University of BRISTOL

Elizabeth Blackwell Institute for Health Research

Elizabeth Blackwell Institute Research for Health Scheme 2015

Stage 1 - Call for Challenges Application Form

Name	Raimondo Ascione
Challenge Title (max 20 Words)	
Developing a miniaturised heart-lung machine with pulsatile blood flow as a novel “organ maintenance” device for surgical programmes of organ transplantation and for translational research labs	

Please describe the specific problem which needs addressing
End stage organ failure has a massive burden on health outcome and hospital resources in the NHS and worldwide. Patients with end-stage organ failure required repeated hospital admissions and have a very poor life expectancy both in terms of quality and duration. Surgical programmes of organ transplantation are well established with proven early and long term benefit for the heart, lung, kidney, corneal, liver areas, while for other areas there is patchy evidence of efficacy, hence relevant surgical programmes are less established. One major problem of organ transplant is a very limited availability of donors leading to a major mismatch between demand and available organs. This means that very often patients die while waiting for an organ to be available. The serious shortage of donors has led to the development of alternative approaches at research level such as developing artificial organs or attempts to repair damaged organs via regenerative medicine. These alternative approaches are at experimental stage and have had to date no impact on patient and system benefit despite a massive funding investment. A further problem is that when an organ is available the current means to preserve and protect it (often during very long transportation via airways in other countries) is suboptimal, and this has a further negative impact on the surgical programme. Current organ preservation methods are often based on keeping the organ not perfused and cooled down on ice. This approach is effective only for few hours, hence triggering issues related to distance, method of transport and setting up of concomitant explant and transplant teams under a lot of time pressure. Often this lead to transplanted organs (and patient receiving the transplant) struggling to recover after surgery or not making it. Recently there are attempts to develop methods of preservations of explanted organs for transplant based on the use of perfusion devices. Cardiac surgery is based on the use of the heart-lung machine that is a perfect perfusion device. It takes over the job of heart and lungs during surgery, hence supporting the whole patient and all his other organs with perfusion of oxygenated blood at a given flow and temperature for

many hours with a physiological approach. This very effective approach of using the heart-lung machine has replaced 50-60 years ago the very initial approach based on cooling down the entire patient in ice baths and then operate on their heart with no pump support.

Idea

It is possible to develop a pump device that can protect explanted organs using the same physiological principles on the heart lung machine. The idea is to develop a miniaturised heart-lung machine using the expertise already available in our clinical perfusion department for adult and paediatric cardiac surgery and connect to it is an organ chamber a single organ soon after explant from donors. The organs will be preserved with an artificial circulation system that pump autologous oxygenated blood, at a physiological pulsatile flow, and at a preserving temperature function. Chemicals can be added in the circulating blood to optimise organ preservation. This device could expand significantly the preservation of a functioning organ for days, hence transforming completely the way organ transplantation is managed.

A prototype developed along these lines can be then tested/validated/refined at the TBRC facility under development, where a normal heart-lung machine for preclinical work is already available.

It is envisaged that the pump devices should be fit with all modern sensors for automatic control/adjustment/display of all live parameters including blood level of key elements to keep them within normal ranges.

A device of this type will be also extremely effective in a translational lab with regenerative medicine programmes and/or with organ preservation research lines.

How does this issue impact on you, your colleagues and your patients?

An organ perfusion/maintenance as described above would be transformational of organ transplant programmes with a worldwide impact on NHS and healthcare systems as well as top translational research settings.
There could be an enormous advantage to patients worldwide suffering with end-stage organ failure with a major reduction in usage of hospital resources and costs.

Can you estimate how many patients or staff are affected by this problem?
Can you describe any associated financial implications for the NHS or patients?
(Don't worry if you are not able to answer this question at this stage – it is not compulsory)

The device if effective could save life and improve significantly life expectancies worldwide while reducing markedly hospital stay/readmissions and rate of postoperative complications with a huge impact on costs.