Medical Technologies

INNOVATION AND KNOWLEDGE CENTRE

Medical Technologies Innovation & Knowledge Centre

2016

Annual review

UNIVERSITY OF LEEDS

contents

Annual review

In 2016 the Medical Technologies IKC has both tightened its focus and broadened its vision.

We continue to target early-stage regenerative device technologies which need to demonstrate proof of concept before obtaining industrial investment. This approach continues to yield tangible results, with a further 15 projects being progressed into clinical trials or commercial investment and development.

At a national level, we're increasing the breadth and depth of our partnerships, working with a growing number of academic institutions, industrial and healthcare partners. Our Phase 2 Proof of Concept calls attracted applications from several universities which were new to the Medical Technologies IKC. Five new projects are now underway, advancing technologies in the fields of directly implanted devices and joint simulation.

We're delighted, too, to be strengthening our partnership with Arthritis Research UK, which has committed a further £0.5m towards new proof of concept projects in technologies that have significant impact potential. We're also pleased to be continuing our close collaboration with NHS Blood and Transplant Tissue and Eye Services on directly implanted devices, which launched a new wound repair product this year.

Most importantly we have worked with other industry and clinical partners to start a further 15 proof of concept projects this year, making a total of 25 active in the last year, and 76 since the start of the IKC in 2009. We have tracked private sector investments of over £111m to support this technology development.

We're also broadening the scope of our activity in the Leeds City Region, building innovation capacity through our HEFCE-funded Translate programme. Working with a small group of universities and regional organisations, we're bringing together diverse partners to identify unmet clinical needs and devise projects that can address them.

This is an exciting programme for the Medical Technologies IKC: through Translate's workshop events, we've been able to spark innovative collaborations at the same time as widening the range of medical technologies under development.

We're proud of the employment successes enjoyed by doctoral graduates who have undergone innovation and career development training through the Centre for Doctoral Training at Leeds and equally delighted – at the other end of the scale – to see our business partners expanding and entering new markets with products underpinned by research carried out by the Medical Technologies IKC.

By continuing to innovate in our approach as well as through strengthening and expanding our partnerships locally and nationally, we're ensuring a very healthy future for regenerative device medicine. ■

Professor John Fisher CBE
Academic Director, Medical Technologies IKC

Our success to date:

£103m
Total public research and innovation funding secured

£111m
Private sector investment in technology development

84
Collaborating partners

205
People have participated in our innovation development programmes

192
Total projects in our innovation portfolio

76
Projects completed and progressing to market

Our first year of phase 2:

15
New projects initiated

£12m
New public research and innovation funding

15
Projects completed and progressing to market

130
Delegates at our first annual conference

Regenerative devices: a £1bn per year industry opportunity in the UK

Estimated global market size per year by 2020:

$25bn + **$50bn** = **$75bn**

Regenerative tissues with autologous cells + Biomaterials and implants, enhanced to deliver regenerative potential = Global market size

Scale of opportunity in the UK:

£10m IKC / leveraged funds

£50m per year R&D in private sector

£1bn per year industry in UK

Estimated scaffold products market sizes by 2020:

£3bn Bone repair

£2bn Ligament and tendon repair

£2bn Meniscus

£3bn Vascular grafts

Sustaining innovation

Our partners, networks and programmes are now starting to take on a life of their own, forming a flourishing pipeline of translation opportunities.

Over the past year in particular, we've seen early-stage ideas that were formed and developed in our partner programme, MeDe Innovation, carried forward into the Medical Technologies IKC, where they've received proof of concept funding.

Even better, some of those researchers have successfully applied for our follow-on funding, bringing in commercial partners and moving their technology even closer towards a commercial application.

At the same time, this process is growing and strengthening our partnerships both within the Medical Technology IKC's network of universities and beyond, as researchers move between institutions.

We're often asked about how we sustain our translation pipeline. The interaction between all these different programmes is absolutely key to that.

Another important aspect, which we've been developing over the past year, is the HEFCE Catalyst funded Translate programme (p6), which develops projects to address unmet clinical needs and create partnership opportunities between academics and colleagues working in healthcare, local authority or industry within the Leeds City Region.

For the Medical Technologies IKC, developing great ideas is obviously key, but we also want to develop capacity and good practice.

Our Translate workshops provide a fantastic way for researchers to make connections and get ideas flowing and we have plenty more of these planned. As well as the excitement of seeing innovative and imaginative ideas emerge from that process, these workshops are enabling people to develop new approaches to innovation.

Also important for developing capacity is our work with Leeds' Centre for Doctoral Training (CDT) in Tissue Engineering and Regenerative Medicine, another vital part of our translation pipeline (p6). All doctoral students access innovation training as part of their professional development. This feeds into the Career Transition Programme that has been enormously valuable in supporting CDT graduates into employment.

Dr Jo Dixon-Hardy
Director of Medical Technology Innovation

Tackling unmet clinical needs through Translate

Translate was launched by the Medical Technologies IKC in 2016 with the aim of establishing the Leeds City Region as a national leader in medical technology innovation.

Bringing together researchers at five regional universities with industrial and clinical colleagues, the programme, which is funded through HEFCE Catalyst funding, is developing vibrant new partnerships to tackle unmet clinical needs in areas such as assisted living technologies for dementia patients, wound care and digital health.

The goal is to create a sustainable community of partners that are committed to identifying and developing new projects. This community can then pool expertise to bring in significant funding and investment in order to grow innovation capability within the region.

The Medical Technologies IKC has appointed dedicated Technology Innovation Managers to the programme to network across the region, bring partners together and support the development of projects.

To kick-start project development in a specific area, workshops bring together academics with colleagues from the Leeds City Region Enterprise Partnership, the NHS, companies and not-for-profit organisations. Each workshop focuses on the challenges and issues around an unmet clinical need and identifies new approaches to address these. The most promising ideas are taken forward, with the support of the Technology Innovation Managers, to build a business case and look for further investment.

HIGHER EDUCATION hefce FUNDING COUNCIL FOR ENGLAND

Translate:
Realising medical technologies innovation in the Leeds City Region

CDT Innovation programmes

Students in the EPSRC Centre for Doctoral Training in Tissue Engineering and Regenerative Medicine – Innovation in Medical and Biological Engineering (CDT TERM iMBE) are developing their innovation skills through a module developed by the Medical Technologies IKC in partnership with Leeds University Business School.

The course, called 'Innovation Management in Practice', is compulsory within the CDT TERM iMBE, and is offered to students undertaking the Medical Engineering MSc. It requires students to complete a reflective dissertation on innovation practices.

In addition, the Medical Technologies IKC is supporting a two-year programme of innovation seminars, developed by Dr Claire Brockett in the School of Mechanical Engineering. Invited speakers from industry, clinical practice and academia lead the sessions, which examine case studies and stimulate discussion and debate. Current themes include understanding research and knowledge as economic drivers, and innovation in tissue engineering.

The Career Transition Programme, which students follow in Year 4, has been hugely successful in equipping students to take their higher level skills into employment. Implemented in partnership with Career Management Coach, Ruth Winden, and the CDT team (Professor Joanne Tipper, Dr Claire Brockett and Cheryl Harris), in its initial year the programme led to more than 70 per cent of final year students securing roles by the end of the programme.

EPSRC
Engineering and Physical Sciences Research Council

Forging links through Regener8

Over the past nine years, Regener8 has been forging links and partnerships among experts in regenerative medicine – initially among the N8 group of universities and UK industry and then beyond, creating a community of professionals with expertise across the field of regenerative devices.

By joining forces with Regener8, the Medical Technologies IKC is able to broaden the scope of its networking activities, creating and strengthening partnerships with world-leading scientists, translational clinicians and international industry.

"As a community, Regener8 is able to facilitate the circulation of ideas and help forge new connections between individuals and groups who are focused on bringing regenerative devices to patients," explains Professor Mike Raxworthy, Regener8 Operations Director.

Regener8 helps keep members up to date with the latest developments in the industry too, through its news service. An expertise directory, hosted on the Regener8 website, also provides a valuable signposting facility to help members connect with experts at different stages of regenerative device translation. ■

"As a community, Regener8 is able to facilitate the circulation of ideas and help forge new connections between individuals and groups who are focused on bringing regenerative devices to patients."

TRANSLATING REGENERATIVE DEVICES
Regener8

Directly implanted devices

Standard regenerative medicine involves regenerating human cells and tissues; what we're doing is providing scaffolds, made from acellular materials, that patients' own cells can grow into.

Developing directly implanted regenerative device technologies is absolutely central to the mission of the Medical Technologies IKC.

Our researchers working in this area are developing scaffolds, biomaterials and devices which enable tissue repair and regeneration. We work closely with our academic, industrial and clinical partners to select technologies with the highest potential for commercialisation and patient benefit.

Standard regenerative medicine involves regenerating human cells and tissues; what we're doing is providing scaffolds made from acellular materials that patients' own cells can grow into. This potentially makes the regulatory pathway more straightforward and enables us to bring technologies to market more quickly and cost effectively.

Directly implanted devices make up a large proportion of the research funded by the Medical Technologies IKC and we've seen some great progress in a variety of different applications.

In the past year, for example, we've seen some of our decellularised tendon devices tested successfully in pre-clinical trials and some really promising proof of concept work in the area of maxillofacial surgery.

Our pipeline of new projects is now well established and we're looking forward to seeing these develop further through the next round of Medical Technologies IKC funding.

Repairing dental decay

> "Untreated tooth decay is the number one disease globally, so the potential market for this technology is staggering."

The self-assembling peptide technology, invented and patented by the University of Leeds, and developed in partnership with Swiss-based dental technology company, Credentis, represents one of our most successful industrial co-development projects to date.

Dubbed "filling without drilling", the peptide technology repairs early dental decay and reverses tooth sensitivity by diffusing into the affected parts of the tooth forming a scaffold-like structure which attracts the building blocks of tooth enamel and dentine – calcium and phosphate – from saliva.

Marketed under the Curolox™ brand as Curodont Repair (treating decay) and Curodont D'Senz (treating sensitivity), the Swiss retail chain Migros integrated the technology into its leading toothpaste brand.

In 2015-16, the team designed, synthesised and evaluated new peptide candidates in remineralisation studies, comparing them with commercially available products, such as fluoride varnishes.

Results showed that the Leeds technology has superior remineralising properties and new patents are being filed.

"This latest work has improved the scientific and clinical understanding of the mechanism of action for the platform technology which supports the use of Credentis' Curolox™ Technology products and the concept of peptide induced enamel regeneration," says Credentis' founder, Dr Dominik Lysek. "Untreated tooth decay is the number one disease globally, so the potential market for this technology is staggering."

Although the original project has drawn to a close, the Credentis-University team are discussing future translational projects to continue the partnership.

Improving dental implant success

A new project will establish whether self-assembling peptide technology can promote bone formation to improve the success of dental implants – the artificial 'roots', usually made of titanium, that are fixed into the jawbone to support false teeth or crowns.

Although success rates for dental implants are high overall, implants in the posterior maxilla – the back of the upper jaw – are prone to failure because the position of the sinuses means that there is less bone available to house the implant.

The project hopes to improve on the outcomes of the current surgical 'sinus lift' procedure that involves making the maxilla thick enough to support an implant using bone grafts or devitalised bone chips. It will explore whether a self-assembling peptide gel combined with the bone chips can augment the implant site to accelerate bone deposition and increase success rates for implants placed in the back of the upper jaw.

Dr Julie Burke, Clinical Associate Professor and Consultant in Oral Surgery at the University of Edinburgh, leads the project alongside Leeds' Head of Oral Biology, Professor Jennifer Kirkham. Dr Burke explains: "Used on their own, bone chips have had mixed results as they can drift from the intended site. We think that the peptide gel will act as a bioactive cement to both help adhesion and promote bone formation.

"If we can establish proof of principle, the combined material may also have potential in the wider field of cranio-maxillofacial surgery, where repairing damaged bones in the head and face can be difficult without impairing function."

Acellular implants for ligament repair

Treatment for anterior cruciate ligament (ACL) injuries may require surgery to replace the ACL by using a tendon from elsewhere in the body or using donor material. There are drawbacks to both types of repair and, because of this, researchers at the University of Leeds have been investigating the use of alternatives.

A proof of concept project, supported by the Medical Technologies IKC and WELMEC, has enabled researchers to test porcine superflexor tendons, which have been 'decellularised' – a process which removes the cells from the tissue – before being implanted into sheep. The performance of the implants was monitored over six months, after which histology tests investigated how well the implanted material had regenerated.

The work complements clinical trials underway by partner company Tissue Regenix, using decellularised porcine tendons (see below).

"Based on the extremely promising results from the histology tests, we believe these types of implant have good regenerative potential, and could offer patients with ACL injuries many more active years," says Professor Eileen Ingham, of the University of Leeds' Faculty of Biological Sciences, who is leading the research.

Further research by Professor Ingham's team, on behalf of NHS Blood and Transplant Tissue and Eye Services, is investigating improvements to human donor bone-patella tendon-bone grafts, also for ACL repair. The graft has been decellularised using a similar process and tested in sheep, with similarly promising histology results. It will now be manufactured by NHSBT TES.

A world-leading partnership

Tissue Regenix is a world-leader in the development of regenerative products. It has been working with the Medical Technologies IKC since 2009 on proof of concept and co-development projects, as CEO, Antony Odell, explains.

Q: What has your partnership with the Medical Technologies IKC achieved during 2015/16?

A: We have new and ongoing projects with the University of York, developing our dCELL technology for bladder repair, with a pre-clinical study currently underway.

We finalised an agreement to establish a tissue bank in Germany which has licensed our dCELL heart valves with a view to launching them in the next few months. This year we've also presented 10-year follow-up data from our ongoing studies with partners in Brazil on the dCELL heart valves, which have shown excellent results.

In addition, we're on course to launch a tendon replacement device, again based on dCELL technology, as well as undertaking characterisation work on a meniscus device in partnership with the Medical Technologies IKC.

Q: How valuable is the relationship between Tissue Regenix and the Medical Techologies IKC?

A: We're able to work with the IKC on products at different technology readiness levels – from the early research phase onwards. Through this relationship we've been able to accelerate our product development from proof of concept to launch.

New grants awarded

Five proof of concept grants were awarded in 2016

1 STERILISING ACELLULAR GRAFTS

A collaboration with NHS Blood and Transplant Tissue and Eye Services will investigate whether a new sterilisation process they have developed could be used in human tissue grafts. Existing methods, using gamma irradiation, have been shown to affect the biomechanical properties of some donor tissues.

A team led by Professor Eileen Ingham, at the University of Leeds, will test the new process using decellularised human bone-tendon-bone grafts and evaluate its effect on the biomechanics and biology of the tissue.

2 BIORESORBABLE SCAFFOLD TO TREAT INFECTED WOUNDS

A project led by the University of Bradford's Professor Des Tobin will establish if the antimicrobial action of a bioresorbable scaffold loaded with a photosensitive agent could treat chronic, infected wounds when activated by light.

The *in vitro* tests will also determine the effect of light at defined wavelengths to decontaminate the wound and prime the wound bed for healing before the scaffold's application. The collaboration includes regenerative medicine company, Neotherix, and the NIHR WoundTec Healthcare Technology Co-operative.

3 REGENERATIVE CELLS TO PREVENT ANASTOMOTIC LEAKS

Professor David Jayne from the University of Leeds will lead a project to investigate whether regenerative cells derived from the omentum – the fatty tissue that covers the intestines and organs in the lower abdomen – can be used to prevent leaks that can occur in the connections between intestines, called anastomoses, following gastro-intestinal surgery.

Anastomotic leakage is the most significant complication after colorectal surgery and is a major cause of postoperative mortality.

4 ACELLULAR SCAFFOLD FOR BLADDER RECONSTRUCTION

Professor Jenny Southgate and colleagues will examine whether the natural biomaterial PABM (porcine acellular bladder matrix) could be useful in bladder reconstructive surgery.

PABM is produced using a decellularisation technique being commercialised by Tissue Regenix and has been successfully tested in a previous proof of concept project looking at the surgical correction of hypospadias – a common congenital urinary tract condition in boys.

5 NEW SIMULATIONS TO ASSESS TISSUE REPAIRS

A team led by Louise Jennings, Associate Professor of Medical Engineering at Leeds, is developing pre-clinical experimental simulation methods to assess the biomechanical and tribological performance of tissue repair interventions for the patellofemoral joint that are made from decellularised human or porcine materials (see p16). ■

Companion technologies

As medicine becomes more personalised, developing technologies that help clinicians understand the needs of each individual patient becomes ever more important.

The companion technologies being developed by the Medical Technologies IKC are designed to do exactly this, from developing new imaging technologies that can give rapid diagnosis of heart attack to supporting new diagnostic technologies that can detect disease biomarkers or predict a patient's likely response to treatment.

Progress in this area is particularly needed in the field of orthopaedics, where medical intervention often only happens once a joint has failed and joint replacement surgery is the only option.

Companion technologies being developed by the Medical Technologies IKC will help clinicians to understand more about a disease or a defect in the context of patients' personal circumstances, which will help them to make the right treatment decisions and offer more precise surgery.

This is particularly important when making a case for early-stage clinical intervention: with the right imaging and diagnostic tools, patients can be offered effective therapies that will enable them to heal faster and enjoy a better quality of life for longer.

Companion technologies being developed by the Medical Technologies IKC will help clinicians to understand more about a disease or a defect in the context of patients' personal circumstances, which will help them to make the right treatment decisions and offer more precise surgery.

IAP device to assist keyhole surgery

The intra-abdominal platform (IAP), a device to assist keyhole surgery in the abdomen, enables surgeons to grasp and retract tissues within the operating site, minimising the need for assistants.

Originally funded with an IKC proof of concept grant and led by surgeon Professor David Jayne from the University of Leeds and Dr Pete Culmer from the University's School of Mechanical Engineering, IAP secured £0.5m from the NIHR's i4i scheme in 2015, which aims to take proof of concept projects through to market.

The team has been working with product design consultancy, Pd-m, to rationalise the prototype design, with input from a clinical advisory group of surgeons and clinicians and a 'box trainer' has been produced to demonstrate the device.

For commercial feasibility purposes, IAP's initial prototype design concept has progressed from a complex-structured, stainless steel, reusable device to a streamlined single-use, injection moulded polymer device which can support the weight of the retracted tissues – and crucially, is much cheaper to manufacture.

"With Health Economics and manufacturing cost reports completed, we've had significant commercial interest," says Dr Culmer. "We're supporting licensing opportunities with extended testing with cadaveric models and surgical users and producing technical documentation to secure regulatory approval."

Creavo launches from quantum spin-out

A former spin-out company, set up at the University of Leeds, has flourished into a multi-award winning medical technology company, securing nearly £5m investment in the past 12 months.

Creavo Medical Technologies, previously known as Quantum Imaging, was set up to develop and commercialise diagnostic technology that could revolutionise the way the NHS diagnoses patients with suspected heart-related problems.

The underpinning technology was developed with funding and professional support from the Medical Technologies IKC. Creavo has now recruited 15 staff and opened a 5000 sq ft commercial facility in the Midlands – as well as being recognised in three national awards.

"Creavo is growing pretty rapidly now and we've made a definite transition from being a quantum physics company working in healthcare to a fully credible healthcare company," says CEO Steve Parker.

The company is set to trial its first device, Vitalscan, in a 750-strong patient study, carried out across the UK's foremost emergency department research sites. A multi-centre US study will follow, which will provide the basis for the company to launch the scanner into the market.

Further recruitment is planned during 2016 and 2017 and the company is also developing a second commercial line for the scanner, for use in cardiology departments to support research into cardiac arrhythmia. ■

Enabling technologies

World-leading simulation facilities at the University of Leeds enable us to put medical implants and devices developed in Medical Technologies IKC projects through rigorous testing before clinical trials.

We use sophisticated computer simulation techniques to both inform and test the design of surgical implants such as joint replacements, spinal implants and heart valves. Our laboratory simulators enable us to validate those models further through comprehensive physical testing. We provide rigorous long-term testing data that can predict clinical performance under a range of conditions to refine device design and ensure patient safety.

We also work closely with a number of companies developing medical devices to produce Standard Operating Procedures for testing and evaluating their technologies. Working with international collaborators, our work informs international standards development for pre-clinical simulations for implant assessment.

The Leeds joint simulation facility allows full validation of an implant, using advanced equipment that can mimic accurately the biomechanics of human joints. This provides important performance data that can be used as part of the device's regulatory compliance and can inform the need for large animal pre-clinical models.

The tissue-engineered devices we are developing within the Medical Technologies IKC have the potential to be extremely disruptive. The ability to test them in natural joint simulators that can allow for variables such as surgical positioning and can calculate the impact of that on the wear of the device is really exciting. Ultimately, it will enable us to validate a range of device solutions for the regeneration and restoration of joints and joint function – and in turn, that will allow clinicians to choose the solution that best suits each patient's specific need.

Putting replacement heart valves through their paces

Replacement heart valves that can be implanted with minimal risk of rejection or failure could benefit thousands of patients undergoing surgery in the UK each year.

Leeds researchers have devised a rigorous portfolio of tests to ensure the biomechanical performance of new types of valve is sufficient to offer patients the improved quality of life that they expect.

The new valves are taken from human donor tissue which has had all the cellular material removed – using decellularisation techniques developed at the University of Leeds.

Tests to assess both the biomechanical properties and the hydrodynamic performance of the valves were formulated by researchers in the University's Institute of Medical and Biological Engineering, in a programme funded by a Medical Technologies IKC proof of concept grant.

Working in partnership with NHS Blood and Transplant Tissue and Eye Services, the portfolio of tests has now been applied to human decellularised pulmonary and aortic valve conduits, allowing them to be fully biomechanically characterised before NHSBT TES take the valves into clinical trials.

"These types of decellularised valves could potentially overcome the limitations of current homograft valves, which degenerate over time, and produce valves with potential for growth, which would make a huge difference to younger patients," says Louise Jennings, Associate Professor of Medical Engineering at the University of Leeds.

"Producing standardised methods for testing them *in vitro* ultimately reduces risk of failure for patients. It also reduces risk for the health service and for investors – and reduces the number of animals needed in pre-clinical trials."

New tests for knee joint repair interventions

New research being carried out in the University of Leeds' joint simulation facility will enable clinicians to predict the performance of tissue repair interventions in knee joints.

The team is developing experimental simulation methods to assess the biomechanical and tribological performance of patellofemoral interventions – which repair the kneecap and thighbone joint – made from decellularised human or porcine material. Louise Jennings, Associate Professor of Medical Engineering at Leeds is leading the research. She says: "In the UK, as many as 11 per cent of men and 24 per cent of women over the age of 55 suffer from isolated patella-femoral arthritis.

"Mixed results have been reported with current interventions to repair cartilage, and this research will help ensure that new implant materials being developed for cartilage repair will be able to perform biomechanically and tribologically.

"There is currently no capability anywhere in the world to carry out rigorous pre-clinical assessments of early repair interventions in the patellofemoral joint, so this research will be a much-needed step forward."

The test is being developed for decellularised devices produced using methods developed at the University of Leeds. It is expected the assessment could also be extended to other devices made using synthetic scaffolds.

Natural knee joint models

A team led by University of Leeds Professor Ruth Wilcox has developed a computational model of the knee that takes into account the solid and liquid components of the soft tissues, including the meniscus and cartilage.

This model will enable the effects of different treatments for the knee to be examined. It will also help our industrial partner, Simulation Solutions, to develop natural knee joint simulators that can be used to test and validate regenerative devices for soft tissue repair.

The model and simulation systems are now being further developed to take into account the variation in knee anatomy from one patient to another through a Medical Technologies IKC proof of concept award. This is crucial in helping to identify which patient groups would be candidates for different treatments.

"Damage to the knee joint or surgical interventions to repair damage change how the joint functions, which can have follow on impact on the remaining soft tissue," says Professor Wilcox.

"By having a model that can take this into account, we can help ensure new devices are more effective and enable surgeons to carry out interventions as safely as possible." ■

Widening our impact

Flourishing partnerships and networks set up by the Medical Technologies IKC have established it as a national centre that is engaging with universities, industrial partners and charities across the UK.

Our expertise in translating medical technologies is one reason why we are a good match for Arthritis Research UK, the biggest funder of research into the cause, treatment and cure for all forms of arthritis in the UK.

Our expertise in translating medical technologies is one reason why we are a good match for Arthritis Research UK, the biggest funder of research into the cause, treatment and cure for all forms of arthritis in the UK.

A two-year pilot collaboration with Arthritis Research UK launched in 2014 offered proof of concept grants for applied and translational research that addressed a clear clinical need and could help improve the lives of people with arthritis.

Three projects were each awarded £100,000 from Arthritis Research UK for a maximum two-year period, and were jointly managed by both organisations.

While the IKC was able to contribute industry and scientific know-how required to move technologies towards the marketplace, Arthritis Research UK also shared its expertise in patient involvement, enabling patients to play a role in designing the technologies that will improve their lives.

"For us, it bridged the gap in our grant portfolio between fundamental research and early stage clinical trials," said Dr Sarah Odoi, Research Translation Manager at Arthritis Research UK. "The IKC team are dedicated, knowledgeable and have the right contacts in the market and we've been particularly pleased and encouraged by the partnerships with industry that the projects have had. We believe there's real momentum building with these pilot projects and the potential to see these reaching the market."

In 2016, a further £500,000 has been made available for new projects.

Healing large joint defects

Developing new methods of repairing large osteochondral defects in knee joints is drawing together veterinary scientists from the University of Cambridge and engineers from Newcastle University, with JRI Orthopaedics and GTS.

These types of large defect can be caused by osteoarthritis or through sporting injuries and affect around 2.3 million working-age people each year.

The team has developed a two-part scaffold material developed at Newcastle, made from a macro/microporous bioceramic with an integrated biopolymer surface. The device matches very closely the mechanical properties of cartilage and subchondral bone. Data taken from the patient's x-rays and CT scans is used to 3D print the implants so they fit the precise contour of the patient's joints.

Dr Frances Henson, who is leading the project in Cambridge, explains: "The deep holes caused by large osteochondral defects pass through very different types of tissue, so we need this two-part scaffold to secure the implant and encourage healing."

The team is investigating the performance of the scaffold in sheep to analyse whether the technology can progress to a 'first in man' clinical trial.

Biomimetic scaffold for cartilage repair

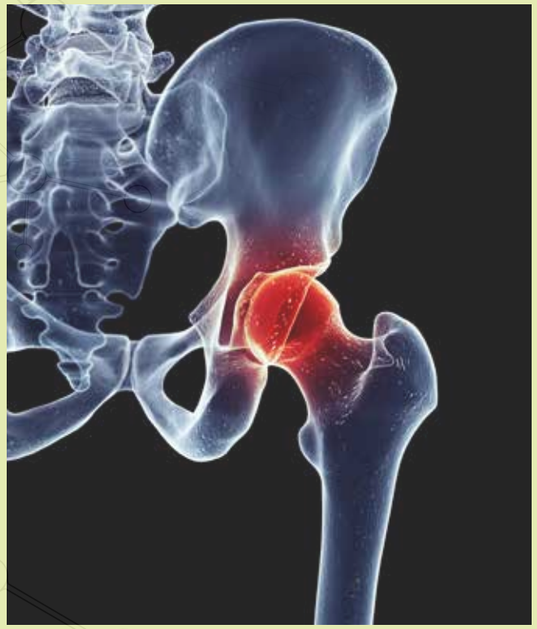
Plans are underway for a 'first in man' clinical trial of a biomimetic PLGA-titanium scaffold which aims to repair large osteochondral defects before they cause osteoarthritis.

The scaffold is being developed by a team from UCL and the Royal National Orthopaedic Hospital, in collaboration with Oxford MEStar Ltd and Collagen Solutions Plc. Early observations from an *in vivo* sheep condyle model show that the sheep recover well and long-term performance is being monitored. The scaffold was also used in a clinical dog shoulder model, in an operation performed by Channel 4's 'SuperVet', Professor Noel Fitzpatrick.

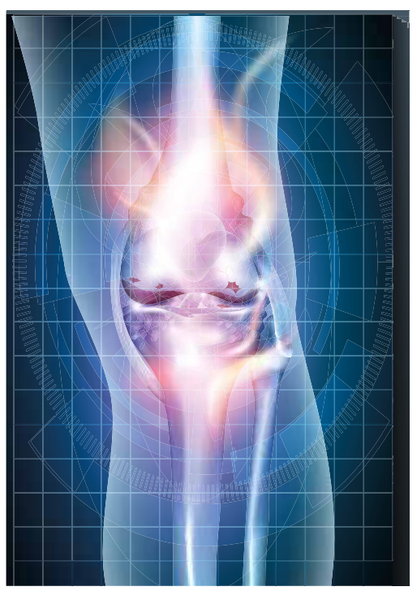
Post-operative scan results demonstrated that the scaffold has both the strength needed to bear the physical load of the joints and encourages consistent cartilage fill and a smooth articular surface.

The team is assessing the pre-clinical performance of the scaffold using human tissue from patients undergoing joint replacement surgery and is preparing for clinical trials that will take place at Royal National Orthopaedic Hospital in Stanmore.

"We're very happy with progress to date and we're confident the scaffold has the potential to address this unmet clinical need," says UCL's Dr Chaozong Liu, who leads the project.



Arthroscopic device to identify early osteoarthritis



Dr Jayesh Dudhia, from the Royal Veterinary College, together with chemists Professor Paul McMillan and Dr Steve Firth from UCL, are progressing a prototype arthroscopic device for surgeons to identify the early stages of osteoarthritis in articulating joints.

The device uses Raman spectroscopy and incorporates an optical probe to detect a known biomarker of subclinical cartilage degeneration to inform treatment decisions in real time. An early design was successfully tested in four patients undergoing minimally invasive knee assessment.

"For knee surgery, surgeons frequently perform partial replacements but these sometimes require revision surgery because it's difficult to visually identify subclinical disease elsewhere in the joint," says Dr Dudhia.

"Our probe will help to make the right decision first time, which would be better for the patient and prevent the need for remedial surgery."

Proof of concept funding has progressed validation of the technology and the team is in discussions with a UK SME whose expertise could significantly amplify the true signal from the background noise to produce a simple, quantifiable signature which can be translated into a 'traffic light' system.

The team is also discussing commercial development with a further UK SME with specialist manufacturing knowledge of orthopaedic devices.

Open sourcing and evaluation delivers new research projects

An experimental approach to assessing new project proposals using a principle of open evaluation led to a new collaboration between the Medical Technologies IKC and the Centre for Technology Innovation and Engagement at Leeds University Business School (LUBS).

The project, devised by Dr Matthew Mount and Professor Krsto Pandza, aimed to investigate the implications of opening the process of evaluation of promising research proposals to evaluators with different backgrounds, in order to make the process of innovation more responsible.

The project used an innovative IT platform provided by Codigital. The Medical Technologies IKC put out a call for proposals via its national networks. Researchers at all different levels were invited to fill in a simple online form, outlining their project.

The proposals were anonymised and reviewed independently by around 30 assessors each contributing different expertise, including legal, medical, IT, business and patient experience. Interestingly, although the assessors delivered their verdicts without consultation, they were in almost complete agreement about which projects should receive funding. The successful proposals were announced at the Medical Technologies IKC Annual Meeting.

Two projects were selected: the first, led by Dr Antonios Anastasiou, at the University of Leeds, will look at periodontal restoration using femtosecond lasers; while Dr Cheryl Miller, at the University of Sheffield, will lead a project investigating dual-action injectable bone graft substitutes for unmet clinical needs in orthopaedic and dental surgery.

"We were really intrigued by the LUBS model and it was fascinating to see it implemented," says Dr Jenny Spear, Technology Innovation Manager at the Medical Technologies IKC. "Many of the proposals we received were from early career researchers, showing there's a real need to develop new funding opportunities for these groups, as well as translational research support for the next generation of researchers."

Several of the evaluators have agreed to continue working with the researchers to further develop and shape the projects, adding a further strength to the collaborative development of science-based research projects. This unique open approach to evaluate, select and co-develop research projects could significantly increase the transparency and responsiveness of innovation. ■

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Building community

Where are they now?

The support of the Medical Technologies IKC goes beyond advancing technologies, products and services: we seek to ensure that those involved with every stage of the translational research pipeline can benefit professionally from their experience of working with us.

Our proof of concept partners have pursued a variety of fascinating career paths in the last 12 months:

Dr Helen Berry

Was: Research & Technical Manager at Tissue Regenix Ltd

Now: University Academic Fellow in Cardiovascular Regenerative Therapies & Devices, University of Leeds

"In my past roles within the University of Leeds and the spin-out company, Tissue Regenix, I was fortunate enough to directly contribute to the successful translation of a research concept through to delivery of a regulatory-approved clinical product.

The experience of working in a spin-out company, from its inception to international expansion, was invaluable in understanding translational and commercial challenges and developing partnerships. It allowed me to develop skills in new product development, establishing quality systems, managing teams, conducting collaborative research, and identifying clinical needs and potential solutions.

Working in partnership with the University kept me connected to my real passion – fundamental and applied research – prompting a return to academia when the opportunity arose. The insights and skills gained from my roles in industry will help inform the future development of regenerative devices and assist in addressing translational challenges."

Dr Hazel Fermor

Was: Post-Doctoral researcher, Institute of Medical and Biological Engineering, University of Leeds

Now: Lecturer in Musculoskeletal Regenerative Medicine, University of Leeds

"My research focus is on the development and translation of acellular scaffolds for musculoskeletal regeneration. I completed a PhD in the Faculty of Biological Sciences, developing a novel bioprocess to produce osteochondral scaffolds for cartilage repair. I undertook postdoctoral research within the same group where I had training in translation through the IKC's PGCert in Professional Innovation Management, as well as competing in – and winning – the national ChemistryYES competition. Both of these activities were encouraged and supported by the IKC.

This training, and the guidance of the Technology Innovation Managers, informed my research, increased my commercial awareness and helped direct the pre-clinical studies to advance our acellular musculoskeletal scaffold products.

My distinctive innovation expertise has allowed me to stand out from the crowd in an academic sense, enabling me to conduct research with much greater likelihood of achieving real impact. I believe it was pivotal in my recent appointment as a Lecturer in the School of Biomedical Sciences at the University."

Dr Martin Stanley

Was: Post-Doctoral researcher, Institute of Medical and Biological Engineering, University of Leeds

Now: Concept Development Engineer at Xiros Ltd

"I am now nearly a year into working at Xiros Ltd exploring new product concepts, having been a postdoctoral researcher in iMBE for 5 years. At Xiros, we develop and manufacture textiles for soft tissue repair, and I'm tasked with exploring new areas to which we can apply our manufacturing capability and skills.

My experience at iMBE was invaluable, working in multidisciplinary teams on projects in addition to my own, and having multiple opportunities to work with both industrial collaborators and clinicians on IKC-funded projects.

I also took advantage of the numerous partner conferences and Early Career Researcher meetings through Regener8, MeDe Innovation and WELMEC, to build up a network of contacts both within the University and externally, which I am now using in my new position.

I recently introduced Xiros to the IKC Proof of Concept Industry Partnership call – we're really interested in this as a means of establishing new collaborative projects with groups at the University."

Bringing patient involvement into the lab

Medical engineer, Dr Claire Brockett, a University Academic Fellow in iMBE has recently been awarded a one-year University Engagement Excellence Fellowship. Here she tells us about her plans for public and patient engagement, and why she believes it's crucial to her research.

What made you apply for a Fellowship?

I took part in an 'Ask the Researcher' event, at Chapel Allerton Hospital organised by Leeds Musculoskeletal Biomedical Research Unit (LMBRU). It became clear during the event that there was a real disconnect between me as a lab researcher and the patients: I wasn't asking the right questions and they had little idea about what went on in the lab. They thought 'involvement in research' was just about signing up for clinical trials and weren't aware that they could help inform the research at an earlier stage too. It was a bit of a 'light bulb moment' for me.

Why is it important for you to engage with patients?

When we're working in the lab it's easy to forget the end user – but patients are the experts in their condition! They know what the problems are, how much pain they're in and what they can and can't do. As medical engineers, we strive to develop solutions to challenges and we have input from industry and clinicians to facilitate design and development, but it's the patients themselves who know what they want from it, and this perspective is really important.

As engineers, we might consider an ankle replacement that only lasts seven years as underperforming, compared with knee and hip replacements that last for much longer – but the patient may be delighted that they've had seven years of pain-free function and movement. Of course we want to keep improving, but we need to embrace the fact that the patient is benefiting and we don't always need to go back to the drawing board.

What are your plans for this Fellowship year?

I'm going to be organising lab tours through LMBRU's patient networks so that they can see what happens in the lab and how new products are designed and tested. I hope that this more open approach will give them more confidence in technologies that are coming through and that they appreciate that they can influence research ideas and new product development.

They'll also meet my PhD students, so the next generation of researchers will also learn to engage with patients, and I believe this experience will make them more rounded researchers as their careers develop. ■

Annual conference

Building the Regenerative Devices Industry – the IKC and Regener8's first partnered annual event.

2016 marked the first IKC conference – partnered with Regener8 – bringing together project partners from across the sector to share best practice in translating regenerative devices. The event was held in Leeds in July 2016.

Four things we learned from this year's annual conference:

1

LASER-BASED TECHNIQUES CAN BE USED TO GENERATE HIGHLY PRECISE 3D SCAFFOLDS WITH SUB-MICRON RESOLUTION, AND FOR PRINTING BIOLOGICAL CELLS INTO 3D PATTERNS.

Professor Boris Chichkov, from the Nanotechnology Department at Laser Zentrum Hannover, delivered a keynote presentation on the application of physics to regenerative medicine, focussing on his interest in the latest laser technologies for the production of implants, tissue engineering, and regenerative medicine.

2

INJURIES AS A RESULT OF SEVERE TRAUMA, BOTH MILITARY AND CIVILIAN, MAY PROVIDE A NEW CHALLENGE TO ESTABLISHED REGENERATIVE MEDICINE RESEARCH PROGRAMMES

Through the event's community-sourced call for submissions, the Medical Technologies IKC invited the Defence Science and Technology Laboratory (Dstl) of the UK Ministry of Defence to lead a session on 'Regenerative medicine on the frontline'. Innovations in regenerative medicine have the potential to generate novel solutions for battlefield interventions and the medical needs of Service personnel with life-changing injuries. The session received excellent acclaim from delegates.

3

ONE-MINUTE PITCHES FROM EARLY CAREER RESEARCHERS OPEN THE OPPORTUNITY FOR A LIVELY NETWORKING LUNCH AND DEBATE

Fourteen postdoctoral and PhD researchers presented projects as one-minute pitches to the conference auditorium before taking questions from delegates.

Ben Golland, a PhD student from the Centre for Doctoral Training in Tissue Engineering and Regenerative Medicine, said: "The pitches gave me the opportunity to let the whole room know about my work, rather than relying on them to visit my poster. My project is in its early stages, so it was useful to hear a range of opinions about my approaches from different stakeholders."

4

THE IKC IS LEADING IN SUCCESSFUL INNOVATION IN REGENERATIVE DEVICES

The event also included six team presentations from Medical Technologies IKC partners and supported academics and their collaborators, updating delegates on progress in their proof of concept projects moving closer to market. We were reminded of the importance of collaboration and of networking to discover potential project partners and access expertise from our community in order to realise these innovations.

Fiona Kingscott

IP & Contracts Manager for Medical Technologies

Specialisms

- Intellectual property
- Contract and commercial law
- Project management

Jenny Spear

Technology Innovation Manager, IKC

Specialisms

- Commercial product development management
- Biomedical engineering
- Funding development

Mike Raxworthy

Operations Director, Regener8

Specialisms

- Medical device translation
- Understanding the regenerative medicine landscape
- Industry and clinical needs in innovation process

Danielle Miles

Technology Innovation Manager, Translate

Specialisms

- Translational biomedical research
- Medical technology regulations
- Technology scouting and development

Meet the team

Our people, working with our partners, provide the foundations for our success.

Our technology innovation and programme support team bring specialist skills and know-how to progress technologies and develop innovation capability across our portfolio of programmes.

See more of our team overleaf.

Jo Dixon-Hardy

Director of Medical Technology Innovation

Specialisms

- Strategic and operational project leadership
- Innovation process and capability development
- ECR career progression support

Graeme Howling

Technology Innovation Manager, IKC

Specialisms

- Medical device development
- Regenerative therapies and devices
- Technical project management

Sean Clarkson

Technology Innovation Manager, Translate

Specialisms

- User-led medical technology development
- Project and business planning
- Academic innovation skills and capability development

MEET THE TEAM

Jane Wilcox

Reporting Manager for Medical Technologies

Specialisms
- Reporting architecture
- Specialist database expertise
- Management of data intelligence

David Moore

Communications and Engagement Assistant for IKC and Translate

Specialisms
- Web development
- Copywriting
- Campaign communications

Rowan Grant

Communications and Engagement Manager for Medical Technologies

Specialisms
- Creative communications
- Community marketing
- Marketing planning

Kelly Broadbent

Project Administrator for MeDe Innovation

Specialisms
- Event co-ordination
- ECR forum engagement
- Cross-centre communications

Beverley Croft

Team Secretary for Medical Technologies

Specialisms
- Committee servicing
- PA to Directors
- Customer service

ACKNOWLEDGEMENTS

Our work would not be possible without our External Advisory Board of global leaders in medical technology innovation. The EAB provides us with academic, industrial, clinical, investment and regulatory perspectives, and their insights shape and steer the strategic direction of our programmes.

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Medical Technologies

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