

equipment. This is also true for technical rescue gear. Therefore, the Research and Development (R&D) section of Unit 669 is in constant search of lighter and more portable monitor devices, for instance, replacing table-top pulse oximeters with portable ones such as the Nonin mini pulse oximeter.

Other aspects of R&D are the search for smaller, lighter and more user-friendly constructs of tourniquet devices, hemostatic dressings and mini-respirators that can be used while carrying a patient on a stretcher or during winch-lifting of the stretcher to the helicopter.

Better, smaller, lighter, more compact and more sophisticated tools will improve capabilities and enable the rescue team to provide better pre-hospital medical care to military personnel as well as to civilians.

DISCUSSION

Air rescue and evacuation is comprised of four types of operations: rescue of air crews, aeromedical evacuation, air inter-hospital transfer and long range medical air repatriation.

In most militaries around the world, each one of these tasks is executed by a different unit or service. Unit 669 executes all of these missions and is capable of performing them, 24/7/365, countrywide and abroad.

From a medical point of view, the unit adheres to the Military Edition of the ATLS/ PHTS. The PHTLS states that the casualty's best chance of survival is if he or she can reach a definite care medical facility (Echelon III or IV) within one hour of the injury ("The Golden Hour") [6]. Implementing this principle in a military scenario is very challenging. Air rescue services like Unit 669 support this effort by substantially shortening the evacuation time and by moving rescue and medical capabilities closer to the scene of injury and, if indicated, overflying lower grade Echelons.

A team of a physicians assisted by at least one paramedic is a basic principle in Israeli combat medicine. When the Air Force started to perform aeromedical evacuation missions in the late 50's, it was only natural that the air medical team would be comprised of a physician and a "medic" [8]. In recent years, however, "medics" are gradually being replaced by qualified paramedics.

We believe that the participation of a medical officer with prior military combat experience and a solid background in combat pre-hospital care provides considerable added value to the air medical team in respect of medical and operational decision making. In addition to executing all types of air rescue missions, the unit is required to constantly update its combat air

rescue technique and technologies in order to adapt to the changing global combat environment.

There is an urgent need for developing target-oriented "intelligent" simulators, that will be able to train upcoming air rescue operators and medical teams in the execution of realistic scenarios of different air rescue missions.

Events in recent years demonstrate how contemporary warfare is changing from the classic bi- or multi-national military conflicts to low-intensity-conflicts. This leads to a growing significance of operations in small formations and the enhanced use of special operation units. Therefore, more soldiers, as well as uninvolved civilians, will sustain injuries in areas where medical support and extrication can only be delivered by air.

Over the course of forty years, Unit 669 has grown from an improvised "On Job Training" air rescue service for air crews in need, to a highly professional multi-task unit addressing all aspects of military air rescue and recovery. Nowadays the unit is self-supporting in sorting, training, and maintaining the operational capabilities of its air rescue operators and air medical teams. In view of the changing global combat scenario, the unit is constantly looking to adopt and implement new rescue and pre-hospital medical technologies for the airborne environment.

REFERENCES

- Hurt WW, Jernigton JG (Edit) Aeromedical Evacuation, Management of Acute And Stabilized Patients. Springerverlag, 2003, pp 8-9
- Dorr RF Chopper: First-Hand Account of Helicopter Warfare, WWII To Iraq, Berkley Books, 2005, pp 1-17.
- Dorr RF Chopper: First Hand Account of Helicopter Warfare, WWII To Iraq, Berkley Books, 2005, pp 18-64.
- Dreyfuss U, Beldegrun A, Wald U, Tchernilas J Aeromedical Evacuation during the Yom Kippur War Harefuah, 1983, 104 (11-12): 501-3.
- Ilnai I 669- A Tale of a Special Unit, Kineret, Zemora-Bitan, Devir Publ. 2014 [in Hebrew], pp 127-137
- Prehospital Trauma Life Support [Military Edition], Sixth Edition, 2007, Mosby Elsevier. p 92.
- Prehospital Trauma Life Support [Military Edition], Sixth Edition, 2007, Mosby Elsevier. p 493-591.
- Cohen S Cohen S: Air Evacuation of Wounded Soldiers and Aircrew Rescue Service. In: Management of War Casualties: A Symposium on The Treatment of The Injured In The 1973 Israel-Arab Conflict. Hugh Keartland Publishers 1976: pp 9-16.

to monitor O2 saturation, heart rate, ECG, non-invasive and invasive blood pressure, capnography, temperature etc. A monitor-defibrillator is deployed when needed.

Glucometer, nasogastric tube and urine catheter sets are also available.

For specific missions a portable ultrasound device may be added to the basic medical set.

Medications

A variety of medications are available for the team:

1. Anesthetics
2. Analgesics
3. Medications for medical emergencies
4. Antibiotics

Musculoskeletal immobilization

Spine backboard are available to the rescue team in addition to an immobilization stretcher allowing winch/hoist rescues of patients requiring spine immobilization. Collars and head immobilizers are used for C-spine protection.

A variety of splints and stretch splints are also available.

Patient warming

The patients are actively warmed by covering them with heating blankets (chemical reaction based) and by using connecting fluid warmers to fluid resuscitation lines.

Pediatric Patients

A pediatric kit is available for civil-oriented rescue missions. The bag contains a variety of accessories needed for the pediatric patient: Broselow Tape, pediatric airway management equipment and c-spine collars, pediatric chest drains and vascular access devices.

OPERATIONAL ASPECTS

To complete an air rescue operation successfully, the air rescue operator must be able to perform complex highly technical tasks under very stressful circumstances. An additional quality needed is the ability to interact well with teammates and air crews. Most Israelis enlist at the age of 18-19, meaning that graduates from the ARS are often less than 20 years old when they start their career as qualified ARO's. All these prerequisites necessitate a very thorough and target-oriented physical and mental qualification process that eliminates candidates who do not have the potential to become air rescue operators. Also, during the rather long training program at the ARS,

a considerable number of trainees drop out of the program and only a handful of those who started ultimately graduate.

The primary responsibility of Unit 669 is to provide air-rescue services to IAF air crews. The unit further renders air-rescue services to the entire IDF. Since there is only one civil air rescue service in Israel, Unit 669 also provides air rescue services to civilians in areas that can only be accessed by air. To perform all of these duties efficiently, 669 teams are on call 365/24/7.

Unit 669 responds to emergency calls from anybody in need, including civilians, Israeli or non-Israeli, within the borders of Israel and beyond, such as ships in distress in the Mediterranean Sea or wounded or sick Israelis on board fixed-wing aircraft from abroad who need air repatriation.

Routinely, the air rescue team (air rescue operators, physicians and para-medics) is assembled "ad hoc" for a weekly tour, during which the team is on call 24/7. Unit 669 does not operate air rescue dedicated helicopters. Having completed a mission, the team returns to the unit for debriefing and refreshing of equipment. The debriefing process addresses operational and medical aspects and if necessary there is also a specific psychological discussion of outstanding stressful events. Afterwards, the team resumes its standby duty until the end of the tour.

Unit 669 also operates a special subdivision for search and retrieval of IAF personnel who are Missing-In-Action (MIA). This subdivision is instrumental in locating persons who have been missing in IAF actions of as early as the "War of Independence" of 1947-49 or their remains. This type of mission is executed by officers and NCO's who received special training in MIA search and recovery techniques.

RESEARCH & DEVELOPMENT

Since the nature of a standard air rescue mission is unknown, air rescue technical and medical equipment must be applicable for most types of possible scenarios (air crew rescue on land or sea, aeromedical evacuation from friendly or hostile area, etc.). Furthermore, the team must be capable of operating in different types of helicopters and also on board military fixed-wing aircraft. Preparedness for many different rescue scenarios necessitates the availability of a very large and heavy contingent of technical and medical equipment. Since space and weight are crucial in all helicopter missions, the present trend is to use, wherever possible, gear made from lighter composite materials and portable versions of standard medical

the downed pilots, wounded soldiers or civilians, the goal is to bring the rescued person back alive and take them to an appropriate medical facility. Therefore, medicine is a key element in the mission of the rescue team.

Every rescue team has the means to stabilize trauma or other life-threatening situations with a "Basic Medical Kit". For specific missions, medical equipment and capabilities may vary from a reduced basic medical set-up to the installation of an OR table and ICU stations.

The basic medical kit is comprised of personal gear and team gear. The personal gear is carried by the ALS providers and by the operators in their vests and backpacks. The team gear will remain on the platform (vehicle, helicopter or fixed wing aircraft) and be taken off only when needed.

The unit's medical arsenal is subject to the same requirements as any other warfare and rescue equipment: compact, lightweight, durable, shock-resistant, and portable. It must be mentioned that some medical electronic devices often cannot be used on board military aircraft because of functional interference or an electromagnetic signature that may jeopardize the mission.

669 Basic Medical Kit:

Airway management

Every member of the rescue team carries an oral airway in his vest.

Each ALS provider has means to secure an airway:

1. Orotracheal Intubation (OTI) kit with a variety of tubes and laryngoscope blades.
2. Cricothyroidotomy kit.
3. Supraglottic airway device.

Every rescue team also has a video laryngoscope.

Airway management

Every member of the rescue team carries an oral airway in his vest.

Each ALS provider has means to secure an airway:

1. Orotracheal Intubation (OTI) kit with a variety of tubes and laryngoscope blades.
2. Cricothyroidotomy kit.
3. Supraglottic airway device.

Every rescue team also has a video laryngoscope.

Oxygenation and ventilation

The medical gear includes oxygen cylinders (either steel or Kevlar), which can be taken off the platform (depending on the situation). For extended evacuations, large Kevlar

oxygen cylinders may be installed on the platform.

Each ALS provider carries a bag valve mask. An automatic electric ventilator is available but usually remains on board the aircraft. A pneumatic oxygenator can be taken by the ALS providers but is used only in specific extraction scenarios.

The ALS providers' vests also include chest decompression measures for immediate response in the case of a tension pneumothorax. Sets for chest drains are carried in the backpacks.

Hemorrhage control

Each rescue team member carries tactical tourniquets, bandages and "combat gauze" for wound-packing.

A traction splint and pelvic stabilization device are also available.

Bleeding patients may be given Tranexamic Acid (TXA), and coagulation factors by means of Freeze-Dried Plasma (FDP).

Vascular access

The team's vascular access measures include:

1. Peripheral Venous cannulation kits - carried by the designated medic and ALS providers.
2. Intraosseous access kits - carried by ALS providers.
3. Central venous cannulation kits (including a high flow catheter and a central venous pressure measurement kit).
4. Arterial line and invasive blood pressure measurement kit.

Fluid resuscitation

The rescue team's basic medical set include crystalloid solutions and blood products:

1. Hartmann solution.
2. Saline solution.
3. O-positive packed red blood cells kept in a cooler.
4. Freeze-dried plasma.

The crystalloid solutions and blood products are administered through a fluid heater in order to reach body temperature before being infused into the patient.

Cold whole blood (CWB) is planned to be added in the near future.

Monitoring

A small monitor is carried by each ALS provider for measuring heart rate, O₂ saturation and Capnometry.

Two tactical monitors are deployed when needed,

Medic training in the IDF Medical Corps Academy.

Basic scuba diving course.

Basic and advanced air rescue training including air-to-land and air-to-sea operations.

By the end of this period they become qualified as Junior Air Rescue Operators [JARO] and are eligible to wear the Air Rescue Operator Wings.

During the first year after graduation, operators undergo further training combined with standby duty periods, as junior members of an air rescue team. Following this initial post-qualification period, some of the operators receive further training to become team leaders. Others are sent to officer training to become air rescue platoon leaders.

All qualified air rescue operators serve for a number of years in regular service and then join the reserve force of the unit. Some JARO's are given the opportunity to complete formal one-year academic paramedic training, to qualify as certified paramedics (EMT's). These advanced studies enable them to serve in a combined pararescue & paramedic function.

The medical crew (physician, paramedic) constitutes an integral part of the air rescue team together with the operators. Most physicians and paramedics are reserve officers or NCO's, who also work in their profession as civilians on a daily basis. The medical background of most physicians is emergency medicine, anesthesiology, intensive care or general surgery.

Physicians who join the unit belong to one of two categories:

1. Physicians who have graduated from medical school prior to a five-year compulsory military service. During their service, they served as medical officers of battalions, brigades or special operation units. These physicians are already graduates of the IDF General Officers Course and the IDF Medical Officers Course when starting their regular service. In the IDF Medical Officers Course, they are introduced to the "Pre-Hospital Trauma Life Support [PHTLS] Course" and the "Tactical Combat Casualty Care Course" [TCCCC]. Having completed their regular service, they will join Unit 669 as reserve Medical Officers.
2. Physicians who attended medical school after a three-year compulsory service (mostly in combat units). Before joining Unit 669, they too will graduate from the IDF Medical Officers Course.

Paramedics join the unit after graduation from the

military paramedic school and having completed a three-year military service as a paramedic in a combat unit. Others will finish their compulsory service (mostly in combat units) and then attend a civil paramedic school. All paramedics can serve in the unit only as long as they continue to practice their profession as civilians.

An introductory course is mandatory for all newly assigned physicians and paramedics. This course addresses issues such as familiarization with the helicopter environment and cooperation and technical support to the air rescue operators, and includes lectures on various aspects of medical emergencies and pre-hospital care. Airborne medical and operational "real time" exercises are executed. These are performed under the guidance and supervision of instructors, using the school simulator. These scenarios focus mainly on aspects that differentiate air rescue missions from other types of military or civil pre-hospital care, namely operation on board a small and crowded platform and under adverse conditions of extreme noise, turbulence and poor lighting.

During their first few tours of duty, new physicians and paramedics perform missions under the supervision of an experienced senior physician, who has already participated in a considerable number of missions.

THE AIR RESCUE SCHOOL (ARS)

In 2000 the Air Rescue School [ARS] was formed. The tasks of the ARS are selection and training of all candidates for the air rescue operator program, training air crews (pilots, navigators, auxiliary air crews) in SERE (Survival, Evasion, Resistance and Escape) techniques, and research and development of operational and medical and new air rescue techniques.

Today, most training is conducted by the ARS. For airborne school training, field medic training, and basic scuba diving, candidates are sent to relevant IDF schools outside of the IAF.

Since 2000, the ARS of Unit 669 has trained hundreds of air rescue operators. Most of them will continue to serve as regulars or reserve operators for many years.

It should be mentioned that the selection and training of candidates for physician and paramedic positions is the responsibility of the ARS but is executed by a subdivision for medical operations.

MEDICAL EQUIPMENT

Medical Capabilities and Equipment of Unit 669

While the combat skills and technical rescue and extraction skills of the rescue team are crucial for retrieving

Table 1: Estimated numbers of evacuees during military conflicts in Israel

Conflict	Year	Unit	Numbers
War of Independence	1948-49	Various	Sporadic
Sinai Campaign	1956	AMEP	120
Six-Day War	1967	AMEP	600
Yom Kippur War	1973	AMU 386	5000
First Lebanon War	1982	Unit 669	2000
Second Lebanon War	2006	Unit 669	700
Operation "Protective Edge"	2014	Unit 669	***

THE FOUNDATION OF UNIT 669

Due to the absence of a formal air rescue service, AMU 386 enhanced by Navy Seal Air & Land ("Navy SEALs") operators, was also called to perform rescue missions of air crews who had abandoned their aircrafts. However, AMU 386 teams were trained mainly for aeromedical evacuation missions and received only basic training in air rescue techniques and even fewer opportunities to gain operational experience.

During the "Yom Kippur War" (1973), a significant number of air crew members were killed or fell into captivity, because the IAF lacked professional air rescue capabilities like those that the United States Air Force (USAF) developed during the Vietnam Conflict (1965-1975). Therefore and immediately after the "Yom Kippur War", the IAF decided to form a new unit capable of performing missions similar to those executed by USAF Pararescue Technicians. The new unit was named Air Rescue Unit 669.

Unit 669 was formed in 1974 with the primary mission to save downed air crews. At that time the IAF had very limited knowledge and experience related to air crew air rescue. Therefore, some officers were sent to train at the USAF Pararescue School. Specific skills such as rope rescue and arctic survival were taught by civil specialists. By the end of this year, the first six operators graduated, after having completed a nine-month improvised training program. A second group of four operators graduated in 1975 [5]. All of these graduates were drafted from other IDF units after having volunteered to serve in this new and unknown unit. In the following years, and after Unit 669 became known to the public, the number of candidates for

military service who expressed their wish to volunteer for the unit grew rapidly. Today the unit can select its future trainees from a large contingent of candidates.

As a special operation unit, the basic concept is that the future Israeli air rescue operator must receive dual training: First he must become a highly qualified airborne "ranger"-type infantry operator, to be followed by an extensive technical, combat-oriented training program to master all techniques needed for rescuing downed air crews. During its early years, Unit 669 received medical support for its operations from teams of AMU 386 who joined every air rescue operation. The growing cooperation between the units led to the decision to unite them. By the end of 1978, the units had merged under the name of Unit 669 for Operational Air Rescue and Evacuation.

Today, Unit 669 is comprised of the following subdivisions:

Operations:

- Air Rescue Operations
- Medical Operations
- Missing in Action [MIA] Branch
- The Air Rescue School
- Research & Development
- Logistics & Administration

CANDIDATES' SORTING & TRAINING

An air rescue mission is a very complex and stressful event. It is conducted under much uncertainty, on board the small and very crowded platform of the helicopter, under conditions of extreme noise and turbulence and often in the dark of the night. Under such circumstances all members of the rescue team, together with the air crew, must function in perfect coordination to complete the mission successfully. Being a military unit, many missions may take place on hostile terrain and beyond enemy lines. Therefore, like most other elite units in the IDF, all 669 operators are volunteers.

Candidates must successfully pass a "Sorting Camp", during which they will undergo a series of physical and mental tests to evaluate their physical and mental potential to become future air rescue operators. Usually the qualification process takes place during the candidate's 12th high school year. Candidates who successfully pass the "Sorting Camp" will start a 72-week training program that includes:

Basic and advanced infantry training, including airborne training.

UNIT 669 FOR OPERATIONAL AIR RESCUE AND EVACUATION

U. Dreyfuss, MD MSc, Colonel (Res.), Unit 669

O. Almog MD, Major, Former Commander, Medical Branch, Unit 669

E. Aviram, MD, Lt. Colonel, Former Commander, Medical Branch, Unit 669

R. Arnon, MD, Colonel (Res.), Unit 669

E. Carmon, MD, Colonel (Res.), Former Surgeon General, IAF

Y. Ehrlich MD, Colonel, Surgeon General, IAF

Israel Air Force Institute for Aviation Medicine, Tel Hashomer, Israel

ABSTRACT

Unit 669 is the Israel Defense Forces (IDF) Air Rescue Unit. The unit was formed in 1974 with the primary mission to save downed air crews. Today, the unit's range of operation includes: rescue of air crews, aeromedical evacuation, air inter-hospital transfer and long range medical air repatriation. This article commemorates forty-four years of the unit's operation. Following a historical review, issues of sorting and training of candidates, operational and medical equipment for air rescue missions, and some operational aspects are discussed.

EARLY DAYS

Hostile activities started in Palestine immediately after the United Nations' decision of November 29th, 1947, on the founding of a Jewish state in Palestine. Following the Declaration of Independence, the State of Israel was founded on May 14th, 1948. The "War of Independence" started immediately afterwards and lasted for 13 months (May 1948 – July 1949). During this war, wounded soldiers were occasionally transported by air from forward first aid stations to rear-service hospitals. For this purpose, the nascent Israeli Air Force (IAF) used light transport & reconnaissance aircrafts. They were the property of civil flight schools or in the hands of private owners. Air evacuations were executed without medical supervision. Only medically stable patients, who were able to sit, could be transported. At a later stage of the war, military type transportation aircraft such as C-47 Dakota were purchased. These aircraft enabled evacuation by air of patients lying on stretchers and under the supervision of nurses.

Experience gained from WWII taught us that air evacuation can reduce mortality compared to evacuation by land. Therefore, in 1954 the IAF formed an "Aeromedical Evacuation Platoon" (AMEP) that included general practitioner physicians, nurses and medical orderlies. The platoon was trained to perform long distance air-evacuations on board the transport aircraft of those days (C-47 "Dakota", "Nord Atlas" 2501). The AMEP gained combat experience during the "Sinai Campaign" (October 1956), where 120 wounded paratroopers were evacuated from the Sinai Peninsula to an in-land military air base and from there, by ground transportation, to various hospitals.

In the mid 1950's the IAF purchased its first transport helicopters (Sikorsky S-55 & S-58). The era of rotary-wing aviation introduced new aeromedical evacuation options and allowed "scene to hospital" operations. These missions were performed by the physicians and medical orderlies of AMEP who were retrained to operate on board helicopters.

The Sinai "War of Attrition" (1969-1970) enhanced the activity of the aeromedical teams to such an extent that necessitated the foundation of a formal Aeromedical Evacuation Unit. This unit -"Air Medical Unit 386" (AMU 386) was formed in 1969 and was operational until 1978. During the "Yom Kippur War" (6-24 October 1973) there were over 5,000 combat casualties on both the Egyptian and Syrian fronts.

Table No. 1 summarizes the main wartime air rescue missions in Israel between 1948 and 2012.