Anaesthesia and Critical Care in a Helicopter

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Introduction

Despite the title, this paper will not focus solely on Anaesthesia and Critical Care (CC) *inside*, a helicopter. It must be noted, in fact, that the vast majority of civilian helicopter used in Helicopter Emergency Medical Service (HEMS) duties are of the 3-4,5 ton of Maximum Takeoff Mass (MTM), and therefore the inside space is quite limited and does not allow to perform most of the procedure that we deem associated with anaesthesia and CC.

In fact, the HEMS systems view the Helicopter as a mean for *transporting* a highly skilled professional medical team (1) to the site where their competence is needed, being the landing spot, its surroundings. Sometimes the patient may be reached using another vehicle, or, thanks to the so called HEMS-Helicopter Hoist Operation (HEMS-HHO) where no other vehicle may ever arrive, like a mountain, a ship and so on.

So, I will deal with the Procedures that are performed, the Equipment needed to perform this procedures, and discuss them against the logistics nightmares where this will be used. I will also briefly discuss the Drugs that are used, but avoid any in-depth analysis, due to the target of this congress.

I must also state immediately that very few Authors published works in this field, and from my Medline peregrinations the majority of those were coming from the military community. So I will more often than not discuss my personal experiences and views.

Procedures

If we look closely at what happens in the pre-hospital emergency arena, we may point out that the procedures that are performed are usually conducted according to a predetermined sequence based on the clinical priorities. This sequence is usually made easier to remember to the rescue personnel using some kind of acronyms, like A.B.C.D.E.

The most common procedures performed in the pre-hospital arena are:

A-Airways

Securing the patient airways with the positioning of an endotracheal or nasotracheal tube, as well as using different kind supraglottic devices or performing a percutaneous or surgical tracheostomy (2).

B-Breathe

Evaluation and support of patient's ventilation, with the use of bag-valve devices or mechanical ventilation.

In this step may be also included the treatment of a pneumothorax, since this is an absolute emergency that may be dealt immediately.

C-Circulation

This step comprise the control of haemorrhages and if needed the infusion of fluids to compensate for blood losses or other clinical needs. This step imply the need to gain access to peripheral, but sometimes also central, venous lines. Sometimes infusion pumps are used, but this is mostly for precise drug infusion, and not for volume replacement.

D-Defibrillation
This step is self explanatory.

E-Exposure
In this step the rescuers will examine head-to-foot the patient but also install all the needed tools to perform a complete monitoring of the vital signs of the patient.

Equipment
To achieve these goals we may use different equipment and devices, but all of them should specially chosen to work inside a helicopter or worse in the field, that may be a street, the mountain, a shore... And these are quite different logistic conditions compared to what is usually encountered in an Operation Room or an Intensive Care Department or a ground based ambulance (3).

Basically, everything is against the machines: temperature, ranging to extremely hot to freezing low, humidity easily reaching the 100%, rain, dust, vibrations. But very few devices are especially constructed to operate in these conditions, and if the HEMS organization is so skilled as to identify such few machines, their cost is obviously higher compared to the ones normally used inside an OR.

There are a series of problems that should be reminded.

One is the need of electrical power for most of the devices. In fact, many of these equipments may be able to operate under normal main power (220V AC), but also on the power of ambulances (12V DC), or on board of a helicopter (where anything between 12 and 28V DC may be available). Obviously using self contained batteries, these machines are able to guarantee a reasonable autonomous operation so as to complete the rescue operations if all else fails.

Any electrical device used on board of a helicopter, moreover, should be certified for this specific task. This is due to the possible interference of the device with the extensive electronic systems of the helicopter. It is obvious that any interference with these systems may pose a severe risk to the safety of flight, more or less to what happens on board of any commercial flight we may have boarded in our business or leisure travels.

The problem is that this kind of certification is machine specific, i.e. the single device should be tested on board of any single helicopter. These is needed since basically any helicopter is different form any other, although similar, machine. Therefore, the costs rise sky-high.

Looking into detail of some specific device used in the pre-hospital field we may appreciate some peculiarities.

Airway control
The devices used to secure an airway range from the long known traditional laryngoscope, to some alternative devices that may be used especially in difficult airways patients, like the McCoy blade or an assortment of different intubating stylets. A very successful difficult airway tool introduced some time ago is the Airtraq, defined as an “optical laryngoscope” by the producer. Recently a more sophisticated device was made commercially available from Pentax, the ASW, that combines the disposable plastic blades on which

the endotracheal tube is mounted and made slide into the patient's trachea like in the Airtraq, with a more effective fibre-optic monitor that allow a direct high quality visualization of the vocal cords (4)(5).

Ventilation

In the pre-hospital setting the de-facto standard for ventilating a patient is the self-expandable bag valve device, since it needs no power to operate and, in conjunction with an oxygen (O_2) source and a reservoir bag may deliver O_2 concentrations up to 100%.

For a higher quality ventilation many different portable mechanical ventilation devices are commercially available, with a range that goes from basic devices powered only by the O_2 pressure, but usally not extremely friendly to the patient's lungs, to very high end machines, with several ventilation modes, able to perform the most sophisticated breathing assistance.

Circulation

Access to the venous system is still recommended with traditional peripheral large bore catheters. There are some circumstances in which these may not be available, i.e. severely burned or shocked patients, and therefore some equipment for gaining access to a central venous line should be available.

In the pre-hospital settings fluids are usually not administered through infusion pumps, but with a free flow, or if needed with pressure bags to assure a quick delivery.

On board of helicopters there are usually some syringe infusion pumps, that may be used for drug delivery. These are subject to the same logistic problems that were described before, although the vast majority works on internal batteries.

Defibrillation

Cardiac arrest recognizes in a prompt defibrillation the only factor influencing the Return Of Spontaneous Circulation (ROSC). It is well known that defibrillation implies delivering a short burst of energy through the patient's chest, and therefore it should not come as a surprise that the pilots did not like much such a procedure being carried on in a flying helicopter.

It is well known to any physician that defibrillation implies the administration of a very short but very powerful burst of electrical energy through the patient's body. This high energy is one of the main dangers for the helicopter's electrical systems, but also to the whole flying team, since it is difficult to ensure total complete isolation of the patient from the helicopter body, due to the cramped spaces and extensive use of metal conductive parts.

Monitoring

One of the mainstay of anaesthesia is keeping a tough monitoring of the patients vital signs. This ensure that any sudden change is promptly recognized and dealt (6).

The need is therefore for sturdy, lightweight, self powered monitoring devices, able to offer at least the most useful parameters: ECG, peripheral Oxygen saturation (SpO2) (7), Non Invasive Blood Pressure (NIBP), End Tidal CO2 (EtCO2) (8).

Several other parameters may be useful, but they may add complexity, weight and power consumption to the device. Their usefulness must be well weighted therefore.

Conclusions

The pre-hospital arena is a complex scenario, and to the Authors knowledge there are few scientific evidences and honestly we see a very limited interest from the industries, at least compared to the in-hospital setting.

For achieving the best results we hope that more articulate research on this field will be performed from the HEMS services, as well as more cooperation with the Industries in the design process of the devices used in the pre-hospital arena.

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