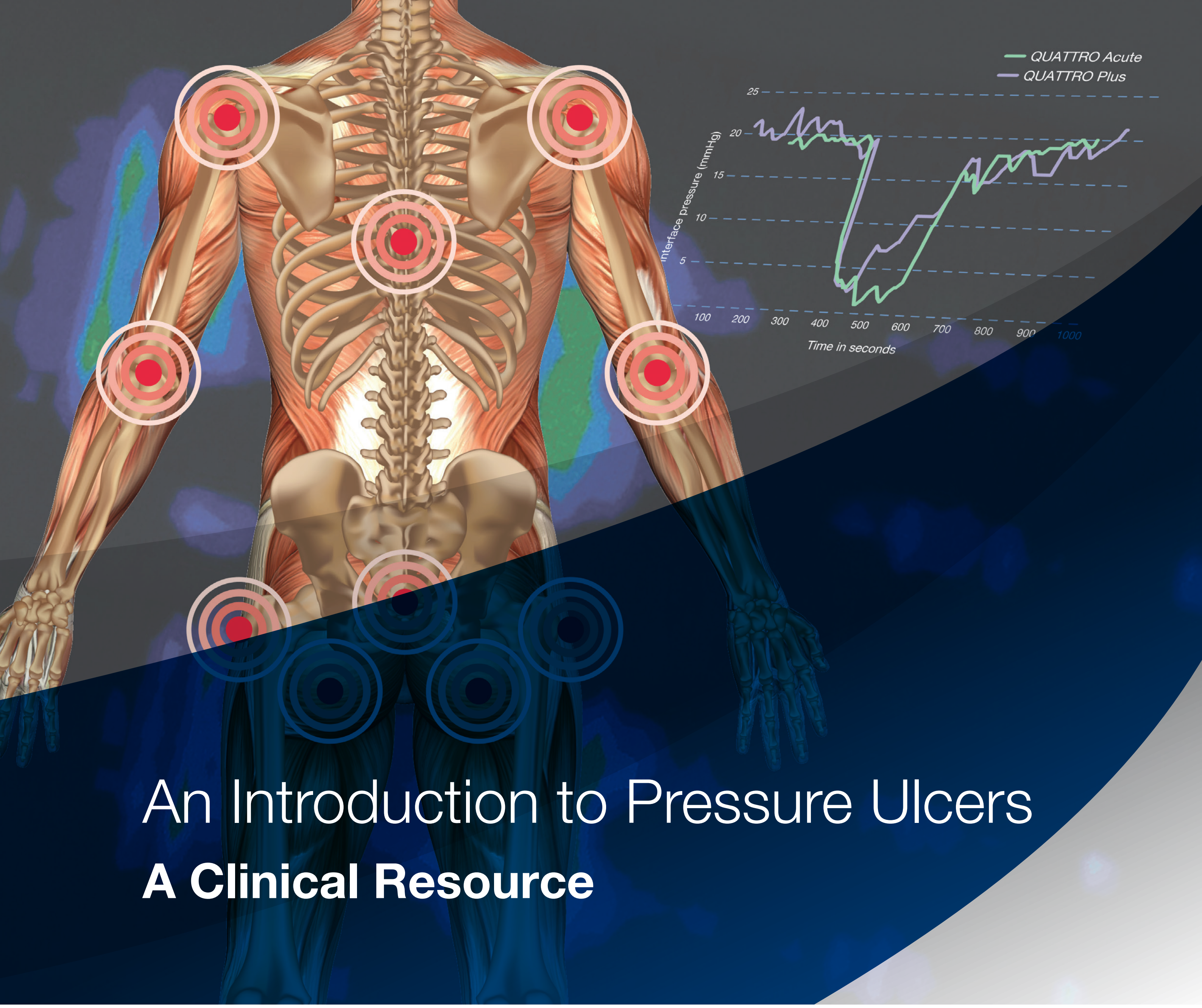


An Introduction to Pressure Ulcers

A Clinical Resource

- Pressure ulcers occur as a result of tissue being exposed to sustained, unrelieved pressure or pressure associated with shear.
- Pressure ulcers may be superficial injuries affecting the epidermis and dermis or they can extend into the subcutaneous tissues and involve muscle, tendon and bone.
- Pressure ulcers typically occur over bony prominences with the lower trunk (sacrum, coccyx, trochanter and ischial tuberosities) and heels being the two most common anatomical locations for these wounds.
- Although these wounds are typically accepted as being a preventable patient harm, up to one in five acute care patients presents with a pressure ulcer and the cost of pressure ulcers on healthcare budgets at a national level runs into billions of dollars, pounds or euros.
- The dominant risk factor for pressure ulcer development is immobility. In simplistic terms, and with the exception of certain specific patient cohorts, the majority of patients are unlikely to develop pressure ulcers if they are mobile.
- The use of active (alternating) and reactive (constant lower pressure) support surfaces can help manage the pressure applied to the patient and depending upon the individual needs of the patient these support surfaces can in some instances help reduce the frequency of manual repositioning.

Talley

...reducing avoidable harms

Welcome to the clinical world of Talley

Dear Reader

Since our origin in 1953 there have been many significant changes in the global healthcare industry; however, the application of pressure, with or without shear, remains the principal cause of pressure ulcers.

As the UK's largest privately owned manufacturer of specialist Pressure Area Care (PAC) support surfaces, Talley are committed to delivering the safest, highest quality and most clinically effective mattresses and cushions to healthcare providers and patients around the world.

In addition to designing, developing and manufacturing our class-leading PAC support surfaces we are also focussed on delivering the highest quality clinical education and information to all healthcare professionals with an interest in pressure ulcer prevention and treatment.

Understanding how key pressure ulcer risk factors interact with each other will empower healthcare staff to make a more informed choice when matching the support surfaces at their disposal to individual patients' pressure area care needs.

This dedicated, evidence based, clinical resource will provide the reader with a broad knowledge base around pressure ulcer definition, classification, prevalence and the costs associated with these wounds. It also looks in greater detail at the critical pressure ulcer risk factors such as pressure and shear, along with the importance of time in pressure ulcer development and relates these to patient physiology, immobility and support surfaces.

Our goal at Talley is to STOP pressure ulcers by helping clinicians and carers deliver safe, effective, harm-free care to patients so we hope you find this clinical resource both educational and informative.

We would be very happy to have one of our clinical specialists answer any questions you may have, so please feel free to contact us through your local representative or via the 'contact us' page at www.talleygroup.com

Chris Evans and John Evans
Directors

What is a pressure ulcer?

A pressure ulcer can be defined as

> *"localised damage to the skin and /or underlying tissue, as a result of pressure, or pressure in combination with shear. Pressure ulcers usually occur over a bony prominence but may also be related to a medical device or other object"* [1].

Pressure ulcers are categorised by their severity and may be limited to the superficial tissues of the epidermis and dermis or extend to deeper tissue exposing and/or involving muscle, tendon and bone (see Figure 1).

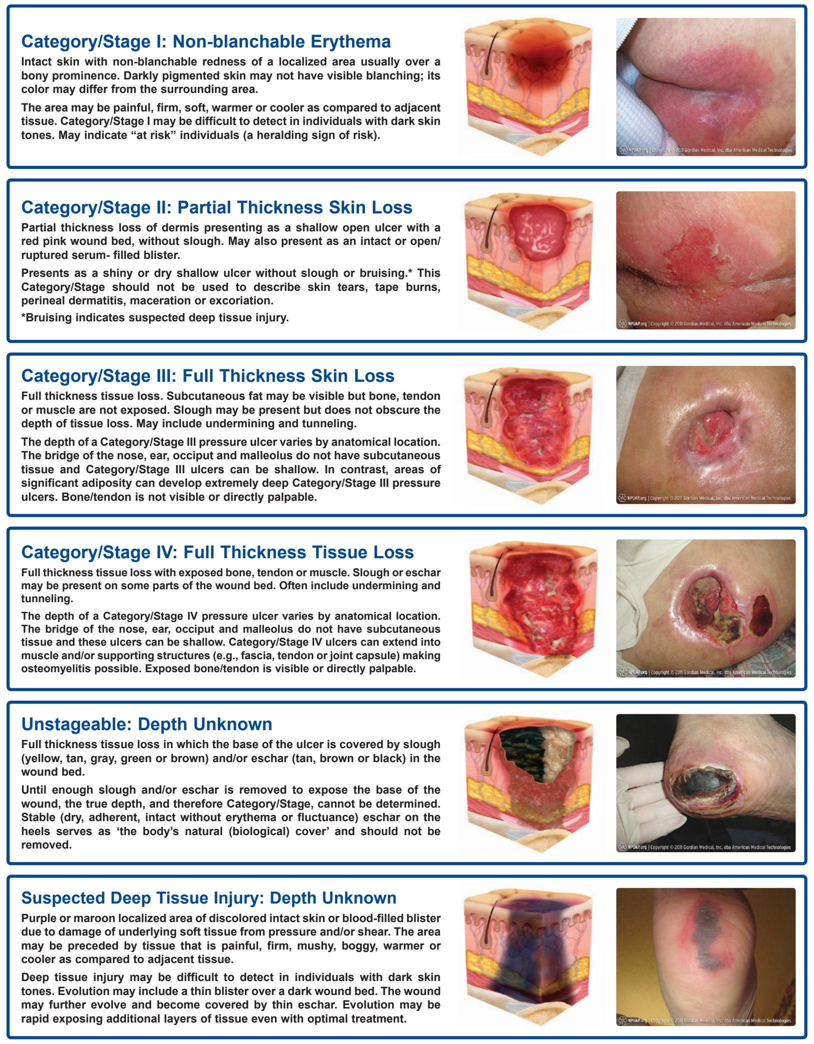


FIGURE 1.
International NPUAP/EPUAP/PPPIA Pressure Ulcer Classification System [2]

Pressure ulcer severity is not always immediately apparent, for example some pressure ulcers may originate within the deep tissue beneath intact skin (suspected deep tissue injury). For others, the wound bed may be obscured from view by slough and/or eschar, these wounds are reported as unstageable until such time as the wound bed becomes visible.

While staging or categorising pressure ulcers is not always straightforward, it is important when communicating the status of a wound, measuring and reporting the quality of preventative interventions and, ultimately, calculating the probable treatment cost. Figure 1 represents a globally recognised pressure ulcer classification system published by the EPUAP/NPUAP/PPPIA in 2014. [2]

It is also important to note that pressure ulcers are not limited to the skin. For example, they can occur on, within or underneath mucous membranes, which is the moist lining of body cavities. Mucosal membrane pressure ulcers are primarily related to medical devices, for example feeding tubes. A pressure injury classification system should not be used to classify a mucosal membrane pressure ulcer. [1]

Which anatomical locations are most frequently affected?

Pressure ulcers can occur in virtually any anatomical location; however the most common anatomical sites are over the bony structures of the lower trunk, which include the sacrum, greater trochanter and ischium (cumulative figure 45.9%), followed by the heels and malleolus with a cumulative figure of 34% [3] (Figure 2). Both the sacrum and heel account for some of the most severe injuries. [3] Heel ulcers are often complicated by underlying vascular disease of the limb [4] and the rate of subsequent amputation may be as high as 42%. [5] Although numbers vary by clinical speciality, these two anatomical locations typically account for the majority of pressure ulcers and therefore represent an important focus for preventative care.

The risk of pressure ulceration is no respecter of age, gender or ethnicity as these wounds can affect anyone from the very young or temporarily incapacitated to the very old and infirm.

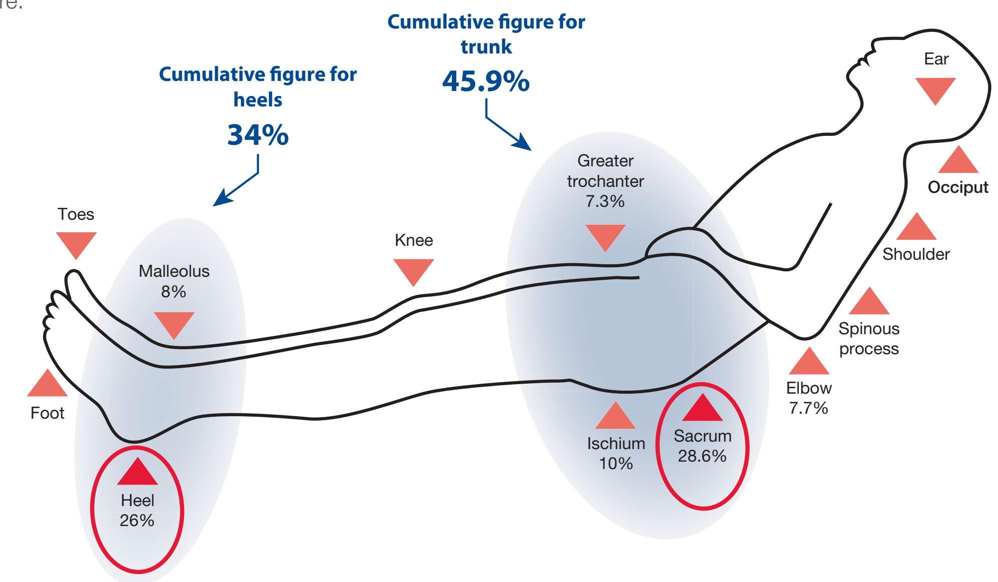


FIGURE 2.
Illustration of the key anatomical locations associated with the development of pressure ulcers

In addition to the risk posed to patients when lying or sitting, clinicians are increasingly aware of the pressure ulcer risk associated with medical equipment such as splints, traction, respiratory support [6] and anti-embolic [7] stockings, these are referred to as device related pressure ulcers. Current literature estimates that patients with a supplementary medical device may be up to 2.4 times more likely to develop a pressure related injury than those without. [8]

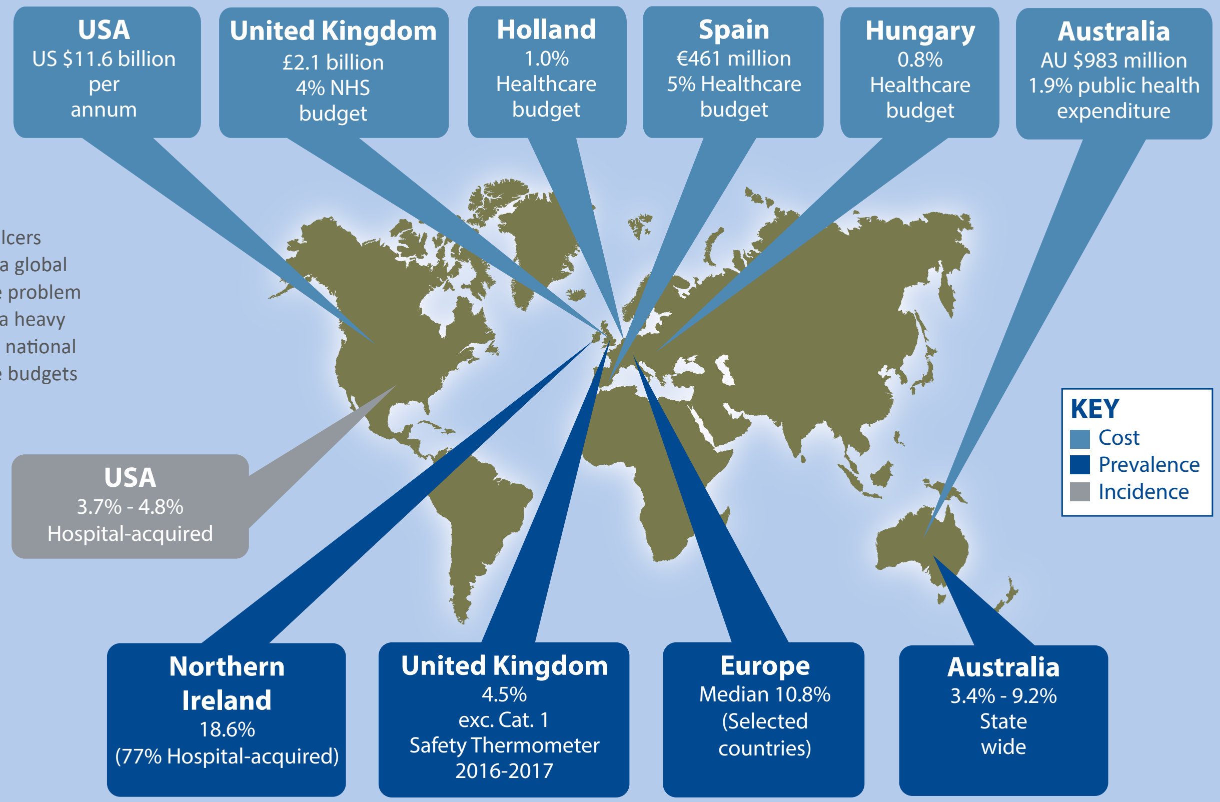


FIGURE 3.
Pressure ulcers represent a global healthcare problem and place a heavy burden on national healthcare budgets

Prevalence

While there is a clear definition for pressure ulcer prevalence, differences in the way it is measured and reported make meaningful comparisons between regions or countries impossible. [9] In spite of this variation in pressure ulcer prevalence methodology the data from unrelated studies undertaken across acute and community healthcare environments in the last decade clearly show that prevalence frequently runs into double figures, with up to one in every five acute care patients presenting with a pressure ulcer. [10, 11, 12, 13, 14, 15] See Figure 3.

Two commonly used methods to measure pressure ulcer figures are Prevalence and Incidence. Pressure ulcer prevalence can vary significantly between different geographic and clinical settings. Worldwide pressure ulcer prevalence in healthcare settings ranges from 0% to 72.5%.[16, 17, 18] A systematic review reported global pressure ulcer point prevalence in acute hospitals as 14.8%, with a mean incidence of 6.3%.[18]

Prevalence: The percentage of people in a given population with a pressure ulcer at any one moment in time.

Incidence: The number of persons who develop a new pressure ulcer, within a particular time period in a particular population.

Healthcare-acquired pressure ulcers

A measurable proportion of all pressure ulcers encountered will develop under clinical supervision, these are known as healthcare-acquired pressure ulcers. [19, 20, 21] They are also referred to as hospital acquired pressure ulcers, nosocomial, and facility acquired pressure injuries/ulcers. [1]

A high proportion of these wounds may be considered to be an unwelcome adverse event or 'medical error' that in many cases are preventable. Unfortunately, investigations reveal that care frequently falls below a minimum standard. [3, 20, 22] For example, one study across five European countries showed less than 10% of patients received a complete care package, while an examination of more than 400,000 legal cases in the USA determined that 90% of nosocomial pressure ulcers might have been avoided. [23] Within public hospitals in Australia 4,313 patients developed pressure injuries in 2015-16, equating to 9.7 injuries per 10,000 hospitalisations. [24]

In the UK, pressure ulcers are recorded via the NHS safety thermometer, and are one of the four most commonly occurring 'avoidable harms' within healthcare. Data from the NHS Safety Thermometer (2016/2017) show that 106,675 (4.5%) of patients were reported as having a pressure ulcer, of which 22,687 occurred 72 hours or more following admission. [25]

Throughout countries around the world, enhancing patient safety and reducing the risk of 'preventable harms' such as pressure ulcers are board level priorities for all healthcare providers. In the UK, both the NHS outcomes framework [26] and the Five Year Forward View [27] documents set out the expectation for the delivery of safe, effective, harm-free care to patients.

The NHS outcomes framework consists of 5 separate domains, one of which is 'Treating and caring for people in a safe environment and protecting them from avoidable harm', with the five year forward view focusing on prevention, funding and efficiency.

Unfortunately, pressure ulcers continue to be a challenge and represent a significant economic and humanitarian burden globally (Figure 3), not only affecting healthcare providers and patients, but also impacting wider society.

The economic impact of pressure ulcers

Relatively few economic studies have been published in the past decade, leaving healthcare systems, particularly those that operate within budgetary 'silos', unable to determine the absolute cost of caring for a patient with a pressure ulcer. As an injured patient will typically cross several departmental boundaries during the course of treatment, and frequently move from primary to secondary care or vice versa, it is difficult to track expenditure on a macro level. However, it is clear that patients with pressure ulcers are more likely to be admitted or readmitted to hospital, remain as an inpatient for longer [28, 29, 30] and are more likely to die. [31]

Given the lack of robust data, financial planning tends to be tackled by calculating the cost of treating an individual wound type, followed by extrapolation to factor in the population density of people affected and the probability of healing. By 2004, the UK was believed to be spending up to 4% of the National Health Service budget on pressure ulcers. [32] A second review, in 2012, predicts that this will increase further as the population ages and more advanced treatments become available with a mid-sized facility (NHS Trust) spending up to £3.6 million per annum. [29]

During May 2012 and April 2013, the pressure ulcer annual spend in the UK was estimated between £506 and £530 million. [33] Putting effective preventative measures and interventions in place in order to minimise and reduce the incidence of avoidable harm, such as pressure ulceration, means that providers can ultimately treat more patient's and therefore make their budgets go further.

Aside from the 'hospital bed' and 'lost opportunity' costs, the financial burden associated with pressure ulcers is largely attributed to providing nursing interventions along with both the diagnosis and treatment of wound complications. [29] Utilising the NHS Improvement pressure ulcer productivity calculator [34], UK treatment cost estimates for pressure ulcer categories 1 to 4 can be seen in Table 1.

Based on the data presented in Table 1 the cost of pressure ulcer treatment in the UK will range from £1,000 for a simple, uncomplicated category 1 ulcer, up to £20,000 for a complicated category 4 wound. There is a similarly high costs

PRESSURE ULCER CATEGORY	CENTRAL ESTIMATE	LOWER RANGE	HIGHER RANGE
	Mean cost	Uncertainty of cost per day, episode length and probability of complications (-10%)	Uncertainty of cost per day, episode length and probability of complications (+10%)
Category 1	£2,000	£1,000	£2,000
Category 2	£7,000	£5,000	£8,000
Category 3	£11,000	£9,000	£14,000
Category 4	£16,000	£13,000	£20,000

TABLE 1.
The economic impact of pressure ulcers (results include elements for nursing workforce time, bed occupancy time and treatment costs both in the hospital and in community)

for the treatment of severe, full thickness pressure ulcers in the US with the treatment cost in the US being almost $130,000. [35]

Surprisingly, the cost of pressure-redistributing support surfaces and equipment, antibiotics and dressings for prevention and treatment accounts for just 3.3% of the overall cost, [29] a finding that supports investment in prevention as the basis of a sound economic model.

As healthcare demand increasingly outstrips funding, many countries have a renewed interest in tackling pressure ulcers and have pressure ulcer prevention high on the quality agenda. In the UK, NHS Improvement launched two key documents in 2018:

- Pressure ulcer: revised definition and measurement [36] (recommendations to support a more consistent approach to the definition and measurement of pressure ulcers at both local and national levels across all Trusts)
- Pressure ulcer core curriculum [37] (to guide education for nurses and other healthcare professionals on preventing pressure ulcers)

The implementation of effective prevention strategies, which lead to improved outcomes, have previously been rewarded and reinforced by financial incentives such as the Committee for Quality and Innovation (CQUIN) programme. [38] Investment has also been directed towards updating the EPUAP/NPIAP/PPPIA Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline international best practice guidelines [1], which was launched in November 2019.

International campaigns such as STOP PRESSURE ULCERS day and national initiatives such as React-To-Red in the UK are all geared to raising awareness of pressure ulcers with clinical staff, patients and carers with the ultimate goal of reducing the incidence of pressure ulcers and thereby the associated spend on this largely preventable patient harm.

The patient and their family

Pressure ulcers also have a considerable impact on the patient and their family, not least the indirect costs of providing informal care and support. [39] Even in their mildest form, pressure ulcers cause clear anxiety and distress, [40] with almost half of patients reporting pain as a notable symptom even where the skin remains intact. [41]

As pressure ulcer severity increases, a patient's quality of life falls [42] and they may experience social isolation, prolonged ill health and endure repeated hospital admissions. In the worst case, patients may lose a limb [43] or succumb to overwhelming sepsis or organ failure and die as a result. Pressure ulcer associated deaths affect many patients and their families each year with the US reporting up to 60,000 deaths each year as a direct result of pressure ulcer related complications. [44]

Sadly, pressure ulcers are still frequently encountered and despite a clear understanding of aetiology and greater access to effective prevention strategies, pressure ulcers remain a major cause of morbidity and mortality. [45] Whilst this is particularly true for people with impaired sensation, prolonged immobility, or advanced age it is important to remember that these injuries can happen to anyone. Babies, children and new mothers can suffer pressure ulcers, as can patients with few risk factors but subject to prolonged pressure from a medical device such as an anti-embolic stocking, [7] traction device or splint.

Involving patients and their families in pressure ulcer related prevention and management decisions is essential. This has been reflected in the development of the 2019 EPUAP/NPIAP/PPPIA Prevention and Treatment of Pressure Ulcers/Injuries, Clinical Practice Guideline [1]. Engagement of patients and care givers was sought in the form of Survey's, identifying care goals, priorities and educational needs, with the findings contributing to the evidence presented in this best practice guideline.

Pathophysiology of pressure ulcers

Pressure ulcers occur as a result of sustained, unrelieved pressure and shear forces (mechanical loads) being applied to living tissue. In the majority of cases these loads originate from the patient's own bodyweight, however, they can also occur as a result of external forces for example from a nasogastric tube resting on a patient's face or a set of compression stockings on the legs. Historically friction was believed to play a direct part in pressure ulcer development and while still important for tissue integrity, friction is no longer considered part of the primary pathology of pressure ulcers. [2]

The accepted model for pressure ulcer development recognises the importance of two interdependent pathways [1] (see Figure 4). One pathway considers 'mechanical loading' which, in essence, relates to the amount, duration and direction of pressure applied to the tissues; the other pathway relates to factors that influence 'tissue tolerance' or the ability to withstand the applied load.

The pathway related to mechanical loading is where Pressure Area Care (PAC) support surfaces can have the greatest impact on outcomes.

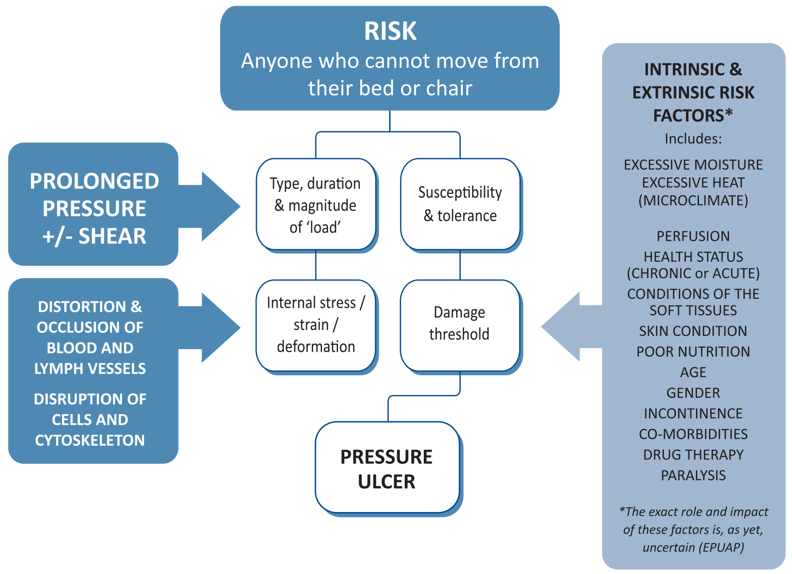


FIGURE 4.
An Illustration of two interdependent pathways involved in PU development (adapted from EPAUP/NPIAP/PPPIA)

The impact of pressure and shear

Pressure can theoretically be an entirely perpendicular force however, due to skeletal anatomy and the inherent flexibility of soft tissues, there is almost always an element of lateral displacement creating additional shear forces in the tissues overlying bony prominences.

The effects of shear may be most noticeable during postural change when skin is held in close contact with a surface that has a high friction coefficient. Factors such as a high backrest elevation, lack of an appropriate knee break or incorrect chair height, causes weight to shift forward, displacing internal structures in relation to the outer surface of the skin (see Figure 5 for a diagrammatic representation of this).

As pressure is applied to the skin surface (for example as a patient sits on a cushion or lies in bed), tissue lying directly between the body structures and external surface will be squeezed (compression stress), while adjacent structures will be distorted (shear stress) and stretched (tensile stress). See Figures 6a and 6b.

This distortion and deformation within the tissues results in reduced fluid flow in the blood and lymph vessels. This reduction in blood flow reduces the oxygen and nutrients being delivered into the tissue whilst simultaneously reducing the removal of metabolic waste products from the tissues. A reduction in lymph flow slows the removal of excess interstitial fluid and proteins from the tissues. Figures 6a and 6b demonstrate the effect of no interface pressure to the skin and how pressure applied over a bony prominence can result in multiple stresses within the tissue, compromising local blood supply.

If the magnitude and duration of pressure applied to the tissues is sufficient then individual cells within the tissue structures (skin, muscle, fat, etc.) will become damaged and could ultimately die. This occurs as a result of the physical distortion of the cells coupled with the insufficient delivery of oxygen and nutrients to the tissue to maintain its normal function. This cellular damage will in turn trigger an inflammatory response, resulting in oedema, which then increases the mechanical loads on cells and tissues through a rise in interstitial pressures. [1]

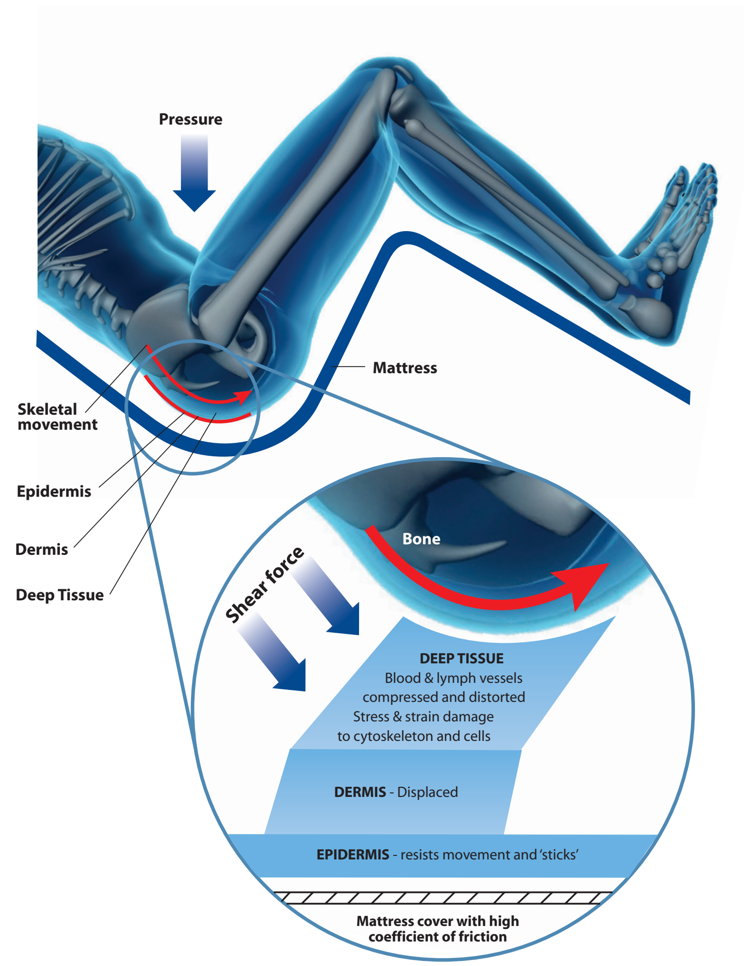


FIGURE 5.
A schematic diagram to illustrate how shear forces occur in deeper tissues

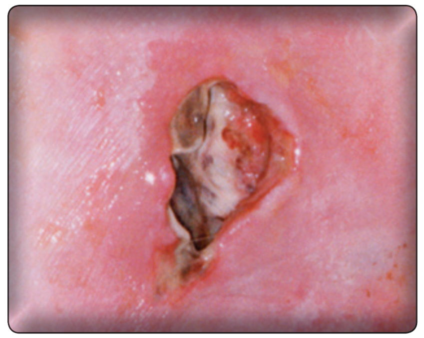
When shear factors predominate, the pressure required to occlude the circulation can be up to 50% lower than the force required with lower levels of shear [46] hence the importance of managing both pressure and shear forces when considering pressure ulcer prevention.

In addition to the impact on circulation, high levels of shear can also have a direct and destructive effect on individual cells and their cytoskeleton. [47] The degree of tissue distortion may be most noticeable where a steep gradient occurs between adjacent areas of high and low pressure. This is most likely to occur when sitting or lying on an unyielding surface that does not conform to, or envelop the body, for example where the sacrum or heels rest on tightly stretched sheets. [48, 49]

Steep pressure gradients can also be more noticeable to the patient. In addition to being uncomfortable some early mattresses with relatively high inflation pressures and rapid inflation-deflation pressure profiles were believed to increase the incidence of reflex spasm in susceptible patients and cause visible ridges in oedematous skin. [50] The use of different cell configurations, such as supporting the patient across three lower-pressure, partly immersible cells, whilst the fourth cell deflates, is thought to be advantageous. The benefit of increased support is to reduce lateral shear, improve comfort, [50] and lower the risk of spasm-induced friction damage.

Whilst there is no agreed consensus on the exact interplay between pressure and shear and how these forces relate to superficial and severe pressure ulcers, one proposal is that there are fundamental differences in the aetiology of superficial pressure ulcers compared to those in deeper tissue layers, [51] with superficial pressure ulcers caused by pressure and high shear at the skin surface, while deep tissue pressure injuries predominantly result from high pressure in combination with shear at the surface over bony prominences. [52, 53-63]

Although not an absolute diagnostic indicator, a pressure ulcer that has developed under significant pressure and shear components may show clear signs of tissue displacement in the direction of travel and resultant undermining of the wound cavity. [64] This can provide relevant information for future care planning.



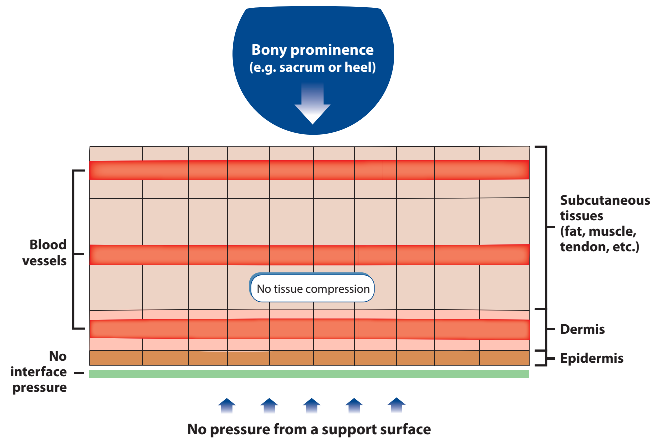


FIGURE 6a.
Schematic illustration to demonstrate the effect of no interface pressure to the skin. There is no tissue compression and blood vessels remain open.

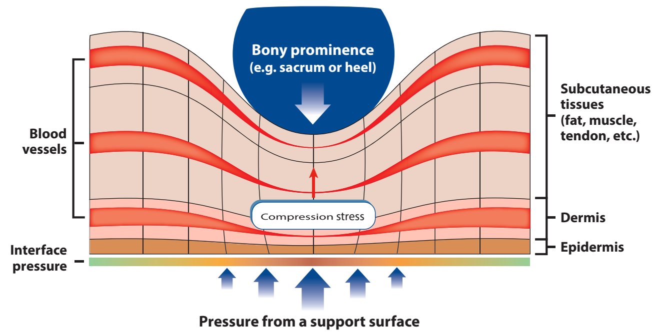


FIGURE 6b.
Schematic illustration highlighting multiple stresses within the tissue caused by pressure over a bony prominence which can result in a compromise to local blood flow.

The importance of time in pressure ulcer development

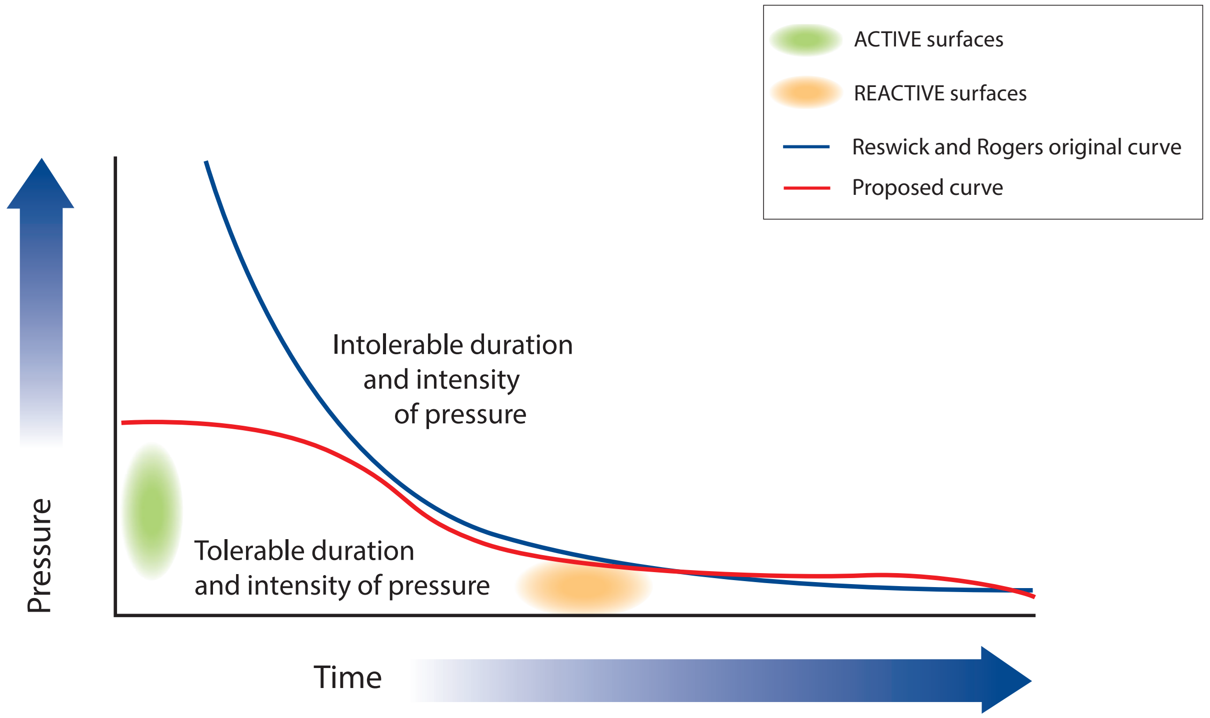
Since both pressure and shear occlude essential blood and lymph vessels, time (i.e. duration of occlusion) becomes a critical factor in pressure ulcer development. The combined effect of hypoxia and the retention of toxic metabolites within the cell environment can cause irreversible damage. The application of constant, unrelieved pressure on the body can result in cell death and tissue necrosis in as little as 1 to 2-hours. [65,66]

In addition, the very act of reperfusion after prolonged vessel occlusion may result in cellular damage. This is referred to as a 'reperfusion injury', however it is important to note that this effect relates to prolonged ischemia, which is typically in excess of 2-hours. [67] Therefore the relatively rapid cycle times of active patient support surfaces fall well within this accepted timespan and therefore pose no risk of reperfusion injury to patients.

Unfortunately, due to the variability in tissue tolerances, individual anatomies and other confounding factors, it is not possible to determine an absolute time threshold beyond which a patient will definitely develop or avoid a pressure related injury. The speed and severity of the onset of pressure ulceration varies between individuals and depends on a wide range of intrinsic and extrinsic risk factors (see Figure 4), many of which cannot be easily mitigated. However, the established principle is that tissue can withstand higher pressures for a short period of time and lower pressures for a longer period of time. [68] This interplay between pressure and time underpins the design characteristics of active (alternating) and reactive (constant lower pressure) support surfaces (Figure 7).

FIGURE 7.
A schematic graph to demonstrate the original theory of the interplay between pressure and time (Reswick and Rogers) and the current theory based on more recent work.

NB. As there is are no absolute time or pressure thresholds by which a patient will develop a pressure ulcer, the axes are not scaled.



The impact of temperature and humidity

While the relative impact of many risk factors is uncertain, there is an increasing body of evidence suggesting that tissue temperature and humidity (i.e. skin 'microclimate') play a role in the development of pressure ulcers. [1]

A small, 1°C increase in temperature will raise the metabolic rate of cells [69] and is likely to induce a sweat response [70] at a time when blood supply may be limited by vessel occlusion. An increase in temperature and humidity can result in the skin becoming excessively moist, less stiff and more susceptible to damage from mechanical forces such as pressure, shear and friction. In addition, skin function will also be negatively affected by excessive moisture levels.

Skin microclimate may also affect the load transfer from the skin to the deep tissues, potentially increasing the risk of a deep tissue injury. Therefore microclimate may possibly play a role in both superficial and severe, full thickness pressure ulcers. Research is ongoing with regards to optimal microclimate characteristics. [71]

Conversely, hypothermia, when the core body temperature drops below 36°C, [72] provokes a systemic protective response that reduces blood flow to the skin. This reaction is particularly problematic for surgical patients where perioperative hypothermia leads to almost double the number of pressure ulcers [73] along with an associated delay in both the speed and quality of post-operative healing. [74] Maintaining core and local normothermia along with the provision of appropriate pressure area care are important clinical goals for the surgical patient.

Patient immobility and support surfaces

While additional risk factors such as skin condition, nutrition, incontinence, age, gender, comorbidities etc. are important, the dominant risk factor for pressure ulcer development is immobility. Being rendered immobile or insensate through disease, trauma, sedation or paralysis, diminishes the body's inherent protective mechanism of spontaneous movement and it is this lack of spontaneous movement which exposes the patient to the significant risk of pressure ulceration. Lack of spontaneous movement means that the areas of the body in contact with a support surface will experience prolonged periods of unrelieved pressure (with or without shear). It is this prolonged exposure to unrelieved pressure which is a primary predictor of risk for all patients where mobility is limited or compromised for whatever reason.

The use of active (alternating) and reactive (constant lower pressure) PAC support surfaces helps with the management of the pressure applied to the patient and may mean that in some instances it is possible to reduce the frequency of manual repositioning in order to manage the pressure exerted on the tissues of patients with limited or compromised mobility.

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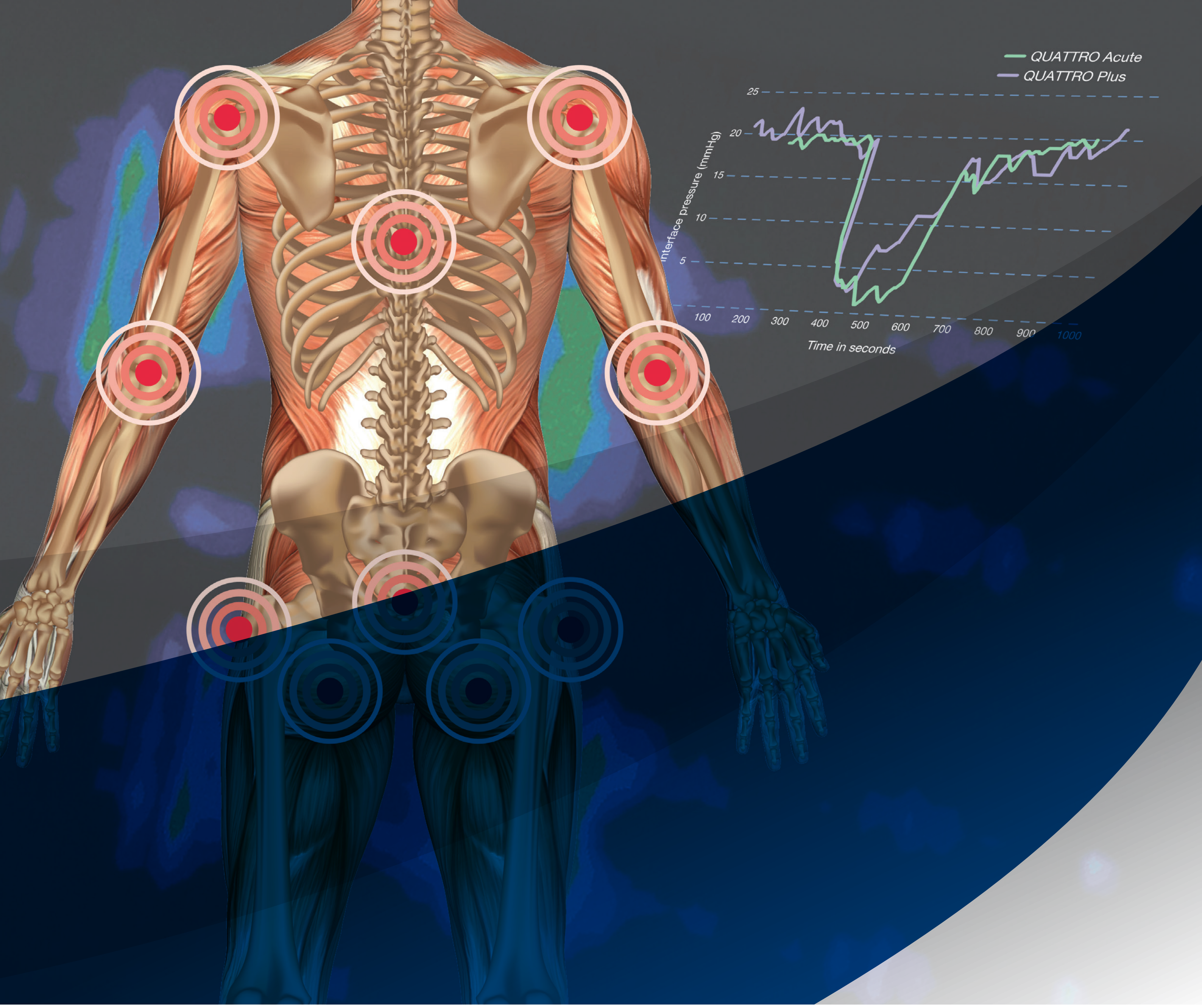

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