Clinical Guide

LINET

Optimal Immersion

Understanding of Pressure Redistribution
and Concepts of Immersion and Envelopment

Optimal Immersion

Challenge

Global pressure injury
incidence in acute hospitals is thought to be around 6.3 %.[1]

Up to 95 % of pressure
injuries are thought to be avoidable.[2]

Nationally, the U.S.
spends about $26.8 billion a year treating pressure injuries.[3]

[Image 1]: 3D CAD image of patient immersed into the Opticare X Mattress

Introduction

Pressure injuries are a serious concern to hospitals and other care facilities, because they can be painful, increase the risk of serious infections and are costly to treat.

Support surfaces are designed to assist pressure injury prevention. They do this by redistributing pressure over a greater surface area, or by alternating pressure to provide regular pressure relief.

This guide will discuss mattresses that redistribute pressure, and explain the important concepts of immersion, envelopment, Critical Immersion and Optimal Immersion.

Pressure Injuries Definition in the 2019 EPUAP/NPIAP Guidelines

Localized damage to the skin and/or underlying tissue, as a result of pressure, or pressure in combination with shear. Pressure injuries usually occur over a bony prominence but may also be related to a medical device or other object.[4]

Pressure Redistribution

In the context of a patient on a mattress, interface pressure is determined by patient weight, gravity and surface area. We cannot do very much to influence gravity. However, increasing the contact surface areas of the mattress can reduce peak pressures. In patient support surfaces, this is known as pressure redistribution.

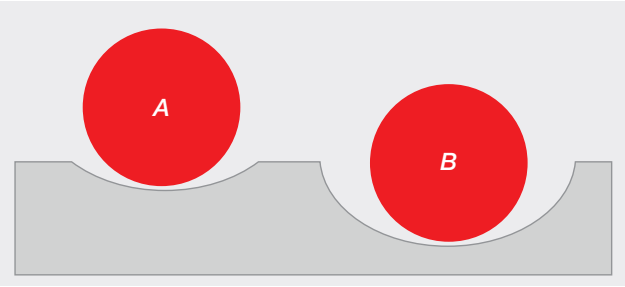
Pressure redistribution is the consequence of two mechanisms:

Immersion

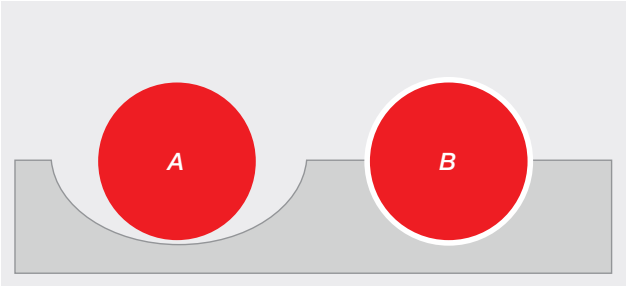
The ability to sink into a support surface

Envelopment

The ability of a support surface to wrap around the shape of the body[5]



[Image 2]: A: Low Immersion. B: High Immersion.

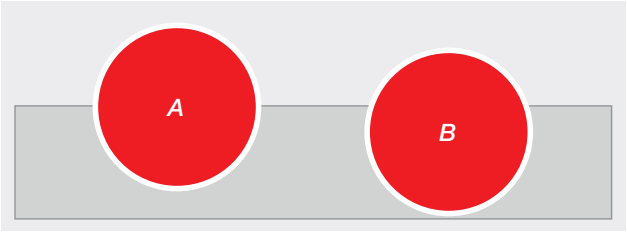


[Image 3]: A: Low Envelopment. B: High Envelopment.

Both immersion and envelopment are required for effective pressure redistribution.

Bottoming Out

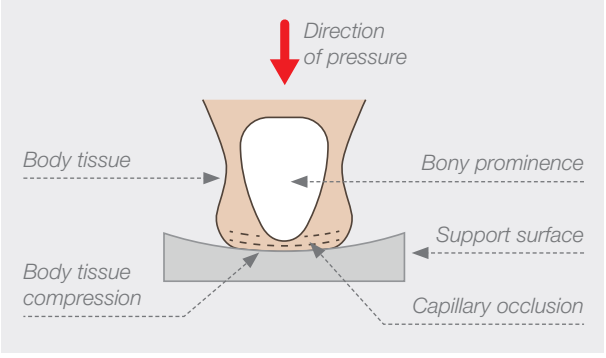
The more a mattress immerses and envelopes a patient, the more pressure is redistributed reducing potentially damaging peak pressures. However, if the patient immerses too far into the mattress, they will encounter the bed frame or a compressed foam layer (if there is one). This is known as 'bottoming out'. As soon as this happens, peak pressures dramatically increase.



[Image 4]: A: Effective Immersion and Envelopment. B: Bottoming out.

Bottoming out is defined by The American National Standard for Support Surfaces (2014) as "the state of support surface deformation at which no increase in mattress/overlay deformation occurs when further loading is applied."[6]

EPUAP/NPUAP guidelines (2019) defines bottoming out as "the state of support surface deformation beyond Critical Immersion whereby effective pressure redistribution is lost."[7]



Critical Immersion

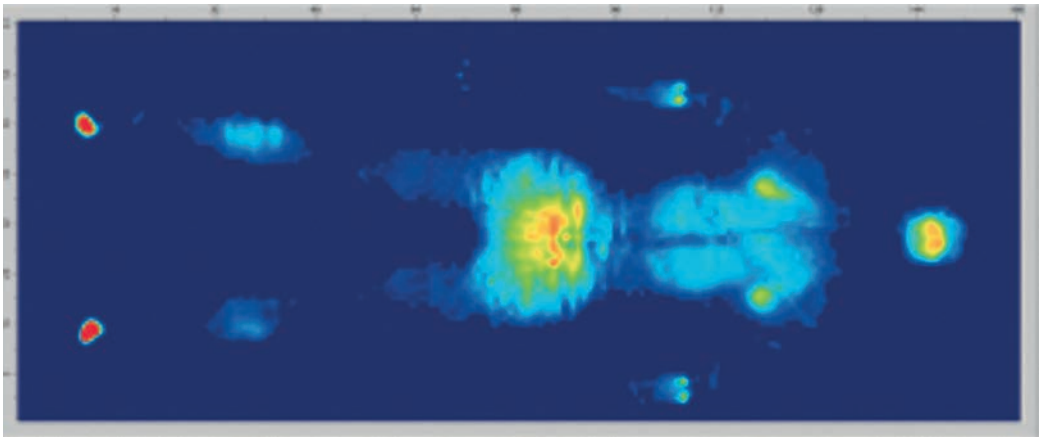
Critical Immersion is the point beyond which an increase in immersion results in a loss of effective pressure redistribution.[8]

To understand this concept, imagine a person laying on top of a fully inflated air mattress (MAX). Their immersion is low and peak pressures are higher than in other modes. Then, you reduce the air level in the mattress. Pressures reduce as the patient becomes more immersed and enveloped into the mattress. At some point the patient will reach an optimal point where peak pressures are minimized.

Peak pressures are at their lowest just before the patient 'bottoms out'. By EPUAP/NPUAP's definition, this point is Critical Immersion.

If you then continue to remove air, the mattress will 'bottom out' and peak pressures increase.

[Image 7]:
Peak pressure over time, as a mattress is deflated from maximum air to 'bottoming out'.



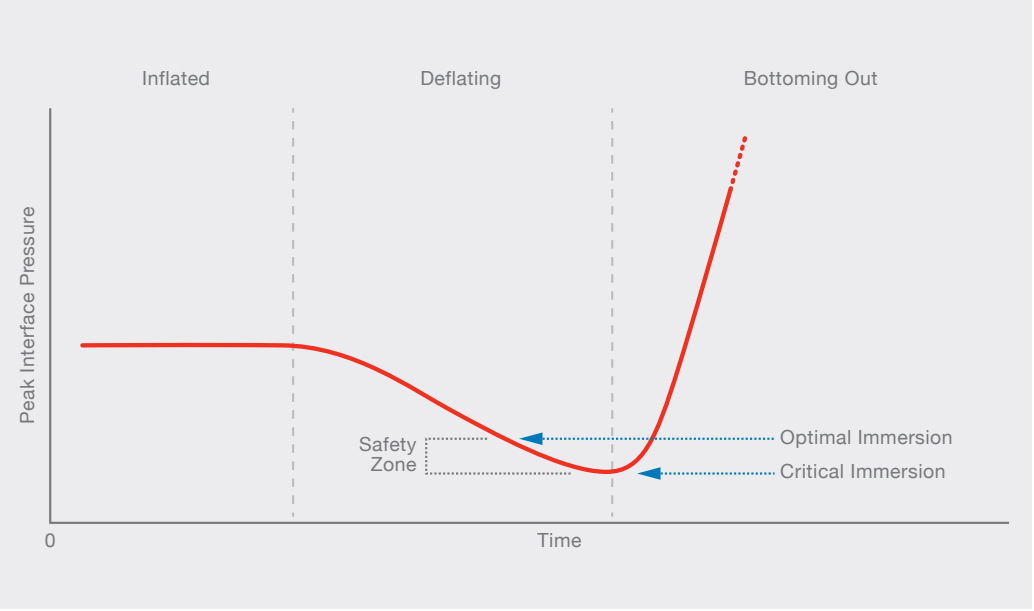
[Image 5]:
Pressure map showing peak pressures to the occiput, scapulas, sacrum and heels.

Optimal Immersion

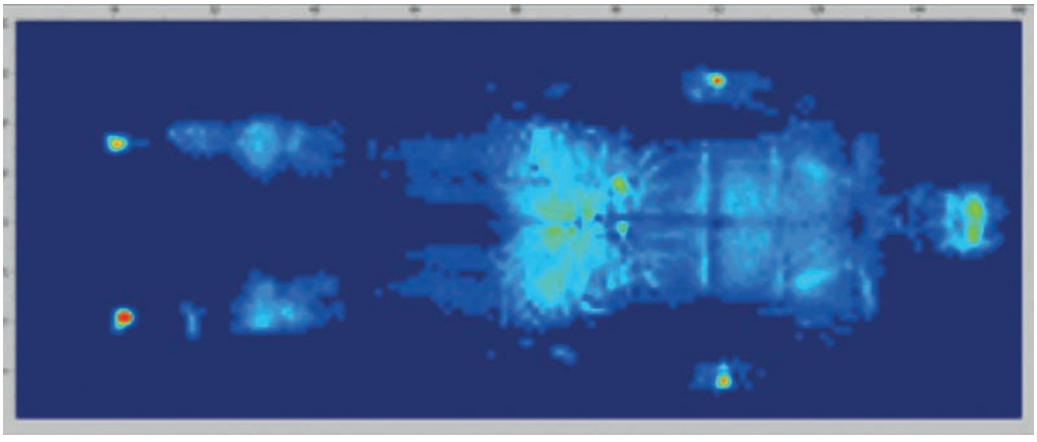
The problem with Critical Immersion, is it is very close to the point of ‘bottoming out’.

This means any movement or change in position can cause the patient to ‘bottom out’. If this occurs, peak pressures will increase, which is not desirable. Therefore, there should always be a ‘safety zone’ of air to mitigate the risks of bottoming out as the patient moves. At LINET we consider this ‘Optimal Immersion’.

Be aware, when an optimally immersed support surface is unloaded, it may appear to be partially deflated until mattress goes into standby mode and re-inflates. This is normal.



[Image 8]: Critical Immersion and Optimal Immersion.



[Image 6]: Mattress pressure reduced through Optimal Immersion.

Support Surface Design and Immersion

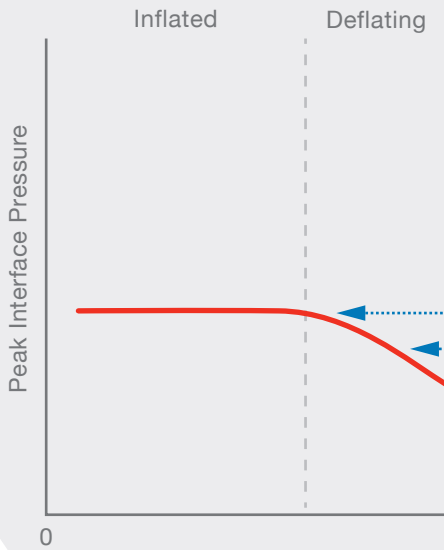
Many active support surfaces provide constant low pressure (CLP). CLP is an active mattresses mode that enables low internal cell pressures. This is so the support surface immerses and envelopes the patient to ensure lower peak pressures.

Some mattresses have manual settings, so the air level can be set by hand. This allows clinicians to adjust the pressure specific to the patient's weight and shape.

More sophisticated support surfaces use special sensors or measure the air pressure coming back to the pump resulting from the patient laying on the surface. This enables the mattress to set the air level automatically.

Mattress Modes

Different mattress types will have different modes. Here we explain the different modes on Opticare X.



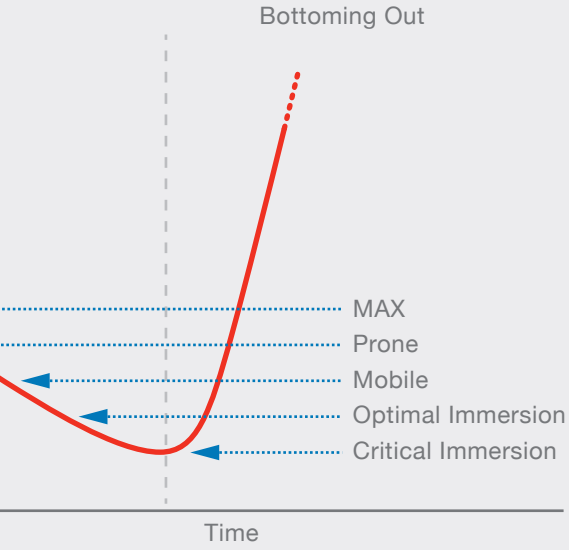
Modes on Opticare X in relation to Critical Immersion

Prone

Prone mode creates a more stable base. It does this by using a higher level of air than other therapeutic modes providing a balance between pressure redistribution and stability. Prone mode never times out, in order to protect the patient's airway. Prone mode is specific to Opticare X.

MAX

MAX inflate fills the mattress with air to create a very stable base. This is useful for sliding transfers, turning patients and certain medical procedures. On both Opticare and Opticare X this mode reverts to the previous therapeutic mode after 30 mins, if the time is not extended. This is to ensure a patient is never accidentally left on a MAX inflated surface after a procedure is completed.



Mobile

As a patient's conditions improve, they become more alert and mobile. Patient mobility is good for pressure injury prevention. This is because regular movement allows for natural pressure relief. As patients become more mobile, it can be desirable to use a less immersive surface to improve comfort and facilitate such independent movement.

In such case's the patient may benefit from moving onto a less therapeutic surface. To enable this, Opticare X offers a Mobile Mode to allow the mattress to be stepped down to a lower level of immersion.

Mobile mode on Opticare X is similar to the Constant Low Pressure (CLP) mode on many alternating mattresses.

Optimize

This mode is specific to Opticare and Opticare X, and is designed to attain Optimal Immersion. This is achieved by using patented sensor technology known as the Pressure Optimization System (POS).

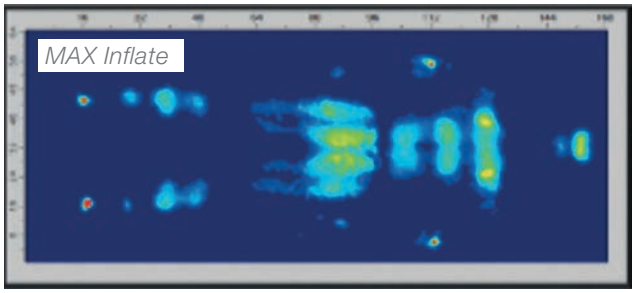
When patients lie down on the mattress, the patient's weight is detected, and the optimization cycle is triggered. This initialization process adjusts the air level to determine the point of Critical Immersion. A safety zone of air is then added to achieve Optimal Immersion. Opticare X regularly checks the air level to ensure they remain optimal.

Mattress Modes in Pressure Mapping

The pressure mapping images below show a 79 kg male subject lying supine on the Opticare X during optimization. A is MAX inflate mode, B, C and D show pressures reducing and the surface area increasing.

When the patient enters the bed it automatically optimizes by detecting when the patient is close to bottoming out, and then adding a safety zone air layer. The mattress regularly checks to ensure the air levels are optimized, thus maintaining Critical Immersion.

Some other mattresses use an algorithm based on the back pressure to the pump. This enables the mattress to adjust according to the patient's weight and size. However, this type of system is not able to accurately determine the point of Critical Immersion. Therefore, to avoid bottoming out, less immersion is offered.



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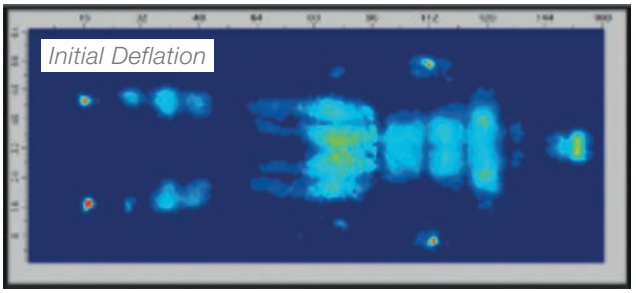

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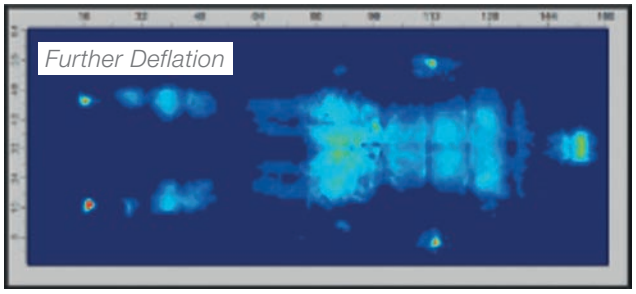

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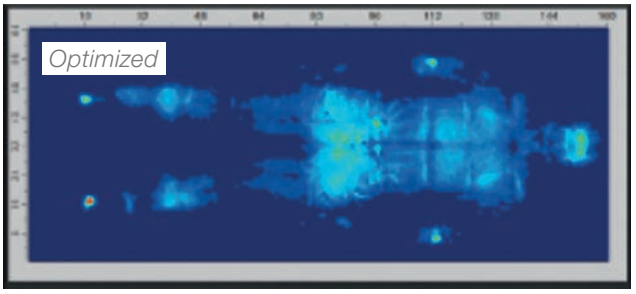

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[Image 10]: Opticare X: Max Inflate, Initial Deflation, Further Deflation, Optimized.

Quick and Effective CPR

The manual CPR valve is a common feature on to all mattresses and aids rapid mattress deflation to facilitate effective patient resuscitation. As Opticare X is an integrated mattress, the CPR function can be also be activated using the one touch CPR button on Multicare/Multicare X flattening the bed and mattress simultaneously.

[Image 11]:The controls for both the Opticare X mattress and Multicare X bed are integrated into a single control panel built into the bed.

Summary

The benefit of advanced technology in support surfaces such as the LINET POS system, is that levels of immersion can be more accurately controlled. This enables the use of ‘optimal Immersion’ to maximise pressure redistribution and minimize the risk of bottoming out.

References

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(2) Hibbs, P. (1988). The economic benefits of a prevention plan for pressure sores. Conference presentation. The Fourth National Pressure Sore Symposium. The Guildhall, Bath

(3) Morse, S. (2019). More on Acute Care: Pressure ulcers cost the health system $26.8 billion a year. Healthcare Finance. Oct 10, 2019.

(4; 7; 8) European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.). EPUAP/NPIAP/PPPIA; 2019.

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