How best to Preserve the Donor Heart

For over 40 years, we have used the same, inexpensive and simple, way to preserve the heart in the time between removal from the donor and restoration of a blood supply in the recipient. With no oxygen supply to the heart during the transport phase, we have the problem of keeping the tissues alive, and the simplest solution is to cool the organ down. We do this by flushing a cold solution down the arteries and then keeping the heart in a simple ice box It is then transported back to the recipient's hospital. We have believed this gives us 4 hours of safe storage, but are increasingly aware that the heart deteriorates all the time once it is in the box – there is a slightly higher early survival rate if the time is less than 2 hours, and it is again slightly worse if more than 3 hours. But even the 4 hours makes planning operations difficult, and this is more so if the recipient surgery is complex – for instance, if there has been a previous operation. This simple storage approach goes by the name of Static Cold Storage, or "SCS"

An obvious way around the problem is to continue to give blood and oxygen to the heart during transport. This requires quite a complex machine, but there is one available, The Organ Care System, or OCS, made by the American Company Transmedics. This is a very sophisticated and beautifully built piece of engineering, and it keeps the heart warm and actually beating during transport. It has to be very reliable, because at normal working temperature, close to 37C, the flow of blood and oxygen to the cannot stop – there is no scope for any breakdown.

There is no doubt that the OCS device does provide much better tolerance of longer travelling time, and it easily permits 8 and possibly even 12 hours to pass by when the heart is out of the body. It does also seem that function of the heart after the implant is better. Finally, when we take hearts from donors who are declared dead only after the heart stops, when the organ has used up it's energy supplies before it is even removed, it is believed that a new source of oxygen should be supplied immediately. The OCS device has been crucial to the development of using hearts from the donor who dies after circulatory death (DCD) rather than the more conventional donation after brain-death.

But there some potential disadvantages. The heart begins to swell after a few hours on the machine, and although it is beating, you cannot actually measure function of the new heart whilst it is being transported. But most important of all, the device is very expensive, and up to £32,000 has to be spent each time the device is used.

There is a new device, developed by Stig Steen, a very innovative cardiac surgeon, at the University of Lund.

Disposable parts of heart perfusion system developed by Prof Stig Steen

The team in Sweden have done an enormous amount of development work, and have shown, in pigs, that this machine can preserve the heart successfully for as long as 24 hours. This is obviously much better than the present standard, the Cold Static Storage. We now have the opportunity to do some of the earliest testing in human hearts, from organ donors, but not used for transplantation, with this machine.
We will be using the machine to transport hearts back to our lab in Newcastle, where we can effectively "re-animate" the hearts and measure the strength of muscle contraction

We have now done our first trial with the machine, and were very impressed by both it's simplicity and the quality of the results. We plan to put 20 hearts on the machine over the next two years, and then move into the early clinical use.

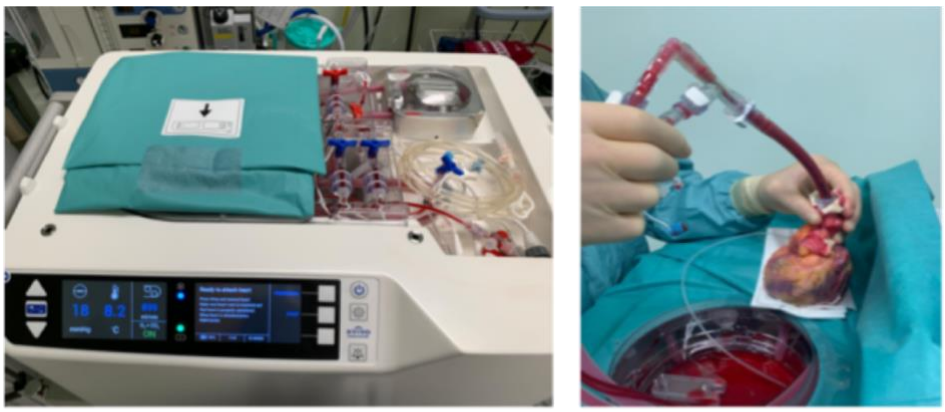

Image 1. The HOP machine primed with blood-based perfusate (left) and attached to a heart (right). (Photos taken during the first HOP preservation run.)

Because the technique is based on **H**ypothermic **O**xygenated **P**erfusion, we often use the abbreviation **HOP**

A very important part of the research are obviously the observations we can make once the heart has been re-animated. One key measure is the amount of blood going down arteries, because it dictates the amount of oxygen available to the heart muscle.

The set-up in the laboratory is shown on the here. As it stands, the blood flow is only measured by the pump-speed of the device which runs the blood flow

Last year you gave us a grant of £20,000, which enabled us to buy the first few sets of equipment for the Stig Steen device, and finish equipping the research laboratory

We are very grateful to the FHLTA for enabling us to order a Transonics flow probe, the very best available for this sort of research. This will enable us to measure the blood flow very accurately, and to show differences when we make changes to the way we preserve the heart.

We hope the benefit of this research will be that we can do more heart transplants, for the good of more patients. We also anticipate that the function of the heart will be better immediately after transplant, leading to a faster recovery from surgery

The support of the FHLTA has been fundamental to this research, and we look forwards to telling you of our progress in the future