

# Stanford Life Flight: A Silver Anniversary Perspective

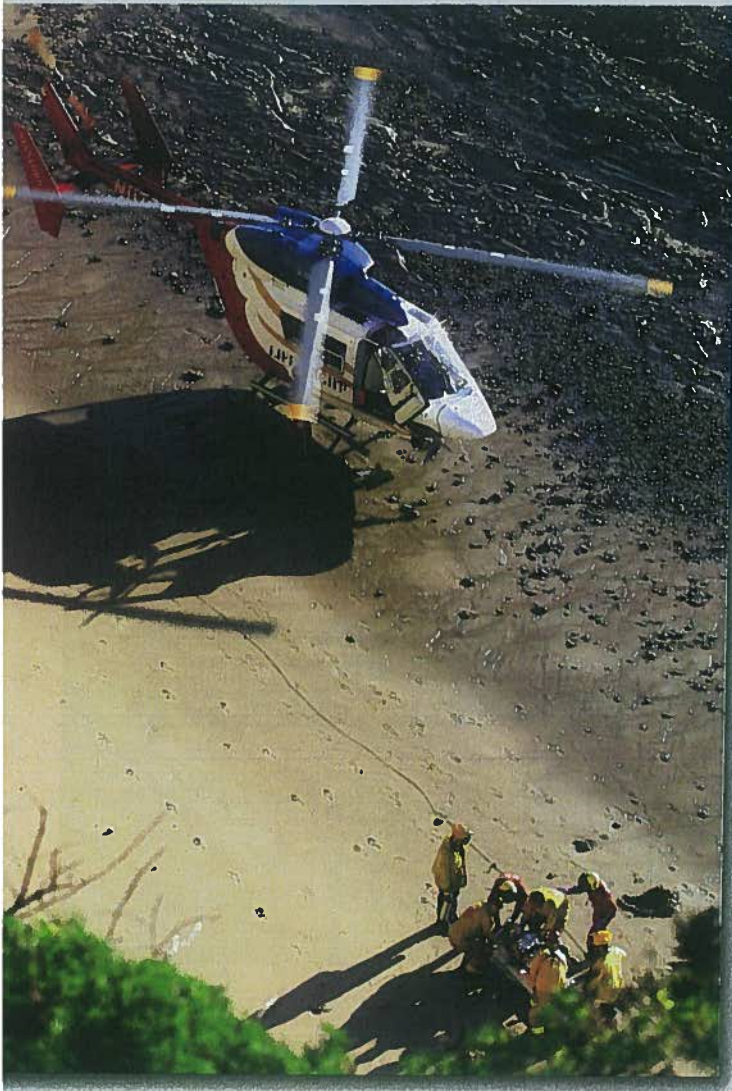
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moving again on a mountain highway. A jack-knifed tractor-trailer truck lay precariously on an uphill embankment. As the CHP officer exited his vehicle, the big rig truck suddenly rolled down the hill, pinning him against his patrol car. The trailer swung around, dragging and throwing him into the slow lane, where he lay unconscious. A Good Samaritan called 911, and the fire department arrived to stabilize the patient. Weather changes prevented a helicopter landing at the scene, so a rendezvous at the nearest fire station was quickly arranged. The coordination between agencies on the ground and in the air enabled the Stanford Life Flight pilot and crew to organize an alternate landing zone. The officer was flown to the trauma center at Stanford Hospital and Clinics, where he was treated for head, chest, and shoulder injuries. He has fully recovered and has returned to active duty.

Recalling the event, this veteran officer still marvels at the speediness of the 11-minute flight and the expertise and professionalism of the ground and air crews. He says it was an invaluable lesson for him as a first responder "whose business is crashes" to experience being a patient himself. From the scene to the level I trauma center, these crews met the objective of patient treatment within the "Golden Hour"—the 60-minute window between a traumatic incident and the delivery of definitive care at a trauma center. This goal requires seamless teamwork from first responders, fire and law enforcement agencies, and EMS, including air ambulance teams.

Trauma care such as in this case also has undergone significant changes since the inception of Stanford Life Flight. The American College of Surgeons oversees the designation of trauma centers throughout the country, and EMS systems have become increasingly regionalized. Currently, approximately 225 helicopter EMS programs with an estimated 861 medical helicopters are in operation.

Advances such as wireless technology and integrated communication systems (ground personnel, flight crew and operations, and destination hospital) have brought substantial improvements in out-of-hospital care. Examples of these resources are two internet-based interactive tracking systems used by communication specialist personnel at Stanford Hospital and Clinics: EMSsystems is a tool that improves communication among hospitals and EMS agencies, both air and ground, regarding bed status, availability, weather issues, advisories, multicase incidents, and disasters by providing real-time communications and resource management and maintaining an EMS database; and Air Methods Flight Tracker is a system based at Operations



In May 1984, Stanford Life Flight flew its first medical mission to airlift a 70-year-old woman critically injured in a motor vehicle crash in Santa Cruz to Stanford Hospital. That pioneering flight launched an air medical transport service that would change the healthcare landscape of Northern California. Initially, Stanford's flight program was staffed with a pilot/physician/nurse team flying in an Alouette III helicopter. Today, a Stanford flight crew consisting of a pilot and two flight nurses in an EC 145 aircraft complete approximately 700 transports each year. Nearly 70% of these transports are interfacility transfers, and the rest are emergency or "scene" calls.

The history of air medical transport over the last several decades parallels major developments in emergency care and technology in both flight medicine and aviation. This evolution in emergency medical care and aviation technology has led to decreased morbidity and mortality in critically ill and injured patients and greater safety for the flight team. Following are three case studies from Stanford Life Flight that demonstrate the significant advances in the science of Emergency Medical Services (EMS) aviation over the last quarter century.

## Case Study—Trauma

May 2005

*It began as a routine traffic collision call for the California Highway Patrol (CHP) officer: Clear the road and get traffic*

Control Center in Denver to monitor helicopter activity for the company's aircraft via satellite telephone and global positioning systems (GPS).

Other trends in trauma care over the last few decades that have improved patient outcomes are advances in prehospital care, the advent of critical care transport, improved neurologic care services (leading to a decrease in the pool of organ donors), and increased safety awareness, including the public campaign against "drunk driving." The motorcycle helmet law enacted in California in 1992 has resulted in markedly improved survival rates among helmeted riders. The National Highway Traffic and Safety Administration estimated that the use of helmets reduced the likelihood of motorcycle crash fatality by 37%.<sup>1</sup> Other factors decreasing morbidity and mortality from trauma include improvement in the requirements for sport helmets for children, mandatory infant and child car seats, more crash-resistant vehicles, and auto restraint systems with air bags.<sup>2</sup>

The increasing use of evidenced-based medicine (EBM) has been perhaps the major agent of change in medical practice over the past 25 years.<sup>3</sup> Dr. Marshal Isaacs, Medical Director of the Dallas Fire-Rescue Department (Stanford Life Flight's last full-time flight physician in 1991–92) credits the integration of the best available research evidence with clinical expertise and patient values for much of the improved patient outcomes. Traditionally, he says, both flight programs and emergency departments believed that care processes used in other areas of medicine must also be good for patients in the back of a helicopter; "what was good for the goose must be good for the gander."

Dr. Isaacs continues, "Medicine is rife with examples of interventions that have been discarded when, based upon research, it was determined that they offered patients little or no clinical benefit. In fact, some were detrimental to patients. We no longer utilize rotating tourniquets<sup>4</sup> and the pneumatic antishock garment.<sup>5</sup> Today we have more confidence that the interventions and therapies we conduct for our patients will augment their care and save lives."

Now flight programs use a best practice model and EBM to consider the incorporation of new technologies, treatments, and interventions; the scientific literature is reviewed and studies are conducted. This ensures that these therapies benefit patients and do not add additional risk of harm to patients and flight crew. The use of rapid-sequence induction for airway management,<sup>6</sup> point-of-care laboratory testing,<sup>7</sup> and



thrombolytics for acute myocardial infarction<sup>8</sup> and stroke patients<sup>9</sup> are examples of successful incorporation of new medical treatments. As health reform takes shape, flight programs must continue to critically evaluate the care they provide, to ensure safety, improved patient outcomes, and cost effectiveness.

"Air medical services have earned a seat at the policymakers' tables," Dr. Isaacs says. "There they must advocate for patients to ensure that local treatment and destination protocols are developed to provide the highest quality care and the greatest access to specialized trauma, stroke, pediatric, high-risk obstetric, and other critical care services."

## Case Study—Aortic Dissection

November 2008

A 46-year old man, described by his wife as a "serious athlete," was training for his next triathlon when he experienced sudden chest pain. On arrival at Alta Bates Emergency Department in Berkeley, he was diagnosed with a type A aortic dissection requiring immediate cardiovascular surgery. The emergent transfer to Stanford Hospital and Clinics involved coordinated teamwork from the emergency department, police and fire departments, and the Stanford Life Flight helicopter. The barely conscious patient was transported from the hospital to the helicopter waiting at the landing zone that had been quickly established by police and fire personnel. He recalls feeling the sun on his face and hearing the sound of the helicopter rotor. Most memorable to him, however, was the reassuring voice of his flight nurse during the 17-minute flight en route to Stanford. "Stay with me, we're getting close..." she told him. Ten hours later he

emerged from surgery with a new mechanical aortic heart valve and Dacron tube graft in his aorta. Now the patient is "appreciative every day for the resources of Stanford Hospital and the collaboration between the public safety agencies and Life Flight." He was able to get where he needed to be with speed and expertise. He is back to running 4 days per week and hopes one day to participate in another competitive race.

Among the most time-critical surgical emergencies are ruptured aneurysms and aortic dissections. Dr. Robert C. Robbins, Chairman of the Department of Cardiothoracic Surgery at Stanford Hospital and Clinics, says untreated acute aortic dissections are associated with a mortality rate of 1% per hour.<sup>10</sup> The key to survival is having trained personnel expeditiously transport the patient to an institution such as Stanford that has the capability to operate on such patients.

The Stanford Life Flight team works in collaboration with many specialized medical and surgical services throughout the hospital to provide the highest quality, cutting-edge medical care. That care begins as soon as patient contact is made at the outlying hospital. Life Flight's objective is to "bring Stanford to the patient" by providing tertiary care resources and expertise for the patient and staff at community hospitals throughout Northern California. Initiating protocols that have been developed in collaboration with Stanford's specialized departments ensures that the therapy delivered by the flight team is a direct extension of the care provided at the medical center.

One of the challenges in EMS aviation is the size, weight, and durability of medical devices, especially monitors and life support equipment. Today, critically ill patients can be safely transported by using miniaturized, lighter-weight, more durable and efficient transport medical equipment. A small, portable intra-aortic balloon pump and less cumbersome ventricular assist device, and the ever-expanding skill set of the flight crew, make transport of the unstable patient more feasible, resulting in decreased patient morbidity and mortality.

Dr. Robbins credits the flight program with saving many lives because of the high-quality care, improvements in flight operations, and the use of data-driven multi-disciplinary Quality Improvement projects. "Life Flight is the best. We know the team and maintain a good line of communication to implement the patients' individualized treatment plans. In the future, I envision that we at the hospital will video/teleconference with the patient and staff in the helicopter like 'The Jetsons.'"

## Case Study—Pediatric Sand Aspiration

October 2008

A young boy's birthday party at the beach became a scene of terror after a sand dune cave collapsed on him and two friends, burying them for several minutes. The birthday boy died at the scene, and a second child had minor injuries. The third child, a 9-year-old boy, became the focus of an intense collaboration between Dominican Hospital in Santa Cruz and Lucile Packard Children's Hospital at Stanford to save his life. The boy had aspirated sand into his trachea and lungs, and suffered a tracheal tear. Stanford Life Flight launched an amazing and challenging rescue mission with the best medical team composition for the patient: a specialty pediatric transport team on board, in addition to the two flight nurses.

Before he could be airlifted, the child's rare combination of life-threatening injuries required advanced airway management, utilization of a multitude of resuscitation medications, and placement of chest tubes for his bilateral pneumothoraces. Once safely delivered to Packard, the surgeons and perfusionists placed the child on cardiac bypass while the sand, shells, twigs, and other debris were lavaged from his airways and lungs. He was then transitioned to extracorporeal membrane oxygenation before he was successfully weaned. He was discharged home 1 week later. Presently, the patient's mother states that he has made a full and miraculous recovery because of the "lucky chain of events" involved in this remarkable effort.

This child was fortunate in many ways. He benefitted from the delivery of excellent medical care and the use of a coordinated transport system that has improved the survival of critically injured children. In addition to the emergent treatment he received in the prehospital and



emergency department phases of his injury, advanced communication capabilities and technologies, the speed of the helicopter, and the expertise of the crews made his recovery possible. The scientific research findings available by quick access to a computerized medical literature search helped the Packard pediatric surgical teams to determine the plan for his specialized care.

Stanford Hospital and Clinics and Lucile Packard Children's Hospital are committed to ensuring access to quality pediatric care for all children. Several years before Stanford's adult critical care transport team was created, the hospital-based pediatric transport team was established in the 1970s by Dr. Al Hackel, a pediatric anesthesiologist at Stanford. The current pediatric transport team is composed of a pediatric transport nurse specialist and a pediatric registered nurse. If needed, a respiratory therapist and pediatric resident or fellow can be added to the team.

In 1976, Dr. Hackel developed the California Perinatal Transport System, which coordinates emergency access to the perinatal system for high-risk maternity patients and critically ill neonates. This network assists in referral and transport of perinatal and neonatal patients throughout the state. Neonatal transports (similarly using a team that includes a neonatal transport nurse specialist, neonatal registered nurse, and respiratory therapist as needed), may use air or ground ambulances. The Stanford Life Flight nurses assist these specialty teams when air ambulance transport is needed. Technological improvements in the infant isolette have made it lighter weight and have consolidated its many components to make it more flightworthy, thereby decreasing the transport time for neonates who require a higher level of care.

## Aviation Advances

"Stanford Life Flight's mission has always been to fly as safely, efficiently, and comfortably as possible, to help ensure the best possible outcome for the patient," said Captain Everett Croes, III (Retired), one of the two original Stanford Life Flight pilots. "The biggest challenge now for the industry is safety and to prevent accidents and crashes from happening." Among the many changes over the past 25 years:

- A transition from single-engine to twin-engine aircraft
- Increased capability to use instrument flight rules (IFR) in addition to visual flight rules (VFR)
- Utilization of GPS for scene location from visually spotting and using maps and coordinates
- Implementation of crew resource management (CRM) training for air medical crews (eg, flight nurses assisting the pilot with radio frequencies, landing instructions with first responders, and participation in briefing/debriefing activities)
- A transition to Nomex flight suits and full flight helmets to increase air medical crew safety

"Stanford Life Flight has always met or exceeded the industry standard for EMS helicopter operations," Croes said. "It was a pleasure to fly for Stanford and the best job I ever had."

Current Lead Pilot Doug Evans agrees. "At Life Flight, the culture of safety comes first. The flight program offers the best equipment, best staff, and best training, with no pressure to fly in less than ideal conditions." The emphasis on CRM also allows each member of the flight crew to be empowered to veto a flight if they deem it necessary for safety reasons.

Captain Evans continues, "We have also made technological leaps." Among the many such advances are:

- Single-pilot IFR system (evolving from one-pilot VFR and two-pilot IFR)
- Night vision goggles to enhance visibility and decrease hazards for night flights, especially bad weather scene calls<sup>11</sup>
- Enhanced ground proximity warning system
- Air traffic information systems (TIS) and air traffic collision avoidance systems (TCAS)
- Multi-function displays in the cockpit (GPS, terrain, radar, instrument approach plates, TIS, TCAS, VFR and IFR charts, instrument landing system, Variable Omnidirectional Receiver, and GPS course guidance)
- Satellite-driven weather radar systems (weather reports and forecasts, radar, temporary flight restrictions)
- Digital autopilot
- Helicopter lighting systems including Night Sun, super scanner, and skid lights
- Satellite phone and flight tracking capability

The military has led the way for improved safety in casualty evacuation. The civilian sector has benefitted from the military's development of synthetic vision systems, heads-up displays, and computer-generated infrared-enhanced screens. Also, the increased use of simulators enables testing and training of personnel in critical decision-making skills with the goal of mitigating the human element and enhancing crash prevention. Evans believes these advanced aircraft capabilities will result in improved monitoring and analysis of each flight in an attempt to diminish human error. The Federal Aviation Administration will likely implement increased oversight in all phases of air ambulance operation in the future.

## Conclusion

The birth of modern flight medicine arose from the Korean and Vietnam Wars, and its infancy has mirrored that of emergency medicine during the 1970s and 1980s. The 1990s saw the air medical services industry emerge as an energetic adolescent, with its expected development and maturation. In the new millennium, the science of flight medicine has entered adulthood and today enjoys its rightful place as a critical component of the nation's EMS system.

Stanford Life Flight's experience in EMS aviation over the last quarter century has paralleled evolution in the industry. By embracing the concepts of evidence-based medicine, appropriate use of new technology, advanced crew training, and improved aircraft safety and equipment, its dedicated team of professionals hope to continue to meet the needs of patients and adapt to changes in healthcare delivery.