

Renal Replacement in the Deployed Setting

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Abstract

We present a case of a UK soldier suffering multiple injuries in Afghanistan including a lacerated liver, complicated by acute anuric renal failure. His condition was stabilised prior to transfer to the UK using continuous venovenous haemofiltration. This is the first deployed use of renal replacement therapy by UK forces for several decades, and raises questions regarding the provision of this high level capability in the deployed setting.

Introduction

At the start of 2010, facilities for renal replacement therapy in the deployed setting were not available in Camp Bastion (BSN) in Afghanistan, as historically, rapid evacuation to a Role 4 facility has been the management of choice for such patients. In part, this may be due to practical considerations such as the logistical demands of the required, complex equipment, lack of trained personnel for specific deployed equipment and in part due to the relatively low numbers of patients requiring such support. With the intensity of the enduring operation in Afghanistan, and the changing nature of casualties caused in this conflict, it may be reasonable to reassess this policy.

Case Report

A 35yr old UK soldier was injured in an Improvised Explosive Device (IED) blast while on patrol in Afghanistan, suffering arm, chest and abdominal injuries. He was retrieved by the Medical Emergency Response Team within 40 minutes of wounding, and admitted to the Role 3 hospital at BSN 15mins later, where he underwent immediate “right turn resuscitation” and emergency surgery for haemorrhagic shock (systolic blood pressure 50mmHg).

At laparotomy he had packing and repacking of a grade IV liver injury (Figure 1) to the right lobe, caudate lobe and segments IV-VII. His other injuries on post-operative CT scan included bilateral small pneumothoraces treated with intercostal drains, consolidation involving almost all of the left lung, a fractured scapula and associated multiple rib fractures, fractures of the spinous process of C7 and right iliac crest, superficial injuries to his thigh, and a partial degloving injury to the left arm. His Injury Severity Score & New Injury Severity Scores were both 41. He required a massive transfusion, calcium and dextrose-insulin for hyperkalaemia during the five hour laparotomy.

Post operatively, he was admitted to the Intensive Therapy Unit (ITU) where he remained unstable with incipient hepatic failure and anuric acute kidney injury; hypotension was only transiently responsive to ongoing fluid loading. A Critical Care Air Support Team (CCAST) retrieval was arranged, alongside



Figure 1: CT scan showing ruptured liver – post operatively

attempts prior to transfer to improve his overall condition to render this as safe as possible. Following a multi-disciplinary case conference, Continuous VenoVeno Haemofiltration (CVVH) was started using an Aquarius machine (Baxter, Illinois) (Figure 2). This machine and associated equipment had fortuitously been sent to BSN a month earlier when CCAST flights were disrupted by the eruption of the Icelandic volcano Eyjafjallajökull. It had been unused, and was overdue its return to the UK.

Initial attempts to filter without anticoagulation were abandoned, and despite an ongoing coagulopathy associated with liver failure, we successfully used systemic heparinisation with



Figure 2: CVVH in use at Camp Bastion

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low dose unfractionated heparin for the next ten hours, when the patient was transferred to the CCAST stretcher, at which point the circuit was washed back and CVVH stopped. Pre- and post-dilution were also used with Accusol dialysis exchange fluid at a rate of 3500ml/hr and a pump speed of 250ml/min.

Other supportive treatment included ongoing transfusion, both of components and whole blood from an emergency donor panel; noradrenaline (0.8-1.2mg/hr) was required to maintain a mean arterial pressure of 65mmHg and intravenous dextrose 50% at 20ml/hr to correct hypoglycaemia. His haematological and biochemical parameters at various stages of management are detailed in Table 1.

The CCAST transfer to the UK was relatively uneventful, although severe ischaemic hepatitis resulted in continuing fulminant hepatic failure. After arrival at Role 4 in UK he was listed for super-urgent liver transplantation which took place 10 days after initial injury. This orthotopic transplant functioned well with resolution of coagulation abnormalities, but unfortunately he did not wake appropriately. A computed tomographic (CT) brain performed 15 days after his original injury was suggestive of hypoxic brain injury. After discussion with his wife, treatment was withdrawn the following day and he died of his injuries.

Discussion

Although renal replacement therapy is not routinely available in the deployed setting for UK forces, and was last used utilised following combat trauma at least twenty years ago [1], this patient's clinical condition was stabilised using a serendipitously available CVVH machine to a greater degree than would have been possible with simple medical management such as dextrose/insulin, calcium and salbutamol. It is likely that this was instrumental in his successful transfer to the UK.

Historically, the UK approach has been to view rapid evacuation as the optimal management, with in-theatre renal replacement either unnecessary, or difficult to achieve on a sustained basis. Likewise, virtually all renal replacement for US forces is provided once patients have been evacuated to Role 4 facilities in the USA or Europe [2]. The US Hospital Augmentation Team (Dialysis) has never been activated, and the doctrine regarding its use is currently under review.

Although US forces have provided renal replacement mainly using improvised peritoneal dialysis to a small number of predominantly local national patients in theatre [3], this modality is relatively contraindicated for patients with abdominal trauma and is also inefficient for providing metabolic control, especially in severely catabolic patients.

A deployed haemodialysis (HD) service would require a significant uplift in logistic support, such as water purification and permanent on-site maintenance for traditional HD. The water requirement alone for traditional HD is 100-1000L/day. Modern systems designed for home haemodialysis could obviate the need for water processing to a large degree [4].

Haemofiltration has recently been made available to UK forces as part of the option for projecting CCAST forward to a deployed location, although in flight CVVH is not feasible at present. This raises the wider issue of whether other supportive measures such as intracranial pressure monitoring, Novalung® or advanced cardiac function monitoring should also be deployed. These adjuncts may facilitate clinical management and allow more prolonged treatment at Role 3.

Time/Event	Admission to Bastion R3	Post op on ITU	Prior to CCAST transfer	Admission to RCDM R4
FiO ₂	0.50	0.45	0.45	0.80
pH	7.1	7.31	7.27	7.32
pCO ₂	7.62	5.2	5.79	4.98
PO ₂	24	11.4	12.6	10.7
BEx	-12		-6	-4
HCO ₃	18		20.2	18
Hb		11.8		10.2
Plt		118		75
WCC		5.8		3.4
PT		19		1.5 (INR)
APTT		43		
Na	136	141	140	143
K	5.8	6.8	4.5	4.6
urea		9.9		11.6
creatinine		320		363
Total Protein		48		48
Alb		24		32
AST		-		4006
CK		1880		2004
BR		57		81
glucose	13	7.4	9.4	6.1
lactate		10.7	13	12

Table 1: Haematological & biochemical parameters.

Although increasing the deployed capability of medical support has the potential to reduce some of the immediate time pressures on CCAST activation, it also may lead to "mission creep" and unintended consequences. These include difficult ethical and practical choices regarding the treatment of coalition forces and local nationals with similar injury patterns who may be offered very different interventions in the same ITU [5].

In the case described here, the decision to commence CVVH therapy was only undertaken following a joint meeting with intensivists, a physician (nephrologist), surgeons, aeromedical team (CCAST), nursing staff and the hospital deployed medical director.

Conclusion

This case illustrates the proof of concept and potential added value of in-theatre, deployed renal replacement therapy in the intensive care setting. Its use, after due thought, establishes CVVH as practical solution although it does not confirm its sustainability nor guarantee deployed personnel are current in its use.

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References

1. Stevens PE, Bloodworth LL, Rainford DJ. High Altitude Haemofiltration. *Brit Med J* 1986; 292; 1354.
2. Chung KK, Perkins RM, Oliver JD. Renal replacement therapy in support of combat operations. *Crit Care Med* 2008; **36(7 Suppl)**:S365-9.
3. Pina JS, Moghadam S, Cushner H et al. In-Theater Peritoneal Dialysis for Combat-Related Renal Failure. *J Trauma* 2010. **68(5)**; 1253-6
4. http://nxstage.com/chronic_renal_care/products/index.cfm Accessed 11th January 2011.
5. Henning J. The ethical dilemma of providing Intensive Care treatment to local civilians on deployment. *J R Army Med Corps* 2009; **155(2)**: 84-86