AUTOTRANSFUSIONS AT REPEATED TREATMENTS WITH THE ARTIFICIAL KIDNEY

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and Stig-Bertil Nilsson³

The great demand for blood for transfusion at a clinic where active treatment with the artificial kidney is performed with machines that require priming is not only a strain on the blood bank but also a problem that concerns the recipient - the patient. A great number of blood transfusions to one patient increases the risk of undesirable reactions.

We have since the autumn of 1963 carried out trials with autotransfusion during treatments with the artificial kidney. We have chosen the designations 'autoblood' for the blood that is collected from the dialyser and 'autotransfusion' for the introduction of this blood into the patient concerned. The patients who are given autotransfusions have previously received transfusions of donor blood. A varying proportion of the blood is thus of homologous and not of autologous type.

Up to the present we have carried out altogether 262 autotransfusions in 32 patients. The highest number of autotransfusions at dialysis of one patient was 47. The only contra-indication to autotransfusion was overt septicaemia.

TECHNIQUE

The Alwall type of artificial kidney, 1952 model, was used: it holds about 800 ml. and the connecting tubes about 200 ml. At all treatments a sigma-pump was used for circulation of blood through the apparatus. After completed treatment, one of the tubes of the dialyser was sterilized by washing with a detergent solution. The tube was punctured with a wide-bore sterile cannula which was connected to a 1000-ml bottle, using an ordinary collection set. The bottle contained 200 ml. of sterile ACD solution (N.I.H. solution B). Air was introduced through the other tube of the dialyser, passing a sterile cotton-filter. The air forced the blood present in the machine into the bottle. The last portion of blood, which had become slightly frothy, was also collected. The blood was carefully mixed with the ACD solution and stored in a blood-refrigerator with thermostat (-2°C- -4°C). Samples for testing were also taken with the collection set. The blood bottle was marked with the patient's name, and other data.

When it was time for this patient to be dialysed again after 1 to 10 days, the autoblood was used. If the plasma layer appeared haemolytic or otherwise discoloured, and if macroscopical clots had formed, the blood was discarded. After specimens had been taken for blood-culture, the blood was transferred to the dialyser by means of an ordinary blood-transfusion set with a filter. If the amount of collected blood was not sufficient to fill the apparatus, a supplement of 6% Macrodex³ or donor blood was given.

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Bacteriological studies:

A prerequisite of such an autotransfusion is that the blood can be drawn and kept sterile. Cultures were made regularly from the autoblood at the same time as the bottle was used. The autotransfusion was thus given before the result of culture was known in the individual case. No culture revealed any significant growth.

Studies of blood viability:

Blood for subsequent autotransfusion was collected after dialysis treatment. These uraemic patients had received transfusions of blood from several donors in connection with one or several previous dialyses. To find out whether there was any difference in viability between blood from uraemic patients and blood from normal donors, we made comparative determinations of the life-span of erythrocytes, mechanical resistance, and adenosine-triphosphate (A.T.P.) concentration.

The erythrocyte survival was studied by $^{51}$Cr-labelling. Figure 1 shows the survival curve for autoblood which had been stored for 7 days before labelling (curve A), homologous red cells which were also given to uraemic patients (curve B), and, for comparison, data from a normal subject receiving his own labelled cells (curve C). The survival after 24 hours was 97.5% in the normal, as against 89% for the autoblood and 91% for the donor blood in uraemic patients.

Mechanical resistance tests were made on blood which had been stored for varying lengths of time after collection from donors and dialysed patients, respectively. The results are shown in Figure 2. No obvious difference can be read in mechanical resistance between ACD blood and autoblood in the period of actual interest. When stored for more than ten days the autoblood erythrocytes seem to be more fragile than those from the donor blood.

Among other laboratory tests serum-bilirubin and serum-haptoglobin were determined before and after dialysis. In Table I the differences in the concentrations before and after dialysis are shown. Because of the combination of increased bilirubin and decreased haptoglobin, some intravascular haemolysis is probable. As donor blood was not infrequently given during the final phase of our dialyses that were started with autoblood, it is impossible to say whether autoblood produces less haemolysis than does ordinary donor blood. It can be stated, however, that haemolysis does not occur in a higher degree with autoblood.

Autotransfusion has not increased the frequency of slight shiverings, which occasionally occur during dialysis treatment. No rise in the incidence of bleeding and thrombocytopenia has been noted since the autotransfusion technique was introduced.

The total number of blood transfusions given at our artificial-kidney centre in 1963 was 1460. In the first half of 1964 there has been a 50% reduction in the required amount of donor blood, despite an increased frequency of treatments.
Figure 1. The percentage survival is expressed as $^{51}$Cr-activity divided by the haemoglobin concentration ('specific activity') per unit volume of haemolysate.
Curve A: Autoblood, labelled and injected into the patient after storage for 7 days.
Curve B: Donor blood, labelled and injected into a uraemic patient after storage for 7 days.
Curve C: Autologous blood, labelled and re-injected immediately.

Figure 2. Mechanical resistance as a function of storage time in percentage of total haemolysis.
Symbols: • donor blood, • autoblood.

<table>
<thead>
<tr>
<th>Dialysis treatment</th>
<th>with autoblood</th>
<th>without autoblood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bilirubin</td>
<td>+ 0.21</td>
<td>+ 0.30</td>
</tr>
<tr>
<td>in serum</td>
<td>(number 75)</td>
<td>(number 26)</td>
</tr>
<tr>
<td>mg / 100 ml</td>
<td>(range -0.5 - +3.1)</td>
<td>(range -0.2 - +2.0)</td>
</tr>
<tr>
<td>Haptoglobin</td>
<td>- 35</td>
<td>- 48</td>
</tr>
<tr>
<td>in serum</td>
<td>(number 67)</td>
<td>(number 23)</td>
</tr>
<tr>
<td>mg / 100 ml</td>
<td>(range -163 - +149)</td>
<td>(range -141 - +13)</td>
</tr>
</tbody>
</table>

Table I. Differences in the concentrations before and after dialysis for bilirubin and haptoglobin.
N. ALWALL (Lund): I should like to say that this technique ('autoblood') seems to be only a temporary solution of the big problem of blood supply which we shall meet in future with the increased frequency of dialysis treatment. This year I think we shall give about 600 treatments, and next year at least 1500. It will then be impossible to get donor blood for priming the apparatus. We are, therefore, trying to do away with the necessity for priming. That is to say, we use artificial kidney with a very small amount of blood (c. 250 ml.) so that we do not need to prime the apparatus. I think that this is the second technical step we have to take in order to solve the problem of organising dialysis treatment in the future.

J. L. FUNCK-BRENTANO (Paris): To reduce the volume of blood which is contained in the artificial kidney, we have, with Dr. Sachs, made a device to stretch the membrane in a plate artificial kidney. For a surface of one square meter of cellophane, the blood content of the apparatus is about 250 ml. Thus this apparatus does not require any blood-priming. I should like to emphasise that our patients are usually put on the dialysis program while they are waiting to be transplanted. As it is important for them not to receive any foreign blood, it is important to use a no blood-priming artificial kidney. If we are obliged to use foreign blood, we give deleucocyted blood.

D. N. S. KERR (Newcastle upon Tyne): I should be interested to hear what has happened to the incidence of pyrogenic reactions to blood since you changed over to auto-transfusion.

T. LINDBOLM (Lund): At the first 49 dialyses started with auto-transfusion we did not give any other blood during the first three hours of the treatment and we saw no reactions. Afterwards, when we knew that there was no danger with these auto-bloods, we now and then gave donor blood if the patient was in shock or bleeding, or if there was any other indication for such a transfusion. When the material is taken altogether, there is no rise in these slight shiverings, and so on. However, as I said, we give some donor blood now and then, so we nevertheless still have some of them.

S. T. BOEN (Seattle): We are using the Kiil-type kidney for our chronic patients, which has a volume of about 300 cc. in the blood compartment, so we do not prime the kidney for dialysis. Nevertheless, we still need blood to keep the haematocrit at a certain level, usually at about 22% to 25%. So, even using a kidney which does not need priming, the problem of blood need is still there. We need about 1 to 3 units of packed cells per month for our patients.

N. SLADE (Bristol): In one or two highly-selected patients, that is young patients with normal blood pressure and a haemoglobin that is satisfactory, we have used a twin-coil kidney without priming it with blood. We followed their haemoglobin levels very carefully during the dialysis and found that it dropped only 10-15% temporarily following the haemodilution. The blood in the machine was chased back into the patient with saline at the end of the dialysis. It seemed to work very well indeed.

S. GIOVANNETTI (Pisa): I would like to point out that we have seen an increased spontaneous autohaemolysis in blood from chronic uraemic
patients. This increased spontaneous haemolysis may be reduced to almost normal values when blood is dialyzed in vitro.

T. LINDHOLM (Lund): There have been some reports that if vitamin E is put into the blood there should be reduced haemolysis. We have not controlled that yet, so I do not know. Another factor that we have to consider in the chronic patient is that we are taking blood samples from the patients, and we should take care not to take too much blood each time the patient comes to dialysis.

THE CHAIRMAN, F. M. PARSONS (Leeds): Is anybody else using stored blood for dialysis? Do you re-cross-match the stored blood before re-use? Would this be a wise precaution, particularly in those patients with acute renal failure who might have had previous multiple transfusions prior to admission to your unit?

T. LINDHOLM (Lund): No, we have not re-cross-matched the blood.