The AutoFlow Function for the 5008 Therapy System
Optimising the Dialysis Fluid Flow Rate
The Dialysis Fluid Flow Rate

In current dialysis practice, a dialysis fluid flow rate of either 500 mL/min or 800 mL/min (at a blood flow rate > 350 mL/min) is commonly used, even though optimal solute clearance is already achieved at much lower dialysis fluid flow rates.

Even when the dialysis fluid flow rate equals the blood flow rate (see red dots Fig. 1), almost 90% of the maximum small solute clearance is achieved. Thus, higher dialysis fluid flow rates do not significantly contribute to an increase of clearances.

Economic considerations

Although the primary target is to achieve the best possible treatment conditions and outcomes, increasing patient numbers and a constantly deteriorating health of patients beginning dialysis have resulted in economic restrictions for dialysis health care thereby necessitating a review of current practices.

The dialysis dose delivered to a patient is influenced by a number of factors: predominantly by the blood flow rate, the selected dialyser, the treatment time, the treatment mode and the dialysis fluid flow rate. Although the dialysis fluid flow rate is the factor that has the least significant influence in determining the dose of dialysis, it nevertheless represents the most significant factor in terms of economic implications.

Through the application of the novel AutoFlow function which is integrated in the 5008 Therapy System and the 5008S Dialysis System, it is now possible to reduce significantly the dialysis fluid consumption and thus the costs in terms of:

- energy/electricity
- water
- waste water

without compromising Kt/V.
The AutoFlow Function of the 5008 Therapy System

The AutoFlow function allows the user to accomplish an optimal ratio between blood flow rate and dialysis fluid flow rate.

When the AutoFlow function is activated on the 5008, the automatic adjustment of the dialysis fluid flow rate is based on the effective blood flow rate and a constant factor chosen by the user.

\[ Q_D = Q_{B\text{ effective}} \times \text{AutoFlow Factor} \]

Example \( Q_{B\text{ effective}} = 300 \text{ mL/min} \)

- Factor 1.2: \[ Q_D = 300 \text{ mL/min} \times 1.2 = 360 \text{ mL/min} \]
- Factor 1.3: \[ Q_D = 300 \text{ mL/min} \times 1.3 = 390 \text{ mL/min} \]
- Factor 1.5: \[ Q_D = 300 \text{ mL/min} \times 1.5 = 450 \text{ mL/min} \]

The dialysis fluid flow rate increases automatically with an increasing blood flow rate, thereby ensuring an equal treatment efficiency for all conditions.

Fig. 2, Relation of blood flow rate and dialysis fluid flow rate in the 5008 Therapy System (activated AutoFlow function, AutoFlow Factor 1.2, blue dots, AutoFlow Factor 1.5, orange dots) resulting in only very minor differences in clearance compared to standard dialysis fluid flow rate \( (Q_D = 500 \text{ mL/min or 800 mL/min}, \text{red dots}) \).
Optimising Dialysis Fluid Flow without Compromising Kt/V

Rather than being a simple mixture of water with acid and bicarbonate concentrates, dialysis fluid is also required to have a very high chemical and microbiological quality – an important feature with respect to patient safety. Moreover, energy is needed to heat the dialysis fluid to the appropriate temperature required by the patient. Thus, dialysis fluids are highly valuable entities and need to be used economically.

The activation of the AutoFlow function leads to a reduced dialysis fluid flow rate and thus enables savings in dialysis fluid consumption (in comparison to standard treatments without the AutoFlow function) of up to ~30 % (Table 1).

<table>
<thead>
<tr>
<th>AutoFlow Factor</th>
<th>( Q_{\text{effective}} ) (mL/min)</th>
<th>( Q_{\text{o}} ) (mL/min)</th>
<th>Treatment mode</th>
<th>Dialysis fluid consumption</th>
<th>Saving in Liter</th>
<th>Saving in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>off *</td>
<td>300</td>
<td>500</td>
<td>HD</td>
<td>120 L</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1.5</td>
<td>300</td>
<td>450</td>
<td>HD</td>
<td>108 L</td>
<td>12 L</td>
<td>10 %</td>
</tr>
<tr>
<td>1.2</td>
<td>300</td>
<td>360</td>
<td>HD</td>
<td>86.4 L</td>
<td>33.6 L</td>
<td>28 %</td>
</tr>
<tr>
<td>1.0</td>
<td>300</td>
<td>300</td>
<td>HDF (18 L)</td>
<td>90 L</td>
<td>30 L</td>
<td>25 %</td>
</tr>
</tbody>
</table>

HD/HDF treatment with 500 L; \( t = 4 \) h.

Table 1: Reduced consumption of dialysis fluid with the AutoFlow function in HD and HDF treatments compared to a standard dialysis fluid flow rate of 500 mL/min

* Dialysate flow manually set to \( Q_{\text{o}} = 500 \) mL/min

However, it should be noted that the potential savings on dialysis fluid and energy (required to heat the dialysis fluid) are dependent upon individual treatment conditions that may vary from one unit to another and according to dialysis practices in different countries.

What happens to dialyser performances and the Kt/V in treatments with a reduced dialysis fluid flow rate?

This of course depends on the chosen treatment mode. Switching to HD treatment with the AutoFlow function may lead to a slight decrease in clearance. But the effect on Kt/V for a particular patient is likely to remain below 0.1 (Table 2, so that the differences hardly have an effect on well-dialysed patients. In large patients, or patients with a high recirculation, or even in general, the decreases can be easily compensated by a slight increase in the effective blood flow rate (~20 mL/min).

A switch to the ONLINE HDF mode ensures an equal or higher Kt/V while consuming a lower amount of dialysis fluid at the same effective blood flow rate (calculation shown in Table 2) and results additionally in higher middle-molecule detoxification. A recent clinical study (1) has validated this data.
To facilitate the application of the AutoFlow Function, the figure below summarises the recommended AutoFlow factors for diverse machine and treatment conditions.

The AutoFlow factor should be carefully adapted to the individual needs of the patient. If the patient cannot achieve an adequate Kt/V, the AutoFlow factor should be increased stepwise until the prescribed target dialysis dose has been reached.

This is best achieved by monitoring the actual dose of dialysis during the treatment itself by means of the Online Clearance Monitoring OCM®, which is a standard feature of the 5008 Therapy System and the 5008S Dialysis System.

### Table 2: ONLINE HDF in combination with the AutoFlow function enables comparable doses of dialysis while saving dialysis fluid

<table>
<thead>
<tr>
<th>AutoFlow Factor</th>
<th>$Q_{\text{effective}}$ (mL/min)</th>
<th>$Q_D$ (mL/min)</th>
<th>Treatment mode</th>
<th>Dialysis fluid consumption</th>
<th>Saving in %</th>
<th>sp Kt/V</th>
</tr>
</thead>
<tbody>
<tr>
<td>off *</td>
<td>300</td>
<td>500</td>
<td>HD</td>
<td>120 L</td>
<td>–</td>
<td>1.41</td>
</tr>
<tr>
<td>1.5</td>
<td>300</td>
<td>450</td>
<td>HD</td>
<td>108 L</td>
<td>10%</td>
<td>1.39</td>
</tr>
<tr>
<td>1.2</td>
<td>300</td>
<td>360</td>
<td>HD</td>
<td>86.4 L</td>
<td>28%</td>
<td>1.33</td>
</tr>
<tr>
<td>1.0</td>
<td>300</td>
<td>300</td>
<td>HDF (18 L)</td>
<td>90 L</td>
<td>25%</td>
<td>1.40</td>
</tr>
</tbody>
</table>

HD/HDF treatment with 5008; $t = 4$ h; FX 80; Hct = 35%; Recirculation = 5%, $V = 40$ L.

* Dialysate flow manually set to $Q_D = 500$ mL/min

The Online HDF in combination with the AutoFlow function enables comparable doses of dialysis while saving dialysis fluid.
Practical Application of the AutoFlow Function

1. The AutoFlow function can be activated in the dialysate menu.
2. Press the button “Factor” to adjust the AutoFlow factor.
3. Press the AutoFlow button “yes” to activate the function.
4. AutoFlow factors between 1.0 and 2.0 can be applied in steps of 0.1.

Fig. 4: Dialysate menu of the 5008 Therapy System and the 5008S Dialysis System.

The standard setting of the AutoFlow factor is 1.5. This pre-setting can be adjusted in the user set-up menu (for constant changes) or for individual treatments.

Reference

1. Kult, J and Stastl, E, Changing emphasis in modern hemodialysis therapies: Cost-effectiveness of delivering higher doses of dialysis, Int J Art Organs (2007); 30(7); 577-582
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