



# All Wales Tissue Viability Nurse Forum

*Ffowm Nyrsys Hyfywedd  
Meinwe Cymru Gyfan*

*All Wales Best  
Practice Guidelines:*

## Seating and Pressure Ulcers



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Viability Nurse Forum**  
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**Pressure Ulcer Prevention  
and Intervention Service**

Swansea Bay University Health Board, NHS Wales



**Helping Hand**  
*Pressure Care*

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# All Wales Best Practice Guidelines: Seating and Pressure Ulcers

These best practice guidelines have been developed through a collaboration between Swansea Bay University Health Board's Pressure Ulcer Prevention and Intervention Service (PUPIS) and the All Wales Tissue Viability Nurse Forum (AWTVNF). The content of this document has been inspired by the Seating Guidelines published in the *Journal of Tissue Viability* (Stephens & Bartley, 2018). These All Wales guidelines reflect the local expert consensus as well as providing an application to Welsh NHS services.

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## Foreword

The Pressure Ulcer Prevention and Intervention Service (PUPIS), formed in 2003, provides a specialist service to healthcare professionals and people in the community with complex pressure ulcers. The multidisciplinary team includes clinical scientists and rehabilitation engineers who work alongside Clinical Nurse Specialists. The service is based at the Rehabilitation Engineering Unit at Morriston Hospital in Swansea, which also provides a regional specialist seating service to wheelchair users with complex postural management needs. The PUPIS has developed, and provide, a range of training and educational resources, which has informed the content of these guidelines.

The work involved input from a range of healthcare professionals and educators in Wales (listed in acknowledgments) to inform the content and ensure that the guidelines can be applied in a range of settings.

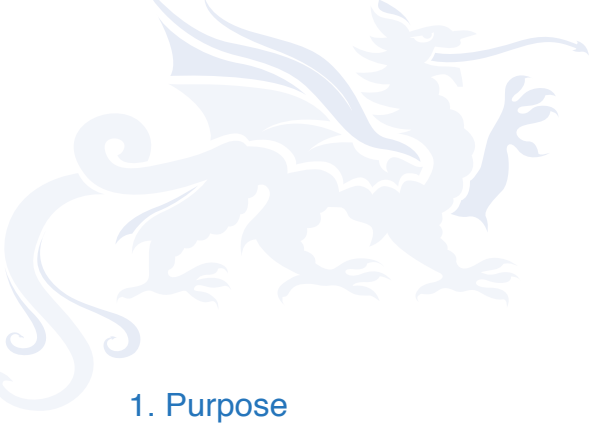
## Suggested citation

The authors and collaborators welcome the use and application of these guidelines and request the citation uses the following format:

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## 1. Purpose

The purpose of these guidelines is to provide a practical application of the evidence base on pressure ulcer prevention and management in relation to people who remain seated for extended periods of time. For the purposes of this document, the use of the phrase 'extended period of time' means that a person is sitting for most of the day.

The guideline is designed to support qualified healthcare professionals and carers working with people with short- and long-term mobility issues and is not condition specific. These guidelines aim to provide the underpinning knowledge of the risk factors and the principles of seating to assist professionals, carers and individuals to identify the appropriate, safe and effective selection and use of seating equipment. These guidelines are focused on the seated individual who uses a range of chairs, including specialist armchairs and wheelchairs in all environments, such as in an individual's home, work or school and residential and nursing care homes.

## 2. Introduction

It has been well recognised for some time that the provision of poor seating is a major cause of pressure ulcer incidence (Dealey, 1992). In many situations, appropriate seating is not provided due to inadequate resources or equipment, however, it is thought that the knowledge and training of healthcare professionals still remains a significant influence in identifying the link between seating, posture and pressure ulcers. These guidelines are designed to inform healthcare professionals of the risks of inappropriate seating and the principles and factors to consider when selecting a suitable seat or cushion for an individual.

Seating equipment is able to facilitate access to the community for those who require assistance with their mobility, resulting in wider health and social benefits. This increases quality of life for the individual, as well as easing the burden of care on family and carers. Seating equipment also facilitates biological functions and is able to provide adequate pressure redistribution to vulnerable areas (AWTVNE, 2017).

There is a large choice of seating equipment available, which can be confusing for both individuals and healthcare professionals, particularly as there is often limited scientific evidence to support manufacturers' claims. It is therefore essential that healthcare professionals acknowledge that the prescription of cushions or other seating equipment needs

a holistic view. It is necessary to look beyond the provision of just a pressure relieving cushion.

### 2.1 What is a pressure ulcer?

*'A pressure ulcer is a localised injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear'*  
(National Pressure Ulcer Advisory Panel [NPUAP] et al, 2014)

Pressure ulcers tend to occur over bony prominences when blood flow is restricted as soft tissue becomes squashed between two surfaces, e.g. the seat and the bones of the pelvis and buttocks (Krouskop, 1983; Schubert & Heraud, 1994). Reduced blood flow can occur when an individual is sat for extended periods, such that the skin and underlying soft tissue becomes starved of oxygen (ischaemia) and nutrients and tissue begins to breakdown, leading to the development of a pressure ulcer. Research also shows that ulcers can occur due to deformation of tissue, where changes to the structure of the cells compromises the tissue. It is thought that this can happen at a faster rate than ischaemia (Gefen et al, 2008).

Some pressure ulcers develop quickly, while others can take longer. The key factors that influence this include, an individual's ability to change position, and to maintain an upright-seated position without slumping or sliding (Gefen, 2008), along with general health, disability and related indicators for tissue tolerance (Coleman et al, 2013; Stephens & Bartley, 2018). When sitting, body weight is supported over a smaller area, resulting in higher pressure through the buttocks and thighs (Barbanel, 1991; Collins, 2001). Sitting in one position, without moving, for 1 to 2 hours could lead to the development of a pressure ulcer, even in a natural sitting position (Kosiak, 1959; Stephens & Bartley, 2018). The time to develop a pressure ulcer will also depend on a person's environment and their equipment (Sprigle & Sonenblum, 2011)

### 2.2 Factors in pressure ulcer development

There are three main factors to consider in pressure ulcer development and the speed of this tissue damage depends on:

1. The amount of pressure applied to the tissue
2. The length of time the unrelieved pressure is applied
3. An individual's tissue tolerance to injury.

This suggests that the higher the pressure on the tissues, the shorter time it takes for the tissue to become damaged and

breakdown. However, lower pressure over longer periods of time also causes ulceration as the tissue is being repeatedly damaged by pressure, and therefore loses its tolerance to injury.

The effect of shear forces (which act in a direction parallel to the skin) can exacerbate the effect of pressure on the tissue, resulting in less time and pressure required for tissue breakdown (Wounds International, 2010; NPUAP et al, 2014).

## 2.3 Managing risk

The ability for an individual to be seated appropriately and safely has a range of health and social benefits. The potential risks of sitting should be considered alongside the potential benefits to the individual (e.g. function, health and wellbeing), and managed as part of a multidisciplinary team approach to the individual's care. This document will cover some of the aspects of managing risk in relation to seating or posture.

The provision of appropriate seating should be used to manage risk and prevent pressure ulcers, however, in circumstances where pressure ulcers occur, conventional advice is that bed rest is often recommended. Despite this, there needs to be a balance with considerations of quality of life, physiological function, additional objectives of care and further risk of pressure damage in other vulnerable areas.

### 2.3.1 Skin checks

Visual skin changes are the best indicator for identifying early pressure damage (AWTVNE, 2017). Discomfort and pain are also useful predictors to skin and tissue damage (Hall & Guyton, 2010; NPUAP et al, 2014). However, some individuals are unable to feel discomfort or communicate these symptoms, so pain and discomfort should not be relied upon as indicators or predictors of tissue damage.

### 2.3.2 Keep moving

It is widely known that there is a strong link between pressure and time on the development of a pressure ulcer (Reswick & Rogers, 1976; NPUAP et al, 2014). Individuals should be encouraged to perform regular small shifts of their position. Guidance or assistance from carers may also be necessary to perform this safely and effectively. This movement may be performed using the "roll" (a side-ways lean); a "forward lean" where the individual leans forward with their chest over their thighs, and can be effective at reducing pressure underneath the ischial tuberosities (Stockon et al, 2009). In care settings where staff are available a full stand is recommended.

### Key recommendations for repositioning when using seating equipment:

1. Pressure relief should be performed every 30 minutes lasting 30 seconds (Sonenblum et al, 2014)
2. Individuals should not remain seated for longer than a 2-hour period at any one time during the day (National Institute of Health and Care Excellence [NICE], 2014)
3. If sitting in a chair is necessary for individuals with existing pressure ulcers in the seated region, sitting should be limited to three times a day in periods of 60 minutes or less. The individual's seat, posture and sitting times should be reviewed and modified if the pressure ulcer fails to improve (NPUAP et al, 2014).

These recommendations may need to be adapted to an individual's level of risk, given that there are a number of influencing factors to consider in relation to reducing and managing the risk of pressure ulcers (such as incontinence, malnutrition and comorbidities).

## 3. Why is seating posture important?

The seating support surface should provide a safe, stable and comfortable means of supporting the forces exerted by the person. In order to remain upright, a seated person is required to maintain a stable position and counteract the forces of gravity. The ability to do this is compromised for people who are acutely ill, frail, or have a neurological impairment (Collins, 2001).

The most important consideration when seated is the position of the pelvis, as this will directly influence the position of the lower limbs, head and the spine (Ham et al, 1998). It is estimated that typically 75% of the body's weight is taken through the pelvis when an individual is sitting (Collins, 2001). The main contact between the pelvis and the seat surface is via the small, rounded ischial tuberosities (sitting bones of the pelvis). Figure 1 illustrates the estimated proportion of an individual's body weight, which ideally should be supported by the surface of a seat.

The sacrum and coccyx area are particularly vulnerable in a poorly seated position, as the pelvis 'rocks' backwards when an individual adopts a slumped posture. This posture is commonly known as 'sacral sitting' (Figure 2a). Similarly, the body can adopt a lean to one side (Figure 2b), due to a number of reasons such as incorrectly sized equipment, creating an uneven loading of the body. Other areas of the body will need to support the increased weight or pressure when poor posture is maintained.



## 4. Principles of seating

This section provides the principles of seating that can be applied to all types of seating to reduce the risk of pressure ulcers. It is intended that these principles provide the fundamental knowledge and considerations when selecting and using seating equipment, as well as identifying when there are problems that need to be addressed.

The 4 'S' principles (Bowtell, 2018) are described as:

- ◆ Size
- ◆ Set-up
- ◆ Surface
- ◆ Shape

An ideal posture when sitting consists of a stable pelvis where the ischial tuberosities (sitting bones in pelvis) are evenly in contact with the seat (as shown in Figure 1) and the head is positioned above the hips and both feet are supported. This posture may not always be possible, however, seating equipment can be provided to help individuals achieve an optimum posture within their limits and functional needs.

The surface of the seat is just as significant as the overall set-up; symmetry is often a goal when considering the principles of seating as this promotes an even pressure distribution.

### 4.1 Size and set-up

If correct, the set-up of a seat or chair can have a positive impact on an individual's comfort, function and stability, as well as preventing pressure ulcers. The following images illustrate the detrimental effect of incorrect seat size and set-up, which will increase the risk of pressure damage.

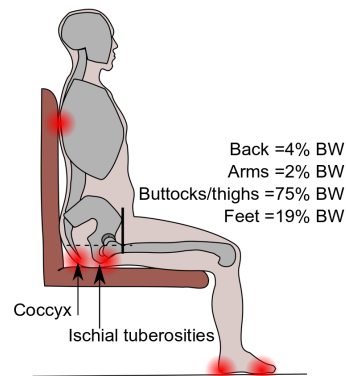


Figure 1. Estimated proportion of body weight support by a seat (adapted from Collins, 2001). Red spots highlight common locations of pressure ulcers that occurs in the seated individual. BW = Body weight.

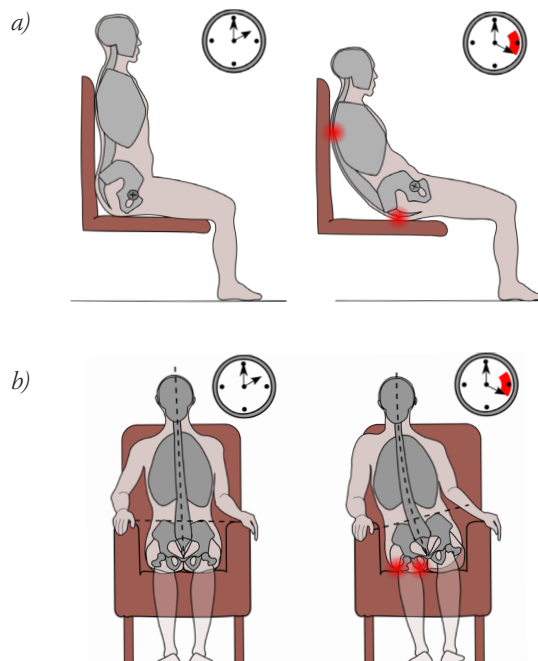
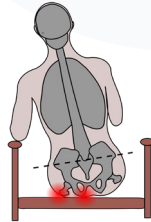


Figure 2. Seated postures that result over time "Sacral sitting" (a) and side-leaning (b) causing uneven loading through the body. The red spots identify areas at risk of developing pressure ulcers.



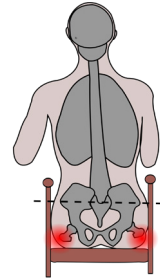
### Seat width – too wide

This results in the individual leaning to one side to support themselves on the armrests. This can cause fatigue if the position is held for long periods of time without support. This leads to increased pressures to one buttock (the side they are leaning towards) and increases the risk of pressure damage to that buttock. Elbows are also at greater risk of skin breakdown when leaning to one side. Over time, postural complications such as scoliosis (spine curvature) can develop.



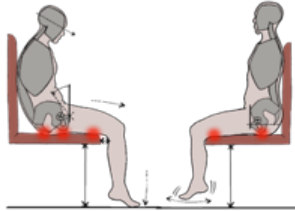
### Seat width – too narrow

This can be restricting for an individual leading to a reduction in function and inability to perform pressure relieving exercises. The outer aspects of the hips are at greater risk of pressure damage. To reduce this risk there should be a 2.5cm gap between the outer aspect of the hip and the inside of the chair's thigh supports/ armrests.



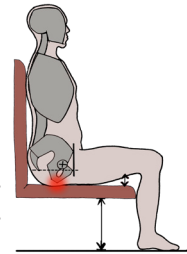
### Seat height – too high

This results in the individual's feet being unsupported and the individual's weight supported only by the seat surface. This position also results in sliding in the chair in order for the individual to feel 'grounded' to provide a more stable sitting position. This increases the shear forces (acting in a direction parallel) to the buttocks increasing the risk of pressure damage, specifically at the sacrum and coccyx.



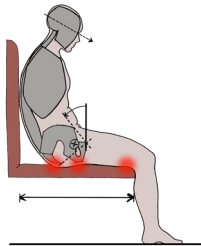
### Seat height – too low

This results in high pressures going through the buttocks, specifically under the ischial tuberosities and feet. The thighs are a good area of the body to distribute pressure, due to a larger surface area with a lack of bony prominences. The seat height should be adjusted to allow for this.



### Seat depth – too deep

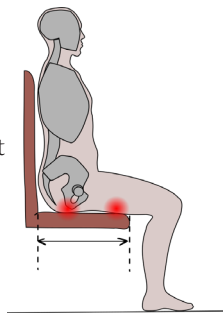
This can have an impact on a person's overall posture and pressure ulcer risk. The individual will not be able to sit all the way back, causing them to lean backwards and resulting in shear forces at the interface of the buttocks. The pressures at the sacrum and coccyx will be higher in this position due to the altered position of the pelvis. To reduce this risk, the set-up of the seat will need adjustment.



### Seat depth – too shallow

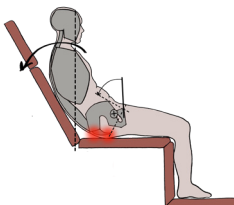
This results in a reduced contact area between the thigh and the seat surface. This will cause poor distribution of pressure throughout the buttocks and upper leg. The ischial tuberosities are at higher risk of pressure damage due to the reduced seat depth.

The set-up of the seat will need to be adjusted to reduce this risk. A distance of 2.5cm is recommended between the back of the knee and the front edge of the seat.



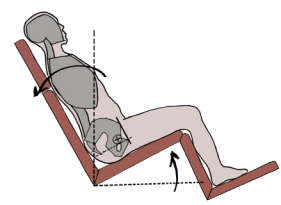
### Seat-to-back angle (Recline)

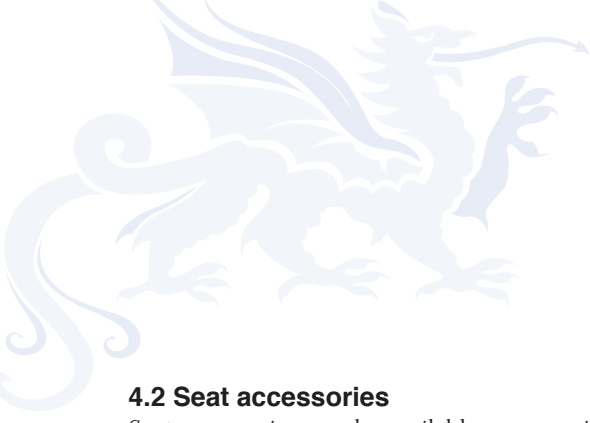
The back section of a chair may be adjustable using recline, this can be beneficial for a change in position for the individual. However, an inappropriate seat-to-back angle may result in excessive pressures, specifically shear forces at the interface of the buttocks as a result of the person sliding forward.



### Ground-to-seat angle (Tilt)

Some wheelchairs and specialist armchairs provide an ability to tilt the seat as shown. This assists a person to maintain a good posture and reduces the risk of pressure damage to the buttocks and feet.





## 4.2 Seat accessories

Seat accessories may be available on a specialist armchair or wheelchair; they have an important role in the set-up and size of a seat. The key considerations for these accessories are outlined in Table 1.

**Table 1. Seat accessories and considerations to reduce pressure ulcer risk**

Seat accessory	Considerations
Backrest	The backrest needs to provide effective postural support and pressure distribution by achieving a symmetrical and even contact with the back. For wheelchairs, a backrest that is too narrow can cause the wheelchair posts to contact with the upper back, increasing pressure ulcer risk.
Leg rest/ footplate	The height of footplates or leg rests should be adjustable and positioned to allow both feet to be effectively supported. Deformities of the foot and/or contractures can make this challenging and advice should be sought from a healthcare professional with the relevant knowledge of seating set-up.
Armrest	An armrest that is too low results in an individual leaning to a particular side. Over time, a persistent lean can result in postural complications such as scoliosis (spinal curvature), which can add a further complexity to pressure management. The height of the armrest may also be critical for an individual for functional reasons.
Headrest	A head support is beneficial for individuals who are unable to maintain good head control or cannot position their head independently; weakened neck muscles can have an effect on respiratory and digestive function. The use of a headrest promotes an overall improved posture.

## 4.3 Surface and Shape (cushions)

There are many considerations when prescribing, assessing for, or using a cushion to reduce the risk of pressure ulcers. This section outlines the importance of a cushion's surface and shape.

### Surface

The cushion surface (material) plays a key part in providing **immersion** and **envelopment**. These terms are often used to describe a cushion's performance and how it adapts, conforms and supports the person's weight through their buttocks. '**Immersion**' describes the ability for an individual to 'sink' into the cushion, and '**envelopment**' describes the cushion's ability to conform to the shape of the body. A cushion that provides better **immersion** and greater **envelopment** without any bottoming-out

theoretically provides safer sitting times (Linder-Ganz et al, 2006; Gefen, et al, 2008).

Bottoming-out is a term to describe when the travel of an individual's buttocks or pelvis has exceeded the compression of cushion and is touching the seat base or wheelchair canvas. It is suggested that the optimal distance that a person is immersed (sinks) into a cushion is 4cm (Collins, 2001), however, this does depend on the depth of cushion in use and whether it permits this.

### The following questions may be asked when assessing the effectiveness of a cushion in preventing pressure damage:

- ◆ How well does the material conform to the body?
- ◆ How well does the material conform in the specific areas at risk, e.g. under the ischial tuberosities?
- ◆ How well does the surface redistribute the pressure to other, less risk-prone regions of the body, e.g. to the thighs?
- ◆ How well does the cushion prevent the individual from bottoming-out?

### Shape

Some cushions will have pre-defined shape such as contouring for the thighs, or an ischial well (lowered section) for the pelvic region. The aim of contouring in a cushion is to promote stability to provide a functional posture that effectively redistributes pressure.


The ability to adjust or change the shape may be possible with some cushion types, such as air cushions or modular-type cushions. It is particularly important for the cushion to respond to the change to the individual's buttocks shape over time (Gefen, 2014). The accurate positioning of an individual, with respect to the shape of the cushion, is paramount to ensure that any localised contouring or material is performing as intended, for example 'is the ischial well of the cushion under the pelvis?'

Custom-contoured shapes may be required when an individual has changes in their skeletal or muscular anatomy that needs accommodation or correction. These may be offered by specialist seating services for individuals with complex needs.

## 4.4 Seating assessment

A seating assessment is recommended for individuals who sit for prolonged periods of time in order to assess posture and appropriately prescribe specialist armchairs or seating for wheelchairs, that will improve and maintain function for the individual.

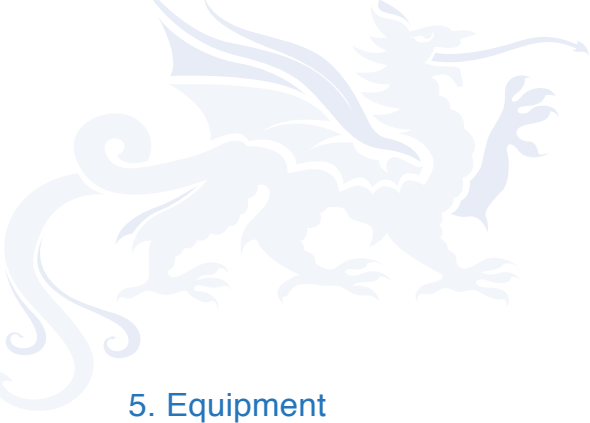




The assessment should be person-centred. The individual needs to understand why specialist equipment is required, the potential impact on their lifestyle and benefits such as the prevention of pressure ulcers (Stephens & Bartley, 2018). Equipment abandonment is more likely if these discussions do not take place (Stephens & Bartley, 2018).

Many healthcare professionals are appropriately trained to conduct a specialist seating assessment and prescribe suitable equipment, such as occupational therapists, physiotherapists, rehabilitation engineers and clinical scientists. This assessment is often in collaboration with the multidisciplinary team which may include a doctor, tissue viability nurse (NICE, 2014), and community nurses. Referrals to other services may be required following the assessment.

The individual, carer and community team play a role in managing any risks or changes associated with the equipment issued and should communicate any concerns with the prescriber.



## 5. Equipment

This section focuses on specialist armchairs (also known as static seating), wheelchairs and cushions and provides professionals, carers and individuals with the underpinning knowledge to assist the appropriate, safe and effective selection and use of equipment.

### 5.1 Wheelchairs and static seating

Appendix contains information about the NHS provision criteria for people in Wales when purchasing a mobility device. Wheelchairs and static seating can be prescribed or purchased with a range of configuration options to reflect an individual's specific needs.

#### 5.1.1 Wheelchairs

Wheelchairs are categorised into the following types:

- ◆ **Powered:** Motor-powered usually from a battery source.
- ◆ **Manual self-propelled:** Manual propulsion by the occupant using the wheel rims.
- ◆ **Manual transit:** Manual propulsion by the assistant using the handlebars.

#### 5.1.2 Static seating

Static seating is a broad term that includes any type of seat that is static in the home, care home or hospital. This type of seating may also be referred to as an armchair, specialist armchair or a riser-recliner.

### 5.2 Equipment options

To achieve the correct prescription, the principles described as the 4 'S's in Section 4 should be applied. The following equipment options may be beneficial in relation to reducing the risk of pressure ulcers:

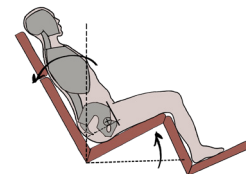
- ◆ **Functions:** (e.g. tilt, recline and leg elevation) may have significant impact on reducing pressure ulcer risk (see Section 5.2.1).
- ◆ **Suspension/dampening:** may be offered through the design of a wheelchair's frame, the material of the wheels or the seat cushion to provide a 'smoother ride' for the occupant. This may be important to protect the skin from trauma, shear forces and excessive pressures.
- ◆ **Cushions:** the surface and shape of the support (e.g. the cushion) is important as outlined in Section 4.3. Section 5.5 outlines further considerations related to the seat cushion specifically in relation to material.
- ◆ **Method of transferring** - see Section 5.4 below.

#### 5.2.1 Tilt, recline, and elevating leg rests

Individuals who are at risk of developing pressure ulcers should be encouraged to change their position frequently (NICE, 2014) and the use of tilt or recline considered to provide effective repositioning.

##### Tilt

Tilt systems allow individuals to change their seat angle orientation in relation to the ground, while maintaining a constant seat-to-back angle and seat-to-leg rest angle (Rehabilitation Engineering and Assistive Technology Society of North America [RESNA], 2015). This will achieve effective pressure reduction and improve skin perfusion over the ischial tuberosities and the buttocks.

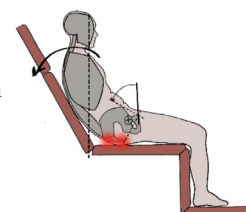


There may be cases where tilt is contra-indicated, for example when the individual has breathing difficulties or when tilting promotes muscle spasms.

##### Recline

Recline allows individuals to change their seat to back angle and maintain a constant seat angle with respect to the ground (RESNA, 2015).

However, this type of repositioning in isolation can be detrimental as individuals may be at greater risk of sliding out of the chair, causing shear and friction forces.



The greatest reductions in pressure are seen when tilt and recline are used together, either at a tilt angle of 35 degrees with recline of 100 degrees, or tilt of 15-25 degrees with recline of 120 degrees (Jan et al, 2010; 2013).

##### Elevating leg rests

Elevating leg rests allows individuals to change the leg and/or footrest angle relative to the seat in order to flex or extend the knee (RESNA, 2015). However, it is recommended that this feature is used in combination with tilt or recline to reduce the risk of pressure ulcers.

It is also important to remember that this may place the posterior heel area at risk, as it will be in a weight-bearing position.

### 5.3 Standing frames and wheelchair standing frames

Where possible standing is advised as part of the 24-hour

pressure management routine for people with short- or long-term mobility difficulties for pressure relief and to improve functional reach, independence, vital organ capacity, circulation, and passive range of motion. Standing reduces the occurrence of abnormal muscle tone and skeletal deformities (Stephens & Bartley, 2018), which may increase the risk of pressure ulcers.

#### 5.4 Manual handling and transfers

Individuals who are seated for extended periods of time may require assistance with transfers; to move themselves from one surface or position to another. Advice should be sought from an occupational therapist or a professional trained in manual handling.

#### 5.5 Cushions

There are many different types of pressure-redistributing cushions available to help prevent and manage pressure ulcers, such as:

- ◆ A single cushion to use on a wheelchair or chair
- ◆ An integrated cushion into a seating system (a cushion that is not removable)
- ◆ A bespoke custom-made cushion.

Examples of cushion types includes flat foam, segmented foam, contoured foams, water/gel-filled, honeycomb structure, and air-cell-based – powered and non-powered. The literature examining cushion technology does not suggest that any one type is superior or most cost-effective than another (Stockon et al, 2009; Hollington & Hillman, 2013).

There are several factors to consider when selecting a cushion, but the key factors are:

- ◆ Size
- ◆ Surface
- ◆ Shape
- ◆ Acceptability to the patient
- ◆ Impact on the chair.

These factors influence how the cushion reduces the pressure exerted on the areas at risk, how it manages temperature and humidity at the buttocks, and improves comfort (Crane & Hobson, 2002; Hollington & Hillman, 2013; Tasker et al, 2014).

Cushion manufacturers may categorise their cushions according to the individual's level of risk of developing pressure ulcers or may state that the cushion is suitable to be used for certain depths of pressure damage (e.g. 'suitable for Category 3-4'). This can be helpful but should not replace a thorough holistic assessment. Cushions state a weight limit for

the individual and this should be considered during selection.

There are advantages and disadvantages to consider with all forms of cushion. Table 2 outlines the considerations of cushion shape. Table 3 provides a list of the most commonly used materials used in cushions and chairs, which are currently commercially available in the United Kingdom.

#### 5.6 How do I know if a cushion is suitable?

The below checklist may be used to determine if a cushion is suitable:

- Is the individual comfortable?
- Is the individual within the quoted weight limit stated by the cushion manufacturer?
- Is the cushion compatible with chair size? Will it stay in place?
- Does adding the cushion change the set-up of the chair? E.g. does it change the height of the user in the chair? Can the user still use the armrests? Does it increase the risk of entrapment?
- Is the cushion prohibiting function or activities for the individual?
- Are there any unloaded areas (not in contact) of the thighs/buttocks?
- Is there risk of it being used incorrectly? E.g. positioned on chair in an incorrect orientation.
- Does the cushion help support the individual's posture in the chair?
- Does the cushion provide adequate pressure redistribution under the buttocks? (Check for 'bottoming-out').
- What training does the individual or their carers require?
- What maintenance does the cushion require?
- Who should be contacted if there is concern about the cushion?

##### 5.6.1 Comfort

Discomfort can be considered as a symptom and pre-cursor to pressure damage (Hall & Guyton, 2010; Braden & Bergstrom, 1988) and therefore comfort is a useful indicator for individuals who have adequate sensation and are able to communicate feedback.

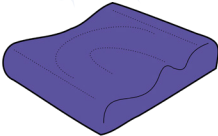
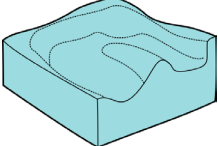
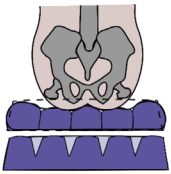
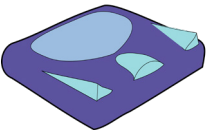
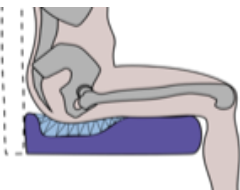
##### 5.6.2 Skin checks

It may be necessary to introduce equipment gradually, particularly if an individual sits after a period of bed rest. Sitting time should be increased gradually in combination with regular skin observation. Regular skin checks are recommended to assess if there are any signs of pressure damage, particularly when new equipment has been issued.

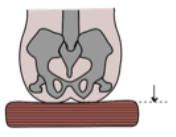

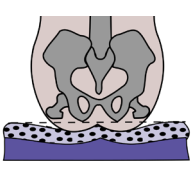
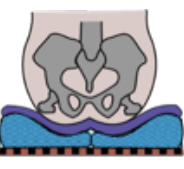
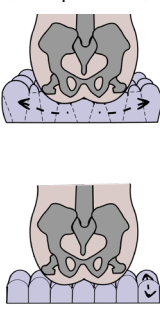
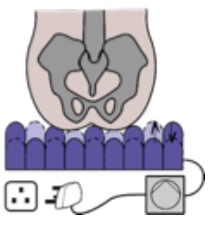
##### 5.6.3 Interface pressure measurements

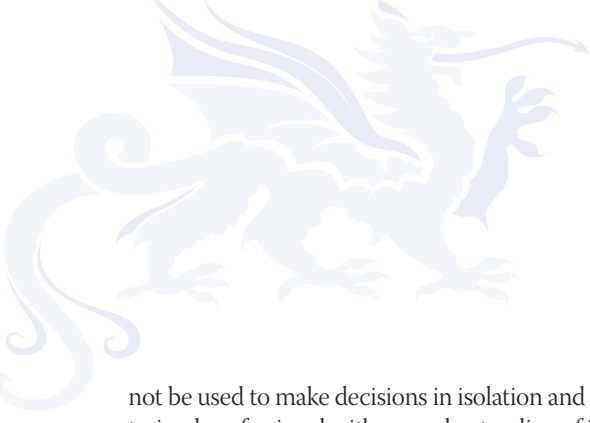
Interface pressure measurements between the individual and the seat can be obtained using pressure mapping equipment and can determine the suitability of a cushion. However, it must

**Table 2. Cushion type by shape aspects taken from Collins (2001)**

Shape/features	Considerations
<p>Contoured</p> 	<ul style="list-style-type: none"> <li>◆ Contouring to thigh and buttock shape</li> <li>◆ Increases pressure distribution, support and postural stability compared to flat surface</li> <li>◆ Aggressive contouring can prohibit self-transfers</li> </ul>
<p>Custom-contoured</p> 	<ul style="list-style-type: none"> <li>◆ Custom-contoured cushions are typically provided to individuals with complex posture needs where off-the-shelf equipment is not able to manage changes in an individual's musculo-skeletal anatomy</li> <li>◆ Assessment and manufacturing is provided by NHS special seating departments or third-party contractors</li> </ul>
<p>Non-continuous e.g. Castellated/matrix/ honeycomb</p> 	<ul style="list-style-type: none"> <li>◆ Machined voids (gaps) within surface allowing surface to buckle/deform under load and accommodate body shape</li> <li>◆ Increased pressure distribution, and resistance to shear forces at the skin</li> </ul>
<p>Positioning features e.g. Ischial well, adductor 'pommel', abductor wedges</p> 	<ul style="list-style-type: none"> <li>◆ Positioning features may be integrated (non-removable) in a cushion to assist with positioning and alignment of the pelvis or thighs. This can optimise posture of the individual to achieve an increased pressure redistribution on the cushion</li> <li>◆ Some positioning features may not be tolerated and can contribute to pressure damage for those with an asymmetrical posture</li> <li>◆ It is important that these are prescribed by a trained healthcare professional with knowledge of the individual's musculoskeletal limitations e.g. joint range of movement</li> </ul>
<p>Cushion inserts / 'hybrid' cushions</p> 	<ul style="list-style-type: none"> <li>◆ These cushions contain a different material under the pelvic region in order to provide specific pressure redistribution in that region (ischial well)</li> <li>◆ Inserts can be viscoelastic foam, gel/fluid, or air, set within with a firmer seat base</li> <li>◆ Inserts may be provided to reduce shear pressure in certain areas</li> <li>◆ It is important that the pressure gradient at the interface between the insert and the seat's firmer material is considered to avoid an 'edge-effect' and shaping may be used to minimise this</li> </ul>

**Table 3. Cushion type by material (aspects taken from (Stockon et al, [2009]; Stephens & Bartley, [2018])**

Material	Considerations	Advantages	Disadvantages	Caution
<p><b>Polyurethane (standard) foam</b></p> 	<p>Surface structure or contouring may be important to increase pressure redistribution</p> <p>Available in various densities and levels of hardness which influences the immersion and envelopment of the individual</p>	<p>Could promote stability/sitting balance</p> <p>Simple to issue and use</p> <p>Less expensive</p>	<p>May warm up and retain heat and moisture which may increase risk of tissue damage</p>	<p>Thin or low-quality foam may not be hardwearing and needs replacement after 6-12 months' use</p>
<p><b>Visco-elastic (memory) foam</b></p> 	<p>Foam contains additional chemicals that increases its flexibility</p> <p>Surface structure or contouring may be important to increase pressure redistribution</p> <p>Available in various densities and levels of hardness which influences the immersion and envelopment of the individual</p>	<p>Increased pressure redistribution is provided compared to polyurethane foam as the foam contours to the buttocks</p> <p>Relatively stable support surface</p>	<p>May warm up and retain heat and moisture which may increase risk of tissue damage</p> <p>Transfers may be compromised due to the cushion contouring and immersion into the cushion</p>	<p>Thin foam cushions may not be hardwearing</p> <p>If stored in a cold environment, they can feel firm until material warms up</p>
<p><b>Gel/silicone</b></p> 	<p>Gel, fluid or silicone come in a variety of forms providing different fluidity and performance</p> <p>The gel might be in the form of a fluid sac, or as a gel layer</p> <p>The gel might be on the top surface or sandwiched between foam</p>	<p>Firm gel or silicon formed in a honeycomb matrix may be used to enhance the cushion's ability to conform</p> <p>Gel may help reduce shear experienced by soft tissue</p> <p>Heat can dissipate through gel and away from the skin</p>	<p>Cushions can be heavier in weight</p> <p>Gel cushions may leak if punctured</p> <p>Need to be stored flat or the gel may malfunction</p>	<p>Risk of 'bottoming out' if the gel section is too shallow or the gel is too fluid</p> <p>The movement of gel may affect the individual's seated balance and ability to transfer</p>
<p><b>Water</b></p> 	<p>Not commonly used due to weight and risk of puncture</p>	<p>Can provide optimum immersion</p>	<p>Cushions can be heavier in weight</p> <p>Can be cold, may retain heat</p>	<p>Risks of water leak</p> <p>Water cells may be contained under a top layer which is some distance from the skin interface and therefore can limit its effectiveness</p>
<p><b>Air (non-powered)</b></p> 	<p>Number of cells and the cell size can be important to achieve optimum immersion and envelopment</p> <p>Ability of air to pass between 'cells' varies in different products</p> <p>Alternative air cushions contain pyramid-shaped air packets that move freely</p>	<p>Light weight and easy to move</p> <p>Can provide excellent immersion</p> <p>Heat can dissipate through the air and away from skin</p>	<p>Can compromise stability, affecting sitting balance or transfers</p> <p>Maintenance required to ensure optimal performance</p>	<p>Risk of puncture</p> <p>User/carer education is required to maintain optimum set-up and maintenance</p> <p>Incorrect set-up can present significant risks to user, e.g. over-inflation (limited immersion) or under-inflation (bottoming out)</p>
<p><b>Air (powered)</b></p> 	<p>Actively redistributes air between different 'cells' to vary loading of different body areas over time</p> <p>Number of cells and the cell size can be important to achieve optimum immersion and envelopment</p> <p>Cycle periods can vary, but generally 10-15 minutes</p>	<p>Alternating inflation and deflation of the air sacs changes pressure points and may stimulate circulation</p>	<p>Can compromise stability, affecting sitting balance or transfers</p> <p>Some may feel unstable with movement beneath them</p> <p>Relies on a powered pump (less appropriate for wheelchairs)</p> <p>Costly in comparison to static cushions</p>	<p>Effectiveness in offloading risk areas should be checked</p> <p>Requires power source (e.g. battery or mains supply)</p> <p>Other repositioning techniques must still be used to reduce risk of pressure ulcers</p> <p>Risk of puncture</p>



not be used to make decisions in isolation and must be used by trained professional with an understanding of its limitations. See Appendix 8.2 for the role of pressure mapping.

#### 5.6.4 Manual checking

Manual checking, by placing your hand between the cushion and the ischium or sacrum, is also considered a valid method in determining the regions of the body which are loaded more than others. This may inform if 'bottoming-out' is occurring. This method should also be used when setting up an air cushion, and the manufacturer's manual should be referred to.

### 5.7 Microclimate and cushion covers

#### 5.7.1 Microclimate

In the context of pressure ulcers, microclimate refers to skin temperature and moisture conditions at the interface between the skin and support surface. Skin moisture and raised skin temperatures weakens the skin's structure which increases the susceptibility to tissue damage (Wounds International, 2010).

Any surface that comes into contact or close contact with skin has the potential to alter the microclimate by changing the rate of evaporation of moisture and the rate at which heat dissipates from the skin. The overall effect on microclimate is dependent on numerous factors, including the material and shape of the support surface, as well as the type of cover the surface has (Wounds International, 2010).

#### 5.7.2 Cushion cover selection

Cushion covers should ideally be:

- ◆ Flexible/stretchable to prevent 'hammocking' (cover not conforming to the natural loaded shape of the surface)
- ◆ Smooth and crease free
- ◆ Minimise and manage temperature and moisture build-up
- ◆ Enable transfers
- ◆ Easy to clean
- ◆ Removable to allow inspection of the cushion
- ◆ Clearly labelled to show the correct orientation.

#### 5.7.3 Do not cover the cover

Anything that is placed between the support surface (cushion) and the skin will affect the performance of the cushion and therefore potentially increase the risk of pressure damage. The following are examples of coverings or other accessories that may increase the pressures and change the microclimate:

- ◆ Clothing – the person should wear flexible or stretchable materials, and avoid materials such as jeans

or any trousers that contain seams and studs around the pelvic region

- ◆ Slings – may need to be removed from the seating surface (with care not to drag the skin). Some slings are marketed as 'leave-in' or 'all day' but may still affect pressure
- ◆ Incontinence pads – where these are essential, take care when positioning; consider the use of wipeable or washable cushion covers where feasible
- ◆ Extra covers, towels, sheets – these should not be placed on top of cushions
- ◆ Catheters/wound drain tubing – careful placement of these may be required to avoid causing contact with the skin and check they are not kinked.

### 6. Education

Education plays a significant part in managing the risk of an individual who remains seated for extended periods of time. All healthcare professionals have a role in education and raising the awareness of pressure ulcer risk to individuals and carers, and this can take the form of provision of leaflets, conversations about posture, equipment and skin care. The use of pressure mapping to reinforce the correct use of equipment and repositioning can be valuable (See Appendix 8.2).

### 7. Concluding remarks

This document provides a reference for individuals and healthcare professionals to guide decisions and to promote best practice in the seating of individuals at risk of pressure ulcers.

The principles of seating in order to increase the knowledge base of the multidisciplinary team should be applied widely. It is vital that all healthcare professionals are critical of an individual's posture, as this has a significant influence on the risk of developing pressure ulcers. The ability to determine if a cushion or the set-up of a specialist armchair or wheelchair is appropriate or correct is absolutely necessary so that specialist services have the earliest opportunity to intervene. The importance of visual and hand checks cannot be underestimated to verify that the equipment is working as intended.



## 8. Appendices

### 8.1 How to access services in Wales

The majority of seating equipment is accessed through local NHS services. Some people may wish to privately purchase equipment from local mobility shops. It is important to consider how privately purchased equipment is regularly repaired, maintained and reviewed, as this is critical for the effectiveness.

#### 8.1.1 Static seating/specialist armchairs

In Wales, there are Health Board and Social Services teams who work in the community assessing and providing static seating/specialist armchairs for the home. These local services, sometimes referred to as Community Resource Teams or Community Equipment Services, can advise on the referral process and criteria for funding. There may be local variation regarding the expectations of equipment provision by care homes – what equipment is to be provided by the care home provider and what will be provided by the Community Equipment Service. A specialist assessment may be conducted whilst an individual is in hospital when there is clinical reasoning within local criteria and protocols. With appropriate training, all members of the multidisciplinary team may screen or assess for specialist static seating.

#### 8.1.2 Wheelchair equipment

The Posture and Mobility Service in Wales provides seating and mobility equipment to individuals who require the long-term use of a wheelchair for 6 months or more and are considered to have a permanent physical impairment or medical condition affecting their ability to walk. Posture and mobility equipment, new or refurbished, is provided from a nationally agreed range.

#### Contact details:

North Wales: 01978 727524  
South Wales: 01443 661799  
[www.alas.wales.nhs.uk](http://www.alas.wales.nhs.uk)

Wheelchairs and cushions are supplied by the Service and are provided on a loan basis and must be returned when the equipment is no longer in use.

Wheelchair cushions can be supplied for use with a prescribed wheelchair and this should be requested at the time of referral. If there are concerns or changes to a wheelchair user's pressure ulcer risk or if there is new pressure damage, the individual, their carer or another healthcare professional should contact their local service

who will be advised of the local pathway for these instances.

A person with complex postural needs may be assessed and provided specialist seating which may be commercially available, or custom made by the rehabilitation engineering departments.

#### Referral

All new referrals to the Service should be made by a registered healthcare professional such as a GP, district nurse, physiotherapist or occupational therapist with the appropriate knowledge and skills. All new referrals need to be directed to the South Wales or North Wales Posture and Mobility Services. Referral forms are available from the Posture and Mobility Services or local community therapists.

#### Assessment

Assessments for complex cases are undertaken by specialist therapists or clinical engineers in clinics, schools, your home and other settings such as a dedicated Posture and Mobility Service site. The venue and duration of the assessment varies according to the individual's requirements.

#### Provision of equipment

Following assessment, equipment may be ordered or, if necessary, custom equipment will be made and fitted by a specialist therapist or clinical engineer.

#### Maintenance

Repair and maintenance of equipment is provided by the service and contact details are provided on issue of equipment.

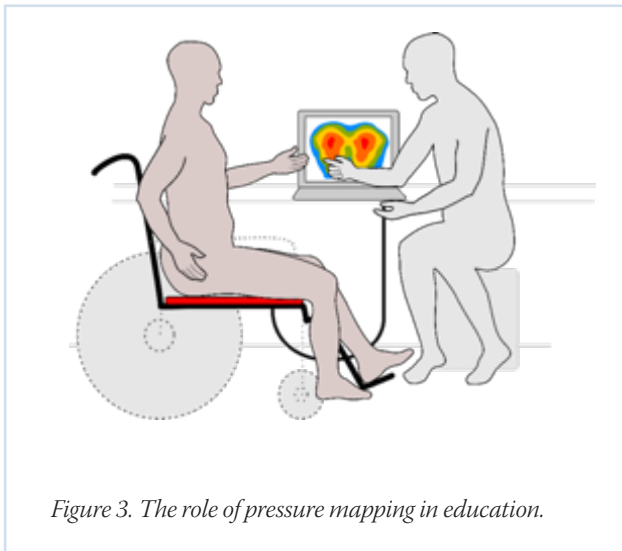
### 8.2 The role of pressure mapping

Pressure mapping may be used to analyse and understand different sitting postures (Swain & Bader, 2002; Stinson et al, 2003) and has a significant role in the education about weight-shifting techniques and the importance of pressure redistribution.

Interface pressure measured using pressure mapping technology (Figure 3), is accepted as a valuable clinical tool (Brienza et al, 2001; Davis, 2009; Reenalda et al, 2009). It is important that a referrer needs to be clear on the specific clinical reasons when requesting pressure mapping. The measurement of interface pressure is considered by many as a measure for risk of ischaemia and the development of a pressure ulcer (Cordell et al, 1995; Brienza et al, 2001; Keller



et al, 2005; Hemmes et al, 2010). However, it recommended that interface pressure measurement alone is not sufficient as a risk indicator for pressure ulcer development (Reenalda et al, 2009), and its usefulness in assessing optimum seating increases greatly when consistent protocols are used.



*Figure 3. The role of pressure mapping in education.*

Pressure mapping uses an array of force sensors to measure interface pressure, which is the pressure between the skin and the support surface. There are a variety of commercial systems available that provide computerised or wireless displays of the interface pressures, displayed as coloured pressure contour maps.

It is essential that healthcare professionals who use pressure mapping systems for their clinical practice and patient education have an appropriate level of training to ensure adequate knowledge of the role of pressure mapping and its limitations. It is also important that pressure mapping systems are maintained according to their instructions for use, such as regular calibration.

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## 10. References

- All Wales Tissue Viability Nurse Forum (2017) *Essential Elements of Pressure Ulcer Prevention and Management*: Based on EPUAP/NPUAP guidance. All Wales Guidance. Available online at: <https://bit.ly/36aCI7v> (accessed 21.10.2019)
- Barbanel J (1991) Pressure management. *Prosthetics Orthot Int* 15: 225–31
- Bowtell M (2018) *The 4 S's Seating principles to reduce pressure ulcer risk*. Available online at: <https://bit.ly/2pY8TRo> (accessed 21.10.2019)
- Braden B and Bergstorm N (1988) *Braden-Scale For Predicting Pressure Sore Risk*. Available online at: [https://www.in.gov/isdh/files/Braden\\_Scale.pdf](https://www.in.gov/isdh/files/Braden_Scale.pdf) (accessed 21.10.2019)
- Brienza DM, Karg PE, Geyer MJ et al (2001) The relationship between pressure ulcer incidence and buttock-seat cushion interface pressure in at-risk elderly wheelchair users. *Arch Phys Med Rehabil* 82: 529–33
- Coleman S et al (2013) Patient risk factors for pressure ulcer development: Systematic review. *Int J of Nurs Stud* 50(7): 974–1003
- Collins F (2001) Seating: Educational Booklet. *The Wound Care Society* 8(1)
- Cordell WH, Hollingsworth JC and Olinger ML (1995) Pain and tissue-interface pressures during spine-board immobilization. *Ann Emerg Med* 26(1): 31–36
- Crane B and Hobson D (2002) The importance of comfort to wheelchair users - a preliminary study. Paper presented at the *18th international seating symposium*, 7-9 March 2002, Vancouver, Canada
- Davis K and Sprigle S (2009) *The science of interface pressure mapping – updates for clinical application*. Available online at: <https://b.gatech.edu/2NiEC7R> (accessed 21.10.2019)
- Dealey C (1992) Pressure Sores: the Result of Bad Nursing? *Br J Nurs* 1(15): 748
- Gefen A (2008) How much time does it take to get a pressure ulcer? Integrated evidence from human, animal, and in vivo studies. *Ostomy Wound Manage* 54(10): 26–8, 30–5
- Gefen A (2014) Tissue changes in patients following spinal cord injury and implications for wheelchair cushions and tissue loading: A literature review. *Ostomy Wound Manage* 60(2): 34–45
- Gefen A, van Nierop B, Bader D et al (2008) Strain-time cell-death threshold for skeletal muscle in tissue-engineered model system for deep tissue injury. *J Biomech* 41(9): 2003–12
- Hall J and Guyton A (2010) *Textbook of Medical Physiology* (12th edition). Philadelphia: Saunders
- Ham R, Aldersea P and Porter D (1998) *Wheelchair Users and Postural Seating: A Clinical Approach*. New York: Churchill Livingstone
- Hemmes B, Poeze M and Brink PR (2010) Reduced tissue-interface pressure and increased comfort on a newly developed soft-layered long spineboard. *The Journal of Trauma* 68: 593–98
- Hollington J and Hillman S (2013) Can static interface pressure mapping be used to rank pressure redistributing cushions for active wheelchair users? *J Rehabil Res Dev* 50(1): 53–60
- Jan Y et al (2010) Effect of wheelchair tilt in-space and recline angles on skin perfusion over the ischial tuberosity in people with spinal cord injury. *Arch Phys Med Rehabil* 91(11): 1758–64
- Jan Y et al (2013) Comparison of muscle and skin perfusion over the ischial tuberosities in response to wheelchair tilt-in-space and recline angles in people with spinal cord injury. *Arch Phys Med Rehabil* 94(10): 1990–6
- Keller BR, Lubbert PH and Keller E (2005) Tissue-interface pressures on three different support-surfaces for trauma patients. *Injury* 36(8): 946–48
- Kosiak M (1959) Etiology and pathology of ischemic ulcers. *Arch Phys Med Rehabil* 40(2): 62–9
- Krouskop T (1983) A synthesis of the factors that contribute to pressure sore formation. *Med Hypotheses* 11(2): 255–67
- Linder-Ganz E, Engelberg S, Scheinowitz M et al (2006) A Pressure-time cell death threshold for albino rat skeletal muscles as related to pressure sore biomechanics. *J Biomech* 39(14): 2725–35
- National Institute of Health and Care Excellence (2014) *Pressure ulcers: prevention and management*. London: NICE. Available online at: <https://www.nice.org.uk/guidance/cg179> (accessed 21.10.2019)
- National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance (2014) *Prevention and Treatment of Pressure Ulcers: Quick Reference Guide*. Available online at: <https://www.npuap.org/wp-content/uploads/2014/08/Updated-10-16-14-Quick-Reference-Guide-DIGITAL-NPUAP-EPUAP-PPPIA-16Oct2014.pdf> (accessed 21.10.2019)
- Reenalda J, Jannink M, Nederhand M (2002) Clinical use of interface pressure to predict pressure ulcer development: a systematic review. *Assist Technol* 21(2): 76–85
- Rehabilitation Engineering and Assistive Technology Society of North America (2015) *Position on the application of tilt, recline, and elevating legrests for wheelchairs: current state of the literature*. Available online at: <https://bit.ly/32XHRrV> (accessed 21.10.2019)
- Reswick J and Rogers J (1976) Experience at Rancho Los Amigos Hospital with devices and techniques to prevent pressure sores. *Bed Sore Biomech*: 301-10
- Schubert V and Heraud J (1994) The effects of pressure and shear on skin microcirculation in elderly stroke patients lying in supine or semi-recumbent positions. *Age Aging* 23(5): 405–10
- Sonenblum S, Vonk T, Janssen T et al (2014) Effects of wheelchair cushions and pressure relief manoeuvres on ischial pressure and blood flow in people with spinal cord injury. *Arch Phys Med Rehabil* 95(7): 1350–7
- Sprigle S and Sonenblum S (2011) Assessing evidence supporting redistribution of pressure for pressure ulcer prevention: A review. *J Rehabil Res Dev* 48(3): 203–13
- Stephens M and Bartley C (2018) Understanding the association between pressure ulcers and sitting in adults what does it mean for me and my carers? Seating guidelines for people, carers and health & social care professionals. *J Tissue Viability* 27(1): 59–73
- Stinson MD, Porter-Armstrong AP and Eakin PA (2003) Pressure mapping systems: reliability of pressure map interpretation. *Clin Rehabil* 17: 504–11
- Stockon L, Gebhardt K and Clark M (2009) Seating and pressure ulcers: Clinical practice guidelines. *J Tissue Viability* 18(4): 98–108
- Swain ID and Bader DL (2002) The measurement of interface pressure and its role in soft tissue breakdown. *J Tissue Viability* 12(4): 132–4, 136–7, 140–6
- Tasker L, Shapcott N, Watkins A et al (2014) The effect of seat shape on the risk of pressure ulcers using discomfort and interface pressure measurements. *Prosth Orthot Int* 38(1): 46–53
- Wounds International (2010) *Pressure Ulcer prevention: pressure, shear, friction and microclimate in context. A consensus document*. Available online at: <https://bit.ly/2q2aaqo> (accessed 21.10.2019)



