

Researchfish Award Download for

EP/N027264/1

**Osteoarthritis Technology NetworkPlus (OATech+): a
multidisciplinary approach to the prevention and treatment of
osteoarthritis**

Professor Catherine Holt

EP/N027264/1

17 Mar 2022

Award Title Osteoarthritis Technology NetworkPlus (OATech+): a multidisciplinary approach to the prevention and treatment of osteoarthritis

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Research Organisation Cardiff University

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Award Categories Call, Department, Scheme, Grant Category, DEP CDR ID, Role Name, UKRI Award Type

Award Abstract In the UK, over 8.75 million people seek treatment for osteoarthritis (OA) each year. It affects 13% of people aged 55-64 and 70% aged 65-74, is characterised by joint pain and loss of cartilage and involves joint loading, shape and structure changes. The links between these factors and the underlying molecular mechanisms that lead to arthritic degeneration and pain are not well understood. Our lack of understanding of the processes that drive joint degeneration in OA prevents timely diagnosis for those at risk of developing OA and hinders optimal treatment. Surgery, rehabilitation and pain management are commonly used for patients with pain and disability associated with OA and musculoskeletal (MSK) disorders; however for a significant proportion of patients, treatment outcome is sub-optimal. If clinicians could predict which patients respond best to which form of treatment, this would allow tailored treatment with clinical and health economic benefits. Patients would get the right treatment at the right time, avoiding pain and inappropriate surgery or rehabilitation. There is a currently a lack of (i) appropriate experimental and clinically relevant tools to monitor subtle changes in joint structure, biomechanics and metabolism for early OA detection; (ii) disease control via targeted drug, surgical and rehabilitation intervention, as standard practice; (iii) validation of surgical and rehabilitation interventions. The Network will address this to trigger the disruptive change in research necessary for future diagnosis and treatment of OA, ensuring international competitiveness for this high impact disease. It includes over 70 academic, clinical and industry UK and international participants with experience and expertise in human, animal and cell experimentation and modelling; data and imaging analysis to provide

high-level evidence for safety and efficacy of medical devices and incorporating engineering technology, biomechanics and biology into clinical studies with strong end user steerage. It will facilitate novel mechanisms to link research disciplines and develop the MSK research area through advances in technology, engineering and physical sciences. By identifying challenges and barriers to technology development that UK research must address it will ensure future studies encompass the necessary scientific advances, fused with clinical and biological solutions to optimise treatment via diagnosis, prediction and evidence-based intervention. A treatments taxonomy will direct the development of future therapies to enhance efficacy, restore function, optimise surgery, and exploit self-management of health. Network activities, from people development (discipline-hopping, innovation awards, studentships), ideas generation (sandpits, hackathons), networking (seminars, conferences); outreach (exhibitions, science cafés); funded flagship, feasibility projects (informed by network activities in year one) and ideas that have high potential for innovation and impact, will ensure success and demonstrate how engineers, physical and computer scientists, biologists and clinicians team up to optimise, review and setup studies that collate biomechanics, clinical, patient and biological information for technology development and validation of experimental and clinical tools and targets. Impact and translation are guaranteed by embedding the Biomedical Engineering community with experience in OA/MSK technology research, with key clinicians and biologists who lead research in animal, cell and patient based studies. User engagement and steerage will be supported via clinical and industry partners, Patient Public Involvement and Public Health links. The metrics for success are research (research income, high impact papers), effectiveness in initiating new collaborations in terms of new cross-disciplinary researchers and end-users; and new academics, fellows, students and members of the public engaged with OA research.

Lay Summary

Sections with Information

INFLUENCE ON POLICY, PRACTICE, PATIENTS AND THE PUBLIC.....	5
PUBLICATIONS.....	13
FURTHER FUNDING.....	15
OTHER OUTPUTS/OUTCOMES	28
NARRATIVE IMPACT	42
SOFTWARE AND TECHNICAL PRODUCTS.....	46
RESEARCH TOOLS AND METHODS	48
COLLABORATIONS AND PARTNERSHIPS	52
RESEARCH DATASETS, DATABASES AND MODELS	85
KEY FINDINGS	87
COVID IMPACT.....	93
MEDICAL PRODUCTS, INTERVENTIONS AND CLINICAL TRIALS	94
NEXT DESTINATION.....	101
SECONDMENTS, PLACEMENTS AND INTERNSHIPS TO OR FROM OTHER ORGANISATIONS.....	105
AWARDS AND RECOGNITION.....	110
ENGAGEMENT ACTIVITIES	113
ANIMAL USE	134

Influence on Policy, Practice, Patients and the Public

Influence Name Contributed to the Welsh Government consultation on Arthritis and Long-term Musculoskeletal Conditions in adults

Influence Type Participation in a national consultation

Healthcare Area

Title

Issuing Organisation

Publication citing your work

Contribution description Welsh Government consultation on Arthritis and Long-term Musculoskeletal Conditions in adults

Arthritis and long-term musculoskeletal conditions - We wish to reflect services for those providing treatment and support to people living with arthritis and musculoskeletal conditions. We also want to consider how services can be best arranged to address a variety of needs; from those who want simple strategies including self-management, to those who have complex needs that require specialist care.

Please note the majority of this document was drafted prior to the Covid-19 pandemic. The current guidance does not currently provide provisions based on the impact of covid-19. The guidance was originally due to go to consultation in 2020 and the majority of the draft guidance was developed prior to the pandemic. We would like respondents to use this consultation as an opportunity to reflect on the changes required to support services to recover following the pandemic and provide optimum support and treatment. The final framework will then reflect on lessons learned during the pandemic and new models of care utilised.

Responses to questions to consider relating to the content of the document:
Overall

1. In light of the effect of the pandemic on service, what should musculoskeletal services consider?
2. What digital solutions are required to support clinicians undertaking their role?
3. What extra provision is needed to support those on waiting lists or receiving management and support in primary care?

Introduction

4. Does the introduction identify the key issues relating to the conditions and services throughout Wales?

Actions

5. Are the proposed actions appropriate and will they provide the service required?

Prevention, self-management and independence

6. Does the guidance demonstrate the most effective and efficient approaches to develop self-management skills and maximise independence?
The model for access and condition management of adult long-term musculoskeletal conditions, excluding osteoporosis
7. Does the chapter provide a clear and comprehensive model for healthcare professionals to follow? Are there any further changes required to this model?
Diagnosis, treatment and long-term management of conditions
8. Does the guidance capture all the elements of inflammatory diseases?
What effective help looks like? What else can be recommended?
9. Will the actions within this chapter, taken together with the chapters elsewhere in this document improve awareness of rare diseases? Diagnosis, treatment and long-term management of osteoporosis and fracture risk in adults (aged 18 and over)
10. Does the guidance capture all the elements of managing and limiting the impact of Osteoporosis? Workforce development, education and recruitment
11. How can this chapter be strengthened to address workforce education and recruitment?
12. How can we ensure health and social care professionals are aware of how to treat and manage musculoskeletal conditions effectively?

Evidenced based care and innovation

13. Is there any recent research, guidance or evidence not included in the document that you are aware of which should be taken into account to better enable people to live with arthritis and musculoskeletal conditions? Additional questions

14. What third sector provision and support can be utilised to support this area?

15. Are there any terms or phrases in the document you feel would benefit from further explanation in a glossary?

16. Certain conditions are known to disproportionately affect people with particular characteristics, such as gender or race. Are there any further considerations required to address any inequity of treatment?

17. We would like to know your views on the effects this guidance would have on the Welsh language, specifically on opportunities for people to use Welsh and on treating the Welsh language no less favourably than English. What effects do you think there would be? How could positive effects be increased, or negative effects be mitigated?

18. Please also explain how you believe the proposed Framework could be changed so as to: have positive effects or increased positive effects on opportunities for people to use the Welsh language and on treating the Welsh language no less favourably than the English language, have no adverse effects on opportunities for people to use the Welsh language and on treating the Welsh language no less favourably than the English language.

19. We have asked a number of specific questions. If you have any related issues which we have not specifically addressed, please use this space to report them:

**Cited
Publication**

**Year First
Realised** 2021

**Geographic
Influence** National

Country United Kingdom

EP/N027264/1

17 Mar 2022

Area of policy influence. Communities and Social Services/Policy, Creative Economy, Digital/Communication/Information Technologies (including Software), Healthcare, Government, Democracy Justice, Pharmaceuticals and Medical Biotechnology

Describe Other

Specific Impacts No impacts yet

Impact Description

URL <https://gov.wales/arthritis-and-long-term-musculoskeletal-conditions-adults>

Digital ID

Source Manual

Publication ID 6230e14643c085.19382967

Influence Name Presentation of Clinical acceptance of technology in remote rehabilitation assessment: Addressing urgent COVID challenges to drive future technology transfer - to the Welsh Government COVID Tag

Influence Type Influenced training of practitioners or researchers

Healthcare Area

Title

Issuing Organisation

Publication citing your work

Contribution description Presented the results of the Welsh Government funded study and linked MRC CiC grant on the barriers and challenges to adopting remote rehabilitation technology as part of a linked study led by C Holt, Published in JBI Evidence Synthesis - 'Technologies used to facilitate remote rehabilitation of adults with deconditioning, musculoskeletal conditions, stroke, or traumatic brain injury –

An umbrella review - Edwards D, Williams J, Carrier J, & Davies JL - key findings:

- There is a paucity of strong, high-quality evidence underpinning technologies to facilitate remote rehabilitation following COVID-19 pandemic
- Setting in which an intervention is delivered
- Population that is targeting
- Details of technology used in the intervention – various components
- Way in which it will be integrated into care

Market research - identified emerging and existing technologies within the marketplace and create a searchable database

Output - 'Technologies for Remote Rehabilitation Assessment Database'
<http://cardiff-rehab-tech.co.uk/> Free to access and Lists (220) commercially available tools and technologies for patient rehabilitation, and suitable for use outside of a clinical setting, e.g., at home or in the community

Exemplars of technologies at various stages of adoption in the NHS/industry (H&S) Output - BACK-on-LINETM : interactive digital intervention website delivery to support self-management of people with self-reported low back pain

- TRAK: web-based intervention for NHS patients with knee conditions: content- health information, personalised exercise plans, remote clinical support

- PhysioNow (Connect Health) online platform using artificial intelligence to remotely triage patients for musculoskeletal physiotherapy

Key message - Possible to develop and trial technologies for rehabilitation in NHS - but can be cumbersome

Interest in developing rehabilitation technology But overarching barriers around interaction between different parties and access to funds and time Primary barrier for researchers working in technology development was access to funds Primary barrier for clinicians was time

Qualitative Study - clinicians and users (actual or potential) opportunity to share experiences - In-depth semi-structured interviews with healthcare professionals involved in rehabilitation assessment - Iterative analysis with the initial 6 transcripts revealed the main barriers

EP/N027264/1

17 Mar 2022

Output - In depth opinion data via interviews – currently preliminary data -
Positive comments “Despite the difficulties, having the NHS as the
development and delivery partner gave the Initiative significant kudos,
exposure and credibility; unprecedented number of organisations from NHS
Wales and England very keen to open the project at their site.”

Key Barriers identified: - Delivering the Initiative (research study) in NHS
lengthy process - ethical approval and NHS site (staff) access

- Lack of resources (money, time, staff, expertise).
- Outdated & often non-transferable patient records & IT systems & stretched
IT support - ‘Tech fatigue’, IT literacy
- Slow & largely top-down approach to change, failing to keep pace with
technological change
- Siloed working
- Knowing what’s out there, having an evidence base to support benefits to
clinicians and patients

**Cited
Publication**

**Year First
Realised** 2022

**Geographic
Influence** National

Country United Kingdom

**Area of policy
influence.** Digital/Communication/Information Technologies (including
Software), Education, Healthcare

Describe Other

Specific Impacts No impacts yet

**Impact
Description**

URL

Digital ID

Source Manual

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Publication ID 6230dec4506733.07497270

Influence Name RAEng Healthcare Technology Policy Group- contribution to the Prime Ministers Council for Science and Technology (CST)

Influence Type Participation in advisory committee

Healthcare Area

Title

**Issuing
Organisation**

**Cited
Publication**

**Year First
Realised** 2021

**Geographic
Influence** National

Country United Kingdom

**Area of policy
influence.** Healthcare

Describe Other

Specific Impacts No impacts yet

**Impact
Description**

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Publication ID 604751176ceb38.65652909

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Influence Name RSC Commission on future of surgery - C Holt contributed to the Call for Evidence for the "Implications for Future Surgical Technology" document via the Royal Academy of Engineering Biomedical Engineering Panel

Influence Type Participation in a national consultation

Healthcare Area

Title

**Issuing
Organisation**

**Cited
Publication**

**Year First
Realised** 2018

**Geographic
Influence** National

Country United Kingdom

**Area of policy
influence.** Healthcare, Government, Democracy Justice, Manufacturing, including Industrial Biotechnology, Pharmaceuticals and Medical Biotechnology

Describe Other

Specific Impacts Not known

**Impact
Description**

URL https://futureofsurgery.rcseng.ac.uk/?_ga=2.104617412.577568556.1550158526-60008457.1547478615

Digital ID

Source Manual

Publication ID 5c7819e25f6456.82523289

Publications

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EP/N027264/1

17 Mar 2022

Further Funding

Funding Scheme Accelerate Wales

Organisation Name Government of Wales Life Sciences Hub

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 63238

**Consortium
Funding Amount**

Reference Number PR-0345

Start Month November

Start Year 2021

End Month November

End Year 2022

Project URL

Digital ID

Source Manual

Source ID

Original Source ID

Publication ID 622638d50dbdd9.01860414

Funding Scheme Cardiff University EPSRC Doctoral Training Partnership

**Organisation
Name** Cardiff University

Type Studentship

Funding Currency GBP British Pound Sterling

Funding Amount 75000

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Consortium 0

Funding Amount

Reference Number

Start Month October

Start Year 2018

End Month April

End Year 2022

Project URL

Digital ID

Source RF

Source ID

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Publication ID 5c77bbd87dd578.03365800

Funding Scheme Cardiff University EPSRC Doctoral Training Partnership - Modelling framework for in-vivo knee joint contact analysis

Organisation Name Cardiff University

Type Studentship

Funding Currency GBP British Pound Sterling

Funding Amount 75000

Consortium Funding Amount

Reference Number

Start Month July

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Start Year 2021

End Month December

End Year 2025

Project URL

Digital ID

Source RF

Source ID

**Original
Source ID**

**Publication
ID** 6230cc32c9e936.84575287

**Funding
Scheme** Clinical acceptance of technology in remote rehabilitation assessment: addressing
urgent COVID challenges to drive future technology transfer

**Organisation
Name** Welsh Government - Sêr Cymru III – Tackling Covid 19. Round 2.

Type Research grant (including intramural programme)

**Funding
Currency** GBP British Pound Sterling

**Funding
Amount** 65605

**Consortium
Funding
Amount**

**Reference
Number** WG Project Number: 111

Start Month October

Start Year 2020

End Month September

End Year 2021

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Project URL

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Source ID**

Publication ID 6047638d92a5f9.37368656

Funding Scheme Clinical acceptance of technology in remote rehabilitation assessment:
Addressing urgent COVID challenges to drive future technology transfer

Organisation Name Medical Research Council (MRC) MRC Confidence in Concept Scheme

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 49923

**Consortium
Funding Amount**

Reference Number

Start Month October

Start Year 2020

End Month September

End Year 2021

Project URL

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Publication ID 6047660a28c592.79884510

Funding Scheme COMSTIG: Motor Cortex Magnetic Stimulation during Gait

Organisation Name Wellcome Trust

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 31038

Consortium Funding Amount 3192

Reference Number

Start Month August

Start Year 2019

End Month July

End Year 2020

Digital ID

Source RF

Source ID

Original Source ID

Publication ID 5e5945fa857790.34630149

Funding Scheme EPSRC

Organisation Name Engineering and Physical Sciences Research Council (EPSRC)

Type Research grant (including intramural programme)

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Funding Currency GBP British Pound Sterling

Funding Amount 550993

Consortium 550993

Funding Amount

Reference Number EP/V032275/1

Start Month April

Start Year 2021

End Month March

End Year 2024

Project URL

Digital ID

Source RF

Source ID

Original Source ID

Publication ID 60476817b49980.54126280

Funding Scheme From brain to biomechanics: Quantifying human dexterity.

Organisation Name Wellcome Trust

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 46000

Consortium Funding Amount

Reference Number

Start Month March

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Start Year 2021
End Month March
End Year 2022
Project URL
Digital ID
Source RF
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Original Source ID
Publication ID 622a1c3c7718d8.83347635

Funding Scheme GW4

Organisation Name University of Exeter
Type Travel/small personal
Funding Currency GBP British Pound Sterling
Funding Amount 11980
Consortium Funding Amount 0
Reference Number
Start Month January
Start Year 2019
End Month June
End Year 2019
Digital ID

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Source RF

Source ID

**Original Source
ID**

Publication ID 5c77bccaaeae78.98833266

Funding Scheme Image-driven subject-specific spine models

**Organisation
Name** Engineering and Physical Sciences Research Council (EPSRC)

Type Research grant (including intramural programme)

**Funding
Currency** GBP British Pound Sterling

**Funding
Amount** 814279

**Consortium
Funding
Amount** 814279

**Reference
Number** EP/V036602/1

Start Month September

Start Year 2021

End Month September

End Year 2024

Project URL <https://gtr.ukri.org:443/projects?ref=EP/V036602/1>

Digital ID

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**Original Source
ID** EP/V036602/1

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Publication ID X00000084|EP/V036602/1

Funding Scheme Innovation for All, Translational Fund: Kickstart funding

Organisation Name Government of Wales

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 10000

Consortium Funding Amount

Reference Number

Start Month December

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End Month December

End Year 2022

Project URL

Digital ID

Source RF

Source ID

Original Source ID

Publication ID 62263bf8454e33.68656661

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Funding Scheme Kinematics at the base of the normal thumb: An analysis of healthy thumbs combining bi-planar fluoroscopy, motion capture and 3D modelling.

Organisation Name Federation of European Societies for Surgery of the Hand

Type Research grant (including intramural programme)

Funding Currency EUR Euro

Funding Amount 9907

**Consortium
Funding Amount**

Reference Number

Start Month December

Start Year 2020

End Month March

End Year 2022

Project URL

Digital ID

Source RF

Source ID

Original Source ID

Publication ID 622a1b5cbf35a9.22633399

Funding Scheme Oncological Engineering - A new concept in the treatment of bone metastases

Organisation Name Engineering and Physical Sciences Research Council (EPSRC)

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

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Funding Amount 5608938

**Consortium
Funding Amount**

Reference Number EP/W007096/1

Start Month January

Start Year 2022

End Month December

End Year 2026

Project URL <https://gtr.ukri.org:443/projects?ref=EP/W007096/1>

Digital ID

Source GTR

Source ID ec8ec967ea4379be43a1215a13da4624

Original Source ID EP/W007096/1

Publication ID X00000084|EP/W007096/1

Funding Scheme Translation of Concept Scheme (Institutional Translational Partnership Award)

Organisation Name Wellcome Trust

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 19985

**Consortium Funding
Amount**

Reference Number

Start Month April

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End Month March
End Year 2022
Project URL
Digital ID
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Source ID
Original Source ID
Publication ID 62263a900f3e39.96313465

Funding Scheme Wales Data Nation Accelerator
Organisation Name Government of Wales
Type Research grant (including intramural programme)
Funding Currency GBP British Pound Sterling
Funding Amount 10000
Consortium Funding Amount
Reference Number
Start Month February
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End Year 2022
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Funding Scheme Wellcome Trust ISSF - From brain to biomechanics: quantifying human dexterity

Organisation Name Cardiff University

Type Research grant (including intramural programme)

Funding Currency GBP British Pound Sterling

Funding Amount 45668

Consortium Funding Amount 10338

Reference Number

Start Month September

Start Year 2019

End Month August

End Year 2020

Digital ID

Source RF

Source ID

Original Source ID

Publication ID 5e5943f57fc3b3.85517950

Other Outputs/Outcomes

Output Name A Delphi study on the Use of Technology in the Subcategorisation of Osteoarthritis.

Details and Impacts Paper for the Novel Experimental technology Theme Delphi Meeting, submitted and currently in review with Osteoarthritis and Cartilage Open

Corresponding Author's Institution: Robert Jones and Agnes Hunt Orthopaedic Hospital Authors: Claire Mennan, Ph.D, Timothy Hopkins, BSc (Hons), Alastair Channon, Ph.D, Mark T Elliott, Ph.D, Brian Johnstone, Ph.D, Timor Kadir, Ph.D, John Loughlin, Ph.D, Mandy J Peffers, Ph.D, Andrew Pitsillides, Ph.D, Nidhi Sofat, MD Ph.D, Caroline Stewart, Ph.D, Fiona E Watt, MD Ph.D, Eleftheria Zeggini, Ph.D, Cathy Holt, Ph.D, Sally Roberts, Ph.D

Paper Abstract: This study utilised a Delphi consensus process within the OATech Network to identify whether technology could aid subcategorisation of patients with osteoarthritis (OA) and determine the level of awareness of these technologies across an expert panel. An online questionnaire was formulated based on technologies which may aid subcategorisation of OA. During a two-day face-to-face meeting concordance of expert opinion was established with online surveys (23 questions) before (Round 1), during (Round 2) and at the end of (Round 3) the meeting. Experts spoke on current evidence for imaging, genomics, epigenomics, proteomics, metabolomics, biomarkers, activity monitoring, clinical engineering and machine learning relating to subcategorisation. For each round of voting, $\geq 80\%$ votes led to consensus and $\leq 20\%$ to exclusion of a statement. Panel members were unanimous that technological advances have potential to improve OA subcategorisation. It was agreed at Rounds 1 and 2 that epigenetics, genetics, MRI, proteomics, wet biomarkers and machine learning could all aid subcategorisation. Talks from experts changed participants' opinions on the usefulness of metabolomics, activity monitoring and clinical engineering, all reaching consensus in Round 2. X-rays lost consensus between Rounds 1 and 2 but their use in the clinic reached consensus in Round 3. Ultrasound failed to reach consensus for either clinical or research use. Consensus was reached that 9 of the 11 technologies identified could aid OA subcategorisation. Interestingly, these 9 are the more recent and rapidly evolving technologies (unlike non-consensus-reaching X-ray and ultrasound). As these technologies continue to improve, further progress in this area is likely.

EP/N027264/1

17 Mar 2022

Progressed Further Yes

Discovery Details Paper has been published in the Osteoarthritis and Cartilage Open and results were shared across the Network of osteoarthritis researchers for the subcategorisation of patients based on available technology.

Patient Benefit

Existing output type Research Tools & Methods

Output Name A new automated method of segmenting trabecular bone: investigating subchondral trabecular changes as a predictor of osteoarthritis at the joint surface.

Details and Impacts Abstract submitted to Bone Research Society

Authors: Eva Herbst, Alessandro Felder, Behzad Jahaveri, Lucinda Evans, Sara Ajamo, Andrew Pitsillides Royal Veterinary College, London, United Kingdom. Palaeontological Institute and Museum, University of Zurich, Zurich, Switzerland. University College London, London, United Kingdom
Funding for Beamtime at Synchrotron, Harwell: ImagingBioPro Network; Proof of Concept Award: A new 'phase' dawns in contrast imaging: visualisation of joint soft and hard tissues (AP with Behzad Javaheri, Lucinda Evans (RVC), Katherine Staines (Brighton) and Nghia Vo (DLS, Harwell) £24K

Progressed Further Yes

Discovery Details Talk at: Modelathon Symposium 2020: MULTISIM, EPSRC Frontier Engineering Award Optimising interventions for OA patients with multi-scale modelling. January 2020, Sheffield. Mechanical interplay across the osteochondral junction. 2 papers currently in draft for submission on the results of this work.

Patient Benefit

Existing output type

Output Name Data Sharing in OA Research Groups and Disciplines Paper Pre-Print

EP/N027264/1

17 Mar 2022

Details and Impacts	A paper based on the funded research feasibility project for data sharing and data driven analysis is currently under review, however available as a pre-print here (https://www.researchsquare.com/article/rs-97815/v1). The paper reviews the opportunities and barriers of OA data sharing and recommendations to facilitate this.
Progressed Further	Yes
Discovery Details	This has developed into the work with the Alan Turing Institute to collaborate on a research project to investigate further.
Patient Benefit	
Existing output type	Publications

Output Name Device Development - Developing an MRI safe device that delivers and measures pressure pain levels in healthy volunteers and patients with chronic musculoskeletal pain.

Details and Impacts Abstract accepted to present at the British Pain Society Annual Meeting 2022 based on work from collaboration formed to develop an MRI safe controlled pressure delivery device to investigate chronic musculoskeletal pain during brain imaging and biomechanical functional testing. The aim of this work is to develop and validate the delivery of precise pressure-pain stimuli during brain imaging studies and osteoarthritis functional movement studies.

Other year 2022

Other url

Other DOI

Existing output type

Output Name Draft consensus statement

Details and Impacts A Delphi study on the Use of Technology in the Subcategorisation of Osteoarthritis Claire Mennan, Timothy Hopkins, Alastair Channon, Mark Elliot, Brian Johnstone, Timor Kadir, John Loughlin, Mandy Peffers, Andrew Pitsilides, Nidhi Sofat, Caroline Stewart, Fiona E. Watt, Eleftheria Zeggini,

EP/N027264/1

17 Mar 2022

Sally Roberts & The OATech Network Consortium. Will be submitted to Osteoarthritis and Cartilage. This study utilised a Delphi consensus process within the OATech Network to identify whether existing technology could aid subcategorisation of patients with osteoarthritis (OA) and identify knowledge gaps requiring further study.

Progressed Further No

Discovery Details

Patient Benefit Provision of a multidisciplinary expert consensus statement

Existing output type

Output Name Imaging protocols

Details and Impacts A PDRA will be employed to look at the development of MRI protocols to create 3D computer models and structural imaging for model-based image registration, and the development of in vivo dynamic biplane X-ray protocols. This project will commence Summer 2019

Progressed Further No

Discovery Details

Patient Benefit The development of standardised imaging protocol that can be shared across research centres. This will allow comparisons across different data sets.

Existing output type

Output Name OA Datasets Project

Details and Impacts A PDRA has been employed for 6-months to explore the feasibility of creating an OA Datasets resource. The project began in January 2019, so is the early stages of undertaking a review of the literature in this field.

Progressed Further Yes

Discovery Details A working group meeting held in January 2019 initiated Network partners coming together to submit an expression of interest to the Alan Turing

EP/N027264/1

17 Mar 2022

Institute call for data sets and application challenges (clinical gait analysis).
The focus was on sharing clinical analysis datasets.

Patient Benefit A shared data resource for researchers, which will allow for larger data sets to be used, and increased power of the resulting research.

Existing output type

Output Name OATech Network Website Update and Redesign

Details and Impacts The website for the network has been restructured to help promote the outputs of the network more clearly, with links provided for all reports, papers, methods, documents and project leads associated with the research activities, and clearly categorised into type of research work. This should aid promotion of the network outputs and formulating grant bids and proposals for driving the research work further. This should also aid to promote further public engagement in the work of the network in terms of where future research should go and aid the search of opportunities for ECRs looking for projects to work on and grant to apply for.

Progressed Further N/A

Discovery Details

Patient Benefit More effective communication of the research network outputs and activities to both researchers and public.

Existing output type Use of Facilities & Resources

Output Name Pump priming project: hedgehog signalling in ligamentocytes, the role of mechanical loading

Details and Impacts Results from this project present valuable information to both mechanobiologists and biologists studying OA and the communication of tissue in OA alike. They have introduced a new factor for consideration in the pathogenesis and the progression of OA in the joint adding to its complexity with the interplay between ligaments and articular cartilage. It has allowed the PDRA working on the project to gain experience in the field

of mechanobiology and project management and for collaboration between University of Liverpool and Queen Mary University of London.

Progressed Further No

Discovery Details

Patient Benefit

Existing output type Collaborations & Partnerships

Output Name Research Theme Focus Meeting 2 resulted in Key Focus Areas

Details and Impacts Current Imaging Technology and what it brings to OATech Experimental and Clinical Tools.

Role of technology in Stratification (e.g., terminology, mechanobiology and biomechanics)

- Joint diseases?
- OA?
- Post traumatic?

Technology and pain - how can they be linked as compared to patient reported measures?

Role of technology in OA outcomes measurement - objective, subjective and clinical

Role of technology in facilitating adherence to treatments and interventions and subsequently understanding efficacy

Technology as intervention - what is there in terms of the taxonomy of treatments and NICE Guidelines.

Data management and harmonisation recommendations - Creation of a shared OA data resource / repository to enhance and increase datasets for research

Progressed Further Yes

Discovery Details There is Novel Experimental technology Themed meeting to follow from OARSI 2018. held in Oswetry and organised by Sally Roberts, the Them Lead. It has

invited speakers from across engineering, biology, rheumatology and will work as a Delphi exercise to establish stratification and phenotypic for OA for targeting current and future technology and is then open to attendees from across the OATech network who can apply to attend. It will take place 30 April/1st May.

Patient Benefit It will lead to a consensus document to allow engineering and technologist to work with biologists and clinicians to better target future research funding into OA technology and therefore improve diagnostics, treatments and outcomes for the carious identified strata of patients across the OA spectrum. It will enable identification of specific Network expertise for targeted collaborations and future proposals.

Existing output type

Output Name Risk factors for pain and functional impairment for people with osteoarthritis: a systematic review and meta-analysis

Details and Impacts Paper submitted and in review. Authors: Sandeep Sandhar (SS) *, Toby Smith (TS) ^, Franklyn Howe (FH) #, Kavanbir Toor (KT) * and Nidhi Sofat (NS) *
Affiliations *: Institute for Infection and Immunity Research, St Georges, University of London #: Neurosciences Research Centre, St Georges, University of London ^: Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford Work done on behalf of the OA Tech working research group. ABSTRACT Objective: Osteoarthritis is the most common form of arthritis. Although prevalent, the factors influencing reporting of symptoms and the progression of disease are not well understood. In this study, we aimed to identify risk factors for pain and functional deterioration in primary knee and hip OA subjects to create a 'stratification tool' for OA development or progression. Methods: This study followed PRISMA guidelines, searching MEDLINE, EMBASE, CINAHL, MEDLINE and Web of Science (1990-February 2020). The Downs & Black tool assessed methodological quality of selected studies before data extraction. A random-effects or fixed effects meta-analysis was undertaken when study heterogeneity (I²) was ≥50% or <50% respectively. Standardised mean difference (MD) assessed continuous outcomes with 95% Confidence Intervals (CI), whilst dichotomous variables used odds ratios (OR). Results: We found 82 studies (41,810 participants) based on our search terms, which were included for analysis. Knee OA pain was associated with: Whole-organ MRI scoring method (WORMS) Knee effusion score ≥1 (OR=1.35,95% CI:0.99,1.83;p=0.05), WORMS Meniscal damage≥1

(OR=1.83, 95% CI:1.23,2.71;p=0.003), Kellgren and Lawrence ≥ 2 (MD:2.04, 95% CI:1.48,2.81;p<0.01) and increasing age (MD:1.46,95%CI:0.26,2.66;p=0.02). Predictors for painful hip bone marrow lesion (BML) development were knee pain (MD: -1.42; 95% CI:-1.61,-1.23; p<0.01) and hip pain (MD:-0.72; 95% CI:-0.97, -0.47;p<0.01). Predictors of joint pain in hip OA were large acetabular BMLs (OR=5.23), chronic widespread pain (OR=5.02) and large hip BMLs (OR=4.43). Conclusions: Our study identified risk factors for clinical pain in OA by imaging measures that can assist in predicting and stratifying subjects with knee/hip OA. A 'stratification tool' combining verified risk factors that we have identified, would allow selective stratification based on pain and structural outcomes in OA.

Progressed Further Yes

Discovery Details A stratification tool utilised and developed by identifying novel risk factors. Future work will test the stratification tool with the use of new therapies to apply the tool more widely.

Patient Benefit

Existing output type Research Tools & Methods

Output Name Sandpit awards

Details and Impacts Two Sandpit awards were made to small projects focused on OA stratification. These will commence in Summer 2019 for 6 months

Progressed Further Yes

Discovery Details Project 1 will commence in July 2019 and will work on the development of a quantitative MRI phantom for knee tissue commencing

Project 2 will commence in August 2019 and will look at objective measurement of nociception (using wearable sensors)

Patient Benefit These areas have been identified as key areas for the Network, and the outputs will inform future decision making and support funding applications from within the network. The long-term benefit to society will be in helping achieve the network's aim of improving patient outcomes in the field of osteoarthritis.

EP/N027264/1

17 Mar 2022

Existing output type

Output Name Scoping Review of Remote Biomechanical Data Collection in OA

Details and Impacts Due to the ongoing Covid-19 pandemic bringing unexpected issues in OA research and lab-based human data collection, the collection of remote data will be beneficial for the development of OA research and treatments. A Scoping Review has been carried out to assess 3 research questions: What technologies are available for gathering kinetic or kinematic data for OA research purposes outside of a laboratory setting? Is the identified technology validated against an existing 'gold standard' technology? Is this technology suitable for use in a remote context and if so is it portable, partly remote or fully remote? The review also aims to identify which of the technology can be identified as being commercially available and therefore available for the researcher to acquire. The final output is in writing with the intention of publication in a peer-reviewed Journal.

Other year 2022

Other url

Other DOI

Existing output type Collaborations & Partnerships

Output Name The opportunities and challenges to sharing data across the Osteoarthritis research community.

Details and Impacts Compiled by Jill Evans, Paul Biggs, Mark Elliott. December 2019. Osteoarthritis (OA) research covers a broad range of sub-disciplines, working largely in siloed groups. The resulting spectrum of datasets is heterogenous and there is no central repository nor any best practice framework or minimum dataset requirement. However, there is growing evidence to suggest that large datasets are of significant benefit to the OA community and could contribute to expedited advances in understanding the disease. OA research typically suffers from small sample sizes which may affect the ability to derive meaningful insights from the data. Recent advances in imaging and wearable technology have generated new opportunities in research, including in the field of OA, to access large datasets and potentially pool

them to create so-called 'big data'. Determining if and how this might be utilised by OA researchers is a challenge which if addressed in the near future could lead to much faster advances in OA research and treatment. One avenue of interest to OA researchers is machine learning, which may transform the field by taking this big data and developing algorithms and pattern identification previously not possible due to time or resource constraints. By doing so, there is potential for earlier identification and stratification of OA to be achieved in a reliable way. However, such advances will not be possible if data are not shared between researchers or collected purposively for repositories. To do this requires either homogeneity of data to begin with, or a feasible way of homogenising heterogenous data which is not prohibitively time consuming. Data pooling also requires anonymisation processes which satisfy data protection legislation in whichever countries and organisations in which the data will be used. Anonymisation is in itself a further challenge, as these processes can result in loss of granularity of data. It is unknown to what extent OA researchers share data or access databanks, and how they currently attempt to address these challenges (if at all). The current project, funded by the OATech Network, aims to find out what the current practices are within OA research in the UK with regards to data sharing and accessing big data. This project involved speaking directly to OA researchers and clinicians to determine not only what the current approaches are to data collection and sharing, but also to ask what the desired future directions are for the field and whether a best practice framework might be achievable. Methodology -Interviews were conducted with nine researchers working in osteoarthritis, one representative from a large databank and two commercial representatives. Semi-structured questions asked participants about their experiences collecting, sharing and using data within OA research, and their opinions on data sharing and associated issues. In addition, a case-study interview was held with a clinician who had set up a UK-wide Cerebral Palsy database, to gain knowledge of data-sharing from a different clinical field. A questionnaire was distributed to the OATech Network mailing list, aiming to build upon the feedback gained from the interviews and to gather data about OA research from a wider sample. Unfortunately, the target sample was not achieved, however a summary of results is presented in this report.

OATech Data Sharing Report 5 9th December 2019

Findings - It was clear from the interviews that whilst there are a range of data collection processes and methods, there are many common factors and goals as well. Primarily, data approaches are driven by the research question and goals, as well as the resources available. Participants were generally open minded about data sharing and new approaches but were pragmatic about the logistics of implementing changes. The following are the main themes within the feedback:
Machine learning: There was a good level of agreement that machine learning and

artificial intelligence offers opportunities to achieve analyses that would not be possible by humans alone, or that would be prohibitively time consuming otherwise. It was also stated that people with the appropriate knowledge are essential in order to develop the correct methods and approaches needed to tackle large datasets and extract meaningful insights. This is both in terms of programming and tools to implement approaches, and also in terms of understanding the research aims and what exactly is being sought within the data. Therefore, collaboration between the OA and data science research communities is essential for success in this area. Stratification of OA: Although there were clear advantages recognised in the use of large datasets for machine learning, specific discussion on pooling data for stratifying types of OA appeared to be met more scepticism. Participants felt that with current resources and technology, this would represent a large amount of effort which could be better spent on other research endeavours. Moreover, challenges in stratification related to the complexity of the condition due to early-stage OA symptoms varying to such a degree it would be difficult to capture reliable data. Use of current large databanks/datasets: The concept of using data repositories was viewed positively, either for increasing sample size and thus improving statistical power, and for reducing replication of others' previous work. The application and access processes when using these datasets were generally viewed as appropriate on a governance level, but there were varied experiences in terms of ease of access. Hence, further guidance or tutorials could be provided to researchers to ensure these facilities are fully utilised in OA research studies. The OA Initiative was a particularly relevant dataset that was mentioned several times in discussions. A detailed interview with a representative from the SAIL database provides an insight into the use of data repositories.

Opinions on future data sharing approaches

Contribution to a central databank: Participants were open to the idea of submitting data to data repositories. It was felt that this would improve collaboration, completeness of datasets, and the potential to discover new insights more efficiently. However, given the availability of the OAI database, it was felt that anything new would need to provide a different angle to existing robust databases. This was seen as particularly important given the resources required to run a new database. An interview with the coordinator of a UK database for Cerebral Palsy is included to give a detailed insight into setting up and running such a repository. Standardisation/Frameworks: Although there was strong agreement that there are currently no formal guidelines or frameworks covering best practice around standardising data collection approaches, it was also considered something that would be highly challenging to achieve. It was noted that even where the same standardised measures are used in different studies, they may not be used in the

same way or at the same time points. However, the route to achieving a standardised approach could be possible if driven by a large centralised organisation, for example the MRC, who have coordinated the UK Biobank. It is clear therefore that there is a trade-off between standardization and flexibility to collect the variables required in the way required. Future work 1). Create best practice guidelines for ethical approvals and data protection that ensures research data collected in the future has everything in place to be shared with other researchers. 2). Related to the above, investigate storage and management facilities that facilitate data sharing whilst retaining appropriate levels of control. This could be through national databanks or localised (University) storage facilities. 3). Provide guidance/tutorials for accessing (inter)national databanks, such as OAI, UK Biobank and SAIL. Include how to cost and write these into funding bids and methods of using such secondary to combine with or validate new primary datasets. 4). Ensure there are collaborative opportunities between OA researcher and data science, e.g. through link ups with Alan Turing institute etc. Researchers felt positively about innovative opportunities for collaboration such as sandpit events and links with experts from other areas of expertise, and felt that collaboration should be facilitated rather than enforced through a one-size-fits-all approach. 5) Provide training and guidance on nomenclature within OA, including clinical codes and terminology which could enable researchers to more easily search and make use of data from a wider range of sources. Encourage streamlining of terminology where possible in order to harmonise as many datasets as possible.

Progressed Yes
Further

Discovery Details On the basis of this report, the data theme working group has established a data sharing agreement across a number of institutions and a data repository with over 1000 biomechanics datasets which has been used as a starting point for a project proposal with the Alan Turing Institute.

Patient Benefit Current biomechanics studies are limited to small cohort sizes. The shared dataset has potential to provide opportunity for increased cohort study sizes focussed on diagnostics outcomes and intervention evaluation. On this basis the working group will work towards a funding application.

Existing output type Research Databases & Models

Output Name The role of technology and lifestyle intervention in osteoarthritis

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17 Mar 2022

Details and Impacts Scoping review to investigate technological and individual impact in OA with final outcomes drafted into 2 reports for publication. One report contains OA specific lifestyle interventions (submitted to BMC Musculoskeletal Disorders) and one for healthy individuals with potential effects in OA (submitted to Frontiers Research Topic). This has been carried out at the University of Salford.

Progressed Further No

Discovery Details

Patient Benefit

Existing output type Collaborations & Partnerships

Output Name Tools for patient stratification in OA

Details and Impacts A PDRA is working on a 12-month project to: To develop tools for patient stratification in OA To identify the characteristics of 'pain' and 'structural damage' characteristics in OA Outputs will include a systematic review

Progressed Further Yes

Discovery Details A working group meeting was held in December 2018 to guide the systematic review search terms. The review is currently in progress

Patient Benefit Working on a consensus on how to stratify patients with OA.

Existing output type

Output Name Towards a Review on Higher level evidence and impact

Details and Impacts High Level Evidence Theme - PDRA started in Feb 2019 for 6 months to conduct review on Higher level evidence and impact, supervised by Mason and McGregor.

Progressed Further No

Discovery

Details

Patient

Benefit

Existing Use of Facilities & Resources
output type

Narrative Impact

Impacts? Yes

Findings RCUK defines economic and societal impact as ‘the demonstrable contribution that excellent research makes to society and the economy’. Economic and societal impacts embrace all the extremely diverse ways in which research-related knowledge and skills benefit individuals, organisations and nations by: - fostering global economic performance (specifically the economic competitiveness of the United Kingdom), increasing the effectiveness of public services and policy, enhancing quality of life, health and creative output.

The OATech Network has contributed to academic and research activities by increasing our network-wide understanding of the challenges to defining, developing, and validation of new technology for OA Research via numerous activities. External reporting at scientific meetings and public engagement has raised awareness of the challenges to establishing, designing, managing and ensuring impact of current OA technology based on research ranging from in-vitro, cellular and tissue based to in-vivo, clinical and patient-based studies. These activities would not be possible without the OATech funded Research Feasibility Studies, Workshops, a Delphi Study and the establishing of a new UK OA Imaging Consortium across 3 UK wide networks. Examples include the following which have formed the basis of surveys, reports, drafted and submitted research papers that is providing the evidence, collaborations and impetus for new funding applications to UKRI/Charities such as:

- UK OA Imaging Consortium – established July 2029. - GW4/OATech/Imaging BioPro Joint funded meeting.
- Exeter OATech ECR Network (Next Generation of OA Research Leaders Theme).
- OATech Data Theme established Combined Database across multiple institutions databanks of healthy, OA and TKR Biomechanics Data involving a Data sharing agreement via Mark Elliott and RFS PDRA, Warwick along with a cross Network survey leading to a combined report on data sharing and a paper publication under review.
- Clinical Theme Focus Meeting (Clinical Theme Lead, Nidhi Soffat and Theme RFS PDRA Sandeep Sandhar) for consensus on factors involved in producing a report on risk factors for pain and functional impairment in OA.

- Published manuscript to OA and Cartilage Open following the Novel Experimental Technology Theme Delphi meeting (led by Theme Lead, Sally Roberts and produced by her funded PDRA, Claire Mannon).
- OA Research Impact and Translation Toolkit and High Level Evidence Theme Leads, Debbie Mason and Alison McGregor, employed a RFS PDRA Dr Janet Deane with 2 papers under review.
- Insigno Institute/OATech Modelathon focussed on Hip and Knee Surgery (2018/2020) bringing together ECR modellers for a week starting with a one-day focus meeting introducing the challenges to OA modelling research, led by Enrico Dal'ara.
- To address the limited spine research in the UK, the 'Image driven spine modelling' project was developed and funded, via collaborations with Exeter to enhance the modelling of the spine with application to non-Low Back Pain pathology.

A number of the Theme Leads continue to present their research at national and international meetings. E.g. D Mason co-led a workshop at Orthopaedic Research Society, Austin, USA, 2019 with F Watt (University of Oxford/Versus Arthritis), C Holt presented OA Research and OA Tech Overview at DKOU, Berlin, alongside M Wilkinson (Rheumatology, Sheffield and BORS President), Germany, a number of members presented their research focus areas at Combined ORS, Montreal, Canada, 2019 where several were nominated and awarded Fellowship of CORS. There were OATech flyers at the Registration Desk of the OARSI, 2018 in Liverpool. A number of members have contributed to BORS Online Annual Meetings (2020, 2020) both in presenting research and outcomes produced by the Network activities and with facilitating a large international conference virtually during challenges and unprecedented circumstances in the Covid-19 pandemic. These have provided the opportunity for the Operations Group and Theme Leaders to disseminate the work of the OATech, the current funded activities and events and calls for funding opportunities.

The OATech Network is achieving impact beyond academia (policy, practice, patients, public, opinion), through a range of diverse engagement activities involving the public to raise awareness of Osteoarthritis and the research that is undertaken in the UK currently. Through the links with Arthritis Research UK (Versus Arthritis) Biomechanics and Bioengineering Centre, interactions with patients and their relatives are a daily occurrence through the studies involving collection of patient data - biomechanics, patient reported, biological tissues. This provides an ongoing platform for Versus Arthritis and OATech activities. Updates and restructuring of the OATech website (oatechnetwork.org) have

allowed the presentation of the outcomes of the network to be displayed more clearly and allow for the engagement from patients and the public. Key engagement and dissemination activities since the start of the Network year have raised the profile of OA Research Technology; focused around OATech being present at national and international research meetings. As examples:

- The OATech Network sponsored two sessions at the BioMedEng 2018 conference held in London in September 2018 (<https://www.biomedeng18.com/>). • There was an OATech plenary session with an excellent invited keynote lecture from Professor Kyriacos Athanasiou (<https://sites.uci.edu/deltai/>) and a separate OATech session of selected high quality research abstracts in the area of OA.
- OATech Sessions held at the British Orthopaedic Research Society (BORS), 2018 and 2019, in Leeds and Cardiff and the IMechE Engineering the Knee Meeting, 2018, London, and continued in the virtual meetings (2020, 2021).
- A talk at the Imaging BioPro Network Meeting at Harwell in 2019, and taking part in the 2 – day Workshop.

Members of the OATech Operations Group are able to provide opinion, evidence and advice on the role of experimental and clinical technology in OA Research. As an example, the OATech PI, Cathy Holt, was in a position to respond to the Call for Evidence from the Royal College of Surgeons Commission on Future of Surgery by contributing to the implications for future surgical technology via the Royal Academy of Engineering Biomedical Engineering Panel. This was also presented by Royal Academy of Engineering representatives at HoC, 2018. The PI was invited to become a Media Spokesperson for Versus Arthritis and thus able to contribute to media commentary in relation to OA technology and influence public opinion. The PI was then nominated by Versus Arthritis to become a member of REF 2021 Sub Panel 12. This was accepted and she is now serving on the REF 2021 Panel which bring an element of cross-disciplinary to REF assessments in appreciation of the challenges to this type of research involving multiple disciplines and patients and currently in its final stages of completion. The PI has given 2 radio interviews: Radio 2 Today Programme about the importance of technology for OA Research and BBC Radio Wales about Biomechanics and OA Research along with live demonstrations of how existing technology can inform our understanding the effects of OA on biomechanics.

Other forms of public engagement have included the Cardiff MSK Biomechanics Team holding a National Biomechanics Day Schools activity (Awarded a prize from Intl. Society of Biomechanics) involving local school children interacting with various biomechanics and imaging technology. The Cardiff School of Engineering,

worked with the National Museum of Wales to bring science and engineering to a wider public. After Dark at the Museum, was a hugely successful night which attracted an audience of more than 1,700 guests. The guests, which included families and young children, involved hands-on exhibitions and activities as well as tours of the Museum. Our exhibit included interaction with biomechanics equipment to understand how people move and raise awareness of research into human movement and OA. This successful event collaboration continued in 2020 and online in 2021. A PPI Day at Cardiff City Stadium involving over 40 members of the public / patients was focused on understanding how patients can interact with arthritis research and the associated developing technology, thus was held in conjunction with the BBRC Versus Arthritis Centre at Cardiff.

Successful collaborations have arisen from funded Research Feasibility and Sandpit Projects with proposals and successful ongoing collaborations. This includes a partnership with Ampersand Health (ampersandhealth.co.uk) and St George's University to pilot an OA management digital application as a patient therapeutic and data collection. Also includes a collaboration with the Cardiff University Brain and Research Imaging Centre to develop methods for pain research and with a digital tool company Agile Kinetic Ltd. developing a pose estimation tool for remote rehabilitation purposes.

Date 2018

Materialised

Type of Impact Cultural,Societal,Policy & public services

Sectors used Healthcare, Leisure Activities, including Sports, Recreation and Tourism, Government, Democracy and Justice, Manufacturing, including Industrial Biotechnology, Pharmaceuticals and Medical Biotechnology

Software and Technical Products

Select type of technical product.	New/Improved Technique/Technology
Short title or name for the product.	A new straightforward method for semi-automated segmentation of trabecular bone from cortical bone in diverse and challenging morphologies
Licensed	No
Open Source license	
Briefly describe technical product.	<p>Many physiological, biomechanical, evolutionary and clinical studies that explore skeletal structure and function require successful separation of trabecular from cortical compartments of a bone that has been imaged by X-ray micro-computed tomography (micro-CT) prior to analysis. Separation often involves manual subdivision of these two similarly radio-opaque compartments, which can be time-consuming and subjective. We have developed an objective, semi-automated protocol which reduces user bias and enables straightforward, user-friendly segmentation of trabecular from the cortical bone without requiring sophisticated programming expertise. This method can conveniently be used as a 'recipe' in commercial programmes (Avizo herein) and applied to a variety of datasets. Here, we characterize and share this recipe, and demonstrate its application to a range of murine and human bone types, including normal and osteoarthritic specimens, and bones with distinct embryonic origins and spanning a range of ages. We validate the method by testing inter-user bias during the scan preparation steps and confirm utility in the architecturally challenging analysis of growing murine epiphyses. We also report details of the recipe, so that other groups can readily re-create a similar method in open access programmes. Our aim is that this method will be adopted widely to create a reproducible and time-efficient method of segmenting trabecular and cortical bone.</p>
Select the year that this output was realised.	2021

EP/N027264/1

17 Mar 2022

Briefly describe notable impacts. In addition to making the Avizo ‘recipe’ freely available, we share its specific steps in a Github repository (https://github.com/evaherbst/Trabecular_Segmentat ion_Avizo) so that the method can also be applied in open-source programmes which are more accessible and may be preferred by other researchers. The aim is that this method will be adopted widely to create a reproducible and time-efficient method of segmenting trabecular and cortical bone.

URL. <https://dx.doi.org/10.1098/rsos.210408>

URL. https://github.com/evaherbst/Trabecular_Segmentati on_Avizo

Digital ID 10.1098/rsos.210408

Source Manual

Publication ID 6230c1347687e9.73336606

Research Tools and Methods

Material Type Improvements to research infrastructure

Material Name Higher level evidence and impact toolkit for OA research

Description A feasibility systematic review study identified and defined higher level evidence in OA research that can be used to develop an impact toolkit. This toolkit can then be applied to abstracts and provide a quality score.

Provided to Others No

Year First Provided

Year First Provided 2021

Impact Description Findings of this study will be presented to the Network to be tested and validated and 2 papers for publication have been drafted to be submitted to Annals of Rheumatic Disease and Lancet Rheumatology.

URL

Digital ID

Source Manual

Publication ID 6036aa10689154.85668119

Material Type Model of mechanisms or symptoms - human

Material Name Knee contact pressure models to quantify the effects of medial knee osteoarthritis and associated surgical and non-surgical interventions

Description The new model result from a collaboration with Cardiff University and KU Leuven and as funded by the Next Generation of research Leaders Theme for ECrs. to work across international laboratories and return with new technology developments to feed into the OAtech Network tools. The tool was developed as a modification

EP/N027264/1

17 Mar 2022

of existing Leuven methods which involve the application of an OpenSim and Joint Contact Modelling pipelines to kinematic and kinetic data obtained from patients undergoing High Tibial Osteotomy surgery to realign their knees and offload the diseased compartment. Data is processed through the pipeline and outputs include muscle forces across the knee to understand co-contractions along with knee contact pressure maps to understand altered loading during dynamic activity for patients with OA and following interventions (surgical and non-surgical - eg gait retraining). Early outputs have been submitted to European Society of Biomechanics and OARSI 2020.

Provided to Others Yes

Year First Provided 2020

Year First Provided

Impact Description Strengthened and new collaborations and data sharing across Cardiff University, KU Leuven and Leeds University that are already generating pilot data, abstracts and drafts of manuscripts towards research funding submissions.

URL

Digital ID

Source Manual

Publication ID 5e595487669721.87022641

Material Type Model of mechanisms or symptoms - mammalian in vivo

Material Name A new model to automatically segment of trabecular bone from cortical bone in diverse and challenging morphologies: a novel automated procedure using Avizo.

Description Novel automated procedure developed enabling trabecular and cortical bone segmentation. This new method speeds up data processing necessary when analysing trabecular bone material, more efficient method than semi-automated procedures and removes subjective element of manual segmentation. The pre-print for this methods paper is shared below. Also available on open access are the CT scans used for the automatic

EP/N027264/1

17 Mar 2022

segmentation algorithm

(https://figshare.com/projects/Trabecular_and_Cortical_Bone_Segmentation_Method/99434) and the code and instructions for the method on github (https://github.com/evaherbst/Trabecular_Segmentation_Avizo)

Provided to Others

Yes

Year First Provided

2021

Year First Provided

Impact Description

Many physiological, biomechanical, evolutionary and clinical studies that explore skeletal structure and function require successful separation of trabecular from cortical compartments of a bone that has been imaged by X-ray micro-computed tomography (microCT) prior to analysis. Separation is often time-consuming, involves user bias and needs manual sub-division of these two similarly radio-opaque compartments. The method developed is an objective, automated protocol which reduces user bias and enables straightforward, user-friendly segmentation of trabecular from cortical bone without requiring sophisticated programming expertise. This method can conveniently be used as a "recipe" in commercial programmes (Avizo herein) and applied to a variety of datasets in different environments. This increases the efficiency of data processing for bone materials.

URL

<https://www.biorxiv.org/content/10.1101/2021.03.02.433409v1>

Digital ID

Source

Manual

Publication ID

5e5d2bf92548c5.48993890

Material Type

Physiological assessment or outcome measure

Material Name

Dynamic Biplane Puled X-Ray and Model Based Image Registration

Description

The Imaging Theme Research Feasibility Study has contributed to the development of the new pipelines for a new bespoke X-ray facility in the UK. It

EP/N027264/1

17 Mar 2022

involved the use of a bespoke system designed with an industry collaborator to allow biplane X-ray recordings of human joints during activities of daily living. The pipelines for the new Dynamic Biplane Pulsed X-Ray and Model Based Image Registration Facility at Cardiff are now in place. The main focus of this technology is to quantify accurate joint kinematics for the lower and upper limbs and enable detailed analysis of joint function and how it changes with disease and surgical intervention. It also provides key data for validation of models (FE and dynamic) and has generated new collaborations between Cardiff School of Engineering and Cardiff Brain Research Imaging Centre, Cardiff University and University of Leeds/KU Leuven to develop imaging and analysis protocols for the foot/ankle, hand/wrist for arthritis and implant studies. Pilot data from these studies is generating information for research funding proposals to investigate kinematics associated with hand OA and ankle arthroplasty as well as advancing knee biomechanics studies already undertaken in the Biomechanics and Bioengineering Centre.

Provided to Others Yes

Year First Provided 2019

Year First Provided

Impact Description Current pilot study outputs will provide proof of concept data for collaborative grants and projects to develop the pipelines for knee, ankle/foot and hand/wrist kinematic analysis.

URL

Digital ID

Source Manual

Publication ID 5e59514634cd45.77758873

Collaborations and Partnerships

Collaboration Title	Assessment of Knee Function using Fluoroscopic Imaging techniques
Partner	
Organisation Name	Zimmer Biomet
Contributed Financially	No
In-kind contribution	No
Contributions Made	Provision of resulting data from total knee replacement implant kinematics involving ZB implants
Partner Contributions	Provision of implant models for image registration purposes.
Year Commenced	2018
Year Ended	2020
URL	
Resultant Outcomes	None yet
Formally Governed	Yes

Collaboration Title	Assessment of Knee Function using Fluoroscopic Imaging techniques
Partner	
Organisation Name	Depuy International

EP/N027264/1

17 Mar 2022

Contributed Financially	No
In-kind contribution	No
Contributions Made	Agreement in place to provide data resulting from fluoroscopic imaging and image registration studies.
Partner Contributions	Provision of knee implant designs for image registration studies
Year Commenced	2018
Year Ended	Still Active
URL	
Resultant Outcomes	None yet
Categorisation of impact	No impact yet
Formally Governed	Yes

Collaboration Title	Automatic 2D-3D Registration and Reconstruction Using Deep Learning
Partner	
Organisation Name	University of New South Wales
Contributed Financially	No
In-kind contribution	No
Contributions Made	Project Partners - Cathy Holt (Cardiff University), David Williams (Cardiff UNiversity) - provision of Dynamic Bi-plane X-ray and MRI data and models for SSM development. collaborative funding application with Mark

EP/N027264/1

17 Mar 2022

Pickering (UNSW Canberra), Thior Besier (University of Auckland), Dianna Perriman (The Australia National University), Hospital Canberra), Paul Smith (The Australia National University)

Partner Contributions Development of SSMs for knee and ankle/foot for use in future image registration technology for OA biomechanics

Year Commenced 2019

Year Ended Still Active

URL

Resultant Outcomes None yet

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title Avizo Novel Analysis and Visualisation Methods

Partner

Organisation Name Royal Veterinary College (RVC)

Contributed Financially No

In-kind contribution No

Organisation Name 3Dmagination Ltd.

Contributed Financially No

EP/N027264/1

17 Mar 2022

Contributions Made	CT imaging data.
Partner Contributions	Expertise in Avizo software, previous use of method for 3D surface morphology of articular aspect of the bone
Year Commenced	2018
Year Ended	Still Active
URL	https://www.diamond.ac.uk/Home/News/LatestNews/2019/02-12-2019.html
Resultant Outcomes	Development of novel method to automate segmentation of trabecular bone compartment. Abstract submitted to Bone Research Society.
Formally Governed	Yes

Collaboration Title BioMedEng18 Plenary Session

Contributions Made	OATech organised a plenary session and a OATech focused session at BioMedEng18. This involved organising an International key note speaker (Professor Kyriacos Athanasiou), and chairing an multidisciplinary OA and technology session: Gwenllian Tawy, University of Manchester, - 'The Efficiency of a Clinical Motion Capture System for Quantifying Knee Function' Sheetal Inamdar, Queen Mary University of London, - 'Multi-scale in-situ Cartilage Mechanics using Small Angle X-ray Diffraction' Lindsay Millar, University of Strathclyde, - 'Robotic Assisted Unicompartmental Knee Arthroplasty Leads to Improvements in Knee Flexion at Five-Year follow-up in Comparison to Conventional Methods' Geoffrey Ng, Imperial College London, - 'Hip Joint Mechanics Before and After Cam FAI' Jessica Mansfield, University of Exeter - 'Tracking Collagen Fibre Reorganisation under Load in Articular Cartilage using Polarization Sensitive SHG Microscopy' Oliver Morgan, Anglia Ruskin University - 'Pre-Clinical Investigation of an Extra-Capsular Knee Joint Unloading Implant' Nimrah Munir, University of Edinburgh - 'Multizone Scaffolds as Cell Free Platforms for Cartilage Tissue Engineering'
Partner Contributions	Organised the key note speaker, and the OATech session. Chaired the OATech session (Prof Cathy Holt) Financial contributions made to support speakers in the field of OA and technology

EP/N027264/1

17 Mar 2022

Year Commenced 2018

Year Ended Still Active

URL https://docs.wixstatic.com/ugd/b3ea6c_745ff60c39a94c368d0a8b767dade38d.pdf

Resultant Outcomes Multi-disciplinary collaboration (biology, engineering and imaging) ECR collaborations Future involvement with BioMedEng

Categorisation of impact Societal

Formally Governed No

Collaboration Title Cardiff & Vale University Health Board

Partner

Organisation Name Cardiff and Vale University Health Board (Bwrdd Iechyd Prifysgol Caerdydd a'r Fro)

Contributed Financially Yes

Contribution Currency GBP British Pound Sterling

Contribution Amount 1650

Contributions Made Directing patient-based research projects involving biomechanics and biology studies

Partner Contributions Ongoing Provision of the following for OATech Imaging Theme Research Feasibility Study alongside existing Arthritis Centre studies:

1. patients for ethically approved studies involving imaging and biomechanics
2. Clinical data for matched cohort studies (in 1.)

EP/N027264/1

17 Mar 2022

3. Clinical expert opinion and leadership for clinical translation studies

Year Commenced Pre-2006

Year Ended Still Active

URL

Resultant Outcomes Multiple publications previously and current drafting of a manuscript.
Multidisciplinary across biomechanics, imaging, orthopaedics

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title COBRA OA

Partner

Organisation Name Boise State University

Contributed Financially No

In-kind contribution Yes

In-kind contribution currency USD

Give an estimate of the in-kind value. 2500

Contributions Made Provision of Biomechanics and Biology Data from linked patients with medial knee OA from BBRCVA study.

EP/N027264/1

17 Mar 2022

Partner Contributions FE and Predictive Models will be developed on the basis of combined biomechanics and biology data using existing models developed by Claire Fitzpatrick (Boise)

Year Commenced 2019

Year Ended Still Active

URL

Resultant Outcomes None yet - will be developed over 2020.

Categorisation of impact Economic

Formally Governed Yes

Collaboration Title Development of a pose estimation medical device for remote measurement of patient joint angles.

Partner

Organisation Name Government of Wales

Contributed Financially Yes

Contribution Currency GBP

Contribution Amount 63000

Organisation Name Agile Kinetic Ltd.

Contributed Financially No

In-kind contribution Yes

EP/N027264/1

17 Mar 2022

In-kind contribution currency	GBP
Give an estimate of the in-kind value.	43300
Contributions Made	<p>The Musculoskeletal Biomechanics Research Facility (MSKBRF) in Cardiff University School of Engineering already houses a full clinical laboratory with human posture measurement devices including the gold standard 3D motion capture technology, inertial measurement unit sensors and electromyographic sensors. Cardiff University MSKBRF / Biomechanics and Bioengineering Centre Versus Arthritis has established links with orthopaedic surgeons. Ethical approval is currently in place, allowing access to clinicians, patients and healthy volunteers with stringent Covid protocols in place. Support is required to build a testing protocol for validation and perform validation on the software so it can be compared to the gold standard for clinical motion analysis in a healthy cohort. This will involve a protocol and calculation pipeline development phase on n=5 healthy volunteers followed by a testing phase on n= 15 healthy volunteers. A total 20 datasets will then be available for statistical comparison of the pose estimation software outputs and the standard biomechanical outputs.</p>
Partner Contributions	<p>Agile Kinetic is seeking support to test and clinically validate its novel pose estimation software with the aim of seeking regulatory approval for the technology. They continue to collaborate and engage throughout data collection and validation to continue the discussions on parameters to develop for the pose estimation tool. This data will be integrated into their existing dataset and expand upon the library of data to develop the 2D analysis AI tool.</p>
Year Commenced	2021
Year Ended	Still Active
URL	https://lshubwales.com/success-stories/developing-pose-estimation-tool-support-musculoskeletal-rehabilitation
Resultant Outcomes	Still ongoing.

EP/N027264/1

17 Mar 2022

Categorisation of impact No impact yet

Formally Governed Yes

Collaboration Title Development of MRI-compatible pressure-delivery device for chronic pain research.

Partner

Organisation Name Cardiff University

Department Brain Research Imaging Centre (CUBRIC)

Contributed Financially No

In-kind contribution Yes

Organisation Name Wellcome Trust

Contributed Financially Yes

Contribution Currency GBP

Contribution Amount 19985

Contributions Made Prototype modification was undertaken in Cardiff University's School of Engineering. An electrical technician was employed on the Translation of Concept Grant to make the modifications to an existing device, with input from CUBRIC's senior technician (Co-I) who built the current prototype. At each iteration, the Clinical Research Co-PIs/Co-Is reviewed modifications and where appropriate, tested in the MR research environment of the Current Pain Imaging Study in CUBRIC. End-user feedback about the Device will be collected using free-text response questionnaires, including questions about device ergonomics, comfort and recommended alterations.

EP/N027264/1

17 Mar 2022

Recommended further modifications will be based on user (participant/operator) and team feedback.

Partner Contributions Imaging and Participant Testing: CUBRIC is a state-of-the-art imaging facility. It hosts an ultrahigh field 7T MRI scanner (alongside other 3T MRI, EEG and magnetoencephalography scanners) where the imaging component of the Current Pain Imaging Study will be performed. There are clinical testing suites where out of scanner testing can be conducted and fully stocked recovery rooms adjacent to each scanner as required for patient participant studies. A team of radiographers and MR physicists are on-hand to help with the set up and safety-testing of new in-scanner devices. CUBRIC also houses a small Workshop where the Device was manufactured by senior technician Co-I using rapid-prototyping. It is thus perfectly suited for pain studies using novel devices in patients and healthy participants.

Year Commenced 2021

Year Ended Still Active

URL

Resultant Outcomes Further funding sought and granted through the Cardiff University Innovation for All Grant Scheme to further develop the device based on market research and end user benefit.

Categorisation of impact Societal

Formally Governed No

Collaboration Title Dynamic Bi-plane Xrays and Model Based Image Registration Technology for foot and ankle biomechanics studies

Partner

Organisation Name Queen's University

Contributed Financially No

EP/N027264/1

17 Mar 2022

In-kind contribution	No
Organisation Name	C-Motion Inc.
Contributed Financially	No
In-kind contribution	Yes
In-kind contribution currency	GBP
Give an estimate of the in-kind value.	12000
Contributions Made	Development of new Dynamic Bi-Plane Xray protocols for calibration tools and Image Registration using MRI and Digitally Reconstructed X-rays
Partner Contributions	C-motion - reduction in XMA software costs to develop new image registration protocols
Year Commenced	2019
Year Ended	Still Active
URL	https://www.c-motion.com/
Resultant Outcomes	New technology for Image Registration using MRI and Dynamic Bi-plane Pulsed X-rays for knee and ankle/foot bio,mechanics studies
Categorisation of impact	No impact yet
Formally Governed	No

Collaboration Title	EPSRC Grant Proposal Data Collaboration
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EP/N027264/1

17 Mar 2022

Partner

Organisation Name	Queen Mary University of London
Department	School of Engineering and Material Science
Contributed Financially	No
Organisation Name	Royal Devon and Exeter Hospital
Contributed Financially	No
Organisation Name	Robert Jones and Agnes Hunt Orthopaedic Hospital
Contributed Financially	No
Organisation Name	University of Exeter
Contributed Financially	No
Contributions Made	Collection of preliminary experimental micromechanics in cartilage data to support EPSRC New Investigator Grant Award.
Partner Contributions	Collection of preliminary experimental micromechanics in cartilage data.
Year Commenced	2019
Year Ended	Still Active
URL	
Resultant Outcomes	Abstract submitted to 2020 World Congress of Computational Mechanics.

EP/N027264/1

17 Mar 2022

Formally Governed No

Collaboration Title Exeter - Cardiff Collaboration - Spine and Knee Radiology and Bi-Plane Xrays for OA diagnostics and outcome measures

Partner

Organisation Name University of Exeter

Contributed Financially No

In-kind contribution No

Contributions Made Imaging Theme funded PDRA David Williams and PI Cathy Holt in discussion with Jude Meakin and Karen Knapp regarding combining research tools for Spine and Knee Radiology and Bi-Plane Xrays for OA diagnostics and outcome measures. Proposed EPSRC funding proposal - Quantifying spine biomechanics

Partner Contributions Imaging Theme funded PDRA David Williams and PI Cathy Holt in discussion with Jude Meakin and Karen Knapp regarding combining research tools for Spine and Knee Radiology and Bi-Plane Xrays for OA diagnostics and outcome measures. Proposed EPSRC funding proposal - Quantifying spine biomechanics Provision of DEXA SOPs and Imaging Protocols across Exeter/Cardiff to develop research tool pipeline for funding application.

Year Commenced 2019

Year Ended Still Active

URL

Resultant Outcomes Draft EPSRC proposal (Meakin - Exeter Lead - with Cardiff PI and Imaging Theme PDRA) - in discussion for submission in next quarter.

Formally Governed No

Collaboration Title GW4 OA Imaging Group

Partner

Organisation Name University of Exeter

Contributed Financially No

In-kind contribution No

Organisation Name University of Bath

Contributed Financially No

In-kind contribution No

Organisation Name University of Bristol

Contributed Financially No

In-kind contribution No

Organisation Name Cardiff University

Contributed Financially No

In-kind contribution No

Contributions Made Network Collaboration across GW4 OA Imaging Consortium, OATech Network Plus and Imaging BioPro Network funded a 2 day UK OA Imaging Meeting at Exeter University which led to the establishment of the UK OA Imaging Consortium.

EP/N027264/1

17 Mar 2022

Partner Contributions Network finding allowed UK wide participation (via applications) for over 40 researchers and clinician to discuss the role of imaging in OA diagnosis and treatment

Year Commenced 2019

Year Ended Still Active

URL

Resultant Outcomes The Imaging Arthritis Consortium Committee - Run by ECRs across GW4, OATech and Imaging BioPro Networks Ben Sherlock Elise Pegg David Williams Flossie Carpenter

This highly interdisciplinary community was formed to bring researchers and clinicians of all career stages together to tackle some of the highest impact challenges in musculoskeletal research. The aims of the community are the following:

1. To connect researchers and clinicians with complimentary interests and expertise.
2. To foster new collaborations and support the development of new research projects.
3. To raise the profile of imaging based solutions to challenging questions in musculoskeletal research.

Developing new ideas for funding proposals - research concepts that were discussed at the symposium included: [?](#)

Patient centred approach: Relevance of radiographic OA in an asymptomatic population. [?](#)

Biomarkers: Imaging biomarkers gap analysis. [?](#)

Big Data/AI: Combining motion capture, demographic and patient reported data for identifying patients with asymptomatic OA. [?](#)

Early OA: Investigating in vitro matrix properties using combination of emerging techniques. [?](#)

Bridging the scales: Multiscale imaging to better understand the initiation and progression of OA.

Contact will be via bi-monthly to share updates from the community and to report progress with onward funding applications.

EP/N027264/1

17 Mar 2022

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title INSIGNEO Institute for in silico Medicine

Partner

Organisation Name University of Sheffield

Contributed Financially No

In-kind contribution No

Contributions Made Modelathon 2020: Optimisation of interventions for osteoarthritic patients with multi-scale modelling

Working together on overlapping areas of interest. In particular co-hosting modelathons in 2018 and 2020 where modelling is linked to osteoarthritis

Partner Contributions Partners were already involved in hosting modelathons. Working together has raised the profile of the Network in the field of modelling, and allowed osteoarthritis modelling problems to be focused - in 2020 on knee surgery for osteoarthritis.

This four-day EPSRC funded Modelathon* event brings together the very best of theory and practice in the area of multi-scale modelling. After four successful events, and in response to last year's positive feedback the Modelathon will once again begin with a symposium. This year our symposium will focus on the role of multi-scale modelling for new treatments of osteoarthritic joints.

Year Commenced 2018

Year Ended Still Active

URL https://insigneo.org/events/list/?tribe_paged=1&tribe_event_display=past&tribe-bar-date=2020-02-28

EP/N027264/1

17 Mar 2022

Resultant Outcomes Discussions about collaborations across the OA Modelling Theme linking to the Data Theme were we are combining data sets.

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title INSIGNEO Institute for in silico Medicine

Contributions Made Working together on overlapping areas of interest. In particular co-hosting modelathons in 2018 and 2019, where modelling is linked to osteoarthritis

Partner Contributions Partners were already involved in hosting modelathons. Working together has raised the profile of the Network in the field of modelling, and allowed osteoarthritis modelling problems to be worked on.

Year Commenced 2018

Year Ended Still Active

URL

Resultant Outcomes Modelathon 2018 Modelathon 2019

Categorisation of impact Societal

Formally Governed No

Collaboration Title Integrating biomechanics motion capture datasets for data driven analyses of knee OA

Partner

Organisation Name Cardiff University

EP/N027264/1

17 Mar 2022

Contributed Financially	No
Organisation Name	University of Warwick
Contributed Financially	No
Organisation Name	Alan Turing Institute
Contributed Financially	No
Contributions Made	The Network provided funding for a feasibility scoping study, providing the foundation for an OA biomechanics repository and the pursuit for data scientist knowledge. Feedback from a Data Study Group application with the Alan Turing Institute has led to a formal collaboration with a 6-month project proposal written to investigate machine learning techniques and data driven analysis.
Partner Contributions	A PDRA from Cardiff University and a data scientist from the Alan Turing Institute will work on the project to investigate key biomechanical markers to identify stage of progression in OA with funding from the Network and ATI.
Year Commenced	2020
Year Ended	Still Active
URL	
Resultant Outcomes	A proposal has been drafted for the project however has yet to start.
Formally Governed	No

Collaboration Title MRC New Investigator Research Grant

Partner

EP/N027264/1

17 Mar 2022

Organisation Name	Queen Mary University of London
Department	William Harvey Research Institute
Contributed Financially	No
In-kind contribution	No
Organisation Name	Columbia University
Department	Engineering
Contributed Financially	No
In-kind contribution	No
Organisation Name	Rutgers University
Department	Department of Genetics and Human Genetics Institute
Contributed Financially	No
In-kind contribution	No
Contributions Made	Collaboration by QMUL Research Fellow, Clare Thompson made with Professor Mauro Peretti through the OATech Grant which then prompted further collaborations with the William Harvey Research Institute, Rutgers University and Professor Clark Hung from Columbia University Engineering.
Partner Contributions	Generation of pump priming data for further fellowship and grant funding.
Year Commenced	2019
Year Ended	Still Active

EP/N027264/1

17 Mar 2022

URL

Resultant Outcomes MRC Fellowship successful application generated followed by Career Development Award successful applications for Research Fellow in at Queen Mary University London.

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title Next Generation Early Career Researcher Placement 2020

Partner

Organisation Name University of Strathclyde

Contributed Financially No

In-kind contribution No

Organisation Name Royal Veterinary College (RVC)

Contributed Financially No

In-kind contribution No

Contributions Made ECR placement funding awarded to PDRA to investigate the effect of mechanical loading on damage to the osteochondral unit in mice with varied bone mineral density and the impact of surgery to treat osteoarthritis on the surrounding joint assessed with gait and biomechanical analysis. The project took place between the 2 institutions adhering to Covid-19 laboratory safe protocols under the supervision of Professor Andrew Pitsillides and Professor Philip Rowe.

EP/N027264/1

17 Mar 2022

Partner Contributions	Work on this placement links with other project work from the Network contributing to those outputs also.
Year Commenced	2020
Year Ended	2020
URL	
Resultant Outcomes	Project report with outputs to come.
Formally Governed	No

Collaboration Title Next Generation Early Career Researcher Placement 2021 (2021-2022))

Partner

Organisation Name	University of Warwick
Department	Institute of Digital Healthcare
Contributed Financially	No
In-kind contribution	Yes
Contributions Made	ECR placement funding awarded by OATech to Research Assistant to investigate the use of smart shoes to identify gait patterns and investigate knee joint angles during walking. The project took place at the University of Warwick Institute of Digital Healthcare supervised by Dr Mark Elliott - Associate Professor at Warwick and Data Theme Lead for the OATech .
Partner Contributions	Work on this placement helps to create further links with work from the Network and provide the ECR with valuable opportunity to work on research in a biomechanics gait lab.
Year Commenced	2021
Year Ended	2022
URL	https://www.oatechnetwork.org/science-portal/1072- 2/

EP/N027264/1

17 Mar 2022

Resultant Outcomes	Report produced uploaded the OATech Website of the method used and results found.
Categorisation of impact	No impact yet
Formally Governed	No

Collaboration Title Next Generation Early Career Researcher Scientific Exchange

Partner

Organisation Name	Cardiff University
Contributed Financially	Yes
Contribution Currency	GBP British Pound Sterling
Contribution Amount	3000
In-kind contribution	No
Organisation Name	University of Leuven
Contributed Financially	No
In-kind contribution	No
Contributions Made	PhD student visited KU Leuven and provided patient biomechanics data to develop a modelling pipeline for high tibial osteotomy knee contact models.
Partner Contributions	Provided training for PhD student in the development of the knee contact model.
Year Commenced	2019

EP/N027264/1

17 Mar 2022

Year Ended 2019

URL

Resultant Outcomes Abstract submitted to European Society of Biomechanics. New technology brought to the OATech community from KU Leuven to understand knee contact pressures in osteoarthritis patients.

Categorisation of impact No impact yet

Formally Governed No

Collaboration Title Next Generation Early Career Researcher Work Placement

Partner

Organisation Name Royal Veterinary College (RVC)

Department Structure and Motion Laboratory

Contributed Financially No

Organisation Name Royal Veterinary College (RVC)

Department Skeletal Biology Lab

Contributed Financially No

Contributions Made Provision of facilities and expertise from the Skeletal Biology Lab to allow PhD student to investigate trabecular changes underlying the subchondral bone plate, used to predict and monitor osteoarthritis

Partner Contributions PhD student with experience in bone materials and bone response to trauma and disease.

Year Commenced 2019

Year Ended 2020

EP/N027264/1

17 Mar 2022

URL

Resultant Outcomes Novel automated method developed to examine trabecular bone structure. Soon to be published.

Formally Governed No

Collaboration Title Next Generation Early Career Researcher Work Placement

Partner

Organisation Name University of Edinburgh

Contributed Financially No

In-kind contribution No

Organisation Name Cardiff University

Contributed Financially No

Contributions Made Provision of Biomechanics Research Facility Laboratory usage, including 3D motion capture, force plates, electromyography and dynamic x-ray data.

Partner Contributions Collection of clinical biomechanics data for healthy participants in the development of a testing protocol to evaluate functional total knee replacement implant kinematics.

Year Commenced 2019

Year Ended 2019

URL

Resultant Outcomes Clinical testing protocol developed. The data collected will work towards a grant application to further investigate instability and knee kinematics in total knee replacement patients.

EP/N027264/1

17 Mar 2022

Formally Governed No

Collaboration Title OATech Presentation Session at BORS 2020

Partner

Organisation Name British Orthopaedic Research Society

Contributed Financially No

In-kind contribution No

Organisation Name Versus Arthritis

Contributed Financially No

In-kind contribution No

Contributions Made Presentations from results of 2 completed research feasibility studies were organised. Professor Nidhi Sofat presented on results from published study, 'Identifying risk factors for pain and functional impairment in large joint OA: a systematic review and meta-analysis approach' and Dr Mark Elliot presented on results from study, 'The opportunities and challenges of sharing and integrating datasets across osteoarthritis research disciplines: a scoping study.' Patient perspective videos organised by Verses Arthritis were also presented.

Partner Contributions BORS provided the online conference for the presentations and VA provided the patient perspective videos.

Year Commenced 2020

Year Ended 2020

URL <https://borsoc.org.uk/bors-2020/programme/>

Resultant Outcomes Study results were presented and disseminated to an orthopaedic research demographic.

EP/N027264/1

17 Mar 2022

Formally Governed No

Collaboration Title Organ-on-a-chip Development.

Partner

Organisation Name The Robert Jones and Agnes Hunt Orthopaedic Hospital NHS Foundation Trust

Contributed Financially No

Organisation Name Queen Mary University of London

Contributed Financially No

Contributions Made OATech funded several pump priming projects for biomechanics and mechanobiology based projects. Within this work was a project to develop a synovium-chondrocyte organ-on-a-chip model with integrated biomechanical stimulation. This project has now formed a collaboration with the Orthopaedic Hospital in Oswestry to develop further.

Partner Contributions Funding has been obtained to progress this work further in a proof of concept award entitled, 'Advancing Human Synovial Chips'.

Year Commenced 2021

Year Ended Still Active

URL

Resultant Outcomes Collaboration has just initiated following a pump priming project.

Formally Governed No

Collaboration Title Osteoarthritis Application Technology

EP/N027264/1

17 Mar 2022

Partner

Organisation Name	St George's University of London
Contributed Financially	No
In-kind contribution	No
Organisation Name	Ampersand Health
Contributed Financially	No
In-kind contribution	No
Contributions Made	Using the model from the rheumatoid arthritis management digital application and the results from the feasibility study at St George's led by Professor Nidhi Sofat, a collaboration has emerged to initiate a pilot project for osteoarthritis. Contacts have been made around the Network and consultants who may be interested in piloting the application with osteoarthritis patients. The pilot will look at both disease management and digital therapeutic options as well as a data gathering tool for integration of osteoarthritis data.
Partner Contributions	Partners at St George's have initiated the collaboration based on the results from the systematic review revealing risk factors for pain and functional impairment in osteoarthritis and partners at Ampersand have a model digital application for the management of rheumatoid arthritis already in use.
Year Commenced	2020
Year Ended	Still Active
URL	
Resultant Outcomes	Collaboration is at initial stages of idea generation for a pilot.
Formally Governed	No

Collaboration Title PhD Studentship

Partner

Organisation Name Versus Arthritis

Contributed Financially Yes

Contribution Currency GBP British Pound Sterling

Contribution Amount 75000

In-kind contribution No

Organisation Name University of Warwick

Department Institute of Digital Healthcare

Contributed Financially No

In-kind contribution No

Contributions Made OATech provided funding for a feasibility data scoping project on Osteoarthritis patient data.

Partner Contributions Final report has been completed with paper submission due shortly, data has been used to apply for a PhD Studentship award.

Year Commenced 2019

Year Ended Still Active

URL

Resultant Outcomes PhD Studentship Award

Categorisation of impact No impact yet

EP/N027264/1

17 Mar 2022

Formally Governed No

Collaboration Title Product Design Research, Cardiff Metropolitan University

Partner

Organisation Name	Cardiff Metropolitan University
Department	Product Design Research
Contributed Financially	No
In-kind contribution	No
Contributions Made	Two network meetings with PDR to define collaborative research; one in particular related to lifestyle monitoring, wearables and patient feedback systems and devices.
Partner Contributions	Organised the second workshop and joined the OATech partners list
Year Commenced	2016
Year Ended	Still Active
URL	
Resultant Outcomes	A mapping exercise to identify common research goals and cross-fertilisation of expertise and ideas.
Categorisation of impact	No impact yet
Formally Governed	No

Collaboration Title Pump Priming Project Governance Process Collaboration

Partner

Organisation Name	University of Leeds
Contributed Financially	No
In-kind contribution	No

EP/N027264/1

17 Mar 2022

Organisation Name	Leeds Teaching Hospitals NHS Trust
Contributed Financially	No
In-kind contribution	No
Organisation Name	InHealth Ltd
Contributed Financially	No
In-kind contribution	No
Contributions Made	OATech provided funding for Pump Priming Project to compare Osteoarthritis knee tissue.
Partner Contributions	InHealth Ltd and Leeds Teaching Hospital Trust have provided Leeds University with guidance for patient identification using a scanning sequence with governance processes. Contract is now in place.
Year Commenced	2019
Year Ended	Still Active
URL	
Resultant Outcomes	Governance process for patient identification finalised using scanning sequences, contract in place.
Categorisation of impact	No impact yet
Formally Governed	Yes

Collaboration Title Sandpit - using technology to improve alignment of discovery science to human disease with a view to fill OA knowledge gaps.

Partner

Organisation Name	Cardiff University
Contributed Financially	No

EP/N027264/1

17 Mar 2022

In-kind contribution	No
Organisation Name	Royal Veterinary College (RVC)
Contributed Financially	No
Contributions Made	This sandpit has consisted of 3 online events and has been led by Professor Deborah Mason and Professor Andrew Pitsillides and demonstrated how research focus meetings could be held online with productive outcomes.
Partner Contributions	The first session was held alongside BORS 2020 online conference and consisted of opinions from global leaders on the knowledge gaps in OA research and how technology and interdisciplinary research can fill these. This informed a 2-day online sandpit that was held later and focussed on idea generation and draft proposal formation. A follow up online focus meeting was held at the beginning of 2021 to help refine these proposals and identify funding applications.
Year Commenced	2020
Year Ended	Still Active
URL	
Resultant Outcomes	Draft grant proposals have been written and currently in refining and review process.
Formally Governed	No

Collaboration Title School of Healthcare, Cardiff University

Partner

Organisation Name	Cardiff and Vale University Health Board (Bwrdd Iechyd Prifysgol Caerdydd a'r Fro)
Contributed Financially	No

EP/N027264/1

17 Mar 2022

Organisation Name	Biomechanics and Bioengineering Centre
Department	Direct monetary contribution is Difficult to estimate as the ARUKBBC Platform funds access to research support officers based at CAVOC who work to recruit and retain patient volunteers.
Contributed Financially	No
In-kind contribution	No
Contributions Made	Working with academics in Healthcare to develop further sensor sets and wearables for monitoring of knee and low back pain patients as part of the Arthritis Research UK Biomechanics and Bioengineering Centre
Partner Contributions	Attendance at several discussions regarding patient rehabilitation schedules and exercises for total knee replacement. Discussions regarding our development of patent based sensor sets in the lab an clinic before home testing. Contributions to the ethical approval applications and protocols.
Year Commenced	2015
Year Ended	Still Active
URL	
Resultant Outcomes	IRAS approval for the initial lab based studies with patients.
Categorisation of impact	Policy & Public Services
Formally Governed	No

Collaboration Title Versus Arthritis (formerly ARUK)

Contributions Made	Have been working together to identify shared priorities and how we can support each other's work.
Partner Contributions	Attendance at focus meetings to decide research priorities. Meetings to plan our continued collaboration.

EP/N027264/1

17 Mar 2022

Year Commenced 2017

Year Ended Still Active

URL

Resultant Outcomes It is multi-disciplinary collaboration involving engineers, research funding managers, clinicians and basic scientists. Outcomes: Resource sharing
Prioritisation of themes Continuation of collaboration to direct future work

Categorisation of impact Societal

Formally Governed No



Research Datasets, Databases and Models

Material Type Dataset/Database/Collection of data

Material Name Data Theme - Data Sharing Report and Agreement and established Combined OA Biomechanics Dataset

Description The Data Theme led by Mark Elliott (Warwick University), and involving Alison McGregor (Imperial College), Cathy Holt (Cardiff), Keele has established a data sharing agreement and database for biomechanics data from healthy volunteers, and OA patients at various stages of OA and with surgical interventions.

The database will form a set for entry into a Turing Institute Hackathon to explore the challenges to data sharing across multiple laboratories and data collection protocols. This will enable the OATech Data Theme to develop a funding application across multiple collaborators to explore patterns and outcomes using a much enhanced and increased cohort. This will the power of the research when answering specific research questions and as compared to existing studies where biomechanics data sets have been low powered due to limited resource for patient based longitudinal studies and technical constraints hen collecting data in the clinical setting. The proposed dataset will enable more effective and appropriate ML approaches to data analysis for predicting outcomes, patient stratification and intervention efficacy testing.

Provided to Others No

Year First Provided

Year First Provided 2019

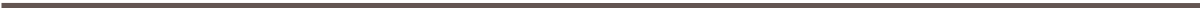
Impact Description The databased is in place and will be explored for practical use and sharing across the wider OATech community during 2020/21 via funding applications.

URL

Digital ID

Source Manual

Publication ID 5e595736f0cfe6.17732990



Key Findings

Key Findings? Yes

Discoveries With respect to important new research questions, several new research networks, collaborations and partnerships are working towards establishing new research resources that have been identified to increase UK OA technology research capability. This is being generated from new opportunities for training delivered in specialist skills, Delphi and consensus studies, reports following network wide surveys, focus meetings, sandpits and training for Early Career Researchers. Description and outputs from these activities are accessible via the OAtech Website (<https://www.oatechnetwork.org/science-portal/research-projects-and-activities/>). Examples of current output generating activities include:

- The Novel Experimental Technology Theme (Sally Robert – Keele/Oswestry) held a Focus meeting and Delphi study approach to OA stratification (Apr 2018) with the results now published in OA and Cartilage Open (Mennan et al., The use of technology in the subcategorisation of osteoarthritis: a Delphi study approach, 2020). During the process, panel members were unanimous that a combination of novel technological advances have potential to improve OA diagnostics and treatment through subcategorisation, agreeing in Rounds 1 and 2 that epigenetics, genetics, MRI, proteomics, wet biomarkers and machine learning could aid subcategorisation. Expert presentations changed participants' opinions on the value of metabolomics, activity monitoring and clinical engineering, all reaching consensus in Round 2. X-rays lost consensus between Rounds 1 and 2; clinical X-rays reached consensus in Round 3. The consensus identified that 9 of the 11 technologies presented should be targeted towards OA subcategorisation to address existing OA research technology and knowledge gaps. These novel, rapidly evolving technologies are recommended as a focus for emergent, cross-disciplinary osteoarthritis research programmes.
- A Sandpit Meeting (Nov 2018) resulted in 8 cross-institutional, multidisciplinary collaborations groups pitching ideas for Short Sandpit Funded Projects (£15k max). 2 of these projects were awarded funding and both with ongoing progress despite many Covid-19 related delays and challenges. These are entitled: 'Development of a quantitative MRI phantom for knee tissue' (David Williams/Hari Markides/Ben Sherlock - ECR's across Cardiff/Birmingham/Exeter) and 'We don't care how much it hurts (but we do care about nociception)' (Debbie Mason/David Hamilton/Val Sparkes/ Jan

Herman Kuiper/Rebecca Hamilton) across Cardiff/Keele/Edinburgh Universities). The successful completion of the proof-of-concept to synchronise data for physiological and biomechanical responses to a quantified nociceptive stimulus suggesting that physiological data mimics biomechanical data in response to a known pain stimuli has led to a poster presentation at the British Orthopaedic Research Society Annual Meeting (Hamilton R. et al 2021, Measuring nociception in knee osteoarthritis using physiological and movement responses: a proof-of-concept study, Orthopaedic Proceedings Vol. 103-B, No. SUPP_16, <https://online.boneandjoint.org.uk/doi/abs/10.1302/1358-992X.2021.16.064>). While this protocol requires further evaluation as to the measurement parameters, the association of the physiological output to the known pain stimulus suggests the potential development of wearable nociceptive sensors that can measure disease progression and treatment effectiveness. Further collaboration and funding discussions are continuing to explore application of the protocol with an OA cohort and links with the Cardiff University Brain Research Imaging Centre have led to further funded studies (WT ISSF and Cardiff University Innovation for All) • The Data Theme (led by Mark Elliott, University of Warwick) have completed an OA Biomechanics Data Sharing Scoping Review, with a full report disseminated to the Network and paper now published in OA and Cartilage Open (Evans et al., Data sharing across osteoarthritis research groups and disciplines: Opportunities and challenges, 2022, <https://doi.org/10.1016/j.ocarto.2022.100236>). This work established that there is clear support for increased data sharing and partnership working in osteoarthritis research. Further investigation will be required to navigate the complex issues identified; however, it is clear that collaborative opportunities should be better facilitated and there may be innovative ways to do this. It is also clear that nomenclature within different disciplines could be better streamlined, to improve existing opportunities to harmonise data. The creation of an OA biomechanics data repository is underway with recruitment of a Research Software Engineer (Warwick) and a template from 3 Institution datasets produced. Data sharing agreements are in place to invite more datasets to contribute, enhance the repository and investigate data driven analysis. As a new research resource which will provide pilot information for a larger EPSRC funding proposal, we currently have a combined data set of up to 750 patients from 7 labs/institutions. About 1/3 of these are healthy controls.

- Next Generation of Leaders Theme (Jim Richards/UCLAN) - Established an ECR Network and ECR opportunities web page, available to see on the OATech website and regularly updated. This includes: - A Mentoring, Database and Web Resource (www.oatechnetwork.org/science-portal/1072-2). The

Network has supported 4 ECR internships in relevant labs with valuable experience on research project – reports on these are available on the website (<https://www.oatechnetwork.org/science-portal/research-projects-and-activities/>), as well as other opportunities that were funded via this theme.

- Imaging Working Group David Williams, Cardiff/Ben Sherlock, Exeter et al) – OATech ECRs gained funding for a GW4 OA Imaging Network to establish a GW4 Network across Cardiff/Exeter/ Bristol/Bath. A very positive outcome from this mnetwork event was a new collaboration between Exeter (Jude Meakin) and Cardiff (Cathy Holt and David Williams), via Karen Knapp (Exeter), leading to a funded EPSRC Investigator Led project
- Focus Event (2 days) was cosponsored by OATech / Imaging BioPro, Exeter, July 2019 - Established the UK OA Imaging Consortium - Imaging Technology and its role in OA diagnostics and monitoring. The linkage across the Imaging BioPro network has led to a new collaboration established during a subsequent Focus meeting and facilitated Network Event led by Profs Debbie Mason and Andy Pitsilides. The outputs from this event have led to current discussions with EPSRC regarding a Programme Grant: An integrative approach to identify the osteoarthritis risk factors for earlier diagnosis, prevention, and delay of disease progression – led by Damien Lacroix (Modelling Theme - Sheffield) with several key Co-Investigators across the OATech .
- Modelling Theme (Working Group across Sheffield/Cardiff) – Modelathon events: - December 2018, Hip Surgery - January 2020 –OA/ Knee surgery – Holt/Pitsillides - Introduced OATech network Plus to Sheffield In Silico Institute Modulation and introduced Human and Animal Studies benefitting from modelling technology OATech Network Plus Expertise Database (available via OATech website and linked to proposals from several theme leaders) - <https://www.oatechnetwork.org/expertise-database-2/> - accessible to all network members, as suggested by the High level Evidence and Impact/Biomechanics and Mechanobiology and Next Generation of OA Tech Researchers Themes. This has already led to a Mentoring Scheme involving 30 mentors across the Network.
- A patient stratification research study (led by Prof Nidhi Sofat, ST George's University) have published their results on risk factors for pain and functional impairment in OA in the BMJ Open (Sandeep et al., Risk factors for pain and functional impairment in people with knee and hip osteoarthritis: a systematic review and meta-analysis, Rheumatology, 2020, <http://dx.doi.org/10.1136/bmjopen-2020-038720>). This study identified risk factors for clinical pain in OA by imaging measures that can assist in

predicting and stratifying people with knee/hip OA. A 'stratification tool' combining verified risk factors that we have identified would allow selective stratification based on pain and structural outcomes in OA. It has led to the collaboration with Ampersand Health to develop an OA management digital health application.

- A novel automated procedure for the segmentation of trabecular bone from cortical bone using Avizo software has been released as pre-print and under review for publication (Herbst A et al R Soc Open Sci, 10.1098/rsos.210408). This was developed from one of the pump priming projects funded within the Biomechanics and Mechanobiology Theme (led by Prof Andy Pitsillides, RVC), with the main aim for it to be adopted widely to create a reproducible and time-efficient method of segmenting trabecular and cortical bone.
- The Imaging Group and one of the Pump Priming Projects led by Claire Brocket (Leeds University), had also led to the development of the UKs first of bi-plane X-ray protocols with pipelines and model-based image registrations now in place at Cardiff University for knee/ankle/foot and hand/wrist – funded by WT ISSF). These protocols and pilot data is generating information for new funding proposals to advance OA imaging and biomechanics research (Cardiff, Holt/Williams) with several universities including Exeter, Leeds, Imperial College, Southampton and with several new industry and NHS clinical collaborators for the development of new medical devices (eg, total ankle replacement, bespoke fixation plates using AM for tibial osteotomy, new modelling and testing for spinal research and development of surgical devices).
- A Scoping Review to investigate the availability of remote technology to collect biomechanical and functional data in OA patients has been carried out at Cardiff University (Williams/Hamilton/Holt). The results of this review have been collated in a report soon to be disseminated and submitted for publication and has linked to an MRC CiC and Welsh Government funded study into the barriers and challenges to remote rehabilitation technology development and adoption in the NHS. A key finding is that indicates a plethora of movement sensor technology and a list of currently commercially available resources will be provided on the OATech website.

Objectives Partially

Reasons Experimental, methodological or technical issues,

Staffing matters (e.g. skills shortages, recruitment delays, unexpected extended leave or departure of staff),

Access to archives, data or participants

Expand

Some of the Network Plus projects are ongoing and have been subject to severe delays due to access to labs, patients, equipment as described in the 2 requests for no-cost extensions that have been granted over the last 2 years.

Further Details

Taken Forward The findings from the various OATech Theme activities are providing Network Consensus Statements on the role of technology in OA. There is real value to the outputs, both consensus and new technology developments and these can be reviewed on the OATech website (<https://www.oatechnetwork.org/science-portal/research-projects-and-activities/>). Interactions across the Network Plus have continued and new Network members as well as industry and clinical collaborators across several of the funded projects are well-engaged.

The Data Theme shared data repository will provide access to large data sets for research purposes to be included in future funding applications. Addressing this challenge will facilitate an important resource across the Network for OA diagnosis, treatment and outcome measures.

The High level Evidence and Impact theme is working on a review of what high level evidence is in osteoarthritis research and how efficacy of interventions is measured across disciplines, to generate a toolkit for the Network to include in future funding applications, and develop a standardised approach to assessing interventions.

The Novel Experimental Technology Theme Delphi Exercise have reported on the various technologies required for OA stratification.

The Sandpit MRI Phantom and Imaging Group funded work is working towards the provision of a standardised phantom for multi-site studies and standard protocols for X-ray and image registration of key synovial joints and will be included into funding application across multi-site studies as pilot studies.

The Sandpit Nociceptive Measures Group funded work are forming collaborations to develop pain related research for other MSK and chronic pain conditions as well as OA. This will be used within brain imaging studies alongside biomechanical and functional measures studies.

EP/N027264/1

17 Mar 2022

The Insigneo Modelathon could provide a standard model for use in knee OA and treatment studies to address key surgical and conservative interventions.

**Interest to
sectors**

Digital/Communication/Information Technologies (including Software), Education, Electronics, Healthcare, Leisure Activities, including Sports, Recreation and Tourism, Government, Democracy and Justice, Manufacturing, including Industrial Biotechnology, Pharmaceuticals and Medical Biotechnology

EP/N027264/1

17 Mar 2022

Covid Impact

Covid negative affect on outputs	Yes
Covid affect on outputs to date	Quantity of outputs/outcomes is lower than originally expected, Variety of output/outcome types is lower than originally expected, Delivery of outputs/outcomes is delayed
Covid positive affect on outputs	No
Statement describing impact of covid	Some negative impact

EP/N027264/1

17 Mar 2022

Medical Products, Interventions and Clinical Trials

Product Name	Agile Kinetic - Development of a pose estimation medical device for remote measurement of patient joint angles - Welsh Government Accelerate Wales funded collaboration - Cardiff University/Industry/NHS
Product Type	Therapeutic Intervention - Physical
Development Stage	Refinement. Clinical
Clinically Trialled	No
CT name	
CT url	
participants number	
total participants	
ISRCTN ID	
ClinicalTrials.gov ID	
EUDRACT ID	
Clinical Trial Phase	
Other ID	
Year Stage Completed	2022
Development Status	Under active development/distribution
Product Description	Following funding from Innovate UK Agile Kinetic have developed a patent pending healthcare application, 'MobilityHub' in association with orthopaedic surgeons, physiotherapists, and patients. The software is a sharing platform between patients and clinicians, enabling patients to self-manage pre and post-operative care at home. The app provides personalised musculoskeletal care through the provision of a rehabilitation

programme, a simple and engaging platform for effective monitoring and clinician support. Given the increased demand for remote patient management and monitoring, the development of an AI pose estimation tool to remotely measure the patients progress is in development. This provides a 2D analysis of patient movements based on tracking specific joint range of motion, angles and whole-body mobility. This can be achieved through single camera footage self-taken by the patient using any smartphone, tablet or webcam and analysed remotely by the clinician. Due to the Covid pandemic, there is currently a significant backlog of patients awaiting joint replacement surgery, realignment surgery and other orthopaedic procedures. There is an opportunity for some rehabilitation to be managed remotely, reducing the need for in-patient follow-up appointments and the demand required to facilitate this. Since 2019 Agile Kinetic have been developing an artificial intelligence (AI) algorithm to provide the model for the 2D analysis joint measurement tool. In Spring 2021 they embarked on a 12 month R&D project in partnership with Cardiff Metropolitan University to refine and improve this model in preparation for CE marking as a class 1 medical device with measurement function. This tool will then be used in conjunction with the existing MobilityHub app on the patient's own mobile device. The resulting data will be available for clinicians to review.

The current study developed through new collaborations between OATech (Holt and Hamilton), an MRC CiC funded project on remote rehabilitation challenges and an active search for industry partners who are developing new tools that are adaptable for rapid clinical adoption for targeted rehabilitation of patients with osteoarthritis. This new collaboration between Cardiff University, Cardiff and Vale University Health Board: Physiotherapy and Industry - Agile Kinetic - has a number of aims

Aim 1: To gain appropriate evidence of accuracy and reliability of the pose estimation predictions towards clinical adoption and CE marking
Objective: To test and measure the generated data against clinically validated technology.

Aim 2: To expand upon Agile Kinetics' existing library of over 9,000 human pose images used to develop the 2D analysis AI tool, for development of a 3 dimensional model
Objective: To capture 3 dimensional image and position data from the clinically validated system and integrate it into Agile Kinetic's existing dataset

EP/N027264/1

17 Mar 2022

Aim 3 : Knowledge sharing to increase understanding of additional applications of AI pose estimation for medical applications

Objective: To identify additional medical applications, detail requirements and shortlist for further collaborative work

Achievements Reinforced existing standards of care,Economic benefits (e.g. more efficient service / reduced burden on limited resource / getting people back to work),Improved/accelerated research approaches

Impact Description The new app is now being developed in direct consultation with the local NHS physiotherapy team which has enabled valuable communications across clinical, biomechanics and computer science interfaces.
As a result the visuals and assessment parameters are now being tailored to the needs of the physiotherapy team, allowing them to anticipate remote objective measures of patient knee movements, movement consistency and asymmetry alongside existing PROMS and clinical assessments. This is attracting new interest from the larger physiotherapy team and is leading to further funding applications to develop the tool to assess the spine and upper limbs

URL <https://www.agilekinetic.com/mobilityhub>

Digital ID

Source Manual

Clinical Trial Registry Source

Publication ID 6230e5caaec705.82722673

Product Name TOKA - Tailored Osteotomy Knee Alignment (TOKA®) is a patient specific surgical treatment for knee osteoarthritis specifically designed for young and active patients

Product Type Therapeutic Intervention - Surgery

Development Stage Small-scale adoption

Clinically TrialledNo

CT name

EP/N027264/1

17 Mar 2022

CT url

**participants
number**

total participants

ISRCTN ID

**ClinicalTrials.gov
ID**

EUDRACT ID

**Clinical Trial
Phase**

Other ID

**Year Stage
Completed** 2022

**Development
Status** Under active development/distribution

**Product
Description** Image based evaluation for validation of a computer aided model of TOKA
(3D-MP/Cardiff University joint project)

Background - High Tibial Osteotomy (HTO) is an effective treatment for this younger patient group. Unlike knee replacement, it preserves the native joint by re-aligning the tibia and redistributing the painful high-pressure regions within the knee. HTO clinical outcomes depend on the accuracy of the procedure, which is complex and surgically demanding. Current HTO solutions are one-size-fits-all resulting in post-operative complications related to the standardised nature of the plates. 3D-Metal Printing (3D-MP) use additive manufacturing (AM) technology to create complex and bespoke geometries, a low energy, environmentally responsible process with minimal material waste. Combining AM with digital technology 3D-MP developed TOKA (Tailored Osteotomy Knee Alignment), a precision-engineered patient-specific HTO treatment for knee Osteoarthritis (OA). It allows surgeons to precisely achieve the planned correction using a combination of intuitive 3D planning and custom-made, minimally invasive devices for superior patient comfort. Thus, providing a significant improvement to healthcare providers' treatment options.

At Cardiff University the Musculoskeletal Biomechanics Research Facility (MSKBRF) was established as part of a Welsh funded bid and includes the state of the art, £1.6M dynamic, bi-plane X-Ray facility. This system is used to capture high-speed 2D X-ray of dynamic motions or activities of in-vivo joint biomechanics.

The Biomechanics and Bioengineering Research Centre Versus Arthritis (BBRCVA) at Cardiff University has led HTO studies for the last 10 years to understand altered loading in the knee OA in terms of the links between biomechanics, biology, and clinical measures. Longitudinal studies have been performed to measure, quantify and compare lower leg and trunk biomechanics to understand the way patients with medial compartment OA alter their gait, and other activities of daily living in response to their degenerative knee joint disease. Additional comparisons between biomechanical function taken pre- surgery to those that result post-operatively are performed to understand the effects of knee realignment surgery on offloading the medial compartment of the knee in order to alleviate the effects of the osteoarthritis in the bone and cartilage and other stabilising structures. Alongside this the effects of non-surgical gait alteration to offload the diseased compartment of the knee are being investigated. During these studies BBRCVA have worked alongside orthopaedic surgeons (at C&V UHB) who have collected and collated clinical data on the patients who have biomechanics and biological data, allowing relationships to be identified between biomechanics and clinical knee alignment. A previous Knee Fellow who collated this information went on to establish the UK's first Osteotomy Registry (UKKOR) and interested in tibial osteotomy has risen extensively since the work started on the HTO study as a Flagship Study for the BBRC Versus Arthritis.

The OATech funded an Imaging Group project to develop new, bespoke dual plane dynamic X-ray imaging protocols (D Williams), focussed on extremity joints (knee, hand/wrist/ankle/foot). As a result of this Research Feasibility Study, these protocols have been adapted for the TOKA project allowing, for the first time, in vivo imaging pre- post HTO for patients having either a standard or a TOKA fixation plate.

Aims - The Personalised Against Standard High tibial Osteotomy (PASHiOn) trial started in 2021 - as part of a study funded by Versus Arthritis and led by Prof Gill (Bath University). This trial, led by Oxford University Clinical Trials Research Unit, is a two-group blinded randomised trial that will be conducted on 88 patients comparing TOKA to standard HTO. A cohort of 22

randomised patients are receiving treatment in Cardiff as part of the double-blind study.

This proposed study is undertaking additional in-vivo biomechanical analysis at the MSKBRF on the Cardiff cohort to provide additional valuable insight on how the surgery changes contact positions of the tibiofemoral joint pre and post-surgery.

The main aims are as follows:

- 3DMP – To develop a diagnostic digital tool for surgeons to predict Pre-op and Post-Op motion and measure contact and contact points post-surgery. This will be integrated into TOKA’s existing HTO planning software.

Cardiff University - To develop pipelines that use the available imaging data (e.g CT) to measure contact pressure and locations and to correlate them to clinical measures and biomechanics that we can measure in our gait lab. Identifying and translating salient information for use in the TOKA’s surgical planning software to enhance patient outcome.

Achievements First product/intervention of its class, Offered new treatment modality, Economic benefits (e.g. more efficient service / reduced burden on limited resource / getting people back to work), Improved/accelerated research approaches

Impact Description The product, developed previously at Bath University, is being trialled in Italy and the UK across 5 surgical centres (PASHiOn). There have been severe delays due to the halting of elective surgery during COVID but the trail has now commenced, and recruitment has begun. The main impact of the work that has resulted from the OATech RFP study, to date, is the ability to quantify previously inaccessible, in-vivo dynamic, loaded arthrokinematics pre and post surgery.

The dynamic and bone models generated and the arthokinematic and gait biomechanics outputs will provide evidence to support the clinical and video vector evidence from the PASHiOn study and will also provide parameters for optimising the models developed for virtual surgical planning and training.

URL <https://www.tokagroup.com/>

Digital ID

EP/N027264/1

17 Mar 2022

Source Manual

**Clinical Trial
Registry Source**

Publication ID 6230bd64f33525.42942494

Next Destination

Label	David Hamilton - Academic Post
Previous Role	Research Project Leader
Has moved role	Yes
Organisation Known	Yes
Organisation Name	Edinburgh Napier University
New Sector	
Destination Country	
Digital ID	
Source	RF
Publication ID	6229dfc7812201.32457174

Label	ECR Ben Sherlock Exeter - academic post
Previous Role	Research Fellow (holding individual fellowship)
Has moved role	Yes
Organisation Known	Yes
Organisation Name	University of Exeter
New Sector	
Destination Country	
Digital ID	
Source	RF
Publication ID	604751c1430442.95603328

Label	ECR David Williams - Research Co-Investigator
Previous Role	Post Doctoral Researcher

EP/N027264/1

17 Mar 2022

Has moved role	Yes
Organisation Known	Yes
Organisation Name	Cardiff University
New Sector	
Destination Country	GB
Digital ID	
Source	RF
Publication ID	6229e552401c50.96579357

Label	ECR Eva Herbst
Previous Role	Post Doctoral Researcher
Has moved role	Yes
Organisation Known	Yes
Organisation Name	University of Zurich
New Sector	
Destination Country	
Digital ID	
Source	RF
Publication ID	6229e4859977d6.06118957

Label	ECR Jake Bowd - Research Co-Investigator
Previous Role	Post Doctoral Researcher
Has moved role	Yes
Organisation Known	Yes
Organisation Name	Cardiff University
New Sector	

EP/N027264/1

17 Mar 2022

Destination Country GB
Digital ID
Source RF
Publication ID 6229e4d56a4bf0.86355317

Label ECR Rebecca Hamilton - Research Co-Investigator
Previous Role Post Doctoral Researcher
Has moved role Yes
Organisation Known Yes
Organisation Name Cardiff University
New Sector
Destination Country GB
Digital ID
Source RF
Publication ID 6229e52196eba1.62940677

Label Philippa Morgan-Jones
Previous Role Post Doctoral Researcher
Has moved role Yes
Organisation Known Yes
Organisation Name Science and Engineering Applications Ltd.
New Sector
Industry sector/discipline the staff member moved to. Digital/Communication/Information Technologies (including Software)
Destination Country
Digital ID
Source Manual

EP/N027264/1

17 Mar 2022

Publication ID 6229e424787758.66789553

Secondments, placements and internships to or from other organisations

Secondments Yes

Secondment, placement or internship

Staff Member Ben Sherlock

**Organisation
involved** University of Wollongong

Start Month February

Start Year 2019

End Month February

End Year 2019

**Known
Impacts** Visiting Prof. Gordon Wallace, University of Wollongong, Australia
Prof. Gordon Wallace is the Director of the Australian Research
Council Centre of Excellence for Electromaterials Science (ACES) at
the University of Wollongong, Australia. In collaboration with Prof.
Peter Choong who holds the Hugh Devine Chair of Surgery at St
Vincent's Hospital, Australia, Prof. Wallace has developed a handheld
3D bioprinting device for intraoperative repair of chondral defects . I
have had several very stimulating research-based discussions with
Prof. Wallace over the phone, and recently Prof. Wallace invited to me
to visit his research group in Wollongong, and present at an
international conference ([https://blogs.deakin.edu.au/aces-
symposium/](https://blogs.deakin.edu.au/aces-symposium/)) he is organising in Melbourne in February 2019.
Benefits to OATech network for part sponsoring this visit

1. Prof. Wallace leads a large, well-funded interdisciplinary research centre (ACES - <http://www.electromaterials.edu.au/>) that has a specific focus on using biotechnology to combat human diseases such as Osteoarthritis.

- i. Prof. Wallace would be able to provide world leading expertise in the field of bioprinting techniques for chondral wound repair.
 - ii. Prof Wallace would be able to offer outstanding training opportunities to PhD students and early career researchers interested in developing knowledge and skills in synthetic bioprinting approaches to cartilage regeneration.
2. The biopen, developed by Prof. Wallace and Prof. Choong is a unique and extremely promising avenue of research into regenerative medicine approaches for cartilage repair.
 - i. Prof Wallace would be able to collaborate with OATech network members working in complimentary areas of research, such as regenerative medicine, imaging and biomechanics.
3. Prof. Wallace is highly experienced in collaborating with industry to translate and commercialise his research. The ACES centre has a specific focus on engaging with industrial partners.
 - i. Prof. Wallace would be able to offer advice, training and exposure to industrial engagement to OATech network members.
4. The biopen has featured prominently in the main stream media: <https://www.dailymail.co.uk/news/article-2529473/Revolutionary-bio-pen-allow-doctors-DRAW-ON-human-cells-repair-broken-bones-cartilage.html>
<https://www.forbes.com/sites/jenniferhicks/2016/03/25/this-handheld-surgical-biopen-can-draw-stem-cells-to-repair-cartilage/#7841abff2fb7>
<https://www.abc.net.au/radionational/programs/coun-terpoint/3d-printing-with-living-cells/9271318>
<https://physicsworld.com/a/handheld-biopen-prints-human-cartilage/> <https://uk.news.yahoo.com/3d-printing-pen-lets-surgeons-155117163.html?guccounter=1>
<https://www.abc.net.au/news/2017-05-25/3d-cell-printer-pen-game-changer-osteoarthritis/8557374>
 - i. Prof. Wallace would be able to offer experience and training to OATech network members interested in enhancing the visibility and impact of their research

EP/N027264/1

17 Mar 2022

Direction of Secondment	out from my research team
Staff Member	David Lunn
Organisation involved	University of Sheffield
Start Month	September
Start Year	2018
End Month	September
End Year	2018
Known Impacts	Joining Modellathon run by In Silico Institute, University of Sheffield.
Direction of Secondment	out from my research team
Staff Member	David Williams
Organisation involved	Queen's University
Start Month	June
Start Year	2019
End Month	June
End Year	2019
Known Impacts	Technology Transfer across two Bi-plane X-ray Facilities Input to software for image registration techniques.
Direction of Secondment	out from my research team
Staff Member	Alex Seghal
Organisation involved	University of Edinburgh
Start Month	July

EP/N027264/1

17 Mar 2022

Start Year	2019
End Month	August
End Year	2019
Known Impacts	Training for PhD student in the use of marker based motion capture and analysis techniques for kinematics of knee stability
Direction of Secondment	in to my research team
Staff Member	Jake Bowd
Organisation involved	University of Leuven
Start Month	November
Start Year	2019
End Month	December
End Year	2019
Known Impacts	Training for PhD Student to use OpenSim and Contact Model pipelines for application to kinematic data for OA patients.
Direction of Secondment	out from my research team
Staff Member	Humaira Mahmood
Organisation involved	Royal Veterinary College (RVC)
Start Month	Aug
Start Year	2020
End Month	Dec
End Year	2020
Known Impacts	This project was to investigate the effect of mechanical loading on damage to the osteochondral unit in mice with varied bone mineral density (at RVC) and the impact of surgery to treat OA on the

surrounding joint assessed with gait and biomechanical analysis (at
Strathclyde University).

**Direction of
Secondment**

in to my research team

Awards and Recognition

Award Type	Awarded honorary membership, or a fellowship, of a learned society
Award Name	Fellow of International Orthopaedic Research (FIOR) - BORS UK NOMINEE
Individual	Cathy HOLT
Award Level	Continental/International
Year Awarded	2019
Award Description	<p>Chair of ICORS International College of Fellows - CATHY HOLT nominated by ICORS member society and approved by the ICORS board to be recognized with the honorary status a Fellow of International Orthopaedic Research (FIOR) of the ICORS International College of Fellows.</p> <p>Nominees selected display a status of excellent professional standing and high achievements in the field of orthopaedic research. Nominees are recognized for their accomplishments and as role models among their peers.</p>
Impact of Award	<p>FIOR honourees foster professional interactions among each other and ICORS members, with research and medical practitioners, regulatory and legislative offices, and promote public awareness of the profession of orthopaedic research and promote and encourage professional and continuing education in orthopaedic research.</p> <p>CATHY HOLT will be admitted as a Fellow of International Orthopaedic Research during a special ceremony at the ICORS 2019 meeting in Montreal (June) that will be hosted by the Canadian Orthopaedic Research Society by resolution of the ICORS board and is then entitled to use the abbreviation FIOR after her name.</p>
URL	
Digital ID	
Source	Manual
Publication ID	5c780fb640f041.54314109

Award Type	Awarded honorary membership, or a fellowship, of a learned society
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EP/N027264/1

17 Mar 2022

Award Name	2021 Worshipful Livery Company of Wales Gold Development Award
Individual	Dr David Williams
Award Level	National (any country)
Year Awarded	2021
Award Description	<p>Dr David Williams was the Post Doctoral RA employed to work on the OATech Research Feasibility Project - Imaging Protocols and he the OATech Sandpit Imaging Phantoms project. He has also worked with Dr Clare Brocket (Leeds University), who led the OATech Pump Priming Project to develop the ankle / foot imaging protocols in the dual plane, dynamic X-ray Imaging Facility at Cardiff. Worshipful Livery Company of Wales - GOLD DEVELOPMENT AWARD WAS PRESENTED TO DR DAVID WILLIAMS, RESEARCH ASSOCIATE, SCHOOL OF ENGINEERING, CARDIFF UNIVERSITY The Gold Development Award, at £5,000, is the largest single award presented by the Worshipful Livery Company of Wales. The aim of the Award is to recognise a young person, who has demonstrated a major contribution to the arts, science or technology to acknowledge exceptional personal achievement. The award attracts a number of high quality applicants, this year was no different with a number of excellent applications.</p> <p>The award for 2020-2021 was awarded to Dr David Williams of Cardiff University's School of Engineering for his pioneering work on the development and validation of a system to measure the internal movement of knee and ankle joints during the activities of daily living. David designed and supervised the building of the unique biplane video X-Ray system now used extensively to carry out examinations of joints.</p> <p>David's work has extended his contact base in academia and industry across many countries, he has 15 peer reviewed published conference papers of his work. He has attracted a great deal of research funding to develop further his work in this field of bio- medical engineering looking into knee, ankle, hand and wrist functions.</p> <p>In addition to his main activity as a research Associate, David has extended his profile by taking an active role in promoting Science, Technology, Engineering and Maths as a STEM ambassador at Cardiff University helping to set up the first Biomechanics Day in Wales.</p> <p>The award will enable David to further his work, allowing access to the MRI scanner at Cardiff University and the provision of specialised IT equipment. The presentation of the cheque was made by the Master, Mr Peter Coleman at a virtual ceremony on 26 March 2021 in the presence of many Liverymen. Dr</p>

EP/N027264/1

17 Mar 2022

David Williams joins the unique group of Gold Award winners and we look forward to his engagement with the Company in the coming years.

Thanks also to the “Gold Award Team” of Senior Warden Dr Kathy Seddon (now Master), Past Masters Dr Sarah Cockbill and Geoff Hughes and Court Assistant Keith Shankland who, once again, were faced with the task of selecting the best of the best.

Impact of Award	Dr Williams has subsequently become the British Orthopaedic Research Society (BORS), Committee Digital Officer –and has worked with the BOSR Organising Committee - Organising/Abstract review and Committee/Media organiser for BORS 2021.
URL	https://www.liverycompanywales.cymru/award-winners -in-2021.html
Digital ID	
Source	Manual
Publication ID	6230c42ac2ad84.51458819

EP/N027264/1

17 Mar 2022

Engagement Activities

Activity Title	'DARE TO ENGINEER'
Activity Type	Event, workshop or similar
How many people?	11 - 50
Geographical Reach	Local
Primary Audience	Schools
Other Audience	Postgraduate students
Activity Years	2018
Result Description	A two-day workshop designed to showcase areas of engineering. In this case the focus was on medical engineering and using motion capture.
Most important impact?	Plans made for future related activity
URL	
Digital ID	
Source	Manual
Publication ID	5c86493a0907d2.56975243

Activity Title After Dark at the Museum, National Museum of Wales, Cardiff, 2018 and 2019

Activity Type Event, workshop or similar

How many people? More than 500

Geographical Reach Regional

Primary Audience General public

Other Audience Schools, Media (as a channel to the public), Policymakers/politicians, Professional Practitioners, Industry/Business, Supporters, Undergraduate students,

EP/N027264/1

17 Mar 2022

Postgraduate students, Other audiences, Study participants or study members,
Patients, carers and/or patient groups, Third sector organisations

**Activity
Years** 2018,2019

**Result
Description** The School of Engineering has been working with the National Museum of Wales to help bring science and engineering to a wider public. One of their first collaborative events was After Dark at the Museum, a hugely successful night which attracted an audience of more than 1,700 guests. The guests, which included many families and young children, were treated to a number of hands-on exhibitions and activities as well as tours of the Museum. The Cardiff University Schools of Engineering, Chemistry, and Physics and Astronomy took part in the event as well as volunteers from the Institute of Physics and the Royal Society of Chemistry.

Some of the university research demonstrated included damage detection in aerospace structures, identifying the location of sound, arthritis research, drone technology and energy generation.

**Most
important
impact?** Requests about (further) participation or involvement

URL <https://www.cardiff.ac.uk/news/view/1013991-after-dark-at-the-museum-a-resounding-success>

Digital ID

Source Manual

**Publication
ID** 5c7beb7f921ea9.78120853

Activity Title BBC Online report for national news

Activity Type A broadcast e.g. TV/radio/film/podcast (other than news/press)

**How many
people?** More than 500

**Geographical
Reach** National

EP/N027264/1

17 Mar 2022

Primary Audience	Media (as a channel to wider audiences)
Other Audience	Media (as a channel to the public), Policymakers/politicians, Public/other audiences, Industry/Business, Other audiences
Activity Years	2017,2018
Result Description	<p>Cardiff Uni bid to create osteoarthritis 'smart patch' By Max Evans BBC News 21 January 2017</p> <p>Dr Davide Crivelli and Prof Cathy Holt, School of Engineering Cardiff University</p> <p>Scientists are hoping to create a smart patch which could detect the early onset of osteoarthritis in patients' knees. Cardiff University's team uses damage sensors from aircraft wings to catch subsonic cracking sounds in joints before the disease fully develops. They believe a disposable patch using them could save expensive diagnosis and treatment of advanced osteoarthritis.</p> <p>This was subsequently reported online and in print in some of the following outlets - Sun, Daily Mirror, Daily Mail and Daliy Express, also the Irish News, Arthritis Digest, ARUK Website, Cardiff University Website</p> <p>https://www.express.co.uk/life-style/health/757955/Arthritis-patches-breakthrough-detection-treatment-new</p> <p>https://www.dailymail.co.uk/sciencetech/article-4147568/The-10p-patch-tell-arthritis.html</p> <p>https://www.mirror.co.uk/science/patches-costing-just-10p-could-9673650</p> <p>http://www.irishnews.com/magazine/2017/01/24/news/sensors-from-aircraft-wings-are-being-used-to-detect-arthritis-903044/</p> <p>http://arthritisdigest.co.uk/smart-patch-enable-earlier-detection-osteoarthritis/</p> <p>https://www.arthritisresearchuk.org/news/general-news/2017/january/new-smart-patch-study-could-aid-early-detection-of-osteoarthritis.aspx</p> <p>https://www.cardiff.ac.uk/news/view/551410-osteoarthritis-smart-patch</p>
Most important impact?	Requests for further information
URL	https://www.bbc.co.uk/news/uk-wales-south-east-wales-38604860
Digital ID	
Source	Manual

EP/N027264/1

17 Mar 2022

Publication ID 5c7816ca14b6a6.10376667

Activity Title	BBC Radio 2 Today programme Interview
Activity Type	Media interview, press release, press conference or other response to a media enquiry
How many people?	
Geographical Reach	National
Primary Audience	General public
Other Audience	Media (as a channel to the public),Public/other audiences,Undergraduate students,Postgraduate students,Patients, carers and/or patient groups
Activity Years	2019
Result Description	BBC Today programme Interview and technology demonstration during live recording from Cardiff University with Today Presenter. Catherine Holt and undergraduate Medical Engineer. Highlighting the role of new technology in understanding MSK disorders, OA and its treatments.
Most important impact?	Requests about (further) participation or involvement
URL	
Digital ID	
Source	Manual
Publication ID	5e594bac297027.75544495

Activity Title	BBC Radio Wales Interview and Strength Testing Demonstration
Activity Type	Media interview, press release, press conference or other response to a media enquiry
How many people?	More than 500
Geographical Reach	National

EP/N027264/1

17 Mar 2022

Primary Audience	General public
Other Audience	Media (as a channel to wider audiences)
Activity Years	2019
Result Description	<p>BBC Radio Wales interview and technology demonstration - breakfast program</p> <p>C Holt interviewed with Cardiff Blues Rugby Team member and Undergraduate Student on the MSK Biomechanics research facility and the importance of new technology for osteoarthritis research.</p> <p>Coincided with International Biomechanics Day event involving local primary school children</p>
Most important impact?	Requests about (further) participation or involvement
URL	
Digital ID	
Source	Manual
Publication ID	5e594ad011b523.55967675

Activity Title	Cardiff Half Marathon - Engagement with Wearable Technology for Exercise and Rehabilitation Monitoring
Activity Type	Event, workshop or similar
How many people?	More than 500
Geographical Reach	International
Primary Audience	General public
Other Audience	Schools, Media (as a channel to the public), Professional Practitioners, Public/other audiences, Supporters, Patients, carers and/or patient groups
Activity Years	2017
Result Description	A stand at the Cardiff Half Marathon demonstrating the use of research to help experts investigate knee and back conditions. The use of state of the art wearable technology for exercise and rehabilitation monitoring was demonstrated by Dr Philippa

EP/N027264/1

17 Mar 2022

Jones as part of the Arthritis research UK Biomechanics and Bioengineering Centre at Cardiff. The Cardiff Half attracted over 22,000 runners and 50,000 spectators over the weekend event.

Most important impact? Requests about (further) participation or involvement

URL <https://www.cardiff.ac.uk/news/view/946685-experts-investigate-knee-and-back-conditions>

Digital ID

Source Manual

Publication ID 5a8acd8fe2c3e1.09907753

Activity Title Chinese undergraduate interactive Medical engineering visit

Activity Type Event, workshop or similar

How many people? 11 - 50

Geographical Reach International

Primary Audience Undergraduate students

Other Audience Professional Practitioners

Activity Years 2019

Result Description 15 undergraduate students from China attended The Musculoskeletal Biomechanics Research Facility (24/01/2019) for an interactive workshop on medical engineering

Most important impact? Requests for further information

URL

Digital ID

Source Manual

Publication ID 5c86470d26d552.95398696

Activity Title Establishing an OATech Network website

Activity Type Engagement focused website, blog or social media channel

EP/N027264/1

17 Mar 2022

How many people?	More than 500
Geographical Reach	International
Primary Audience	Patients, carers and/or patient groups
Other Audience	Policymakers/politicians, Professional Practitioners, Public/other audiences, Industry/Business, Supporters, Postgraduate students, Other audiences, Study participants or study members, Third sector organisations
Activity Years	2017
Result Description	<p>The OATech Network website has been established as a tool of engagement, collaboration and multi-disciplinary user communication.</p> <p>The site offers two portals:</p> <p>A science portal established for those interested in research in the field of OA, and for the multi-disciplinary Network Partners to interact and collaborate. This is also there to engage with industry, clinicians and policymakers</p> <p>A public and patient portal established to communicate Network opportunities and findings to the public and patients, offer engagement opportunities and opportunities to influence research, encourage across portal interaction, provide links to OA relevant events, support groups and charities.</p> <p>Ultimately the website is there to encourage engagement across multiple stakeholder groups, with the aim of sustaining the Network beyond its initial four year period of funding.</p>
Most important impact?	Plans made for future related activity
URL	http://oatechnetwork.org/
Source	Manual
Publication ID	58c9201bc9a109.57792858
<hr/>	
Activity Title	French School Group workshop
Activity Type	Event, workshop or similar

EP/N027264/1

17 Mar 2022

How many people?	11 - 50
Geographical Reach	International
Primary Audience	Schools
Other Audience	Postgraduate students
Activity Years	2018
Result Description	Secondary School children from France attended a workshop on medical engineering
Most important impact?	Plans made for future related activity
URL	
Digital ID	
Source	Manual
Publication ID	5c8648520af583.12500778

Activity Title	Involving Network People Annual Conference
Activity Type	Event, workshop or similar
How many people?	1 - 10
Geographical Reach	National
Primary Audience	Patients, carers and/or patient groups
Other Audience	Professional Practitioners, Public/other audiences, Third sector organisations
Activity Years	2017
Result Description	Nine individuals chose to attend a "pitch session" introducing the OATech Network, as part of the Involving Network People Annual event. WE had a engaging session with discussion on OA, current management, problems with management, Cardiff University research and the introduction of the Network. We shared personal experiences, engaged in activities organised by myself, had a demo of new technology used in clinical research, and evaluated the newly commissioned Network website.
Most important impact?	Requests about (further) participation or involvement

EP/N027264/1

17 Mar 2022

URL <https://www.healthandcareresearch.gov.wales/events/2017/03/01/involving-people-network-annual-meeting/>

Source Manual

Publication ID 58c7e5cf3169f9.39936022

Activity Title Meeting with Versus Arthritis

Activity Type A formal working group, expert panel or dialogue

How many people? 1 - 10

Geographical Reach National

Primary Audience Third sector organisations

Other Audience No other audiences

Activity Years 2019

Result Description The Operations Group travelled to Versus Arthritis headquarters to engage with the charity on invitation. The Network activities and funding of projects was presented to the charity. This facilitated discussion of overlaps in areas of priorities, and possible collaborations.

The impact reported by Versus Arthritis (Shereen Sabbah) is detailed below: We thoroughly enjoyed the opportunity to meet with and update the OATech Network leads on our aims as a new Charity, and importantly hear about the Network's numerous activities since its inception and plans for 2019. The discussions which emerged from the meeting have given us a lot 'food for thought' on where some of our activities in the field of Osteoarthritis research would benefit from interaction and engagement with the Network in future. We also look forward to seeing the outcomes of the Network's numerous activities and funded projects upon completion.

Most important impact? Plans made for future related activity

URL

Digital ID

Source Manual

EP/N027264/1

17 Mar 2022

Publication ID 5c828bec9c6009.89706632

Activity Title	Modelathon at the University of Sheffield
Activity Type	Event, workshop or similar
How many people?	51 - 100
Geographical Reach	International
Primary Audience	Postgraduate students
Other Audience	Professional Practitioners
Activity Years	2018,2020
Result Description	<p>Aim of Modelathon: To engage researchers in the field of musculoskeletal and cardiovascular research with the principles and practice of multiscale modelling through addressing an authentic research challenge using both industrial and open source research tools and frameworks. To raise the profile of the project amongst the academic community and industry. The MultiSim Modelathon brings together PhD and PostDoc researchers in the field of Multi-Scale Modelling and Biomechanical Engineering, from around the world, to compete in teams against one another to solve a complex multi-scale modelling problem. This three-day event is based on the concept of a hackathon event where different teams work on a challenging problem to 'hack' a computer code. Here there is no 'hacking' but 'modelling'. The teams competed to solve a challenging multi-scale biomechanical problem within the musculoskeletal system using state-of-the-art techniques and software. Industry members and multi-scale experts supported the event, including software providers and Ansys, Simpleware, Materialise and Simulia. They supported the Modelathon by providing licences for the academic developers preparing and testing the challenges before the event, and the Modelathon participants during the event. They provided expertise and technical support during the event to encourage participants to make the most of the software available and sponsored the events to subsidise the costs to the participants. The 2018 and 2020 offerings of the Modelathon were co-sponsored and supported by OATech , and focused on the</p>

EP/N027264/1

17 Mar 2022

clinical problem of osteoarthritis in the hip and knee joints respectively. Each year the Modelathon attracts approximately 25 researchers.

Most important impact? Audience reported change in views, opinions or behaviours

URL <http://multisim-insigneo.org/modelathon/>

Digital ID

Source Manual

Publication ID 5e5ced542690d8.98722638

Activity Title National Biomechanics Day Schools Event at the MSK Biomechanics Research Facility, Cardiff University

Activity Type Participation in an open day or visit at my research institution/facility

How many people? 11 - 50

Geographical Reach Local

Primary Audience Schools

Other Audience Media (as a channel to wider audiences)

Activity Years 2019

Result Description 35 local inner city primary school pupils attended for a school visit to the research organisation, and had the opportunity to interact with state of the art technology including motion capture, imaging, electromyography, biodex strength testing, pressure walkways, which sparked many excited questions and discussion afterwards, and the school reported that the pupils had gained a fun and thorough insight into the types of research undertaken into arthritis research at Cardiff.

The organisers (PGRs and ECRs) were awarded a prize from the International Society of Biomechanics Society for Best Content It was the first National Biomechanics Day in Wales and the ECR was also successful as a Co-I on a Royal Academy of Engineering Ingenious Grant. This is to develop more engineering resources to engage girls and young women with engineering. She was also selected as the winner of The Worshipful Company of

EP/N027264/1

17 Mar 2022

Engineer's Mercia Award 2019. we are repeating it again this year.

Most important impact? Requests about (further) participation or involvement

URL

Digital ID

Source Manual

Publication ID 5e594ea89e3793.40301285

Activity Title OATech Network Focus Meeting

Activity Type A formal working group, expert panel or dialogue

How many people? 11 - 50

Geographical Reach National

Primary Audience Professional Practitioners

Other Audience Industry/Business, Supporters, Patients, carers and/or patient groups

Activity Years 2017

Result Description Forty-five multi-disciplinary Network Partners and patients attended a professionally facilitated two-day Focus Meeting in Cardiff, to reach a consensus on the Network's Themes, gaps in knowledge and research priorities. Theme leaders led working groups encompassing ten different Themes relating to OA. The outputs were: The identification of the priority areas for each theme, justification based upon the impact on the rest of the Network, and proposals for meeting these priorities. Post meeting, the information gathered from each Theme has been collated, shared across the Network, and peer reviewed to establish the immediate actions and resulting activities for the entire Network.

Most important impact? Plans made for future related activity

URL

Source Manual

EP/N027264/1

17 Mar 2022

Publication ID 594ce3d6dc5879.87810173

Activity Title OATech network sponsored two sessions at the BioMedEng 2018 conference held in London in September 2018

Activity Type A talk or presentation or debate

How many people? 101 - 500

Geographical Reach International

Primary Audience Other audiences

Other Audience Professional Practitioners ,Industry/Business, Postgraduate students, Study participants or study members, Third sector organisations

Activity Years 2018

Result Description OATech network sponsored two sessions at the BioMedEng 2018 conference held in London in September 2018 (<https://www.biomedeng18.com/>). There was an OATech plenary session with an excellent invited keynote lecture from Professor Kyriacos Athanasiou (<https://sites.uci.edu/delta/>) and a separate OATech session of selected high quality research abstracts in the area of OA. The meeting was attended by over 500 delegates representing the largest gathering of UK bioengineers.

Most important impact? Requests about (further) participation or involvement

URL <https://www.biomedeng18.com/>

Digital ID

Source Manual

Publication ID 5c7be7cacd6255.71250037

Activity Title OATech Session at British Orthopaedic Research Society, Leeds, IMechE Engineering the Knee, London - 2018

Activity Type A talk or presentation or debate

EP/N027264/1

17 Mar 2022

How many people?	101 - 500
Geographical Reach	International
Primary Audience	Other audiences
Other Audience	Professional Practitioners, Public/other audiences, Industry/Business, Supporters, Postgraduate students, Other audiences, Third sector organisations
Activity Years	2018
Result Description	<p>The OATech sponsored a session at BORS 2018 in Leeds and IMechE Knee in London, and flyers were placed around the lecture room.</p> <p>The BORS Leeds session introduced the OATech (Holt) and there were two talks delivered by Sally Roberts</p> <ul style="list-style-type: none">- Novel Experimental Technology Theme Leader- on Biology and OA, and by Phil Rowe - CI- on Motion Capture and its use in biomechanics and OA research. <p>The IMechE Knee London session introduced the OATech (Holt) and there were two talks delivered by Debbie Mason</p> <ul style="list-style-type: none">- High level Evidence and Impact Toolkit Theme Leader- on Biology and OA, and by Phil Rowe - CI- on Motion Capture and its use in biomechanics and OA research. <p>Flyers were also placed at the Registration Desk and there was a presence at OARSI, Liverpool, 2018.</p>
Most important impact?	Requests about (further) participation or involvement
URL	
Digital ID	
Source	Manual
Publication ID	5c7be9a17bcb28.34015416

EP/N027264/1

17 Mar 2022

Activity Title	Patient Public Involvement in Research - OA Engagement Day
Activity Type	Event, workshop or similar
How many people?	11 - 50
Geographical Reach	National
Primary Audience	General public
Other Audience	Public/other audiences, Supporters, Postgraduate students, Patients, carers and/or patient groups, Third sector organisations
Activity Years	2020
Result Description	<p>Patient and Public Involvement in Research Cardiff City Stadium Full day of brief presentations and Cafe style break out sessions. Understanding the role of patients in research design and ethics.</p> <p>This event generated a vast amount of patient / carer opinion on topics such as Genetic Screening and the use of Media in research.</p> <p>Feedback of the day was all positive and a full feedback document will be produced in the future and will be circulated as appropriate.</p>
Most important impact?	Requests about (further) participation or involvement
URL	
Digital ID	
Source	Manual
Publication ID	5e5949b68cf455.66470317

Activity Title	Public engagement event
Activity Type	Event, workshop or similar
How many people?	11 - 50
Geographical Reach	Local
Primary Audience	General public

EP/N027264/1

17 Mar 2022

Other Audience	Undergraduate students, Postgraduate students
Activity Years	2019
Result Description	A public engagement event was held to increase awareness of osteoarthritis, and the local research being undertaken in this area. The event involved a mixture of activities, and talks, and was led by a third-year undergraduate undertaking a project in engagement.
Most important impact?	Requests for further information
URL	
Digital ID	
Source	Manual
Publication ID	5c828d00b48601.16005057

Activity Title	Science Museum Late event using Organ on a Chip Technology.
Activity Type	Event, workshop or similar
How many people?	More than 500
Geographical Reach	Regional
Primary Audience	General public
Other Audience	Schools, Public/other audiences
Activity Years	2019
Result Description	Over 4000 visitors attended this museum event for educational experience on 'organ on a chip' technology. Visitors make their own organ on a chip keyring, using a variety of "ingredients" such as coloured beads, pens and tapes – representing the key cell types, 3D environments and mechanical forces present within the organ. Visitors created their own lungs, brains, livers and joints, which, when miniaturised, were turned into key rings for them to take home. Network engineers and scientists who helped run the shop came from a variety of Universities including Brunel, Oxford, Kent, Dublin, Cambridge and Queen Mary London.
Most important impact?	Plans made for future related activity

EP/N027264/1

17 Mar 2022

URL <https://www.organonachip.org.uk/news/4629/the-organ-on-a-chip-shop-a-science-museum-highlight#>

Digital ID

Source Manual

Publication ID 5e593e90a6b3f7.96826214

Activity Title Science Museum Late Event, Gaitrite walkway used for public engagement around gait analysis.

Activity Type Event, workshop or similar

How many people? More than 500

Geographical Reach Regional

Primary Audience General public

Other Audience Schools,Public/other audiences

Activity Years 2020

Result Description Over 1000 visitors attended this museum late night event. A walkway lined with pressure sensors for gait analysis was used with a projector to show audience potential variables that are analysed. Virtual Reality goggles with videos of 3D motion capture, used to entertain people in the queue. PhD students, undergraduate students and early career researchers were available to engage with the public around ways in which biomechanical analysis is used for research.

Most important impact? Plans made for future related activity

URL

Digital ID

Source Manual

Publication ID 5e5940bceed013.88434586

Activity Title Social Media Accounts

EP/N027264/1

17 Mar 2022

Activity Type	Engagement focused website, blog or social media channel
How many people?	101 - 500
Geographical Reach	International
Primary Audience	General public
Other Audience	Policymakers/politicians, Professional Practitioners, Industry/Business, Postgraduate students, Study participants or study members, Patients, carers and/or patient groups
Activity Years	2017,2018,2019
Result Description	OATech Network social media accounts were established and went live. Twitter and Facebook were set up to engage with Network Partners, the public, patients and other stakeholders such as industry and clinicians
Most important impact?	Requests for further information
URL	http://twitter.com/OATechNetwork
Digital ID	
Source	Manual
Publication ID	59564059e185b0.79091706

Activity Title	Stakeholder engagement poster
Activity Type	Event, workshop or similar
How many people?	101 - 500
Geographical Reach	National
Primary Audience	Professional Practitioners
Other Audience	Policymakers/politicians, Public/other audiences, Industry/Business, Undergraduate students, Postgraduate students, Study participants or study members, Patients, carers and/or patient groups, Third sector organisations
Activity Years	2019
Result Description	Presenting a poster on public engagement and osteoarthritis at the Public Health Wales Research Showcase Bringing Together

EP/N027264/1

17 Mar 2022

Health and Social Care: A Revolution in Transformation. The poster details a public engagement project focused on osteoarthritis, the Musculoskeletal Biomechanics Research Facility at Cardiff University, and using a logic model to monitor and evaluate.

Most important impact?	Requests for further information
URL	https://www.eventbrite.co.uk/e/public-health-wales-research-showcase-event-bringing-together-health-and-social-care-research-a-tickets-49692807525
Digital ID	
Source	Manual
Publication ID	5c863f8ac06af0.04061790

Activity Title Stakeholder engagement poster

Activity Type A talk or presentation or debate

How many people? More than 500

Geographical Reach National

Primary Audience Professional Practitioners

Other Audience Industry/Business, Patients, carers and/or patient groups

Activity Years 2017

Result Description An abstract was accepted for a poster presentation, that was subsequently delivered at Physiotherapy UK 2017 (10-11th November 2017), to engage with clinical stakeholders and their patients. Supporting the poster discussions over the two-day conference, handouts of the poster were also given out to promote the purpose of the Network, provide contact information, highlight key areas of research, and to convey the importance of stakeholder engagement to support Network success towards improving patient outcomes. In advance of the conference, the Network website and social media channels advertised that the poster was to be presented. Post conference, social media was used to convey the

EP/N027264/1

17 Mar 2022

Network presence at the conference, and website metrics gained from our next digital report will be used to record any increase in Network interest from a social media perspective.

Most important impact? Requests for further information

URL <http://www.physiotherapyuk.org.uk/>

Source Manual

Publication ID 5a27bc4301ddd2.66698270

Activity Title Tour of lab by PETIC

Activity Type A talk or presentation or debate

How many people? 1 - 10

Geographical Reach Local

Primary Audience Professional Practitioners

Other Audience Professional Practitioners, Postgraduate students

Activity Years 2019

Result Description Researchers from PETIC attended to listen to presentations, tour the Musculoskeletal Biomechanics Research Facility and discuss collaborations.

Most important impact? Plans made for future related activity

URL

Digital ID

Source Manual

Publication ID 5c8647da766f01.05193387

Activity Title Versus Arthritis Media Spokes Person

Activity Type A magazine or newsletter (print or online)

EP/N027264/1

17 Mar 2022

How many people?	More than 500
Geographical Reach	National
Primary Audience	General public
Other Audience	Media (as a channel to wider audiences)
Activity Years	2018,2019
Result Description	CATHY HOLT - was invited to comment on in a Daily Mail interview regarding different walking styles and altered knee loading. She was Informed that it would be published in the Daily Mail in March 2019. The impacts/outcome have yet to be observed.
Most important impact?	Not aware of any impact.
URL	
Digital ID	
Source	Manual
Publication ID	5c78138734cf37.80856360

EP/N027264/1

17 Mar 2022

Animal Use

Scientific Procedures act Yes

Animal project licence Yes

No licence required description

Species

Species Mouse

3Rs Shared use of tissues, organs or other material

Changes No

Animal reduction Yes

Impact of animal use The Pump Priming project used archived mouse scans therefore no sacrifice of any new animals was required to develop the software tool