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ARTICLE

Metabolic acidosis following hemodialysis

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Abstract

Hemodialysis using a bicarbonate dialysate is the treatment modality of choice for correction of metabolic acidosis of renal failure. However a dialysis fluid containing improper ratios of the acid and bicarbonate concentrates can result in an iatrogenically produced metabolic acidosis.

We observed five cases of severe metabolic acidosis during dialysis, that resulted from a failure of the dialysis machine (NCU-10E) to add bicarbonate concentrate to the dialysate during preparation. This resulted in the death of one elderly patient and a severe hypotension and acidosis, (requiring peritoneal dialysis and the use of life support systems) in another. In all five cases the dialysate had a low bicarbonate level, but a normal conductivity, and alarm was not activated.

A high index of suspicion and a rapid check of the dialysate in cases where patients unexpectedly worsen instead of improving with hemodialysis may help in averting this potentially lethal complication.

Key Words:- Bicarbonate, Hemodialysis, Acidosis, Conductivity.

Introduction

Hemodialysis using a bicarbonate dialysate is the treatment modality of choice for correction of metabolic acidosis of renal failure. Most modern dialysis machines prepare a bicarbonate dialysate by mixing an acid concentrate containing acetic acid, a bicarbonate concentrate and treated water in a fixed proportion. The conductivity of the final dialysate is monitored by a sensor and an alarm is triggered if the conductivity falls outside the set limits. Dialysis machines usually have 2 safe modes of operation, so that in case of malfunction of the normal mode, the patient is isolated from the harmful effects[2]. Here we report five cases, who developed severe metabolic acidosis following hemodialysis, due to low dialysate bicarbonate, which did not affect the dialysate conductivity, and therefore trigger an alarm, or cause the machine to bypass the dialysate to drain.

Case1

A 60 years old male patient of end stage renal disease, developed tachypnoea, and sweating 2 hours after completion of his 3rd haemodialysis session. Prior to the current session the patient was assymptomatic and had an interdialytic weight gain of1.0 kg. He was found to have hypotension and tachypnoea, and there were no abnormal systemic signs on examination. His hemodynamic parameters are shown in Table 1 and blood biochemical values in Table 2. The analysis of the dialysate from the machine is shown in Table 3. He was treated with volume expansion, inotropic support, mechanical ventilation and peritoneal dialysis. However the patient suffered cardiac arrest, within an hour of starting above treatment, and he could not be revived.

Case 2

A 22 years old male patient on maintenance hemodialysis since 8 months, with no complaints and an interdialytic weight gain of 1.5-2.0 kg, suddenly complained of headache, nausea, uneasiness and general discomfort after 3 hours of a 4-hour dialysis session. Clinically no abnormality could be found. Prior to connection to the machine the patient had been asymptomatic and hemodynamically stable. The blood biochemistry reports are shown in Table 2,and dialysate values in table 3. The machine conductivity was within the normal range and no alarm was triggered. In view of the low dialysate bicarbonate, dialysis was stopped, the machine rinsed with hypochlorite and oxalic acid solution, and the patient redialyzed with an acetate dialysate on a cardiac monitor, for a further 4½ hours. Further dialysis were uneventful.

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Table 1 - Clinical Profile of patients during the acidosis episode

	Case 1	Case 2	Case 3	Case 4	Case 5
Cause of ESRD	Diabetic Nephropathy	Reflux Nephropathy	Unknown	Unknown	Chronic GN
Associated morbidity	Diabetes, Ischemic Heart Disease	Hypertension	Anemia	-	Hypertension, Anemia
Duration on MHD	5 days	8 months	5 days	1 year	9 months
Dialyzer	FB-130T*	FB-130T	FB-130T	F-6#	FB-130T
Vascular access	IJV –DLC^	A-V fistula	A-V fistula	IJV -DLC	A-V fistula
Blood flow	250ml/min	300ml/min	300ml/min	275ml/min	300ml/min
Dialysate flow	500ml/min	500ml/min	500ml/min	500ml/min	500ml/min
Pulse	120 / min	100/ min	100 / min	84/ min	96 / min
Blood pressure [mm of Hg]	70 systolic	130 / 70	80 systolic	140 / 80	110 / 70
Respiratory rate	32 / min	26/min	28 / min	30/min	20 / min
Systemic examination	N A D	N A D	N A D	N A D	N A D

*FB-130T = Cellulose diacetate dialyser 1.3m² (Nipro)

#F-6 = Polysulfone dialyser 1.3m² (Fresenius)

^IJV-DLC =internal jugular double lumen cannula

MHD = maintenance hemodialysis

Table 2 - Biochemical parameters (mEg/L) of patients during acidosis

Parameters	Case 1	Case 2		Case 3		Case 4		Case 5
		During HD	After 4 hrs of acetate H D	After HD	On PD	On HD	After PD	
Na^+	136	128	130	126	138	128	135	132
K^+	4.0	8.0	4.5	3.2	2.8	4.0	3.5	3.6
Cl^-	-	95	98	88	103	98	102	96
HCO_3	3.6	7.9	16	6.0	21	12	24	14

Table 3 - Dialysate electrolytes during acidosis

Electrolytes meq/L	Case 1	Case 2	Case 3	Case 4	Case 5
Na^+	132	134	137	135	135
K^+	2.0	2.4	1.8	2.1	2.2
Cl^-	105	103	104	106	105
HCO_3	6.0	9.0	12	6.8	12

Case 3

A 40 years female patient of chronic renal failure, developed lower limb pain, difficulty in breathing and chest discomfort two and a half hours after her 2nd dialysis, and was found to have hypotension. She had experienced no problems during her previous dialyses with the same dialyser and circuit, and had been hemodynamically stable prior to starting dialysis. Her clinical and biochemical parameters at the time of this event are shown in Tables 1 and 2, and dialysate analysis in Table 3. She was treated with a dopamine drip and 40 cycles of peritoneal dialysis of 40 minutes dwell time and 1000ml dwell volume. The bicarbonate inlet line of the machine was subsequently found to be blocked by deposits of bicarbonate.

Case 4

A 42 years old female patient on maintenance hemodialysis, previously on maintenance dialysis in UK developed bouts of vomiting during her 2nd dialysis at our center. She had no history of such episodes during previous dialysis and was asymptomatic prior to starting the dialysis session. Analysis of blood and dialysate from the sampling ports revealed metabolic acidosis and a dialysate with a low bicarbonate, which did not improve upon changing the concentrate can. The patient was then dialysed on a different machine, and an overhauling of the machine revealed a block in the T connection prior to the dialysate mixing chamber. When this was replaced the dialysate preparation normalized.

Case 5

A 25 years old male patient of chronic renal failure on regular thrice weekly maintenance hemodialysis complained of 2 bouts of vomiting and pain in both lower limbs, 2 hours after a dialysis session. He had had no symptoms prior to or during dialysis and no complaints after previous dialysis sessions. His examination findings and investigation are shown in table 1 & 2, and analysis of dialysate in Table 3. The patient refused admission, but improved gradually and subsequent hemodialysis were uneventful.

Discussion

In five patients described above, severe metabolic acidosis developed following or during hemodialysis, because a block in the inlet lines led to failure of the machine to add bicarbonate to the dialysate. All the above events occurred during bicarbonate dialysis on Nipro NCU – IOE machines Although the dialysate bicarbonate decreased, the conductivity remained within the set normal range and hence no alarm was triggered, nor was the dialysate bypassed to drain. Although conductivity has been considered a better indicator of dialysate bicarbonate than pH, when moderate decreases in buffer occur, our experience with these five patients shows that a dialysate with normal conductivity may have a dangerously low bicarbonate concentration and pH. Patients dialysed against such a dialysate may develop severe clinical manifestations of metabolic acidosis. In the 1st case because of the advanced age and comorbid factors like diabetes and ischemic heart disease the patient was unable to tolerate the metabolic acidosis and succumbed, despite all resuscitation attempts. The other four patients being acclimatized to CRF and dialysis were better able to tolerate the derangements.

A similar experience of patients dialysed with a dialysate having normal conductivity, but low pH, has been reported by Brueggemeyer (1987)[1] with a Gambro AK – 10 machine supplied with the wrong concentrates for running in both the acetate and the bicarbonate mode. Sethi et al[3] have described metabolic alkalosis due to high bicarbonate, caused by connecting dialysate containers in reverse. The Monitral 'S' machine described by them had a malfunctioning pH meter electrode. Color coding or keying of concentrate containers, ports and inlet lines, suggested by the above authors would still not eliminate the problem of blockage of the bicarbonate lines by deposits, which we found in our patients. Machines, which independently monitor the conductivity of the incoming bicarbonate and acid concentrates as well as that of the final dialysate, may be able to detect this problem and isolate the patient by bypassing the faulty dialysate to drain.

Checking the electrolytes of the dialysate, in the case of any patient who develops symptoms or deterioration of his / her clinical condition during or after dialysis allows early detection of the problem and is the policy now followed in our unit.

Finally we echo the conclusions of Brueggemeyer and Ramirez, that clinical deterioration instead of improvement with dialysis can be due to concentrate errors and being aware of the problem and knowing that it exists is probably the best safe guard.

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