"IN FLIGHT CATERING": FEEDING CRITICAL CARE PATIENTS DURING AEROMEDICAL EVACUATION

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Introductions

Military and entitled personnel requiring intensive monitoring and clinical support are returned to the UK, from both operational theatres and worldwide locations, by RAF Critical Care Air Support Teams (CCAST) based at Tactical Medical Wing, RAF Lyneham in Wiltshire. The teams are extensively trained for purpose and comprise a Consultant Anaesthetist, Flight Nurse, a Flight Nursing Assistant and a Medical and Dental Servicing Section Technician. The equipment used weighs around 500kg and is independent of aircraft power and oxygen supplies. The CCAST fulfils both a strategic role (returning patients to the host nation) and a tactical role (moving patients of all nations and affiliation within the theatres of operation).

While CCAST missions may be mounted to support operations, exercises, illness or accidents around the world, this review focuses on the strategic evacuation of patients from Op HERRICK and the issues surrounding patient feeding in-flight.

The interaction of nutrition and aviation

Victims of trauma, and in particular those with burn injuries, are catabolic and require supra-normal nutrition to prevent the harmful consequences of negative nitrogen balance [1]. Such complications include impaired wound healing, difficulty in weaning from invasive ventilation and an increased susceptibility to infections. Delivery of nutrition to patients receiving invasive ventilation may be challenging in the civilian population [2]. Problems include incorrectly placed feeding tubes and aspiration of gastric contents [3]. It is generally accepted that when feasible the enteral feeding route is superior over parenteral [4]. Enteral feeding may be accomplished via a tube placed into either the stomach or jejunum. Current practice in the United States military involves placing naso-jejunal tubes when patients are admitted to the role 4 hospital in Germany, prior to return to the USA.

The placement of a cuffed tube in the trachea is the gold standard technique for prevention of aspiration. Modern cuffs are of the high volume, low-pressure variety in order to minimise the harmful effects of pressure necrosis on the wall of the trachea. However, the presence of liquid sitting above the cuff may lead to *micro-aspiration*, whereby material passes the cuff and enters the trachea. This may lead to the development of pneumonia, dependent on the frequency of occurrence. This is addressed in civilian intensive care by measurement of cuff pressure to prevent under or over-inflation of the cuff, positioning the patient at 30° head-up to prevent passive regurgitation of gastric contents and regular suction toileting of the trachea and mouth. Despite these measures, micro-aspiration may still occur. Historically, some endotracheal tubes have been designed to allow suction to be applied to the region directly above the cuff but these are not currently used.

Figure 1

The aim of CCAST is to provide patient care at least as good as that currently existing in the civilian intensive care setting. However, the care environment in the air may predispose patients to risks from micro-aspiration. CCAST patients are exposed to high levels of coarse and fine vibration throughout the flight and during periods of turbulence. They are also exposed to +/- G in all axes, particularly +Gz on take-off and -Gz on landing[a]. Furthermore, due to the requirement for securing the patients and equipment, a head-up position may not be easily achieved (Figure 1). There are no studies in the literature pertaining to the effects of the above on the incidence of micro-aspiration. Another issue specific to the aviation environment is that the volume of air filled spaces increases on ascent as barometric pressure decreases. Subsequently the pressure in a cuff correctly inflated at altitude will fall on descent and increase the risk of micro-aspiration. This pressure change is managed by the frequent use of a Mallinckrodt cuff manometer to add or release air as required.

CCAST missions from OP HERRICK may last up to thirteen hours depending on the requirement to refuel. This provides a useful opportunity to address nutritional requirements early in this patient population; particularly relevant since feeding is often difficult to continue in the role 4 setting in light of repeated trips outside the intensive care unit for surgery and/or investigations, such as CT or MRI.

[a]Gz refers to a gravitational force acting in the longitudinal access of the body. eg a supine patient loaded head first on an aircraft experiences a force down through the head (+Gz) on take-off or up through the feet (-Gz) on landing.

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Obtaining the necessary evidence

CCAST members believe feeding in-flight may be of benefit, but wish to avoid potential complications.

CCAST proposes to undertake a study to look at the incidence of micro-aspiration in this patient population, prior to considering the introduction of a policy on the commencement of enteral feeding.

Several different techniques for the detection of micro-aspiration exist. However some rely upon patient feeding to have started [5]. This may result in patients coming to harm before we know whether the additional stresses of flight increase the risk of micro-aspiration. Other techniques employ the detection of dyes but may result in accumulation of dye at the mitochondrial level [6] where methylene blue exerts cytotoxic effects by interfering with the electron transfer chain, hence its role in chemotherapy [7].

The technique used for detection of micro-aspiration in our study will be via assay of tracheal aspirates for the presence of pepsin [8,9] which will be taken as part of routine clinical care. Pepsin is secreted into the stomach, initially as the pro-enzyme pepsinogen, as part of digestion and its presence within the trachea allows definitive proof of micro-aspiration as one study demonstrated 100% sensitivity and specificity for detection of pepsin in adult intubated patients who were known to have aspirated [10]. Previous studies using pepsin as a marker of micro-aspiration have shown that upwards of 80% of patients may micro-aspirate, but importantly, those who repeatedly do so are significantly more likely to subsequently develop pneumonia [2]. The study will look at periods that may be associated with an increased risk of micro-aspiration such as take-off, landing and during turbulence. This may drive policy towards only feeding at cruising altitude and in stable flight.

Summary

The benefits of early enteral nutrition are well recognised but may be incompatible with CCAST evacuation due to the risk of micro-aspiration predisposing to pneumonia. A study has been approved by the Surgeon Generals Research Strategy Group designed to quantify the risks of microaspiration during CCAST flights in order to inform DMA policy with regard to feeding critically ill casualties during flight.

References

1. Chiarelli A, Enzi, G, Casadei, A. Very early nutrition supplementation in burned patients. Am. J. Clin. Nutr. 1990; **51**:1035–1039.
2. Metheny NA, Clouse RE, Chang Y. Tracheobronchial aspiration of gastric contents in critically ill tube-fed patients: Frequency, outcomes, and risk factors. Crit Care Med. 2006; **34**(4):1007–1015.
3. Metheny NA, Meert KL, Clouse RE. Complications related to feeding tube placement. Curr Opin Gastroenterol. 2007; **23**(2):178-82.
4. Chen Z, Wang S, Yu B, Li A. A comparison study between early enteral nutrition and parenteral nutrition in severe burn patients. Burns. 2007; **33**(6):708-12.
5. Kinsey GC, Murray MJ, Swensen SJ. Glucose content of tracheal aspirates: Implications for the detection of tube feeding aspiration. Crit Care Med 1994; **22**:1557–1562.
6. Gabrielli D, Belisle E, Severino D. Binding, aggregation and photochemical properties of methylene blue in mitochondrial suspensions. Photochem Photobiol. 2004; **79**(3):227-32.
7. Wainwright M, Phoenix DA, Rice L, Burrow SM, Waring J. Increased cytotoxicity and phototoxicity in the methylene blue series via chromophore methylation. J Photochem Photobiol B. 1997; **40**(3):233-9.
8. Metheny NA, Dahms TE, Chang YH. Detection of pepsin in tracheal secretions after forced small-volume aspirations of gastric juice. J Parenter Enteral Nutr 2004; **28**:79–84.
9. Gopalareddy V, He Z, Soundar S. Assessment of the prevalence of microaspiration by gastric pepsin in the airway of ventilated children. Acta Paediatr. 2008; **97**(1): 55-60.
10. Ufberg JW, Bushra JS, Patel D, Wong E, Karras DJ, Kueppers F. A new pepsin assay to detect pulmonary aspiration of gastric contents among newly intubated patients. Am J Emerg Med. 2004; **22**(7):612-4.