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The Chairman (Kennedy, Glasgow): Thank you. Leaving aside for the moment the questions of cost and simplicity in use, I suppose that the fundamental question which must be in all our minds is: 'can the suggested new developments in the technical aspects of dialysis be achieved without any reduction in the quality of dialysis from the patient's point of view?' In this connection, we should note that, so far, only four of the six speakers have tested out the apparatus in clinical practice.

Bier (Tucson): May I impose briefly on the audience to display a similar model to Dr. Nosé's of a disposable cartridge for Kii dialysers? I was equally impressed with the beauty of the membrane support and I used no bonding agent. The membranes are sealed within polystyrene foam gaskets and a netting support is used to permit the dialysate flow and to protect the membrane. It can be manufactured very simply. All the materials are readily commercially available. It is being clinically tested at present in several hospitals in the United States. It comes pre-tested for leakage, it is quite rugged and simple in use. Its performance is slightly better than the Kii dialyser. It is perfectly compatible with existing Kii equipment. In addition, you can greatly simplify the Kii boards, because the grooves and the gaskets are completely unnecessary. The gasketing is provided by the polystyrene foam and the grooves which permit the dialysate flow are provided by the mesh support, so that a grossly simplified and much cheaper Kii dialyser is possible.

Sachs (Paris): I would like to ask several questions to different speakers: Dr. Alwall what is disposable in your kidney?

Alwall (Lund): The total kidney is disposable.

Sachs (Paris): I have seen that this was a parallel-flow kidney, which has outside iron pieces... can you throw everything away?

Alwall (Lund): That is right.

Sachs (Paris): The second question is for Dr. Lavender. We tried to use the same type of artificial kidney about six years ago and we gave it up after published preliminary results because we had not solved three types of problem. The first was that we used epoxy-resin: this was Araldite, and Araldite gives only hydrogen bonds with cellophane. The question is, how many times do you have to try out an artificial kidney before you get one which does not leak? Once it does not leak, it holds for a long time, but do you get only one out of ten which does not leak from the manufacturer?

The second problem is that, if you get epoxy-resin in contact with blood, then you get some haemolysis and clotting.

The third point is that—as you mentioned—because you have channeling in the blood flow as well as in the dialysate flow, you have a very poor coefficient of extraction. You have as little as 30%. In your slide, you have an urea dialysance of 100 ml/min., but you have blood flows of 360 ml/min., and I do not believe that you can get that flow from a radial artery.

Lavender (Chicago): In the past twelve months, we have probably dealt with twenty-five or twenty-six of these dialysers and the number which have leaked has been three or four. The units we have on display here we have been pumping for over four months. When we
have had leaks, they have not been at the bond—they have been pin-holes in the membrane, and this, of course, is a problem which we face with any dialyser construction.

Secondly, on the question of clotting, we have not had problems of clotting with the resin that we are using on this dialyser. The resin has been tested for toxicity in animals: it is non-reactive in tissue culture and in subcutaneous implants.

Thirdly, on the problem of distribution, I indicated that this is a problem, and this is true with any parallel-flow dialyser, regardless of the design one uses. As far as blood flow from radial arteries is concerned, 300 ml/min. is not, in our experience, difficult to obtain from an ordinary arterio-venous shunt, unless you have problems with fibrin build-up or a very tiny artery. But what we are trying to indicate here is not so much how much dialysans we get at this point in time, because this is obviously not a perfected dialyser—we are trying to demonstrate that there are techniques available now which can be automated to build dialysers very inexpensively with a minimum of material, which, hopefully, will end up giving us an inexpensive throw-away dialyser that can be used on a daily basis over a long period of time.

Fritz (Bonn): One question to Dr. Alwall: you showed, as far as I saw, only values of chloride dialysans. Chloride is not a very good testing substance, because of its small molecule and also it is an electrolyte ion, whose dialysans depends on the cations which are in the fluid which you are testing. Do you also use creatinine clearance, which would be of much more importance for the evaluation of such a kidney?

For Dr. Lavender I have the question: how long does it take to set up your kidney?

Alwall (Lund): We have tested our dialyser for molecules other than chloride. I have not brought the figures here. We are using commercial cuprophane membrane and I think the clearances for all well-known substances are proportional in all kidneys using cuprophane membranes.

The Chairman: Thank you. Dr. Lavender, a question for you on the time required to set up your apparatus.

Lavender (Chicago): Well, the one we have on display here has a tube that goes in and a tube that goes out, so it is a matter of just hooking up the artery and the venous shunts to those two tubes. Also a tube goes in and out for dialysate, so it is however long it takes you to hook them together.

Frost (Newcastle): A pattern which seems to be emerging from the last few papers is the following: firstly, in a dialyser where no attempt is made to create turbulent conditions in the dialysing fluid, there is very little increase in dialysance of the dialyser for dialysing fluid flow rates above 1000 ml per minute. However, with those devices which do create turbulence in the dialysing fluid by using a mesh, there is considerable increase, apparently almost indefinitely. The latter pattern is one which we ourselves have confirmed with standard Travenol coil dialysers and the question comes up, what is the best way of using these new efficient dialysers? Should one use single pass with the total volume of dialysing fluid available, or should one use recirculating single pass? I would particularly ask Drs. Nosé and Miller whether they have any conclusions on this point.

Nosé (Cleveland): I believe that at this moment everybody has a Kiiil dialyser and everybody uses a single pass system. I believe that the best way is not to change any techniques, so of course it is necessary to have two envelopes. However, if we can make a recirculating single pass system and put the 500 ml in and out, we can get more or less the same efficiency with one single envelope. However, I think this will be a later development, and I believe that to use the same single pass system and to use two envelopes is the best way at this moment.
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CLARK (Chester): With our own device, we have found that recirculating single pass is preferable. As I mentioned, single pass systems with a coil-type device would require far too much dialysing fluid.

SHACKMAN (London): I would like to compliment Professor Alwall and his colleagues in Sweden for developing their parallel flow disposable—and it is, gentlemen, if you doubt it, truly disposable—artificial kidney. We have dialysed between 60 and 70 patients consecutively using his apparatus and I confirm all he claims. Using the apparatus with the Lucas proportionating and monitoring system, in my opinion, it is even more efficient than the standard Kiil machines that we have used. In fact, if we could afford to buy them, Professor Alwall, we would scrap our Kiil dialysers immediately.

The CHAIRMAN: Thank you, Professor Shackman. Just for interest, perhaps I might ask Professor Alwall: how much do these cost?

ALWALL (Lund): So far, I do not know, but I think there is an exhibition outside.

SEINFELD (Munich): We have heard a lot about the hardware, but I find that some of the more basic software aspects have not been touched upon. First of all the membrane: until now, cellophane is out, cuprophone is the last word, and still it gives a very slow dialysis. We are dialysing six to twelve hours and nobody mentioned here (a) the haemolysis, (b) the essential changes in the blood proteins.

What happens to the blood during the long dialysis, and what is being done about new membranes?

Nosé (Cleveland): I am not very optimistic about new membranes for the time being. In fact, the artificial kidney programme in the United States has rather decided to slow down the effort than increase it. We have nothing much better than cuprophone for the purpose of dialysis. Indeed, before we can use better membrane, we have to have designs which permit the use of the membrane to the utmost and that means designs in which all the resistance is concentrated in the membrane and not in the fluid film.

MUTH (Kansas City): I should like to comment on the last paper. I think our experience has been very similar with several dozen of the EX-01 coils. In our last 200 patient-months of experience using four different coils we have not primed with blood, we have not saved blood after dialysis, we have pumped it back into the patient and we have had no difficulty, and I just wonder what might happen if the coil were increased slightly in size. We have tried a one square metre cuprophone-wrapped coil from Travenol and this does increase our urea dialysance to 200 and our creatinine dialysance to approximately 165. I wonder if you might have a comment on a slight increase in size of the cuprophone membrane?

CLARK (Chester): The size that was selected was entirely arbitrary. I am sure that any time we increase the surface area of cuprophone we are going to increase dialysance.

SIMPSON (Birmingham): I should like to ask Dr. Clark if he has any figures on blood-to-dialysate leak using this Bemerg cuprophone tubing? You say it has a high burst strength and you did talk about some bursts. In fact, two years ago we performed at Birmingham about 260 dialyses using coils built with Bemerg cuprophone tubing, but we had to give it up because the burst rate was just not acceptable. This was largely due to some pin-holes in the cuprophone tubing as produced by Bemerg then.

CLARK (Chester): In the first 75 dialyses, we only had one leak. We have had several since
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then just in the week before I left, I think probably because we have had new wrapping tech-
niques.

Hilton (Birmingham): May I ask for comments from the panel as to how important they
think it is to fit their various dialysers into a fully automated monitoring system? I think the
single pass closed systems would fit more easily into this system, but a recirculating open
system, perhaps like Dr. Hoeltzenbein’s, might be more difficult and might require more
personnel to look after it.

Nose (Cleveland): As I said, at this moment single pass is preferable.

Lavender (Chicago): I would agree that single pass is preferable and I think that monitoring
should be kept at a minimum.

Hoeltzenbein (Münster): I have tried to construct the apparatus as simply as possible
and to avoid any technical thing which could break down. Blood leaks are easily detectable
in the tank which turns red. I must add that we do not do dialysis at night. We have the
patients on the machine for four hours and they watch the machines themselves.

Galletti (Providence): In our experience with the small filter press machine, a reduction
from about 800 to 400 ml/min. of dialysate flow represents a saving of about 8800 a year. I
think that is an important factor.

Clark (Chester): We feel strongly that we should try to adapt the equipment to the patient.
In our own home dialysis programme, we are using Kils both of the Milton-Roy and the
Drake-Willock type and we are using coil-type dialysers both of the recirculating single pass
and tank type. I think it is important to try to take the patient’s problems into consideration,
so we are using all four of these types, depending upon the patient, and we try to keep
monitoring as simple as possible.