

## **SIDE EFFECTS IN BICARBONATE DIALYSIS DUE TO LOW DIALYSATE pH**

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### **Summary**

In six commercially available bicarbonate containing dialysates pH and pCO<sub>2</sub> were determined. Side effects resulted from low pH and high pCO<sub>2</sub>. Use of two of the six dialysates was associated with fatigue, muscle cramps and somnolence.

### **Introduction**

Recent studies have demonstrated that bicarbonate dialysis is superior to acetate dialysis with regard to frequency of intradialytic and interdialytic symptoms in haemodialysis patients [1, 2]. During the past four years bicarbonate dialysis machines of various types have been developed and many concentrates of various compositions have become commercially available, generating specific problems (Figure 1). This study assesses the influence of a low dialysate pH and a correspondingly high pCO<sub>2</sub> (Henderson-Hasselbalch equation) on specific symptoms during haemodialysis treatment.

### **Material and methods**

Two thousand one hundred and five bicarbonate dialyses in 25 patients were evaluated. pH and pCO<sub>2</sub> were measured using ABL 2 (Radiometer Copenhagen); total CO<sub>2</sub> was determined with Titroprocessor 636 (Metrohm). The following dialysers were used: Gambro Optima, Major, Fiber GF 120; Salvia KF 1.2; Terumo Clirans TH 15, TE 15.

Dialysis machines and bicarbonate concentrates examined are listed in Table I. The composition of acetate containing dialysate was: Na 140mmol/L, K 2mmol/L, Ca 1.5mmol/L, Mg 1mmol/L, acetate 35mmol/L, glucose 100mg/dl.

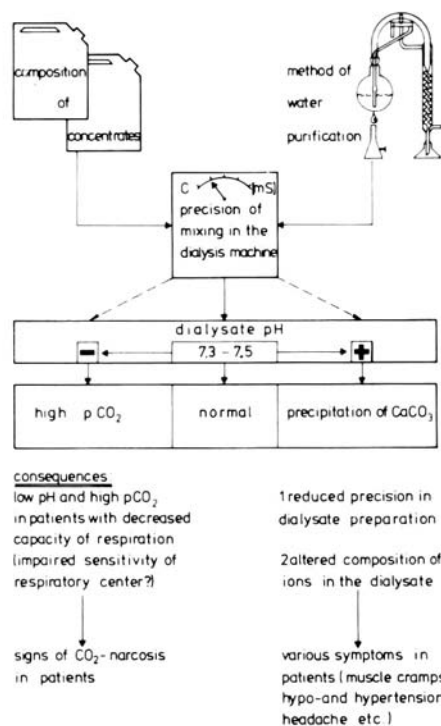


Figure 1

TABLE I. Characteristics of various bicarbonate dialysates

Concentrate (each n = 5)	pH	pCO <sub>2</sub> (mmHg)	T CO <sub>2</sub> * (mmol/L)	Acetate† (mmol/L)
1 <sup>1</sup>	7.348 ± 0.057	45.5 ± 3.2	33.73 ± 0.84	2.1
2 <sup>2</sup>	7.368 ± 0.048	43.8 ± 3.5	33.73 ± 0.85	2.1
3 <sup>3</sup>	7.136 ± 0.036	84.4 ± 10.9	30.7 ± 0.3	10.0
4 <sup>4</sup>	7.478 ± 0.019	41.8 ± 2.8	34.25 ± 0.42	7.5
5 <sup>5</sup>	7.109 ± 0.018	96.6 ± 3.8	35.04 ± 1.02	8.0
6 <sup>6</sup>	7.508 ± 0.028	45.4 ± 3.9	36.65 ± 0.85	5.8

\* Titroprocessor 636 (Metrohm)

† According to the producer's information

<sup>1</sup> Salvia KB 102 + SV 090/DMS 5

<sup>2</sup> Salvia KB 104 + SV 090/DMS 5

<sup>3</sup> Bellco BL 185 B/Bellco Unimat

<sup>4</sup> Bellco BL 185 E/Bellco Unimat

<sup>5</sup> Schiwa SW 56 A + SW 56 BC/Extracorporeal

<sup>6</sup> Schiwa SW 58 A + SW 56 BC/Extracorporeal

Concentrates of Gambro (+ AK10) and Fresenius (+ MTS) are examined presently

## Results

The characteristics of the six bicarbonate dialysates examined are shown in Table I. Significant differences were seen in pH and  $p\text{CO}_2$ . Despite a low pH (7.0–7.2) and a high  $p\text{CO}_2$  (80mmHg) in bicarbonate dialysates generated from

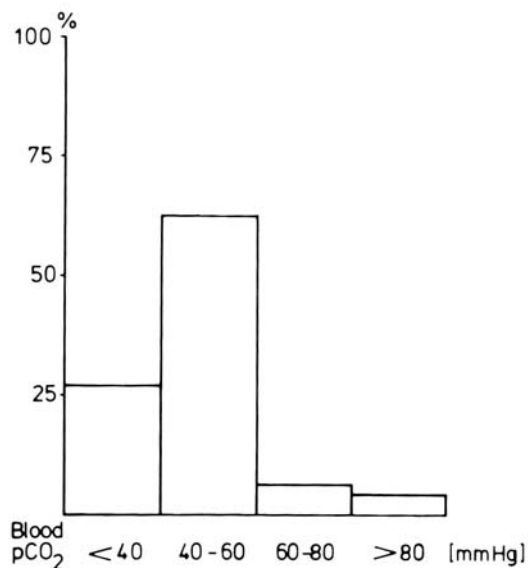


Figure 2. Bicarbonate dialysis (pH 7.0–7.2/ $p\text{CO}_2 > 80\text{mmHg}$ ). 48 dialysis (16 patients)

Patient: I. M. ♀, age 54

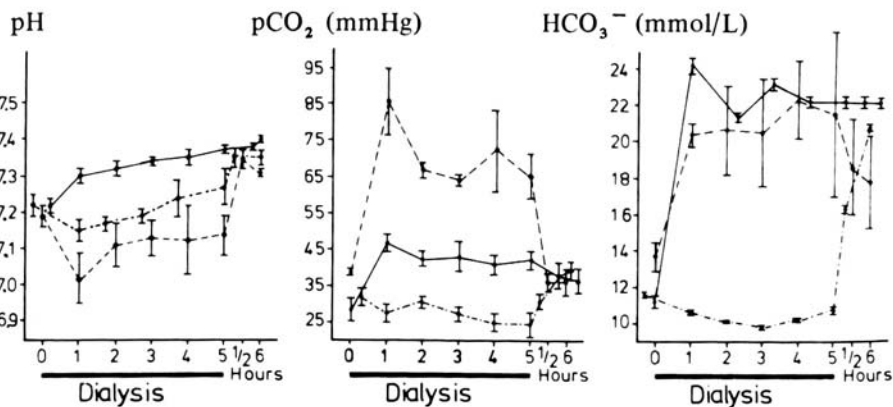


Figure 3. - - - - Bicarbonate dialysis (pH 7.1/ $p\text{CO}_2$  99.2mmHg/ $\text{HCO}_3^-$  33mmol/L)  $n = 2$ .  
 — Bicarbonate dialysis (pH 7.48/ $p\text{CO}_2$  44.0mmHg/ $\text{HCO}_3^-$  34mmol/L)  $n = 3$ .  
 ····· Acetate dialysis (pH 6.94/ $p\text{CO}_2$  8.4mmHg/ $\text{CH}_3\text{COO}^-$  35mmol/L)  $n = 3$

concentrates number 3 and number 5 the majority of 16 patients during 48 treatments did not develop hypercapnia. In only five treatments  $p\text{CO}_2$  rose above 60mmHg with a maximum of nearly 100mmHg (Figure 2). Nevertheless no signs of dyspnoea occurred. But, as expected, no increase in respiratory rate was observed. In all instances an increase of blood- $p\text{CO}_2$  was accompanied by fatigue. Patient I.M. (Figure 3) in addition suffered from severe leg muscle cramps and developed somnolence. This patient was subjected to an intra-individual comparison in three successive dialyses using a bicarbonate dialysate with pH 7.48, no side effects occurred.

Patients generating symptoms during high  $p\text{CO}_2$  bicarbonate dialysis remained free of symptoms when dialysed against a low  $p\text{CO}_2$  dialysate. In Figure 4 a summary of side effects during bicarbonate dialyses (pH 7.3–7.6) is demonstrated.

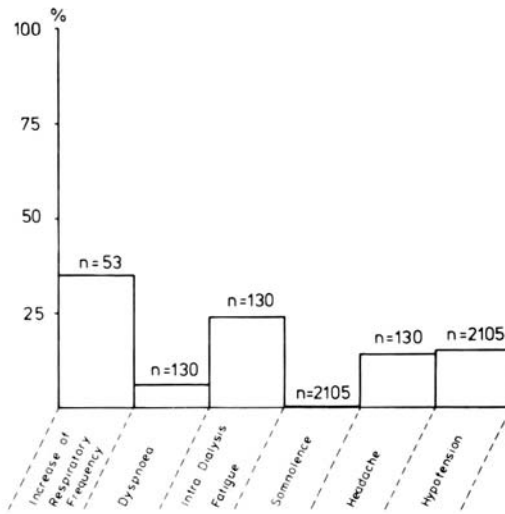


Figure 4. Bicarbonate dialysis (pH 7.3–7.6/ $p\text{CO}_2 < 50\text{mmHg}$ ). Blood  $p\text{CO}_2 < 50\text{mmHg}$  during entire dialysis

## Discussion

The importance of a low pH and a high  $\text{PCO}_2$  in commercially available bicarbonate concentrates have not been recognised until recently, as the majority of patients are capable of eliminating the increased amount of  $\text{CO}_2$  via respiration [3]. In patients with metabolic acidosis treatment with bicarbonate containing dialysate is followed by increased  $\text{CO}_2$  generation in blood, which has to be compensated for by increased respiratory activity. In this situation the continued passage of  $\text{CO}_2$  [4] from dialysate to blood may lead to respiratory decompensation, particularly in patients with lung function impairment, or with decreased sensitivity of the respiratory centre (perhaps caused by tranquillisers or hypnotics),

with subsequent CO<sub>2</sub> accumulation. Consequences may be: 1) worsening of acidosis; 2) development of latent or overt CO<sub>2</sub> intoxication; 3) acid-base-dysequilibrium, i.e. difference of pCO<sub>2</sub> between blood and cerebrospinal fluid [5].

These considerations in connection with our data demonstrate, that the pH and pCO<sub>2</sub> of bicarbonate containing dialysates have to be in a physiological range in order to prevent possible side effects.

## References

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- 3 Richards CJ, Newhouse CE, Freeman RM. *Proc Clin Dial Transplant Forum* 1977: 104
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