortality in one system for patients undergoing interfacility transfer to a tertiary trauma center.[12] The reality faced by emergency practitioners in many rural hospitals is that critical care units don't exist, and many don't have local specialists comfortable with treating critically ill/injured patients. The Emergency Medical Treatment and Active Labor Act places the responsibility of identifying the appropriate mode of transportation squarely on the sending physician. We won't even touch liability concerns.

Advances in care such as treatment of acute ST segment elevation myocardial infarction with percutaneous transluminal coronary angioplasty, time-critical interventions for acute ischemic stroke, and other services offered by tertiary-care medical centers are likely to increase pressure on helicopter EMS, not reduce it. Determining which patients benefit from helicopter EMS and its highly skilled crews will rest with us and the science of triage. Let's strive to make our decisions good ones because in this business, there are always souls on board.

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