Transformative Healthcare Technologies for 2050
Healthcare Technologies Information Day
Birmingham Botanical Gardens
27 March 2019

This document contains the material presented and produced at the information day for the ‘Transformative Healthcare Technologies for 2050’ call.

Please note there is a separate document containing all the questions asked at the event alongside the answers provided by members of staff.

Contents of this document

• Agenda
• Delegate List
• Presentations
• Truly Transformative Table Discussions
Transformative Healthcare Technologies for 2050 Information day
Westbourne Road, Edgbaston, Birmingham, B15 3TR
27 March 2019

Agenda

10:00 – 10:30 Registration - Tea and coffee available
10:30 – 10:40 Welcome and Introduction
   Dr Philippa Hemmings (Head of Healthcare Technologies)
10:40 – 11:10 “Truly Transformative” – table discussions
11:10 – 12:00 Presentation of call detail and Q&A
   Katherine Freeman (Senior Portfolio Manager)
   Iain Larmour (Senior Portfolio Manager)
12:00 – 12:30 Translation opportunities 1
12:30 – 13:45 Lunch
13:45 – 14:15 Translation opportunities 2
14:15 – 14:35 Transformative Healthcare Technologies
   Ian Craddock (University of Bristol)
14:35 – 15:00 General Q&A session with UKRI representatives
15:00 – 15:30 Refreshment break
15:30 – 15:45 Next steps and thank you
15:45 Meeting Close
Healthcare Technologies Information Day
Birmingham Botanical Gardens
27 March 2019

Attendee List

Lisa Alcock
Cameron Alexander
Salah Al-Majeed
Kaspar Althoefer
Nabil Aouf
Jo Armes
Lynne Baillie
Jeffrey Bamber
Deren Barsakcioglu
Philip Bell
James Lee John Bilzon
Kaddour Bouazza-Marouf
Iain Buchan
Adriane Chapman
Michael Chappell
Jinju (Vicky) Chen
Bernard Conway
Jonathan Cooper
James Cornford
Ian Craddock
Torbjorn Dahl
Safak Dogan
Mauro Dragone
Rory Duncan
Christos Efstratiou
Dominic Eggbeer
Mark Elliott
Pedro Estrela
Dario Farina
Simon Goodwill
Ruchi Gupta
Steve Hailes
Liangxiu Han
Yvette Hancock
Yang Hao

Newcastle University
University of Nottingham
University of Gloucestershire
Queen Mary University of London
City University of London
University of Surrey
Heriot-Watt University
Institute of Cancer Research
Imperial College London
NIHR Surgical MedTech Cooperative
University Of Bath
Loughborough University
University of Liverpool
University of Southampton
University of Warwick
Newcastle University
University of Strathclyde
University of Glasgow
University of East Anglia
University of Bristol
InstaDeep Ltd
Loughborough University London
Heriot-Watt University
Heriot-Watt University
University of Kent
Cardiff Metropolitan University
University of Warwick
University of Bath
Imperial College London
Sheffield Hallam University
University of Birmingham
University College London
Manchester Metropolitan University
University of York
Queen Mary University of London

Organisations correct at time of event
Welcome and Introduction
Dr Philippa Hemmings – Head of Healthcare Technologies
## Overview of the Day

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>10:00 – 10:30</td>
<td>Registration&lt;br&gt;Arrival and <strong>Tea and Coffee</strong></td>
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<tr>
<td>10:30 – 10:40</td>
<td>Welcome and Introduction&lt;br&gt;• Philippa Hemmings</td>
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<tr>
<td>10:40 – 11:10</td>
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<tr>
<td>11:10 – 12:00</td>
<td>Presentation of call detail and Q&amp;A&lt;br&gt;• Katherine Freeman and Iain Larmour</td>
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<tr>
<td>13:45 – 14:15</td>
<td>Translation opportunities 2</td>
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<tr>
<td>14:15 – 14:35</td>
<td>Transformative Healthcare Technologies (Speaker: Ian Craddock)</td>
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<td>General Q&amp;A session with UKRI representatives</td>
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<td>15:00 – 15:30</td>
<td><strong>Tea and Coffee</strong></td>
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<tr>
<td>15:30 – 15:45</td>
<td>Next steps and thank you - Philippa Hemmings</td>
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<tr>
<td>15:45</td>
<td>Meeting closes</td>
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</tbody>
</table>
Welcome

Thank you for attending

All material will be made available on the call webpage within one week of today

House Keeping
  - Fire alarms
  - Toilets
  - Lunch
We’ve been thrilled by the level of interest in this call but want to ensure that the key aims of the call are met:

- Increased support within Frontiers of Physical Intervention and Transforming Community Health and Care
- Novel transformative ideas that are not current areas of interest/work and which will become routine in the NHS or wider healthcare landscape in 30 years’ time
- Multidisciplinary teams that work together to maximise and accelerate the pathway to impact
Truly Transformative
Katherine Freeman
You were asked “Which technology do you think has transformed healthcare in the past 60 years?”

Pitch the idea to others on your table

Decide one idea per table

On the poster provided fill in:
  - What is the technology/background?
  - Why is this transformative?
Call Details
Katherine Freeman and Iain Larmour
Call Details - Overview

- Up to £25m is available for 4-6 projects (£4-6m each)
- Awards are expected to be 4-6 years long
- Outline stage will be anonymous by expert panel.
- We want to focus on the transformative idea

Timeline:

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Information Day</td>
<td>27 March 2019</td>
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<tr>
<td>Deadline for Outline Proposals</td>
<td>16:00, 02 May 2019</td>
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<tr>
<td>Outline Expert Panel</td>
<td>June 2019</td>
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<tr>
<td>Full Proposal Postal Peer Review</td>
<td>September 2019 – January 2020</td>
</tr>
<tr>
<td>Full Proposal Expert Interview Panel</td>
<td>February 2020</td>
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</table>
Principal Investigators may only lead on one application, they can be Co-Investigator on one other.

Applications to this call are encouraged across the breadth of engineering, physical sciences, mathematical sciences and ICT.

All applications must be predominantly within the remit of EPSRC.

Applications which are not within EPSRC remit will be rejected.
We are looking for applications that do not just consider health treatment but also homecare, prevention and wellbeing with the overall goal of keeping people physically and mentally healthy.

We are keen to develop and help realise the potential of:
- Next-generation digital healthcare systems
- Engineering healthier environments where people live and work
- Future affordable and inclusive healthcare solutions
- Technologies to improve healthcare treatment
Examples of well-known disruptive, innovative technologies which have become routine and led to real impact within the healthcare sector.
Frontiers of Physical Intervention

Restoring function, and optimising surgery and other physical interventions to achieve high precision with minimal invasiveness.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to develop prostheses and devices to restore normal function, and develop precise, minimally invasive physical interventions to repair damage or remove disease.

Interventions may include established techniques such as surgery, radiotherapy or high field ultrasound, but we also encourage new approaches to physical treatment.
Specific impacts that could be achieved under this challenge include:

- **Autonomous or cooperative robotic surgery** to reduce costs and recovery times, and improve outcomes by enabling minimally invasive intervention, improving accuracy and lowering infection rates.

- Advances in **physics modelling and image guided planning** for surgery and radiotherapy to improve precision/targeting, leading to fewer side-effects, faster recovery, and better outcomes.

- **New affordable, targeting methods**, including but not limited to nanoscale devices, for delivering non-ionising energy into patients to revolutionise treatments for cancer and other diseases, by improving efficacy and reducing side effects.

- **Bioelectronic devices** that enable long term sensing and control, which could re-establish function, reduce pain, or aid recovery.

- Disruptive technology for **implants, prostheses and assistive devices**, to restore function, adapt to changing needs and capabilities, improve success-rates and longevity (e.g. reducing the need for revision surgery), and encourage uptake.
Transforming Community Health and Care

Using real-time information to support self-management of health and wellbeing, and to facilitate timely interventions.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to transform community-based health and care.

Research supported by EPSRC will seek to integrate, interpret and communicate information from multiple sources, including real-time sensing, to help individuals stay healthy, and support a collaborative model of care involving patients, healthcare professionals and informal carers.

This should empower individuals to self-manage effectively, and facilitate timely intervention when necessary.
Specific impacts that could be achieved under this challenge include:

- **Methods for recognising person-specific abnormal patterns** in physiological and behavioural time-course data, providing early warning of deterioration to patients, carers, and healthcare professionals.

- **Decision support dashboards and tools** for healthcare professionals, supporting safe and effective management in the community of patients with long-term conditions or following early discharge.

- An **intelligent 'companion'** that is fully aware of an individual's healthcare history and experience, empowering them to self-manage their health and care by providing directly relevant feedback, information and advice.

- **Individually adaptive** data-collection, interaction with healthcare professionals, and self-reporting requests, to support effective care whilst minimising intrusion.

- **Technologies for promoting wellbeing** by providing timely, personalised feedback, and exploiting social networking to influence health behaviours.
There may be research cross over with other Grand Challenges. However, proposals focusing primarily on the other Grand Challenges will not be accepted.

This call will only support preclinical and precompetitive research projects, and results will be placed in the public domain.
Early end user engagement is particularly important to the successful design of a project which will have long term impact.

Applicants should demonstrate that applications are being co-created with relevant stakeholders which may include: service users, industry, clinicians, policy makers and practitioners including allied healthcare workers.

Applications to this call should include plans for engagement with new and future stakeholders.

At full proposal stage: applicants should describe how any new stakeholders will be involved throughout the project.
"The development landscape for Healthcare Technologies can be complicated, the journey from bench to bedside can be long and the pitfalls for new technologies are many. Successfully traversing this landscape requires preparation and an understanding of those challenges not commonly encountered in other sectors."
**EPSRC HT Impact and Translation Toolkit**

- Draw attention to some of the issues associated with key topics
- Suggest things to consider when preparing a proposal.
- Highlight resources that can be requested from EPSRC.
- Signpost additional relevant information.

[https://epsrc.ukri.org/research/ourportfolio/themes/healthcaretechnologies/strategy/toolkit/](https://epsrc.ukri.org/research/ourportfolio/themes/healthcaretechnologies/strategy/toolkit/)
Expectations

We don’t expect the toolkit to tell researchers everything they need to know.

We don’t expect researchers to know everything before applying.

We don’t expect that all aspects of the toolkit will be relevant to every project.

We don’t expect topics to be addressed completely in a project.

We don’t expect researchers to do everything themselves, or become experts in everything.
In line with the UK Research and Innovation Diversity Principles, EPSRC expects that equality and diversity is embedded at all levels and in all aspects of research practice.

With this in mind, we welcome applications from academics who job share, have a part-time contract, need flexible working arrangements or those currently committed to other longer, large existing grants.

Please see our Equality and Diversity webpages at [https://epsrc.ukri.org/funding/equalitydiversity/](https://epsrc.ukri.org/funding/equalitydiversity/) for further information.
Call Details - Equipment

Individual items of equipment between £10,000 and £400,000 can be included on proposals if the equipment is essential to the proposed research and if no appropriate alternative provision can be accessed.

Research organisations will be expected to make a 50% contribution to the cost.

Details of the proposed contribution to the cost of the equipment, must be provided in the justification of resources.

For any items or combined assets with a value above the OJEU (Official Journal of the European Communities) (£138,000 for EPSRC) a two-page Equipment Business Case must also be included.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Quotation requirements</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Under £10k</td>
<td>No quotes required</td>
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<tr>
<td>£10k-£25k</td>
<td>No quotes required</td>
<td></td>
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<tr>
<td>£25k-£138k</td>
<td>3 verbal quotes to be detailed in JoR</td>
<td>Written quote optional. If sole supplier or &lt;3 this should be justified in the JoR</td>
</tr>
<tr>
<td>Over £138k</td>
<td>3 written quotes</td>
<td>If sole supplier or &lt;3 this should be justified in the JoR</td>
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</table>
Call Details – How to Apply

- Principal Investigators can lead on a maximum of one application and may be named as Co-Investigator on one other.

- Outlines must align to the Healthcare Technologies Grand Challenges of: **Transforming Community Health and Care** and/or **Frontiers of Physical Intervention**

- Although it is expected there may be cross over with other Grand Challenges, outlines or invited full proposals focusing primarily on other Grand Challenges **will not be accepted**

- Any proposals whose majority does not fall within EPSRC remit **will be rejected** prior to the outline panel meeting.

- Please ensure sufficient time to create Je-S accounts for Investigators who do not currently have one.
Outline Proposals

Multi-institutional bids should be submitted as a single, combined Je-S proposal form at both outline and full application stage

2 documents to upload:
- Completed Proposal Form
- Case for support

Clicking ‘submit document’ on your proposal form in Je-S initially submits the proposal to your host organisation’s administration, not to EPSRC

EPSRC must receive your application by 16:00 on 02 May 2019

Outline proposal will be assessed by both EPSRC staff and an expert general panel, therefore your outline should be written for a lay audience
Call Details – How to Apply

- All attachments must be in single-spaced typescript in Arial 11 or other sans serif typeface of equivalent size
- Margins of at least 2cm
- Text in diagrams or pictures, numerical formulae or references can be smaller but **must** be legible
- This is to ensure accessibility of your paperwork to all potential reviewers
Call Details – How to Apply

- Completed Proposal Form (only seen by the office)
  - Organisation where the grant would be held
  - Project title (up to 150 characters)
  - Duration of Grant (this must be reflected in the full proposal)
  - Applicants

- Summary to include the following headings and detail:
  - Equipment
  - Grand Challenge – listed in order
  - EPSRC Research Areas addressed
  - Summary of resources required for project (Project partner contributions not required at outline. All costs including equipment may only vary 10% (up or down) between Outline and Full)
Case for Support (must be anonymous)

- Your academic publication or research track record should **not** be included in your case for support, neither should any references that may reveal your identity.

- Any submitted applications which reveal your identity will be rejected by EPSRC.

- Should clearly articulate the scientific challenges which relate to Engineering, Physical Sciences, Mathematical Sciences or ICT.

- Any proposals where the majority of the research is not within EPSRC remit will be rejected prior to the shortlisting panel meeting.
Case for Support (maximum of 5 pages)

- Title
- Grand Challenges Addressed
- Research Vision and Ambition

Page 2-5

- Need for a Large Grant
- National Importance
- Impact and Application Co-creation
Call Details – How to Apply

Research Vision and Ambition

- The novelty of the research, either fundamental or applied, must be clearly expressed
- The science detailed within Page 1 must be clearly articulated to demonstrate that the majority of the research is within EPSRC remit
- Researchers should clearly articulate how their vision will impact and transform the healthcare landscape

Need for a Large Grant

- Why is a large grant needed to tackle the identified research project opposed to other funding routes?
- Full proposal will ask for a work package outline for the first two years (as a minimum) with subsequent years being flexible
- Researchers should also explain why flexibility to reallocate resource is required for their particular project
National Importance

How does the research address Transformative healthcare Technologies for 2050 by outlining:

- The need for the development of ambitious near-future technologies expected to have an impact within the next 30 years for the NHS, community or home care and/or an ageing workforce
- How the research will contribute to, or help maintain the strength of other research disciplines, contribute to addressing key UK societal challenges, contribute to current or future UK economic success and/or enable future development of key emerging industry(s)
- How the research will meet national strategic needs by establishing or maintaining a unique world leading research activity (including areas of niche capability)

Also comment on how the research contributes to:

- Grand Challenges
- Healthcare Technologies Strategy
- Wider EPSRC Research Area strategies
- Fits and compliments other research already funded
Impact and Application Co-Creation

- Must demonstrate application co-creation with relevant and appropriate stakeholders
- The co-creation process that is carried out can be explained in detail
- Collaborations should be forward thinking and must consider the future impact needs of the research
- Plans for on-going engagement should be briefly discussed but will be more fully assessed at full proposal stage
- Non-academic partners can be listed but care should be taken
  - For example rather than “Great Western Hospitals NHS Foundation Trust” state “local NHS Trust”

Do Not Use “Other” attachment type documents listed as these will not be seen outside of the office
Outline Panel

Applications will be assessed and prioritised by an expert outline panel against the assessment criteria:

- Alignment to Grand Challenges
- Research Vision and Ambition
- Need for a Large Grant
- National Importance
- Impact and Application Co-Creation

Applicants who reveal their identity at outline stage will not be invited through to full proposal.
## Call Detail

**Activity** | **Date**
--- | ---
Information Day | 27 March 2019
Deadline for Outline Proposals | 16:00, 02 May 2019
Outline Expert Panel | June 2019
Full Proposal Postal Peer Review | September 2019 – January 2020
Full Proposal Expert Interview Panel | February 2020

Thank You

Any Questions???
You were asked “Which technology do you think has transformed healthcare in the past 60 years?”

One idea per table from the first session

30 minutes to imagine you are at the beginning of the project for these technologies:

- What gaps and potential partners could you have identified
- How would you have accelerated this impact to realise it earlier?

<table>
<thead>
<tr>
<th>Transformative Technology:</th>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
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<tbody>
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28/03/2019
Translation Opportunities - 2
Katherine Freeman
Translation Opportunities

- Different perspectives highlight different translation challenges
- Please swap proformas with another table
- In a different coloured pen spend **10 minutes** looking at and adding ideas to the new proforma
- How does getting perspectives from a different group of people change the challenges?
- Please provide feedback (one or two minutes) to the room

- We will take the proformas away and type them up to add into the report from this workshop
SPHERE and some lessons

A presentation for EPSRC
Transformative Healthcare Technologies for 2050

Prof Ian Craddock
Director and PI of the SPHERE IRC
Director of the EPSRC CDT in Digital Health and Care
Institutional Lead for Digital Health at University of Bristol
REF2021 Comp Sci panel member
Overview

• What SPHERE did and what we might learn from it.
• Five challenges for you.
Funding

• Proposal written 2012 (Bristol, Southampton, Reading)
  • 2013-2018 £12M from EPSRC + £3M other contributions
  • Mid term review in 2015

• SPHERE Next Steps proposal
  • 2018-2021 £4M from EPSRC + £1M other contributions

• Total budget ~£20M over 8 years.

1 Vision for the IRC
This IRC’s vision is not to develop fundamentally-new sensors for individual health conditions but rather to impact all these healthcare needs simultaneously through data-fusion and pattern-recognition from a common platform of non-medical/environmental sensors at home. The system will be general-purpose, low-cost and hence scalable. Sensors will be entirely passive, requiring no action by the user and hence suitable for all patients including the most vulnerable. A central hypothesis is that deviations from a user’s established pattern of behaviour in their own home have particular, unexploited, diagnostic value.
Outcomes:
Research, Diagnosis and Treatment of long term conditions needs long term, hence pervasive/passive monitoring. Similarities between disease conditions greater than the differences. Needs to scale to at least n=100.
Emergent Outcome:

MRI scanner  
Gene sequencer

The ultimate machine for analysing human behaviour
Sensors developed

Custom PCB, custom firmware, very flexible, includes on-board processing. Wearable BLE, 20Hz accelerometer continuous streaming, 2 month battery. Environmental sensor 2.4GHz TISCH, humidity, temp, PIR, 12 month battery.
Wearable receiver (gateway)

- BLE in, TISCH out (star or mesh network topology)
Wristband v1

Main problem:
Wireless charging.
Physical enclosure design.

v1: bit too large but OK.
v2: glued enclosure (1cm smaller).
v3: watch size/shape, with display, drops wireless charging, currently in assembly in China.
• Localising the wearable
Installed Video Solution

Camera (ASUS Xtion)

Intel NUC (Implementing human detection and tracker based on an enhanced Kernalised Correlation Filter that tolerates occlusion and can model scale changes)
UOB Open

Wristbands:

Environmental Sensors:

ASUS Xtion depth cameras:

Appliances and water:

Cellular monitoring data:

Home Hub:

Home Router:

University SPHERE Gateway

SPHERE ‘Genie” GUI:

BLE

802.15.4 TSCH & 6LoWPAN/RPL mesh

802.11ac network - extracted features

University
SPHERE House, Bristol

- House sensor platform since 2013.
- Aim for each person in the house
  - Where are they?
  - What activity?
  - What quality of activity?
- Learning how to do this research (experiment design, data management, user acceptance, ethics process, skills training for researchers).
- En route to 100 Home roll out in 2017-2018.
300 wireless networks
4000 sensors
300 cameras
400 computers
Age Ranges

- **Unknown**: 15%
- **Under 8**: 3%
- **Ages 8-15**: 14%
- **Ages 16-24**: 3%
- **Ages 25-34**: 9%
- **Ages 35-44**: 11%
- **Ages 45-54**: 14%
- **Ages 55-64**: 11%
- **Over 65**: 20%
- **Unknown**: 15%
Visits

• Three technicians:
  • 2018:
    • Consent surveys: 53 completed, 1 pending
    • Installations: 50 completed, 3 pending
    • Maintenance visits: 122 completed, 7 pending
    • Platform removals: 19 completed, 31 pending
    • Experiment visits: 22 completed, 0 pending
  • 2019:
    • Over 300 home visits completed, 10 pending
“Video” data from household 1193, March 2017 (used with their permission)

Video removed due to ethics/consent
T1. STS Classifier

- Using MuViLab, we have annotated 4 months of video data for STS transitions.
- Using a convolutional neural network we were able to achieve >90% accuracy in classifying video sequences:

Examples of 4 seconds video sequences detected as stand up transitions.
What Does This Look Like for a Patient?

Hip/knee surgery

Sit-to-stand speed

Weeks 1 2 3 4 5 6 7 8 9 10 11 12

Speed m/s

2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
EPSRC IRC SPHERE outcome

- The main outcome for SPHERE is a bespoke sensor platform for capturing and mining human behaviour indoors, over years.
- “Behaviours” include sleeping, eating, social contact, cooking and quality of movement. The project has developed sensors and analytics but also:
  - Ethics frameworks
  - Public engagement
  - And the demonstrated ability to monitor and maintain 1000s of devices in family homes over years.
- Applications of SPHERE now funded for Parkinsons Disease, Dementia, Cardiovascular Surgery, Orthopaedic Surgery.
- This could demonstrably not have been achieved through responsive mode funding.
Overview

• What SPHERE did and what we might learn from it.
• Five challenges for you.
Challenge 1

• **Lead a project, not a network.**
  - Big investments should transform research not catalogue it.
  - If the activities in each part of your research plan could have been done under a number of standard stand-alone grants, where are you adding value?

• *What does this mean for you?*
• You need to be empowered to say “no” to fellow academics.
Challenge 2

• Your job is to write the first paragraph, the rest is just detail.
  • Nobody can understand the detail of a large multidisciplinary grant.

• What does this mean for you as PI?
• Your job is to coalesce a large team around a compact vision which they might not initially understand or buy into.
Challenge 2

• Your job is to write the first paragraph, the rest is just detail.

1 Vision for the IRC
This IRC’s vision is not to develop fundamentally-new sensors for individual health conditions but rather to impact all these healthcare needs simultaneously through data-fusion and pattern-recognition from a common platform of non-medical/environmental sensors at home. The system will be general-purpose, low-cost and hence scalable. Sensors will be entirely passive, requiring no action by the user and hence suitable for all patients including the most vulnerable. A central hypothesis is that deviations from a user’s established pattern of behaviour in their own home have particular, unexploited, diagnostic value.
Challenge 3

- **It’s OK to be transformed**
  - Your transformative vision might need capabilities that don’t exist.

- *What does this mean for you?*
- Your colleagues may have to move outside their comfort zone.
- Academics often don’t react well to this.
Challenge 4

• Public engagement is not about telling members of the public how clever you are.
  • It is about giving up control of your research to the public.

• What does this mean for you?
• Find the right space for this to happen.
Challenge 5

• **Multidisciplinarity is not product development.**
  • It is high quality, low TRL, EPSRC research shaped and actioned from the outset by different disciplines.

• *What does this mean for you?*
• Your EPSRC-remit technology might take 20 years to get to market.
• All the more reason to ensure it is solving the right problem.
The best time to plant a tree was 20 years ago. The second best time is now.

- Chinese Proverb
Conclusions

• SPHERE is a good example of a project that is bigger than the sum of its parts and demonstrably needed a large investment to deliver.

• Lead a project not a network.
• Your job is to write the first paragraph.
• It’s OK to be transformed.
• Public engagement is not telling people how clever you are
• Multidisciplinarity is not product development.
General Q&A session
Philippa Hemmings
Panel Discussion

- Facilitated by Philippa Hemmings

Those available to answer questions on the panel:

- Katherine Freeman - EPSRC
- Iain Larmour - EPSRC
- Kerry Young - ESRC
- Agnes Leong - MRC
Tea and Coffee Break
Next Steps and Thank You

Philippa Hemmings
Sharing outputs of the day

- We have covered the key aspects of the call today
- Using examples of what you’ve identified as already transformative we’ve discussed ways to increase the rate of translation
- We are really excited by this call and want to see truly transformative healthcare technologies ideas for 2050
- Material from the workshop will be made available on the call webpage within a week including a collated FAQ document
Feedback

- Was today useful or not?
  - Please tick the relevant area on the flipchart sheet
- How could we improve future events?
  - Ideas on post-it notes and put on the other flipchart sheet

- If you have any questions please get in touch with the team: healthcare@epsrc.ukri.org

Safe travelling!
**Truly Transformative Discussions**

Delegates were asked to discuss their responses to the survey question: “Which technology do you think has transformed healthcare in the past 60 years?” and decide on one idea for the table.

They were then asked to consider, with hindsight, activities that could have accelerated achieving the transformative idea. This activity was to encourage people to consider pathways to impact activities within health. The material below captures these table discussions.

<table>
<thead>
<tr>
<th>Idea: Diagnostic Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What is the technology/background information</strong></td>
</tr>
<tr>
<td>• Low cost diagnostics e.g. ultrasound, MRI, CT, PET, x-rays</td>
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<tr>
<td>• Modality</td>
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<tr>
<td>o In community (USS/MRI/CT Scanning)</td>
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<td>o Point of care</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Idea: Non-invasive Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What is the technology/background information</strong></td>
</tr>
<tr>
<td>• MRI, CT, Ultrasound, PET = Physics-based technologies</td>
</tr>
<tr>
<td>• Motion-capture, AI</td>
</tr>
<tr>
<td>• ‘Smart’ data analyses and image processing</td>
</tr>
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</tbody>
</table>
### Idea: A Suite of Non-invasive Imaging Technologies

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
</table>
| • A collective toolbox of approaches for visualisation of internal body parts, their function and identification of abnormalities  
  • Need physics and engineering | • A vast majority of medical conditions can be diagnosed with imaging  
  • Low cost (for NHS)  
  • Fast |

### Idea: Internet

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
</table>
| • Networking  
  • Devices – computing and mobiles  
  • Storage  
  • Communications technologies and information provision  
  • User experience  
  • Access...grid etc.  
  • Internet and medtech?  
  • Health perspective? | • Worried well – hypochondriacs (negative)  
  • Sharing – open source  
  • Information/dis-information  
  • Networking expertise  
  • Data exchange between experts e.g. scan data is viewed in any country  
  • Patient empowerment (good and bad)  
  • Mental health, negative and positive (mostly negative)  
  • Insurance; experts; patients/public, companies |

### Idea: Imaging

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
</table>
| • Imaging – CT, MRI, isotope, PET, US, image intensifiers/fluoroscopy | • Diagnostic  
  • Monitoring  
  • Management planning  
  • Enabling – key hole surgery |
### Idea: Medical Imaging

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Electronic Health Records</td>
<td>• Largest population effect</td>
</tr>
<tr>
<td>• Ultrasound/ Medical Imaging</td>
<td>• Social Impact</td>
</tr>
<tr>
<td>• NHS</td>
<td>• Low cost and a wide impact</td>
</tr>
<tr>
<td>• Human Genome Project</td>
<td></td>
</tr>
<tr>
<td>• Emergency Care</td>
<td></td>
</tr>
<tr>
<td>• Cataract surgery and intraocular lenses</td>
<td></td>
</tr>
<tr>
<td>• Cognitive Behavioural Therapy</td>
<td></td>
</tr>
<tr>
<td>• Implants e.g. Pacemakers or Hip replacements</td>
<td></td>
</tr>
<tr>
<td>• Vaccination</td>
<td></td>
</tr>
</tbody>
</table>

### Idea: Connected conversation of care and measurable health systems

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge Management- knowledge bases--- Computable health and care data</td>
<td>• Enables environments for actionable information for:</td>
</tr>
<tr>
<td>• Internet</td>
<td>• Prevention</td>
</tr>
<tr>
<td>• Electronic Health Records</td>
<td>• Early intervention</td>
</tr>
<tr>
<td>• Imaging and omics</td>
<td>• Self-Care</td>
</tr>
<tr>
<td></td>
<td>• Population health management</td>
</tr>
</tbody>
</table>

### Idea: Joint Replacement

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Arthritis- 8.4 million sufferers in the UK</td>
<td>• Quality of life</td>
</tr>
<tr>
<td>• Ageing population</td>
<td>• Material Improvement</td>
</tr>
<tr>
<td>• Multiple implants needed</td>
<td>• Customised implants</td>
</tr>
<tr>
<td></td>
<td>• Robotic approaches enable better placement</td>
</tr>
<tr>
<td></td>
<td>• New fabrication technologies</td>
</tr>
<tr>
<td></td>
<td>• Osteointegration</td>
</tr>
</tbody>
</table>
### Idea:

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Imaging</td>
<td>• Usability</td>
</tr>
<tr>
<td>• Blood Pressure, heart rate and other patient health monitoring systems</td>
<td>• Accepted by both patients and clinicians</td>
</tr>
<tr>
<td>• MRI</td>
<td>• Hardware and software/algorithmic bundle</td>
</tr>
<tr>
<td>• Pagers/alert systems</td>
<td>• Both physical and mental health</td>
</tr>
<tr>
<td>• Digitisation of medical records</td>
<td>• More precise diagnostics/treatment plans</td>
</tr>
<tr>
<td>• Genetic Profiling</td>
<td>• Continuous development</td>
</tr>
<tr>
<td>• Implants</td>
<td>• Safer, cheaper and more widespread</td>
</tr>
<tr>
<td></td>
<td>• 3D moving metabolic processes, brain function</td>
</tr>
<tr>
<td></td>
<td>• Interactive</td>
</tr>
<tr>
<td></td>
<td>• Helped to learn and compare across groups of patients</td>
</tr>
</tbody>
</table>

### Idea: Imaging

<table>
<thead>
<tr>
<th>What is the technology/background information</th>
<th>Why is this transformative?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging:</td>
<td>• Real time</td>
</tr>
<tr>
<td>• Ultrasound</td>
<td>• Diagnostic</td>
</tr>
<tr>
<td>• MRI</td>
<td>• Non-Invasive</td>
</tr>
<tr>
<td>• FMRI</td>
<td>• Interactive</td>
</tr>
<tr>
<td>• FNIRS</td>
<td>• Accessible at point of care</td>
</tr>
<tr>
<td>Multidisciplinary</td>
<td></td>
</tr>
<tr>
<td>• Chemical</td>
<td></td>
</tr>
<tr>
<td>• Engineering</td>
<td></td>
</tr>
<tr>
<td>• Medical</td>
<td></td>
</tr>
<tr>
<td>• Materials</td>
<td></td>
</tr>
<tr>
<td>• Electronics</td>
<td></td>
</tr>
<tr>
<td>• Math/Sci</td>
<td></td>
</tr>
<tr>
<td>• ICT/Comp Sci</td>
<td></td>
</tr>
<tr>
<td>• Physics</td>
<td></td>
</tr>
<tr>
<td>Idea: Vaccines</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td><strong>What is the technology/background information</strong></td>
<td><strong>Why is this transformative?</strong></td>
</tr>
<tr>
<td>• Cancer Vaccines and others</td>
<td>• Society (transforms all round world)</td>
</tr>
<tr>
<td></td>
<td>• Cost effectiveness</td>
</tr>
<tr>
<td></td>
<td>• Cancer vaccines etc.</td>
</tr>
<tr>
<td></td>
<td>• Prevention (emphasis on prevention)</td>
</tr>
<tr>
<td></td>
<td>• Manufacturing -&gt; Quicker</td>
</tr>
<tr>
<td></td>
<td>• Scale/Production</td>
</tr>
</tbody>
</table>
## Transformative Technology: Neuroimaging

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Time to tech adoption</td>
<td>• Health economics experts</td>
<td>• Healthcare providers</td>
<td>• Patients</td>
</tr>
<tr>
<td>• Engaging clinicians and users at the beginning of research and all stages of technology development</td>
<td>• Physicists, computer scientists and engineers -&gt; working with patients to understand disease -&gt; medical champions</td>
<td>• Patients!</td>
<td>• Researchers</td>
</tr>
<tr>
<td>• Safety and trust of public</td>
<td>• Regulatory trials</td>
<td>• To understand disease manifestation, symptoms, lifestyles</td>
<td>• Equipment</td>
</tr>
<tr>
<td>• Credibility for clinicians</td>
<td>• Data management access to patient record</td>
<td>• Carers!</td>
<td>• Clinicians</td>
</tr>
<tr>
<td>• Cost/efficacy</td>
<td></td>
<td>• Environment</td>
<td>• Time!</td>
</tr>
<tr>
<td>• Data capture cross multiple sites</td>
<td></td>
<td>• Neuro nurses, what they need to use new technology</td>
<td>• Energy!</td>
</tr>
<tr>
<td>• Longitudinal studies in patients</td>
<td></td>
<td>• Social services</td>
<td>• Strong cross-disciplinary teams with common vision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Commissioners</td>
<td>• Risk takers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Funders for further trials</td>
<td></td>
</tr>
</tbody>
</table>
**Transformative Technology: Digitisation**

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unnecessary bureaucracy</td>
<td>• Interdisciplinary team formation</td>
<td>• Stakeholders/end-users</td>
<td>• To be funded by this call</td>
</tr>
<tr>
<td>• Excessive regulation/GDPR</td>
<td>• Consulting stakeholders</td>
<td>• Patients and carers/beneficiaries</td>
<td>• Time</td>
</tr>
<tr>
<td>• NHS Job replacement</td>
<td>• Raising awareness and providing training</td>
<td>• Clinicians</td>
<td>• Human resources (admin assistance also)</td>
</tr>
<tr>
<td>• Risk aversion/Tech aversion</td>
<td>• Evidence of cost-effectiveness</td>
<td>• Industry</td>
<td>• Physical resources</td>
</tr>
<tr>
<td>• Fragmented NHS</td>
<td>• Engaging with opinion leaders and champions</td>
<td>• Investors</td>
<td>• Stakeholder consultancy</td>
</tr>
<tr>
<td>• Inertia (NHS)/acceptance</td>
<td>• Creating opportunities and building the incentive for the NHS to engage with EPS</td>
<td>• Legal</td>
<td>• Access and storage of data</td>
</tr>
<tr>
<td>• Validation</td>
<td>• Produce rigorous scientific basis</td>
<td>• Regulators</td>
<td>• Ethics assessment</td>
</tr>
<tr>
<td>• Complex cost models</td>
<td>• IP assessment — challenging existing models for innovation</td>
<td>• Government/policy makers</td>
<td>• Regulatory advice</td>
</tr>
<tr>
<td>• Time/academic constraints</td>
<td></td>
<td>• NHS/other health organisations</td>
<td>• Legal</td>
</tr>
<tr>
<td>• Resource</td>
<td></td>
<td>• Tech/disruptives</td>
<td></td>
</tr>
<tr>
<td>• IP assessment</td>
<td></td>
<td>• Broader academic community</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Charities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Behavioural scientists</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Health economics experts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Important to prioritise stakeholders</td>
<td></td>
</tr>
</tbody>
</table>

- NHS:
- EPS: Enhanced Patient Services

- Stakeholders/end-users
- Patients and carers/beneficiaries
- Clinicians
- Industry
- Investors
- Legal
- Regulators
- Government/policy makers
- NHS/other health organisations
- Tech/disruptives
- Insurance companies (US)
- Broader academic community
- Charities
- Behavioural scientists
- Health economics experts
- Important to prioritise stakeholders

- Stakeholders/end-users
- Patients and carers/beneficiaries
- Clinicians
- Industry
- Investors
- Legal
- Regulators
- Government/policy makers
- NHS/other health organisations
- Tech/disruptives
- Insurance companies (US)
- Broader academic community
- Charities
- Behavioural scientists
- Health economics experts
- Important to prioritise stakeholders

- To be funded by this call
- Time
- Human resources (admin assistance also)
- Physical resources
- Stakeholder consultancy
- Access and storage of data
- Ethics assessment
- Regulatory advice
- Legal
### Transformative Technology: Imaging

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• General public and patients</td>
<td>• Public engagement programme</td>
<td>• Public, patients</td>
<td>• Money</td>
</tr>
<tr>
<td>• Cost</td>
<td>• Clinician champion and early adopters</td>
<td>• Government</td>
<td></td>
</tr>
<tr>
<td>• Education</td>
<td>• Press/media</td>
<td>• Other governments (EU)</td>
<td></td>
</tr>
<tr>
<td>• Clinical culture</td>
<td>• Scientific publications (Journals and magazines)</td>
<td>• Business (start in private health?)</td>
<td></td>
</tr>
<tr>
<td>• Buy-in</td>
<td>• GP buy-in/Pharmacy buy-in (Boots)</td>
<td>• NHS procurement</td>
<td></td>
</tr>
<tr>
<td>• Fear of the unknown</td>
<td>• Advertising/influencing activities</td>
<td>• Existing and new manufactures</td>
<td></td>
</tr>
<tr>
<td>• Public perception of animal testing</td>
<td></td>
<td>• International angle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PPI</td>
<td></td>
</tr>
</tbody>
</table>

### Transformative Technology: Internet

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Keep it simple stupid</td>
<td>• Managing standards</td>
<td>• Standards committees e.g. ISO, FDA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Regulation</td>
<td>• Medical specialists</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Harmonisation e.g. Dicom</td>
<td>• Healthcare IT services</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ISP</td>
<td></td>
</tr>
</tbody>
</table>
**Transformative Technology:** Non-invasive imaging technologies

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs a service model to be delivered in NHS -&gt; to avoid resistance to change</td>
<td>Disseminate evidence of efficacy</td>
<td>All</td>
<td>Long-term investors</td>
</tr>
<tr>
<td>Manufacturers supply chain not in place</td>
<td>Business/supply model in place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training needs not met</td>
<td>Education and training</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>User acceptance via patient champions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Transformative Technology:** Connected data-driven care systems

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security and privacy (perception)</td>
<td>Engagement</td>
<td>Patients</td>
<td>Open Research and Innovation/ regulation of digital futures</td>
</tr>
<tr>
<td>Regulations</td>
<td>Involvement</td>
<td>Public</td>
<td>Funding</td>
</tr>
<tr>
<td>Anachronistic, paternalistic, passive patient</td>
<td>Education</td>
<td>Practitioners</td>
<td>Time</td>
</tr>
<tr>
<td>Care IT interoperability</td>
<td>Citizens juries</td>
<td>Engineers</td>
<td>People</td>
</tr>
<tr>
<td>Care system collaboration management/governance</td>
<td>Hackathons</td>
<td>Health informatics</td>
<td></td>
</tr>
<tr>
<td>Data not digitised</td>
<td>Low bandwidth in remote areas</td>
<td>Cyber security specialists</td>
<td></td>
</tr>
<tr>
<td>Software and hardware availability</td>
<td></td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platform system architect</td>
<td></td>
</tr>
<tr>
<td>Barriers to getting the technology adopted?</td>
<td>What activities can you carry out to accelerate progress and overcome the barriers?</td>
<td>Who do you need to engage with?</td>
<td>What resources do you need?</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>• Multiple stages from idea to product/market. Can stall at any stage e.g. getting funding for clinical tests. • Need incentives to involve clinicians in the project. • Danger of short term planning in the NHS and industrial partners. • Regulation can be inhibitory-MHRA costs and length of time it takes. • Lack of supporting technologies e.g. AI came late to Imaging. • Research moves faster than regulation</td>
<td>• Involve industry from an early stage. • Be free with budgets. • Be more speculative. • Talk to and engage with government policies. • Co-design and co-production. • Find willing investors • Publish • Present patents</td>
<td>• Clinical researchers, hospital managers • Healthcare Economists • Industry including defence, clinical services • Clinicians • End users • Top Scientists and Engineers- international • Internet communities • Garage engineers for example ‘hacking the pancreas’ • Open source • Regulators</td>
<td>• Funding • Blue skies research- horizon scanning • Fundamental • Longer and larger grants for example LOLA- BBSRC • Follow-on funding</td>
</tr>
<tr>
<td>Barriers to getting the technology adopted?</td>
<td>What activities can you carry out to accelerate progress and overcome the barriers?</td>
<td>Who do you need to engage with?</td>
<td>What resources do you need?</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>• Materials- base material/fixation</td>
<td>• Emphasis benefits of outcome</td>
<td>• Reputable partners in related field</td>
<td>• Time</td>
</tr>
<tr>
<td>• Infection- death</td>
<td>• Research and development in materials</td>
<td>• Patients</td>
<td>• Money</td>
</tr>
<tr>
<td>• Proof it works</td>
<td>• Development of animal models</td>
<td>• Clinicians</td>
<td>• People</td>
</tr>
<tr>
<td>• Availability of imaging</td>
<td>• Influence policy makers</td>
<td>• Healthcare providers</td>
<td></td>
</tr>
<tr>
<td>• Availability of machining tools</td>
<td>• Workshops</td>
<td>• Policy makers</td>
<td></td>
</tr>
<tr>
<td>• Early failure rates</td>
<td>• Training</td>
<td>• Researchers</td>
<td></td>
</tr>
<tr>
<td>• Patient acceptance and expectations</td>
<td>• Clear Financial case (QALYs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Surgical skills</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Transformative Technology:** Diagnostic Imaging

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Credibility gap</td>
<td>• Linking funding bodies- EPSRC, MRC and NIHR</td>
<td>• End users</td>
<td>• Model agreement/arrangement for data release from NHS</td>
</tr>
<tr>
<td>• Clinical scepticism</td>
<td>• Engaging stakeholders early on in the project</td>
<td>• Regulators</td>
<td>• Appropriate people</td>
</tr>
<tr>
<td>• Technology to clinical speed and application</td>
<td>• Inform regulatory frameworks</td>
<td>• NICE</td>
<td>• Funding</td>
</tr>
<tr>
<td>• Shared vision</td>
<td>• Inform guidance for healthcare commissioners</td>
<td>• NHS structures around data holdings</td>
<td>• Time</td>
</tr>
<tr>
<td>• Critical mass- industry, funding bodies</td>
<td>• Lobbying for public benefits</td>
<td>• Health Economists</td>
<td></td>
</tr>
<tr>
<td>• Funding hardware</td>
<td>• Health economics built into the project</td>
<td>• Patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Need human studies to engage with NICE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Transformed Technology: Medical Imaging

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Personal Interest</td>
<td>• Health economic studies</td>
<td>• Clinicians</td>
<td>• (Money/Flexibility)</td>
</tr>
<tr>
<td>• Cost</td>
<td>• Economies of scale</td>
<td>• Economists</td>
<td>• Travel money</td>
</tr>
<tr>
<td>• Compute and Storage</td>
<td>• Informing people of opportunities</td>
<td>• Electronics Engineer</td>
<td>• EPE? Workshops</td>
</tr>
<tr>
<td>• Training</td>
<td>• Spin out clinical trials</td>
<td>• Phillips</td>
<td>• Outsourced studies</td>
</tr>
<tr>
<td>• Hospital Infrastructure</td>
<td>• Peoples assembly</td>
<td>• Siemens</td>
<td>• Impact acceleration</td>
</tr>
<tr>
<td>• Algorithmic Complexity</td>
<td>• Forums with stakeholders</td>
<td>• Mathematicians</td>
<td>• Time</td>
</tr>
<tr>
<td>• PR: Informing people of opportunities</td>
<td>• Meeting people 1-2-1</td>
<td>• Health Planners</td>
<td>• Location</td>
</tr>
<tr>
<td>• Regulatory</td>
<td>• Validation</td>
<td>• US/EU</td>
<td>• Commercial people</td>
</tr>
<tr>
<td>• Validation</td>
<td></td>
<td>• China</td>
<td>• ‘Know how’</td>
</tr>
<tr>
<td></td>
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<td>• FDA</td>
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<td></td>
<td></td>
<td>• NICE</td>
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<td></td>
<td></td>
<td>• The public</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trust</td>
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</tbody>
</table>

- Travel money
- EPE? Workshops
- Outsourced studies
- Impact acceleration
- Time
- Location
- Commercial people
- ‘Know how’
### Transformative Technology: Lessons from Vaccines

<table>
<thead>
<tr>
<th>Barriers to getting the technology adopted?</th>
<th>What activities can you carry out to accelerate progress and overcome the barriers?</th>
<th>Who do you need to engage with?</th>
<th>What resources do you need?</th>
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</thead>
<tbody>
<tr>
<td>• Safety</td>
<td>• New chemistry and biotech would have speeded up vaccine development</td>
<td>• Manufacturer</td>
<td>• Money and time</td>
</tr>
<tr>
<td>• Proof Of Concept for efficacy</td>
<td>• Patient consultation and trust building</td>
<td>• Material Suppliers</td>
<td>• Flexibility</td>
</tr>
<tr>
<td>• Cold – Chain</td>
<td>• Publicise the problem</td>
<td>• Health economist</td>
<td></td>
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<tr>
<td>• Needs to be refrigerated</td>
<td>• Consult with engineers</td>
<td>• Social Scientists</td>
<td></td>
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<tr>
<td>• Cost</td>
<td>• Computation models of complex problems</td>
<td>• Clinicians</td>
<td></td>
</tr>
<tr>
<td>• Shelf life</td>
<td></td>
<td>• Patients</td>
<td></td>
</tr>
<tr>
<td>• Disposability</td>
<td></td>
<td>• International (WHO)</td>
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- Safety
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