UNIVERSITY OF Southampton

PRODUCT DEVELOPMENT AND RESEARCH FOR STRONGER, ACTIVE BODIES. FORTISNET

The global musculoskeletal health challenge

Welcome advances in medicine mean that we are living longer, but with an increased burden of age-related diseases and associated reductions in quality of life. The clinical problem is significant; for example, bone fractures alone cost the European economy €17 billion and the US economy $20 billion each year; the numbers of hip fractures worldwide will increase from 1.7 million in 1990 to 6.3 million in 2050. Diabetic amputations have increased to 7,000 per year in the UK, an estimated 40,000 in India and over 70,000 in the USA. Almost 300 service personnel suffered traumatic limb loss in recent UK military operations in the Middle East, with over a third involving significant multiple amputations. Amputees will require sophisticated rehabilitation and, even with modern medicine, specialised care for years to come. Meanwhile, in many lower and middle income countries there is limited access to orthopaedic surgery, modern prosthetics or assistive technologies, so we must develop intelligent low-cost solutions to meet those needs.

Healthcare resources are becoming more limited, with a predicted NHS funding gap of £10 - 30 billion by 2020, yet an ever increasing demand for quality of care. Innovative use of technologies can offer solutions to challenges in musculoskeletal health. Typically however, the journey to implementation is slow, for example around 17 years within the NHS.

By bringing experts from different disciplines together at the earliest stages to truly understand and work on these challenges collaboratively, we can reduce the cost of research and development, increase the speed to market, improve technology adoption and become a unique body of expertise that is much greater than the sum of its parts.

FortisNet

The University of Southampton Institute for Life Sciences launched FortisNet ('fortis' meaning strong) in 2016: an interdisciplinary and vocational network to transform musculoskeletal health, with capabilities in regenerative medicine, orthopaedics, prosthetics and orthotics, rehabilitation and assistive technologies, epidemiology and clinical trial design.

The aim of the network is to lead the world in the development of products and services for enhanced musculoskeletal health. By doing this we aim to improve lives, attract new businesses to our region and create jobs for our skilled graduates.

Strength through Collaboration

FortisNet promotes a collaborative and interdisciplinary approach to solving musculoskeletal challenges. We actively encourage and catalyse research projects that connect clinicians, enterprise, the end-users of research and academic researchers, so that our research clearly serves clinical, end-user and market needs.

FortisNet Members

Led by Professor of Musculoskeletal Health, Jo Adams, and supported by a steering group of leading academic, clinical, patient and industry experts, FortisNet started in 2016 as a local network of over 70 researchers and clinicians at the University of Southampton and University Hospital Southampton NHS Foundation Trust. We have since been joined by experts from UK universities, hospitals, industry, local government, defence organisations, health networks and the people our research is intended to serve. We offer access to a world class partnership and energised community:

Over 130 researchers from over 20 universities, 50 businesses, 12 healthcare providers and 15 stakeholders have participated in FortisNet events and activities since 2016.

FortisNet Activities

We host a programme of events and activities to catalyse collaborative research to address challenges in musculoskeletal health. We provide an informal and stimulating environment to bring people with different insights and skills together. We actively pursue opportunities to support network activities and the translational pipeline.

> "No single group or research team has all the expertise. The problems users face are so complex and multifaceted that we really need to pull in all the expertise for the delivery of new technology."

Dr David Moser
Head of Research, Chas A Blatchford & Sons

CASE STUDIES

COMPONENTS

Growing cartilage-like tissue in the lab using human bone stem cells.

Cartilage covers the surface of joints where they meet, acting as a shock absorber and allowing smooth movement of the bones. It does not heal easily when damaged through injury or wear and tear, which can lead to joint pain and stiffness. Our researchers are pioneering work to grow and characterise effective engineered cartilage from a patient's own stem cells.

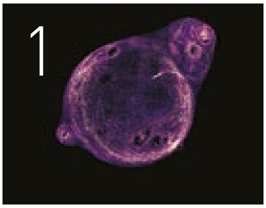

Image courtesy of Dr Catarina Moura, Dr Rahul Tare, Professor Sumeet Mahajan and Professor Richard Oreffo, University of Southampton.

Understanding how to design better implant materials.

Many biomaterials that are implanted in the body don't work as well as they should. Researchers from the University of Southampton, working with colleagues at the University of Iowa in the USA, have shown how human cells 'feel' how soft or stiff biomedical materials are by working together as teams. Research suggests that the hardness of the biomaterial will affect how well the cells around an implanted material will work. This has important implications for the design of future implants, like hip replacements.

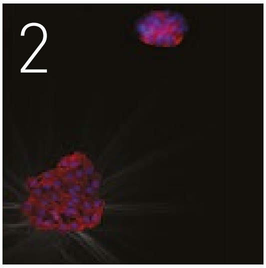

Image courtesy of Dr Nick Evans and Camelia Tusan, University of Southampton.

Imaging to understand how to improve blood supply to ageing bone.

Using X-rays generated by a synchrotron, extremely high levels of detail can be revealed in bone structure and its blood supply. This helps our researchers to understand the differences in blood supply and structure between healthy and osteoporotic bone. A reduced blood supply is linked to thinning bone and increased fracture risk. Understanding the reasons underlying this will pave the way for new therapies to prevent bone loss during ageing.

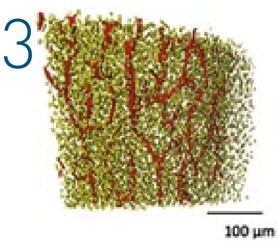

Image courtesy of Dr Juan Núñez, Dr Philipp Schneider, Dr Claire Clarkin, University of Southampton (Figure adapted from Eur Cell Mater 35:281-99, 2018).

LIMBS

Keeping people physically active for longer, by understanding the complexity of arthritis in the feet through research and education.

Images courtesy of Professor Cathy Bowen, Dr Lucy Gates and Dr Charlotte Dando, University of Southampton.

People who do not walk well are much more vulnerable to other problems such as weight gain or lessened resilience to chronic conditions such as heart disease and social isolation. Research at the University of Southampton funded by the National Institute of Health Research involves the investigation of foot pain and pathologies associated with musculoskeletal disease. From this we have advanced knowledge and understanding of foot pathologies and how they markedly contribute to the morbidity associated with musculoskeletal diseases due to the wide range of articular and extra-articular complaints that can occur. With investment from FortisNet, in partnership with a local 3D print company, SO3D and business partner, Cynapse Ltd, we are developing and testing an innovative insole, the Spidersole™. The innovative lightweight design of the Spidersole™ has the potential to be embedded within mass market footwear to provide comfort for foot joints affected by arthritis.

See case study 5 overleaf.

Added Value of FortisNet

Since 2016, we have invested funds from the Engineering and Physical Sciences Research Council, Wessex Academic Health Science Network, the Higher Education Innovation Fund and the University of Southampton in 40 new projects and 11 studentships in musculoskeletal health, involving 15 university collaborations, 35 business partnerships, 11 healthcare organisations and 5 stakeholders. To date there has been a 20-fold return on investment, yielding over £3,000,000 in new research funding. FortisNet has helped development of two new technologies towards patent application, the formation of 2 spin-out companies, and numerous business-business interactions. Our Patient and Public Involvement in Research representatives have provided the inspiration and stimulus for new technology development and have been instrumental in shaping a successful Fellowship application for an early career researcher.

How to get involved

We welcome new members. If you are a researcher, clinician, member of the public, charity, donor, policy maker or work in industry; if you share our collegiate, interdisciplinary vision and want to help shape the future of musculoskeletal research, please contact **IfLSAdmin@southampton.ac.uk** for more information.

Prosthetics services are a means to an end. FortisNet partner NGO Exceed Worldwide also provide community support like small business training, which enables people with disabilities to live more independently.

LIMBS

Working in partnership with clinicians and communities to improve access to prosthetics and orthotics in Cambodia.

Robust prosthetics are available for harsh environments, such as agricultural work (left). Residual limb tissues go through considerable biomechanical adaptation in response to prosthetic limb loading (right). Images courtesy of Dr Alex Dickinson, Dr Peter Worsley, Dr Maggie Donovan-Hall and Dr Cheryl Metcalf, University of Southampton.

About 100 million people worldwide need prosthetics (artificial limbs) or orthotic devices (braces and splints), but an estimated 80% to 90% of those do not have access to prosthetic and orthotic services. The higher incidence of traumatic amputations in lower and middle income countries (caused by accidents, conflict and landmines) means patients are typically younger, with more physically active years ahead of them, than users in more economically developed countries, for whom most prosthetics technology has been developed. A large interdisciplinary team led by University of Southampton is investigating digital measurement tools to assess a user's residual limb anatomy, biomechanics of gait, typical daily prosthetic limb use, and health status. They are also developing a portable digital case note system delivered through a robust and secure IT network for travelling prosthetists to visit remote communities where people cannot afford to travel for healthcare. Key to the project is a user-led model of work with our partners in Cambodia as co-researchers, where the prosthetists, physiotherapists, community workers and patients themselves are involved in directing the technical work. The project is funded by the Engineering and Physical Sciences Research Council and the National Institute of Health Research through the Global Challenges Research Fund.

By working in close partnership with communities in Cambodia, interdisciplinary teams are together developing digital solutions to improve access to prosthetics and orthotics healthcare. People living in remote communities may depend upon their prosthetics or orthotics to be able to earn a living, yet often cannot afford time away from work to travel into cities for treatment.

Improving the function and control of myoelectric prostheses in children.

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Image courtesy of Professor Liudi Jiang, University of Southampton.

Myoelectric arms are controlled by electrodes that are usually fixed within the prosthetic interface, called the socket. These electrodes require close, secure contact against the skin of the child's residual limb to operate efficiently. Prosthetic sockets for children often last only a few months before they become too tight. When a new socket is made, with a small amount of growing room, the electrode may be too loose to work the hand effectively. Funded by the NIHR Devices for Dignity MedTech Cooperative (the StarWorks initiative), researchers from the Universities of Salford (lead University) and Southampton are developing a user-friendly, adjustable device to help optimise the contact, with a view to providing better levels of prosthesis control for the child.

Improving the assessment of how well patients can move their body after stroke.

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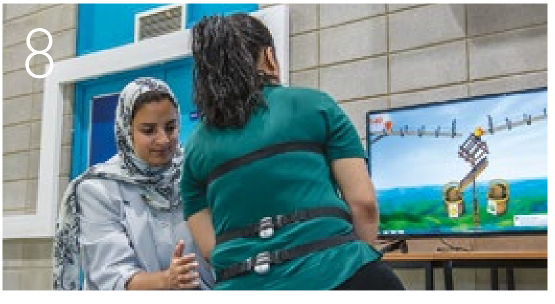

Image courtesy of Norah Alhwoaimel, Dr Ruth Turk and Dr Ann-Marie Hughes, University of Southampton.

Trunk control and balance problems are common in stroke survivors and these can impair everyday activities, for example when leaning sideways to grasp a salt holder from the other side of a table. Many studies have shown that stroke survivors use extra trunk movements when using their arms to reach. If this extra compensatory movement during reaching continues for a long time, it may also lead to abnormal arm and hand movement, which may limit recovery in the longer term. Therapists often use the Trunk Impairment Scale (TIS) to assess trunk control. People with stroke are asked to do 17 tasks including static sitting, dynamic sitting and trunk coordination. University of Southampton researchers are currently testing if we can make it easier and faster to assess trunk control using an instrumented TIS (iTIS). This involves placing three wearable sensors on the chest and lower spine.

INDIVIDUAL

Wearable e-textiles to ease pain in people experiencing osteoarthritis.

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Images courtesy of Dr Kai Yang, University of Southampton.

The number of people in the UK with knees affected by osteoarthritis is expected to reach 6.5 million by 2020. In partnership with patients, industry and clinicians, a Fellowship project funded by the Engineering and Physical Sciences Research Council is developing cutting-edge electronic textiles for wearable therapeutics, where dry electrodes printed on everyday clothing fabric can deliver a small electrical current to interfere with the pain signals and stimulate the release of the body's natural endorphins, easing the pain.

Monitoring astronauts' muscle health during and after space flight.

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Image courtesy of the European Space Agency, Prof Dieter Blottner (Centre for Space Medicine Berlin), and Prof Maria Stokes, Paul Muckelt and Dr Martin Warner, University of Southampton.

The European Space Agency Myotones Project (with funding from the UK Space Agency) aims to document the changes that occur in astronauts' muscles during their six-month stay on the International Space Station. The loss of skeletal muscle mass and strength is a well-known side-effect of space travel, despite intensive daily exercise, but the ability to test muscles during an actual mission had until now been limited by lack of appropriate equipment. The Myotones Project involves novel use of compact technology that enables direct non-invasive testing of muscles in a confined and weightless (termed microgravity) environment. The technologies include a hand-held device to measure muscle tone (MyotonPRO) and an ultrasound scanner to measure muscle and fat thickness. The lessons learnt will help develop effective exercise programmes for people on Earth living with musculoskeletal and neurological disorders, as well as help reduce the effects of ageing.

FortisNet Interdisciplinary Collaborative Research

Economic Development

We aim to develop a regional specialisation in regenerative biology, orthopaedics, prosthetics and assistive technologies that will create jobs, attract new businesses and retain our skilled graduates in the region.

Product development and research for stronger, active bodies

We offer new opportunities in clinical research and practice, and product development, and the opportunity to work in a unique clinical environment that combines cutting edge surgery with regenerative medicine, bioengineering and rehabilitation.

Training the next generation of interdisciplinary scientists and engineers

We believe the greatest advances in addressing societies' problems will be made at the interface between disciplines. Through investment in interdisciplinary studentships, we are working to dissolve the boundaries between traditional ways of thinking, to create a new generation of life scientists and engineers.

Virtuous circle of product development

We connect clinicians, researchers, enterprise and the people our research is intended to serve, to ensure that our work in musculoskeletal health can be applied with maximum impact in the home, clinic and marketplace.

Find out more:
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