

Harnessing clinical and surgical expertise to guide a rapidly changing landscape in foot and ankle biomechanics

A/Prof Luke Kelly

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Getting started

The screenshot shows a social media-style interface with a blue background. At the top left, the word "Opener" is displayed in white, followed by a plus sign and three dots. Below this, there are three white rounded rectangular cards, each representing a pinned post. Each card has a grey header with a pin icon and the word "Pinned". The first card contains the text "Where does biomechanics fit within daily clinical practice for Podiatric Surgeons?" and has a heart icon with a zero and a comment icon with a zero at the bottom. The second card contains the text "How are a patient's individual structure and function considered in context of aetiology, management via restoration/repair, and treatment outcomes?" and also has a heart icon with a zero and a comment icon with a zero at the bottom. The third card contains the text "How do you measure biomechanics in clinical/surgical practice?" and has a heart icon with a zero and a comment icon with a zero at the bottom. Each card also has a three-dot menu icon in the top right corner.

The past, present and shaping the future

Biomechanics: the past, the present and shaping the future

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BIOLOGICAL REVIEWS
Cambridge Philosophical Society

Chasing footprints in time – reframing our understanding of human foot function in the context of current evidence and emerging insights

Anja-Verena Behling^{1,2,*}, Michael J. Rainbow³, Lauren Welte³ and Luke Kelly¹

¹School of Human Movement and Nutrition Science, The University of Queensland, St. Lucia, Queensland 4067, Australia
²Department of Mechanical and Material Engineering, Queen's University, 130 Stuart Street, Kingston, Ontario K7L 3N6, Canada
³Department of Mechanical Engineering, University of Wisconsin-Madison, 1517 University Ave, Madison, WI 53706, USA

ABSTRACT

In this narrative review we evaluate foundational biomechanical theories of human foot function in light of new data acquired with technology that was not available to early researchers. The formulation and perpetuation of early theories about foot function largely involved scientists who were medically trained with an interest in podiatry/orthopedology, driven by a desire to understand human foot pathologies. Early observations of people with flat feet and foot pain were similar to those of our primate ancestors, with the concept of flat feet being a primitive trait, which was a driving influence on early biomechanics research. We describe the early emergence of the mobile/adapted rigid lever theory, which led to most biomechanical theories of human foot function. Many of these theories attempt to explain how a pre-existing behaviour of the foot enables forward propulsion. Interestingly, none of the subsequent theories have

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If we can break down the technology barriers, how can high-fidelity biomechanics improve clinical practice and outcomes?

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Improved diagnostics and monitoring?

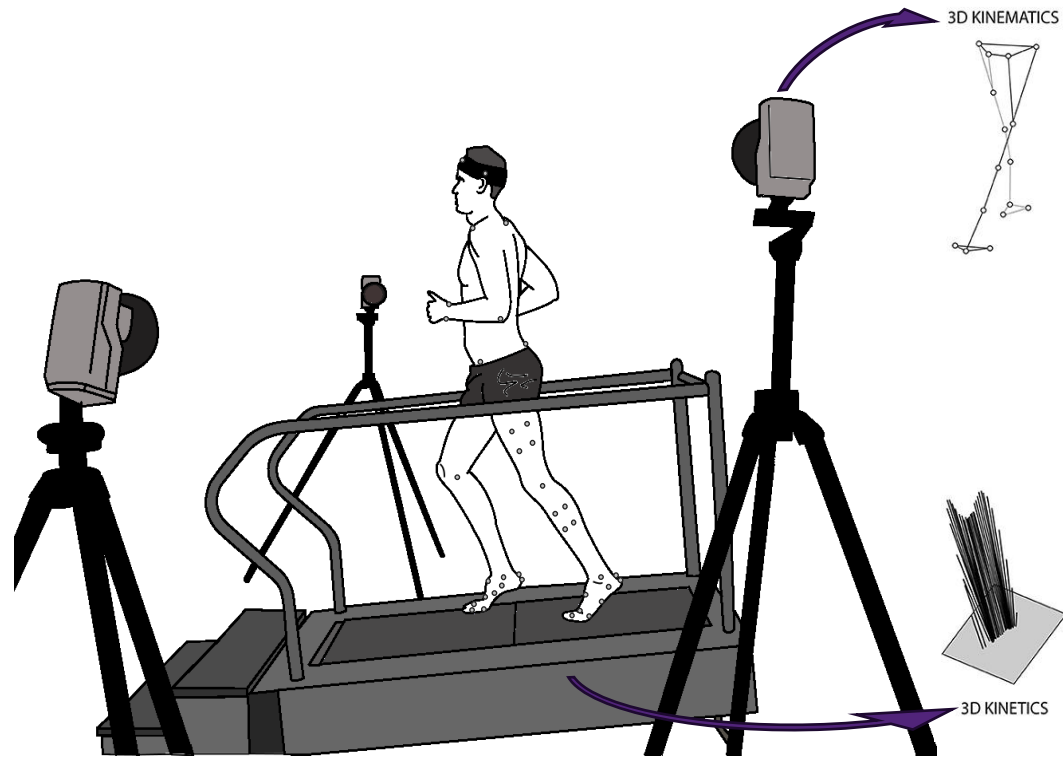
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Improved surgical planning?

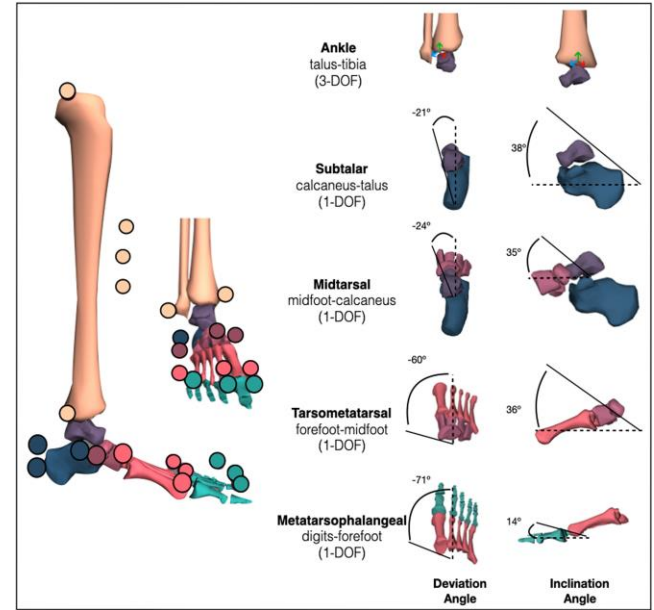
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The past, present and future of foot biomechanics

Musculoskeletal foot models



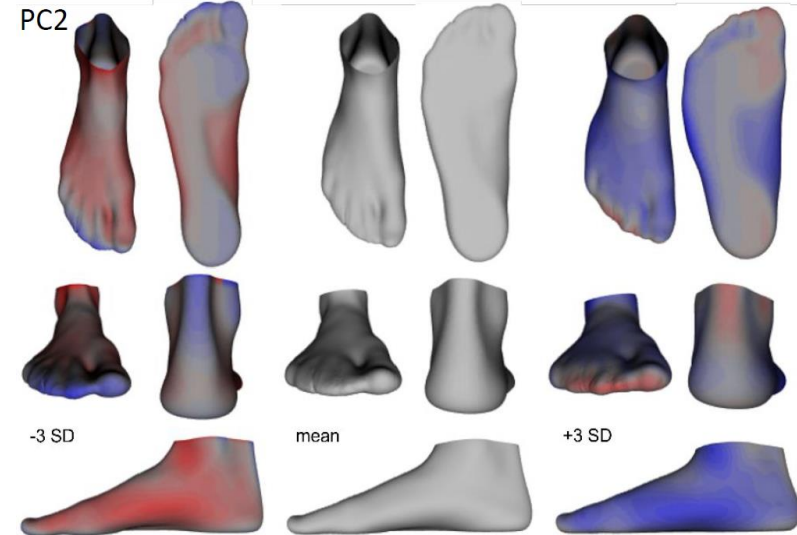
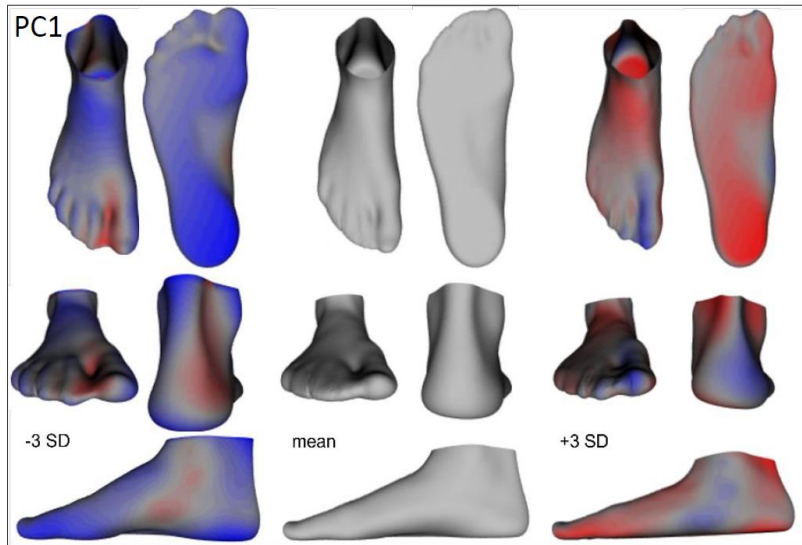
OpenSim



Maharaj et al. (2022)

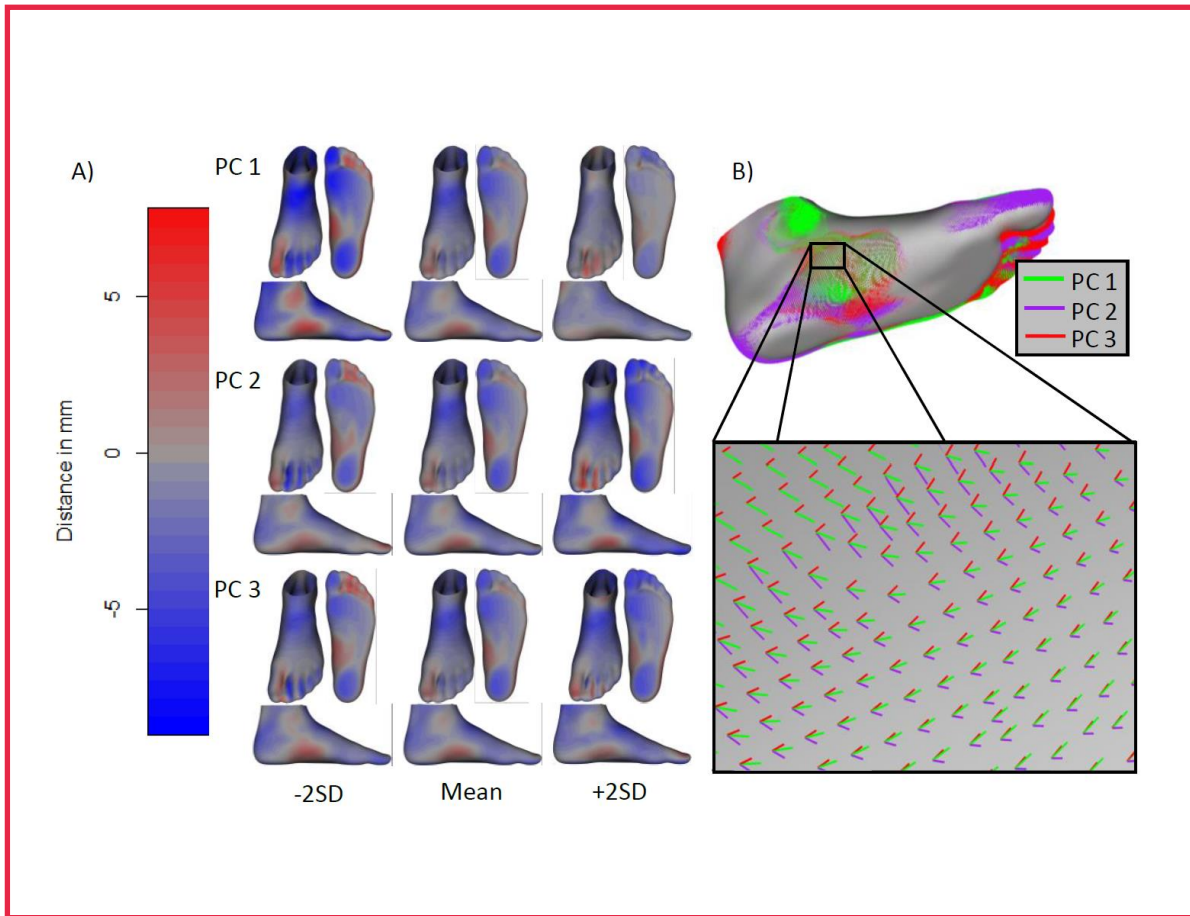
How does the shape of our feet influence function?

Quantifying external foot shape – Statistical Shape Modelling



Robert Schuster

How do feet change shape? - Foot shape deformation modelling



Contents lists available at ScienceDirect

Journal of Biomechanics

journal homepage: www.elsevier.com/locate/jbiomech
www.JBiomech.com

Reliability and quality of statistical shape and deformation models constructed from optical foot scans

Robert Wolfgang Schuster*, Andrew Cresswell, Luke Kelly

School of Human Movement & Nutrition Sciences, The University of Queensland, Australia

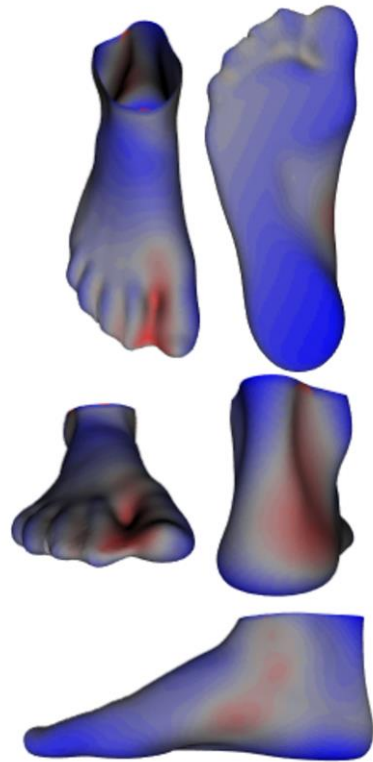
Check for updates



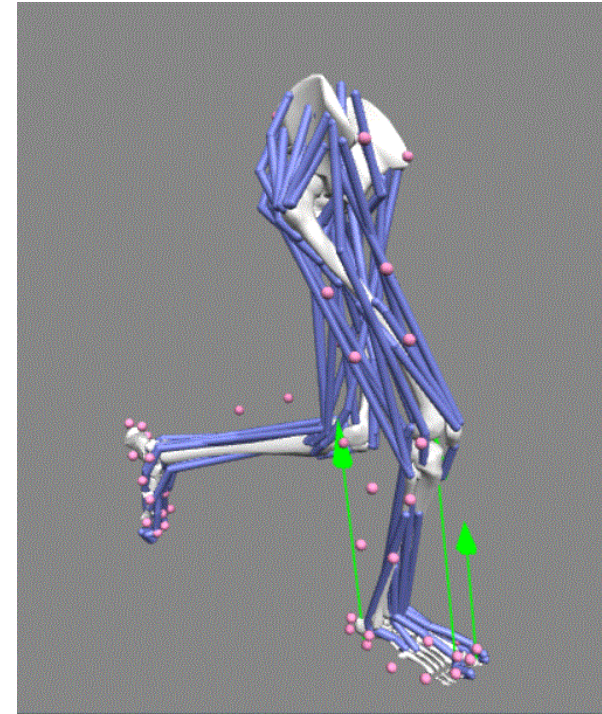
Robert Schuster

Predicting complex function from shape data

Does Foot Shape Matter? – Predicting foot function from external foot shape

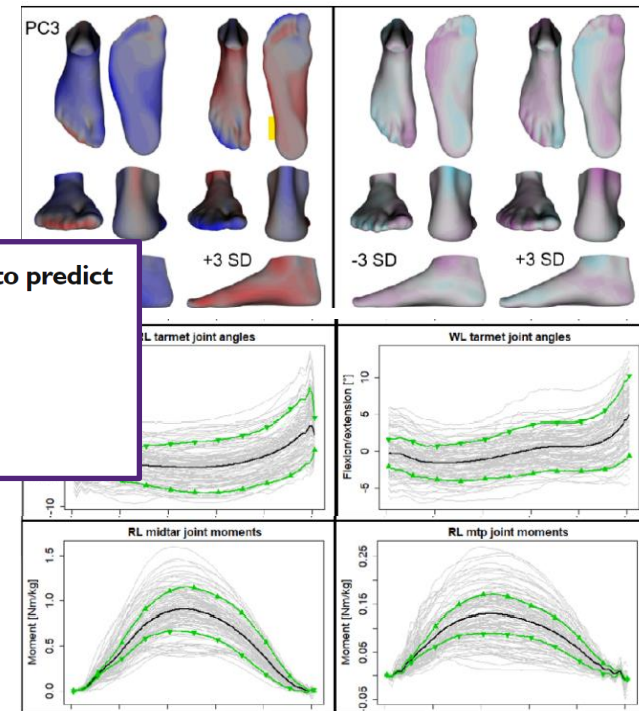


Predictive Models



Predicting complex function from shape data

Does Foot Shape Matter? – Predicting foot function from external foot shape



Foot form and function: Variable and versatile, yet sufficiently related to predict one from the other

Robert W. Schuster, Andrew Cresswell, Luke A. Kelly
 doi: <https://doi.org/10.1101/2022.10.02.510569>
 This article is a preprint and has not been certified by peer review [what does this mean?].



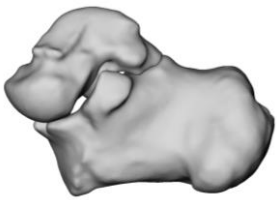
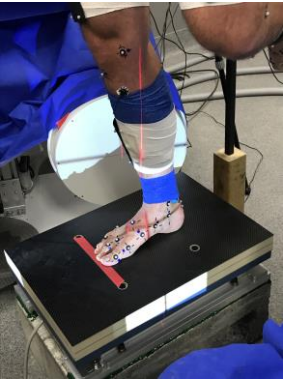
Non-invasive high-resolution foot biomechanics

Biplanar Video-radiography

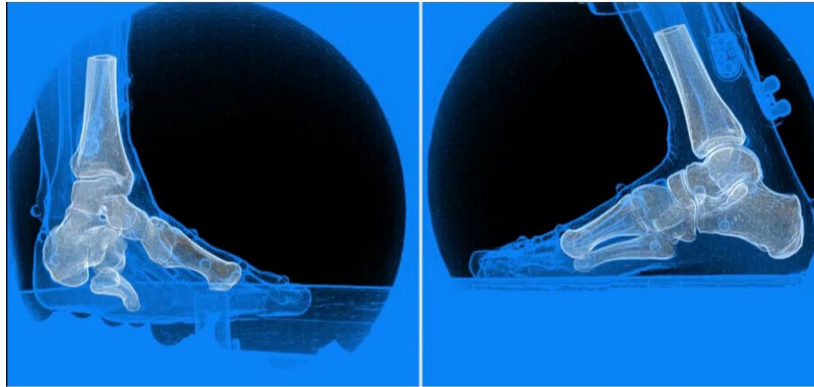


A/Prof Michael Rainbow
Queens University

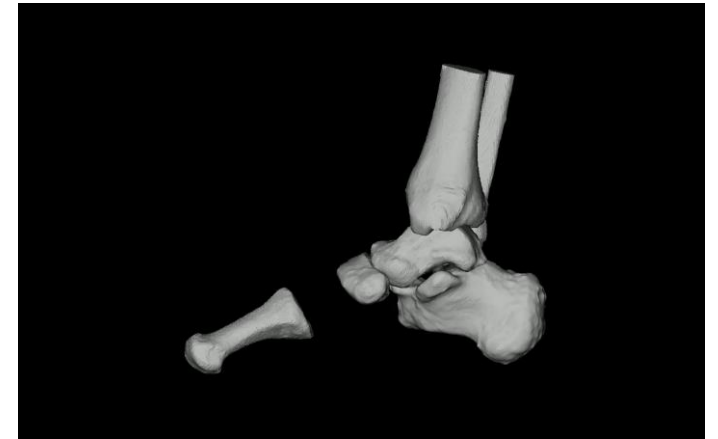
BVR Data



3D Bone models



Align bone models to x-ray data



Dynamic 3D bone reconstructions

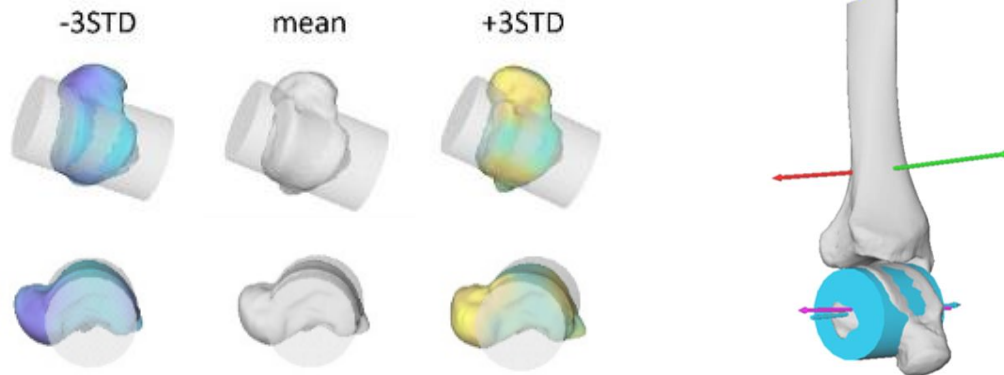
Non-invasive high-resolution foot biomechanics



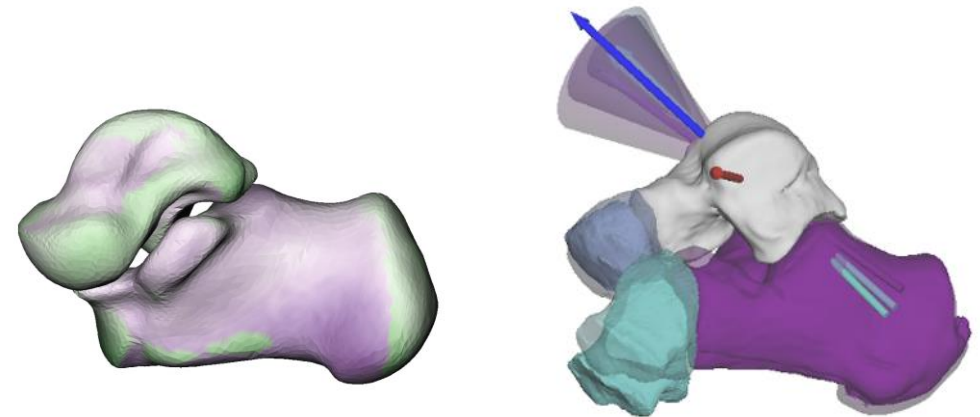
A/Prof Michael Rainbow
Queens University

Combining shape models with BVR to understand subject specific function

Talocrural joint



Subtalar and midtarsal joints

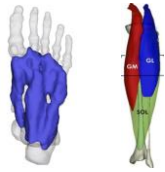


What's in the future?

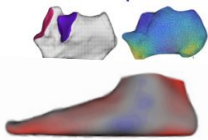
Innovative technologies to enable precision clinical care

Subject specific data

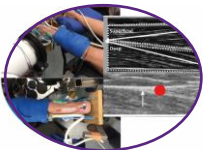
Muscle size



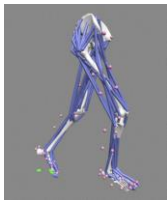
Shape & deformity



Material properties (stiffness)



Motion

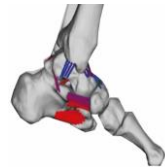


Physics based models

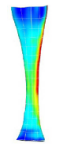
Time intensive data collection

Quantify individual tissue loads

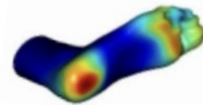
Joint Loading



Tendon strain



Soft tissue stress



AI informed models

Reduce complexity of data capture to enable clinical use

Precision Clinical Measurements

Treat to target model for clinical practice



Precision surgical simulations

In-silico simulations to predict surgical outcomes



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Improved surgical planning?

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Where can research and development have the greatest impact for your practice?

What are your priorities? Where should research teams invest their energy to deliver the greatest impact?

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Journal of Foot and Ankle Research
2023 | 16:32
https://doi.org/10.1186/s13047-023-00629-9

RESEARCH Open Access

Research priority setting in UK podiatric surgery

Lesley Prosmak¹, Robyn L. Carter-Wale², Kerry Clark³, Lorna Danson⁴, Jill Halstead⁵, Natalie Lennox⁶ and Helen Milnes⁷

Abstract
Evidence-based practice provides the foundation for high quality patient care, and in the NHS, research is seen as vital to enable service transformation and improve outcomes. Research is one of the four pillars of enhanced and advanced clinical practice and is therefore a fundamental part of podiatric surgery services. In order to meet the UK health research strategies, the most recent being 'Saving and Improving Lives: The Future of UK Clinical Research Delivery (2021)', the Faculty of Podiatric Surgery in the UK agreed to support the development of research priorities in order to inform a future research strategy.
The Podiatric Surgery Research Strategy Group was set up and embarked on a project with the aim of engaging its members in formulating and agreeing national research priorities. The initial stage included a national research scoping survey to identify key themes, topics, and research questions. The final stage consisted of developing and evaluating research topics that met the agreement criteria were: 1. Surgical treatment – forefoot, 2. Patient reported outcomes, 3. Post-operative management, 4. Surgical treatment – midfoot and 5. Service delivery. The top 5 research topics that met the criteria were: 1. How does quality of life improve following elective foot surgery? 2.

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Research priority setting for UK podiatric surgery

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Top five research topics

1. Surgical treatment – forefoot
2. Patient reported outcome measures
3. Post-operative management
4. Surgical treatment – midfoot
5. Service delivery.

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Top 5 Research Questions

4. What is the most effective Lapidus fixation option?

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