Proc EDTA (1982) Vol 19

CONTINUOUS HAEMOFILTRATION MAINTAINS FLUID BALANCE AND REDUCES HAEMODIALYSIS REQUIREMENT IN ACUTE RENAL FAILURE

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Summary

We have used continuous arteriovenous haemofiltration with Amicon 20S Diafilters in combination with conventional haemodialysis as routine management for acute oliguric renal failure in fifteen patients. Haemofiltration provided a variable fluid output of up to eight litres daily, enabling unrestricted nutrition and reduced frequency of haemodialysis.

Introduction

Haemodialysis (HD) when employed in the treatment of acute oliguric renal failure is often applied daily in order to allow adequate nutrition and thus reduce catabolism. Daily HD, however, may impose excessive stress on the patient's cardiovascular system, is time consuming and requires expert nursing and technical assistance. We have evaluated continuous arteriovenous haemofiltration (CAVH) using Amicon 20S Diafilters as a means of establishing a pre-selected, variable fluid output between dialyses thus allowing unrestricted parenteral or enteral nutrition, and reducing haemodialysis requirements.

Device and circuit

The Amicon 20S Diafilter is a small hollow fibre device based on a polysulphone membrane with a surface area of 0.2 square metres. Blood inflow and outflow ports are present at each end of the casing and there is a single filtrate outlet on the side (Figure 1). The device may be connected to the patient by short tubing to any suitable arteriovenous access (we have used Quinton-Scribner shunts). No blood pump or bubble trap is necessary since the device operates on the patient's blood pressure. Heparinisation is usually required and may be provided by continuous infusion of 500 to 1,000 units per hour into the diafilter inflow line. Filtrate outflow is controlled by a gate clamp which may be used to reduce the filtration rate. Filtrate is collected in a urimeter placed at least 40cm below the diafilter.

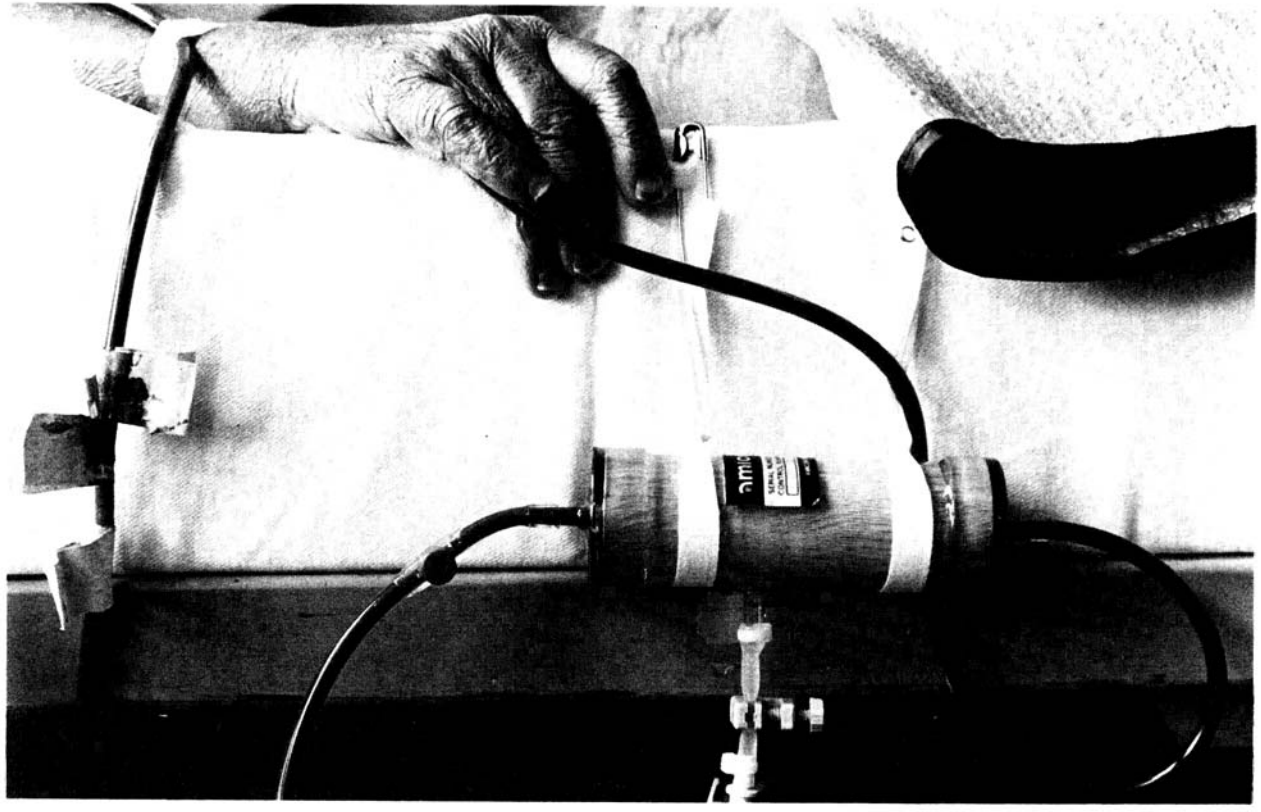

Figure 1. Amicon 20S Diafilter in use, attached to a brachial Quinton-Scribner shunt

Filtrate

The low molecular weight solute content of the filtrate is identical to that in plasma so that the fluid closely resembles unmodified glomerular filtrate. Clearance rates of urea and creatinine are therefore the same as the filtration rate. Calcium is present in its ionised form, incidentally providing a measure of the ionised proportion of total plasma calcium. Similarly water soluble conjugated bilirubin is filtered, retaining the unconjugated protein bound proportion. No significant protein loss occurs and the enzymes alkaline phosphatase and aspartate transaminase are found in very low concentrations. We have not yet measured the amino acid content.

Patients

We have used CAVH during the oliguric phase of acute renal failure in 15 patients. Details of diagnosis and management are given in Table I.

TABLE I. Patient diagnosis and management details

Patient	Age	Diagnosis	Filtrate L/day	Duration of CAVH days	Frequency of HD days	Outcome
1 (F)	45	Pulmonary hypertension ARF	3.5	4	1:4	Dead
2 (M)	34	Rhabdomyolysis ARF	6–8	8	1:3	Alive
3 (M)	26	Trauma ARF	7.5	3	1:2	Dead
4 (M)	61	Aortic aneurysm ARF	7	8	1:3	Alive
5 (M)	50	Colonic resection septicaemia ARF	6	9	1:3	Alive
6 (F)	41	Renal transplant septicaemia ARF	5	2	1:2	Dead
7 (M)	68	Septicaemia ARF	4.8	2	0	Alive
8 (M)	57	Ruptured aneurysm ARF	5–7	3	1:3	Dead
9 (M)	30	Trauma ARF	4.8	5	1:2	Dead
10 (F)	67	Acute on chronic RF	2.5–3	7	1:3	Dead
11 (F)	43	Septicaemia ARF	3.5–5	5	1:3	Alive
12 (M)	34	Pancreatitis ARF	7.2	3	1:2	Dead
13 (M)	66	Ruptured aneurysm ARF	2.5–5	6	1:2–1:3	Dead
14 (M)	32	Trauma ARF	5–7	2	1:3	Alive
15 (F)	49	Legionnaires Disease ARF	2.5–7	28	1:3–1:4	Alive

Blood flow rates through the diafilter varied between 20 and 40ml per minute depending upon blood pressure and haematrocrit. Filtration rates up to 12ml/minute (17 litres/day) were obtained which, following fluid overload correction, were reduced to between 3 and 7ml/minute by tightening the gate clamp on the filtrate outflow. When balance was achieved, the output volume was matched by an equivalent fluid input usually administered intravenously, providing adequate

caloric and amino acid nutrition and including 1.8 per cent sodium chloride in an appropriate amount to maintain sodium balance. A typical fluid regime was as follows: Filtrate, 6 litres per day; intravenous fluid: one litre 20 per cent dextrose, 1.5 Vamin Glucose, 0.5 litre 20 per cent Intralipid (Kabi Vitrum) and 2.5 to 3 litres 1.8 per cent sodium chloride. Trace elements and vitamins were supplemented.

Heparinisation requirements were low and patients were often managed with 500 units heparin per hour into the haemofilter inflow line. Activated whole blood clotting times (Hemochron) demonstrated that at low heparin doses very little systemic heparinisation occurred, whilst diafilter outflow blood was adequately heparinised (Hemochron 50 seconds over baseline with heparin levels of 0.3–0.6u/ml). Each diafilter was used for 24 to 72 hours although many were discarded prior to haemodialysis despite remaining fully functional.

Biocompatibility of the system is high with no effect on white cell or platelet count, no induction of hypoxia, and usually no effect on systemic blood pressure.

All fifteen patients tolerated the technique without any side effects. Fluid removal was efficient, the rate of rise of creatinine and urea was reduced and haemodialysis was tolerated well since high transmembrane pressures to induce fluid removal were unnecessary. No membrane blood leaks occurred. An example of the response of blood urea to CAVH in a patient is shown in Figure 2.

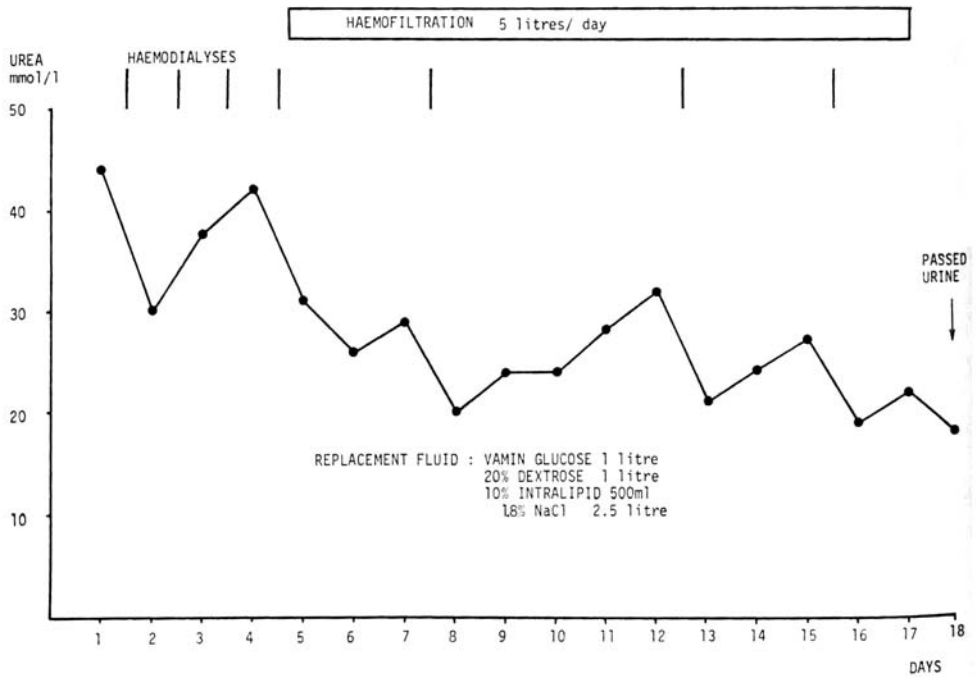

Figure 2. Patient 15 response to CAVH

Discussion

Continuous haemofiltration is a safe reliable method of fluid removal, developed in the United States [1], which we have used in addition to, rather than instead of haemodialysis. Oliguric patients are artificially converted to a 'polyuric' phase enabling maintenance of stable fluid balance and improving tolerance of haemodialysis. It has been demonstrated that with high filtration rates (12–15 litres per day) and large volume intravenous fluid substitution, a steady state can be obtained which obviates the need for haemodialysis [2]. We decided not to use such a high volume exchange technique in view of the potential hazard of small errors in fluid balance calculation, and also because intermittent haemodialysis would enable maintenance of lower values of plasma urea and creatinine. In addition to fluid removal, clearance of large molecular weight toxins is improved by haemofiltration which is of likely benefit in acute renal failure and also suggests a worthwhile application in end-stage renal failure [3]. This technique is easy to use and may now be regarded as an integral part of the management of oliguric renal failure. As a means of fluid removal haemofiltration has potential in many areas of clinical practice in particular during cardiopulmonary bypass, in burns units and other areas of intensive care medicine.

References

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