Pushing and Pulling In Health Care Environments – A Review of the Risks and Ergonomic Solutions

Perceived Impact of NHS Reform
The Health and Social Care Act 2012 is changing the National Health Service (NHS) in an unprecedented way, (GB Parliament 2012). Increasing economic pressures are having an impact on staffing levels and healthcare professionals are facing additional stress as they endeavour to work more efficiently to deliver high quality care. Restructuring of job roles, stress and high workload are driving many nurses to consider leaving the profession. (RCN 2012)

Musculo-Skeletal Disorders
It is known that work related stress and musculo-skeletal disorders (MSDs) are significant causative factors for sickness absence in NHS staff with up to 40% attributed to MSDs (Topping 2011) There is also a link between stress and recovery outcomes for persons experiencing lower back pain (CSAG 1994 and Whysall 2008). Clearly the impact of psychosocial factors cannot be overlooked in the management of MSDs especially if work related anxiety, stress and depression are impeding recovery.

There are six (6) worked related stress factors outlined by the Health and Safety Executive (HSE 2007), some of which could increase in severity due to increased work pressures, additional work demands and overall significant changes to the workload

- Demands
- Control
- Support
- Relationships
- Role
- Change

Demands
This is relevant as it includes stresses placed on the employee that may result from poor ergonomic design of the environment or the equipment being used. The job may be unnecessarily more difficult if it is not correctly and ergonomically matched to the employee; an example would include manually pushing patient trolleys frequently over long distances or up inclines. This failure to match the job to the person can result in stress and musculo-skeletal problems.

Control
Employees should be consulted and have some control regarding the tasks they carry out. They should be involved in risk assessments and the possible solutions including the trial and selection of equipment that is purchased to reduce musculo-skeletal risks.

Change
Organisational change within the NHS is inevitable and undue stress can be mitigated if employers consult with employees and advise them of change in a timely manner. Support should be provided for new roles and training given as necessary.

This overview outlining some of the stress factors illustrate how significant changes to job roles; if combined with a lack of understanding and support from management; can be a recipe for occupationally-related ill health. This emphasises the need for sound management structures and systems of work, including risk assessment, to mitigate ergonomic hazards and stress related ill health.

The evidence shows that MSDs are a cause for concern in the United Kingdom, particularly for those working in health care environments and having direct contact with patients.

HSE Statistics - MSDs
HSE statistics relating to MSD for the period 2011/12 indicate that there were 439,000 cases out of a total of 1,073,000 work related illnesses (HSE 2012a). Back disorders form part of this category and the industries with the highest prevalence rates averaged over 2009/10 and 2011/12 are construction and human health activities but notably those that are hospital related. Within these industries the main work factors giving rise to problems are:-

- Manual handling including lifting, pushing and pulling
- Awkward postures
- Workplace accidents

Over a 5 year period 2006/07 – 2010/11 pushing and pulling was the most common specified type of major manual handling injury. Lifting and lowering being the most common specified type that resulted in lost time injury >3 days (HSE 2012b).

Legislation and Ergonomic Factors
Employers have a responsibility to improve ergonomic standards and reduce the risks related to manual handling activities such as lifting, pushing and pulling. A European Directive 90/269/EEC was issued on 29 May 1990 (European Parliament 1990). The response in the United Kingdom was the implementation of The Manual Handling Operations Regulations 1992 (HSE 1992). These regulations offer guidance and some statutory obligations relating to lifting, pushing and pulling activities. Emphasis is often placed
on the guideline weights for lifting and lowering but equally important is the need to minimise the pushing and pulling forces. This is especially relevant with pushing and pulling incidents being cited as the most common cause of major handling injury within the HSE statistics and MSD category. There are a number of physical factors relating to pushing and pulling that can contribute to musculo-skeletal risk (Brace 2005)

- Friction
- Wheel design
- Load weight
- Posture – handle height

**Friction**

Friction can be defined as the resistance offered to the movement of one body past another body with which it is in contact. The hardness of the wheel material, floor surface, and wheel orientation are factors that can increase friction and influence the amount of force needed to push a trolley or bed. A harder wheel composition and floor surface will make pushing easier. This change in friction and forces required to initiate or sustain momentum is verified when riding a bicycle and noting what happens when the bicycle is pedalled on a dry paved surface, sand or ice?

**Wheel Design**

The diameter of the wheels is significantly important as the start-up forces are reduced as the diameter increases. This is demonstrated by Al-Eisawi et al. This research looked at factors affecting push and pull forces in which it was found that increasing the wheel diameter by a factor of 2 reduces the pushing and pulling force by half. The influence of wheel width was less significant with little change in start up forces when the wheel width was increased by 50%. The positioning of wheels has relevance and also which ones will swivel. When pushing it is better if the rear wheels will swivel, for pulling the front wheels should swivel. Trolleys having only 4 corner swivelling castors are harder to push as they may not be lined up in the same direction. Pushing in a straight line can be difficult due to lateral forces affecting the operator. (Al-Eisawi 1999)

These issues can be improved by the addition of a fixed centre wheel or placing a fixed wheel at each edge of the trolley in the exact centre position. This combination has been shown to improve manoeuvrability by reducing the turning circle and also decreasing the forces required when changing direction. (Das 2002a)

**Load Weight**

There is a correlation between trolley weight and the forces needed to gain and sustain momentum. The technology for beds and trolleys is constantly improving, one of these enhancements is the ability to carry heavier loads. A negative aspect of this can be an increase in the net trolley weight and total weight when transporting a patient. This increases the start up forces needed to gain momentum and relevant if being manually operated. The forces required to stop momentum may also be significant and often overlooked (Ferreira et al 2004) Start up and stop force guidelines are provided by the Health and Safety Executive (HSE 2004). These force guidelines are designed to act as a filter to help determine if a more in depth risk assessment is required. In the UK the start up and stop forces are 20kg for men and 15kg
for women, to sustain momentum a guideline of 10kg for men and 7kg for women is specified. It must be noted that these are recommendations only and not statutory requirements.

The start up and stop force measurements are not the same as the compression and shear forces impacting on the lumbar vertebræ during pushing and pulling activities. Load weight and distance being pushed are important risk factors to consider. Waters et al 2011 makes reference to the AORN Ergonomic Tool 7. The tool considers the risk factors and forces required to manoeuvre different items of equipment generally found in a perioperative environment. The tool offers guidance regarding the estimated forces, the number of staff that may be required and also the recommended maximum distance to travel (Waters 2011). It is interesting to note that loading a patient trolley with a 300lb load would limit the maximum pushing distance to 60 metres. Based on experience many wards in a large acute hospital are beyond this 60 metre range thus indicating that additional risk controls would be required. It is recommended that patient trolley loads be kept below 225kg in order to avoid excessive compression forces to the lumbar spine (Resnick & Chaffin 1995). In many circumstances this may not be possible especially as obesity becomes more prevalent creating an increased risk of hospital admissions for bariatric persons (Cookson & Rush 2011).

Postural Concerns

Assuming a pushing task cannot be avoided, there is a requirement to make the task safer and more efficient for the operator. There are a number of postural factors to consider; these can be affected by the trolley design e.g. a fixed height trolley would cause some carers to stoop or be unable to have their arms in a position to deliver optimum force. Stooping forward during a pushing activity has been shown to increase compression and shear forces in the lumbar spine. Trolley handle height, width and hand grip diameter are other areas to consider (Das 2002b and Jansen 2002). When pushing; it is generally accepted that the optimum hand height be approximately 1 metre or in the elbow to hip range. Feet position should be in a walking stance with one slightly in front of the other.

Discussion - Ergonomic Solutions

It is clear from the evidence cited that health care professionals are under pressure in a demanding working environment. Basic everyday manual handling tasks and especially pushing and pulling activities can be potentially hazardous unless the ergonomic problems are risk assessed and control measures introduced. Hospital staff having input into the purchase of beds or trolleys should have some insight into the potential problems linked to pushing and pulling tasks. Without this insight it is logical to assume that inappropriate purchases could be made.

Stryker are keen to address these ergonomic challenges and actively consult with end users during the planning and design stage. This coupled with commissioned research projects provides a higher probability that the end product is fit for purpose.

One of these recent research projects has clearly demonstrated that it is possible to reduce pushing risks by considering evidence based research principles and incorporating these into trolley design (Butt et al 2012). The Zoom motorised trolley incorporates many proven ergonomic features already featured in this article.

![Figure 4 External driving device – two trolley wheels raised off the floor. How does the operator calculate how much weight is being applied to the machine?](image1)

![Figure 5 External device using a remote control option – far superior to manually pushing but still a long wheelbase and distance to the drive wheel](image2)

![Figure 6 Trolley Type Comparison - L4/L5 Compression Rate Reduction (Adapted from Butt et al 2012)](image3)
In most cases the connection of a separate drive unit will increase the overall length, this can be hard to steer and may not fit in a lift. There can be some manual handling activity involved to connect the drive unit to the bed or trolley. Understanding the maximum safe working load can be confusing. Some devices raise one axle off the ground and staff may be unsure of the load being taken. Assuming a trolley weighs 150kg and the patient weighs 150kg how much load is taken if only one axle is lifted off the ground, this can be confusing for staff as they may wrongly assume they have overloaded the device.

Conclusion
Pushing and pulling hospital equipment such as bed and trolleys is a potential hazard. The level of risk is often overlooked or not fully understood with perhaps more importance being placed on the avoidance of lifting. There is however sufficient evidence based research to highlight the potential harm to the musculo-skeletal system. Fortunately there are a number of ergonomic solutions that will reduce or in some cases eliminate the risk. Providing training to personnel can help but this should not be regarded as the primary solution. Introducing ergonomic solutions matched to risk assessments is the way forward. Equipment purchases should be subject to discussion and collaboration with end users. Consider the ergonomic design features and supporting evidence supplied by the manufacturer. Staff should assess the whole pushing and pulling scenarios within their organisations. Before making any purchases consider a number of risk factors and question whether the item being purchased can reduce the risk.

References
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