Joint replacement is now the largest surgical cost to the NHS, and to other healthcare providers in the developed world. Hospital managers are faced with tough decisions - they have to reduce costs, but in choosing where to wield their knife, they need information. Which treatments are relatively expensive and less effective, and which are excellent value? Easy questions to answer, one might think, but there are many factors to take into consideration:

People are living longer, with ever higher expectations of maintaining a quality of life, which puts pressure on the health service. Joint replacement continues to grow steadily, with over 180,000 hip and knee replacements carried out last year in England and Wales alone, old and young alike.

The National Joint Registry (NJR), which monitors the types of surgery carried out, only reports their success rates in terms of revision surgery. Oddly it counts death as a success, and a patient who lives in pain but without revision is also a success, while if a patient has a problem that can be fixed, that is a failure. This has led them to conclude that the small operation of partial knee replacement is not cost effective.

Implant manufacturers, which are often huge multi-national companies, are all competing for market share and negotiating contracts with hospitals one at a time. Their profit margins are substantial.

The team in the MSk Lab have been looking into 3 different aspects of the economic burden that OA puts on the NHS and how this can be reduced: the way that companies tender for implant prices, the relative cost of partial and total knee replacements, and the cost of the instrumentation and inventory associated with each operation.

Alvin Chen has been examining the health economics of knee replacement surgery for his thesis. In 2010, the cost of all the total hip and knee replacements in the NHS was £852 million. The cost of hip and knee replacements varies considerably from trust to trust. He estimates that savings of as much as £35 million could be achieved by reducing variability in pricing of implants alone.

Barry Andrews compared the relative costs of total knee replacements and uni-knee replacements using data from our NJR, and registries around the world. Barry's in-depth analysis took the lifetime costs into consideration, as well as risks of death and revision surgery. He concluded that uni-knee arthroplasty is a more cost effective option in the long-term, being cheaper, safer, and resulting in superior outcomes. If the procedure was adopted as standard practice, savings of as much as £500,000 a year could be realised in each hospital, or £20m a year for the NHS. For this to happen, registries will have to change their views on 'the appropriate procedure to carry out' while surgeons will have to adapt to a more conservative way of thinking about joint surgery.

There have been other examples of changes like this: only 25 years ago, all women faced mastectomy, or even radical mastectomy as part of their treatment, while now they can often avoid that distress with no cost to their health. But the change took a great deal of effort. In the knee, while cancer is not the problem, there is a huge industrial complex of companies, hospitals and surgeons, all making enormous profits. They won't give this up easily.

The final area where costs could be cut substantially is in the operating theatres. Theatres currently need to keep a huge amount of sterilised equipment available for surgeons to carry out their work; a routine joint replacement requires five substantial trays of instruments to help the surgeon perform the operation, together with over £50,000 of inventory.

With the advent of 3D printing and the adoption of 'just-in-time' ordering by many industries it may be time for the NHS to look at its procurement process and consider adopting new technologies and processes. Dr Susannah Clarke won a grant from the Technology Strategy Board to look into this. Using a planned patient matched procedure, each operation will require a single 'pizza sized box' of surgical instruments. Susannah and her group have written code that automates the design of instruments for each patient, which can then be printed in house, at low cost. This combination of software and 3D printing may revolutionise the supply chain, resulting in a superior product, which has been tailor-made for each patient, and saves over £300 per operation. This could save £54 million to the NHS today.

So these three investigators have found entire avenues of opportunity for reducing cost and improving joint replacement at the same time. Their adoption would mean changing practice in theatres, training surgeons and theatre staff in less invasive surgical techniques and a change in the business models of suppliers.

We hope that the results of our research will inform the purchasers of healthcare, persuading them that the science and technology developed in college can help save the NHS £100 million a year, while relieving pain and restoring function more effectively.

Both the NHS managers and our patients should be able to smile at that news.
Camera, lights, action...over to the uni-knee’d ex-dancer

By Mrs Natascha McQueen

I first met Professor Cobb back in 2009 based on a very strong personal recommendation and he told me we would be friends for life! I believe I could be one of his youngest patients. I saw him to solve my on-going knee problem, sustained from my dancing days. In the last four years I have had three arthroscopies and two uni-knee replacements – it’s been a long journey so far, but I am enjoying life! When asked what my goals would be after my first surgery without hesitation I said that I wanted to dance again.

Natascha shares her story with us as she believes there are some early-warning signals and painful truths that may be useful to others who read this.

Nowadays, children showing promise in sports and performance skills are measured, weighed, tested and tracked to try and help adapt training schedules to strengthen the body in ways that will aim to prevent potential injuries.

I went on to dance all over the world and enjoyed it enormously...until it all came to an abrupt end at the age of 26. I was dropped on stage by my partner and badly damaged my knee – my dancing career was over. I was put in plaster for three months, giving me time to contemplate what to do next. Dancing was my passion and all I had known the last 20 years – so it was a very unsettling and daunting time for me.

I ended up going into media and have had a very rewarding career as a freelance television producer. It has enabled me to travel extensively, to some of the remotest parts of the world. However the years of carrying television equipment, lights and film rushes (as well as luggage) has taken an additional toll on my ‘well-worn’ knees.

After one extremely long and demanding production, I found myself in Professor Cobbs clinic. I was barely able to walk, in breath-taking pain and two knees in a shocking state. X-rays, MRI scans and examinations showed the extent of the damage - I had my first Oxford uni-knee replacement in 2009 and the second a year later. I underwent extensive physiotherapy, aqua-therapy (and every other kind of therapy) to alleviate the pain and rehabilitate my body and knees to a fully-functioning state/set!

I need further surgery and am not pain free; however I am delaying surgical intervention for now with six-monthly Durolane injections in both joints. This was agreed in consultation with Professor Cobb and may not be the answer for everyone – but the injections certainly provide enough pain relief for me to live a full life. I also contribute to his research programme at the MSk Lab, so together with his colleagues; advances into this complex joint can be made.

 Donate

We don’t just want your body, research is expensive, and the speed of our development is restrained by what we can afford, so financial contributions are very welcome. Imperial College is a registered charity and there are a number of ways you can give: please either visit our Just Giving page (http://www.justgiving.com/Justin-Cobb) or contact Miss Zoe Williams on either: z.williams@imperial.ac.uk or 020 3311 5217.

Donate
Computational detection of knee osteoarthritis

by Dr Margarita Kotti

Dr Margarita Kotti is the face of an entirely new world of science: Big Data. Margarita is working on this project as part of the OA Centre funded by the Wellcome Trust and The Engineering and Physical Sciences Research Council. The main aim is to develop a sensitive non-invasive computer based tool which can assess knee joint health and identify early warning signs of osteoarthritis. Taking data gathered from gait analysis and simple biomechanical measures of how people carry out daily activities, Margarita performs a complex statistical analysis on literally millions of data points. The final developed algorithms will lead to conclusions as to the health of joints and help consultants judge the appropriate intervention needed. The tool will provide a ‘Joint MOT’ which is quick to use and can be easily performed in a GP clinic on an annual basis. By changing gait patterns, the project aims to achieve disease prevention and mitigation, which is far more cost effective than disease management.

Machine learning techniques have been employed, which involves the construction of computer systems and algorithms that can learn from data. Using decision trees to analyse quantitative data about quality of life, biomechanical and kinematic data; patterns should emerge helping to draw conclusions. The constructed systems demonstrate high discrimination accuracy between ‘normal’ and ‘OA’ subjects and are capable of revealing the motion parameters that are related to knee osteoarthritis.

Working with researchers in the MSk Lab and bioengineering, Margarita's main objectives are to automatically compute the degree/severity of knee OA, identify markers, and reveal the cause relationships between motion and knee OA. The results of which, will enable personalised care, achieve an objective assessment of disease progression and ultimately empower and enhance patient compliance.

Joint PRO

Emily Moore – Project Manager

Emily joined the MSk Lab just over a year ago, and has since been working under Professor Cobb to develop JointPRO, a low-cost web-based tool that electronically captures Patient Reported Outcomes (PROs). PROs are evaluated using validated PROs instruments (Oxford Scores and EQ5D), as well as a novel patient centred outcomes (PCOs) instrument developed in the MSk Lab. The latter is unique in enabling us to evaluate outcomes in the context of each individual patients’ aspirations, thus heightening patient relevance and sensitivity.

JointPRO enables patients to track their progress over time, whilst viewing their scores in the context of a patient-matched group and their own individual aspirations. This facilitates patient partnership with the medical team by providing a platform for patients to co-own their surgical episode – empowering patients to set personal aspirations, make treatment decisions, and direct their functional rehabilitation.

JointPRO provides clinicians with a valuable tool to support clinical decision-making and actively monitor their patients. Critically it reduces unnecessary clinic appointments, enabling ‘smart’ target patient reviews. This is more convenient for the patient, yet maintains adequate surveillance at a time when the economic realities force clinical commissioning groups (CCGs) to restrict outpatient appointments.

Importantly, JointPRO will provide consented researchers with the information they need to explore factors influencing clinical effectiveness, thus informing future treatment.

The first phase of this project is due for completion in November, at which stage the tool will be rigorously tested before its official launch in January.

“To measure is to know and if you cannot measure it, you cannot improve it” – Lord Kelvin

Engage

There are a number of ways you can keep up to date with the MSk Lab and what we are working on. You can visit or link to any of our networks.

Please contact Miss Zoë Williams on: z.williams@imperial.ac.uk or call 020 3311 5217

http://www2.imperial.ac.uk/blog/msklab

http://www.flickr.com/people/84938068@N03/

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http://www.justgiving.com/Justin-Cobb

www.imperial.ac.uk/medicine/msklab

MSk LAB > Advancing musculoskeletal research and treatment
Are We Cracking Up (Part 2)
By The Bone Boffin

Bone health

Last year (Lab Report Edition 2) I reported that the MSk Lab was embarking upon a study of micro-cracks in bone and in this issue we have an update...

As many of you know, the frontline treatment for osteoporosis is the drug bisphosphonate. Osteoporosis is caused by an imbalance in bones natural repair process. In young healthy bone, damaged tissue is removed and replaced with new tissue. With advancing age the cells that remove bone (osteoclasts) become over-active whilst the cells that deposit new tissue (osteoblasts) become inactive.

Involve:

He joined us 4 months ago and is responsible for patient recruitment and support for all of our trials. He is coordinating the diaries of the various research associates who have trials underway, so if you are interested in supporting us with your time and body, please contact David on: d.egbosimba@imperial.ac.uk or call 020 3311 7326.

We are looking for healthy, pre-operative and post-operative volunteers for a number of studies:

- Gait using a instrumented treadmill
- Gait using vicon motion sensors
- Gait using treadmill and motion sensors
- Motor control function
- Impact of flexibility

…and more. Please do not hesitate to contact David if any of these are of interest to you.

The net loss of tissue reduces the strength of the bone and increases the risk of a fracture. Bisphosphonates work by slowing bone resorption and increasing deposition leading to an increase in bone mass (Figure 1). However, by preventing natural repair bisphosphonates may also prematurely age the bone, particularly by causing the accumulation of cracks. As a result of daily walking and running, bones are loaded cyclically (i.e. repeatedly). The cyclic loading causes the bones to micro-fracture e.g. 1/100th mm diameter. It is thought that long-term suppression of bone repair with bisphosphonates can cause cracks to grow and merge leading to painful brittle fractures [1]. At MSk we have been testing this hypothesis.

What have we learned?

The 3D scans allowed us to analyse the mechanism of bisphosphonate brittle fractures. The simulation revealed high stress concentrations at the crack tip, which could cause the fissure to grow and propagate (Figure 4B). Growth of the cracks could cause them to merge. Over time the merging micro-cracks could form one large crack across a bone, causing a fracture.

What next?

We have to validate the computer model by experimentally testing bone samples using a loading gantry. We expect to confirm that the micro-cracks grow in length and merge together, causing a fracture, when the bone is stretched or compressed. It should be possible to capture a series of 3D images describing the process so we can explain our finding to other researchers and the public. Watch this space............