Case Report

Severe metabolic acidosis during haemodialysis: a rare but life threatening complication

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Dialysis fluids are real ‘drugs’ and as a consequence they need pharmacological preparation in order to meet the criteria of quality and standardization. Modern dialysis machines permit accurate proportioning of treated water and salts and also guarantee a continuous monitoring of the accuracy of the final composition and maintenance of the desired proportions. However, errors with dialysate concentrations are numerous and may go underdetected as causes of morbidity and mortality in patients undergoing haemodialysis (HD) [1].

Two cases of severe metabolic acidosis as complications of HD have been recorded in two dialysis units, which have been dialysing more than 50 patients daily during the last 5 years. Early recognition and proper treatment resulted in favourable outcome.

Case 1

A 54-year-old male patient, on acetate HD for 5 years due to chronic glomerulonephritis, complained that ‘something strange was going on’, and asked the nursing staff to disconnect him from the machine. He was in the first hour of his HD session, during the first shift of the day, and was being dialysed with a Cobe Centry® 2000 HD machine. A relevant comorbidity, which he had, was chronic obstructive pulmonary disease. When examined after his complaint, his blood pressure was 155/85 mmHg, pulse 90/min and he was tachypneic (30 breaths/min). Blood gas analysis revealed severe metabolic acidosis: pH 7.03, HCO₃ 6 mmol/l, PCO₂ 27.4 mmHg and PO₂ 85 mmHg.

This was due to the accidental substitution of acidic concentrate for acetate. The patient received intravenous bicarbonate, and was switched to another HD machine and bicarbonate buffer. After 4 h of HD, he recovered fully and his blood gas analysis revealed a pH of 7.46, HCO₃ 25 mmol/l, PCO₂ 44 mmHg and PO₂ 70 mmHg.

Case 2

A 68-year-old female patient, who had needed bicarbonate HD for the past 9 years due to nephropathy of unknown origin, started complaining that ‘something was going wrong’. She was in the second hour of her HD session, during the second shift of the day. She was being dialysed with a Fresenius 4008B HD machine. Upon examination after her complaint, her blood pressure was 130/80 mmHg and pulse 98/min; however, she was breathing at 30 breaths/min. An ECG was normal. Blood gas analysis from the arterial port of the extracorporeal circuit revealed severe metabolic acidosis: pH 7.17, HCO₃ 5.2, TCO₂ 5.6, PCO₂ 14.7 mmHg, PO₂ 138.7 mmHg (without oxygen supplementation) and SBE 22.6 mmol/l. A sample from the dialysate was abnormal in composition: pH 5.97, HCO₃ 0.1 mmol/l, TCO₂ 0.3 mmol/l, sodium 123 mmol/l, and potassium 2.1 mmol/l.

Dialysis was stopped; the patient received intravenous bicarbonate and was transferred to another machine. After 2 h, her blood gases changed: pH 7.03, HCO₃ 6 mmol/l, PCO₂ 27.4 mmHg and PO₂ 85 mmHg.

This was due to an incorrect bicarbonate concentration in the dialysate along with the failure of the conductivity and pH alarms to sound. The nursing staff reported that they had observed a problem regarding conductivity during the priming mode of HD, but everything seemed fine when the patient was connected (conductivity 142 ms/cm).

The local Fresenius technical staff were surprised to find that the HD machine was totally out of calibration. However, no one in the unit was aware of it. They
started to calibrate the machine and discovered that it
displayed higher conductivity values than the external
conductivity meter (for example 16.5 instead of 13.5).
The hydraulic parts were not malfunctioning. The
problem was in the computer of the HD machine.
After adjustment, the machine worked well for 2 days
and then lost calibration again during a priming mode.

Comment

Metabolic acidosis during HD can develop due to
defective delivery of buffer base in the form of sodium
acetate or sodium bicarbonate to the dialysate.

During acetate HD the acetate concentrate can
accidently be replaced by the acid concentrate
component of a two-component, bicarbonate-based
dialysate generating system. As this concentrate has no
buffer base, its use removes bicarbonate from the
blood by osmosis and results in metabolic acidosis.
Metabolic acidosis has been reported during bicarbon-
ate dialysis resulting from damaged tubes responsible
for the siphoning-off of bicarbonate concentrate in
machines not equipped with pH sensors [3]. The first
patient we describe was undergoing acetate dialysis,
and had a course similar to those described in other
reports [1–4], a consequence of an error made in the
selection of the dialysate concentrate. The acidic
concentrate is capable of replacing the acetate without
sounding alarms and matching conductivity. The
largest difference and potential problem is the low
pH. Metabolic acidosis has been reported after
accidental substitution of acidic concentrate for acetate
in many HD machines—such as Gambro® AK-10 [1]
or Hospal Monitral® N [2]. These machines lack a pH
meter. It has been proposed that all HD machines
should be fitted with pH meter and alarms, especially
in centres where both acetate and bicarbonate dialysis
are used [2]. (Our patient’s severe acidosis (pH 7.03)
also had a respiratory component due to his chronic
obstructive pulmonary disease.) Many manufacturers
safeguard against some of the potential errors by
colour-coding the concentrate containers, but this is
not foolproof when multiple equipments from a list of
manufacturers are utilized in a dialysis unit.

The second patient, however, was being dialysed
with a newer generation machine with sensors for both
pH and conductivity. Nevertheless, that did not
prevent a potentially lethal complication because the
computer software of the machine malfunctioned.
Otherwise, the machine would be able to recognize
early the incorrect dialysate concentration, an alarm
would sound and the ‘bypass’ mode would be
activated, protecting the patient.

So far, we do not know what led to the failure of the
computer software, but the local technical staff sug-
gested possible interference by cellular phones used by
many dialysis patients—despite our recommendations
against their use.

Metabolic acidosis during HD is rare but dangerous.
Being aware that it can occur is the best safeguard
against human or machine errors. Intravenous admin-
istration of bicarbonate and dialysis with bicarbonate
dialysate of a correct composition are the appro-
priate therapeutic measures when metabolic acidosis
occurs.

References

1. Brueggemeyer CD, Ramirez G. Dialysate concentrate: a potential
2. Gainza FJ, Zarraga S, Minguela I, Lampreable I. Accidental
substitution of acidic concentrate for acetate in dialysis fluid
69: 480–482
3. Hartmann A, Reisaeter A, Holdaas H, Rolfsen B, Fauchard P.
Accidental metabolic acidosis during hemodialysis. Artif Organs
1994; 18: 214–217
of dialysate concentrates cause severe metabolic acidosis during

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