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CASUALTY EVACUATION BY HELICOPTER

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ABSTRACT

Three different concepts may be applied to casualty evacuation :

1. Transport the casualty, as found and the quickest as possible, from the accident site to the nearest medical centre.

2. Send a first aid unit to the site and transport the casualty only after having given the first cares required by his condition.

3. Place the casualty in a vehicle, equipped as emergency medical unit, give him the first cares - in particular re-animation - during his transport. Then, evacuation becomes an integral part of the medical treatment. The transport time is thus neutralized.

Up to now, due to the small space available in helicopter cabins, only evacuations according to the first concept could be carried out, at least at the «primary» stage.

One of the latest AEROSPATIALE models - the «DAUPHIN» - while still being in the light helicopter class, offers, in its cabin and luggage hold, a useful volume which is sufficient to contemplate an improved casualty evacuation procedure according to the third concept.

In cooperation with medical services, AEROSPATIALE is designing, for the DAUPHIN, a very modern ambulance installation allowing in-flight performance of all medical actions required for reanimation and small surgery together with transmission of medical data to the hospital which will receive the patient.

A first trial installation was made and tested, in flight, on the occasion of a traffic accident simulation. At the same time, due to quite unpredictable circumstances, the aircraft so equipped was used for an actual evacuation mission, in a particularly serious case. A full success demonstrated the validity of this concept.

SOME HISTORICAL FACTS

The use of aerial transport, for the benefit of Medical Services, is a very old idea.

In 1870, during the siege of Paris, 160 seriously ill, or wounded persons were evacuated by balloons ! The technique of the removable «patient carrying» frame hooked to the balloon was well in advance of its time. The same principle is found on the first helicopters used for casualty evacuation.

The birth of the ambulance aircraft dates from the end of the First World War, and it can be considered that this innovation in casualty evacuation was initially a French idea. Doctor Chassaing rightly deserves the title of «Father of Medical Aviation».

In 1915, he had noted that the wounds of aviators were healing quicker than those of the men fighting in trenches. He thought this was due to the fact that airmen were taken to hospital immediately after landing, thus being cared for sooner, without having to go through the awful stressing period of a much too long road transport. He felt that all casualties should have the benefit of such fast and comfortable evacuation means.

Quickly, between the two wars, the young medical aviation will gain its nobility quarters. During the last world war, the U.S. Forces, in particular, made great use of this type of transport. In the period between the landing on Normandy beaches and the capitulation of Germany, the «Sky-Masters» transported to Great-Britain or to the United States 385576 casualties, 82000 of which during the sole month of April 1945.

The same year, General Eisenhower write : «We have air lifted nearly all the wounded people treated in our front line hospitals, and without any doubt this has saved hundreds, thousands of lives». One Director of the U.S. ARMY Health Service added : «Among the means allowing the saving of the greatest number of human lives, air evacuation is to be placed on the same rank as plasma and penicillin».

In this field, helicopters really made their appearance during the Indochina war only. It was on April 7th, 1950, that they were seen in the Indochina sky. They were two HILLERS 360, each capable of transporting two casualties. Their first action had a significant effect on the troop morale. Quickly, thanks to its manoeuvrability and ability to land practically anywhere, the helicopter has supplanted the aeroplane, at least for primary evacuations.

The Vietnam conflict, involving the United States, consecrated the helicopter both as a war machine and as an ambulance vehicle.

This conflict showed a complete revolution in the casualty evacuation concept through the general use of helicopters: in fact, we saw not only the replacement of the conventional ambulance car by the helicopter, but also the use of aircraft instead of ground vehicles for the transport of casualties. Indeed, 90 % of all casualty evacuations were carried out by rotary-and fixed-wing aircraft, this giving fabulous figures, such as 25 000 air evacuations during the last quarter of 1965 (500 000 men being engaged in Vietnam).

The advantage of this system, besides the comfort offered to the wounded persons, is obviously the speed of evacuation. To give you some idea, let us recall some figures :

- Average useful speed of ambulance cars during World War II : 10 km/hour.
- Average useful speed of helicopters in Vietnam : 130 km/hour.

The concrete result was that the time elapsed between the moment the wound was inflicted and the arrival of the casualty in a hospital had been reduced in the same proportion. The average time of 16 hours, in 1945, had been reduced to 1 hour approximately.

A first thing to be noted is that numerous casualties, who, before the advent of the helicopter, would have died between the battlefield and the hospital, have now a good chance of survival.

A second noteworthy finding is that in spite of a higher percentage of serious casualties, fatality rate has decreased strongly compared with that of previous battles :

– 1914/1918	8 %
– 1940/1945	4.5 %
– Korea	2.5 %
– Vietnam	1.5 % (ARMY) 1.2 % (MARINES)

In 1973, during the Kippour war, the Israeli Medical Service also used the helicopter extensively, but not in the same manner as the U.S. Forces.

Unlike in Vietnam, where helicopters were used right up to the fighting line, this means of transport was rarely used further forward than the battalion medical post, and this for two reasons :

- On economic grounds, «TSAHAL» did not have at its disposal the great number of helicopters available to the U.S. Army.
- Also, because the mobility of armoured units on the battlefield was, in no way, comparable to the relative immobility of positions during the Vietnam war. Therefore, the battalion medical post, due to its low mobility, was the sole forward unit allowing the initiation of evacuation by helicopter.

But, however, in 80 % of cases, aerial means were used for evacuation after the first cares had been given to wounded men.

- Either, for casualties requiring urgent care, using U.S. «IROQUOIS» helicopters, from the battalion medical post to field hospitals installed at the rear.
- Or, using «IROQUOIS» and French «SUPER FRELON» helicopters, from brigade collecting points to hospitals.

The average time elapsed between the wound and the operating table never exceeded 4 hours, for those evacuated from the farthest point. This rapidity clearly explains th very low fatality rate (1.3 %) recorded in Israeli hospital.

Happily, we are no longer on a war footing. The problem fundamentals are widely different :

- the number of evacuations required is greatly reduced.
- however, the geographical scatter of accident sites is very much greater.
- at last, for obvious economic reasons, the possible fleet of available ambulance helicopters is far from having the size of that pushed into service during military operations.

Nevertheless, if the number of evacuations to be carried out is very much smaller, it becomes possible to contemplate the improvement in the quality of evacuations.

THE AMBULANCE HELICOPTER – A REANIMATION AND URGENT CARE UNIT

1. THE HELICOPTER POSITION IN THE AMBULANCE FIELD

In districts provided with an important road network and very dense medical structures, it is out-of-question to contemplate the complete replacement of ambulance cars by an aerial vehicle, such as the helicopter, and this for several reasons :

(a) In some weather conditions, flying may be hazardous or even impossible.

(b) Full coverage of a country by helicopters would require an excessive number of machines and an infrastructure - both in men and materiels - largely out-of-measure.

(c) The full penetration of helicopters in built-up areas is far from being accepted and shall be possible in future cities only.

Therefore, the helicopter is a complementary means of evacuation.

But, however, it cannot be replaced in many circumstances:

(a) For seriously ill or wounded persons, when time becomes an essential factor.

(b) Penetration in areas lacking road network (sea rescue, islands, mountains . . .) or when accessibility by road is temporarily impossible (blocking of motor ways by successive accidents).

(c) Weather conditions preventing road traffic (snow, ice, floods).

In large districts, but with a low density of medical facilities, it is obvious that, in all cases, the helicopter is the most suitable means of evacuation.

2. ROLE OF THE AMBULANCE HELICOPTER

At present, due to the aircraft and installations available to our assistance organisations (Civil Protection - Gendarmerie), evacuation by helicopter is limited to the simple transport of an ill or wounded person, without any possibility of medical action during this operation - the only advantages of this concept being speed and the possibility of collecting the patient in areas inaccessible by ambulance cars.

For an installation of a new generation, intended for the casualty evacuation by helicopter, AEROSPATIALE has retained the following principle :

«Transport must be an integral part of the medical treatment».

Thus, the casualty benefits, not only from a quicker action and a transport time shorter than with conventional means of transport, but he can receive cares right from the onset. Therefore, transport time is neutralized.

The roles of the new generation ambulance helicopter may be summarized briefly as follows :

(a) Primary transport

- Quick access, in the immediate vicinity of the accident site.
- Preparation of the casualty and his conditioning for transport.
- Cares during transport and, if necessary, medical actions required by changes in the patient's condition.
- Transmission to the receiving medical centre of all the information which can be useful to prepare the treatment and on taking over the patient on his arrival.

(b) Secondary transport

The patient having been stabilized and treated in a medical unit has to be transferred to another centre where more suitable equipment is available to continue the treatment.

It is important to be able to continue, in flight, the initial therapy which could be harmful if interrupted. Further, as in primary transport, an immediate medical action found necessary, in flight, by a change in the patient's condition should be possible.

This concept has been developped by AEROSPATIALE in cooperation with Professor BOURRET, Director of the Centre of Research in Traffic Accident Traumatology, of Salon-de-Provence, and Professor SERRES of the Montpellier University.

3. AIRCRAFT CHARACTERISTICS

The helicopter, implicitely defined by the concept outlined above, has a dual role :

- a vehicle function
- a medical unit function

3.1. VEHICLE FUNCTION

The main characteristics required for this function are :

. Availability
. Quick preparation for operation
. Possibility of landing on any spot, in the immediate vicinity of the accident
. Reliability
. Low operating cost
. Capability of right and all-weather flying

These considerations lead us to select a light helicopter, equipped with a skid type landing gear.

Therefore, this selection limits the number of casualties who can be transported on each flight. Statistics derived from traffic accident analysis show that in the majority of serious accidents, two casualties require urgent action and evacuation. Hence, transport capacity has been limited to :

. 2 serious casualties, with possibility of medical action in flight.
. or 1 serious casualty and 2 lightly wounded persons, always with medical assistance
. or 4 lightly wounded persons, with a medical attendant, if necessary, but, practically, without possibility of medical action in flight.

3.2. MEDICAL UNIT FUNCTION

3.2.1. Primary evacuation

(a) Bring to the site :

- The medical team,

- The equipment required to clear the casualty : cutting tools in the case of traffic accidents - spotlights, special equipment in the case of mountain accidents, etc ...

- The medical equipment required to prepare the casualty for transport, in particular shell type mattress, inflatable splints, immobilizing devices, first aid equipment.

(b) Allow easy loading of the casualty already installed on a stretcher or a shell type mattress.

(c) On board and during flight, allow the performance of medical actions required by the patient's condition :

- respirating reanimation
  - lung ventilation
  - tracheal intubation
  - suction - tubing

- Circulatory reanimation
  - blood transfusion - perfusion

  Cardio-vascular electronic monitoring
  - heart stimulation - heart massage
  - defibrillation

- Small surgery

(d) During flight, transmit to the receiving hospital all the information required for the patient reception and the preparation of actions required by his condition, either by radio or by automatic data transmission.

3.2.2. Secondary evacuation

The patient condition being stabilized already, ground preparation is no longer required. However, the in-flight continuation of the therapy may neccessitate the carrying of specific equipment.

- large reserve of air or oxygen

- power source to ensure the operation of special equipment (incubator, artificial lung)

- and so on.

3.2.3. Aircraft lay-out allowing the accomplishment of the «Medical unit» role

If from the weight aspect, the «medical unit» installation is not very penalizing, it is not quite the same as regards the volume required.

The aircraft should have :

- a large hold, easily accessible and capable of accommodating all the equipment required for ground action, the batteries powering the electronic and electric equipment, the air and oxygen reserve and the volumetric respirator.

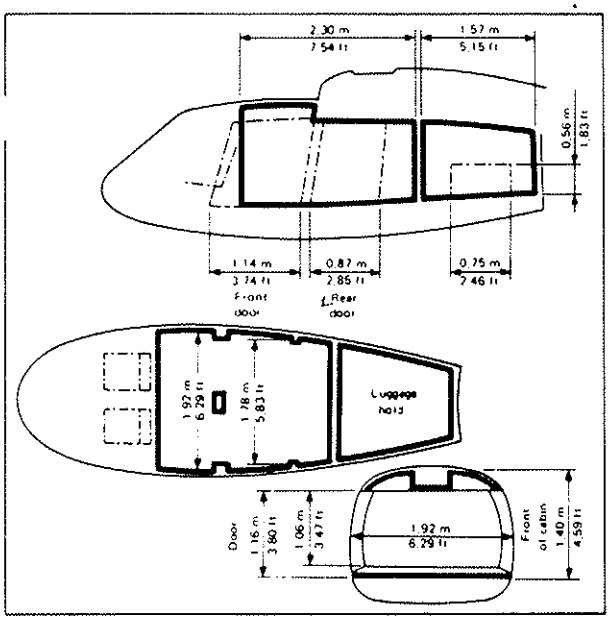
- an amply dimensioned cabin :

  - to allow the installation of the medical team, the casualties, the medical equipment and stowage cupboards for small materiels, various products and medicines.
  - to allow the performance of medical actions in flight.

  - to give a comfort level sufficient to protect the casualty against any harmful effect from the ambient conditions and to allow the performance of the medical team task. In particular :
    - flight stability
    - low vibration level
    - sound proofing
    - heating

4. SELECTION OF THE AIRCRAFT – THE SA 360 «DAUPHIN»

In the range of AEROSPATIALE helicopters, the SA 360 «DAUPHIN» appears to be particularly suited for this role. While still in the light helicopter class, it features a general lay-out and dimensions which fully meet the requirements stated above.



Although its overall dimensions are only slightly greater than those of the ALOUETTE III, it offers an impressive cabin volume of 5 cu.m., a flat floor of 4.2 sq.m., four wide access doors, a separate hold of 1 cu.m: provided with a large door and easily accessible.

Further, the comfort offered by the DAUPHIN is really exceptional, both from the vibration and noise level viewpoints. It is also to be noted that the tail rotor is of the shrouded type (FENESTRON), as it is an important safety factor during ground operations.

But, the subject of this lecture is to present an ambulance installation and not to describe the vehicle, so we shall restrict ourselves to a brief reminder of the DAUPHIN main characteristics.

Characteristics	SA 360 Single-engine
Maximum take-off weight	3000 kg 6615 lb
Useful load	1432 kg 3157 lb
Maximum speed (VNE)	315 km/hr 170 kt
Fast cruise speed	270 km/hr 146 kt
Best-range speed	247 km/hr 133 kt
Maximum endurance, without fuel reserve, at 130 km/hr (70 kt)	3 hours 42 minutes
Range, without fuel reserve, at best range speed.	655 km 350 n.m.
Radius of action, with 20 minute fuel reserve at best range speed	300 km 162 n.m

5. TRIAL INSTALLATION ON «DAUPHIN»

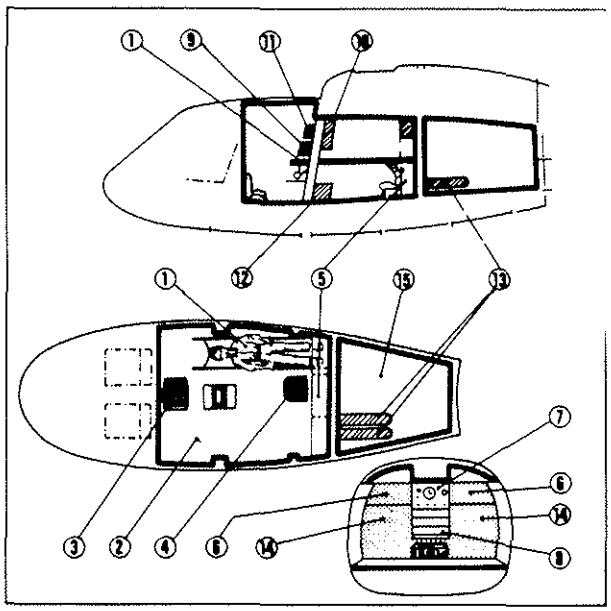
In close cooperation with Medical Services and Emergency Medical units, AEROSPATIALE has designed a first trial installation, whose objective was not to optimize the aircraft for casualty evacuation, but to check the validity of the concept.

In fact, this installation is a flying mock-up.

Obviously, the lay-out, which we are presenting, can not be considered as imposed or final. It has only a proofing value, showing :

- that the space available in the cabin is necessary, but sufficient to realize the installation by the Medical Services, and that this installation is fully operational.
- that the DAUPHIN exceptional comfort qualities - particularly from the noise - and vibration level aspects allow the performance of medical actions in excellent conditions and that the patient evacuation conditions are free from additional traumatism hazards resulting from ambient conditions.

The 3-view drawing below, shows the installation principle



1. Stretcher on its support
2. Second stretcher location (not installed)
3. Seat for reanimator
4. Seat for medical attendant (with folding back to give access to cupboard drawers)
5. Cupboard for the storage of instruments, surgery kits and medicines.
6. Cardiology equipment
7. Volumetric respirator
8. Drawers for the storage of medicines and miscellaneous items
9. Mucus suction device
10. Perfusion - Transfusion
11. Flowmeter
12. Suction equipment, operating from Venturi nozzl
13. Air and oxygen bottles
14. Space available for other medical equipment
15. Hold of 1 cu.m. for the storage of ground equipment (cutting equipment, mattress, immobilizing devices, splints, etc ...).

This diagram is self-explanatory, so we shall not go into all the installation details, all the more as it is the user who has to define the medical equipment required and not the aircraft manufacturer. Obviously it depends on the operating areas and conditions. The role of the aircraft manufacturer is limited essentially to the provisions for accommodating the type of equipment required.

The photo, shown opposite, represents the installation as defined by the MARSEILLE and MONTPELLIER emergency medical units with equipment selected by them. But it can be seen clearly that reanimation and monitoring equipment may be replaced by that of any other make without any structural modification, and there remains a large space available for installing other complementary equipment. (The second stretcher has not been installed. It is located symmetrically to the first strecher).

A very particular point regarding this installation is the stretcher support. Taking advantage of the great cabin length (2.30 m - 7.54 ft), it was desirable to have the possibility of moving the patient in the fore-and-aft direction, in flight, to facilitate the access to the various parts of the body. Further, on medical grounds, it was necessary to be able to tilt the stretcher up or down, as required during flight. At last, it is always difficult to load a stretcher in a vehicle through a side door, as the man who carries the strecher inside the vehicle has to take up particularly uncomfortable positions

The solution retained is an interface system, between stretcher and aircraft, consisting in :

- A rail-borne locking support allowing fore-and-aft motion.
- A light alloy frame accommodating the stretcher and tilting over ± 10°
- A mechanical assembly, allowing the simultaneous rotation and fore-and-aft motion of the above frame. Thus, through a very simple movement, it is possible to push the frame through the rear door for loading the casualty. Retractable telescopic feet ensure the stability in the «out» position.

Loading a casualty

The stretcher support, shown in the various photos, has been designed to accommodate the stretcher of the type used by the emergency medical units. A support suitable for all stretcher types is being designed.

At the same time, studies on stretcher visco-elastic suspension system have been initiated with a view to filtering the vibrations - already at a very low level - transmitted by the floor.

On the photo, shown opposite, it can be noted that when the stretcher is fully rearward, the space thus cleared is sufficient for the reanimator to kneel down behind the patient and perform the intubation operations easily.

At last, for very specific secondary transport, the «DAUPHIN» is provided with the necessary tie-down provisions for special equipment, such as an incubator, and the power sources required for their operation in flight.

In addition, a radio link system capable of transmitting fundamental physiological data is being developed by specialized equipment manufacturers. This programme is sponsored by the French Authorities (D.R.E.T.). Experimentation on the «DAUPHIN» is scheduled for this year.

The DAUPHIN, so equipped, was presented to the second Worl Forum of Reanimation, held in PARIS from September 19th to 23rd 1977, where it was well appreciated by many reanimators.

Quite recently, it was tested under operational conditions, during a traffic accident simulation, by the MONTPELLIER and MARSEILLES emergency medical units, and, in particular by Professors BOURRET and SERRE. Its real efficiency was proved by an unpredictable incident that occured while a film was being taken for didactic and pedagogic purposes.

Early in the afternoon, while the filming team was busy on the landing area of SAINT ELOI hospital, in MONTPELLIER, the emergency medical unit received an urgent call from the hospital of VAISON LA ROMAINE, a small town 120 km away as the crow flies. A man, in his forties, just had a heart attack and his transfer to a specialized cardiology service was urgently required.

But, due to social troubles, no ambulance car was available and the road transport time was not compatible with the patient's condition. Moreover, let us remind you, the aircraft equipment was just a mock-up and - luckily enough - consisted of real medical equipment.

Ten minutes after the call and the loading of assistance equipment, the aircraft took off and, during flight, the crew completed the various electric and pneumatic connections required to make the mock-up operational and ready to ensure the patient's survival during his transport to MONTPELLIER.

Sixty-five minutes later, the aircraft was back to the landing area where the emergency medical team awaited the patient, who had somewhat recovered already as the installation had operated perfectly and allowed the performance, in flight, of reanimation and urgent medical actions required.

It should be noted that the same operation carried out by an ambulance car would have required 4 hours.

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