High altitude haemofiltration

P E STEVENS, L L BLOODWORTH, D J RAINFORD

Abstract

Evacuating people in acute renal failure by air is difficult because the hazards of fluid overload and anaemia are potentiated by altitude. In two such patients continuous arteriovenous haemofiltration was used to control their fluid problems during aeromedical evacuation. In the first case, a patient with renal failure and blast lung, haemofiltration was performed at 500 ml/h over a four hour journey; in the second, a woman with severe pre-eclamptic toxaemia who developed acute renal failure after caesarean section, haemofiltration was performed at 200 ml/h over a 14 hour flight. Both patients recovered fully.

In these two cases haemofiltration permitted control of the intravascular volume during aeromedical evacuation. The technique represents a major advance in the safe transfer of casualties.

Introduction

The practical difficulties of aeromedical evacuation of casualties in acute renal failure include the nature of the underlying illness, electrolyte abnormalities, fluid overload, and low haemoglobin. The hazards of fluid overload and anaemia are potentiated by altitude.

With the advent of continuous arteriovenous haemofiltration the potential for controlling fluid problems in flight has been realised, thus enabling early evacuation of patients in acute renal failure. We describe two patients moved safely by air using this technique; to our knowledge they are the first such cases.

Case 1

A 31 year old man received multiple injuries in a culvert bomb attack. Despite receiving prompt and appropriate treatment,[1] he developed acute renal failure and blast lung. A Scribner shunt was inserted in his left wrist and he was ventilated via a nasotracheal tube. Haemofiltration was started using 500 units of heparin an hour as anticoagulation.

He was then aeromedically evacuated to the renal unit at Princess Mary's RAF Hospital, Halton; haemofiltration was continued at 500 ml/h throughout the four hour journey, a total of 2 litres being removed (table). He subsequently made a full recovery.

Data on both patients before and after their flights

	Case 1		Case 2	
	Before	After	Before	After
Urea (mmol/l)	26	29	21	28
Creatinine (μmol/l)		577	609	736
Potassium (mmol/l)	5·2	5·2	4·1	4·3
Haemoglobin (g/l)	106	106	78	61
Albumin (g/l)		38	22	22
P_{O_2} (kPa)	9*	20*		10·3†
Central venous pressure (cm H_2O)	10	6·5	6	3

*Inspired oxygen concentration of 0·40 and †of 0·21.
Conversion: SI to traditional units—Urea: 1 mmol/l≈6 mg/100 ml. Creatinine: 100 μmol/l≈1·08 mg/100 ml. P_{O_2}: 1 kPa≈7·6 mm Hg.

Case 2

A 20 year old Falkland Islander with severe pre-eclamptic toxaemia developed acute renal failure after delivery by caesarean section. Peritoneal dialysis was started and after 48 hours she was aeromedically evacuated to Ascension Island. Peritoneal dialysis was suspended in flight and fluids restricted.

At Ascension Island a Scribner shunt was inserted in the left wrist and haemofiltration was started with 500 units of heparin an hour as anticoagulation. She was then aeromedically evacuated back to Halton. Haemofiltration continued throughout the flight at a rate of 200 ml/h, a total of 2·8 litres being removed. She was given 800 ml of human plasma protein fraction during the flight to maintain her plasma albumin (table). She subsequently made a full recovery.

Discussion

Aeromedical evacuation of patients in acute renal failure in peacetime is indicated either if no local facility is available or for security reasons. Many of these patients have severe underlying disorders and fluid balance problems which may make transfer to a renal unit hazardous.

The major concern in moving these patients is safe control of fluid balance and fluid shifts in cramped conditions with a minimum of sophisticated equipment. Fluid overload and resultant hypoxia may occur either because of the underlying condition or because of the particular problems of altitude.

The development of pulmonary oedema is related to left atrial pressure and plasma oncotic pressure[2] and may be enhanced by a reduction in atmospheric pressure.[3] The administration of albumin to an oedematous anuric patient will lead to fluid shift to the intravascular compartment and aggravation of fluid overload. The use of haemofiltration allows us to control the intravascular volume while administering albumin to offset the tendency to pulmonary oedema. Haemofiltration also permits the use of intravenous dextrose and insulin to control catabolism and potassium during the journey.

Peritoneal dialysis is not a safe alternative to haemofiltration in the air because of hypoventilation due to splinting of the diaphragm and the potential hazards of catheter blockages and difficulties in fluid retrieval. Obligatory protein loss may also aggravate the problems of hypoalbuminaemia.

The renal unit at Halton has 30 years' experience of treating patients with acute renal failure by the use of a mobile team. There is no doubt that the facilities available in a specialised unit improve the potential for survival. Early movement back to base is therefore preferable when feasible.

We believe that the use of haemofiltration is a major advance in the safe transfer of casualties and will allow us to effect early transfer in most cases.

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Department of Renal Medicine, Princess Mary's RAF Hospital, Halton, Bucks HP22 5PS

P E STEVENS, BSC, MRCP, senior specialist
L L BLOODWORTH, MB, MRCP, consultant physician
D J RAINFORD, MB, FRCP, consultant in renal medicine

Correspondence to: Flight Lieutenant Stevens.

References

1 Kirby N, Blackburn G. *Field surgery pocketbook*. London: HMSO, 1981.
2 Guyton AC, Lindsay AW. Effect of elevated left atrial pressure and decreased plasma protein concentration on the development of pulmonary oedema. *Circ Res* 1959;7:649.
3 Nunn JF. *Applied respiratory physiology*. 2nd ed. London: Butterworths, 1977.

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