

Reducing the risk of pressure ulceration in wheelchair users with a novel support surface

ROHO Hybrid Select Cushion



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Introducing ROHO Hybrid Select Cushion

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ABSTRACT

This article first describes the presentation, impact, prevalence and aetiology of pressure ulceration in wheelchair users. It then explores how to assess the risk of a wheelchair user developing a pressure ulcer and how to reduce this risk with effective skin care, moisture management and surface support, as well as repositioning, nutrition and advice. The article concludes by examining the clinical benefits of wheelchair support surfaces and how to select a cushion from the reactive, dynamic and hybrid types available, with a focus on the ROHO Hybrid Select Cushion (Permobil).

There are more than 1 billion people worldwide living with a disability, and 200 million (20%) of those people have considerable functional impairments and may use a wheelchair (Ferro et al, 2020). Many wheelchair users are at risk of pressure ulceration, and health professionals involved in their care need to be familiar with the impact and cause of these wounds and how to minimise that risk with appropriate pressure redistribution.

Pressure ulceration in wheelchair users

Presentation

Pressure ulcers (PUs) – also referred to as pressure injuries – are localised damage to skin and/or underlying tissue caused by sustained pressure and shear forces. They can present as intact skin or an open wound, often over a bony prominence (NHS Improvement, 2018a). The damage often begins deep within soft tissue at the interface with the bone, with skin breakdown occurring later as tissue death progresses, meaning that PUs are not always immediately visible. In practice, a distinction is made between device-related pressure ulcers and other PUs that are not caused by a medical or other device.

Impact

PUs are often painful and have significant physical, psychological and social impacts (White, 2014; Shiferaw et al, 2020). Consequently, PUs require significant healthcare resources to prevent, manage and heal (Guest et al, 2018). For those who are wheelchair dependent, PUs can impair rehabilitation, social interaction and ability to work (Ferro et al, 2020). Wheelchair users with spinal cord injury (SCI) who develop PUs are more likely to experience repeated hospital stays, multiple surgeries, higher risks for infection and mortality (Shiferaw et al, 2020). Some wheelchair users with a PU lack the physical sensation to feel pain from a PU, but they are still likely to have anxieties about infection and mortality, as well as the appearance, leakage and odour associated with having an open wound (Ferro et al, 2020). Another factor in the impact of PUs on rehabilitation is the extended periods of bed rest required by many patients with SCI and other neurological conditions. Guidelines

from the National Pressure Injury Advisory Panel (NPIAP) (2019) recommend that removing the pressure is the key to healing PUs.

Prevalence

The prevalence and incidence of PUs across all wheelchair users is difficult to establish. Research on this topic tends to focus on specific patient groups, with many studies focusing on spina bifida, multiple sclerosis (MS) and particularly SCI, possibly because this condition is relatively easy to follow from acute to chronic stages. There is considerable overlap between these groups of wheelchair users when it comes to PU prevention.

Wheelchair users with SCI have a reported PU incidence within 6 months of discharge from hospital or rehabilitation centre of up to 42% (Kovindha et al, 2015). This was supported by a meta-analysis that put the global prevalence of PUs in all SCI patients at 30–40%, with the highest regional prevalence being 56% in Europe (Shiferaw et al, 2020). This meta-analysis also estimated that PU management accounted for up to 25% of the total cost of treating paraplegic and tetraplegic people (Shiferaw et al, 2020). According to EPUAP et al (2019), up to 95% of people with SCI will experience a PU at some stage in their life. In the author's experience, these are most likely to occur over the ischial tuberosities and sacrum due to prolonged periods of sitting in wheelchairs.

Aetiology

PUs occur when direct sustained pressure between a surface and bony prominence deforms the cells that comprise the tissue in between. This deformation damages the cell's membrane and increases its permeability, which disrupts the cytoskeleton, with a decrease of the pH level, eventually resulting in cell death (Stekelenburg et al, 2007; Jagannathan and Tucker-Kellogg, 2016). The pressure can also compress blood vessels within the tissue, restricting the flow of blood to the surrounding cells and thus depriving them of nutrients and oxygen, causing ischaemia and progressing to cell death if the pressure is not relieved and blood flow restored (Young, 2021).

Pressure is often combined with the shear force of bone moving through soft tissue. Shear forces can distort, stretch and ultimately tear cells and vessels, causing fluid to leak into the surrounding tissues, resulting in oedema and bleeding. Shear forces are exacerbated when a person slides on a surface, for example slipping down or dragging up without lifting free of the surface (Young, 2021).

There is also increasing evidence that the microclimate of a person's skin surface can impact shear and pressure forces (EPUAP et al, 2019). A humid microclimate, with excessive heat and moisture, can reduce the skin's resistance to these forces and so increase the risk of rapid breakdown (Kottner et al, 2018).

In wheelchair users, long periods spent seated cause sustained pressure over the bony prominences of the pelvis, particularly the ischial tuberosities and coccyx. The large load of the whole-body weight placed exposes these relatively small bony prominences to intense pressure (Ferro et al, 2020). This risk is increased the

longer the person sits in the same seated position without effective repositioning for pressure relief. Sustained periods of sitting in a wheelchair without repositioning can also increase sweating and restrict airflow to the skin, which risk increasing the humidity of the skin's microclimate (Kottner et al, 2018). Prolonged contact with moisture can compromise skin integrity and so increase the risk of pressure ulceration or skin tears on movement or transfer.

Reducing the risk of pressure ulceration in wheelchair users

Reducing the risk of pressure ulceration in wheelchair users requires a systematic, holistic and evidence-based strategy. NHS Improvement (2018b) recommend the use of a care bundle to ensure all aspects of prevention and management are included. The aSSKINg bundle brings together several tools to form a structure for both education and care. The aSSKINg model includes: assessment of risk, skin inspection and care, surface, keep moving, incontinence and moisture management, nutrition and hydration, and giving advice. Each element can be applied specifically to the needs of those in wheelchairs.

Assessment of risk factors

Wheelchair users should be assessed for general intrinsic and extrinsic risk factors for pressure ulceration using a tool such as the Waterlow Scale or Braden Scale (Box 1). It is also important to assess for risk factors specific to wheelchair users (Box 2). Wheelchair users with motor or sensory impairments are at a particular high risk of developing a PU, with greater prevalences reported among those with more severe vs less severe SCI (EPUAP et al, 2019; Shiferaw et al, 2020). Perhaps the most significant risk factor is immobility, as many wheelchair users lack the functional ability to make frequent position changes without assistance. Wheelchair users may also have reduced or absent sensitivity to notice discomfort, which is normally the prompt for movement (Ferro et al, 2020). Additionally, wheelchair users may have postural and balance issues associated with their condition that expose specific bony prominences to greater pressure and shear forces (Ferro et al, 2020). For example, post-stroke paralysis may cause someone to lean to one side, putting additional forces pushing through that ischial tuberosity or possibly the trochanter against the edge of a wheelchair.

A person assessed to be at risk of a PU will require more than a single daily skin assessment. In these cases, an aSSKINg assessment should be performed at every care intervention, with a clear plan of how often that individual requires repositioning. This applies in both community and acute care settings (NPIAP, 2019).

Box 1. Elements of the Braden Scale for pressure ulcer risk assessment

- Sensory perception
- Mobility (ability to change own position)
- Nutrition
- Moisture
- Friction and shear forces
- Activity

Source: Braden and Bergstrom, 1984

Skin inspection and care

The skin over bony prominences should be checked at least daily (NICE, 2015). Health professionals should ask to do this daily in a hospital/care setting and at each visit in the community (NICE, 2015). Self-inspection should be encouraged where possible, and wheelchair users can be taught to use mirrors to visually inspect hard-to-see areas, as well as to feel their skin and recognise unusual sensations such as heat, hardness, bogginess or skin scuffing. However, this can be a challenge for wheelchair users who rely on someone else to check areas that they cannot see or feel. This may explain why those without an intimate partner are at higher risk of pressure ulceration (Shiferaw et al, 2020).

Support surface

Wheelchair users spend long periods sitting on a particular support surface, often a cushion. To reduce the risk of skin breakdown, wheelchair users should be encouraged to inspect and change their cushion or chair as frequently as is recommended in the manufacturer's instructions. The choice and condition of the cushion is essential for reducing the risk of pressure ulceration, and this is discussed in detail later in this article (Ferro et al, 2020).

Keep moving

One of the most effective ways to prevent PUs is repositioning the person to offload pressure from exposed areas of skin. Wheelchair users should be encouraged to spend time out of their chair, laying on their sides to relieve the pressure from the areas most affected by sitting. If a person develops a PU over these prominences, their sitting should be limited to three times a day and for no more than 60 minutes at a time, and any repositioning regime in the chair should match that when a person is in bed (EPUAP et al, 2019). Wheelchair users can achieve offloading using movements, such as forward leans, providing the person has the stability not to fall too far forward (Giripunje and Tembhurne, 2021).

Side-to-side leans are no longer recommended, because they significantly increase the pressure under the lower ischial trochanter, leading to excessive tissue strains and stresses, can lead to deep tissue injury (EPUAP et al, 2019). EPUAP (2019) guidelines may still recommend vertical push-ups for those with the physical strength to lift themselves. However, the Consortium for Spinal Cord Medicine (2005) strongly discourages vertical push-ups, because of the extreme strains and stress placed on the upper limb (with an associated risk of repetitive strain injury), as well as the low level of correct execution (the requirement to lift for least 1–2 minutes two-to-four times an hour being impossible for most manual wheelchair users).

Box 2. Risk factors for pressure ulcers in wheelchair users

- Body misalignment
- Comorbidities
- Immobility
- Incorrect wheelchair size
- Incontinence
- Lack of an intimate partner
- Lack of sensation
- Male sex
- More than 1 year post SCI
- Older age
- Poor nutrition
- Quadriplegia (severe SCI)
- Smoking
- Underweight or overweight

Source: Shiferaw et al, 2020

For people who spend long periods in a wheelchair, offloading may be essential, but repositioning is often challenging. Many wheelchair users report only lifting their weight for very brief moments to relieve pressure and spending most of the day sitting (Ferro et al, 2020). In the author's experience, wheelchairs give people with limited mobility the independence to continue daily life, activity and work. This independent mobility can make these wheelchair users reluctant to spend time on a bed during the day. Younger people especially may take a blasé attitude to PU risk, especially if they lack physical sensation or previous experience of a PU. Therefore, when planning a repositioning regimen for a wheelchair user, it is important to consider their psychosocial needs (EPUAP et al, 2019).

Incontinence and moisture management

The management of incontinence or other sources of moisture is particularly important in wheelchair users. A hot, humid microclimate increases the risk of not only pressure ulceration but also moisture-associated skin damage and urinary tract infections (LaBerge et al, 2021). Incontinence risk should be assessed and, if present, appropriately managed. A cushion or seating material that allows air flow and microclimate management will reduce the impact of sweating.

Nutrition and hydration

Good nutrition and hydration are essential for maintaining skin health. Poor hydration causes the skin to become dry and inelastic, increasing risk of fragility from trauma and pressure (Posthauer et al, 2015). Someone who is very underweight will have less fatty tissue protecting their bony prominences, reducing their tolerance for being in one position for long periods. A person who is overweight can also be undernourished and not have the necessary micronutrients reaching the skin.

An injury or condition that results in wheelchair dependency is likely to significantly change a person's muscle and fat density and thus their body shape, particularly in the lower body (Holla et al, 2020). Loss of mobility is increasingly associated with obesity, which further restricts the ability to move or offload pressure.

Wheelchair users face additional barriers to healthy eating. They may struggle to get out of the house to obtain healthy food and drinks, or they may lack the emotional motivation to manage their health. They may not understand how their metabolism and energy requirements have changed following their injury or condition (Holla et al, 2020). Therefore, short- and long-term access to nutritional support is essential for the holistic prevention of PUs and skin breakdown in wheelchair users.

Giving advice

Patients who are informed about their condition are more likely to adhere to treatment and take an active interest in their care. Implementing a patient education programme in patients with SCI has been shown to significantly reduce the incidence and severity of PUs (Robineau et al, 2019).

Wheelchair users should be encouraged to be as involved as possible in PU prevention. This may include self-checking of their skin and repositioning exercises while sitting. There is a plethora

of literature available to guide skin checking and offloading techniques (Wirral and West Cheshire Wheelchair Service, 2015). Wheelchair users should also be educated about the equipment they are given and shown how to check for damage and function, and they should be supplied with appropriate contact details for equipment manufacturers and other professionals to reach for support as needed.

Wheelchair support surfaces

Selecting a cushion

Wheelchair users spend long periods sitting on a particular support surface or cushion, and so the nature of that surface will be a major determiner of their risk of pressure ulceration (Ferro et al, 2020). Health professionals caring for wheelchair users face an enormous task in selecting the most appropriate cushion from the a wide variety of available on the market, each with a range of different features. This decision should be made with the support of a seating specialist, based on a seating assessment and following best clinical evidence. Most importantly, this choice should meet the user's individual needs (Box 3) and ensure their comfort and concordance (Ousey and Parfitt, 2017). For example, a wheelchair athlete may need a different cushion to someone with a more sedentary lifestyle. Selecting the appropriate equipment to suit individual concerns and comfort is essential in reducing the risk of pressure ulceration, and the properties of seating and cushions are extremely important for both comfort and PU prevention (Ferro et al, 2020).

Types of cushion

Wheelchair cushions designed to reduce the risk of PUs have traditionally been of two types:

- Reactive cushions are made from a contouring material (static foam, reactive gel or air-filled cells) designed to immerse and envelope the person's body, redistributing pressure evenly over the body surface area and lowering the pressure at susceptible bony prominences, thus reducing the risk of pressure ulceration (Shi et al, 2018). As most reactive cushions are not powered, they rely on the person's ability to shift their position and weight distribution on the stable surface to continually reshape the underlying material and maintain the pressure redistribution (Clark, 2011). If left unchecked, the level of support can decrease over time, as foam or gel becomes compressed and loses its ability to recover shape and density or air-filled cells are punctured and lose air.

Box 3. Requirements of a wheelchair support surface

- Allows a full range of activity
- Matches the person's level of activity
- Does not have high-pressure areas (eg ring/donut cushions)
- Does not impair circulation
- Matches the level of support provided in bed
- Minimises pressure and shear exerted on skin and soft tissues
- Offers acceptability and comfort for the user
- Provides adequate support and stability

Source: EPUAP et al, 2019

- Dynamic (or active) cushions comprise a series of air-filled cells that are inflated and deflated by an air pump in sequence to relieve pressure from different key areas of the body in turn, reducing the risk of pressure ulceration (*Figure 1*). This flow of air can also stimulate capillary blood flow and help to reduce moisture at the skin surface (Clark, 2011; Mahoney and Kembery, 2020). Dynamic systems may be unstable for someone with loss of sensation or muscle control. They are also relatively cumbersome, being dependent on a power source and thus require plugging in to mains electricity or carrying a heavy motor or battery pack, which can impact on the stability and manoeuvrability of a wheelchair. Hybrid cushions are a more recent and more flexible option, constructed with both a layer of static foam or reactive gel and a layer of air-filled cells. The former redistributes pressure across the whole body via immersion and envelopment, while the latter provides additional targeted pressure relief where and when it is needed. Together, this combines the stability and independence of reactive cushions with the high-level support of dynamic cushions. Hybrid cushions may or may not be powered:

- Non-powered hybrid cushions use valves to manually lock or release air flow to inflate or deflate the air-filled cells
- Powered hybrid cushions use an air pump, powered by mains electricity or a motor or battery pack, to inflate and deflate the air-filled cells.

The incidence of PU has been found to be as much as 75% lower in hybrid cushions than in traditional dynamic cushions or foam reactive cushions (Newton, 2015). PU incidence has been also found to be lower in non-powered hybrid cushions than in traditional dynamic cushions in care home settings (Shi et al, 2018). Moreover, hybrid cushions can be less expensive than traditional dynamic cushions and thus present a more cost-effective solution, helping to reduce the

costs associated with PU prevention. Should a user's redistribution needs change, hybrid cushions have the advantage of being able to easily switch between reactive and dynamic modes without having to change the whole cushion (Clark et al, 2018). However, a focus group expressed concerns that wheelchair users whose PU risk level increases may need to be changed from a hybrid cushion to another product, although there was no consensus on when to do this (Ousey and Parfitt, 2017).

ROHO Hybrid Select Cushion

The ROHO Hybrid Select Cushion (Permobil, 2023) is an innovative non-powered hybrid cushion formed from a contoured foam base and an overlying air-filled cellular layer (*Figure 2*).

The contoured foam base is shaped to mimic the natural shape of the seated individual, with distinct channels for the upper thighs to rest, supported to ensure stability. This shape provides stability across the pelvic zone, with a pelvic tilt to minimise the interface pressures and shearing forward forces over the sacrum and ischial tuberosities and through the coccyx and buttocks (EPUAP et al, 2019).

The overlying cellular layer (ROHO) comprises air-filled cells that can move independently of each other and adjust with the weight distribution and movement of the person as they sit and adjust. The immersion and pressure-redistribution functions allowed by the air-filled cells, intended to minimise shear and friction forces, all have been mechanically tested according to International Organization for Standardization (ISO) standards (*Table 1*).

While some cushions require a person to sit in a particular way to receive the benefit of the pressure redistribution in the product (EPUAP et al, 2019), the ROHO Hybrid Select Cushion has design elements that are more tailored to the person, rather than the

Figure 1. Air-filled cells for wheelchair cushions



Figure 2. ROHO Hybrid Select Cushion



Table 1. International Organization for Standardization (ISO) tests passed by the ROHO Hybrid Select Cushion

Test	Measures
Immersion test (ISO-16840-2)	The depth a body sinks into a cushion
Resistance test (ISO-16840-2)	The level of force needed to slide forward on a cushion when seated
Envelopment test (ISO-16840-12)	The ability of a cushion to cradle bodyweight
Lateral tilt test (ISO-16840-13)	The stability of a cushion during side-to-side leaning
Contact area test (pressure mapping)	How much contact is between a body and a cushion

person having to adjust to the product. One such tailored element is the ability to remove a section of the air-filled cells to completely offload the coccyx or ischial region. Additionally, the air within the cells can be adjusted to balance any uneven weight distribution, giving more stability for people who may lean when sitting. The air-adjustment valve is situated at the front of the cushion, where it is easily reached by the wheelchair user. This can be locked and unlocked by the user to adjust the airflow. In the locked position, the air-filled cells become firm, giving maximum stability for transfers and repositioning, which is essential for maintaining skin integrity and reducing the risk of PUs.

The valve locks the three segments and restricts the airflow from the left, centre and right compartments. This helps to position the user correctly and can correct or accommodate pelvic obliquity. The cells in each compartment are still interconnected and retain their capability to adjust to position changes (never becoming firm) to protect the skin and tissue from breaking down. The combination of the anatomically shaped foam base and the air cell inlay provides the user with a solution that supports the greater trochanters to provide lateral stability. The centre part (ischial trochanter insert) of the inlay with air cells is removable, which converts the cushion into an offloading and redirection solution to completely remove the pressure from under the ischial trochanters. This can be needed to relieve the pressure in the acute phase of an ischial pressure ulceration or to permanently offload the ischial trochanter area to mitigate the very high rate of PU re-occurrence because of present scar tissue.

The ROHO Hybrid Select Cushion (Permobil, 2023) is a versatile support surface suitable for a wide variety of wheelchair users, with or without stability and balance concerns. It offers a high level of pressure redistribution, along with options to completely offload vulnerable areas. Together, its features support greater independence and personalised management of individual needs (Ousey and Parfitt, 2017; Ferro et al, 2020).

Conclusions

It is essential for health professionals caring for wheelchair users to understand the presentation, impact, prevalence and aetiology of pressure ulceration. Assessing a wheelchair user's risk of developing a PU is the first step to reducing that risk with a combination of effective skin care, moisture management and surface support, as well as repositioning, nutrition and advice. Wheelchair support surfaces are an important part of a PU-prevention strategy, which make it important to select the right reactive, dynamic or hybrid cushion for the user's individual holistic needs.

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Case study 1 (Anne)

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Anne (not her real name) was a 65-year-old woman who used a wheelchair following spinal cord injury and had an asymmetric seating position asymmetry that presented the risk of pressure ulceration.

History

Anne developed persistent back pain in June 2022. An initial examination by her GP was followed by a series of investigations, including medical imaging, and she was diagnosed with a type 4 thoracoabdominal aneurysm (TAA).

Anne underwent a complicated open surgical repair of the aneurysm, with a high-risk of ischaemia in the spinal cord. ischaemia occurred, and on waking she had developed a paraplegia T10 ASIA A. The paraplegia left her completely wheelchair-dependent, with extensive consequences for all her independent mobility-related activities of daily living, including her personal care, domestic activities and social life.

Despite initial concern that the rehabilitation would be too challenging for her, she started multidisciplinary therapy in a specialised rehabilitation centre, where she learned self-care activities, transfers and wheelchair skills. This allowed her to regain a large part of her independence, despite remaining a wheelchair user. Anne

was provided with a fitted rigid-frame wheelchair, and a freewheel and hand bike were presented and tested. The occupational therapists gave advice for home modification and adaptive tools necessary to maximise the functional possibilities. After 5 months, she was able to leave the specialised rehabilitation centre and return home.

Anne was retired and living with her husband in an apartment, accessible by elevator. She was a proud grandmother of eight grandchildren. She enjoyed being outside and in nature, singing in a choir and volunteering at a museum.

Presentation

Anne showed a mild postural asymmetry in the pelvis, causing her body to sag to the left (*Figure 1a*). She herself was not aware of this asymmetry, but it was visually demonstrated to her with objective pressure measurement using Boditrak Pro (*Figure 2a*). In the process of testing and fitting the wheelchair, a good posture in the wheelchair is very important. The choice of cushion will have an influence on correct sitting position, as well as the fitting of the wheelchair itself. Some cushions also have the possibility, to some extent, to compensate for an asymmetrical seating position. From the beginning of rehabilitation, she started sitting up using a ROHO HP Quadtro Select cushion (*Figure 3*).

Anne was educated about the importance of a good sitting position and was given tips to correct her posture. However, these corrections did not last over time. After wheeling, performing transfers or other

activities, the same thing would happen, and her attention to correct herself diminished over time. Even passive corrections, by adjusting the air in the cushion to support the lower tuber, were not enough to solve the problem and improve the symmetry of the pelvis.

Intervention

This persistent asymmetry led Anne's carers to search for another type of cushion that could better correct her seating position and support her overall pelvic posture, preventing seating problems in the future.

In the search for alternatives, it was necessary to take in account the need to protect the skin. Anne's complete spinal cord injury with muscle atrophy and no sensation meant that she had a high risk of developing pressure ulcers. Even though Anne showed no signs of pressure ulceration, such as redness of the skin, it was extremely important to provide a cushion with a high degree of pressure-ulcer prevention. The clinicians' experience suggested that this should be a cushion with air-filled cells.

Anne was trialled on three different suitable cushions for 2 weeks:

- ROHO Hybrid Select Cushion (*Figure 4*)
- Otto Bock Terra Flair
- Jay Balance Air.

Results

After 2 weeks, the ROHO Hybrid Select Cushion showed good results regarding Anne's seating position (*Figure 1b*). There was significant improvement in the spontaneous symmetry of the pelvis

Figure 1. Patient seating position (a) before intervention showing pelvic drop to the left and (b) after intervention showing symmetry in pelvis



Figure 3. ROHO HP Quadtro Select



Figure 4. ROHO Hybrid Select Cushion



(Figure 2b), and her left leg was straighter in alignment. In addition, her foot was better positioned on the footrest, which gives overall improved symmetry. With extra self-correction to compensate the pelvis, first coming down the right tuber after lifting, even the equalising of the asymmetry could be seen (Figure 2c).

Regarding pressure ulceration, no redness or skin problems were seen after 2 weeks of use. The professionals expressed some concern about the lower height of the air-filled cells, as Anne already had atrophy of the muscles in the buttocks. In complete paraplegia, there is no muscle activity below the injury (and Anne had no spasticity), leading to atrophy in the muscles so that the sitting lumps and coccyx are more pronounced. Therefore, it was considered necessary to closely monitor her skin over a longer period.

Anne reported that she experienced more comfort and stability while seated with the ROHO Hybrid Select Cushion and that she felt that she was sitting straighter than before. However, she felt that the difficulty of placing a transfer board on the cushion's upward sides made independent lateral transfers more challenging. However, these upward sides were what was providing the advantage of an improved sitting posture through better positioning of her legs, and this would be undermined if the shape of the cushion were adapted.

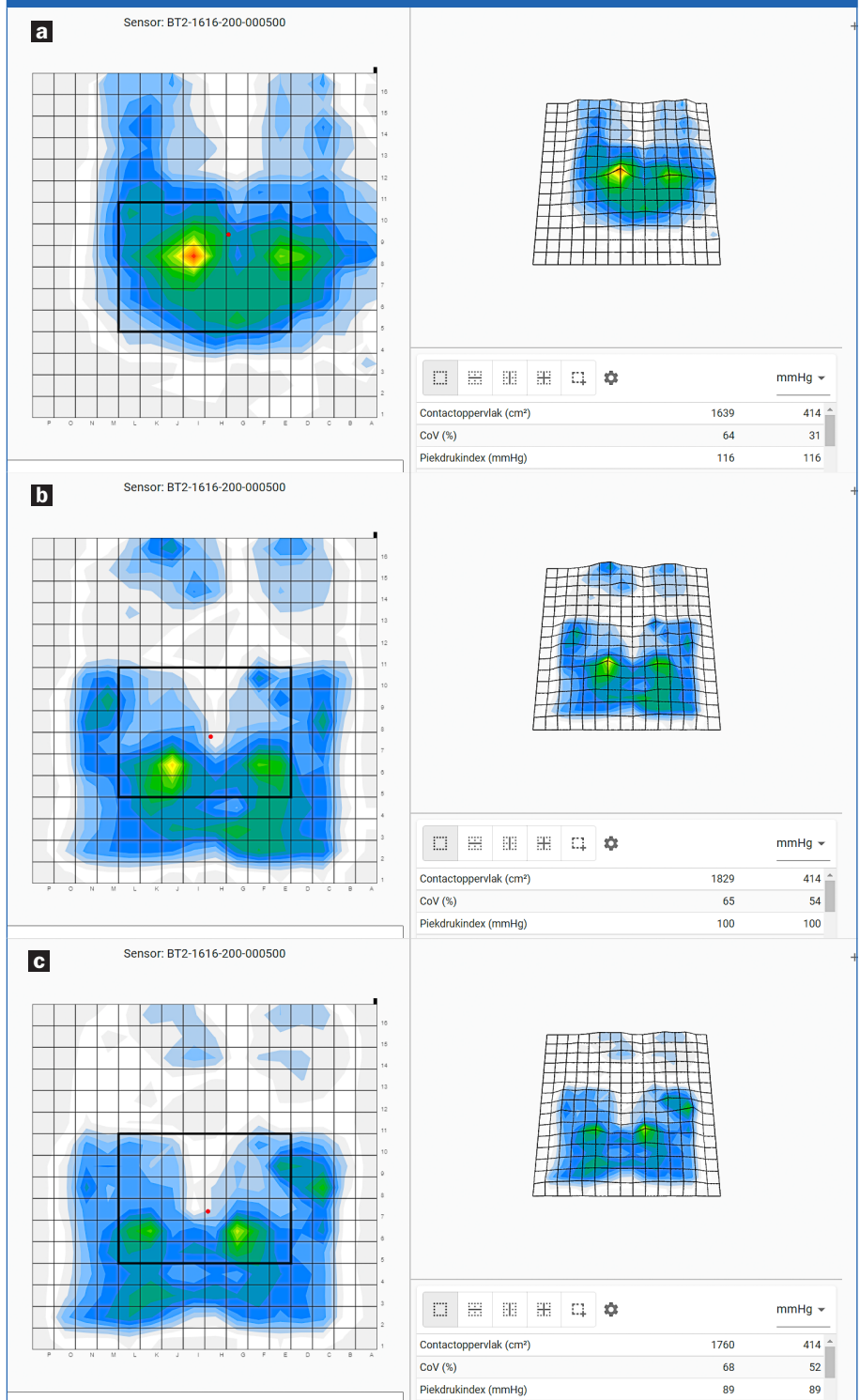
The Jay Balance Air Cushion offered less pressure redistribution, and Anne found it less comfortable compared with the alternatives.

The Otto Bock Terra Flair gave also good pressure relief and comfort. It also had the extra functional advantage that transfers were less challenging, which made it Anne's preferred option. However, pelvic self-correction by the patient was more frequently necessary than with the other options.

Discussion

The ROHO Hybrid Select Cushion appeared to be effective at correcting an asymmetric seating position and avoiding pressure ulcers. However, for a good result, this must be supported by patient education around awareness in self-correcting the seating position and prevention of pressure ulceration.

Figure 3. Pressure mapping (a) before using ROHO Hybrid Select Cushion showing extra pressure on the left tuber ischiadicum, (b) after using ROHO Hybrid Select Cushion showing comparatively symmetrical pressures and (c) after self-correcting the pelvis, showing symmetrical pressures



Case study 2 (Bernard and Charles)

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Two patients with spinal cord injury (SCI), Bernard and Charles (not their real names), trialled a supportive cushion for their wheelchairs.

Presentation

Bernard was a 22-year-old man with C6 SCI (American Spinal Injury Association (ASIA) Impairment Scale grade B) who had been using a wheelchair for over a year. He was 1.73 m tall and weighed 62 kg. He had osteoma but could be seated at 90 degrees, and he was able to perform transfers with assistance. He had a history of pressure ulcers on the feet but no pressure ulceration on presentation, although redness was present. He had trialled multiple cushions.

Charles was a 73-year-old man with C6 SCI (ASIA Impairment Scale grade C) who had been using a wheelchair for around a year. He was 1.69 m tall and weighed 74 kg. He had difficulty maintaining a seated balance, which was exacerbated with fatigue. He could not perform transfers independently, and transfers were achieved with a lift-aid. On presentation, there was redness but no pressure ulceration or skin sensitivity. He had trialled several cushions.

After being discharged from the hospital, Bernard and Charles were admitted to a rehabilitation centre, where they received care from occupational therapists. This rehabilitation centre was specialised in treating patients with SCI, as well as those with multiple traumatic injuries and amputations.

Patients with SCI face an elevated risk of pressure ulceration, and those with reduced skin sensitivity are at an even greater risk of developing pressure ulcers (PUs). Patients admitted to the rehabilitation centre often already have existing PUs, and the treatment and prevention of PUs is a crucial part of the occupational therapists' role.

Intervention

On admission, Bernard and Charles were provided with an air mattress for their

beds and a supportive cushion for their wheelchairs where necessary. Patients without skin sensitivity have a wheelchair cushion consistently incorporated into their seating arrangement.

The decision of which specific wheelchair cushion to use was made by the occupational therapists based on X-sensor evaluation (pressure mat that detects pressure points with on-screen visual feedback), patient consultation and clinical expertise. In these two cases, the cushion selected was the ROHO Hybrid Select Cushion (Permobil), a hybrid cushion with air-filled cells (Figure 1). Hybrid cushions combine elements of reactive and dynamic cushions, and they are increasingly favoured for long-term seating solutions. Cushions with air-filled cells are thought to reduce the risk of PUs compared with other alternatives.

These two occupational therapists were informed about the research project and subsequently signed a consent form. The collected data were anonymised and collected in compliance with the reference methodology MR-004 of the French National Commission for Informatics and Liberties (CNIL).

Follow-up

Both Bernard and Charles adhered to their occupational therapist's guidance and expressed satisfaction with their overall treatment. They not only followed their occupational therapist's guidance diligently but also consistently reported a significant improvement in their pain levels and overall comfort throughout the course of treatment. Their expressions of satisfaction highlight the effectiveness of the therapeutic approach employed by the occupational therapist, underscoring the positive impact on their wellbeing. The successful collaboration between the patients and the therapist fostered adherence to the treatment plan and contributed to a notable enhancement in the patients' overall quality of life, emphasising the crucial role of

personalised care in addressing pain and promoting comfort.

Bernard provided highly positive feedback and felt well-positioned on their ROHO Hybrid Select Cushion. Their X-sensor results were favourable, and their skin condition remained healthy. However, they also reported that the greater side coverage of the ROHO Hybrid Select Cushion made transfers more challenging and less comfortable. They expressed a desire to explore other options with less side coverage. At the time of writing, Bernard is using a ROHO Hybrid Select Cushion.

Conversely, Charles reported that the ROHO Hybrid Select Cushion was well-suited for transfers and noted that its stability resulted in reduced wrist discomfort. However, their X-sensor results were unfavourable, indicating high pressure and inadequate protection against PUs at the ischial level. The occupational therapist noted that the patient had bony ischial points and suspected that there was insufficient air cushion surface on the seat. This was resolved with the use of a ROHO Enhancer Cushion (Permobil), which the patient is using at the time of writing.

Discussion

It is important to assess which support surface is most suitable for a person with SCI. In clinical practice, this decision is a highly individualised process. Clinicians need to find the right balance between

Figure 1. ROHO Hybrid Select Cushion



the person's needs in terms of providing stability and correcting posture, as well as reducing the risk of pressure ulceration and allowing effective transfers.

A cushion that significantly reduces a patient's risk of pressure ulceration should, in turn, directly reduce their pain levels and improve their overall quality of life. A cushion that provides the stability needed to perform independent transfers can have a profound impact on the user's autonomy and overall quality of life.

The occupational therapists expressed their intention to integrate the ROHO Hybrid Select Cushion more extensively into their practice, citing several advantages of hybrid cushions. They highlighted the benefits of the rigid base on the front, emphasising its facilitation of transfers and stability, which are crucial elements in

enhancing patient mobility. The retention of an air cushion element addresses the concern of comfort, providing a balanced and supportive seating experience.

However, the therapists acknowledged certain drawbacks, notably the risk of punctures, often associated with pets, such as cats. Additionally, they recognised a prevalent issue among patients using air cushions, who tend to obsess over the inflation levels, leading to discomfort if not properly managed. In environments such as this setting, where moulded seating is prevalent, the therapists emphasised the importance of ensuring compatibility and careful consideration when introducing hybrid cushions.

Despite these considerations, the occupational therapists expressed confidence in the potential of the ROHO

Hybrid Select Cushion and conveyed their commitment to navigating and addressing these challenges effectively as they progressively incorporate hybrid cushions into their therapeutic repertoire.

Acknowledgement: The author would like to thank Florence Garrec, Emma Schoendorff, Rozenn Le Besque and Willy Allègre of Kerpape Rehabilitation Center, Ploemeur, France, for their contributions to this case study.

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Case study 3 (Diego and Elena)

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Patients with spinal cord injuries (SCIs) and wheelchair users face an elevated risk of pressure ulcers (PUs), a primary concern due to prolonged wheelchair use and constant pressure on vulnerable areas. A comprehensive review by Groah et al (2015) emphasised the critical importance of PU prevention in SCI patients, highlighting its significant impact on morbidity and healthcare costs. Additionally, another study underscored the prevalence of PUs in wheelchair users, emphasising the urgent need for effective preventive strategies (Kovindha et al, 2015).

Background

This case study evaluates the effectiveness of the ROHO Hybrid Select cushion in mitigating PU risk in individuals with chronic SCI following bariatric surgery. Wheelchair cushions have a pivotal role of in reducing PUs, as optimal support surfaces are needed to enhance postural stability and prevent skin breakdown (Gefen et al, 2021).

Assessment

Understanding the causes of PUs involves considering the interrelation between pressure on bony prominences, shear, skin microclimate and cell deformation (Sprigle, 2020). Wheelchair users face unique risk factors including pressure on specific bony prominences; postural and balance issues; and mobility limitations. The nature of support surfaces can worsen these risks. Standard prevention strategies include skin care, repositioning and pressure offloading. Wheelchair-cushion technology, with its diverse designs and materials, plays a crucial role in preventing PUs (Mansouri, 2023).

By studying two patients with SCIs, Diego and Elena (not their real names), and using a pressure-mapping assessment, this work compares the efficacy of the ROHO Hybrid Select Cushion (Figure 1) against their previous support systems. A detailed

analysis of the patients' wheelchair seating dynamics was conducted, comparing their position with a regular cushion to that with the study cushion. The patients' seated position was also described, assessed and comprehensively analysed using the Boditrak Pro pressure-mapping system. Evaluations at 4 weeks aimed to demonstrate the cushion's potential in reducing pressure areas, improving stability and preventing PUs, aligning with established scientific literature on the effectiveness of appropriate cushions in this specific population.

Assessing risk factors for PUs in wheelchair users involves a comprehensive evaluation of bony prominences, mobility, age, skin fragility and continence status. The use of mapping or sensor devices aids in determining pressure and shear points, providing valuable insights into risk assessment.

Assessing risk factors for PUs is a crucial aspect of maintaining quality nursing care, particularly for physically handicapped patients with elevated risks due to neuropathy and incontinence associated with paresis and paralysis. A systematic review of assessment scales by Neugebauer (2020) examined the utility of four scales (Norton, Braden, Waterlow and Spinal Cord Injury Pressure Ulcer Scale) in physically handicapped patients between 2016 and 2018. Results from the review highlight the popularity of the Braden and Waterlow scales in clinical practice. While the Norton scale is primarily used for scientific comparisons, its use in clinical practice is sporadic. Notably, the Spinal Cord Injury Pressure Ulcer Scale shows promise, with expert opinion suggesting its potential to reduce PU incidence in physically handicapped patients. This review underscores the importance of using appropriate assessment tools for precise evaluation and intervention, ultimately contributing to the reduction of PU risks in physically handicapped individuals.

Ethical considerations

This case study adheres to relevant ethical standards, with a comprehensive protocol established and approval obtained from the Institutional Review Board (IRB) - Comitè Ètic d'Investigació Clínica (CEIm) at the Fundació Unió Catalana d'Hospitals. The study operated under the framework of compassionate use, aiming to assess the effectiveness of the ROHO Hybrid Select cushion in two patients with chronic SCIs following bariatric surgery.

Aligning with ethical guidelines, the study prioritised patient welfare, privacy and informed consent. All participants voluntarily provided informed consent after receiving detailed information about the study's purpose, procedures, potential risks and benefits.

The study's ethical considerations extended to safeguarding patient confidentiality; anonymising data during analysis and reporting; and using acquired information solely for research purposes. Any potential conflicts of interest were disclosed and managed appropriately to uphold the integrity of the research process.

Case study 3a (Diego)

Diego was a 64-year-old male with a SCI at T5 American Spinal Injury Association Impairment Scale (AIS) A who had been an active wheelchair user for 18 years. Maintaining an engaging lifestyle, he excelled in basic activities of daily living (ADLs) with a noteworthy Functional

Figure 1. ROHO Hybrid Select Cushion

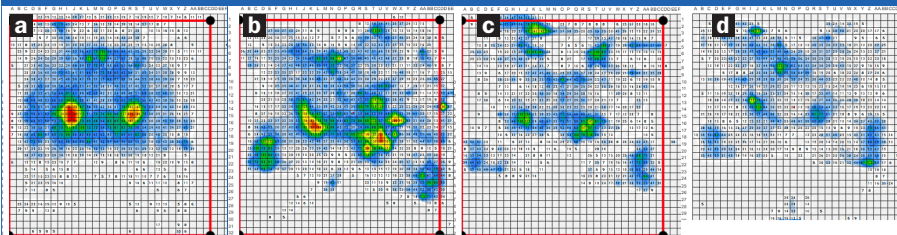


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Figure 2. Diego's seating position (a) with ROHO medium-profile air cushion and (b) with ROHO Hybrid Select Cushion



Figure 3. Pressure map of Diego using (a) the ROHO medium-profile air cushion and (b) ROHO Hybrid Select Cushion before and (c) after adjustment and (d) at week 4



Independence Measure (FIM) motor score of 72. His active pursuits included sports engagement, and he independently drove an adapted vehicle.

History

Throughout his 18 years of wheelchair use, Diego had consistently relied on a lightweight wheelchair paired with a medium-profile air cushion (ROHO). Despite encountering a left tibia fracture from a casual fall 2 years previous, he

remarkably avoided any PUs on the sacral or gluteal area until this point.

In September 2022, Diego underwent bariatric surgery to address a history of morbid obesity. The postoperative period and subsequent rehabilitation process resulted in an impressive total weight loss of 50 kg. Seeking professional evaluation for emerging seating issues and noticing redness in the bilateral gluteal area, his concerns were promptly addressed by the nursing team, who diagnosed a stage II PU.

Presentation

In his usual seated position, Diego demonstrated commendable trunk balance and maintained correct pelvic alignment; however, a slight left thoracic scoliosis had developed over time. He achieved stability using a medium-profile air cushion with adjustable positioning through the front valve (Figure 2a). The pressure map taken with Diego's own ROHO medium-profile cushion (Figure 3a) revealed two red marks indicating heightened pressure in the bilateral ischial area. Despite adjustments to the parameters, minimal improvement was observed, with maximum values of 200 mmHg in the pelvic area and an increased load in the posterior region of the cushion. The persistently high pressure signified a significant risk of pressure ulceration (Figure 3a).

Intervention

During the evaluation of the ROHO Hybrid Select cushion, Diego reported an increased sense of stability, particularly during wheelchair propulsion. Despite this improvement, the cushion did not correct the existing spine deviation. However, it notably enhanced stability in thoracic alignment (Figure 2b). The pressure map taken with the Roho Hybrid Select cushion initially noted higher pressure on the right hemipelvis, with a maximum value of 200 mmHg (Figure 3b). However, subsequent adjustments, including inflation pressure reduction and central pad air adjustment, resulted in an optimal distribution of pressures and loads across the pelvic area (Figure 3c). Notably, the maximum pressure value reduced to 147 mmHg, indicating a substantial improvement in pressure distribution. The pressure maps capture the distinct pressure profiles, highlighting the effectiveness of the Roho Hybrid Select cushion in achieving an optimal distribution of pressures and mitigating the risk of PUs.

Follow-up

Based on the comprehensive assessment of studies and images, the decision was made to transition to the Roho Hybrid Select cushion. This choice was driven by its superior performance, offering optimal regional pressure distribution and effectively alleviating pressure on

the ulcerated area. The nursing team was promptly contacted for a thorough wound assessment and treatment proposals, with pending reports and images of the PU.

At the 4-week follow up, a rigorous assessment was conducted, accompanied by a new pressure analysis. The results revealed a favourable distribution of pressures (*Figure 3d*) and, notably, the absence of new symptoms or skin lesions. Implementing the ROHO Hybrid Select cushion had a successful outcome, with a sustained positive impact in maintaining optimal pressure distribution and preventing the occurrence of new pressure-related issues.

Case study 3b (Elena)

Elena, a 58-year-old woman, had been living with spina bifida since birth, resulting in a SCI at AISA level 3 (AIS A). Remarkably, she had been actively using various manual and lightweight wheelchairs for 53 years.

Despite her SCI, Elena led a dynamic lifestyle, demonstrating a medium level of proficiency in basic activities of daily living (ADLs), as indicated by a FIM Motor Score of 66. While she maintained a high level of independence, Elena required assistance primarily in bathing within an adapted environment and dressing the lower part of her body.

History

Throughout Elena's extensive 53-year experience in wheelchairs, the patient had consistently chosen lightweight options, complemented by a low-profile air cushion. In the previous 5 years, she had made the decision to transition to a motorised wheelchair due to a combination of weight concerns and age-related factors. Despite these changes, she had never encountered any issues related to pressure ulcers.

In December 2022, Elena underwent bariatric surgery due to a history of obesity.

Following the postoperative period and rehabilitation process, she lost a total of 39 kg. After surgery, she sought consultation for pain and discomfort issues in the gluteal area with her air cushion due to weight and muscle-mass loss. This situation led to a stage II PU on the left ischium. The ulcer was resolved with nursing care provided to the patient at home. By the time the study began, the ulcer had already healed.

Presentation

Maintaining a commendable seated position, Elena demonstrated good trunk balance and correct pelvic alignment. She used a ROHO low-profile air cushion, with adjustments made through the front valve, to achieve stability. While a distal deviation to the left in the lower part of the legs, specifically in the feet, was observed, it did not appear to be directly related to the type of cushion used (*Figure 4a*).

The pressure map of the patient's own ROHO low-profile cushion displayed a pronounced distribution of pressure in the anterior area, reaching maximum values of 162 mmHg (*Figure 4a*). Elena's feedback indicated less stability with this cushion, occasionally leading to difficulties in maintaining good trunk control.

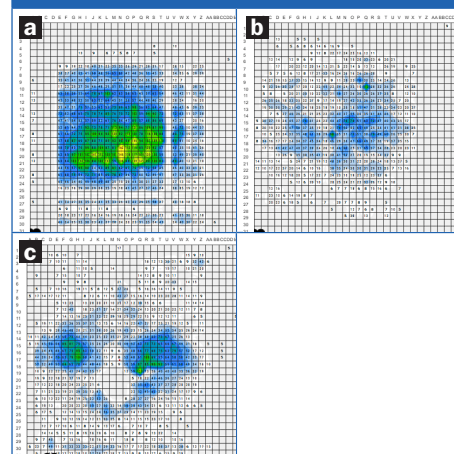
Intervention

Upon introducing and evaluating the ROHO Hybrid Select Cushion, Elena reported a more comfortable position (*Figure 4b*). This observation suggests a

Figure 4. Elena's seating position with (a) the ROHO low-profile air cushion and (b) the ROHO Hybrid Select Cushion



Figure 5. Pressure map of Elena using (a) the ROHO low-profile air cushion and ROHO Hybrid Select Cushion (b) initially and (c) at week 4



positive subjective experience with the new cushion.

The pressure map using the ROHO Hybrid Select Cushion showcased significant improvement, marked by a reduction in pressure in the anterior area and enhanced distribution and support in the gluteal region throughout the entire cushion. Despite a higher-pressure zone observed in the left gluteal area, the maximum values were measured at 130 mmHg, representing an improvement compared to the previous cushion (Figure 5b). The distinctive profiles of the pressure map highlight the positive impact of the ROHO Hybrid Select Cushion in reducing anterior pressure and enhancing overall distribution and support.

Follow up

Based on a thorough assessment of studies and images, the decision was made to transition the patient to the ROHO Hybrid Select Cushion. This decision was rooted in its superior performance, evident in optimal regional pressure distribution and the avoidance of loading on the PU area.

At the 4-week follow-up, a comprehensive assessment was conducted, accompanied by a new pressure analysis. The results revealed a favourable distribution of pressures, and no new symptoms of skin lesions were observed (Figure 5c). This positive outcome underscored the continued effectiveness of the ROHO Hybrid Select Cushion in maintaining optimal pressure distribution and promoting skin health.

Discussion

Understanding the impact of PUs extends beyond clinical measures to encompass profound implications on patients' lives. Skin damage and associated postural and balance issues compromise physical health and significantly affect the overall wellbeing of individuals with SCIs. These case studies aimed to contribute comprehensive insights into the multifaceted impact of PUs, informing both clinical practice and health

policy decisions. This holistic approach fosters a more comprehensive view of patient care and resource allocation.

For wheelchair users, PUs are more than physical disorders, affecting independence, limiting mobility and casting a shadow on psychosocial health. The discomfort and pain associated with PUs can impede the ability to perform routine activities of daily living, eroding autonomy and hindering participation in social and recreational pursuits. The psychological toll of managing chronic wounds often leads to emotional distress and reduced quality of life.

Beyond the personal toll, PUs contribute substantially to the health-economic burden of this patient group. Chronic wounds need prolonged healthcare interventions, ranging from specialised wound care treatments to surgical interventions, imposing considerable financial strain on healthcare systems. Moreover, the long-term impact on productivity and employability adds an additional layer to the economic burden borne by individuals with SCIs and their communities.

Preliminary data from this ongoing study indicates a direct correlation between the use of the ROHO Hybrid Select Cushion and a notable reduction in PU incidence. At the 4-week follow-up, both patients demonstrated a marked improvement in skin health, with pressure mapping revealing a significant decrease in high-pressure areas. This not only substantiates the cushion's efficacy, but it also underscores the potential to alleviate the economic strain associated with prolonged wound management and healthcare resource use.

Conclusions

Both cases reveal the compelling effectiveness of the ROHO Hybrid Select Cushion. Notably, it consistently reduced pressure areas, improved stability and enhanced overall comfort, as reflected in measured values in mmHg. The cushion emerges as a promising solution for

wheelchair users, addressing key elements for promoting the wellbeing of individuals with chronic SCIs.

Particularly noteworthy is the cushion's efficacy in preventing and reducing PUs in patients post-bariatric surgery. The tailored support provided by the ROHO Hybrid Select Cushion cushion mitigates pressure-related issues, emphasising its potential as a valuable asset in the holistic care of individuals recovering from bariatric procedures.

These findings underscore the practical significance of selecting appropriate wheelchair-cushion technology, showcasing the potential for the ROHO Hybrid Select Cushion to be a valuable asset in enhancing the quality of life for individuals with chronic SCIs, especially those facing unique challenges following bariatric surgery.

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