Development of E-Textile-Based Medical Devices for Managing Chronic Conditions

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WSA E-textile Innovation Lab

MATERIALS & MANUFACTURING

→ Ink formulations
→ Knitting & weaving & printing
→ Garment construction

DESIGN FOCUS

→ User-centred design
→ Design for scalable production
→ Sustainability and circularity

APPLICATIONS IN HEALTHCARE & WELLBEING

→ Health monitoring
→ Rehabilitation and assisted living
→ Managing chronic conditions (e.g. pain management)

ENTERPRISE ACTIVITIES & COMMERCIALISATION

Partnerships & knowledge transfer with:
→ Higher education institutions (HEIs)
→ Industrial entities including startups and SMEs
→ Non-profit organisations and third-sector groups

Outline

Introduction of E-textiles in Healthcare

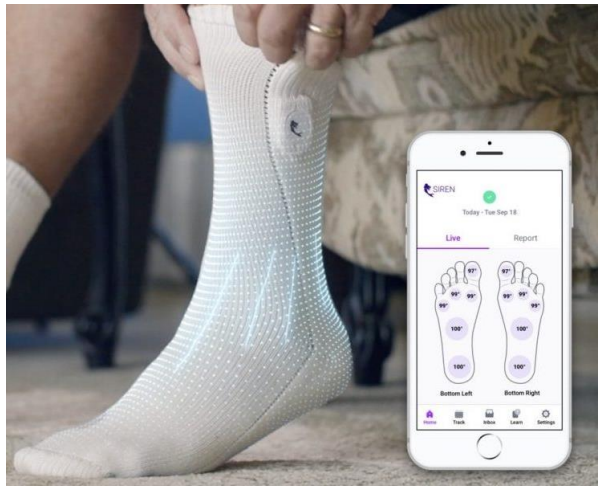
E-textile based medical product development

- Stroke rehabilitation
- Pain management

Considerations in developing e-textile products

E-textiles in healthcare

E-textiles: textiles with electronic components (e.g. sensors, actuators, data processor) integrated to achieve functions that traditional textiles do not have.



Siren socks for diabetic foot

SensingTex health wheelchair

Cionic neural Sleeve

Why use textile in wearable medical products?

Traditional materials: plastic, metals, ceramics – rigid & uncomfortable

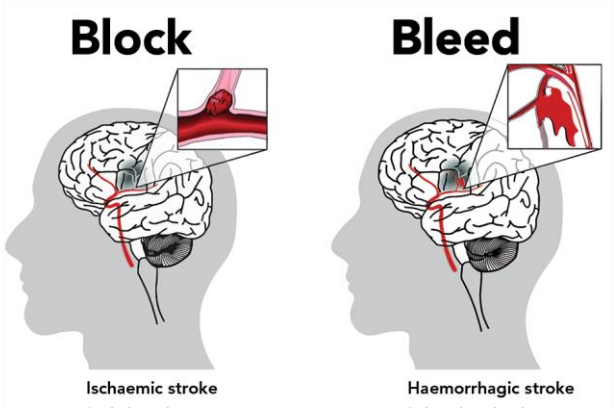
Textiles: Soft, breathable, skin-friendly – comfortable to wear & safe to use
Wearables items – easy to use & unobtrusive

Potential benefits of using e-textiles: improved use compliance and patient outcomes ONLY IF WE CAN GET IT RIGHT.

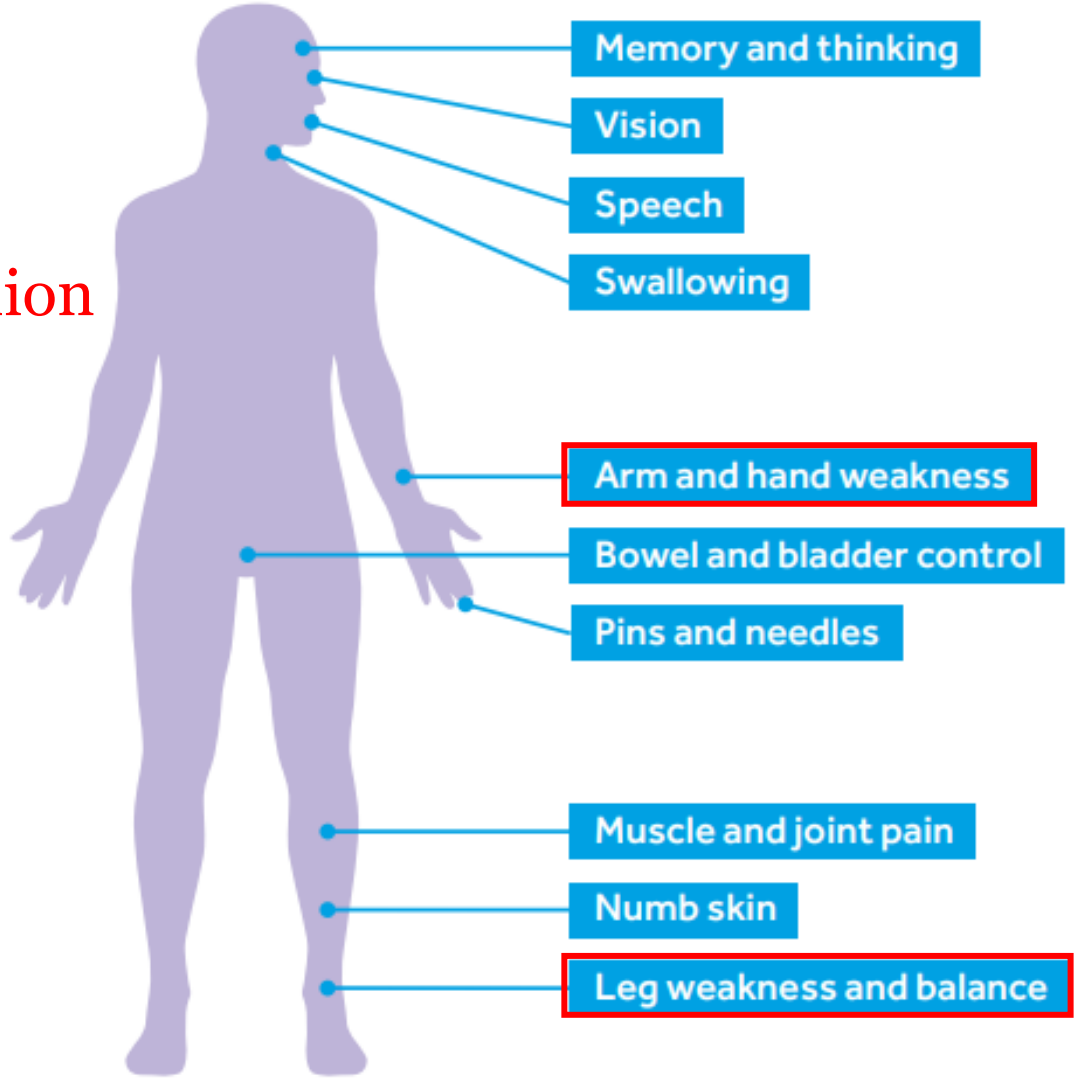
Challenges: Function, reliability, durability, user acceptance, clinical effectiveness, manufacturing and cost, regulatory compliance.

Example 1 – stroke rehabilitation

The problem – stroke



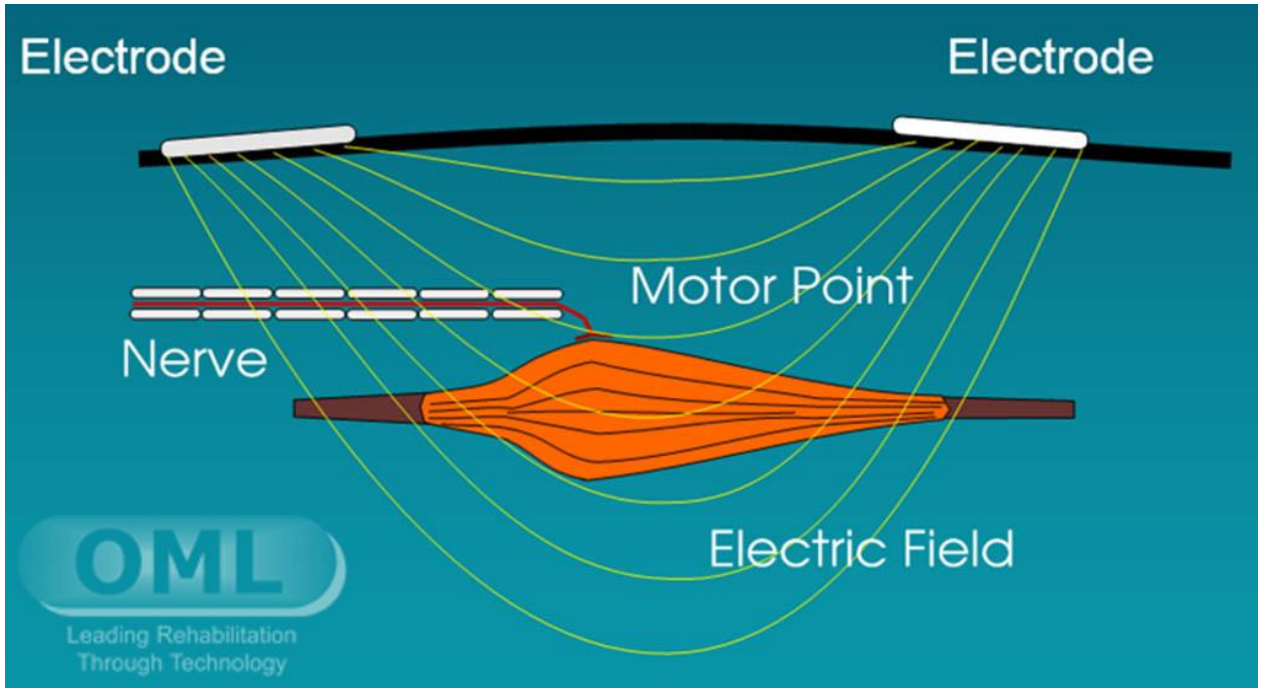
Stroke in the UK: 1.3 million
Cost: £26 billion/year

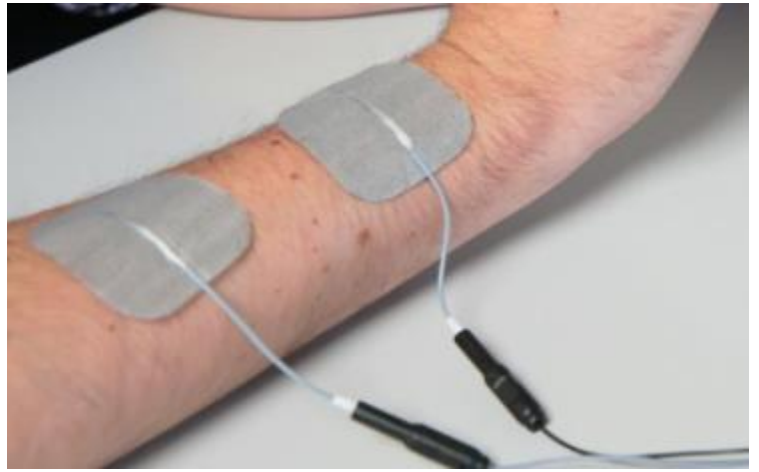


- Death and disability
- Impact on quality of life
- Cost to families and the society

How FES works?

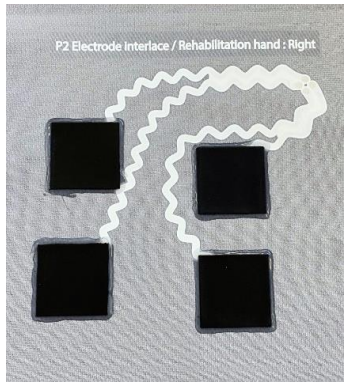
Functional electrical stimulation (FES) sends electrical impulse through electrodes placed on the skin stimulating motor nerves and muscles to facilitate functional movement.





E-textile sleeve for stroke rehabilitation

Innovate UK “Reliable and Accessible Electronic Textile for Stroke Rehabilitation”



"It's life changing - it means I can move my hand - something I've been unable to do for eight years. This is breath-taking," – Dave (stroke survivor)

"It's giving Dave the opportunity to do that grip and release movement that he finds very difficult to do naturally. Things like picking up normal everyday items become a lot easier to do.” – Dave’s wife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Glove offers 'life changing' movement to stroke patients

29 November 2023

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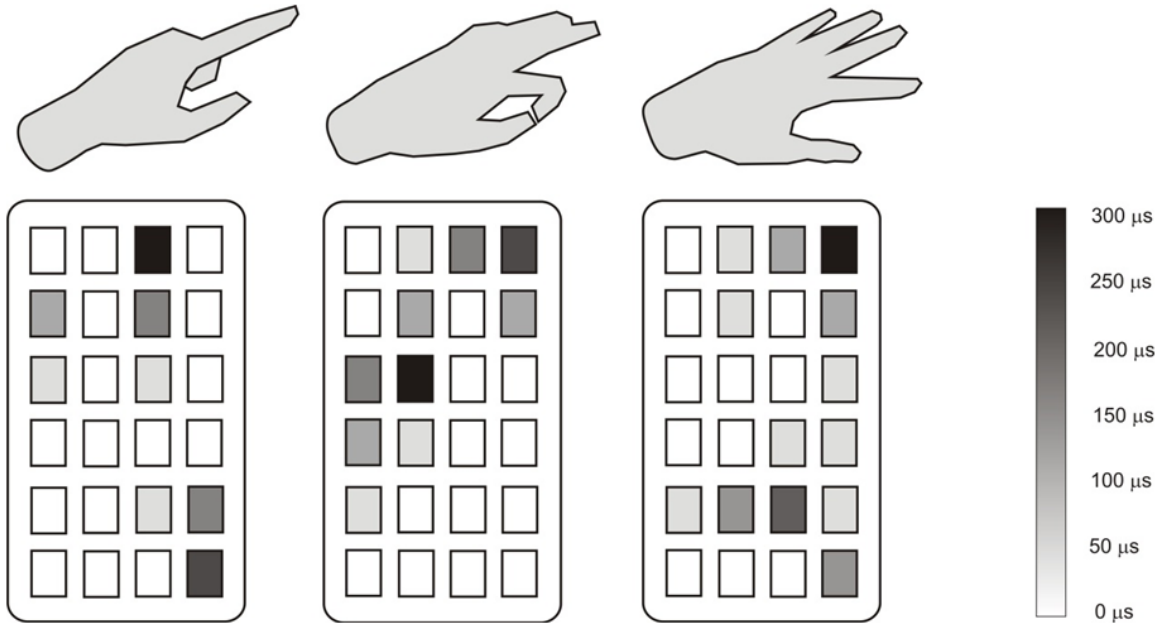
FES for stroke rehabilitation

Medical Research Council

"Low-cost personalised instrumented clothing with integrated FES electrodes for upper limb rehabilitation"



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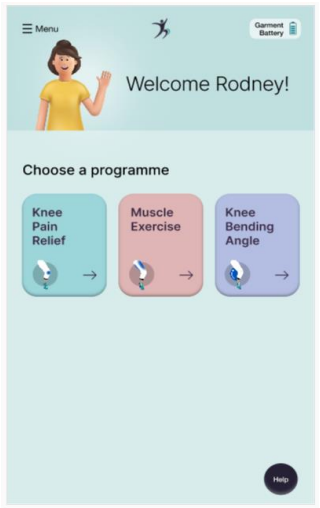
Example 2 – pain management



Electrical Nerve Stimulation (TENS)

-Pain relief

Electrical Muscle Stimulation (EMS)

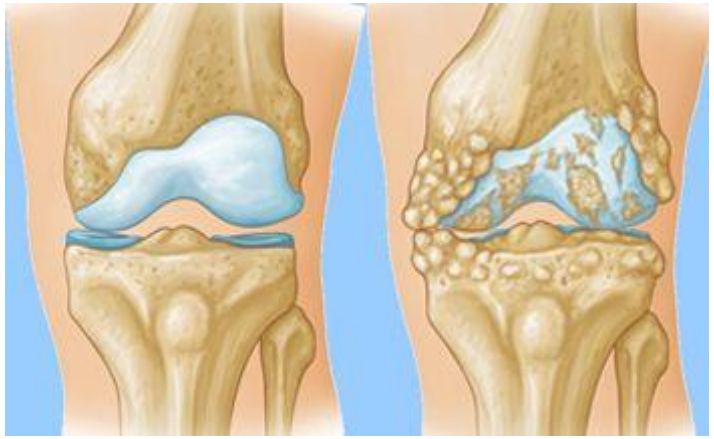
- Muscle exercise

Inertial measurement unit (IMU)

-Monitoring of knee bending

The problem – osteoarthritis

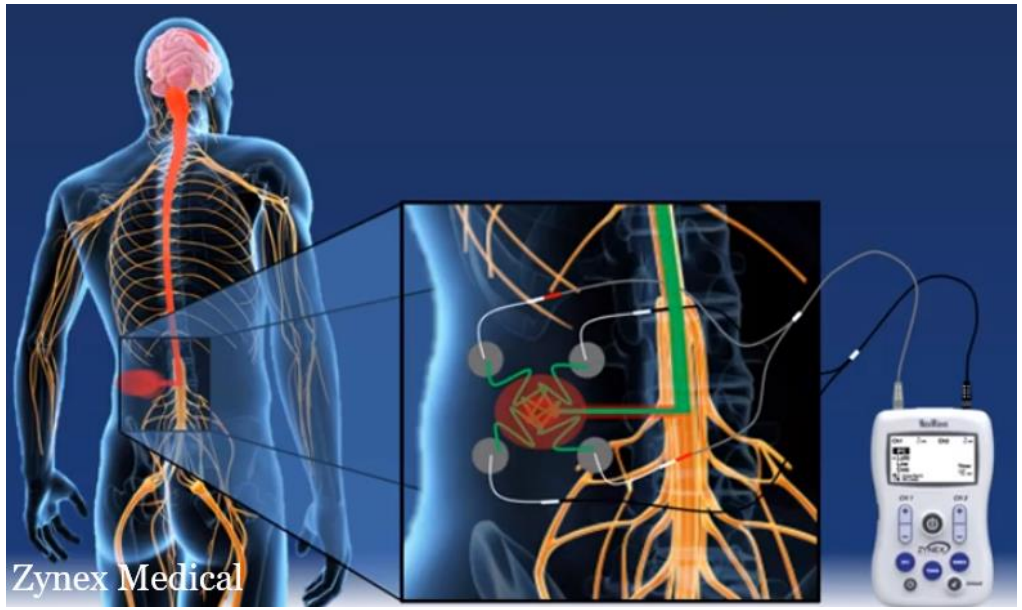
Wear and tear of the knee joint



Osteoarthritis in the UK: 8.75 million
30% of GP consultations
27.8 million lost working days
98% of knee replacement

- Impact on the quality of life
- Loss of productivity
- Cost to healthcare system

How electrotherapy works?



Transcutaneous Electrical Nerve Stimulation (TENS) sends electrical current through the electrodes placed on the skin typically either side of the painful area to reduce pain. This is achieved through:

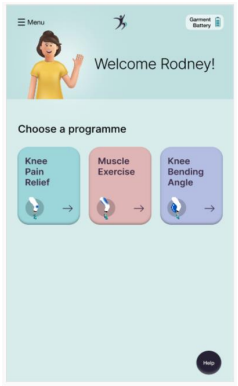
Stimulate the sensory nerves to prevent pain signals from reaching the brain (Gate Control Theory).

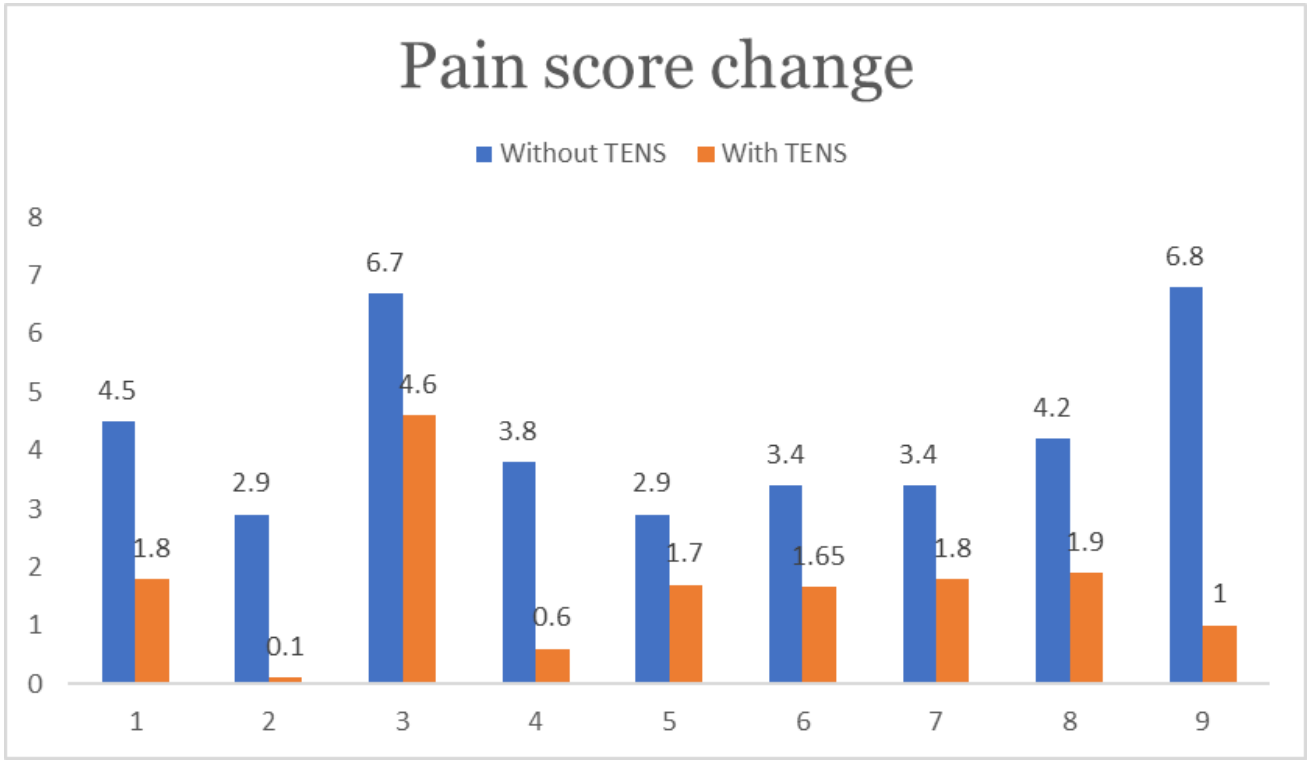
Stimulate the motor nerves to cause to release endorphins - body's nature pain killer (Endorphin Release Theory).

E-textiles for knee joint pain management

Medical Research Council

"Wearable Textile with Integrated Electrotherapy and Sensing for Joint Pain Management".





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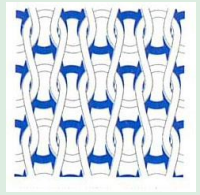
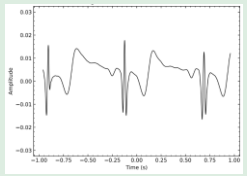
Other research projects





Fetal heart monitoring (SIAH) University of Southampton

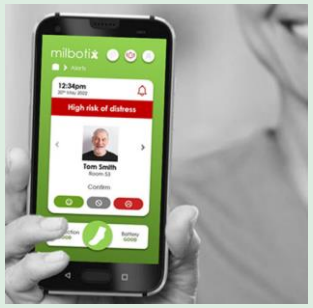
PREVAYL

ECG monitoring (EPSRC IAA) UKRI Engineering and Physical Sciences Research Council

BPMpathway

270 Vision

Pre/post-surgery (AHRC Commercialisation) UKRI Arts and Humanities Research Council



milbotix

Sustainable socks for dementia (IfLS) University of Southampton

University of Southampton

Challenges and opportunities

- Technology/product development – novelty vs practicality, deliverables and milestones, availability…
- Staff recruitment – electronic/software engineers
- Subcontractors – product/UI design, regulatory
- Ethics approvals
- Clinical investigation
- Regulatory compliance

Considerations in developing e-textiles

Functionality

- Biocompatibility and electrical safety
- Reliability, durability, clinical effectiveness
- User acceptance (e.g. ease of use, comfort)

Manufacturing

- Scalability
- Cost
- Sustainability and circularity

Regulatory

- Regulatory requirement (e.g. UKCA, EU)
- Quality management system (ISO 13485)
- Technical document

Routes to market

- NHS
- Private healthcare sectors
- Medical device companies

Acknowledgement

- **Colleagues** in WSA, ECS, Medicine, Health Sciences, Physics & Astronomy, iSolutions.
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- **End users**
- **Advisory board members**
- **Funders**

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UKRI Engineering and Physical Sciences Research Council
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