ACID-BASE DISTURBANCES DURING INTERMITTENT HAEMODIALYSES

H. G. SIEBERTH
Medizinische Universitätsklinik, Köln, German Federal Republic

Lowering of pH in cerebrospinal fluid (CSF) causes deeper and more frequent breathing. This is due to the fact that special cells sensitive to pH are situated in the ventrolateral area of the medulla oblongata, as Mitchell et al. (1963) have shown.

Actual pH in blood and CSF is a function of log \( \frac{\text{HCO}_3^-}{\text{pCO}_2} \) as expressed in the Henderson-Hasselbalch equation. Changes of pCO₂ in blood are immediately followed by equivalent changes of pCO₂ in CSF (Gesell and Hertzman, 1926), whereas changes of [HCO₃⁻] in blood are followed much more slowly by changes of [HCO₃⁻] in CSF (Collip and Backer, 1920). Patients with metabolic acidosis in acute renal failure showed increase of pH in blood even to alkalotic values during haemodialysis, this being due to increased [HCO₃⁻], while pCO₂ stayed constant (Sartorius and Lemperle, 1963). In CSF very little or no changes of [HCO₃⁻] were found during or shortly after haemodialysis (Bühlmann et al., 1963). Consequently, pH of CSF stayed low throughout the dialysis, and the acidic type of respiration persisted. It seemed to be of interest to investigate if similar changes in acid-base balance would occur in patients with chronic renal failure on a chronic intermittent dialysis program. In spite of low pH in blood we did not observe acidic respiration in these patients.

METHODS

In 18 male and female patients, age 19-64, with chronic renal failure and being dialysed twice weekly for 8-10 hrs for 5-30 months pH, pCO₂ and [HCO₃⁻] of arterial blood and in 6 cases of CSF were determined before and after dialysis. pH, pCO₂ and [HCO₃⁻] were also determined before and after the first dialysis in 48 patients with acute renal failure. Blood and CSF were drawn with polyethylene syringes under anaerobic conditions. pH was determined with an Astrup capillary microelectrode and a radiometer pH meter at 38° C. pCO₂ and standard [HCO₃⁻] were determined using the micromethod described by Siggaard-Anderson et al. (1960) and the Siggaard-Anderson and Engel nomogram.

RESULTS

In acute renal failure a significant correlation was found between pH and pCO₂ values in blood samples drawn before dialysis but no correlation after dialysis. During chronic intermittent dialysis there was no correlation found between these values before dialysis, in linear and semilogarithmic sense; there was however a good correlation with negative regression found in samples of blood drawn after dialysis (Figs. 1-4). Correlation between standard [HCO₃⁻] and pCO₂ is significant before and after dialysis in acute and chronic renal failure. However, for comparable values of standard [HCO₃⁻], values of pCO₂ are higher in chronic patients than in patients with acute renal failure both before and after dialysis by 5 and 3 mm Hg respectively (Figs. 5 and 6). The dotted line in Fig. 5 gives the regression in acute renal failure in comparison. Table I shows the mean values
Fig. 1. Chronic renal failure, predialysis.

Fig. 2. Chronic renal failure, postdialysis.

Fig. 3. Acute renal failure before first dialysis. Fig. 4. Acute renal failure after first dialysis.

Relation between pH and pCO₂ in chronic and acute renal failure. The dotted line in Fig. 1 represents the regression line in Fig. 3.
Fig. 5. Correlation between standard $[\text{HCO}_3^-]$ and $\text{pCO}_2$ before dialysis in chronic renal failure (dotted line, regression line of Fig. 6).

### TABLE I

Comparison between pH, standard $[\text{HCO}_3^-]$ and $\text{pCO}_2$ before (B.D.) and after (A.D.) dialysis in acute (A) and chronic (C) renal failure

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Standard [HCO$_3^-$]</th>
<th>pCO$_2$</th>
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</thead>
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<tr>
<td></td>
<td>A</td>
<td>C</td>
<td>A</td>
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<tr>
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<td>7.28</td>
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<td>s</td>
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<td>0.07</td>
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<tr>
<td></td>
<td>p</td>
<td>&lt; 0.001</td>
<td>&gt; 0.05</td>
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<tr>
<td></td>
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<td>130</td>
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<tr>
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<td>7.41</td>
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<tr>
<td></td>
<td>p</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>46</td>
<td>130</td>
</tr>
</tbody>
</table>
DISCUSSION

In spite of the low [HCO₃⁻] in blood before dialysis, patients on the chronic intermittent dialysis program do not have such low values of pCO₂ as patients in acute renal failure have, before they are dialysed for the first time. The smaller respiratory compensation of the metabolic acidosis causes a lower actual pH in chronic patients. In consequence of that, we suppose, according to the above mentioned measurements, that [HCO₃⁻] and pH of CSF of chronic patients in between two dialyses lags behind the decreasing [HCO₃⁻] in blood long enough not to bring into play respiratory compensation of metabolic acidosis. In acute renal failure on the other hand time elapsing before the first dialysis usually is sufficient to bring [HCO₃⁻] and pH of CSF to low enough values to start acidotic respiration.
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REFERENCES