FREE PAPER 4

**Clinical Interpretation of ISO16840-2
Measurements for Wheelchair Seating Cushions**

Presenters: Susan Hillman and James Hollington

Additional authors: Dr Carmen Torres-Sanchez, Jens Boeckx, Neil Crossan

Summary

The ISO16840-2 standard defines a set of mechanical characteristics intended to differentiate cushion performance, but the clinical interpretation of these measures is not established. This study uses linear discriminant analysis to explore whether the measures may correspond with current knowledge on the clinical performance of 14 wheelchair seating cushions.

Aims and Objectives

This study aims to explore the relationship between four sets of measures from the ISO16840-2 standard for the mechanical characteristics of wheelchair cushions and the clinical performance of the cushions, as judged by experienced clinicians. The objective of the study is to help with the clinical interpretation of the ISO measures by determining which measures are most relevant to pressure and stability performance.

Background

Prescription of an appropriate wheelchair seating cushion is a critical factor to the function, comfort and tissue integrity of wheelchair users. Clinical selection of an optimum cushion however continues to be based on custom and practice, and the individual clinician's experience. The ISO16840-2 standard, published in 2007, attempts to address this by defining a set of tests for wheelchair seating cushions which are intended to differentiate performance characteristics. The standards however do not include clinical interpretation of the test data. This study therefore uses multivariate statistical techniques to explore the clinical potential of the ISO16840-2 standard.

Load Deflection and Hysteresis (section 9), Impact Damping (section 11), Recovery (section 12), and Loaded Contour Depth and Overload Deflection (section 13) measurements were made on 15 cushions according to ISO16840-2. The cushions were selected to represent a range of different designs, or cushions and foams in regular clinical use. The cushions tested were the Roho Single Valve, Jay J2, Jay Gel, Flo-tech Contour, Flo-tech Solution, Flo-tech Lite, Propad, Vicair Academy 10, Varilite Evolution, 2" CM60 foam with Dartex cover, 3" CM60 foam with Dartex cover, 3" pink viscoelastic foam with Dartex cover, 3" Sunmate foam with Dartex cover, 1" pink visco on 2" chip foam with Dartex cover, 1" Sunmate on 1" CM35 on 1" CM60 foam with Dartex cover.

The 15 cushions were also classified by two clinicians experienced in wheelchair seating cushion prescription for postural and tissue integrity management. Each cushion was classified as low, medium or high, according to its clinical appropriateness for pressure management, static, and dynamic postural stability. It was not possible to proceed with the analysis according to static stability because there was insufficient variation across the three classifications. Also, impact damping could not be measured on the Varilite Evolution because the rigid cushion loading indenter rebounded clear of the cushion after the first impact. The remaining 14 cushions were therefore used in the subsequent analysis.

Linear discriminant analysis (LDA) was used to explore whether the ISO measures could be used to produce the same classifications for pressure management and dynamic stability as the experienced clinicians. Three-fold cross-validation was used, in which the cushions were divided into three groups, and then two groups were used to train the LDA and the remaining group used to test. This was done three times such that each cushion was tested once.

For the pressure performance classifications, eight cushions were correctly classified by the LDA, five were classified wrongly by one category and one was classified wrongly by the maximum of two categories. For the dynamic stability classifications eight were correctly classified, three were classified wrongly by one category and three were classified wrongly by two categories. The Kappa statistic, which quantifies agreement while taking account of chance agreement, indicated that agreement between LDA and the original clinical classification was no better than chance.

Analysis of a larger selection of 38 cushions will be presented at NTE and an updated abstract supplied.

Discussion

Linear discriminant analysis is a multivariate statistical technique which establishes a set of equations intended to classify sets of input data into categories. In this study the input data sets were the sets of ISO measurements for each cushion, and the categories were the clinical performance categories for pressure and stability. The equations are developed using data for which the categories are already known, and in this study these were determined by the experienced clinicians. When successful, LDA can classify unknown data correctly, and by examining the coefficients of the equations the most relevant measures for the correct classification can be discovered.

This study however has failed to identify any relationships between the ISO16840-2 measurements examined in the study and the clinical performance of the cushions as determined by experienced practitioners. This does not however necessarily mean that the ISO standard is unable to inform on the clinical effectiveness of wheelchair seating cushions because this study suffers from a number of shortcomings. In particular the sample of cushions used was very small which is likely to have compromised the effective training of the LDA. Also the clinical classification of the cushions was subjective which means that some cushions may have been misclassified. It is hoped that more work will be done by extending the number of cushions in the study and hence increase the potential of the linear discriminant analysis to identify the most clinically relevant discriminating measures from the ISO standard.

References
BS ISO 16840-2:2007. Wheelchair seating - Part 2: Determination of physical and mechanical characteristics of devices intended to manage tissue integrity - Seat cushions

Correspondence details

Susan Hillman
Southeast Scotland Mobility and Rehabilitation Technology Centre
Astley Ainslie Hospital
133 Grange Loan
Edinburgh
EH9 2HL

Email: susan.hillman@nhslothian.scot.nhs.uk