Air Medical Journal 000 (2023) 1–4

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Featured Article

Air Medical Support for a Peripheral Hospital in Southern Israel: An Evolving Role for the Air Ambulance and Emergency Department Clinicians

Revital Bar-Osher, MD [1], Anthony Bleetman, PhD, FRCEM, FRCSEd [2,*], Hilla Van Zyl, MD [1], Amit Regev, MD [1], Donia Khouri, MD [3], Ata Salman, MD [3]

[1] *Yoseftal Hospital, Eilat, Israel*
[2] *Rabin Medical Centre, Beilinson Campus, Israel*
[3] *Sheba Medical Centre, Ramat Gan, Israel*

A B S T R A C T

The early use of helicopters on the battlefields of Korea and Vietnam led to the introduction of "air ambulances" into civilian practice. Initially, these aircraft were tasked to retrieve casualties and provide conventional paramedic care at the scene and en route to the hospital. The introduction of advanced medical teams on helicopters led to the evolution of helicopter emergency medical service units. Yoseftal Hospital is a 65-bed hospital serving the town of Eilat in southern Israel. It does not offer full intensive care or specialist services but does provide general surgical, medical, pediatric, and psychiatric services. The hospital is 100 km from the nearest tertiary center in Be'er Sheva, an ambulance journey of 2 hours across desert. The hospital serves a population of 70,000 residents and up to 500,000 tourists. Recognizing the need to provide a facility to transfer critical or complex patients, in August 2021, the Israeli Ministry of Health provided a dedicated helicopter to Yoseftal Hospital. The first 100 missions are presented. Forty-four missions were for cardiac presentations. For patients with ST-segment elevation myocardial infarction, the median time from the initial medical contact at Yoseftal to reception at the tertiary center was 141 minutes. Other transfers were for ear, nose, and throat (2); neurosurgical (14); trauma (9); respiratory (6); obstetrics and gynecology (3); and pediatric services (14) and nontraumatic surgical emergencies (15). Our experience validates the need for this resource and highlights the importance of robust clinical, operational, and transfer protocols between Yoseftal and the receiving specialist units. The challenging and diverse clinical activity requires additional skills and competencies for the critical care paramedics on the aircraft. Integrating the flight crew into the emergency department team facilitated early activation of the aircraft and expedited patient preparation for flight. Our experience describes an evolving new role for the helicopter—support for a remote peripheral hospital.

The Wright brothers flew the first powered fixed wing aircraft in 1903. Military commanders rapidly identified a potential role to use aircraft to evacuate wounded soldiers from the battlefield, but this proved largely impractical until the development of the helicopter.[1–3]

Until 1936, controlled vertical flight was still a dream, but since the latter stages of World War II, the use of helicopters has evolved in prehospital care and is now used worldwide in both military and civilian scenarios. The first fully controllable helicopter was demonstrated by Igor Sikorsky in 1936. The US military identified the helicopter as a potentially very useful military asset, and mass production of military helicopters commenced in 1939. On April 23, 1944, Lieutenant Carter Harmon performed the first helicopter evacuation of wounded soldiers in Burma during the Second World War.[4] The use of helicopters in the casualty evacuation role became established in the Korean and Vietnamese conflicts in the 1950s and 1960s.[5]

By the time of the Vietnam War (1961-1972), helicopters were much larger, and a dedicated fleet of medevac helicopters was created [Fig. 1]. Each aircraft could take up to 9 casualties, and a medical technician was able to provide medical care en route to the hospital. Evacuation times to the hospital from the battlefield dropped to 35

*Address for correspondence: Anthony Bleetman, University of Warwick Medical School, Centre for Neuroscience, Surgery and Trauma, 1 Brewery Passage, Faringdon SN7 7HE, London, UK.
E-mail address: a.bleetman@gmail.com (A. Bleetman).

1067-991X/$36.00

https://doi.org/10.1016/j.amj.2023.01.006

minutes. Advances in medical care together with a much faster evacuation time from the battlefield led to a significant reduction in mortality.[5–8] The medevac units in the Vietnam War were centrally coordinated, and advanced care was provided in flight, a model that was incorporated into the subsequent development of civilian helicopter emergency medical service (HEMS) units of the 21st century.

The impact on mortality reduction attributed to the use of helicopters in the Vietnam War was 1 of the major learning points of that conflict [Table 1]. In 1965, a project was set up in Philadelphia known as the Helicopter Emergency Lifesaving Patrol, which was unique in its time because it coupled doctors and medical personnel from Lankenau Hospital with the regional traffic helicopter. Several other units were established in the United States in the years that followed.[9]

In civilian practice, the helicopter has evolved to provide 2 primary functions: as a vehicle to transport casualties to hospital (an air ambulance) and as a rapid response asset delivering advanced medical skills to casualties in the field (HEMS). The air ambulance model provides standard paramedic-level care; the HEMS model flies advanced clinicians (usually medical) to the scene to offer casualties advanced medical and surgical interventions in the field before transfer to the most appropriate medical facility.

HEMS crews can deliver anesthesia, ventilation, thoracotomy, chest drainage, amputation (with some crews), resuscitative endovascular balloon occlusion of the aorta, and advanced invasive monitoring. HEMS crews may also assume a command role at the scenes of major incidents.

In the United Kingdom, the HEMS model has largely replaced the traditional air ambulance model that was prevalent until 2010. The integration of HEMS units with tertiary centers has demonstrated improvements in survival and patient outcomes.[10,11] Improved outcomes have also been demonstrated with timely helicopter transport to specialist centers of patients suffering myocardial infarction, severe burns, and acute coronary syndrome.[12-16]

In Israel, the Israeli Air Force 669 unit was established in 1974. Its intended role was to rescue downed aircrew. The unit's helicopters are crewed by highly specialized, special forces–trained soldiers supported by a doctor and a paramedic [Fig. 2]. Because there were no established civilian air medical service units in Israel, 669 was more often called on to respond to civilian HEMS-type work. Initially, remote rescues of civilians were considered to be useful to 669 crews in providing operational experience with rescues and prehospital medical care, but the additional workload started to distract the unit from its primary role—support for military units.[17] Recognizing the need for a civilian air medical service, 2 units were established in Israel in 2007. These units are managed by Magen David Adom, the Israeli national ambulance service (MDA), and are staffed by paramedics holding advanced clinical skills; they are dispatched principally to trauma scenes to offer HEMS. The units will also respond to nontraumatic medical emergencies and critical care interhospital transfers. One unit is based in Tiberius in the north of the country and the other at Sde Teiman in the Negev Desert in the south.

Eilat

Eilat, a resort at the southern tip of Israel, has a resident population of 70,000. This can increase to 500,000 during the tourist season. The town is served by Yoseftal, a small (65-bed) hospital that provides emergency care, general surgery, general medicine, general orthopedics, pediatrics, maternity services, and some outpatient services. It does not provide neurosurgery, plastic surgery, burns, cardiothoracic surgery, acute stroke, acute cardiology, or maxillofacial services and has a limited intensive care facility. Ambulance transfer time to the nearest tertiary center in Be'er Sheva is approximately 2 hours. The nearest MDA helicopter at Sde Teiman is approximately a 30-minute flight to Eilat.

The Israeli Ministry of Health recognized that transfer times for critically ill patients and those requiring specialist services needed to be improved. A dedicated helicopter was provided for the hospital in 2021 [Fig. 3]. The service is crewed by advanced paramedics and serves primarily for interhospital transfers for the critically ill and those requiring specialist services. The aircrew serve as clinicians within the emergency department when not engaged in flying duties. Incorporating them into the hospital's clinical team ensures that they are clinically involved with the management of patients before activation of the helicopter facilitating early preparation for flight and transfer to the aircraft, continuing care in flight, and handover at the receiving specialist units.

This new service represents a new role for an air medical service (beyond air ambulances and HEMS)—support for a peripheral hospital. We present our experience with the aircraft's first 100 missions and identify successes and areas for improvement.

Results

Between August 12, 2021, and May 30, 2022, the aircraft flew 100 missions. Sixty-three were daytime missions, and 37 were at night. On 14 days during the 9-month period of data collection, the aircraft was deployed twice, and on 2 days, 3 air medical evacuations were required with the need for activation of a second aircraft (the MDA aircraft based at Sde Teiman).

Two patients were neonates (birth to 1 month), 4 were infants (1 month-1 year), and 8 were older pediatric patients (ages 1-14 years). The majority (83%) of the transfers were to Soroka, the nearest tertiary center in Be'er Sheva. The remainder were to other specialist units in Israel. The clinical workload is presented in Table 2.

For all patients, the median time from the initial medical assessment at Yoseftal to reception at the tertiary center was 141 minutes. The average time to activate the flight crew and handover the patient for flight was 15 minutes, the average flight time was 57 minutes, and the average time from landing to handing over the patient was 14 minutes.

A senior emergency physician accompanied the paramedic flight crew on 1 flight for the transfer of a ventilated patient with a penetrating gunshot wound to the chest in readiness for a resuscitative thoracotomy. All other transfers were managed independently by the flight paramedics.

Of the 25 patients with ST-segment elevation myocardial infarction (STEMI), 23 underwent emergency percutaneous coronary intervention on arrival at the tertiary center, and 1 underwent coronary artery bypass graft surgery. All survived to discharge. For patients with STEMI, the median time from diagnosis to takeoff was 78 minutes (minimum = 44 minutes, maximum = 702 minutes, mean = 120 minutes). Delays in activating the helicopter to fly patients with STEMI to the tertiary center were caused by the need to perform prolonged resuscitation in 2 patients before flight and management of cardiogenic shock in 1 who was too unstable to fly. For the rest, there were reported delays in accepting patients by the receiving cardiology team. This was addressed by a review of the transfer arrangements between both hospitals. Ongoing audit will track progress in reducing delays in the transfer process.

Only 2 of the 9 transferred trauma patients underwent surgery (1 a tracheostomy and 1 terminalization [surgical closure] of an

Table 1
The Reduction in Time to Transfer From the Battlefield and the Decrease in Mortality in Conflicts of the 20th Century

Conflict	Time to Care	Mortality Rate (%)
World War I	12-18 h	8.8
World War II	6-12 h	5.8
Korea	2-4 h	2.4
Vietnam	1-1.4 h	1.7

Table 2
An Overview of All Missions Flown From Yoseftal to Tertiary Centers by Clinical Discipline and Condition

Cardiology (44)	Neurologic and Neurosurgical (15)	Trauma (13)	Medical (3)	ENT (3)	General Surgery (10)	Respiratory (6)	`Obstetrics and Gynecology (3)	Vascular Surgery (2)
STEMI (25)	Ischemic CVA (5)	Drowning (1)	Myxoedema coma (1)	Peritonsillar abscess (2)	Gastrointestinal bleeding (7)	Ventilated respiratory failure (2)	Advanced pregnancy with complications (3)	Aortic dissection (1)
NSTEMI (4)	Hemorrhagic CVA (2)	Gunshot wound to the chest (1)	Diabetic ketoacidosis (1)	Neck abscess (1)	Intra-abdominal bleeding (1)	Pulmonary fibrosis (1)		Ischemic limb (1)
Chest pain (2)	Subarachnoid hemorrhage (1)	Traumatic intracranial hemorrhage (4)	Sepsis (1)		Bowel obstruction and septic shock (1)	Pleural effusion (1)		
ROSC after cardiac arrest (3)	Hydrocephalus (1)	Finger amputation (1)			Cholangitis (1)	Pulmonary embolism (1)		
Cardiogenic shock (2)	Subdural hematoma (1)	Unstable spinal fracture (1)				Dyspnoea (1)		
Myocarditis (1)	Intracranial hemorrhage (4)	Genital trauma (1)						
Arrhythmias (3)		Multisystem trauma (3)						
Endocarditis (1)		Renal injury (1)						
Congenital heart defects in neonates (2)								
Pericardial effusion (1)								

ENT = ear, nose, and throat; NSTEMI = non–ST-segment elevation myocardial infarction; ROSC = return of spontaneous circulation; STEMI = ST-segment elevation myocardial infarction.

Figure 1. The evacuation of wounded soldiers in the Vietnam conflict on a Bell 105 helicopter. Care was provided en route to the hospital by a combat medical technician.

Figure 2. The 669 unit provided most of the HEMS responses in Israel.

amputated digit). One of the 3 transferred stroke patients underwent thrombectomy.

For general surgical patients, the average time from the decision to transfer to handover at the tertiary center was 516 minutes (range, 211-1,031 minutes, median = 394 minutes). Two underwent endoscopy, 1 had abdominal surgery for bowel obstruction, and 1 underwent abscess drainage.

The pediatric patients presented significant clinical challenges for the aircrew. One of the 2 neonates had been resuscitated from cardiac arrest; the other had a congenital heart defect and underwent cardiac surgery on arrival at the tertiary center. Both required careful use of inotropic and ventilatory support, areas in which the flight paramedics felt underprepared.

From an operational perspective, operating in a very hot environment creates several challenges. From May to September, the average daily temperature reaches 38°C during the day and 27°C at night.[18] The aircraft's avionics are designed to work at a temperature not exceeding 25°C. Many drugs carried by the flight crew may degrade and be ineffective if exposed to high temperatures. Additionally, the

Figure 3. Yoseftal Hospital's Bolkow 117 helicopter asset started operations in 2021.

aircraft's performance in high temperatures is degraded by virtue of a reduction in air density. To combat the problems of operating an aircraft in this climate, when the aircraft is on the dispersal area, it is kept cool by keeping it under a cover and pumping in cold air from an external air-conditioning unit. The aircraft's weight and balance calculations are critical when operating in this environment.

Conclusions

Deployment of the helicopter in the civilian air medical role has evolved into 2 principal roles: transporting patients to hospital (air ambulance) and the provision of advanced care in the field before transport to a specialist center (HEMS model). We described a new air medical role for helicopter—support for a peripheral hospital for critically unwell patients requiring initial management and onward safe and rapid transfer to tertiary centers.

Integrating the flight crew into the emergency department team facilitated early activation of the aircraft and expedited patient preparation for flight. The integration of the paramedic aircrew into the emergency department has enabled us to maintain and develop their clinical skills because it is evident that they are required to care for patients with a very broad spectrum of ages and clinical presentations. Through our reporting and debriefing process, we have identified learning needs that will be addressed within the hospital through education and simulation.

References

1. van Wijngaarden M, Kortbeek J, Lafreniere R, Cunningham R, Joughin E, Yim R. Air ambulance transport: a quality review. *J Trauma*. 1996;41:26–31.
2. Macnab AJ. Air medical transport: "hot air" and a French lesson. *J Air Med Transp*. 1992;11:15–18.
3. Sanders MJ. *Mosby's Paramedic Textbook*. 2nd ed. London, UK: Mosby; 2001:1374–1385.
4. Grant RG. *Flight: 100 Years of Aviation*. London, UK: Dorling Kindersley Ltd; 2002.
5. Neel Jr. SH. Helicopter evacuation in Korea. *U S Armed Forces Med J*. 1955;6:691–702.
6. Driscoll RS. New York Chapter History of Military Medicine Award. U.S. Army medical helicopters in the Korean War. *Mil Med*. 2001;166:290–296.
7. Lilja GP, Swor R. Emergency medical services. In: Tintinalli JE, Krome R, Ruiz E, eds. *Emergency Medicine: A Comprehensive Study Guide*. New York, NY: McGraw-Hill; 1978:189–192.
8. Rodenberg H, Blumen IJ. Aeromedical transport and in-flight medical emergencies. In: Marx J, Hockberger R, Walls R, eds. *Emergency Medicine – Concepts & Clinical Practice Volume 1*. 4th ed., London, UK: Mosby; 1998:334–350.
9. Holmes E., 1997, Available at: http://members.cox.net/eholmes333/soun-pg4.html. Accessed January 22, 2004.
10. Taylor C, Jan S, Curtis K, et al. The cost-effectiveness of physician staffed helicopter emergency medical service (HEMS) transport to a major trauma centre in NSW, Australia. *Injury*. 2012;43:1843–1849.
11. Sullivent EE, Faul M, Wald MM. Reduced mortality in injured adults transported by helicopter emergency medical services. *Prehosp Emerg Care*. 2011;15:295–302.
12. Youngquist ST, McIntosh SE, Swanson ER, Barton ED. Air ambulance transport times and advanced cardiac life support interventions during the interfacility transfer of patients with acute ST-segment elevation myocardial infarction. *Prehosp Emerg Care*. 2010;14:292–299.
13. Chipp E, Warner RM, McGill DJ, Moiemen NS. Air ambulance transfer of adult patients to a UK regional burns centre: who needs to fly? *Burns*. 2010;36:1201–1207.
14. Rinburg AN, Thomas SH, Steyerberg EW, van Lieshout EMM, Patka P, Schipper IB. Lives saved by helicopter emergency medical services: an overview of literature. *Air Med J*. 2009;28:298–302.
15. Hata N, Kobayashi N, Imaizumi T, et al. Use of an air ambulance system improves time to treatment of patients with acute myocardial infarction. *Intern Med*. 2006;45:45–50.
16. Nishigoori S, Kobayashi N, Shibata Y, et al. Helicopter emergency medical service for patients with acute coronary syndrome: selection validity and impact on clinical outcomes. *Heart Vessels*. 2022;37:1125–1135.
17. Wikipedia. Unit 669. Available at: https://en.wikipedia.org/wiki/Unit_669. Accessed November 1, 2022.
18. Climate and average weather year round in Eilat, Israel. Available at: https://weatherspark.com/y/98152/Average-Weather-in-Eilat-Israel-Year-Round. Accessed November 1, 2022.