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Ergonomics for the diverse workforce

Roshana Mehdian and Deborah Eastwood

The *'Oxford English Dictionary'* defines ergonomics as the 'study of working conditions, especially the design of equipment and furniture, in order to help people work more efficiently'. Whilst *'Ergonomics for Dummies'* defines this as 'the study of how the human body interacts with the workplace'.

Let us put aside for the moment, that it is not uncommon to use a bin as a chair in the NHS, and ask ourselves which 'human body' are we talking about? Caroline Criado-Perez's best-selling book *'Invisible Women'* leaves little uncertainty that most commonly, the 'human body' is the male of the species whether it be in the design of car restraints or town planning and public transport routes, the historical data standard used has been that of 'the average man'!

The issue of ergonomics in surgery is gaining widespread recognition due to a surge in musculoskeletal injuries reported by surgeons in various specialties. Orthopaedic surgery is a physically demanding surgical specialty that puts enormous pressure on the musculoskeletal system via forceful and repetitive manoeuvres.

Predominant musculoskeletal (MSK) injuries reported involve the neck and lower back, followed by upper extremity injuries, including shoulder and rotator cuff disease, lateral epicondylitis, tendinitis and carpal tunnel syndrome. The career prevalence of MSK disorders in junior doctors ranges from 37% to 97%². It is also recognised that the risk of injury may be higher in orthopaedics than in other surgical specialties due to unique ergonomic challenges of orthopaedic procedures.

It is true that trauma and orthopaedic surgery has historically been dominated by men and that there has been reason to use the 'average man' for workplace ergonomic consideration, however with the increase in female orthopaedic surgeons and greater ethnic diversity in the profession, there is a pressing need to revisit this standard.

This revisit ranges from tools to rota and service design. It follows that to fairly diversify the workforce we must design the workplace to meet the needs of this workforce, a significant undertaking.

When the price we pay is not only with efficiency, but also with our health, these considerations need to be taken seriously. Gone should be the days that these should be considered an occupational hazard when we now have the awareness, data and scientific capabilities to radically improve ergonomics in the workplace. All we need now is the will to make change happen or at the very least the eradication of our corporate willful blindness to these issues. Improvements in these areas for diverse surgeons will benefit all surgeons. The advocacy for diversification of ergonomics needs to come, from both surgeons and their employing trusts.

Inclusive orthopaedics

The British Orthopaedic Association Diversity and Working Group Committee, in recognising the need for updating of workforce ergonomic considerations, launched the Campaign 'Inclusive Orthopaedics' appealing to Orthopaedic Medical Devices Industry partners to set a new standard in tool design to meet the diversifying workforce. The letter



Figure 1: Ergonomics in the workplace.

recognised the legacy of dynamic innovation in the orthopaedic industry and sought to galvanise its use in this new direction of travel.

The average glove size is around 7.5 for men and 6.5 for women. A significant number of surgeons self-report that hand size could be the cause of physical discomfort in their hands. Women have a smaller glove size, on average, and studies have shown that ill-fitting instruments are associated with greater difficulty and injury. The correct sizing could improve excess ulnar and radial deviation, ring handle pressure on fingers, and pressure on the thenar eminence that leads to better operation ergonomics². In post menopausal women, both grip and pinch strength reduce making some tasks more difficult or impossible.

It is not only women who would benefit from an alternative approach to the design of tools. This approach could help others who have had to adapt to the one-size fits all approach, for example left handed surgeons, those with disabilities, or those that generally struggle with heavy weight power tools. There is evidence that power tools may present difficulties even in those they are ideally designed for, with problematic levels of vibration and wrist torque identified in previous studies³.

Surgeons who are not of average body size and shape may find it difficult to fit into a lead gown, and there is some evidence that gowns may increase levels of back pain and abnormal forefoot loading³.

Tools

Repetitive use of heavy hammers, drills, and heavy equipment including jigs and instruments may account for high rates of occupational injury. Using appropriately sized instrumentation may reduce hand and forearm pain, as well as using lighter equipment to lessen the peak forces on upper extremities.

Table height

Table height plays a significant role in decreasing strain on back muscles, minimising neck flexion and reducing leaning and reaching over. The table height should also vary based on the nature of task performed. Performing a precise task such as soft tissue dissection or mobilising critical structures requires the table height to be about 5 cm above the level of your elbow (elbow height). For light work such as screw

insertion or suturing, the table height should be approximately 5–10 cm below the elbow height. When performing heavy tasks, and downward forces are needed, such as

drilling or impacting a component with a mallet, table height is recommended to be 20–40 cm below the elbow height. Diversity in design concepts might encourage a foot control to be used by the surgeon to adjust the table height - this would make it much more likely that adjustments were made as the surgical team would not be reliant on other staff to adjust the table height.

Non-musculoskeletal work-related injuries

Orthopaedic surgeons also face a higher incidence of non-musculoskeletal work-related injuries. These include the risks of radiation exposure

from using intraoperative C-arms; infections from accidental skin punctures by drills, saws, Kirschner wires, and bone shards; >>

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inhaling surgical smoke and encountering chemicals like polymethylmethacrylate (PMMA) and isocyanate; as well as the risk of hearing damage due to the high decibel levels from power tools and intense suction device. Orthopaedic surgeons also experience cardiovascular and mental stress during procedures with higher mean blood pressure and heart rate on operating days³.

The strain brought about by poor work-place ergonomics is likely exacerbated by altruistic attitudes among surgeons, with many surgeons prioritising the health and safety of their patients whilst neglecting their own comfort and well-being.

Ergonomic solutions

Three categories of ergonomic solutions should be considered to reduce MSI risks:

- 1) Engineering controls (changes to the environment).
- 2) Administrative controls (workforce or human changes).
- 3) Personal protective equipment (PPE).

Engineering controls are changes that can be made in the operating theatre environment; these include structural changes such as bed height and equipment changes, such as the use of floor mats. Administrative controls are workforce or human changes. These include taking short breaks during prolonged operations and ergonomic training. PPE are tools individual staff may use, such as lighter lead aprons or body support equipment. Orthopaedic device companies are exploring instrument design through ergonomic research in collaboration with engineers.

Koshy *et al.* evaluated the literature on interventions currently used to minimize MSI in surgeons and reported that 69.9% of surgeons noted improvement in symptoms after implementing ergonomic solutions³.

One difficulty is that despite recommendation and guidance on ergonomics there is a lack of data on the logistics of designing and executing ergonomic training programmes and how these programmes impact on surgeon outcomes. A study by Franasik *et al.* utilised a brief surgical ergonomics programme within a group of robotic surgeons to demonstrate proper positioning and strategies to avoid robotic strain⁴. The programme consisted of a slideshow presentation and an in-person training session on how to set up the robotic console. They found that 88% of participants made changes to their operative practice

after taking part in the programme, and 74% reported reduced robotic associated strain because of the training.

With the drive for national teaching programmes, there is a clear opportunity to incorporate surgical ergonomics training into higher surgical training programmes so surgeons can understand the potential risks and how to mitigate them.

PPE and X-ray protection

The most high profile case of poor ergonomics is that of PPE, coming to light as the COVID-19 pandemic struck, with high rates of fit test failure amongst women and non-Caucasian ethnicities⁶. Ill-fitting PPE in surgery is a common frustration amongst the diverse workforce with, for example, surgical gowns often being too long, too small or too large, and limited options available at any one trust.

Disposable surgical gowns also carry a significant environmental cost and there is a need for surgeons to be more involved in gown design and procurement.

Most recently, PPE specific to surgeons exposed to ionising radiation by theatre based C-arms/X-ray has been found to be inadequate at protecting women. Exposure has been linked to increased incidence of breast cancer in female health workers. Studies have shown that current gown designs, during certain specific operative procedures, risk exposing the upper outer quadrant of breast tissue to excess irradiation. This is the area of the breast which is most likely to develop the disease.

A UKHSA/BOA study dosimetry study is currently underway to quantify the amount of exposure to ionising radiation of the chest wall versus the axilla. This study hopes to provide important evidence on the relative exposures to irradiation for surgeons of all grades over a three-month period.

Irrespective of the study results, there is clearly a requirement for trusts to provide lead gowns, thyroid shields and eye guards that are appropriate for their diverse staff to use comfortably and safely. Such diversity includes factors such as age, size, shape and specialty interest. Heavy, poorly fitting gowns also contribute to MSK occupational problems affecting agility and stamina and causing pain and stiffness.

There is also a need for both research and training on image intensifier positioning and use in theatre, to ensure that radiation use is minimised, with careful thought to the positioning of key personnel in theatre when

using it. Orthopaedics will always be an X-ray dependent specialty but a starting point must be to minimise its use.

If it is a requirement that office workers in the NHS are assessed for appropriate desk and chair heights and shape for example (see figure 1), it must surely also be a requirement that PPE fits the person wearing it.

In summary, the research of improving the ergonomics of operating and reducing musculoskeletal injury in surgeons has been gaining widespread recognition. It is hoped that with improvements in the design of the operating environment and the use of tools that elevate user comfort while improving safety, performance, and efficiency this will enhance work performance and reduce the incidence of work-related musculoskeletal injury. An increasingly diverse workforce, with rising retirement ages means there is an urgent need to increase our understanding of surgical ergonomics and ensure the long-term health of our workforce and patients. ■

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