Investigation into the minimum thicknesses of foam needed to provide pressure relief in custom contoured seating – based on the material and user body weight

Bethany Gill
Specialist Disability Service, Oxford University Hospitals NHS Foundation Trust
Department of Medical Engineering and Physics, Kings College London

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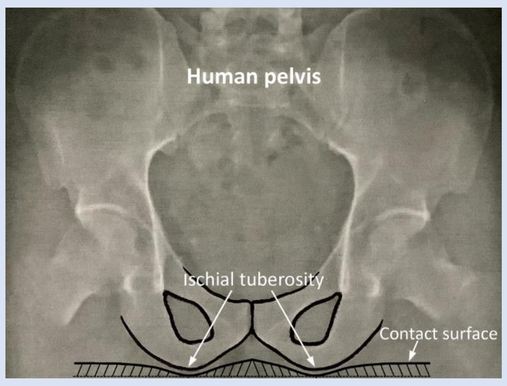
Introduction

Indicators for custom contoured seating (CCS):
- Postural asymmetries
- Reduce further deterioration
- Provide pressure relief
- *Optimise comfort and function* [1]



Highest pressure often acts through ischial tuberosities (ITs) [2]

CCS is often made from foam however…

Currently no evidence-based guidance as to suitable tolerances

Insufficient tolerance under a bony area may cause 'bottoming out'

Reducing the amount of foam used would

Reduce wastage	Reduce height of knees	Reduce head height

Increase accessibility

Aim

To provide useful guidance for the usage of foam within seating, that can be tailored based on the body weight of the patient and type of foam

Protocol decision making

Body weights to be tested:
- 400 – 850N, representing body weights of ~ 52 - 114kg [3] [4] [5]

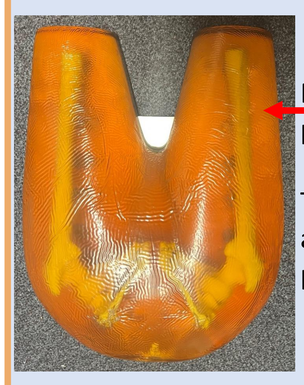
Materials to test:
- CM50
- GB42H
- LD24

} Similar properties, so direct comparisons made

Key parameters determined from literature review:
- Peak pressure index (PPI)
- Coefficient of variance (CoV)
- Dispersion index (DI)

- Peak [6] [7] and average pressures [8] deemed unreliable

Equipment



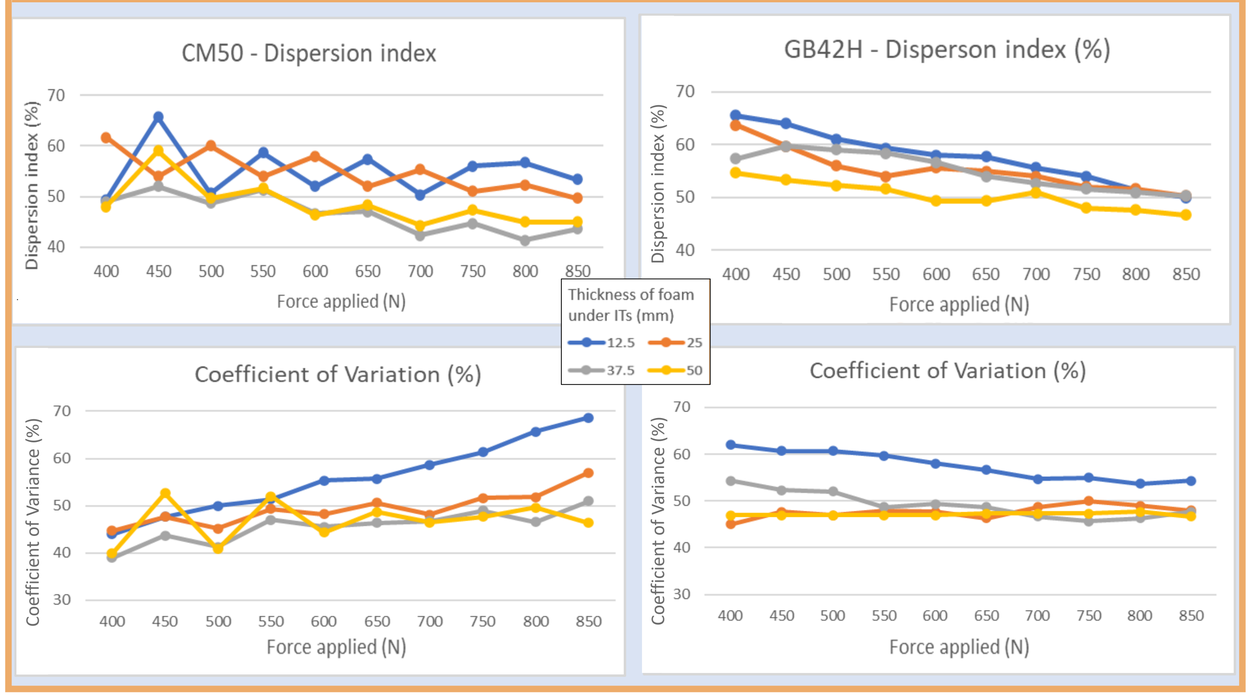
Model and testing rig specified by ISO 16840 [9]

Rigid skeleton encased in gel, modelled on a 50th percentile male with a T6 spinal cord injury [10]

Testing rig ensures a perpendicular force is applied through the ITs, as in the ideal seated posture

BodiTrak2 Pressure Mapping Systems

Results



Application to clinical practice

From current literature, it can be determined that DI less than 55% shows good distribution of pressure [8] [11]

Peak pressure less than 60mmHg can increase the risk of pressure injury incidence [12] [13]

Considering both of these factors alongside results, the following guidelines can be proposed:

CM50	GB42H
12.5mm not sufficient for either foam	
Up to 66kg can use 25.0mm	Up to 98kg can use 25.0mm
Up to 98kg can use 37.5mm	Up to 111kg can use 37.5mm
Up to 105kg can use 50.0mm	Up to 111kg can use 50.0mm

Overall, the GB42H foam appears to better suited to heavier body weights – as it requires a higher force to compress.
LD24 foam does not meet these thresholds, and so care should be taken when using in weightbearing areas

Longitudinal testing

Seats were loaded for a period of 8 hours, with pressure readings taken every hour. All foams had the same reaction when left loaded for a period of 8 hours:

Slight increase in PPI over time. Peak pressure continue to increase – which increase the PPI (PPI=average pressure within 10cm^2 of highest reading)

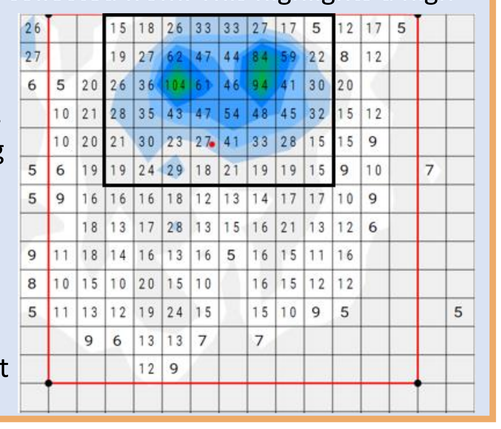
Slight decrease in CoV and DI over time. As foam 'sinks in', more lower peripheral readings are included in calculations, therefore decreasing them.

Most notable change within DI in the first 2 hours, then results plateau.

Data analysis and discussion

The pressure relieving parameter considered influences whether the thickness of foam, force applied, or both, are significant in the results.

Of note, data analysis for the GB42H and LD24 foams found the repeats to be significant – meaning the output was dependent on which repeat it was collected from. This highlights a high chance that the results are affected by method.



Using a flat pressure mat within a highly contoured seat causes inevitable creasing, leading to artificial high reading. This can be reduced by placement of the red box (removing artefact top left) however this introduces some inter/intra-assessor variability. As does defining the IT/sacral region (black box) for DI calculation.

Variation dependent on parameters highlights that they should always be considered together rather than using just one for clinical decision making.

Future Work

The following factors that influence pressure relieving qualities are not considered within this study: moisture, temperature, airflow, humidity.

Although the 'body weight' was increased it was not possible to alter the soft tissue distribution accordingly.

No dynamic forces were applied, and so the above data can only be applied to the static conditions in which they were tested.

Testing over longer periods of time would be beneficial for investigation of material creep.

The main limitation is that it does not consider the changing properties of foam over time.

Testing new and used foam over time would establish the differences: ISO 3386-1 determines a method for the determination of compression properties [14].

The results only considers a neutral, level pelvis – which is often not the case for CCS users.

Future testing should include consideration of: recline, tilt-in-space, shear forces, backrest interaction.

References

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