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

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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

Figure 1 Scuff marks - Start of the Incline – loss of traction

Figure 2 Good posture can be attained during 90 degree turns

Figure 3 Inclined corridors no longer a problem -short wheelbase to drive unit

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 vertebrae 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?

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

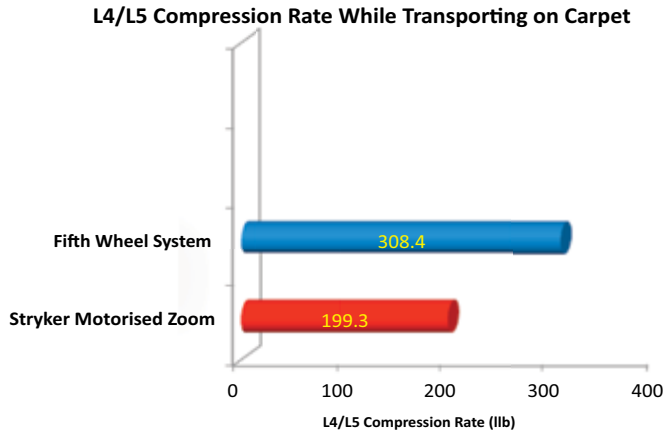

Figure 6 Trolley Type Comparison - L4/L5 Compression Rate Reduction (Adapted from Butt et al 2012)

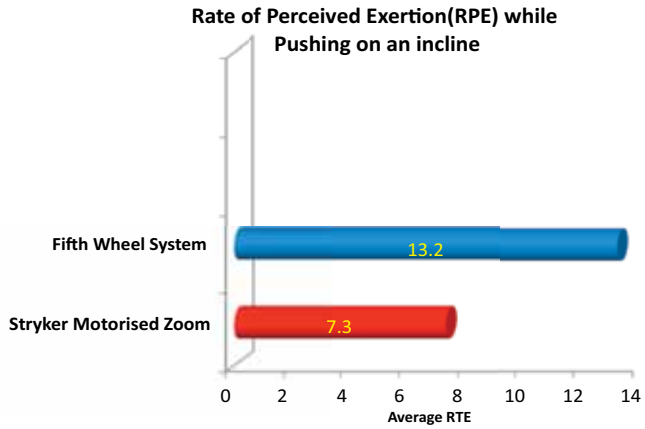

Figure 7 Trolley type comparison - Average Rate of Perceived Exertion (Adapted from Butt et al 2012)

Learning: Points to Consider

- Calculate the overall distance for the chosen route
- What is the total weight including the trolley, patient and accessories
- Are there any inclines on the route
- Does the journey include any 90 degree turns
- Are there any spatial constraints i.e. manoeuvring in confined spaces
- What is the floor surface constructed from on the selected route
- Who will push the trolley
- Take a good look at the wheel design, composition, quantity and configuration.
- Ensure that the equipment you are about to purchase is designed and able to mitigate the risk
- Try before you buy

The specific research compared two trolleys, one having the standard 5th wheel design and the other having a large 5th wheel and integral drive motor. 20 Registered Nurses aged between 24 and 61 years were selected, they did not disclose any history of MSDs.

The tasks involved a series of manoeuvres using both trolleys; the first task involved pushing, cornering and stopping a trolley with a 300lb load. The second task involved pushing a trolley up an 8 degree incline; this was carried out using two flooring surfaces i.e. smooth laminate type and carpeted tiles.

The results demonstrated that the Rate of Perceived Exertion was reduced by **42%** when compared to the standard 5th wheel trolley design. This figure was recorded moving from horizontal to the start of the incline. This move from flat to the incline is a point where some bed and trolley driving devices can lose traction due to the additional forces required. (**Fig 1**) A 35.4% reduction in the L4/L5 compression rate was also achieved when manoeuvring up the motorised Zoom trolley up the carpeted incline. (**Fig 6 & Fig 7**) In all the tests the compression forces were below the level of 3,400 to 6,400 Newton that is a generally accepted safety margins for potential tissue damage. (Marras 2008)

The Stryker Zoom incorporates a number of ergonomic features in addition to the motorised unit. The trolley can be adjusted to attain the optimum height for pushing, the hand grips are soft touch and comfortable. The drive unit is central, shortening the wheelbase and making it easier to manoeuvre on inclines and 90 degree turns. (**Fig 2 and Fig 3**) The drive unit is also integral so the overall trolley length is not increased

External trolley drivers are universally available and although an improvement compared to manual pushing they do have some inherent problems. (**Fig 4 and Fig 5**) When required the device must be secured to the bed or trolley, this can be castor cups that are designed to support the 2 wheels on a single axel. Other methods include jaws that grip the trolley at a specified point. These methods are sometimes marketed as universal adaptors or in some cases specific attachment bars have to be fabricated to match each different bed or trolley model that is being moved.

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 axel 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 axel 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

Al-Eisawi K.W. Kerk C. Congleton J. Amendola A. Jenkins O. Gaines W. Factors Affecting Minimum Push and Pull Forces of Manual Carts Applied Ergonomics 30 (1999) P235-245

Brace, T (2005) The Dynamics of Pushing and Pulling in the Workplace – Assessing and Treating the problem. AAOHN Journal May 2005 Vol53 No 5 P224-229

Butt S. Fredericks T. Cure L. Burns J. Harms K.(2012) Effects of Transport Stretcher Mobility Related Design Features On Healthcare Workers Department of Industrial & Manufacturing Engineering College of Engineering & Applied Sciences Western Michigan University

Clinical Standards Advisory Group (1994) Back Pain Page 51 HMSO 1994 ISBN 0-11-321887-7

Cookson K. Rush A, (2011) The Guide to the Handling of People – A systems Approach 6th ed Chapter 12 Page 194 People handling for Bariatrics – A systems Approach Edited by Jacqui Smith, Published by BackCare Teddington Middlesex

Das, B., Wimpee, J., & Das, B. (2002a). Ergonomics evaluation and redesign of a hospital meal cart. *Applied Ergonomics, 33*, 309-318.

Das, B., Wimpee, J., & Das, B. (2002b). Ergonomics evaluation and redesign of a hospital meal cart. *Applied Ergonomics, 33*, 309-318.

European Parliament (1990) Council Directive 90/269/EEC 29th May 1990 On the minimum health and safety requirements for the manual handling of loads where there is a risk particularly of back injury to workers http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1990:156:0009:0013:EN:PDF Accessed 29th Nov 2012

Ferreira, J. Boocock M. Gray M (2004) Review of the risks associated with pushing and pulling heavy loads Research Report 228 HMSO ISBN 0 7176 2845 0

Great Britain Parliament (2012) Health and Social Care Act London HMSO

HSE (1992) The manual handling operations regulations 1992 (As amended) HMSO London

HSE (2004) Manual Handling - Guidance on Regulations L23 HSE Books http://www.hse.gov.uk/pubns/priced/l23.pdf Accessed 29th Nov 2012

HSE (2007) Managing the causes of work related stress – A step by step approach using the management standards.

HSE document HSG218 ISBN 978 0 7176 6273 9 http://www.hse.gov.uk/pubns/books/hsg218.htm Accessed 29th Nov 2012

HSE (2012a) Musculo-skeletal Disorders http://www.hse.gov.uk/statistics/causdis/musculoskeletal/msd.pdf Accessed Nov 21st 2012

HSE (2012b) Handling Injuries http://www.hse.gov.uk/statistics/causinj/handling-injuries.pdf Accessed Nov 21st 2012

Jansen, J.P., Hoozemans, M.J., van der Beek, A.J., & Frings-Dresen, M.H. (2002). Evaluation of ergonomic adjustments of catering carts to reduce external pushing forces. *Applied Ergonomics, 33*, 117-127.

Marras W. (2008) The Working Back, A systems Review John Wiley & Sons, IncHoboken, New Jersey, United States

RCN (2012) Royal College of Nursing Evidence to the NHS Pay Review Body 2013 -14 URL http://www.rcn.org.uk/__data/assets/pdf_file/0019/482230/PRB_report.pdf accessed 20th Nov 2012

Resnick, M.L., & Chaffin, D. (1995). An ergonomic evaluation of handle height and load in maximal and sub maximal cart pushing. Applied Ergonomics, 26, 173-178. This relates to excessive compression forces above 225kg

Topping J (2011) Getting back to work is the best medicine Nursing Times; Aug 30-Sep 5, 2011; 107, 34; P33

Waters T Lloyd J. Hernandez E. Nelson A (2011) AORN Ergonomic Tool 7: Pushing, Pulling and Moving Equipment on Wheels AORN Journal September 2011 Vol 94 No 3 p254-260

Whysall Z (2008) Stress and MSDs: Moving Towards Common Ground? Occupational Health February 2008 60 (02) 27-29 http://www.personneltoday.com/articles/08/04/2008/44364/link-between-stress-and-musculoskeletal-disorders.htm

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