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 |
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| Challenge Title (max 20 Words) | |
| Developing a topical “heart jacket” for structural and functional sensing during cardiac surgery | |

| Please describe the specific problem which needs addressing |
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| Background points:<br><br>1. Patients are listed for cardiac surgery after receiving a variety of in-vivo imaging scans (4-5 different type) carried out in previous weeks/months. This includes often scans to check the blood supply to the heart (coronary angio), an echo cardiogram (TTE or TOE) to assess structural and functional aspects like valvular problems and/or degree of heart pumping failure, congenital conditions. Cardiac magnetic resonance (MRI) imaging adds more refined structural and functional imaging including evaluation of scar size and distribution after heart attack (MI), presence of thrombus in the heart, etc.<br>2. Some of these imaging modalities have limitations:<br>**Coro angio:** is able to tell the surgeon if a coronary blockage is a. severe (to operate); b. mild (no need to operate); or c. moderate (not sure if to operate or not). Cannot be done during surgery.<br>**TTE/TOE:** is good to pick up valvular conditions, but suboptimal in describing if there is heart scar, where and how much after an MI; does not show well thrombus/clots in the heart. TTE cannot be done during surgery. TOE can be done during surgery but works only if the heart is moving and not when it is stopped.<br>**MRI:** cannot be done during surgery.<br>3. Cardiac surgery is often carried out 3-4 months after the baseline scans, hence the previous scans may not represent events occurred after the listing (i.e. worsening of a coronary blockage, new thrombus/clots, new heart rhythm or pump problems, or new heart attack/scar.<br>4. During cardiac surgery the heart is stopped with cardioplegic arrest (CA) by the instillation of cold cardioplegic solution to protect it. There should be a practical way of ensuring that the heart temperature is reasonably low during surgery.<br><br>**Problems of current practice**<br>Current intraoperative management is still based on information derived from rather old approaches mostly based on clinical experience and TOE. While this approach has worked well for many years, the case mix of the surgical population is worsening dramatically and is a new challenge to face. The current intraoperative practice is depending too much on fragmented |

heart scans carried out 3-4 months prior to surgery. In addition, it relies only on intraoperative TOE, hence with potential to miss important events such as poor flow down the new bypass grafts, intramural injury, precise distribution of myocardial scars to inform surgical approach (or injections of stem cells/drugs), poor global pumping and/or synchrony between right and left heart chambers, regional and global heart wall thickening, regional and global heart electricity. In addition, during CA there is a tendency for the heart to rewarm and this should be prevented by global, continuous measurement of surface temperature.

There is a need to develop an effective multifaceted sensing/imaging/diagnostic tool based on emerging technologies able to sense and display live critical information about all the aspects described above, to provide this key information to the team to improve decision-making process and reduce in hospital mortality and morbdity. Ideally, a "heart sensing jacket" coming at different sizes that is wrapped around the heart at surgery and able to provide this information could achieve the goal of helping identify damaged (previous or new) areas of the myocardium.

The "jacket" should fit around the heart without compressing, hence not affecting the heart systo-diastolic motion (that should be sensed). It should cover all the segments of the heart with 2 or more sensing points per segment.

The sensors would ideally measure and display cardiac temperature, distinguish and display fibril/scar tissue from healthy/viable tissue, measure and display electrical signals as in an ECG, measure and display the systo-diastolic motion of the heart; measure regional heart wall thickening (healthy function give heart wall thickness expanding from 0.6-0.8 cm to 1.5-1.8cm during pumping - Damaged, scarred tissue does not expand as much or at all); measure fluid type in wall; identify clots/thombous attached on the internal surface of the heart wall; possibly measure poor blood flow down new bypass grafts.; possibly pace the heart via an electrical sensing/stimulating mode based on epicardial surface assessment of delay depolarisation potential triggering pacing at RV to LV synchronising areas; NIRS technology could be used to provide a jacket able to sense and measure myocardial oxygenation level.

This jacket could be cabled or wireless linked to a display to provide measures of ongoing evaluations.

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

Information available during surgery is based on technologies developed 30-40 years ago. Modern technologies could improve significantly the quality and amount of information available to the team to optimise intra and postoperative management. A heart jacket able to provide the information above could transform worldwide the intraoperative management in both adult and paediatric cardiac surgery (and other type of surgery if developed as a percutaneous device).

There could be an enormous advantage to patients worldwide 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)***

Approx 40,000 patients undergo adult and paediatric cardiac surgery in the UK every year. Worldwide this is about 1.5million.

The device if effective could save life, reduce hospital stay and rate of postoperative complications with a huge impact on costs.