

LINET

**NEXT-GEN HYBRID MATTRESSES
THE EVOLUTION OF PRESSURE INJURY
PREVENTION IN HEALTHCARE**



BACKGROUND

Globally, pressure injuries significantly impact healthcare. The National Pressure Injury Advisory Panel (NPIAP) presents some hard-hitting facts about the burden of pressure injuries. According to them, managing pressure injuries is costly; in 2019, this cost amounted to 26.8 billion USD (NPIAP, 2019). The NPIAP's findings are consistent with those of the NHS in the UK, which estimated that costs related to pressure injuries (PI) can account for up to 4% of the annual healthcare budget. (WoundsUK, 2023)

Factors influencing this include an aging population and a shortage of healthcare professionals, leading to a continual increase in pressure injury-related expenditures within healthcare systems. Pressure injuries are among the leading causes of increased hospital stays, reduced patient quality of life and poor outcomes. High mortality rates are also associated with pressure injuries in hospitalized patients, resulting in 60,000 pressure injury-induced deaths annually in the US (NPIAP, 2019).

The current approach of pressure injury prevention includes choosing support surfaces according to the patient needs. Support surfaces include the use of passive mattresses and when a patient's risk of PI increases, they are then placed on a pressure air overlay or a pressure air mattress. The most challenging aspects of the mattress replacement process include the time needed for inflation, the logistics of moving them to and from storage, the staffing required for the task, and the necessary storage space for the pressure air mattresses and compressors. At this point, a faster solution for effective step-up and step-down care could be in the form of hybrid mattresses. These can be used as passive mattresses, and when connected to a compressor, they can provide active alternation for the patient without the need to transfer the patient or transport equipment across the department or hospital.

CONCLUSION

In response to the challenges of preventing pressure injuries, LINET has developed the HybriMatt mattress system. This system offers the flexibility to switch from a passive to an active system with a simple step of connecting to a compressor. This easy step allows quick responses to changing patient conditions, thereby supporting acceptance with alternating therapy, which can often be poorly tolerated by conscious patients on pressure air mattresses. In comparison to traditional pressure air mattresses, the HybriMatt system provides gentle alternation due to the presence of viscoelastic "memory" foam on top of air cells. This foam not only contributes to even pressure redistribution across the body for individuals of different weights and body types, proven by pressure maps, but also enhances patient comfort.

Furthermore, another crucial aspect of pressure injury prevention is the support of the patient's skin microclimate, where increased temperature and moisture can contribute to the development of pressure injuries. To address this concern, the HybriMatt 200 model is equipped with MicroClimate Maintenance (MCM) technology designed to support moisture vaporization. The effectiveness of MCM was demonstrated in testing, showing a reduction of moisture by 27 % after 24 hours.

This multifaceted approach to pressure injury prevention makes the HybriMatt mattress system a comprehensive solution for patient care and comfort.

PREVENTION VS. TREATMENT OF PRESSURE INJURIES

Treating pressure injuries is not only costly but also results in prolonged hospital stays for patients, with an average extension of 9.4 days for those with hospital-acquired pressure injuries (HAPI). In terms of financial impact is reported that the cost for treating these injuries ranges from £1,214 to £14,108 GBP, varying based on the injuries category (DeDealey C, 2012). Compounding this issue, in the Tervo-Heikkinen study they stated that the prevalence of HAPI in acute care settings worldwide is between 6% and 18.5% (Tervo-Heikkinen TA, 2022). Therefore, these findings underscore the critical need for more effective prevention of pressure injuries in hospital settings.

Bearing this in mind, along with the evidence that healthcare facilities should try to reduce the prevalence of PI, which can be prevented in 73% of cases with effective preventive strategies (Moore, 2023), it becomes clear that reducing the risk of pressure injuries in patients can make a significant difference. Even a small reduction in HAPI prevalence can impact a hospital's costs, improve patient outcomes, and reduce the length of stay for these patients. This creates additional capacity for more inpatient cases and increases revenue (Lfache NV, 2022)

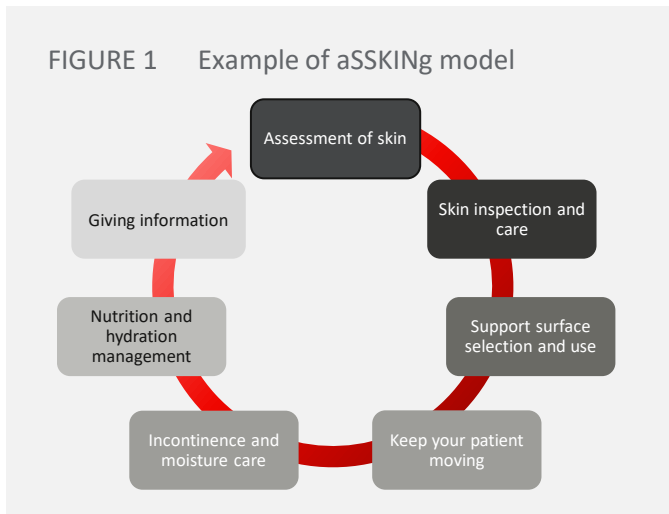
**73 % of pressure injuries can be prevented
with effective preventive strategies.**

(Moore, 2023)

However, not all healthcare systems are equal globally. There are differences in each healthcare setting regarding prevention programs, influenced by budget constraints, equipment availability, policies and procedures, which may hinder the implementation of a pressure injury prevention program (Solley, 2020).

In conclusion, it is important to remember that pressure injuries impact not only hospitals and caregivers but also the health and quality of life of patients.

PROACTIVE PRESSURE INJURY PREVENTION STRATEGIES BEYOND HEALING



Building a comprehensive prevention program requires a multidisciplinary team including the patient, family, doctors, nurses, nursing assistants and caregivers, dietitian, therapists, and other health care providers. The main four components of a comprehensive prevention program are a comprehensive skin assessment, a standardized pressure injury risk assessment, care planning, and implementation of the program to address areas of risk. There are various models of strategies, one example is the aSSKING model (Young, 2021), which aids nurses in tracking and covering necessary steps for PI prevention.

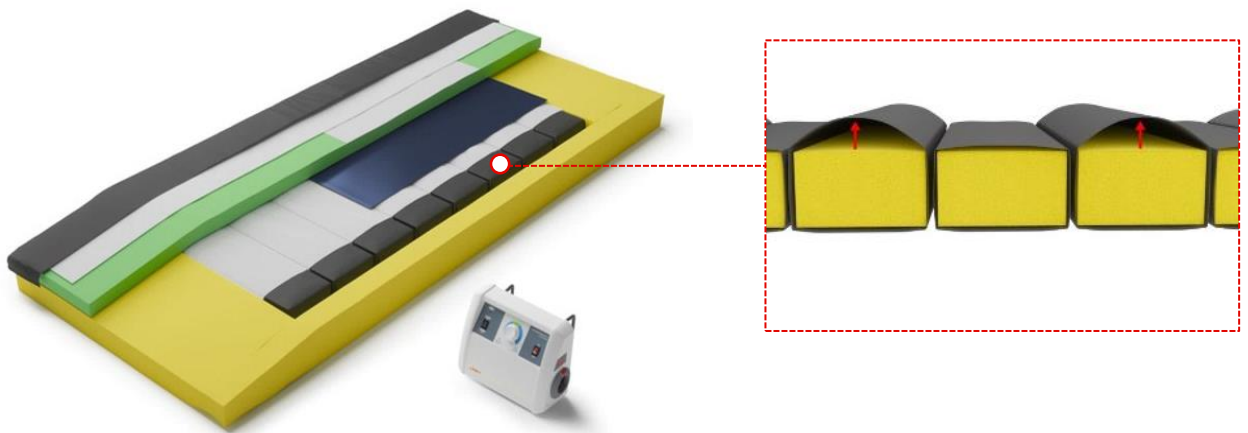
A key part of the pressure injury prevention is the selection and use of support surfaces. While support surfaces play a crucial role, they're just one part of the comprehensive strategy. Their impact extends to other stages in the model, like patient mobilization and managing their microclimate, as highlighted in the aSKING model. Factors to consider when choosing the right support surface according to a patient's needs (EPUAP/NPIAP/PPPIA, 2019) include:

1. Level of immobility and inactivity,
2. Need to manage microclimate and reduce shear,
3. Patient size and weight,
4. Number, severity, and location of existing PIs,
5. Risk of developing new pressure injuries.

As a patient's condition changes during their hospital stay, so does their risk of developing pressure injuries. This necessitates adjustments in nursing care and reassessment of the adequacy of the current support surface for pressure redistribution or microclimate management. Changes in patient conditions and mobility mainly influence stepping up-or down the support surface. (NT, 2022).

Caregivers now have several options for enhancing pressure injury prevention from a single block foam mattress, including high-specification foam mattresses, pressure air overlays, pressure air mattresses with alternation/immersion capabilities, and recent hybrid mattresses. Each technology has its advantages and disadvantages, indicating that no single mattress is the best solution for every patient with the same level of provided nursing care.

INTRODUCTION TO THE WORLD OF HYBRID MATTRESSES



A hybrid support surface blends the benefits of reactive and active support surfaces by using high-quality foam material inside inflatable air cells.

Hybrids function as passive mattresses when there is no active compressor. Designed to cater to various needs, they offer patients a supportive and comfortable surface. Depending on the type of foam used, the mattress either envelops or immerses the patient to redistribute pressure effectively.

Hybrid mattresses can be converted into an active system by the addition of power, which provides alternating pressure therapy via air/foam cells in the mattress. This active mode generates a soft tissue offloading effect.

An advantage of this type of system is the quick ability to convert between a passive and active surface without having to move the patient (Katz T, 2023).

Hybrids simplify the choice of mattress for caregivers as they are one piece of equipment and are suitable for a broader patient cohort. There are two types of hybrid surface: non-powered (can be called also “reactive”) that work on the principle of air displacement and allows the mattress to conform to the patient’s body shape and increases the surface area in contact with the mattress.

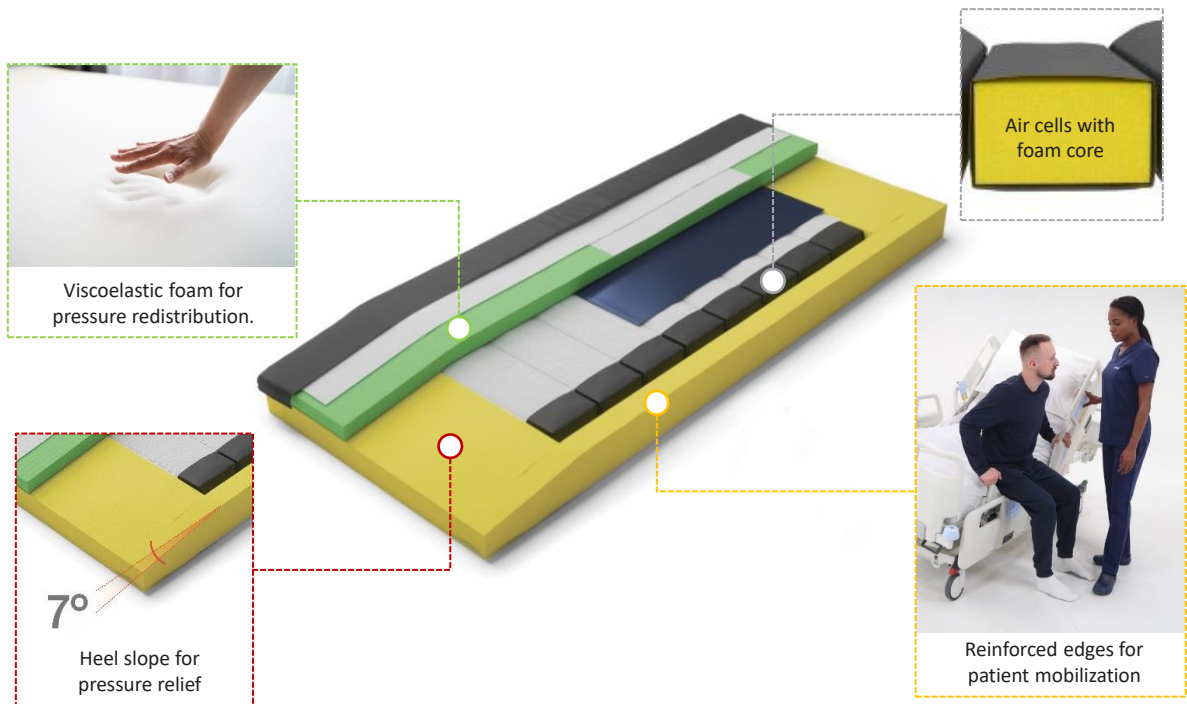
Powered hybrids also typically have a layer of foam with a series of air cells beneath and they function like a non-powered hybrid when not connected to a power source. When a power source e.g. compressor is attached to the mattress then alternating therapy can be provided and increase the pressure redistribution offered by the mattress. Hybrids also support patients throughout their hospital journey as they optimize ‘step-up’ ‘step-down’ approach to pressure injury prevention.

LINET HYBRIMATT SOLUTION

LINET has developed a new line of hybrid mattress system called HybriMatt, which comprises of three models: HybriMatt 100 (for either mattress replacement or integrated version) and HybriMatt 200 (for mattress replacement).



HYBRIMATT FAMILY FEATURES WHEN IN PASSIVE MODE (NON-POWERED)



The mattress itself is designed to enhance patient comfort and facilitate pressure redistribution when used non-powered mode. The top layer is made of viscoelastic foam, also known as "memory foam," which increases patient's pressure redistribution through envelopment . The impact of viscoelastic foam on pressure injury (PI) prevention has been investigated in studies. In the Yap study, it was described that the incidence of PIs decreased from 11% to 7.8% due to viscoelastic foams (Yap TL, 2018). The Li Bay study also investigated the impact of mattresses with viscoelastic foam, finding that patients on these mattresses had a lower prevalence of PIs compared to standard mattresses (Bai DL, 2020).

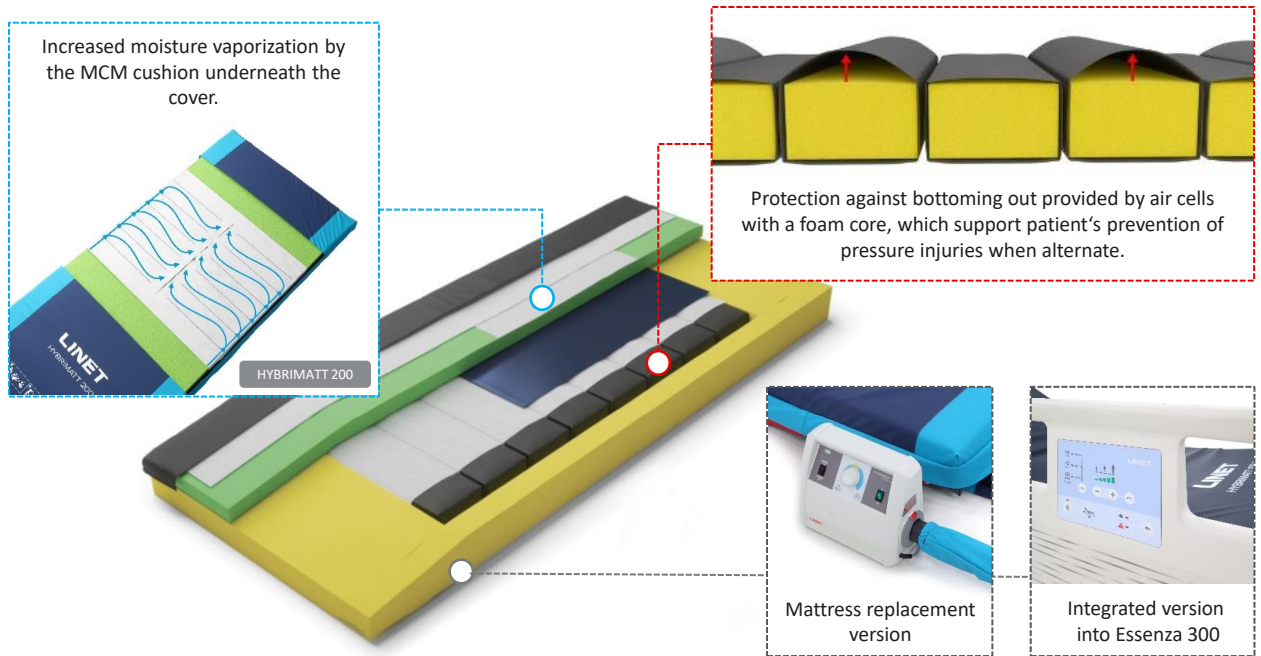
The use of viscoelastic foam in mattresses reduces the prevalence of pressure injuries.

(Bai DL, 2020; Yap TL, 2018)

Inside the mattress, a polyurethane layer can be found, which is divided into a frame, reinforced edges, and air cells with a foam core. The mattress edges are made from foam with higher density, creating a firmer surface named "reinforced edges," which support patients during mobilization and reduce the physical demand for egress compared to softer foams.

Foam with a 7° profile is cut in the foot area, allowing for effective pressure relief of the heels. The HybriMatt mattress is specifically designed to protect heels, which, after the sacrum, is the second most area impacted by pressure injuries, (EPUAP/NPIAP/PPPIA, 2019).

HYBRIMATT FAMILY FEATURES WHEN IN ACTIVE MODE (POWERED)



Inside of foam frame of the HybriMatt mattress are air cells with foam core, which can alternate if mattress is connected to compressor. With HybriMatt mattress range you can choose external or integrated compressor. This allows the health care facility to choose HybriMatt model according to their needs.

When HybriMatt mattress system is used in active mode, we can choose from Alternating Pressure Therapy (APT) or Constant Low Pressure (CLP). APT is used for patient which need to be supported by periodic reduction of pressure, mainly under sacrum, hip and scapula. In comparison with fully pressure air mattress, the HybriMatt creates gentle alternation thanks to a top viscoelastic layer, and conscious patient can tolerate it. This principle of gentle alternation was inherited from predecessor LINET CliniCare 100 HF.

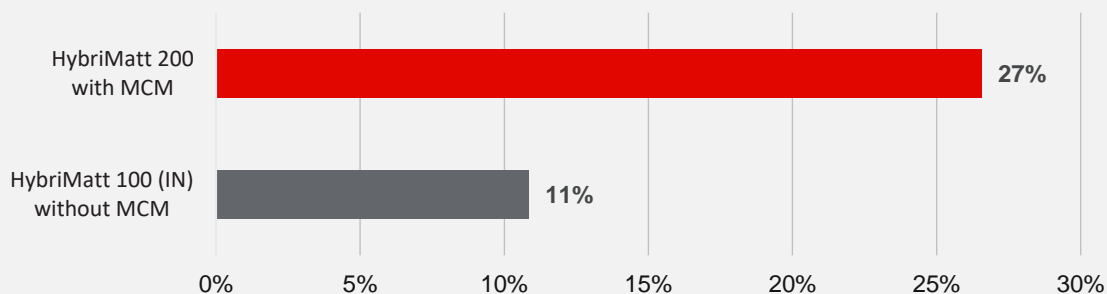
Another benefit of alternating hybrid mattresses is that the patient is protected from "bottoming out" due to the foam core inside the air cells, which supports the patient. In contrast, with pressure air mattresses, the patient is supported only by the air in the cells. These need to be periodically checked by the caregivers to ensure they are sufficiently inflated for the patient and not damaged.

MCM FUNCTION OF HYBRIMATT 200 FOR ENHANCED MICROCLIMATE SUPPORT

HybriMatt 200 is equipped with support of patient microclimate called Microclimate Maintenance (MCM). MCM is located under patient torso and allows air flow to increase moisture vaporization. For testing of effect of MCM we tested moisture vaporization, where we simulated 130 kg patient lying on mattress with mannequin and heating pad, where we measured moisture change over 24 hours.

For MCM testing we used Comfort cover, which has high vapor permeability. Results are explained in following figure.

GRAPH 1 | Vaporized moisture after 24 hours [%]



**HybriMatt 200 with integrated MCM
reduced moisture by 27% after 24 hours.**

(Linet Lab)

In summary, LINET laboratory measured that HybriMatt 200, equipped with MCM and a Comfort cover, can reduce moisture under the patient's body by 27%, compared to 11% when used HybriMatt 100 (IN) without MCM. Therefore, if you aim to maximize moisture vaporization underneath the patient, please consider using HybriMatt 200 equipped with Comfort cover and integrated MCM.

HYBRIMATT THROUGH THE LENS OF PRESSURE MAPPING

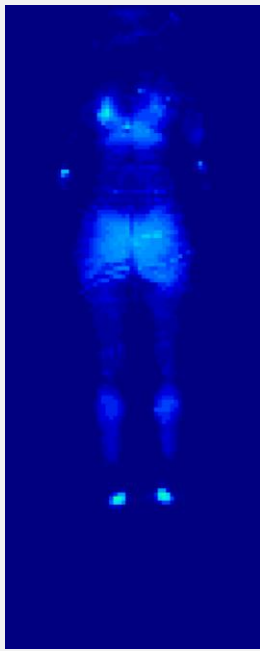
For validating the design of the HybriMatt mattress system, we utilized pressure maps to ensure optimal pressure redistribution beneath the patient's body. By analysing pressure distribution, we could tailor the mattress layers and internal pressure to achieve the best results in pressure offloading during mattress alternation.

Pressure mapping serves as an important tool in the development of hospital mattresses, aimed at preventing pressure injuries, offering invaluable insights into the distribution of pressure points of patient's body. Utilizing pressure-sensitive technology, these maps provide both visual and numerical representations of weight distribution.

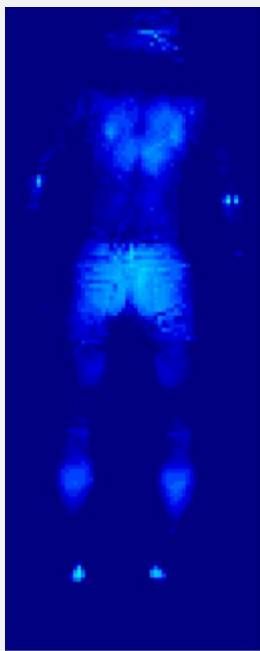
We conducted multiple pressure mapping sessions with healthy volunteers of varying genders, weights, and body types to gather sufficient data demonstrating the performance of the HybriMatt mattress system. For testing purposes, we employed the XSensor system, renowned for its thin material and conformable high-resolution sensors. However, due to the nature of this mat, occasional wrinkles in clothing or the mat may be visible, particularly in individuals with higher weights. Despite this, we have included these images to showcase the HybriMatt mattress. Additionally, all testing participants were provided with a cushion under their head to enhance comfort during testing.

PRESSURE MAPS | Display of pressure redistribution of 6 people on HybriMatt mattress

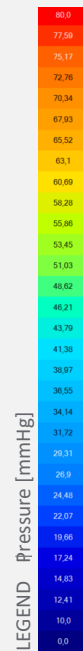
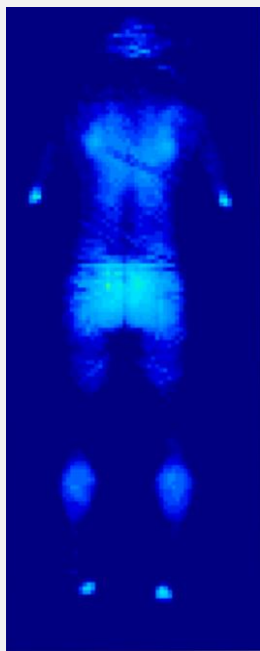
SUBJECT 1 | Female, 53 kg



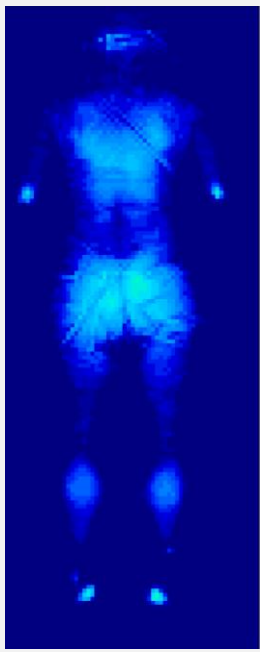
SUBJECT 2 | Male, 69 kg



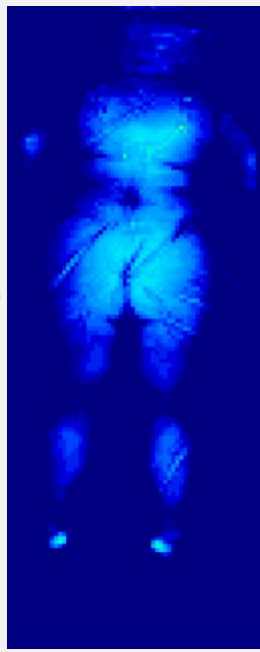
SUBJECT 3 | Male, 91 kg



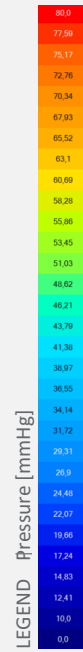
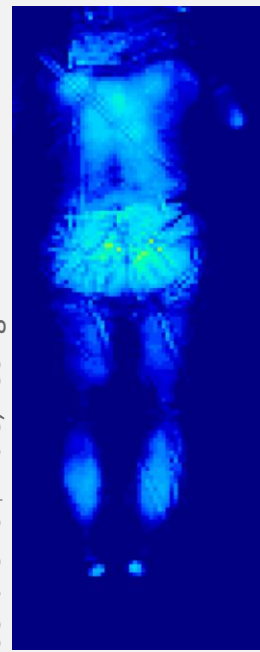
SUBJECT 4 | Male, 100 kg



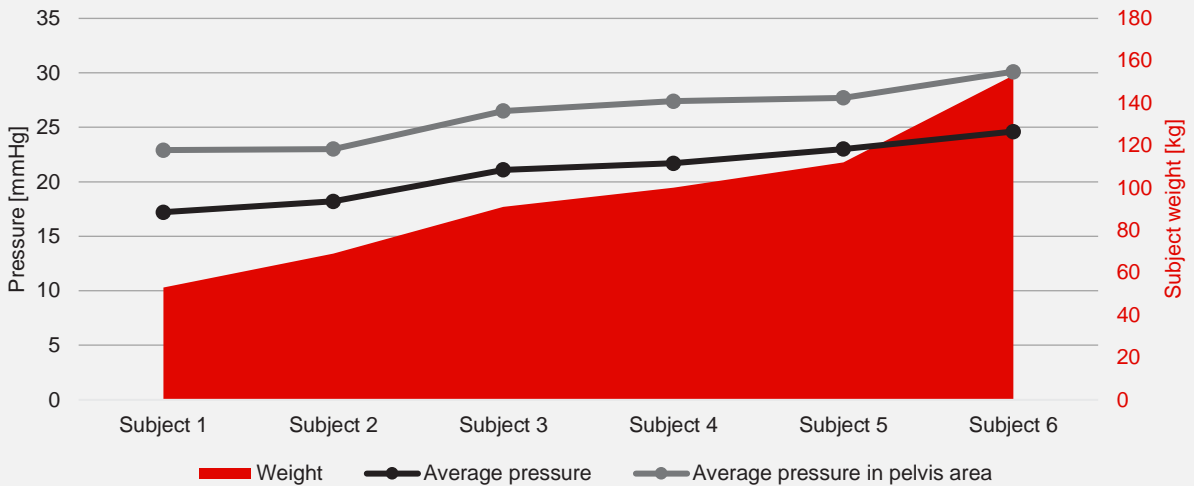
SUBJECT 5 | Female, 112 kg



SUBJECT 6 | Male, 153 kg



GRAPH 2 | Relationship of average pressure under all body and pelvis area with subject weight



In summary, we observed that as the weight of the individual increases, so does the average pressure across the entire body, including the pelvis. However, even with this increase in weight, the difference in average pressures between a person weighing 53 kg and one weighing 153 kg is only 7 mmHg. Based on the pressure maps, we can conclude that there is adequate pressure redistribution for various body types and weights.

HybriMatt mattress can adequately redistribute pressure for various body types and weights.

(Linet Lab)

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