COMMISSION OF THE FUTURE OF SURGERY

(Response prepared by the BOA with input from the British Orthopaedic Research Society executive)

There are changes in our society and environment that have occurred or are expected to occur over the next 20 years that will have an effect on the practice of trauma and orthopaedics (and other specialties) over the next two decades. These will be considered first followed by the impact of more specific innovations.

Changes in Society and the Environment

Antibiotic resistance

The relentless increase in antibiotic resistance threatens to transform the practice of trauma and orthopaedics. It will alter the risk/benefit balance for a patient such that surgery may no longer be the best option for them, resulting in increased patient morbidity and disability. The reduced mobility and independence will result in increased cost on the welfare state. Although antibiotic resistance will impact on all branches of surgery, trauma and orthopaedics with its high percentage of procedures that use implants will be particularly severely affected.

- Innovations such as implant modification (surface topography and surface coatings), patient vaccination and operating theatre design, may help mitigate the potential catastrophe on the horizon from increased antibiotic resistance.

Society's Demographics: Age and Obesity

The increasing age and obesity of the population is already having a major impact on two of the most prevalent conditions in society: namely osteoarthritis and osteoporosis.

Osteoporosis: As the age of the population has increased, so has the incidence of osteoporotic fractures and the survival time after an osteoporotic fracture so that a steadily increasing number of patients now suffer multiple osteoporotic fractures with progressively weaker bone. Current pharmacological intervention is inadequate and therapies that replace bone stock rather than just reduce bone loss are needed if trauma and orthopaedic surgeons are to continue to keep elderly osteoporotic patients mobile.

- Agents such as pulsed parathyroid hormone have the ability to replace bone but are difficult and costly to administer. If this is used in a more widespread fashion, it will have significant resource implications.

Osteoarthritis: Joint replacement continues to be one of the most successful of all operations with fantastic friends and family provider scores (for total hip replacement 71, compared to the iPhone 69) however they were designed in the last century for patients of the last century where life expectancy after total joint replacement was approximately 10 years.

- With the increasingly ageing population, the demand for joint replacement will continue to increase substantially
- Whilst the longevity of a total joint replacement has improved over the last 10 years, life expectancy has increased at a faster rate.
- Both of the above will impact on the ability of trauma and orthopaedics to keep people mobile and independent with joint replacements.

Obesity: Maintaining patients' mobility is being subject to a second challenge created by the massive rise in obesity, which is associated with destruction of people's joints at a far younger age.

- Consequently, patients are needing joint replacements at a far younger age than previously.

Environment Changes: Driverless Cars

A substantial component of the trauma and orthopaedic workload is trauma, and although the majority of fractures in the UK are associated with osteoporosis, a component is secondary to road traffic accidents.

- The advent of driverless cars may reduce the incidence of poly-trauma, however this would not be expected to impact greatly on the total workload of trauma and orthopaedic surgeons. However there may be a further shift in their case mix towards osteoporotic injuries.

The advent of big data

- With more data being available across a wider number of procedures, it may be possible to determine which procedures are performing less well which may result in the alteration of practice in these areas (e.g. GIRFT initiatives) or the need for further evaluation in the form of prospective trials for these procedures.

- Mobile phone based apps are expected to play an increasing role and may well have a major function in patients rehabilitation after surgery. This is not expected to have major resource implications.

Specific Innovations

Robotic Surgery

Various forms of robotic surgery have been trialled in orthopaedics for over 30 years. However, until recently, the technology has not demonstrated the possibility of improving patient outcomes or increasing the efficiency of the operation.

Robotic assisted surgery is currently in use (so far 100,000 procedures have been done worldwide) for knee replacements. It is expected its usage will steadily increase, especially if large RCTs demonstrate an improvement in patient outcomes.

- As approximately 100,000 knee replacements are performed in the UK every year, the introduction of robotic surgery will have a major resource implication as there is a significant upfront cost for the equipment for this technique.

- As robotic devices become more commonplace, it would be expected that there will be an increase in their fields such as trauma surgery (intramedullary nailing, distal locking) and limb reconstruction procedures as well as other types of joint replacement.

Regenerative Medicine, Cell Therapy, Tissue Engineering

Autologous chondrocyte implantation(ACI) is an established cell therapy that was recently recommended by NICE as an option for treating large (>2cm) symptomatic articular cartilage defects of the knee in patients without previous surgery or and who have minimal osteoarthritic change.

- Implementing cell therapy for all suitable cartilage defects will have significant resource implications as each treatment costs in the region of £5-15,000.

Currently there are no cell therapy techniques that have been demonstrated to be of benefit for widespread destruction of a joint such as in generalised osteoarthritis.

- However over the next 20 years, it is envisaged that therapies for osteoarthritic joints will be developed. Cell-based treatments are likely to be more expensive than total joint replacement and will have significant resource implications (especially if trials indicate that they need to be autologous rather than an allogeneic source).

Cell therapies for diffuse joint arthritis would be expected to maintain the patient's joints for 5-10 years thereby delaying the age of first joint replacement.

- However, over the next 20 years, we envisage the need for total joint replacement will remain until durable cell therapy solutions are developed.

Tissue engineered constructs for treating bone defects or replacement of whole structure such as a joints could be of benefit to some patients. However, intramedullary nail lengthening and cell therapy are expected to minimise the need for segmental grafts and tissue engineered joints.

Bone remains the second most commonly transplanted tissue and there is still a massive need for bone graft for fusion procedures.

- Tissue engineered grafts are expected to impact on the bone graft market over the next 10 years. This is expected to have moderate cost implications as they are likely to cost more than existing graft materials.

Machine learning/artificial intelligence

Screening accident and emergency x-rays to identify non-obvious fractures by AI is expected to become widespread over the next 10 years. This couples well with fracture clinic redesign which is being introduced across the UK.

- There is likely to be a resource implication for implementing AI X-ray screening technology but it would be expected to be offset by a reduction in the number of trained personnel needed to screen these x-rays.

Imaging

There are several unmet clinical imaging needs in Orthopaedics and Trauma. These include imaging techniques for a) the early identification of a failure of fracture healing , b) assessment of the organic (rather than the mineral) component of bone, c) the live/dead status of bone and d) the viability of articular cartilage.

- Novel technologies which may include Raman spectroscopy and 3-D ultrasound may be developed over the next 20 years for current unmet clinical needs. They will require additional resources but these should be offset by reduction in total treatment costs.

Pharmacology

Drugs to delay or prevent osteoarthritis and to build up rather than just reduce resorption of bone would be of benefit to patients and would have a major impact on the need for surgery. However no simple therapies exist for these problems and there are a number of barriers to producing them both on the commercial side and also on the scientific side. None are expected to impact on the market over the next 15 years.

There is also an unmet need for drugs to combat sarcopenia. These would not be expected to reduce the need for surgery but may enhance the patient's function postoperatively.

3-D printing

3-D printing is already in clinical use for niche procedures. It is used for printing of templates and models in the planning of complex reconstructive procedures. There is expected to be a steady but slow increase in this niche market for these products over the next 20 years.

Genetics

The advances in genetics will impact on a small percentage of the single gene inherited disorders. An individual's genotype may also help deliver personalised surgery where several options exist (particularly in the regenerative medicine arena), but it is not expected to impact significantly on the practice of orthopaedics and trauma over the next decade.

References

1. National Institute for Health and Clinical Excellence (2017). Autologous chondrocyte implantation for treating symptomatic articular cartilage defects of the knee. NICE guideline (TA477).