

Poster Presentation Winner:
Charles Lachenbruch Award for Innovation 2020

It's All About the Base: A Comparison of Mattress Ticking Base Materials to Explore Implications for Pooling

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Background

A study by Haxby et al (2019)¹ demonstrated that using breathable material for the top of mattress tickings can help reduce pressure ulcers, by wicking the moisture away from the patients, but there is little research into the choice of base material.

The same study by Haxby et al (2019)¹ showed that support surface covers and cores need to work together to achieve optimum breathability, in order to best manage patient microclimate at the skin/support surface interface.

PVC is often used in the healthcare sector for base material on mattress tickings.

PVC is not breathable, which can lead to moisture damage inside the mattress.

Water vapor molecules travel down the humidity gradient, away from the heat source (the patient) and then condense when they cannot escape the PVC, forming a wet patch at the bottom of the mattress. This is referred to as the 'pooling' effect.

It can incorrectly give the impression the cover has leaked and could also lead to the formation of bacteria and mold.

There is little research available into the effects of pooling in medical mattresses.

Purpose

This paper aims to explore the difference in temperature and humidity levels seen inside the mattress when using different materials for the base of mattress tickings, and therefore can the risk of pooling be reduced by choice of base material.

Method

A castellated foam core mattress was covered with a mattress ticking first made with a PVC base material, and then a breathable polyurethane (PU) base material. Both mattress tickings were made using a breathable PU material for the top.

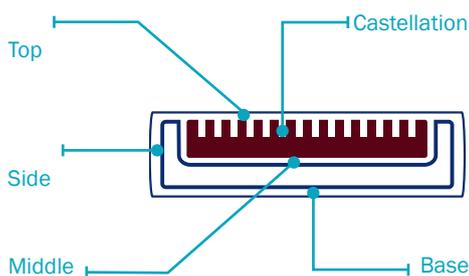
Humidity sensors were placed throughout the layers (top; inside castellations; middle; bottom & side) of the mattress construction (See 'Sensor Set Up' Diagram). A sweating torso, designed to replicate a human body, was placed on top of the mattress. A duvet was placed over the sweating torso to further

simulate a real-life experience. Data was collected using a Body View system supplied by Inside Climate GmbH. The test was run for 27.5 consecutive hours, with the torso actively providing heat and humidity for the first 20 hours. After this time, the torso remained on the mattress and moisture levels continued to be monitored for another 7.5 hours as the mattress recovered.

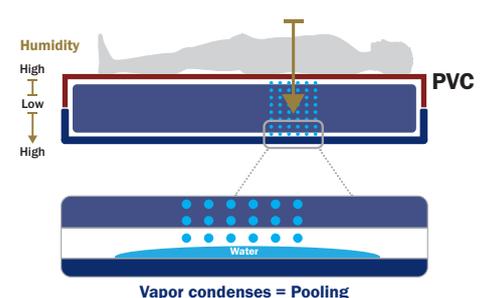
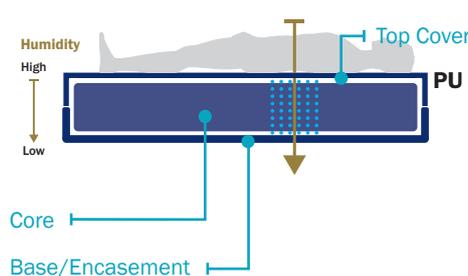
Each mattress ticking was tested 5 times and the results from each test were averaged.



SENSOR SET UP



WHAT IS POOLING?



With a PU base, the water vapor molecule travels down the humidity gradient, away from the heat source (the patient) and escapes as a gas.

With a PVC base, the water vapor molecule turns back to liquid form when it cannot escape through the non-breathable base layer, 'pooling' at the bottom.

Results

LAB TESTING OF FABRIC SAMPLES

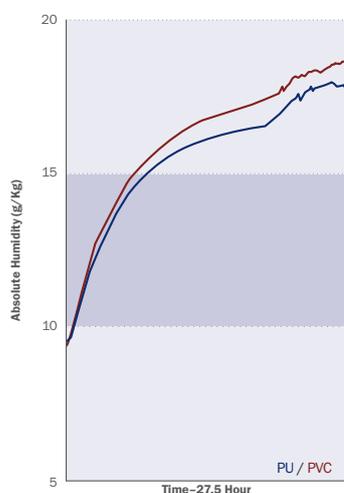
In a laboratory setting, the PU base material is demonstrably more breathable than the PVC base material:

TEST METHOD	PAYNE CUP ASTM D1653	ASTM E96 METHOD B	ASTM E96 METHOD BW
UNIT	g/m ² /24HOURS	g/m ² /24HOURS	g/m ² /24HOURS
PU BASE - MIC624	1200	300	600
PVC BASE	57	25	33

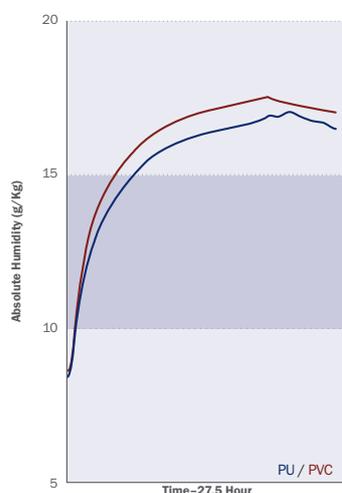
GRAPHS - ABSOLUTE HUMIDITY

As the test progressed, the humidity seen at the base of the mattress rose quicker for the PVC base ticking than with the breathable PU base ticking:

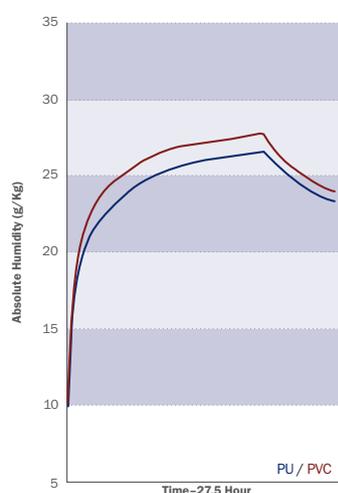
ABSOLUTE HUMIDITY: SEEN AT BASE OF MATTRESS



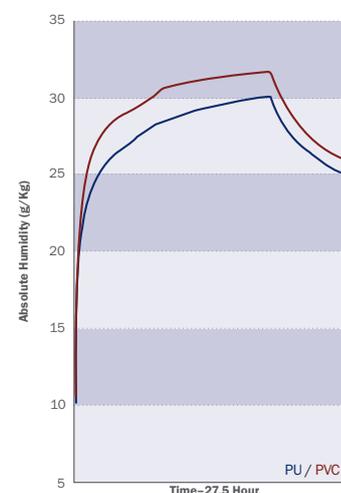
ABSOLUTE HUMIDITY: MIDDLE



ABSOLUTE HUMIDITY: INSIDE CASTELLATIONS



ABSOLUTE HUMIDITY: TOP



Throughout the other layers of the mattress the level of humidity recorded by the sensors was consistently higher with the PVC coated base fabric than with the PU coated base fabric.

As expected, as the test progressed, we saw higher humidity in the mattress with the PVC base compared to the PU base in the middle and at the base of the mattress, although the difference was not as large as anticipated.

Unexpectedly, a large difference was seen at the top of the mattress, where we would have expected both readings to be roughly the same as the same fabric was used for the top cover on both samples.

As moisture diffuses down a concentration gradient, the higher humidity seen in the PVC base could slow down transfer of moisture away from the patient.

At the middle and base of the mattress, the humidity continued to rise after the torso was turned off, whereas at the top and inside the castellations, the humidity started to decrease at this point. This suggests that patients who are in bed for prolonged periods of time, for example at end-of-life, could be more at risk of developing moisture build up in the mattress.

Conclusion

Using a PU rather than PVC base reduces the humidity at the bottom of the mattress, which should reduce the risk of pooling, and water damage to the foam.

Breathable mattress tickings work as moisture diffuses down a concentration gradient from the high humidity area between skin and fabric to the low humidity area inside the mattress. A high humidity inside the mattress will reduce the rate moisture can be removed from the patient. The lower humidity measured in the mattress with the PU base should increase the surface's ability to move moisture away from the patient, maximizing patient comfort and minimizing the risk to skin integrity from high humidity.^{2,3}

A breathable base fabric with a higher MVP will allow more moisture within the mattress core to pass through, reducing the occurrence of pooling, and

increasing the lifetime of the mattress.

When specifying mattress tickings in a medical environment, is it important to consider the choice of fabric for the base as well as the top ticking, especially when teamed with a highly breathable top ticking, as the best outcomes occur when cover and core work together to move moisture through the mattress.

Further research is required to build on these findings and further demonstrate the benefits of using polyurethane-coated fabrics for medical support surface bases.

REFERENCES

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- Fisher SV, Szymke TE, Apte SY, Kosiak M. Wheelchair cushion effect on skin temperature. Arch Phys Med Rehabil 1978; 59(2): 68-72.
- Brienza DM, Geyer MJ. Using support surfaces to manage tissue integrity. Adv Skin Wound Care 2005; 18: 151-57.

ACKNOWLEDGMENTS

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