Discussion

Dr. Lawrence Brettschneider (Denver): I have greatly enjoyed hearing this paper because this kind of research is the key to really effective cadaveric transplantation. In 1968, there no longer seems to be any doubt about the validity of the widely used serological technics for the measurement of histocompatibility. Unfortunately, time is required for these tests and statistically the chances are remote of achieving a good match between any donor and any given recipient. Both factors mean that it is necessary to be able to hold an organ in viable condition, sometimes for many hours or days, while biological assays are being performed and an appropriate recipient is found. It is also evident that different cities and institutions must pool their resources in order to carry out cadaveric transplantation with some semblance of efficiency.

We have recently been exploring this latter possibility. In two cases, excellent cadaveric donors became available by virtue of the cooperation of Dr. Ben Eiseman and the Denver General Hospital. Well matched patients could not be found in our pool of potential recipients. However, Dr. Rubini of Los Angeles had one such patient on his chronic dialysis program and another candidate was being carried on a similar program in Washington, D. C. These patients were flown to Denver. In both cases, the donor died while the recipients were en route. The kidneys were removed, preserved in a cold hyperbaric chamber and transplanted as long as 8 hours postmortem. Both organs functioned well from the outset.

Today, Dr. Belzer has indicated to us how it might be possible, not only to do this more effectively, but also how to use the converse approach; that is, how one may be able to exchange kidneys and other vital organs between centers where such homografts are needed.

Dr. Ben Eiseman (Denver): For years we have been plagued by a progressive rise in vascular resistance in excised perfused organs. Our greatest experience has been with the liver, spleen, and lung. Of these organs, the problem is most limiting during prolonged perfusion in the spleen. Our particular interest during the past 3 years has been in utilizing such an *ex vivo* spleen as a source of lymphocytes during 3–7-day perfusions.

We were able to minimize vascular resistance by using an erythrocyte perfusate. Further improvement was achieved by using a silastic tube membrane oxygenator. Concomitant with a rising vascular resistance after several days of perfusion with this system, my associate, Dr. Tony Moore, of Melbourne, noticed a layer of "silt" forming on the silastic. Dr. Cleve Trimble and Dr. Bob Atkins, another Australian colleague, in our laboratory finally were able to eliminate this "silt" by freezing and filtering the thawed perfusate. They thought that the "silt" might be a cryoglobulin.

The asanguinous perfusate thus filtered of its precipitate supported normathermic spleen perfusion for as long as a week. Thus, although we did not specifically identify the "silt" as a lipoprotein as did Belzer and his colleagues, we can confirm that freezing, thawing, and micropore filtering will minimize silting of a membrane oxygenator and permit more prolonged *ex vivo* organ perfusion.

When dealing with a protein-producing organ, such as liver, the perfusate may periodically have to be replaced as newly produced lipoprotein is added. I am not entirely certain why lipoprotein "silt" accumulates during extracorporeal perfusion. Our system—like that of Dr. Belzer's—uses a membrane oxygenator, but, even so, I suspect that lipoprotein "silt" accumulation is due to an air-fluid interface somewhere within the system.

Both hypothermic excised organ preservation and normothermic functional organ perfusion have immediate practical implications. I think that Belzer's contribution is, therefore, a significant one.

Dr. F. O. Belzer (Closing): First, in regard to Dr. Brettschneider's discussion, I fully agree with him, and we have been impressed that during our experience with cadaveric kidneys the actual time we really need is usually around 12 hours, 8 to 12 hours. But we went as far as 72 hours because we had the same idea, if we could not find a patient in our own pool we must fly in a patient from New York or a patient from Los Angeles, and this is why we needed the 72 hours.

Regarding the machine, it is still easier at this point to transport a patient by plane than the machine, but we hope that in the future with new engineering, we will be able to make it a little more compact. Second, in regard to Dr. Eiseman's discussion, the really interesting aspect to us is not so much that we remove 35% of the lipoproteins, but that we do not have to remove the other 65 per cent.

Why don't we remove them all? We have done some studies with complete lipoprotein free perfusate and our results are poor with this type of solution. It might be that we have to eliminate this 35% in the perfusate and keep the other 65% to maintain the organs' viability.