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Thermal and Comfort Measurements of Mattress Protectors Used for Prevention of Pressure Ulcers

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OBJECTIVE

This work attempts to characterize several mattress protectors in terms of their ability to prevent Pressure Ulcers by testing their thermal and mechanical characteristics.

INTRODUCTION

Pressure Ulcers develop when there is excessive pressure on a bony prominence for a long period of time, which may compress the tissue and blood vessels between the bone and the support surface. This compression, when prolonged, can cause ischemia, and eventually necrosis of the tissues. See Figure 1 for an example of the four stages of an ulcer.

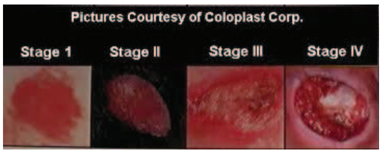

Figure 1 – Stages of a Pressure Ulcer

Pressure Ulcers show a high incidence and prevalence, are extremely costly to treat, and provoke immense suffering for patients, who are at risk of dying from related complications, such as sepsis.

Pressure Ulcers are the result of a combination of factors, with some of the most important being pressure, temperature and humidity. The assessment of these properties in different textiles is a first crucial step for the objective of a broader project: the development of textiles that aid in the prevention of Pressure Ulcers by redistributing pressure, reducing temperature and managing humidity.

APPROACH

The characteristics of the six tested mattress protectors are summarized in Table I.

Table I – Characteristics of all samples

Code	Fabric	Filling	Base
A001	70% bamboo; 30% polyester	70% polyester; 30% bamboo	100% cotton
A002	100% cotton	100% polyester	100% polyurethane
A003	100% cotton	-	100% polyurethane
A004	80% cotton; 20% polyester	-	100% polyurethane
A005	100% polyester	100% cotton	100% cotton
A006	75% cotton; 25% polyester	100% polyester	100% PVC

RESULTS AND DISCUSSION

Samples A001 and A005 showed the highest mass per unit surface (approximately 700g/cm^2) and thickness (7-8mm), whereas samples A003 and A004 where the ones with the lowest mass (between 100 and 150 g/cm^2), and less than 1.5mm thick.

It was found that only two samples were permeable to air – A001 and A005. This is explained by the fact that all the other textiles had an impermeable coating of PVC or polyurethane.

As for draping properties, most samples showed a drape coefficient higher than 0.9, making them extremely stiff. The exceptions were samples A003 and A004 (0.6). These results confirm the stiffness test, in which we calculated flexural rigidity.

KES was used to evaluate compression, tension and shear. Only two samples were analyzed for their compressive properties. Results showed that sample A003 had the best recovery from compression (52%), but it was sample A004 that showed the best compressibility (70%).

It was impossible to test sample A001 in both tensile and shear evaluation, due to its thickness. As for the other fabrics, it was found that tensile resilience varied between 29% and 50% (A005 and A002, respectively). Moreover, results indicated that all samples tended to be inelastic – the highest value was achieved by sample A004 (17%).

Shear testing revealed that sample A002 had the highest shear stiffness. On the other end of the scale, samples A003 and A004 denoted the lowest stiffness. Again, this appears to confirm both draping and stiffness results.

Friction was determined using FricTorq. Again, it was not possible to test sample A001 due to its thickness. All samples showed similar values (approximately 0.2), with the exception of A004 (0.3), making it the smoother fabric. This was expected, given previous results of stiffness, drape and other mechanical properties.

The evaluation of thermal properties included testing with the Alambeta equipment and with a dry thermal manikin. The Alambeta yields four relevant parameters: thermal conductivity (λ), diffusion (α), absorptivity (b) and resistance (r). Table II shows the results obtained.

Table II – Alambeta results

	λ (W/mºK)	α (m^2/s)	b (W.$s^{1/2}$/m^2 ºK)	r (m^2ºK/W)
A001	64.3	0.79	71.04	125.8
A002	48.62	0.62	61.8	114.4
A003	40.2	0.14	114.44	8.82
A004	36.98	0.53	52.62	37.94
A005	52.18	0.41	82.62	135
A006	50.26	0.76	57.78	127.2

To determine the thermal isolation of the fabrics we used a thermal manikin on a constant temperature program, and employed the parallel method for determining isolation. Results showed small differences between samples, with values varying between 0.6 and 0.8 Clo (samples A002 and A006, respectively). These results indicate that all mattress protectors have good thermal properties, but sample A006 is the best at keeping the body's temperature constant.

Finally, we tested the protectors for their ability to wick water vertically. Results showed that all samples have similar wicking abilities in both directions, with the exception of sample A006, which only wicks water in the direction of the warp. Sample A003 showed the slowest wicking velocity (approximately 0.05cm/min), whereas sample A004 was the fastest – approximately 0.5cm/min. Moreover, it was found that samples A004 and A002 achieved the highest height in water wicking – approximately 5cm.

CONCLUSIONS

All these results combined appear to indicate that samples A004 and A005 would be the best choices for the prevention of Pressure Ulcers. Table III shows a qualitative evaluation of all samples tested.

Table III – Evaluation of samples

	Thermo	Mechanic	Humidity	Struct.
A001	Good	No data	Good	Excel.
A002	Good	Fair	Excellent	Good
A003	Good	Excel.	Poor	Fair
A004	Excel.	Excel.	Excellent	Fair
A005	Excel.	Poor	Good	Excel.
A006	Excel.	Fair	Fair	Good

Sample A005 is extremely thick and has a low coefficient of friction. Its thickness is expected to absorb pressure from the user and distribute it across its surface, thereby delaying a situation where too much pressure would lead to the development of Pressure Ulcers. Moreover, its low coefficient of friction means that it is capable of sustaining the user's body without the person sliding, which could cause the skin to break down. However, sample A004 showed opposite, less desirable results.

Although sample A005's mechanical properties are not the best (high stiffness, low drapeability, inelastic and with a low recovery from mechanical forces), it appears that this is a necessary trade-off in order to have good results in other properties. In terms of mechanical properties the best sample was by far A004.

Finally, sample A005's thermal properties were fairly good – excellent water absorbency, reasonably good wicking capability and excellent thermal isolation. On the other hand, sample A004 did not absorb water and had poorer thermal isolation, although it did show the best wicking capacity.

In sum, these results suggest that samples A004 and A005 perform best for the purposes of preventing Pressure Ulcers. Therefore, future work will focus on how to best apply them in a clinical setting.

FUTURE WORK

Future work will focus on conducting water-vapor permeability tests and on analyzing the protector's capacity to manage and distribute pressure. This will be accomplished by using a pressure-sensing mat in conjunction with the thermal manikin.

ACKNOWLEDGMENT

This work was supported by FCT with the grant SFRH/BD/79762/2011.

REFERENCE

Theaker, C. (2003). "Pressure sore prevention in the critically ill: what you don't know, what you should know and why it's important." *Intensive and Critical Care Nursing, 19* 163–168.