This month's pressure ulcer references consider the role of wheelchairs and cushions in pressure ulcer prevention and treatment. All references were retrieved from MEDLINE using pressure ulcer, wheelchair and cushion as search terms.

Agam, L. and A. Gefen (2007). "Pressure ulcers and deep tissue injury: a bioengineering perspective." Journal of Wound Care 16(8): 336-42.

Wheelchair users are highly susceptible to deep tissue injury. Interface pressures are unlikely to predict this, and an alternative assessment approach is needed that can easily monitor internal mechanical stresses and deformations. [References: 108]

Akimoto, M., T. Oka, et al. (2007). "Finite element analysis of effect of softness of cushion pads on stress concentration due to an oblique load on pressure sores." Journal of Nippon Medical School = Nihon Ika Daigahu Zasshi 74(3): 230-5.

The concentration of mechanical stress in soft tissue can cause or worsen pressure sores. We have previously reported the results of analysis of stress concentration in soft tissue using a finite element model. In the present study, we hypothesized that even if a cushion pad was thin, it would effectively reduce horizontal loads that can increase stress concentration in soft tissue. To our knowledge, there have been no previous reports describing stress distribution in soft tissue attached to a thin cushion pad with a horizontal load. In the present study, we performed mechanical analysis of a model of a human seated on a thin cushion pad with a range of hardness values (i.e., Young's module). Two-dimensional finite element models were used to perform this analysis. Loads were applied at the upper edge of the model as oblique compulsory displacement. In all of the cushion pad models, the peak value of effective stress was less than that of the control model without a cushion pad. Also, the peak value of effective stress decreased as Young's module of the cushion pad decreased. These results suggest that use of a thin cushion pad is an effective way to prevent the development of pressure sores.

Anthony, D., J. Barnes, et al. (1998). "An evaluation of current risk assessment scales for decubitus ulcer in general inpatients and wheelchair users." Clinical Rehabilitation 12(2): 136-42.

OBJECTIVES: To study the components of two risk assessment scales for decubitus ulcer risk, Waterlow and Braden, and of the Chailey score for the same purpose. DESIGN: Experimental study of patients at risk of developing decubitus ulcers. SETTING: The West Midlands and Yorkshire. SUBJECTS: One hundred and fifty wheelchair users from the West Midlands and 9022 patients from a District General Hospital in York, the latter consisting of all admissions to the hospital in a four-month period. INTERVENTIONS: Braden, Chailey scores (wheelchair users) and Waterlow scores (all subjects) measured. MAIN OUTCOME MEASURES: Development of a pressure sore, receiver operating characteristic (ROC) curves. RESULTS: Waterlow outperformed Braden for classification of wheelchair patients with respect to decubitus ulcer. The Chailey score performed randomly in this group. The sensitivity and specificity as seen in ROC curves was different for Waterlow scores for wheelchair users and general patients, the latter being much better classified. Only three items out of 11 in the Waterlow score appeared to have any classification ability in the wheelchair group. CONCLUSIONS: Risk indicators used for general patients are probably poorly suited for wheelchair users. There is a need for large-scale predictive studies of wheelchair users and other groups to allow regression analysis of the subscales of risk indicators. From the provisional data of this study it appears that splitting patients by gender and into full- and part-time wheelchair users classifies almost as well the much more complicated risk assessment tools currently available.

Anton, L. (2006). "Pressure ulcer prevention in older people who sit for long periods." Nursing Older People 18(4): 29-35.

Pressure ulcers cause distress to patients and give health professionals cause for concern because of the dramatic effects on patients' quality of life, as well as the implications for resources (Hampton and Collins 2001). By understanding the changes in tissue physiology that take place and the complications of sitting, nurses can make pressure ulcer prevention part of their practice. [References: 35]

Apatsidis, D. P., S. E. Solomonidis, et al. (2002). "Pressure distribution at the seating interface of custom-molded wheelchair seats: effect of various materials." Archives of Physical Medicine & Rehabilitation 83(8): 1151-6.

OBJECTIVE: To identify which of 4 materials has the most favorable pressure distribution when used in custom-molded seats (CMSs) to assist clinicians in providing appropriate seating for wheelchair-bound individuals who are prone to develop pressure ulcers. DESIGN: Repeated-interface pressure measurements for all materials, followed by statistical analysis. SETTING: The general community and referral centers. PARTICIPANTS: Seven subjects, 5 with cerebral palsy, 1 with Schilder's disease, and 1 with postmeningitis effects. All subjects were seated in a CMS and had spinal deformities. INTERVENTIONS: Viscoelastic polyurethane foams (Pudgee, Sunmate) and gels (Floam trade mark, Jay) were used as inserts in the CMSs. Evazote foam was used as a control material. MAIN OUTCOME MEASURES: Pressure readings were taken at the seat interface with pneumatic pressure sensors and the Talley Pressure Monitor. Peak pressure readings, mean pressure ratio, and peak pressure ratio for the different materials were compared. RESULTS: Foams, Sunmate in particular, produced lower peak-interface pressures and also showed better pressure distribution than did gels. CONCLUSION: Foams are the preferred insert material with CMSs when increased tissue breakdown risk is present. Copyright 2002 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Attard, J., S. V. Rithalia, et al. (1997). "Pressure relief characteristics in alternating pressure air cushions." Prosthetics & Orthotics International 21(3): 229-33.

In this study a computerised system was used which continuously measured air pressure, interface pressure and pressure-time cycle characteristics of an alternating pressure air cushion (APAC), and calculated the time the interface pressure remained below three chosen thresholds of 20, 40 and 60 mm Hg. Ten healthy volunteers were used to evaluate the pressure relieving characteristics of four APACs. Results indicated significant differences between products when the

threshold periods were analysed, showing some devices were not capable of relieving interface pressures below 20 mm Hg. Though deflation pressure decreased to nearer zero, interface pressure did not follow suit.

Barnes, J. (1996). "Preventing pressure sores in wheelchair users." Community Nurse 2(10): 57-8.

Many wheelchair users believe getting pressure sores is part of everyday life Pressure sores may be more likely to develop if the person has had one before Simple measures can promote good posture and reduce risk Cushions should be placed on a firm base Pressure sore prevention is more than providing a cushion Patients should take their own wheelchair into hospital Education is needed for patients and carers on pressure sore prevention.

Batavia, M. and A. I. Batavia (1999). "Pressure ulcer in a man with tetraplegia and a poorly fitting wheelchair: a case report with clinical and policy implications." Spinal Cord 37(2): 140-1.

Bliss, M. R. (1997). "3D-mapping of pressure sores.[comment]." Lancet 349(9060): 1251.

Brienza, D. M. and P. E. Karg (1998). "Seat cushion optimization: a comparison of interface pressure and tissue stiffness characteristics for spinal cord injured and elderly patients." Archives of Physical Medicine & Rehabilitation 79(4): 388-94.

OBJECTIVE: A method for designing tissue deformation minimizing seat surfaces was evaluated. Pressure and stiffness criteria were used to optimize surface shape. The method's efficacy for patients with spinal cord injuries (SCI) and a comparison of cushion performance and interface characteristics with a group of 30 elderly patients are presented. DESIGN: Repeated measures, prospective study. SETTING: University medical center. PATIENTS: SCI (n=12), elderly (age 65 +

years) [n=30]. INTERVENTIONS: One flat and two custom foam seat cushions. MAIN OUTCOME MEASURES: Interface pressure measured using a pressure sensing pad; tissue stiffness and pressure recorded on a rigid programmable seat surface. RESULTS: Pressure distributions on contoured cushions for the SCI group contained lower values than distributions on flat cushions. A comparison of the pressure data between the elderly and SCI showed that significant differences exist between interface characteristics. The SCI group had higher peak interface pressures for all cushions tested. Tissue stiffness measurements were similar for each group. CONCLUSIONS: Results showed improved effectiveness of custom contoured foam seat cushions versus flat foam cushions. The results suggest that pressure distributions for SCI are more sensitive to support cushion characteristics than for the elderly. Further research is needed to determine the extent of the difference between the populations represented by these groups.

Brienza, D. M., P. E. Karg, et al. (1996). "Seat cushion design for elderly wheelchair users based on minimization of soft tissue deformation using stiffness and pressure measurements." IEEE Transactions on Rehabilitation Engineering 4(4): 320-7.

A method for designing seat support surfaces using interface pressure and soft tissue stiffness criteria was evaluated. An algorithm designed to drive a rigid support surface on a programmable seating system to a shape for which the externally applied pressure is inversely related to the measured stiffness of adjacent soft tissue was evaluated on 30 elderly subjects (age 65 years or older). The resulting support surface shapes were transferred to compliant foam cushions and evaluated using interface pressure measurements. Pressure and stiffness measurements on the seating system indicated the surface shape control algorithm met the desired programmed criteria by achieving an inverse relationship between pressure and stiffness, as it converged to an "optimal" support surface shape. Evaluation of interface pressures on the compliant foam cushions showed that the pressure distributions on the cushions contoured to the optimal surface shapes were more uniform and had lower values than distributions on flat foam cushions and foam cushions contoured to shapes measured using state-of-the-art load-deflection devices. The results suggest that support surfaces designed using tissue stiffness as

a criteria can provide loading conditions intended to minimize relative deformation and, thus, stress in load-bearing soft tissue. [References: 27]

Brienza, D. M., P. E. Karg, et al. (2001). "The relationship between pressure ulcer incidence and buttock-seat cushion interface pressure in at-risk elderly wheelchair users." Archives of Physical Medicine & Rehabilitation 82(4): 529-33.

OBJECTIVE: To investigate the relation between pressure ulcer incidence and buttock-wheelchair seat cushion interface pressure measurements. DESIGN: Secondary analysis of data from a randomized clinical trial. SETTING: Skilled nursing facility. PATIENTS: Thirty-two elderly patients (age, > or = 65 yr), with Braden score < or = 18 and Braden mobility and activity subscale score < or = 5, who used wheelchairs > or = 6 hr/d, were free of existing sitting-induced pressure ulcers, and weighed < or = 250 lb. INTERVENTIONS: Generic foam seat cushion or pressure-reducing seat cushion. MAIN OUTCOME MEASURES: The incidence of sitting-induced pressure ulcers over a 1- to 12-month period was compared with pressure measured between patients' buttocks and wheelchair seat cushions. A flexible pad with a 15 x 15 pressure sensor array was used to measure interface pressure. RESULTS: Interface pressure measured on wheelchair seat cushions was higher (p < or = .01 for both peak pressure and average of highest 4 pressures) for patients who developed sitting-acquired pressure ulcers compared with those patients who did not. CONCLUSIONS: Results indicated that higher interface pressure measurements are associated with a higher incidence of sitting-acquired pressure ulcers for high-risk elderly people who use wheelchairs.

Broadbent, I. (2002). "Relieving pressure." Nursing Times 98(48): 54-5.

Mrs Smith has been resident on a continuing care ward for approximately six years. She was originally admitted after a left cerebral vascular accident that resulted in a right-sided hemiplegia. She is dysphasic but appears to understand much of what is said to her, and she is continent of urine and faeces, using facial expressions and body gestures to communicate her needs. In recent years her weight has

increased from 63 kg to 83 kg and she is now chairbound, following a recent leg fracture.

Browning, D. (1997). "A team approach to pressure relief for people with disabilities." Journal of Wound Care 6(6): 298-300.

Call, E. and L. E. Edsberg (2007). "A new initiative aiming to improve our understanding of shear force." Journal of Wound Care 16(5): 209.

Clark, M., M. Benbow, et al. (2002). "Collecting pressure ulcer prevention and management outcomes: 2." British Journal of Nursing 11(5): 310-4.

The first part of this article (Vol 11(4): 230-8) outlined the argument that a combination of efficacy and effectiveness is required to assess fully the impact of interventions such as pressure-redistributing (PR) beds and mattresses. In addition, it described the methodology of this multinational, multicentre, prospective, non-randomized cohort study designed to record the occurrence and characteristics of patients vulnerable to, or with, established pressure ulcers. This article reports further details of the characteristics of the 2507 UK adult hospital patients recruited to the study. Over 40% (42% n = 1046) of all subjects were considered to be at an elevated risk of developing ulcers (Waterlow score of 15 or greater) (Waterlow, 1985). Many were inactive with 332 (13%) confined to bed alone with a further 262 (10%) confined to bed and their chair. Most (74% n = 1868) were nursed upon PR beds and mattresses, while fewer subjects were provided with a PR seat cushion (n = 547; 27%). Two hundred and fifty-seven subjects (10%) experienced at least one change of bed mattress during their stay in hospital, with two subjects being nursed on five different mattresses during their hospital stay.

Coggrave, M. J. and L. S. Rose (2003). "A specialist seating assessment clinic: changing pressure relief practice." Spinal Cord 41(12): 692-5.

STUDY DESIGN: Description of a clinical service, evaluation of pressure relief practices. OBJECTIVES: To describe a specialist seating assessment clinic and a change in clinical practice arising from its work. SETTING: National Spinal Injuries Centre, Stoke Mandeville Hospital, UK. METHODS: Retrospective review of the ischial transcutaneous oxygen measurements of 50 newly injured and chronic spinal cord-injured (SCI) individuals seen in a specialist seating assessment clinic. Tissue oxygenation was measured in the sitting position (loaded) and during pressure relief (unloaded). RESULTS: Mean duration of pressure relief required to raise tissue oxygen to unloaded levels was 1 min 51 s (range 42 s-3 min 30 s). CONCLUSION: These results confirmed the clinical perception that brief pressure lifts of 15-30 s are ineffective in raising transcutaneous oxygen tension (TcPO(2)) to the unloaded level for most individuals. Sustaining the traditional pressure relief by lifting up from the seat for the necessary extended duration is neither practical nor desirable for the majority of clients. It was found that alternative methods of pressure relief were more easily sustainable and very efficient.

Collins, F. (1998). "Sitting pretty." Nursing Times 94(38): 66-70.

Collins, F. (1999). "The contribution made by an armchair with integral pressure-reducing cushion in the prevention of pressure sore incidence in the elderly, acutely ill patient." Journal of Tissue Viability 9(4): 133-7.

The paper describes a clinical controlled trial of an armchair with integral pressure-reducing cushion, which took place on two elderly acute medical wards in a district general hospital. The aim of the study was to evaluate whether the armchair would have an impact on reducing the occurrence of pressure sores. All patients were provided with a mattress or overlay in accordance with the hospital policy on mattress provision following a Waterlow risk assessment. Patients on ward A were provided with an armchair with integral pressure-reducing cushion, whilst patients on ward B continued to use their existing bedside armchair. Nominal data were collected on all pressure sores in patients who were not bedridden. Ward A had a significantly lower incidence of hospital-acquired pressure sores compared to ward

B, and non-hospital-acquired pressure sores on this ward showed more improvement than those on ward B.

Collins, F. (2001). "An adequate service? Specialist seating provision in the UK." Journal of Wound Care 10(8): 333-7.

Collins, F. (2001). "How to assess a patient's seating needs: some basic principles." Journal of Wound Care 10(9): 383-6.

Collins, F. (2001). "Selecting cushions and armchairs: how to make an informed choice." Journal of Wound Care 10(10): 423-7.

Collins, F. (2002). "Use of pressure reducing seats and cushions in a community setting." British Journal of Community Nursing 7(1): 15-22.

It is generally accepted that sitting for long periods of time without frequent repositioning or provision of appropriate cushions or chairs can lead to pressure ulcer development in people who are elderly, frail, immobile or neurologically impaired. When sitting, in comparison to lying, only a small surface area of the body is providing support, predominantly the buttocks and thighs, and the feet. Therefore, interface pressures are much greater in sitting than lying. Sitting for long periods of time can result in the person adopting poor posture, which in turn can lead to the development of pressure ulcers, particularly on the buttocks, sacrum, greater trochanter and heels. Assessment and provision of appropriate seating equipment for people at risk is often difficult for clinicians working in the community. This article aims to describe the problems experienced by people who sit for long periods of time, to discuss where people should go in order to obtain help with seating needs, and outline some of the potential solutions to poor seating which are available to community staff.

Collins, F. and T. F. Shipperley (1999). "Assessing the seated patient for the risk of pressure damage." Journal of Wound Care 8(3): 123-6.

Cooper, P. (1998). "Cushions and specialist chairs for pressure sore management." British Journal of Nursing 7(15): 914-6.

Many patients spend more time sitting out of bed than being cared for in bed. Consequently, the demand for specialist support surfaces for chairs to reduce the risk of pressure damage while the patient is up sitting is rising. This product focus examines a number of seating support surfaces produced by Karomed. [References: 12]

Crawford, S. A., M. D. Stinson, et al. (2005). "Impact of sitting time on seat-interface pressure and on pressure mapping with multiple sclerosis patients." Archives of Physical Medicine & Rehabilitation 86(6): 1221-5.

OBJECTIVE: To examine changes in seat-interface pressure with multiple sclerosis (MS) patients. DESIGN: Case series. SETTING: Multiple Sclerosis Society's Resource Centre and community. PARTICIPANTS: Convenience sample of 15 MS wheelchair users and 12 MS non-wheelchair users. INTERVENTION: Interface pressure was measured for 8 minutes using the Force Sensing Array pressure mapping system. MAIN OUTCOME MEASURES: Number of activated sensors, standard deviation, average and maximum pressures. RESULTS: With the wheelchair users, significant decreases were found in the standard deviation and average and maximum pressures during 0 to 2 minutes of sitting (P <.01). Average pressure was the only parameter to show a significant decrease in the non-wheelchair users (P <.01) during 0 to 2 minutes. Significant increases were found in all output parameters during 2 to 4 minutes with both groups (P <.05). Non-wheelchair users showed no significant changes in the output parameters after 4 minutes, but wheelchair users showed significant continued increases in the output parameters from 4 to 8 minutes (P <.05). CONCLUSIONS: Because no significant changes in interface pressure occurred after 4 minutes of sitting with the non-wheelchair users, 4 minutes may be a reasonable sitting time before interface

pressure is recorded with this group. Significant changes in interface pressure continued up to 8 minutes with the wheelchair users, therefore 8 minutes or beyond may be a reasonable sitting time before recording with this group.

Crawford, S. A., B. Strain, et al. (2005). "An investigation of the impact of the Force Sensing Array pressure mapping system on the clinical judgement of occupational therapists." Clinical Rehabilitation 19(2): 224-31.

OBJECTIVES: To examine the impact of pressure mapping technology on the clinical decisions of occupational therapists and to examine the role of the Braden Scale in assisting with the selection of pressure-reducing cushions. DESIGN: Case studies. SETTING: Community. SUBJECTS: Forty clients. INTERVENTIONS: Clients were pressure mapped on their current seating surface and on four pre-selected cushions by the principal researcher. An occupational therapist completed the Braden Scale and a decision tree to assist in recommending a suitable pressure-reducing cushion. MAIN OUTCOME MEASURES: Interface pressure maps, Braden Scale, and the cushion recommended, using a decision tree to guide clinical judgement. RESULTS: Thirty per cent (12) of the 40 cushions recommended were changed when the pressure maps from the Force Sensing Array (FSA) system were viewed. In 70% (26) of cases, the maps supported the cushion recommended. In 25% (10) of the cases, the maps showed that the client's current seating surface was unsuitable. After viewing the pressure maps, a surface other than the client's current surface was recommended in 47% (19) of the cases. There was a lack of agreement between the risk level of the clients as identified by the Braden Scale score, and the risk level of the clients as identified by the occupational therapist using a decision tree and the FSA maps. CONCLUSION: Pressure mapping technology has a positive impact on clinical decisions regarding the provision of pressure-reducing cushions. Future research should examine the predictive validity of this technology. The Braden Scale may underpredict the risk level of the clients.

Defloor, T. and M. H. Grypdonck (1999). "Sitting posture and prevention of pressure ulcers." Applied Nursing Research 12(3): 136-42.

The aim of this study was to gain insight about the influence of body posture on the pressure at the seat surface and to establish to what extent different seat cushions designed for incontinent patients reduce maximum pressures. Pressures were measured for 56 healthy volunteers in eight postures using four cushions. The posture in which the lowest maximum pressure was measured was the sitting-back posture with the lower legs on a rest. If the seat could not be tilted back, the maximum pressure in the upright sitting posture with the feet on the ground was significantly lower than sitting upright with the legs supported on a rest. Sliding down and slouching caused the highest maximum pressure. Regular checking of the posture and using positioning cushions should form part of any pressure-ulcer prevention protocol. The four selected cushions each have different pressure-reducing effects. A thick air cushion (Repose) has the lowest maximum pressure and is significantly better than the other cushions at reducing the high pressure when slouching or sliding down.

Duncan, S. T. and A. D. Levi (2001). "Multi-tiered treatment of pressure sores in two cynomologous macaques (Macaca fascicularis)." Journal of Medical Primatology 30(5): 283-9.

Successful treatment of one Grade III and two Grade IV pressure sores on two female Macaca fascicularis, subsequent to a T11 hemilaminectomy and left spinal cord hemisection, was achieved through a combined strategy of wound care, diet, and husbandry. Wound care consisted of early and thorough debridement of all necrotic tissue, initial twice daily cleaning with an iodine scrub and application of a multi-ingredient ointment. Tissue hydrolyzer, a drying agent, vitamin E, ground selenium, and topical antibiotics were applied to the wound during the respective 45- and 46-day courses of treatment. Oral antibiotics were administered; vitamins C and E, and selenium were increased in the diet. No infection occurred and both animals recovered fully to complete the study. Importantly, pressure sores in subsequent study animals were prevented by post-operative padding of the perch with towel-covered foam and placement of a wheelchair cushion on the floor of the cage.

Eitzen, I. (2004). "Pressure mapping in seating: a frequency analysis approach." Archives of Physical Medicine & Rehabilitation 85(7): 1136-40.

OBJECTIVES: To discuss the methodologic challenges related to pressure mapping in seating and to present a new approach to the analysis and interpretation of results: the frequency analysis approach. DESIGN: Pressure mapping was performed on 3 prototypes of a newly developed foam and gel seat cushion. SETTING: Data collection was done in a private laboratory. PARTICIPANTS: Eight nondisabled men. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: Average pressure, peak values, and the size of the contact area were measured continuously for 74 minutes on each cushion prototype. A supplementary frequency analysis provided information on the number of times each value occurred during the measurement period. RESULTS: Average pressure and peak values showed only very small, nonsignificant changes over the measurement period for all variants. The frequency analysis, however, showed significant differences that enabled the manufacturer to select the prototype best suited for further development. CONCLUSIONS: Verifying significant differences in pressure-relieving properties between products has to date been difficult. Findings from this study indicate that a frequency analysis approach may enable more adequate and precise ways to perform such studies.

Ferrarin, M., G. Andreoni, et al. (2000). "Comparative biomechanical evaluation of different wheelchair seat cushions." Journal of Rehabilitation Research & Development 37(3): 315-24.

The aim of the present study was to perform a comparative biomechanical analysis of four antidecubitus wheelchair cushions. Thirty wheelchair users were considered divided into three groups: paraplegic subjects (with no cutaneous sensation), neurologic subjects (with intact cutaneous sensation), and elderly subjects. The biomechanical evaluation was performed using a piezoresistive sensor matrix system to quantify parameters referred to pressure distribution, seating surface and posture. Dedicated software was developed for the automatic elaboration of the raw data and the computation of the parameters of interest. Differences among cushion types and subject groups were analyzed. An analysis of

time-transient behaviors was also performed. Results showed that no significant differences in pressure peak reduction were found among the four cushions. Moreover, no time-transient behavior was shown by any cushions. However, both the location of pressure peaks and posture were dependent on cushion types. Comparison of the three subject groups showed that elderly subjects had the highest mean pressure and the lowest contact surface, while paraplegics presented the highest pressure peaks. This procedure appears indicated for individualizing the prescription of a wheelchair cushion and even for customizing a cushion to induce a specific posture.

Ferrarin, M. and N. Ludwig (2000). "Analysis of thermal properties of wheelchair cushions with thermography." Medical & Biological Engineering & Computing 38(1): 31-4.

Thermal properties of wheelchair cushions have been traditionally studied with thermistor probes, which provide temperature values of limited areas (spot analysis). In this paper, we describe a novel procedure based on thermography for assessing the distribution of temperature over the entire surface of wheelchair cushions. The thermal transient during contact with the body (heating phase) and after use (cooling phase) is considered. The procedure was tested in four different seat cushions (with a gel pad, air-filled cells, gel-filled bubbles and foam-filled bubbles) used by a normal subject. Observed results were compatible with the predicted outcomes based on an analysis of the materials and structures. Specifically: (i) air-filled cushions exhibited the fastest thermal transients, gel cushions the slowest transients, while cushions with a mixed structure exhibited intermediate behaviour; (ii) cushions made from flat surfaces of foam exhibited the highest peak temperatures (30.8 degrees C) as compared to those with air-filled cells (30.35 degrees C) or bubble-shaped surfaces (29.7 degrees C); (iii) the average temperature under the thighs was significantly higher than that under the ischiatic area in all cushions (29.6 degrees C compared with 28.7 degrees C, $p < 0.05$). It is shown that the present method can be used to differentiate between different cushions. Although the 'macro-analysis' inherent in thermography appears

to be suited for improving cushion design, this approach should be further investigated to determine its reliability.

Gavin-Dreschnack, D. (2004). "Effects of wheelchair posture on patient safety." Rehabilitation Nursing 29(6): 221-6.

Wheelchairs originally were designed to transport people from one place to another quickly and easily. They have evolved to rank among the most important therapeutic devices used in rehabilitation. Currently, an estimated 2.2 million people who use wheelchairs generally are living longer and moving about more. However, the increased use of wheelchairs has been accompanied by many types of adverse events and repetitive stress injuries. Wheelchair prescription, posture, training, and maintenance are critical components of safety in this population, and may be enhanced through increased awareness and education. Since nurses and nursing staff are most often involved directly with wheelchair users (particularly in long-term-care settings), providing specialized programs for adaptive wheelchair fitting allows for a proactive approach to seating problems. [References: 65]

Gear, A. J., F. Suber, et al. (1999). "New assistive technology for passive standing." Journal of Burn Care & Rehabilitation 20(2): 164-9.

The anesthetic skin of patients with spinal cord injuries makes these patients a high-risk population for burn injuries. Innovations in rehabilitation engineering can now provide the disabled with mechanical devices that allow for passive standing. Passive standing has been shown to counteract many of the effects of chronic immobilization and spinal cord injury, including bone demineralization, urinary calculi, cardiovascular instability, and reduced joint range of motion and muscular tone. This article will describe several unique assistive devices that allow for passive standing and an improvement in daily living for people with disabilities. [References: 14]

Gefen, A. (2007). "Risk factors for a pressure-related deep tissue injury: a theoretical model." Medical & Biological Engineering & Computing 45(6): 563-73.

Pressure-related deep tissue injury is the term recommended by the United States National Pressure Ulcer Advisory Panel to describe a potentially life-threatening form of pressure ulcers, characterized by the presence of necrotic tissue under intact skin, and associated with prolonged compression of muscle tissue under bony prominences. In this study, a theoretical model was used to determine the relative contributions of the backrest inclination angle during prolonged wheelchair sitting, the muscle tissue stiffness and curvature of the ischial tuberosities (ITs) to the risk for injury in the gluteus muscles that pad the IT bones during sitting. The model is based on Hertz's theory for analysis of contact pressures between a rigid half-sphere (bone) and an elastic half-space (muscle). Hertz's theory is coupled with an injury threshold and damage law for muscle-both obtained in previous studies in rats. The simulation outputs the time-dependent bone-muscle contact pressures and the injured area in the gluteus. We calculated the full-size (asymptotic) injured area in the gluteus and the time for injury onset for different sitting angles alpha (90-150 degrees), muscle tissue long-term shear moduli G (250-1,200 Pa) and bone diameters D (8-18 mm). We then evaluated the sensitivity of model results to variations in these parameters, in order to determine how injury predictions are affected. In reclined sitting (alpha=150 degrees) the full-size injured area was approximately 2.1-fold smaller and the time for injury onset was approximately 1.3-fold longer compared with erect sitting (alpha=90 degrees). For greater G the full-size injured area was smaller but the time for injury onset was shorter, e.g., increasing G from 250 to 1200 Pa decreased the full-size injured area approximately 2.5-fold, but shortened the time for injury onset 6.2-fold. For smaller D the time for injury onset dropped, e.g., decreased approximately 1.5-fold when D decreased from 18 to 8 mm. Interestingly, the full-size injured area maximized at D of about 12 mm but decreased for smaller or larger D. The susceptibility to sitting-acquired deep tissue injury strongly depends on the geometrical and biomechanical characteristics of the bone-muscle interface, and, particularly, on the radius of curvature of the IT which mostly influenced the size of the wound, and on the muscle stiffness which dominantly affected the time for injury onset.

Gefen, A., N. Gefen, et al. (2005). "In vivo muscle stiffening under bone compression promotes deep pressure sores." Journal of Biomechanical Engineering 127(3): 512-24.

Pressure sores (PS) in deep muscles are potentially fatal and are considered one of the most costly complications in spinal cord injury patients. We hypothesize that continuous compression of the longissimus and gluteus muscles by the sacral and ischial bones during wheelchair sitting increases muscle stiffness around the bone-muscle interface over time, thereby causing muscles to bear intensified stresses in relentlessly widening regions, in a positive-feedback injury spiral. In this study, we measured long-term shear moduli of muscle tissue in vivo in rats after applying compression (35 KPa or 70 KPa for 1/4-2 h, N = 32), and evaluated tissue viability in matched groups (using phosphotungstic acid hematoxylin histology, N = 10). We found significant (1.8-fold to 3.3-fold, $p < 0.05$) stiffening of muscle tissue in vivo in muscles subjected to 35 KPa for 30 min or over, and in muscles subjected to 70 KPa for 15 min or over. By incorporating this effect into a finite element (FE) model of the buttocks of a wheelchair user we identified a mechanical stress wave which spreads from the bone-muscle interface outward through longissimus muscle tissue. After 4 h of FE simulated motionlessness, 50%-60% of the cross section of the longissimus was exposed to compressive stresses of 35 KPa or over (shown to induce cell death in rat muscle within 15 min). During these 4 h, the mean compressive stress across the transverse cross section of the longissimus increased by 30%-40%. The identification of the stiffening-stress-cell-death injury spiral developing during the initial 30 min of motionless sitting provides new mechanistic insight into deep PS formation and calls for reevaluation of the 1 h repositioning cycle recommended by the U.S. Department of Health.

Gefen, A. and J. Levine (2007). "The false premise in measuring body-support interface pressures for preventing serious pressure ulcers." Journal of Medical Engineering & Technology 31(5): 375-80.

Presently, commercial cushioning products for pressure ulcer prevention are being evaluated for their protective effect exclusively based on interfacial pressures between the cushion/mattress and the patient. However, interface pressures cannot

predict elevated mechanical stresses in deep tissues adjacent to bony prominences. Such deep tissue stress concentrations are associated with local ischaemia and hypoxia, which over time result in deep tissue necrosis, particularly of muscle tissue. In order to demonstrate this phenomenon, a physical phantom of the mechanical interaction between the ischial tuberosities (IT) and gluteus muscles of the buttocks was built, incorporating geometric replica of the human IT and real (bovine) muscle tissue. Internal muscle stresses directly under the IT were five to 11-fold greater than stresses at more distal locations, and a Pearson correlation test showed that they could not have been predicted from the interface pressures in the phantom. Accordingly, though pressure ulcer prevention clinics which utilize routine sitting pressure measurements report effective outcomes, the present results highlight a problem in using body-support pressure measurements to predict the risk for pressure-related deep tissue injury.

Geyer, M. J., D. M. Brienza, et al. (2003). "Wheelchair seating: a state of the science report." Assistive Technology 15(2): 120-8.

Regardless of the field, agenda-setting processes are integral to establishing research and development priorities. Beginning in 1998, the National Institute on Disability and Rehabilitation Research mandated that each newly funded Rehabilitation Engineering and Research Center (RERC) hold a state-of-the-science consensus forum during the third year of its 5-year funding cycle. NIDRR's aim in formalizing this agenda-setting process was to facilitate the formulation of future research and development priorities for each respective RERC. In February 2001, the RERC on Wheeled Mobility, University of Pittsburgh, conducted one of the first such forums. The scope encompassed both current scientific knowledge and clinical issues. In preparation, expert interviews were carried out to establish the focus for the forum. Because a stakeholder forum on wheelchair technology had recently been held, opinion favored wheelchair seating as the focus and included the following core areas: seating for use in wheelchair transportation, seated postural control, seating discomfort, and tissue integrity management. The aim of this report is to present a summary of the workshop outcomes, describe the process, and increase awareness

of this agenda-setting process in order to enhance future participation in a process that critically influences the field of wheeled mobility.

Geyer, M. J., D. M. Brienza, et al. (2001). "A randomized control trial to evaluate pressure-reducing seat cushions for elderly wheelchair users." Advances in Skin & Wound Care 14(3): 120-9; quiz 131-2.

OBJECTIVE: To determine if the use of pressure-reducing wheelchair cushions for elderly nursing home resident wheelchair users who are at high risk for developing sitting-acquired pressure ulcers would result in a lower incidence rate of pressure ulcers, a greater number of days until ulceration, and lower peak interface pressures compared with the use of convoluted foam cushions over a 12-month period. To determine the feasibility of conducting a subsequent full-scale definitive trial to evaluate the use of pressure-reducing seat cushions for elderly nursing home resident wheelchair users. DESIGN: Randomized control trial SETTING: 2200-bed skilled nursing facilities (1 suburban and 1 urban academic medical center) PATIENTS: 32 male and female at-risk nursing home residents who were wheelchair users > or = 65 years of age. Participants had Braden Scale scores < or = 18, Braden Activity and Mobilitysubscale scores < or = 5, no sitting surface pressure ulcers, and a daily wheelchair sitting tolerance of more than 6 hours. All met criteria for using the ETAC Twin wheelchair. INTERVENTIONS: Seating evaluation with pressure-mapping and subsequent seating prescription. Subjects were assigned to either a foam (n=17) or pressure-reducing cushion (n=15) group and weekly assessments of skin and pressure ulcer risk were made. MAIN OUTCOME MEASURES: Incidence of pressure ulcers, days to ulceration, and peak interface pressure. MAIN RESULTS: At a 95% confidence interval, a 2-tailed analysis showed no differences between the FOAM and pressure-reducing cushion groups for pressure ulcer incidence, total days to pressure ulcer, or initial peak interface pressure. Pressure-reducing cushions were more effective in preventing sitting-acquired (ischial) pressure ulcers (P<.005). Higher interface pressures were associated with a higher incidence of pressure ulcers (P<.001). CONCLUSIONS: A definitive randomized control multicenter cushion trial is feasible with a sample size

of 50 to 100 per study group. In the definitive trial, the definition of sitting-acquired pressure ulcers should be limited to lesions occurring over the ischial tuberosities.

Gilcreast, D. M., J. B. Warren, et al. (2005). "Research comparing three heel ulcer-prevention devices." Journal of Wound, Ostomy, & Continence Nursing 32(2): 112-20.

OBJECTIVE: To compare 3 pressure-reduction devices for effectiveness in prevention of heel ulcers in moderate-risk to high-risk patients. DESIGN: A prospective quasi-experimental 3-group design was used. SETTING AND SUBJECTS: A sample of 338 "moderate-risk to high-risk" adult inpatients, ages 18 to 97, at 2 medical centers in South Texas were studied. INSTRUMENTS: The Braden Scale for Pressure Ulcer Risk and investigator-developed history and skin assessment tools were used. METHODS: Subjects were randomly assigned to the High-Cushion Kodel Heel Protector (bunny boot), Egg Crate Heel Lift Positioner (egg crate), or EHOB Foot Waffle Air Cushion (foot waffle). Data are demographics, Braden scores, comorbidities, skin assessments, lengths of stay, and costs of devices. Analyses were Chi-square, analysis of variance, and regression. RESULTS: Of 240 subjects with complete data, 77 (32%) were assigned to the bunny boot group, 87 (36.3%) to the egg crate, and 76 (31.7%) to the foot waffle. Twelve ulcers developed in 240 subjects (5% incidence). Six subjects had only 1 foot. Eleven ulcers were Stage I (nonblanchable erythema), and 1 was Stage II (partial thickness). Overall incidence was 3.9% for the bunny boot, 4.6% for the egg crate, and 6.6% for the foot waffle (not significantly different among groups). The bunny boot with pillows was most cost effective (F[3], N = 240) = 1.342, p <or= .001). CONCLUSIONS: In this study, the bunny boot was as effective as higher-tech devices. The results, however, were confounded by nurses adding pillows to the bunny boot group.

Gray, D. (1999). "Pressure ulcer prevention and treatment: the Transair range." British Journal of Nursing 8(7): 454-8.

The Transair range has been updated as a result of clinical and technical advances. The Transair 500 cushion system utilizes foam and air technology to minimize disturbance to the user. Clinical trials suggest that this cushion is of benefit in both the prevention and treatment of pressure ulcers. The Transair 1001 alternating pressure air overlay and the Transair 2002 mattress replacement have both been revised to provide improved performance and both have been subjected to clinical trials. The results of these trials suggest that both have a role in the prevention and treatment of pressure sores in the individual in the high/very high risk group. This article examines these innovations in the Transair mattress and seating systems. [References: 21]

Grioni, G., G. Taveggia, et al. (1996). "[Selection of antidecubitus cushion seats]." Giornale Italiano di Medicina del Lavoro 18(1-3): 13-8.

The choice of anti-pressure cushion presupposes two fundamental requisites: a correct assessment of the patient and a precise understanding of the properties of the aids available. The prescription of such cushions is not a simple task in that the physical and clinical needs of each individual patient must be taken into account. The prevention of pressure ulcers is essential for both the physical and psychological wellbeing of the patient and avoids any slowing of the pace of rehabilitation programmes. The protection of the cutaneous and subcutaneous tissue on the areas of bone prominence is extremely important for those patients who pass much or all of the day seated in a wheelchair. In this talk, we hope to provide some practical advice concerning the choice of cushion that is best for each patient, not forgetting that the final success depends on the maintenance of a correct sitting position.

Guimaraes, E. and W. C. Mann (2003). "Evaluation of pressure and durability of a low-cost wheelchair cushion designed for developing countries." International Journal of Rehabilitation Research 26(2): 141-3.

Pressure sores are a medical problem for wheelchair users worldwide. In developing countries this problem is more critical because of lack of access to specialized technologies and medical assessment. Seat cushions to relieve pressure

represent one of best ways to prevent pressure sores for people with spinal cord injury, amputation, cerebral palsy, and other disabilities that require use of wheelchairs for long periods of time. The purpose of this study was to evaluate the performance of a low cost cushion, called the Tuball, designed for low-income communities in developing countries. The Tuball is made from bicycle inner tubes and plastic balls. Its durability and pressure-relieving characteristics were compared with the ROHOTM cushion and the foam cushions now used in Brazil. A sample of 30 participants tested the three cushions: 15 persons with paraplegia and 15 matched able-bodied persons evaluated the capacity of the cushions to distribute pressure. This study also addressed the use of samples of persons without disabilities to test wheelchair cushions.The Tuball cushion provided significantly better pressure distribution than the foam cushion. A t-test was used to compare disabled persons and non-disabled persons as samples in testing cushions. No difference between pressure distribution between non-disabled and disabled participants was found in testing the ROHO cushion or the foam cushion. However, both capacities of pressure distribution and HICPR varied between non-disabled and disabled participants for the Tuball cushion.To determine the useful life of the Tuball cushion, a fatigue test was conducted to simulate sitting and transfer. Both the Tuball and ROHO cushions withstood the equivalent of at least 1 year of use, whereas the foam cushion broke down.

Hamanami, K., A. Tokuhiro, et al. (2004). "Finding the optimal setting of inflated air pressure for a multi-cell air cushion for wheelchair patients with spinal cord injury." Acta Medica Okayama 58(1): 37-44.

Pressure distribution patterns of the seating interface on the multi-cell air cushion (ROHO High Profile) of 36 adults with spinal cord injury (SCI) (Neurological level Th3 -L1) were measured at different air pressure levels by a pressure mat measurement system. Stress distribution relative to the inflated air pressure in the air cushion on the patients' wheelchairs was analyzed to determine the appropriate inflated air pressure of the cushion for patients. The maximum pressure points in all subjects were at the areas of the ischial tuberosities (82 to 347 mmHg). The optimal reduction in interface pressure at the ischial tuberosities was obtained just before

bottoming out. The cushion air pressure at that point was between 17 and 42 mmHg, and correlated well to body weight (r = 0.495, P = 0.0021). In contrast, the maximum pressure levels did not correlate to body weight or the Body Mass Index (BMI). Pressure at the ischial area could be reduced, but not eliminated, by adjusting the air pressure. The maximum pressure levels seemed to be related to the shape of the buttocks, especially the amount of soft tissue, and exceeded the defined threshold for pressure ulcers (> 80 g/cm2).

Hampton, S. (2002). "Introducing the Reflexion pressure-redistributing cushion." British Journal of Nursing 11(7): 509-13.

Preventing pressure ulcer incidence and ensuring patient comfort are essential components of providing quality clinical care (Hampton, 2001), and therefore comfortable pressure-redistributing seating should be a prerequisite to care provision. However, even though education in tissue viability has increased, it is only within the last 2 years that chair cushions have been noted for their importance in reducing pressure ulceration. It is not unknown for patients to have excellent pressure-reducing equipment on the bed but have chair cushions that are of an inferior standard (Hampton, 1999). This article, therefore, examines the Reflexion cushion, manufactured by Vitafoam, and the role it may have in preventing pressure ulceration.

Hansen, R., S. Tresse, et al. (2004). "Fewer accidents and better maintenance with active wheelchair check-ups: a randomized controlled clinical trial." Clinical Rehabilitation 18(6): 631-9.

OBJECTIVE: To investigate whether active intervention using a compiled checklist for wheelchair check-ups increases user satisfaction and/or decreases accidents, near accidents and pressure sores. DESIGN: A randomized controlled trial comparing active intervention versus standard intervention for prescribed, manually propelled wheelchairs. SETTING: Patients within primary health care of Boras and Bollebygd municipalities, a mixed urban and rural population. SUBJECTS: Users of manually propelled wheelchairs over 16 years of age. INTERVENTIONS:

The accident rate, extent of pressure sores, number and extent of repairs, reconditioning, adjustments as well as user satisfaction were measured initially and at one year. In the standard intervention, the user and carer were encouraged to initiate contact when necessary. In the active intervention, an occupational therapist performed a scheduled, thorough check-up of the wheelchair, following a compiled checklist for safety, comfort and positioning, manoeuvrability and transportation. RESULTS: Of 253 registered wheelchair users, 216 were suitable and randomized. In the active intervention group, 99% (95% confidence interval 96-100%) of the inspected wheelchairs required maintenance. The incidence of accidents was unchanged in the standard intervention group, but decreased to 'no accidents' in the active intervention group (p = 0.03). User satisfaction was not affected by the active intervention. CONCLUSION: Most wheelchair users are unable to determine on their own when adjustments are needed. An active check-up on manually propelled wheelchairs seems to reduce accidents. More information is available at http://www.wheelchair.se

Harrow, J. J., P. Malassigne, et al. (2007). "Design and evaluation of a stand-up motorized prone cart." Journal of Spinal Cord Medicine 30(1): 50-61.

BACKGROUND/OBJECTIVE: Prone carts are used for mobility by individuals with spinal cord injury in whom seated mobility (wheelchair) is contraindicated due to ischial or sacral pressure ulcers. Currently available prone carts are uncomfortable, subjecting the user to neck and shoulder strain, and make social interaction and performing activities of daily living difficult. A better design of prone carts is needed. In addition, standing devices have shown some medical benefits. The objective was to design and evaluate an improved prone cart that facilitates standing. DESIGN: Engineering development project with user feedback through questionnaire. Users selected by convenience sampling. METHODS: A marketing survey was performed of nurse managers of spinal cord injury units. Then 2 prototype carts were designed and built. These carts are able to tilt up to 45 degrees and have a joystick-controlled motor for propulsion and other design features, including a workspace storage shelf and rearview mirrors. The carts were evaluated by both patients and caregivers at 2 Veteran's Administration hospitals. OUTCOME MEASURES: Questionnaire of

subjects, both patients and caregivers, who used the cart. FINDINGS: Both patients and caregivers liked the carts and the ability to assume a nonhorizontal body angle. The major complaint about the cart was that it seemed too long when it came to making turns. CONCLUSION: This prone cart design is an improvement over the standard, flat variety. However, further design changes will be necessary. This study provided valuable information that will be useful in the next-generation prone cart design project.

Hefzy, M. S., G. Nemunaitis, et al. (1996). "Design and development of a pressure relief seating apparatus for individuals with quadriplegia." Assistive Technology 8(1): 14-22.

Persons with spinal cord injury above C7 lack the ability to extend their elbows and grip with their hands. Consequently, when seated, they are unable to press down to shift their weight to relieve pressure on the ischial tuberosities. This can ultimately cause serious pressure sores to develop on the buttocks. Those with adequate insurance coverage can eliminate this problem with an electric power recliner wheelchair. With the touch of a button, the backrest will fold down to a laying position, thus relieving the pressure on the ischial tuberosity. Unfortunately, not all individuals with quadriplegia possess this type of coverage. Therefore, the problem requires an alternate design that will utilize mechanical rather than electrical power to produce a cost-effective solution. The purpose of this project was thus to design and build an affordable apparatus adaptable to wheelchairs that allows individuals with quadriplegia to shift their weight from one side to the other thus relieving the pressure on the ischial tuberosities. A pneumatic system that utilizes two inflatable air bladders was employed. One cushion is placed under each buttock and inflated separately to tilt the user from one side to the other. The inflated cushion elevates one side of the buttock, which relieves the pressure from the other side. The power required to operate the system is generated using repetitions of elbow flexion. The system was evaluated on an individual with C6 quadriplegia. The subject demonstrated independent pressure relief without intrusion on cosmesis or independence.

Ho, C. H. and K. Bogie (2007). "The prevention and treatment of pressure ulcers." Physical Medicine & Rehabilitation Clinics of North America 18(2): 235-53.

Pressure ulcers remain a significant secondary complication for many individuals with spinal cord injury (SCI). Technological advances have the potential to affect both the prevention and treatment of pressure ulcers. The focus of this article is hi-tech devices and methodologies. The current state-of-the-art methods are discussed and conceptual approaches are presented. [References: 59]

Izutsu, T., T. Matsui, et al. (1998). "Effect of rolling bed on decubitus in bedridden nursing home patients." Tohoku Journal of Experimental Medicine 184(2): 153-7.

Decubitus is one of the most difficult management problems encountered in bedridden elderly patients. Relief of pressure over decubitus is the most important principle of the management. We developed a rolling air cushion bed which turns the patient to a 15-degree inclined lateral position with an inflating ripple mattress, a longitudinally aligned air inflatable tube. The position of the patients was changed between right and left laterals and to supine every 15 minutes automatically. Nineteen bedridden patients with decubitus used the rolling air cushion bed for 3 months and 12 bedridden patients with decubitus used a conventional bed and had their position changes every 2 hours by care givers. Severity of decubitus was divided into 4 grades and the decubitus significantly improved from 2.8 (S.E. 0.2) to 2.0 (S.E. 0.3) after 3 months in patients using the rolling air cushion bed, while in patients with conventional beds it changed from 3.0 (S.E. 0.2) to 3.2 (S.E. 0.2) (not statistically significant). We suggest that the rolling air cushion bed would be beneficial to decubitus relief in bedridden elderly and may relieve labor by care givers.

Kang, T. E. and A. F. Mak (1998). "Development of a simple approach to modify the supporting properties of seating foam for pressure relief." Journal of Rehabilitation Research & Development 35(1): 52-60.

Pressure sores are a major problem frequently encountered by persons who use wheelchairs. Custom seat design, including contoured seating and various modular seating devices, has become an important option for pressure relief, especially when the market size is small and the variations of individual needs and requirements are large. An alternative approach in custom seating design for pressure relief is proposed in this paper. Holes were drilled in foam cushions to lower their supporting properties, particularly at the high pressure areas. This technique is evaluated systematically in this article. The scope of this study included: 1) a comparison of the foam material properties before and after such modifications, and 2) an evaluation of the static and dynamic degradation behaviors of the foams before and after modifications. It was found that the compression load (C-L) of the foam could be reduced by up to 46% using this simple drilling technique, while the material removed was only up to 28% by volume. It was also found that this approach would not significantly compromise the static and dynamic degradation behaviors of the foam; that is, such modification apparently did not dramatically shorten the lifespan of the foam material. Simple hole-drilling seems to be an effective approach to altering the supportive properties of foam cushions for pressure relief.

Karatas, G. K., A. K. Tosun, et al. (2008). "Center-of-pressure displacement during postural changes in relation to pressure ulcers in spinal cord-injured patients." American Journal of Physical Medicine & Rehabilitation 87(3): 177-82.

OBJECTIVE: To evaluate the center-of-pressure displacement in spinal cord-injured patients, to investigate dynamic sitting stability and its relationship with pressure ulcers. DESIGN: Sixteen spinal cord-injured patients and 18 healthy volunteers were included in the study. For the assessment of dynamic sitting stability, center-of-pressure displacement during maximum unsupported forward, backward, and right- and left-sided trunk leaning were measured with a seat sensor system, which was placed between the subject's buttocks and chair. RESULTS: Center-of-pressure displacements in all directions in spinal-injured patients were smaller than healthy volunteers ($P < 0.05$). Center-of-pressure displacements for high- and low-thoracic spinal cord-injured patients were not significantly different. History of previous pressure ulcer was not different between high- and low-thoracic

spinal cord-injured patients (chi = 0.90, $P = 0.62$). Mean center-of-pressure displacement during forward and backward leaning were smaller in patients with pressure ulcer history ($P = 0.04$ and 0.03, respectively). CONCLUSIONS: The results of this study suggest that impaired dynamic sitting stability is associated with pressure ulcer development.

Kennedy, P., C. Berry, et al. (2003). "The effect of a specialist seating assessment clinic on the skin management of individuals with spinal cord injury." Journal of Tissue Viability 13(3): 122-5.

OBJECTIVE: To evaluate the specialist seating clinic's effectiveness in improving skin management knowledge and independence, represented by the Needs Assessment Checklist (NAC). DESIGN: Longitudinal, between subjects design, with two intervention groups and one control. SETTING: Tertiary care, spinal cord injury centre (National Spinal Injuries Centre), Stoke Mandeville Hospital, United Kingdom. METHOD: This study assessed the skin management ability of three groups. Group 1 consisted of individuals who had attended a specialist seating assessment (SSA) clinic before their first needs assessment, group 2 had attended SSA between their first and second needs assessment, and group 3 (control) had not attended at all. Patient skin management ability was assessed using the skin management subscale of the NAC, a measure of rehabilitation outcome, at two time points. RESULTS: Significant differences were identified between group 3 and group 1 at both the first ($t = 2.36$, degrees of freedom (df) = 37, $p < 0.05$) and second ($t = 2.84$, df = 37, $p < 0.01$) needs assessment. Significant improvements were also observed within each group between the first and second needs assessment time points in all seating assessment categories. CONCLUSION: Skin management achievement scores were significantly higher for patients who had attended a SSA clinic before their first NAC (group 1) at both time points, supporting the use of SSA as a proactive intervention to improve patient independence, knowledge and awareness, and potentially reduce pressure ulcer incidence.

Kernozek, T. W., P. A. Wilder, et al. (2002). "The effects of body mass index on peak seat-interface pressure of institutionalized elderly." Archives of Physical Medicine & Rehabilitation 83(6): 868-71.

OBJECTIVE: To determine if body mass index (BMI) influenced seat-interface pressure in a population of institutionalized elderly. DESIGN: A cross-sectional comparison of peak seat-interface pressure in 4 groups of institutionalized elderly was compared with BMI scores defined as either thin (<20 kg/m(2)), desirable range (20-24.9 kg/m(2)), grade I obesity (25-29.9 kg/m(2)), or grade II obesity (30-40 kg/m(2)). SETTING: Several small nursing homes and a university in a small urban community. PARTICIPANTS: A convenience sample of 75 individuals (age range, 65-95 y) living in 1 of 3 skilled nursing facilities. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: The Novel Pliance seat pressure-mapping system was used to collect seat-interface pressure data. Each participant was asked to sit in the wheelchair for up to 10 minutes while the seat-interface pressures were recorded. Body weight and height of each participant were obtained from the medical chart; these characteristics were then used to calculate a BMI for each participant. RESULTS: A 1-way analysis of variance on the peak seat-interface pressures revealed significant differences between the 4 groups (P<.05). Post hoc comparisons showed differences in peak seat-interface pressure between the thin and desirable range groups (P<.05), the thin and grade I obesity group (P<.05), and the thin and grade II obesity groups (P<.05). Differences in peak seat-interface pressure decreased as BMI increased. CONCLUSIONS: The results are consistent with the results of a previous study of individuals with spinal cord injuries. In the current study, peak seat-interface pressure was highest in the thin elderly group, which had the lowest BMI levels of any of the 4 groups. Differences in the peak seat-interface pressures were less as BMI increased. Copyright 2002 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Klenck, C. and K. Gebke (2007). "Practical management: common medical problems in disabled athletes." Clinical Journal of Sport Medicine 17(1): 55-60.

Disabled athletes face many challenges during training and competition. As the number of disabled athletes grows, sports medicine professionals must become proficient in dealing with this population. A functional classification system is used to classify disabled athletes into 1 of 6 categories: wheelchair athletes, amputees, athletes with cerebral palsy, visual impairment, intellectual impairment, and les autres. Injury patterns have been identified for certain groups, with wheelchair athletes typically sustaining upper extremity injuries, blind athletes sustaining lower extremity injuries, and cerebral palsy athletes sustaining both. Common problems affecting wheelchair athletes include autonomic dysreflexia, difficulty with thermoregulation, pressure sores, neurogenic bladder, premature osteoporosis, peripheral nerve entrapment syndromes, and upper extremity injuries. Cerebral palsy athletes often have injuries involving the knee and foot due to problems with spasticity and foot deformities. Amputee athletes sustain injuries to the stump, spine, and intact limbs, while blind athletes suffer lower extremity injuries. Intellectually disabled athletes frequently have underlying ocular and visual defects, congenital cardiac anomalies, and atlantoaxial instability that predispose them to injuries. This article reviews key information pertinent to the care of these athletes. [References: 33]

Kordasiewicz, L. M. and R. O. Schultz (2003). "A paraplegic with stage IV pressure ulcers: risk factors and wound care." Journal of Wound, Ostomy, & Continence Nursing 30(2): 84-9.

Lacoste, M., R. Weiss-Lambrou, et al. (2003). "Powered tilt/recline systems: why and how are they used?" Assistive Technology 15(1): 58-68.

Prolonged static sitting can lead to discomfort, pain, pressure sores, spinal curvatures, and loss of functional independence. In order to counteract these harmful effects, adjustable tilt and/or recline systems are often prescribed. Considering the current context of assistive technology service delivery and budget cuts, it is essential to have a better knowledge of the use of these technical aids and user's satisfaction with them. The purpose of this study was to characterize the use of

powered tilt and recline systems. A questionnaire was developed for this purpose, and 40 subjects were interviewed at home. They were asked to identify, from a list of 25 objectives, the reasons for which they used their repositioning system and to rank these reasons in order of importance. For each objective, they were also asked to identify the frequency and range of use as well as their satisfaction level with their system. Results revealed that 97.5% of the subjects were using their powered tilt and recline system everyday, and their satisfaction was high. The main objectives for using this type of assistive technology were to increase comfort and to promote rest. Although mainly descriptive, results are of clinical relevance and can be helpful when selecting wheelchairs.

Lee, E.-T. (2004). "A new wound closure achieving and maintaining device using serial tightening of loop suture and its clinical applications in 15 consecutive patients for up to 102 days." Annals of Plastic Surgery 53(5): 436-41.

A device that can both achieve and maintain wound closure by serial tightening of a loop suture was developed. The device consists of 3 components: a hollow plastic cylinder with a 1-way locking mechanism, a flat plastic strip passing though the cylinder, and a plastic cushion between the cylinder and the skin. The body of the device is composed of a soft cylinder and a hard strip. This difference in flexibility enables the device to absorb impacts of positional changes and daily activities, while the device preserves tension of loop suture and wound closure ().(Figure is included in full-text article.)After debridement or excision of a lesion, the passage of 0-1 nylon suture is designed. The nylon suture is threaded through the deep dermis across the wound. Both ends of the suture are then tied to make a loop, which is secured to 2 holes at one end of a plastic strip. The plastic strip, which holds the loop suture, is pulled away from the skin gradually through a hollow plastic cylinder to approximate wound margins ().(Figure is included in full-text article.)From January 2003 to August 2003, the device was applied 21 times in 15 consecutive patients. A mean stretching of 42.0 mm was performed for defects with a mean shortest dimension of 24.5 mm (from 2 mm to 60 mm). All 21 wounds were closed primarily (21/21 = 100%), and the closure was maintained successfully for 18 wounds (18/21 = 85.7%) in 13 patients (13/15 = 86.7%). The device was left in situ

for as long as 102 days (average application time of 34.5 days). Three wound dehiscences (3/21 = 14.3%) occurred in 2 diabetic foot patients, which were cured by skin grafting. In 2 sacral pressure ulcer patients, minimal skin lacerations were caused by the loop sutures at the skin entrance site but without true wound dehiscence. These lacerations healed with minimal debridement and routine wound dressing within 2 weeks. This instrument was devised to overcome the limitations of previous skin stretching methods. It has wider indications and shows better compliances. In particular, because of its longer period of application, the device does not only stretch the skin to achieve wound closure, but also helps maintain it during wound healing.

Linder-Ganz, E., M. Scheinowitz, et al. (2007). "How do normals move during prolonged wheelchair-sitting?" Technology & Health Care 15(3): 195-202.

The clinical practice for minimizing the risk of pressure sores (PS) is to relief pressures under bony prominences of immobilized patients by changing their postures frequently. The US Department of Health advises to relief sitting pressures at least every 1 hour, and every 15 minutes for individuals who are body-abled. Surprisingly, there is paucity of information in the literature concerning motion of healthy subjects during prolonged sitting, which can be compared with these recommendations. Considering that healthy individuals are able to sit for hours without suffering injuries, such information seems particularly important. Accordingly, our objective was to measure frequency of postural changes and extent of motion during postural changes among healthy subjects who sit in a wheelchair (N=10), in order to provide information that is missing in the literature of PS biomechanics. Subjects were asked to sit comfortably for 90 minutes, during which their trunk's frontal and sagittal motions and sitting pressures were measured. We found that normals change their posture every 9 +/- 6 minutes in the sagittal plane, and independently, every 6 +/- 2 minutes in the frontal plane. Shoulders, thoracic-spine and lumbar-spine frontal plane motions were 8 +/- 4 degrees , 14 +/- 7 degrees and 15 +/- 7 degrees , respectively, and sagittal trunk-thigh movement was 10.3 +/- 7 degrees . The frequency of postural changes in normals, measured herein, was higher than frequencies reported in the literature for patients who suffered PS. This

small study population therefore supports the hypothesis that prolonged immobilization contributes to PS onset.

Makhsous, M., M. Priebe, et al. (2007). "Measuring tissue perfusion during pressure relief maneuvers: insights into preventing pressure ulcers." Journal of Spinal Cord Medicine 30(5): 497-507.

BACKGROUND/OBJECTIVE: To study the effect on tissue perfusion of relieving interface pressure using standard wheelchair pushups compared with a mechanical automated dynamic pressure relief system. DESIGN: Repeated measures in 2 protocols on 3 groups of subjects. PARTICIPANTS: Twenty individuals with motor-complete paraplegia below T4, 20 with motor-complete tetraplegia, and 20 able-bodied subjects. METHODS: Two 1-hour sitting protocols: dynamic protocol, sitting configuration alternated every 10 minutes between a normal sitting configuration and an off-loading configuration; wheelchair pushup protocol, normal sitting configuration with standard wheelchair pushup once every 20 minutes. MAIN OUTCOME MEASURES: Transcutaneous partial pressures of oxygen and carbon dioxide measured from buttock overlying the ischial tuberosity and interface pressure measured at the seat back and buttocks. Perfusion deterioration and recovery times were calculated during changes in interface pressures. RESULTS: In the off-loading configuration, concentrated interface pressure during the normal sitting configuration was significantly diminished, and tissue perfusion was significantly improved. Wheelchair pushups showed complete relief of interface pressure but incomplete recovery of tissue perfusion. CONCLUSIONS: Interface pressure analysis does not provide complete information about the effectiveness of pressure relief maneuvers. Measures of tissue perfusion may help establish more effective strategies. Relief achieved by standard wheelchair pushups may not be sufficient to recover tissue perfusion compromised during sitting; alternate maneuvers may be necessary. The dynamic seating system provided effective pressure relief with sustained reduction in interface pressure adequate for complete recovery of tissue perfusion. Differences in perfusion recovery times between subjects with spinal cord injury (SCI) and controls raise questions about the importance of changes in vascular responses to pressure after SCI.

Makhsous, M., D. M. Rowles, et al. (2007). "Periodically relieving ischial sitting load to decrease the risk of pressure ulcers." Archives of Physical Medicine & Rehabilitation 88(7): 862-70.

OBJECTIVE: To investigate the relieving effect on interface pressure of an alternate sitting protocol involving a sitting posture that reduces ischial support. DESIGN: Repeated measures in 2 protocols on 3 groups of subjects. SETTING: Laboratory. PARTICIPANTS: Twenty able-bodied persons, 20 persons with paraplegia, and 20 persons with tetraplegia. INTERVENTIONS: Two 1-hour protocols were used: alternate and normal plus pushup. In the alternate protocol, sitting posture was alternated every 10 minutes between normal (sitting upright with ischial support) and with partially removed ischial support (WO-BPS) postures; in the normal plus pushup protocol, sitting was in normal posture with pushups (lifting the subject off the seat) performed every 20 minutes. MAIN OUTCOME MEASURE: Interface pressure on seat and backrest. RESULTS: In WO-BPS posture, the concentrated interface pressure observed around the ischia in normal posture was significantly repositioned to the thighs. By cyclically repositioning the interface pressure, the alternate protocol was superior to the normal plus pushup protocol in terms of a significantly lower average interface pressure over the buttocks. CONCLUSIONS: A sitting protocol periodically reducing the ischial support helps lower the sitting load on the buttocks, especially the area close to ischial tuberosities.

Masatsugu, M., T. Akata, et al. (2005). "[Quantitative assessment of pressure relief at the sacral area in adults lying supine on the operating room table]." Masui - Japanese Journal of Anesthesiology 54(3): 313-9.

BACKGROUND: It is important to prevent development of the pressure ulcers in patients undergoing lengthy surgery, particularly at areas of skin overlying bony prominences. This study was designed to investigate distribution of the interface pressure (IP) over the body area (from the head to pelvic area) in supine adults and also evaluate the ability of a polyurethane-made cushion to reduce the IP at their sacral area. METHODS: Utilizing a recently developed device to measure the IP

(ERGO-CHECK, ABW Co., Germany), we evaluated distribution of the IP (estimated per 3 x 4 cm2 area) over the body area in healthy volunteers (n=31) and patients under general anesthesia (n=6) lying supine on the operating room (OR) table. RESULTS: In all the subjects, the highest IP was generated at the sacrum; 62.5 +/- 23.8 (mean +/- SD) and 35.7 +/- 5.5 mmHg in the volunteers and patients, respectively. The polyurethane-made, "doughnut" cushion (5 cm in thickness) inserted between the pelvic area and the OR table significantly reduced (P < 0.05) the IP at the sacrum in both groups: the IPs after the insertion in the volunteers and patients were 35.1 +/- 11.1 and 25.6 +/- 6.5 mmHg, respectively. In addition, the insertion significantly reduced (P < 0.05) the high-risk area (i.e., area of IP > 32 mmHg) in both groups. CONCLUSIONS: Quantitative assessment of the IP would be useful in evaluating precisely the effectiveness of various types of pillows, cushions, or mattresses designed to reduce the IP.

McDonald, H. (2001). "Preventing pressure ulcers." Rehab Management 14(6): 40-6.

Meiners, T., G. Friedrich, et al. (2001). "[Pressure distribution measurements during use of wheelchairs]." Orthopade 30(4): 208-13.

There is a growing number of mobility-impaired and wheelchair-dependent patients caused by diseases and injuries of the central nervous system. The risk is high for pressure sores to develop due to disturbances of the motor, sensory, and autonomic nervous system. Numerous seating systems for prophylaxis and treatment of decubitus ulcer are available. To identify risk parameters, the literature on animal experiments regarding pressure ulcers was reviewed. A study on the reproducibility of the analysis method with capacitive sensors tested in ten paraplegics with 470 measurements is presented. It shows the reliability of the procedure.

Michael, S. M., D. Porter, et al. (2007). "Tilted seat position for non-ambulant individuals with neurological and neuromuscular impairment: a systematic review." Clinical Rehabilitation 21(12): 1063-74.

OBJECTIVE: To determine the effects of tilt-in-space seating on outcomes for people with neurological or neuromuscular impairment who cannot walk. DATA SOURCES: Search through electronic databases (MEDLINE, Embase, CINAHL, AMED). Discussions with researchers who are active in field. REVIEW METHODS: Selection criteria included interventional studies that investigated the effects of seat tilt on outcome or observational studies that identified outcomes for those who had used tilt-in-space seating in populations with neurological or neuromuscular impairments. Two reviewers independently selected trials for inclusion, assessed quality and extracted data. RESULTS: Nineteen studies were identified which fulfilled the selection criteria. Seventeen of these were essentially before-after studies investigating the immediate effects of tilting the seating. All studies looked at populations with neurological impairment, and most were on children with cerebral palsy (n=8) or adults with spinal cord injury (n=8). REVIEWER'S CONCLUSION: Posterior tilt can reduce pressures at the interface under the pelvis. [References: 32]

Moody, M. (1998). "Review of the STM range of pressure distribution products." British Journal of Nursing 7(18): 1078-80.

STM Healthcare is a division of the Recticel Group which has been actively involved in the production and use of polyurethane foams for the past 40 years, and is now one of Europe's leading manufacturers of polyurethane foam for insulation, packaging, filtration, aerospace, the automotive and furniture industries, domestic and specialist bedding and seating products. STM Healthcare is able to draw upon the wealth of experience and expertise of the manufacturing facilities, enabling products to be developed using the latest environmentally friendly specification foams best suited to the requirements of pressure-reduction technology. All STM Healthcare mattresses, cushions and Linknurse mattresses are manufactured with Safeguard combustion modified high resilience foams. (Linknurse is a licensed product name; products are manufactured by Recticel and distributed by STM). [References: 6]

Norman, R. A. and M. Bock (2003). "Wound care in geriatrics." Dermatologic Therapy 16(3): 224-30.

Wound care is a crucial aspect in caring for the geriatric population. It is important to recognize a wound when it begins and know the proper treatment once a wound develops. First, it is important to assess the wound and determine the type of wound that is being dealt with. One must establish whether the wound is acute of chronic. Then a proper treatment plan must be devised. This article will take you through step by step process of different types of wounds and the proper treatment of those wounds that commonly occur within the geriatric population.

Olshansky, K. (2006). "The chair: low-tech device helps prevent pressure ulcers." Advances in Skin & Wound Care 19(2): 68.

Peich, S. and R. Calderon-Margalit (2004). "Reduction of nosocomial pressure ulcers in patients with hip fractures: a quality improvement program." International Journal of Health Care Quality Assurance Incorporating Leadership in Health Services 17(2-3): 75-80.

Pressure ulcers (PUs) continue to be a distressing medical problem. The Nursing Quality Improvement Unit of Israel's Hadassah Mount Scopus Medical Center designed and implemented a quality improvement intervention program to reduce the incidence of nosocomial PUs. Assessing data, it was found that 46.7 percent of nosocomial PUs develop inpatients with hip fractures. Following the first audit of all patients with hip fractures, an intervention program was focused on the orthopedic ward and the recovery room. Intervention in the orthopedic ward included providing each patient with a visco-elastic mattress and a specially designed cushion for the elevation of the affected limb. In the recovery room, pressure-relieving practices were introduced. Following the implementation of the intervention program, the second audit revealed a reduction in the incidence of nosocomial PUs from 12.9

percent to 0 percent. Although patients with hip fractures are still at very high risk of developing nosocomial PUs, prevention is feasible.

Price, P., S. Bale, et al. (1999). "Challenging the pressure sore paradigm." Journal of Wound Care 8(4): 187-90.

This study determines the effectiveness of a new low-unit-cost support system in patients at very high risk of developing pressure sores. In a prospective randomised controlled trial, a low-pressure inflatable mattress and cushion system (Repose) was compared to a dynamic support mattress (Nimbus II) used in conjunction with an alternating-pressure cushion (Alpha TranCell) in 80 patients with fractured neck of femur and high scores on a pressure sore risk assessment scale. All patients received best standard care, including turning at regular intervals. Skin condition was assessed in 17 locations on admission, preoperatively, and seven and 14 days postoperatively. No difference was found between the groups in skin condition or the occurrence and severity of pressure sores at any time point.

Rader, J., D. Jones, et al. (2000). "The importance of individualized wheelchair seating for frail older adults." Journal of Gerontological Nursing 26(11): 24-32; quiz 46-7.

Ragan, R., T. W. Kernozek, et al. (2002). "Seat-interface pressures on various thicknesses of foam wheelchair cushions: a finite modeling approach." Archives of Physical Medicine & Rehabilitation 83(6): 872-5.

OBJECTIVE: To investigate the effect of cushion thickness on subcutaneous pressures during seating by using a finite element modeling approach. DESIGN: Seat-interface pressure measurements were used in a computational model. SETTING: Biomechanics laboratory. PARTICIPANT: A single healthy man (weight, 70 kg). INTERVENTIONS: Subject sat upright either with or without cushions of various heights. Seat-interface pressures measured by using a sensor mat interfaced to a personal computer sampling at 15 Hz. MAIN OUTCOME

MEASURES: Peak seat-interface pressure; finite-element software was used to model the buttock, ischial tuberosity, and seat cushion. Subcutaneous stresses were calculated from the model. RESULTS: The region of highest subcutaneous stress in the soft tissue was concentrated within 1 or 2 cm of the ischial tuberosity, with the maximum compressive stress inferior to the bottom surface of the ischial tuberosity. The maximum subcutaneous stress, maximum seat-interface pressure, and maximum subcutaneous shear stress each changed with cushion thickness. Subcutaneous pressures decreased with thicker cushions, but almost all of the reduction was obtained with an 8-cm cushion. The amount of subcutaneous shear stress increased slightly for thicker cushions. The maximum subcutaneous stress was greater than the maximum interface pressure but not by a constant factor. Instead, the former was consistently larger by 0.7 to 0.8 N/cm(2). CONCLUSIONS: Cushion use reduced the maximum subcutaneous stress inferior to the ischial tuberosity. However, increasing the cushion thickness beyond 8 cm was ineffective in further reducing subcutaneous stress. It was also found that seat-interface pressures were a good indicator of the subcutaneous stress reduction in seating. Copyright 2002 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Rindflesch, A. B. and N. E. Miller (2002). "The thoracic suspension orthosis--a seating option for patients with pressure ulcers." Journal of Spinal Cord Medicine 25(4): 306-9.

BACKGROUND/OBJECTIVE: For patients with pressure ulcers, wound healing and prevention are important steps in reducing disability. Ulcers that fail to heal adequately may interfere with normal sitting. By relieving pressure, the thoracic suspension orthosis (TSO) may allow some patients with recurrent pressure ulcers to return to sitting and sit for longer periods. METHODS: In this retrospective case series, 6 patients with chronic pressure ulcers were managed with TSO. Each patient had at least one of the following: (1) severe, non-healing pressure ulcers unresponsive to standard therapy, (2) recurrent ulcers requiring multiple surgeries, (3) chronic pain associated with sitting, or (4) bilateral lower extremity amputation resulting in instability or ischial pain in the seated position. RESULTS: Each

participant had a favorable functional outcome. Patients were able to resume modified sitting. Others were able to sit for longer periods. Some have used the TSO for long-term management. CONCLUSIONS: A TSO is an additional seating option for patients with chronic pressure ulcer, chronic pain associated with sitting, or bilateral lower extremity amputation. It is recommended after less restrictive, conservative measures have failed. In some patients, it has been used in lieu of extreme surgical measures. [References: 7]

Rithalia, S. V. (1997). "Assessment of pressure relief characteristics in alternating pressure air cushions." International Journal of Rehabilitation Research 20(2): 205-8.

Rosenthal, M. J., R. M. Felton, et al. (1996). "A wheelchair cushion designed to redistribute sites of sitting pressure." Archives of Physical Medicine & Rehabilitation 77(3): 278-82.

OBJECTIVES: Despite the diversity of wheelchair cushions currently in clinical use, pressure on bony prominences continues to be a major problem for wheelchair-bound patients, and the incidence of pressure ulcers remains high. No static surface has been reported to reduce resting pressure under the ischial tuberosities to below that of capillary pressure, which may well be the threshold for inducing tissue damage. An entirely new form of seating was designed to decrease absolute pressure using a prosthetic fitting technique analogous to a below-the-knee prosthesis. DESIGN: A repeated measures randomized design was used to test differences between the experimental (TCS) and three other standard cushions. SETTING: A Veterans Medical Center outpatient service. PATIENTS: Wheelchair-bound volunteer subjects, n = 47, were selected who weighed more than 60kg. MAIN OUTCOME MEASURES: Pressures were measured by a standard air pressure pad and also by a computer-linked array of pressure transducers. The grid was standardized and used to generate topographic maps for each site over time. These data were used to measure the seating interface pressures. RESULTS: There was a significant main effect of cushion over site, F = 131 for left ischial tuberosity. Pressure were lowest while patients sat on the experimental seat and differences

were significant at all time points. Using 1psi as presumed capillary pressure, frequency of success at achieving this pressure threshold was greatest for the experimental seat, $p < .001$. This difference persisted throughout the 30 minutes of testing. CONCLUSIONS: A computerized pressure grid was developed that allowed evaluation of anatomically localized pressures. The prosthetically designed TCS displays lower seating pressures than any other cushion tested. Consistent and sustained pressures were below the postulated threshold for tissue damage.

Russell, L., T. Reynolds, et al. (2000). "A comparison of healing rates on two pressure-relieving systems." British Journal of Nursing 9(22): 2270-80.

The authors have previously reported the preliminary results of a randomized-controlled trial comparing the relative efficacy of two pressure-relieving systems: Huntleigh Nimbus 3 and Aura Cushion, and Pegasus Cairwave Therapy System and ProActive Seating Cushion (Russell et al, 2000). Although both the mattresses and cushions were effective treatments for pressure ulcers, the Huntleigh equipment was demonstrated to be statistically more effective for heel ulcers, but no differences were demonstrated for sacral ulcers. This article gives a more detailed analysis of the 141 patients assessed using computerized-image analysis of the digital images of sacral ulcers captured during the trial and specifically discusses the healing rates and other patient characteristics. Ninety-eight per cent of ulcers examined were deemed superficial (Torrance grade 2a, 2b, 3). Precision of image analysis assessed by within- and between-batch coefficients of variation was excellent: calibration CV 0.93-1.84%; area CV 4.61-5.72%. The healing rates on the two mattresses were not shown to be statistically different from each other.

Russell, L., T. M. Reynolds, et al. (2000). "Randomised controlled trial of two pressure-relieving systems." Journal of Wound Care 9(2): 52-5.

The primary objective of this randomised controlled trial was to determine whether there were significant differences between two pressure-relieving systems. A secondary aim was to investigate whether the availability of extra pressure-relieving equipment would reduce the incidence of ulcers in an acute hospital setting.

A total of 141 patients in a care-of-the-elderly unit, who were assessed to have a high risk of developing pressure ulcers using the Waterlow score, were recruited; 70 were nursed using Huntleigh Nimbus 3 in conjunction with the Aura cushion (Group A), and 71 using the Pegasus Cairwave Therapy System in conjunction with the Proactive 2 Seating cushion (Group B). The main outcome measure was visual assessment, supported by a photographic record. There were three main findings: for non-heel ulcers and overall improvement, there was no statistically significant difference between the two products tested; for heel ulcers there was a significant difference (P = 0.019) with more patients healing in Group A than in Group B. The average length of stay of patients who completed the trial was 21.6 days (Group A) and 21.7 days (Group B) for patients completing a live (range 1-121 days) and for patients who died 29.7 days (Group A) and 24.3 days (Group B). Routine monitoring showed that, before the trial, the incidence of hospital-acquired pressure ulcers (Torrance grade 2+) was 0.2%; during the trial, this dropped to 0.13%. The study showed differences in the efficacy of different mattress products; with a sufficiently large study, it is possible to demonstrate statistically significant results. Provision of extra pressure-relieving equipment can reduce the incidence of pressure ulcers but may not influence length of stay.

Russell, L. J., T. M. Reynolds, et al. (2003). "Randomized clinical trial comparing 2 support surfaces: results of the Prevention of Pressure Ulcers Study." Advances in Skin & Wound Care 16(6): 317-27.

OBJECTIVE: To determine whether a viscoelastic polymer (energy absorbing) foam mattress was superior to a standard hospital mattress for pressure ulcer prevention and to analyze the cost-effectiveness in comparison with standard hospital mattresses. DESIGN: Unblinded, randomized, prospective trial. SETTING: Elderly acute care, rehabilitation, and orthopedic wards at 3 hospitals in the United Kingdom. PARTICIPANTS: 1168 patients at risk of developing pressure ulcers (Waterlow score, 15 to 20), with a median age of 83 years (25th to 75th percentile range, 79-87). INTERVENTIONS: Participants were allocated to either the experimental equipment (CONFOR-Med mattress/cushion combination) or a standard mattress/cushion combination; all were given standard nursing care.

Pressure areas were observed daily. MAIN OUTCOME MEASURE: Development of nonblanching erythema. RESULTS: A significant decrease in the incidence of blanching erythema (26.3% to 19.9%; P =.004) and a nonsignificant decrease in the incidence of nonblanching erythema occurred in participants allocated to the experimental equipment. However, when the survival curve plots were analyzed at 7 days, both categories showed statistically significant decreases (P =.0015 and P =.042, respectively). Participants on standard equipment had a relative odds ratio of 1.36 (95% confidence interval [CI], 1.10-1.69) for developing blanching erythema or worse and 1.46 (95% CI, 0.90-1.82) for developing nonblanching erythema or worse. To prevent nonblanching erythema, the number needed to treat (NNT) was 41.9 (95% CI, -82.6-15.3). To prevent any erythema (blanching or nonblanching), the NNT was 11.5 (95% CI, 41.6-9.3). Participants with blanching or nonblanching erythema were significantly less mobile than participants with normal skin and more likely to have worsening mobility (P <.001). For participants with similar pressure ulcer status, mattress type was not associated with difference in mobility. CONCLUSIONS: Regardless of prevention routine, pressure ulcers occur. In this study, the experimental equipment showed statistical significance to standard equipment for prevention of blanching erythema; significance was not achieved for nonblanching erythema. Trend and survival analysis show that a larger study is required to determine whether this nonsignificant difference is genuine.

Samaniego, I. A. (2003). "A sore spot in pediatrics: risk factors for pressure ulcers." Pediatric Nursing 29(4): 278-82.

A retrospective, exploratory study was conducted as part of a performance improvement project examining pressure ulcer development in children. In 1 year, 69 children visited the hospital's wound clinic: 50 children had pressure ulcers, and 19 children had skin breakdown secondary to delayed operative wound healing. This article reviews findings from the 50 children with pressure ulcers. The primary diagnosis was myelodysplasia. Risk factors identified included (a) paralysis, (b) insensate areas, (c) high activity, and (d) immobility. The majority of the pressure ulcers occurred in the lower extremities, primarily the feet. As children get older or neurological condition deteriorates, sacral ulcers are seen particularly among

wheelchair users. Pressure ulcers occur predominantly in the child's home environment.

Shipperley, T. and F. Collins (2000). "How to choose the correct pressure-relieving cushion." Nursing Times 96(23 Suppl): 18-20.

Shipperley, T. F. and F. Collins (1999). "A seating assessment tool for community use." Journal of Wound Care 8(3): 119-20.

Sprigle, S. (2000). "Prescribing pressure ulcer treatment." Rehab Management 13(5): 72-7.

Sprigle, S., W. Dunlop, et al. (2003). "Reliability of bench tests of interface pressure." Assistive Technology 15(1): 49-57.

Determination of an appropriate wheelchair cushion to optimize loading on buttock tissue is crucial to pressure ulcer prevention. Standardized test methods aim to simplify selection by helping clinicians and users identify a class or category of cushions that will meet the important medical need of adequate pressure distribution. The objective of this project was to determine the test-retest reliability of interface pressure measurements taken using bench tests as opposed to human subject tests. Ten wheelchair cushions were tested following the methods for interface pressure measurement as defined in a draft International Organization for Standardization document. Dispersion index, contact area, percent force in the ischial regions, peak pressure index, and seating pressure index-standard deviation are reliable measures. Average pressure is reliable but not very volatile between cushions. The data also indicate that peak pressure, seating pressure index-skew (SPI-sk), and the other five percent force regions are not reliable. Certain bench interface pressure variables were found to have adequate intralaboratory repeatability. Interlaboratory reliability must also be tested. If a bench interface pressure test is used to indicate

cushion performance, its validity should also be studied. Research is underway to relate interface pressure variables to clinical measurements of wheelchair users. Once validity is shown, standardized test results can then be used by clinicians to simplify and improve the wheelchair cushion selection process.

Sprigle, S. and L. Press (2003). "Reliability of the ISO wheelchair cushion test for loaded contour depth." Assistive Technology 15(2): 145-50.

Standardized test methods that report cushion characteristics and performance can simplify cushion selection by helping clinicians and users identify types of cushions that may meet a user's needs. The loaded contour depth (LCD) test is one of the test methods included in the International Organization for Standardization (ISO) standards for wheelchair cushions. LCD measures the depth of immersion into a cushion. The objective was to determine the reliability of LCD and overload deflection measurements. LCD and overload deflection tests were repeated on 17 cushions. Intraclass correlation coefficient (ICC) and repeatability coefficient (RC) were calculated. The reliability of LCD (ICC = 0.98; RC = 0.21) and overload depth (RC = 0.15) were very high. LCD measures can reliably be used to differentiate cushions that vary by at least 1 cm. The overload test can be used as a criterion-referenced measure, but it is not sensitive to variation.

Stockton, L. (1998). "Pressure relief seating: are your patients comfortable?" Community Nurse 4(1): 47-8.

Stockton, L. (2000). "Guide to choosing the right pressure-reducing cushion." Community Nurse 6(2): 33-4.

Stockton, L. and S. Rithalia (2007). "Is dynamic seating a modality worth considering in the prevention of pressure ulcers?" Journal of Tissue Viability 17(1): 15-21.

Sumiya, T., K. Kawamura, et al. (1997). "A survey of wheelchair use by paraplegic individuals in Japan. Part 1: Characteristics of wheelchair cushions." Spinal Cord 35(9): 590-4.

The characteristics of wheelchair cushions used by 218 paraplegic patients who lived independent lives were surveyed to clarify the present state of wheelchair cushioning for pressure sore prevention in Japan. Out of 586 cushions surveyed, 91.0% were ready-made and the rest were custom-made. The outstanding popularity of polyurethane foam ready-made cushions (76.3%) suggested that insufficient consideration was taken in the selection of cushions. Custom-made cushions displayed unique modifications to relieve contact pressure or to stabilize sitting posture, which should be systematically provided for all patients. The variety of cushion types and the frequent dissatisfaction with cushions seen in patients with current pressure sores suggested a strong demand for the effective prescription of cushions. Furthermore, 30% of all cushions had had an excessively prolonged use, indicating insufficient follow-up. A medical system including deliberate prescription and regular follow-up of wheelchair cushions should be established for the effective prevention of pressure sores.

Sumiya, T., K. Kawamura, et al. (1997). "A survey of wheelchair use by paraplegic individuals in Japan. Part 2: Prevalence of pressure sores." Spinal Cord 35(9): 595-8.

A cross-sectional survey was done to clarify the incidence of pressure sores in 218 self-supported Japanese paraplegic patients and to determine effective measures for prevention. The majority of patients (85.7%) had previous pressure sores, and 46.3% had undergone multiple surgeries. Some patients (17.9%) were still suffering from persistent sores which commonly developed at the ischial tuberosities, suggesting insufficiency of self-care practice during wheelchair activities. Sensory disturbance over the seating surface, urinary incontinence, and general complications were seen in 85.8%, 49.5%, and 18.8% of total subjects, respectively. They were seen as risk factors for pressure sores, but only urinary incontinence clearly increased the current pressure sore prevalence. Nevertheless, both self-care practice and sports activities, seen in 85.3% and 36.2% of total

subjects, respectively, contributed to greatly reduce the incidence. A patient education system including acquisition of basic knowledge and proper technique should be established to promote effective prevention of pressure sores in Japan.

Tuncbilek, G., S. Nasir, et al. (2004). "Partially de-epithelialised and buried V-Y advancement flap for reconstruction of sacrococcygeal and ischial defects." Scandinavian Journal of Plastic & Reconstructive Surgery & Hand Surgery 38(2): 94-9.

Defects in the sacrococcygeal and ischial soft tissues can be treated with gluteus maximus and posterior thigh V-Y advancement flaps. However, late complications include recurrence and dehiscence of the suture line. Increasing the amount of the soft tissues over the bony prominences and multilayered closure may have an advantage for long-term durability. We modified the V-Y advancement technique by de-epithelialising the medial parts of the flap and burying them under the opposing edge of the wound or the flap. Sixteen patients with various defects of the sacrococcygeal and ischial soft tissues were operated on using this technique. All the flaps healed well with no partial or complete loss of the flap. Three patients developed complications. The main advantage of our technique is the use of healthy tissues to obliterate the dead spaces under the edges of the wound or the opposing flap. In this way, not only the defect in the skin but the defect in the subcutaneous tissue, with its iceberg tip at the surface, is treated effectively. To have an additional layer of tissue between the bone and the superficial tissues provides an extra cushion of soft tissue and avoids putting the suture line directly over the bony prominences. We used this modification safely for both unilateral and bilateral flaps. It could also be used successfully in other parts of the body.

Volker, H. U., G. Roper, et al. (1999). "[The effect of soft care mattresses on subcutaneous tissue pressure and pO2 over the os sacrum]." Unfallchirurg 102(6): 439-46.

In this study the influence of soft-care systems on subcutaneous tissue pressure and pO2 has been examined. In 14 volunteers 3 probes were implanted

over the os sacrum for measurement during the 20-minute periods. Then the probands were asked to lie on a standard mattress, on 8 static beds of various kind and on 3 dynamic soft-care systems. The clinical mattress pressure values amounted to 25.5 mm Hg (+/- 5.2; n = 14). The gell-cushion showed increased values (26.9 +/- 9.5 mm Hg; n = 5). Compared to the standard mattress the other systems showed reductions in pressure from 32.7% to 83.1%. The lowest pressure was recorded with an air-supported mattress (8.3 +/- 2.3 mm Hg; n = 5). The pO2 initial values before lying down varied greatly from individual to individual (26.9-71.3 mm Hg). In the course of the 20-minute periods the pO2 value sometimes remained constant, sometimes increased and at other times it decreased. Under extreme conditions (with 8 probands asked to lie on the floor) a correlation (r = -0.787) between pressure and pO2 was observed (pressure values between 20.6 and 192.9 mm Hg). The results indicate the use of modern soft-care systems depending on the individual risk of pressure sores.

Wall, J. (2000). "Preventing pressure sores among wheelchair users." Professional Nurse 15(5): 321-4.

A research study was undertaken to increase understanding of the causes of pressure sore development in regular wheelchair users. This information may help identify whether existing risk assessment tools exclude important information relating to this patient group. A risk assessment tool for regular wheelchair users has been produced, based on the findings of this study, and is being tested for reliability and validity.

Wall, J. and T. Colley (2005). "A study to evaluate factors for inclusion in a new self-assessed risk indicator for persons who use a wheelchair for mobility." Journal of Tissue Viability 15(1): 9-16.

A preliminary analysis of a 2-year prospective study of the health, degree of physical disability and skin integrity of 160 permanently seated persons is presented in this paper. The study was undertaken to inform the development of a self-managed risk assessment tool for the prevention of pressure ulcers in permanently

seated individuals. The results of this study offer further insight into the challenges of pressure ulcer prevention and the role of education and self management in achieving this.

Williams, C. (1997). "The Vicair Academy and Liberty range of pressure-reducing seating." British Journal of Nursing 6(16): 950-3.

Many patients can be sitting in a chair for between 3 and 14 hours each day, consequently the type of cushion they are sitting on is of the utmost importance. These patients are often at high risk of developing pressure sores--possibly more so than bed-bound patients. Vicair, whose UK distributor is Gerald Simonds Healthcare, has developed two types of pressure-reducing cushions: the Vicair Academy and Liberty Fluid-Air. These cushions offer pressure reduction in a system that is user-friendly and particularly lightweight. This product focus highlights the problems associated with seating and explains how the Vicair range of cushions attempts to address them.

Williams, C. (2000). "The Flo-tech Adjuster chair from Medical Support Systems." British Journal of Nursing 9(18): 2044-7.

Pressure ulcer prevention in the seated patient is a neglected area. The early rehabilitation of bed-bound patients has reinforced the need for suitable seating to compliment pressure-reducing mattresses. Medical Support Systems has developed a hospital chair, the Flo-tech Adjuster, which addresses the problems of both pressure ulcer prevention and manual handling. The launch of the Flo-tech Adjuster has followed many years of research and constant refinement and improvement, and has filled a gap in the market for pressure-relieving devices.

Willis, J. (1996). "Pressure relief: a guide to what is on offer." Nursing Times 92(23): 50-2.

Yuen, H. K. and D. Garrett (2001). "Comparison of three wheelchair cushions for effectiveness of pressure relief." American Journal of Occupational Therapy 55(4): 470-5.

OBJECTIVE: Previous studies have suggested that no single wheelchair pressure-relieving cushion material was optimal for all persons with spinal cord injury (SCI). The purpose of this study was to compare the effectiveness of the short-term pressure-relieving ability of the three most commonly prescribed wheelchair cushions (Roho, Jay, Pindot) for a person with SCI. METHOD: The number of pressure sensors registering at the buttock-cushion interface during wheelchair sitting was measured by the Xsensor Pressure Mapping System after 5 min of sitting. An alternating treatments research design, with an initial baseline and a final treatment phase ending with the most effective cushion for relieving pressure, was used for the clinical evaluation. Measurements were compared using visual inspection and a Wilcoxon signed ranks test. RESULTS: Data analyses indicated that the number of pressure sensors that registered potential harmful levels of pressure at the buttock-cushion interface for the Roho cushion was significantly less than those of the Jay and Pindot cushions. CONCLUSION: The Roho cushion was more effective in relieving pressure at the seating surface than the Jay and Pindot cushions.