

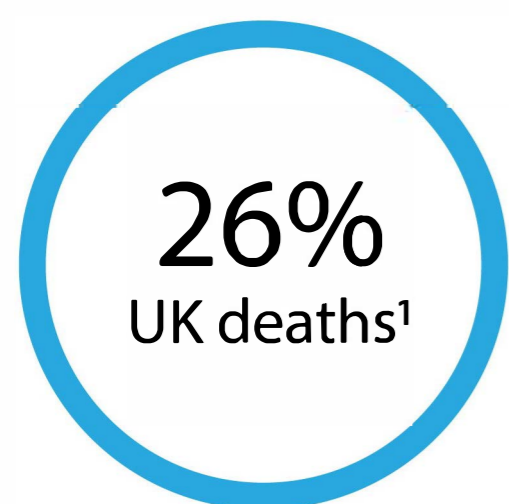
This research was conducted at Nottingham Trent University and was funded by Newcastle Hospitals Charity and Freeman Heart Lung Transplant Association.

## Background

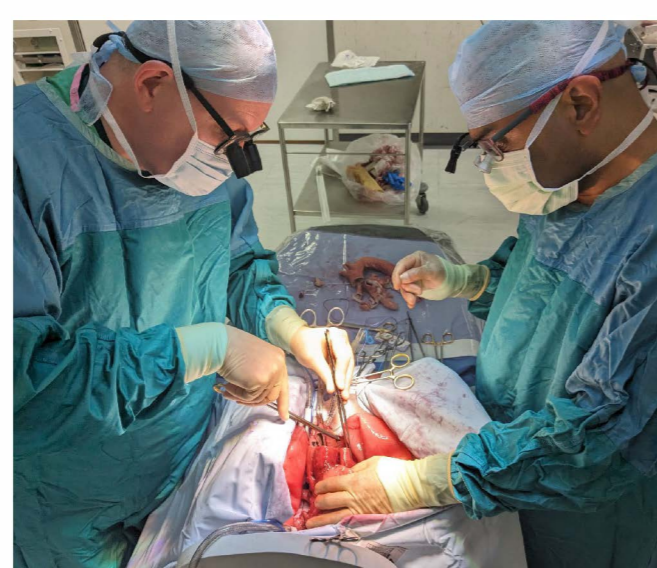
NHS spend £7.4B on CVD annually

NHS spend £50M on surgical simulation P/A

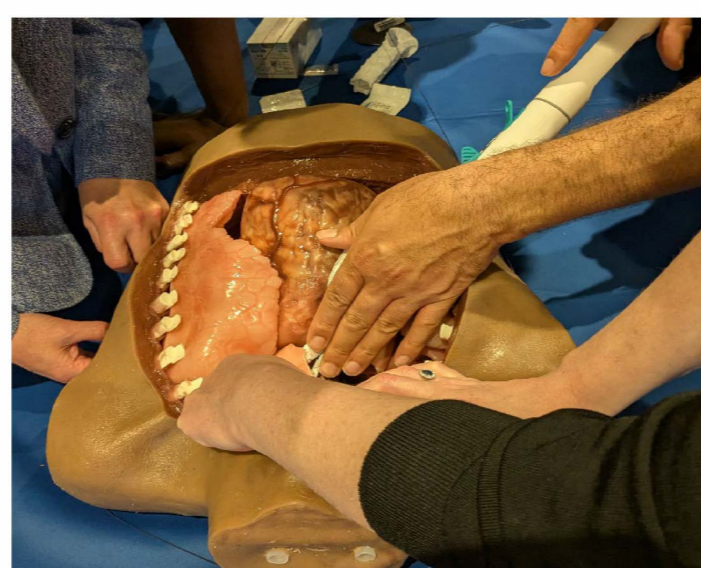
NHS spend up to £500k & 18yrs training each surgeon



Caused by cardiovascular disease (CVD)<sup>1</sup> annually



Heart transplantation best solution for advanced heart failure



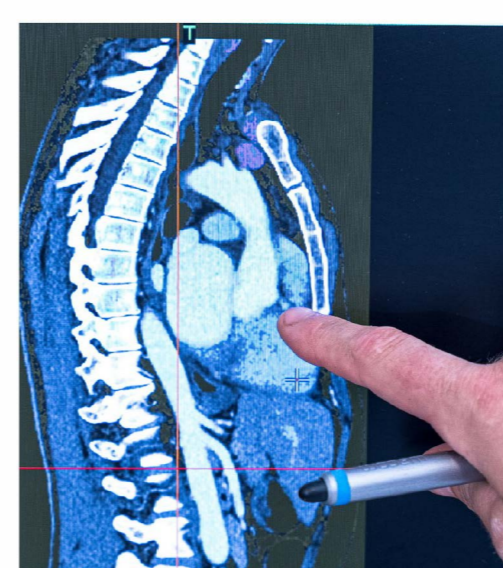
Surgeons need more immersive training opportunities

## The problem

Scan data and 3D prints cant be operated on

Current soft models not realistic enough

Current VR simulation lack realistic feedback



Scan data and 3D printing unsuitable for skill practice



Rigid models, cadavers and animal models limit access



Not realistic enough for surgical robot training

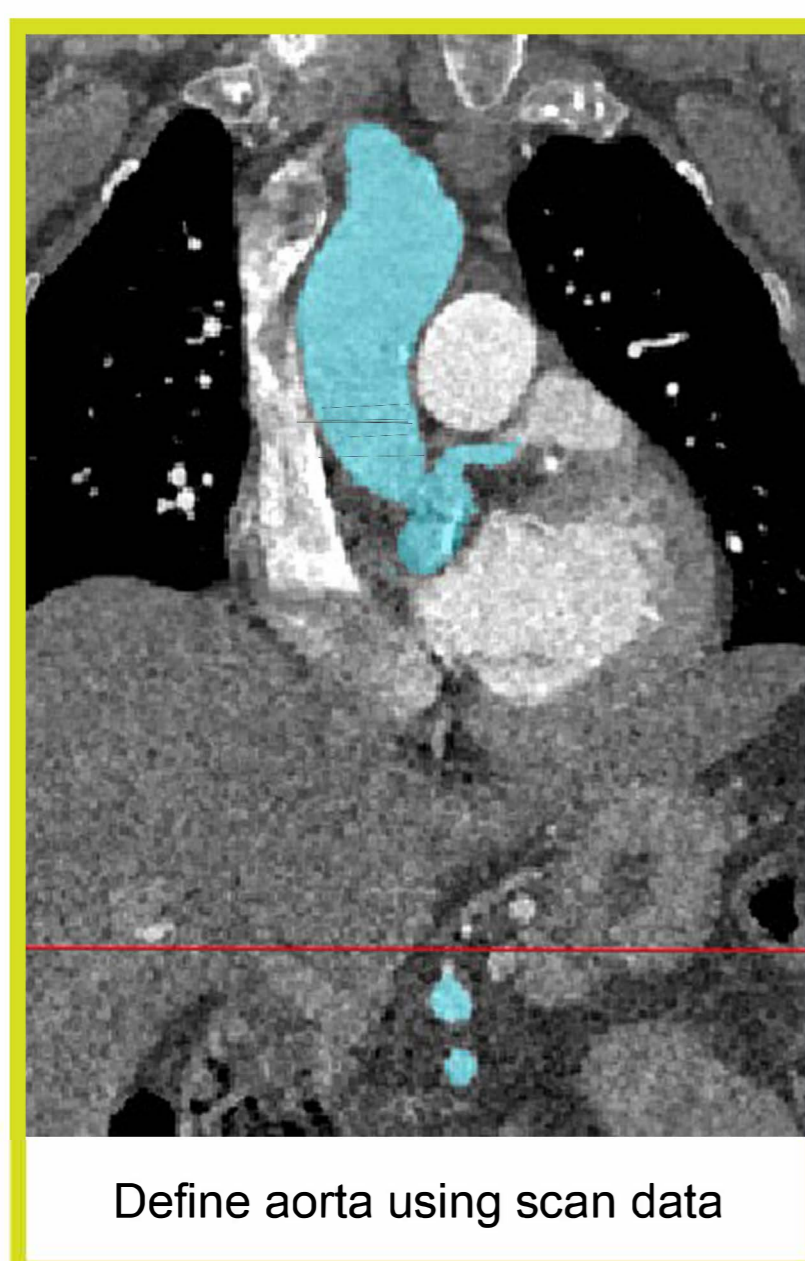
## The solution

Risk-free, accessible, low-cost, immersive training for surgeons

Use patient scan data and 3D printing for accuracy

Replace rigid prints with soft materials that feel familiar to the surgeon

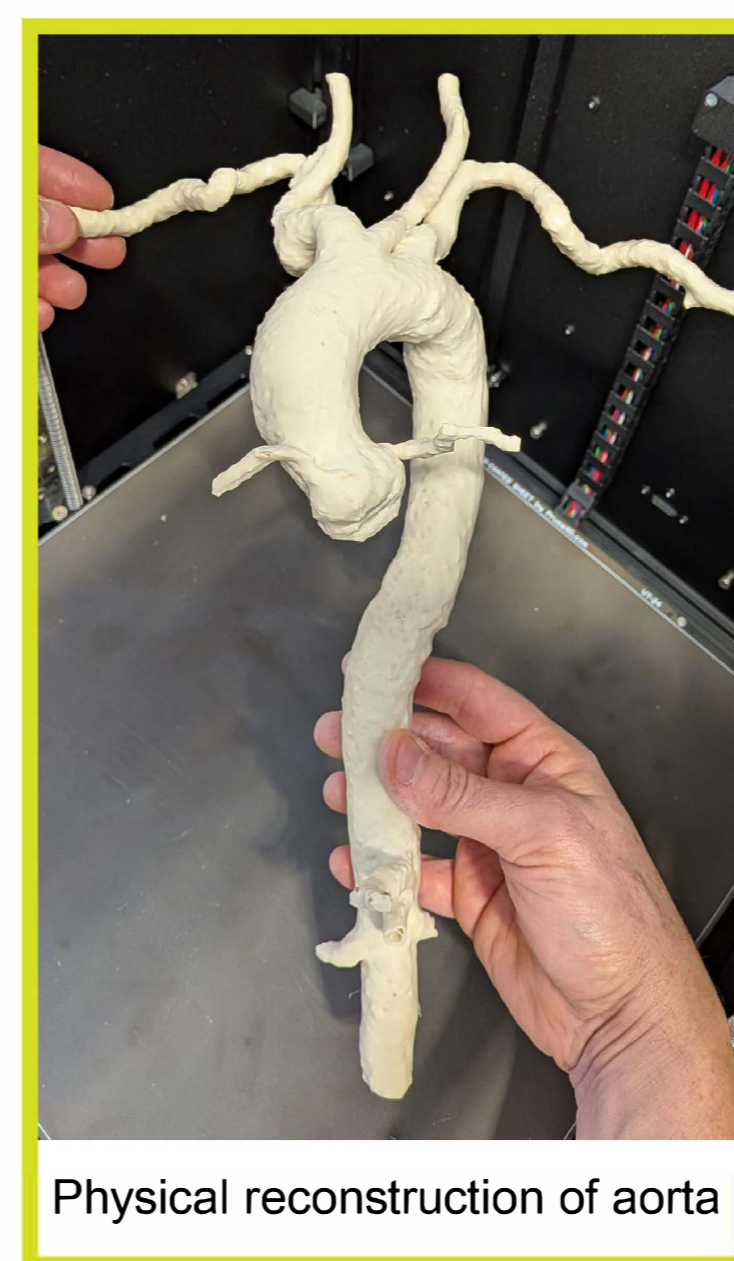
New multi-layered membranes for greater realism and reparability



Define aorta using scan data



Digital reconstruction of aorta



Physical reconstruction of aorta



Manufacturing synthetic aortas

- A range of synthetic, fibre-filled silicone gels and thermoplastic elastomers were mechanically assessed as candidates for synthetic soft tissues

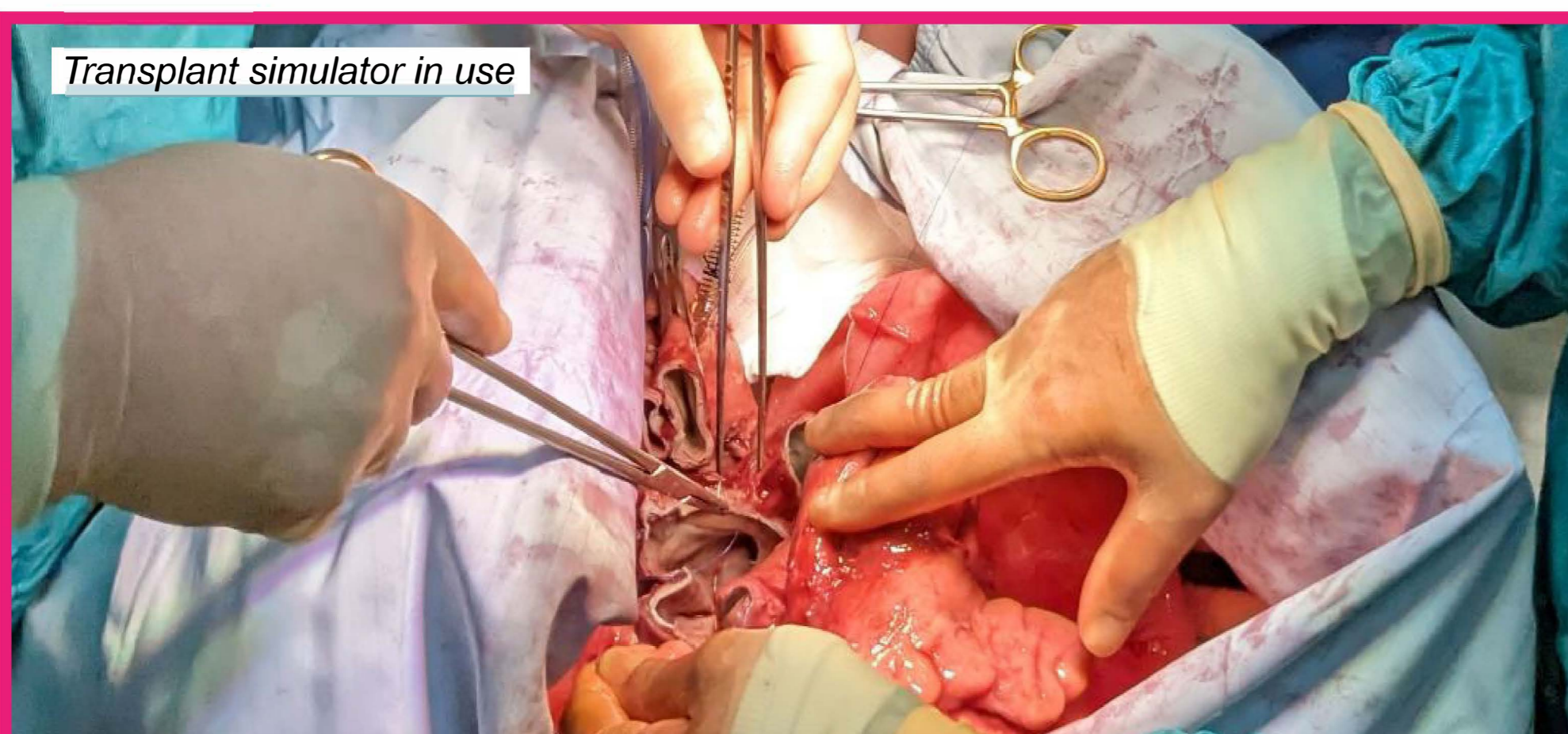
- Embedded fabrics and multilayer composition aid reparability and reusability and allow for variable elasticity and strength

## The application

- CT scans of patient and donor were digitally segmented and 3D printed
- Materials designed to mimic real organs using novel, multi-layering techniques
  - Properties were mechanically tested to match real organs

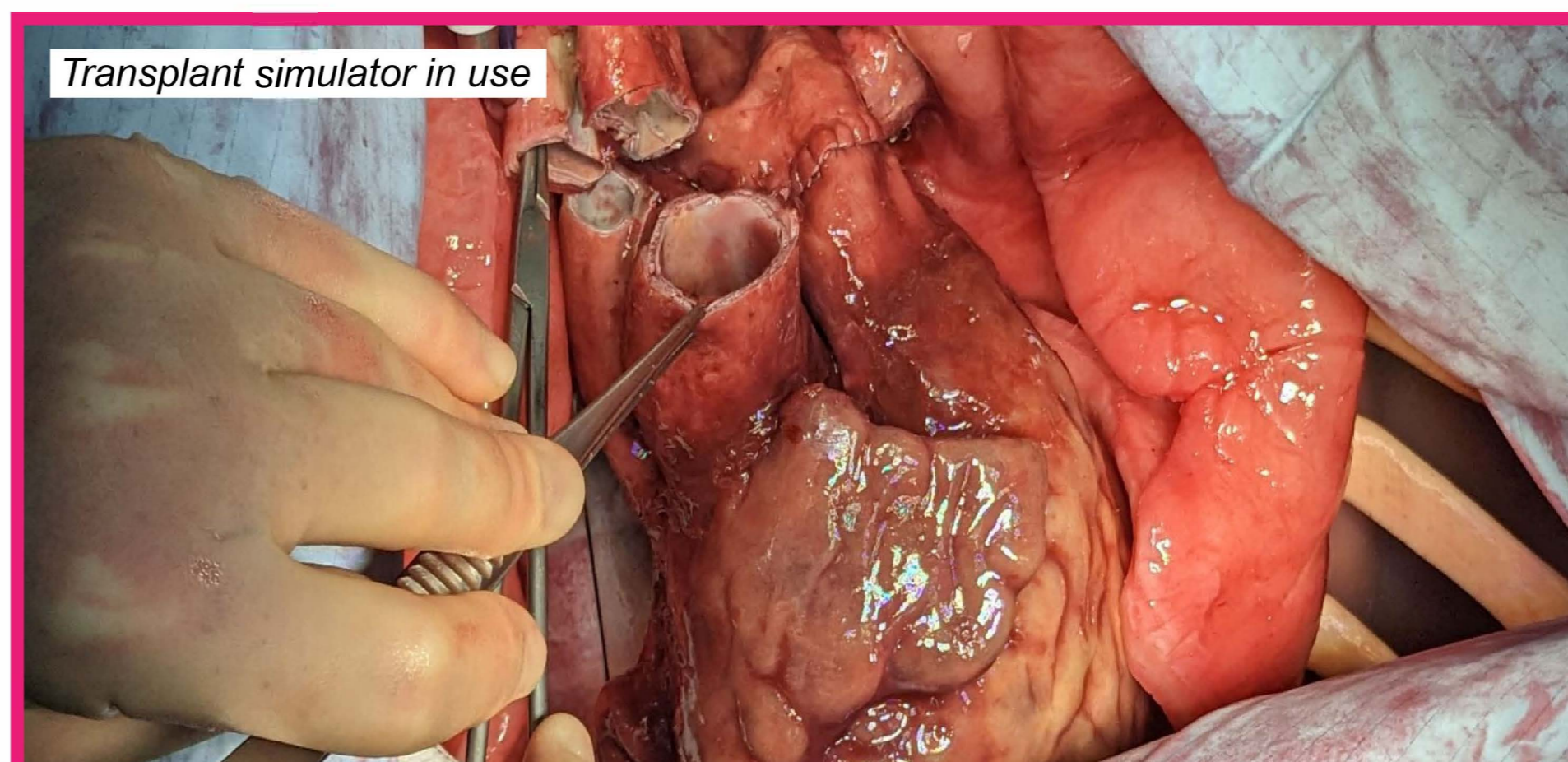
**"...improvement in trainee performance (was) observed across repeated simulations".**

Professor of Cardiothoracic & Transplant Surgery



Transplant simulator in use

Surgeon demonstrating the trainee how to remove the simulated diseased heart



Transplant simulator in use

Surgeon demonstrating the trainee how to attach the simulated donor heart

## The future

- Wider access to high-fidelity models could accelerate surgical training
- Expanding traditional and contemporary learning environments

- Complementing cadaver, animal, and virtual surgical training methods
- Providing a safe platform for training surgical robots and operators