Methodology to Measure the Adjustability of Skin Protection Features of Wheelchair Cushions

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ABSTRACT

KEYWORDS *cushions, pressure sore prevention*

BACKGROUND

The Center for Medicare & Medicaid Services (CMS) categorizes wheelchair cushions based on their performance characteristics as they relate to skin protection and postural support. With the Statistical Analysis Durable Medical Equipment Regional Carrier (SADMERC), CMS develop codes and performance requirements for general use, skin protection, positioning, and skin protection and positioning wheelchair cushions. In 2004, these agencies determined that these codes alone did not adequately describe the characteristics of adjustable wheelchair cushions in their provision of skin protection. An adjustable skin protection code was defined for cushions that had all the characteristics of required for a skin protection code, and was adjustable by the addition or removal of significant quantities of air, liquid, gel, or other fluid medium in physiologically appropriate areas of the cushion to promote pressure reduction. (1)

This broad definition does little to define the load distribution characteristics of adjustable skin protection cushions or how they differ from the characteristics of skin protection cushions. The purpose of this project is to develop a test methodology to distinguish the load characteristics from adjustable versus non-adjustable wheelchair cushions.

APPROACH

Adjustable wheelchair cushions are those wheelchair cushions which provide clinical appropriate load distribution characteristics for a variety of body types and masses. Load distribution can be characterized by three properties: magnitude, envelopment, and immersion. Magnitude properties represent the cushions ability to reduce pressure values. Envelopment represents the ability of the cushion to conform to the body. While immersion is a property which describes how far one can sink into a cushion.

In order to assess the characteristics of adjustable and non-adjustable wheelchair cushions, models need to representing different body types need to be apply differing loads to the wheelchair cushion. Properties of load distribution should be evaluated for each model at different mass representations.

Model
Protocol
Metrics

Loading: This test is designed to measure how well cushions accommodate different body weights of users. Two loads are applied that reflect the buttock loading of an 84 kg and 56 kg person. These weights equal +/- 20% of 70 kg – the approximate worldwide average mass of humans. While 84 and 56 kg are not the actual forces applied to the model, the respective representative loads will be referred to using these body mass values. Preliminary testing also investigated the effect of soft tissue mass simulated by adding gel pads. Test results after t-test analysis indicated that a ½" gel pad did not alter results.

Scoring: Multiple metrics have been developed to reflect the magnitude, immersion and envelopment of recorded pressures. Points are awarded when a cushion meets thresholds based upon these categories. This obviates a need to come up with a single metric to characterize cushion adjustability. Two approaches are being investigated: relative scoring and normative scoring.

Relative scoring is done using 3" flat HR45 foam as a comparison. Variables are calculated for this reference cushion, and thresholds are set at 85% and 80%. Therefore, points are awarded when the test cushion returns values that are either 15% or 20% lower than this reference foam. The benefit of using a reference material is that comparative values or thresholds are defined at each test lab and within a few hours of the test cushion. This helps eliminate the need to precisely define the instrumentation used. The drawback is that testing a reference cushions adds time and cost to a test battery.

Normative scoring is done using normative values taken on flat foam cushions. Currently, two different reference foam cushions have been tested nine times each. This data set allows the calculation of means and standard deviations. Threshold values are defined at 1 and 2 standard deviations below the mean. Again, points are awarded when the test cushion returns values that are below these thresholds. The benefit of this approach is that normative values remove the need to test a reference material as threshold values are set by the normative data set. The drawback is that we do not know how test variables will vary across sensors and loading instrumentation.
In addition, two metrics are binary scores with no comparison: IT magnitude and contact at 4 cm. For IT magnitude, the test cushion is awarded a point if the pressure at the IT is less than 100 mmHg. For contact at 4 cm, a point is awarded if the cushion makes contact (defined as pressure over 10 mmHg) at 4 cm vertical and lateral to the IT.

Over 15 variables have been defined and calculated for all cushions tested. A subset of 9, presented here, reflect the most promising variables based upon coverage of the 3 categories and repeatability.

envelopment	**Parity10**= relationship between -1 cm, IT & +1 cm; closer to 0 reflects greater parity
envelopment	**Parity20**= relationship between IT and 2 cm; closer to 0 reflects greater parity
magnitude	**Mag IT**= magnitude of the pressure at the most inferior point
magnitude	**IT change by condition**= % change in IT values from lower to higher load; only calculated for 84 kg load
magnitude	**IT-100**= IT value minus 100; 1 if <100 & 0 if >100 (only for 84 kg load)
immersion	**Contact at 4 cm**= binary value; +1 if contact is made to 4 cm sensor; contact is defined as >= 10 mmHg

envel/mag	**%IT centrally**= % of IT load compared to 3 inferior values; help discern off-loading of IT
envel/mag	**%IT laterally**= % of IT value compared to sum of IT, +1 and +2 values; helps discern off-loading of IT
magnitude	**%diff of sum to foam**= % diff between sum of all 4 values in test cushion compared to foam

Two subsets of these defined variables have been defined and scores tabulated for each subset

Subset A	**Subset B**
Parity10	MagIT
Parity20	IT change by condition
MagIT	IT-100
IT change by condition	Contact at 4 cm
Contact at 4 cm	%IT centrally
%IT centrally	%IT laterally
%IT laterally	%diff of sum to foam
%diff of sum to foam	

Cushion cohort: A 10 cushion cohort has been tested to date (in addition to the reference foam cushion). This cohort includes 7 cushions that have been coded K0108 due to their purported adjustability. For the adjustable cushions, the 'best' value obtained for each variable was used for scoring. For example, the Jay2 is adjusts by means of different pads – normal fill, overfill, and underfill. Data was taken and variables calculated with each fill. Then the best value – the value most likely to receive a point, usually the lowest – was used for scoring. With this method, certain 'best' metrics may have been obtained with the normal fill pad while others may have come from the overfill or underfill pads.

Adjustable cushions will be tested by mimicking different body weights and tissue thicknesses. Body weight is represented by the loading on the model and tissue thickness represented by gel pads.

RESULTS

DISCUSSION

REFERENCES:

(1) DMERC Region C "Wheelchair Seating: Coding and Pricing Changes." Medicare Advisory 51(Winter 2004): 169-170.