

## Wounds UK – Pressure Care December Newsletter References

The final pressure ulcer reference list for 2008 was derived from a search on EMBASE looking for references that discussed beds or mattresses and pressure ulcers.

Allen, V., D. W. Ryan, et al. (1994). "Measurements of interface pressure between body sites and the surfaces of four specialised air mattresses." *British Journal of Clinical Practice* 48(3): 125-129.

Four specialised air mattresses had interface pressure measured under six body sites prone to pressure sores in 10 subjects, supine and sitting. The mattresses were the Clinirest (SSI) and FirstStep (KCI) continuous airflow mattress overlays, and Airwave (Pegasus) and Nimbus (Huntleigh) alternating pressure air mattresses. On the mattress overlays, average supine interface pressures were 2.33 kPa (scapula), 4.15 kPa (elbow), 1.94 kPa (sacrum) and 2.79 kPa (buttock), although they were higher at the occiput (7.97 kPa) and heel (11.7 kPa). The alternating pressure air mattresses had an average minimum interface pressure close to zero for three sites, rising to 4.28 kPa under the heel. Average maximum interface pressures were 8.61 kPa (occiput), 5.21 kPa (scapula), 4.90 (elbow), 4.85 kPa (sacrum), 4.61 kPa (buttock) and 13.2 kPa (heel). No accepted scientific method exists for comparing the two types of mattress. Our data suggest a clinical benefit at the occiput and heel (supine) in using an alternating pressure air mattress and a benefit in using a continuous airflow mattress overlay at other sites.

Andersen, K. E., O. Jensen, et al. (1983). "Decubitus prophylaxis: A prospective trial on the efficiency of alternating-pressure air-mattresses and water-mattresses." *Acta Dermato-Venereologica* 63(3): 227-230.

Six hundred patients at risk for pressure sores were randomized in either a control group or one of two experimental groups placed on alternating-pressure air-mattresses and water-mattresses. The groups remained comparable throughout the 10-day study period. Twenty-one patients from the control group developed decubitus ulcers, compared with 7 in each of the other groups. Patient and ward personnel opinions on the acceptability of the three types of mattresses were registered.

Baeke, J. L. (2001). "More about the superiority of pegasus "zero-pressure" mattresses [8]." *Plastic and Reconstructive Surgery* 107(7): 1917-1918.

Barbenel, J. C., M. W. Ferguson-Pell, et al. (1985). "Monitoring the mobility of patients in bed." *Medical and Biological Engineering and Computing* 23(5): 466-468.

A method of detecting and logging movements made on King's Fund hospital beds is described. The results of such mobility measurements indicate that during the first three nights after admission there is a progressive alteration in the number of movements made by elderly hospital patients. The group of patients clinically assessed as being at risk of developing pressure sores, or receiving sedatives, made a reduced number of movements.

Berjian, R. A., H. O. Douglass Jr, et al. (1983). "Skin pressure measurements on various mattress surfaces in cancer patients." *American Journal of Physical Medicine* 62(5): 217-226.

Twenty-eight patients with histologically proven carcinoma were studied on two dynamic and six static mattress surfaces to determine which mattress surface would provide the least skin surface pressure at the sacrum, dorsal spine, trochanter and heels. Measurements were taken with an especially designed inflatable bladder, and the mean of the maximum skin surface pressures was determined for the static and dynamic surfaces in the inflated and deflated state. Using [less-than or equal to]32 mm Hg as the skin surface pressure at which the arteriolarcapillary blood flow is interrupted, we concluded that the mud gel bed generally tended to record the lowest skin surface pressure for all of the sites. Although some of the static surfaces recorded pressure [less-than or equal to]32 mm Hg at the sacrum and dorsal spine, the deflated dynamic surfaces were superior to the remaining static surfaces in reducing the skin surface pressures.

Berlowitz, D. R. and S. V. B. Wilking (1989). "Risk factors for pressure sores. A comparison of cross-sectional and cohort-derived data." *Journal of the American Geriatrics Society* 37(11): 1043-1050.

The purpose of this study was to identify prospectively risk factors for pressure sores and to compare these results with a cross-sectional analysis in the same population. Medical records on all admissions to a chronic care hospital over a 13-month period were reviewed. Data on potential risk factors were abstracted from the initial history, physical examination, nursing assessment, and laboratory studies. Pressure sore status on admission and at three weeks was determined from a standardized form completed on all patients with a sore. The cross-sectional analysis was performed by comparing patients with and without a pressure sore at the time of admission. The cohort analysis used patients initially without a pressure sore and monitored for a new sore at three weeks. Factors associated with pressure sores on univariate testing were entered into a stepwise logistic regression model. One hundred of the 301 admissions presented with a pressure sore. Factors significantly associated with the presence of a sore were altered level of consciousness (OR = 4.1), bed- or chair-bound (OR = 2.4), impaired nutritional intake (OR = 1.9), and hypoalbuminemia (OR = 1.8 for 10 mg/mL decrease). Of the 185 patients without a pressure sore, 20 (10.8%) developed a sore. Factors significantly associated with the development of a new pressure sore were a history of cerebrovascular accident (OR = 5.0), bed- or chair-bound (OR = 3.8), and impaired nutritional intake (OR = 2.8). Neither urinary nor fecal incontinence, nor the presence of hypoalbuminemia, was associated with sore development. We have prospectively identified risk factors for pressure sores. Although cross-sectional studies may identify several of these risk factors, important differences exist. Cohort studies should be used in future research.

Biesecker, J. E., H. L. Thomas Jr, et al. (1995). "Innovations in the design and performance of underpads for patients with burns." *Journal of Burn Care and Rehabilitation* 16(1): 65-73.

The purpose of this study was to determine the biomechanical performance of commercially available underpads and bed linens to reduce the development of pressure sores patients with burns who are at high risk. The three biomechanical performance

parameters examined were coefficient of friction, absorbent capacity, and rewet. Because wetting either cotton or cotton/polyester bedsheets markedly increases their coefficients of friction, underpads should be used routinely to protect the skin against frictional forces. One disposable underpad is ideally suited to protect the skin of the patient at high risk. It has a polyolefin backing with a low coefficient of friction that serves as an effective barrier to moisture transmission while still shifting easily with the patient's movement. In addition, it is the only underpad studied that contains a superabsorbent polymer that provides a far superior absorbent capacity and minimizes rewet. Wet-back is further inhibited by its thick intermediate tissue layer and its spunbonded polypropylene coverstock.

Bliss, M. R. and H. P. Henderson (1995). "Pressure sores [7]." *British Medical Journal* 310(6972): 126.

Chin, T., H. Hyakusoku, et al. (2003). "A contrivance of a new irrigation system for decubitus at the bedside. [Japanese]." *Japanese Journal of Plastic and Reconstructive Surgery* 46(9): 936-938.

Chronakos, J. and D. M. Nierman (2003). "Managing pressure ulcers in critically ill patients." *Journal of Respiratory Diseases* 24(8): 365-371.

Critically ill patients are at increased risk for the development of decubitus ulcers as a result of impaired mobility, blunted sensation, and decreased serum albumin levels. Therefore, patients in the ICU need careful daily inspection of skin for early evidence of breakdown, with special attention to pelvic, sacral, elbow, and heel areas. Existing ulcers should be examined and staged. Preventive measures that can reduce the potential for decubitus ulceration include repositioning every 2 hours and minimization of friction and shear forces. Special bedding options range from foam to air-fluidized beds. For established ulcers, nutritional supplementation with ascorbic acid or zinc appears to promote healing. Mechanical, chemical, and surgical debridement are options for deeper wounds. Exogenous cytokines are useful adjuncts to medical and surgical care. Growth factors and cultures of human keratinocytes may have an expanded role in the future.

Clark, M. and J. Andrews (1991). "Comparison of interface pressures measured at the sacrum while resting upon two types of foam mattresses and between Platilon and plastic mattress covers." *Age and Ageing* 20(4): 267-270.

We investigated the pressure-redistributing characteristics of a 5-inch foam mattress compared with the Clinifloat slotted mattress fitted with a Platilon cover or with a tight-fitting plastic cover. We confirmed earlier work showing that a loose-fitting cover is necessary for the effectiveness of the slotted mattress.

Couturier, P., A. Franco, et al. (1996). "Body actimetry to warn of pressure sores [27]." *Lancet* 347(9001): 627.

Cristina Nogueira, P., M. H. L. Caliri, et al. (2002). "Risk factors and prevention of pressure ulcer in spine cord injury patients. Experience of members of nursing team at FMRP - USP hospital. [Portuguese]." *Medicina* 35(1): 14-23.

Pressure ulcers are frequent in spinal cord patients and can bring complication as osteomyelitis, sepsis, amputation and even death. It interferes on quality of life of patients and families and brings difficulties for rehabilitation access. Being that, prevention or treatment in their initial stages needs to be the goals of a quality care. This study had as objectives to identify the causes of pressure ulcer in spinal cord injury patients and to describe prevention measures considered important as seen by professional nurses, nurses technicians and nurses auxiliaries, members of nursing team on an university hospital in Brazil. Through a survey, data was collected using an validated instrument containing 35 phrases descriptors of risk factors and 18 descriptors of preventive interventions. Each of 85 participants gave a value from 1 to 7 to the importance of the item and mean, standard deviation analysis of variance was calculated. The results of descriptive analysis and inferential statistics showed that the nursing team identified as important factors related to patient, to institutional structure and process of care. By their perception patients with spinal cord injury present immobility and impaired sensory perception, being dependent for mobilization. The process and structure of care does not respond to this need so the turning of patient is not rigorously done and bed mattress are not adequate what causes an excess of pressure on bone prominence. After discharge, the problem continues as families do not have enough knowledge and do not care adequately. Related to preventive measures there were differences between professional nurses and nurses technicians/auxiliaries. The former considered every measure as important but nurses technicians and auxiliaries did not and discrepancies were found between what they see as causes for pressure ulcer and what they consider important as preventive measures to minimize the problem.

Daechsel, D. and T. A. Conine (1985). "Special mattresses: Effectiveness in preventing decubitus ulcers in chronic neurologic patients." *Archives of Physical Medicine and Rehabilitation* 66(4): 246-248.

Thirty-two chronic neurologic patients between 19 and 60 years of age were randomly assigned, for a period of three months, to either an alternating air mattress or a silicore mattress to test the preventive qualities of special mattresses in the occurrence of decubitus ulcers. The two groups were comparable on the variables of age, weight, diagnoses, history of disease process, history of being wheelchair bound, history of previous pressure, and mean scores on Norton's scale of risk, which is based on the subject's physical conditions, mental alertness, ambulation, mobility and incontinence. No significant differences were observed in the preventive qualities of the two types of special mattresses in terms of the incidence, location, severity, or healing duration of the subjects' decubitus ulcers. Improved studies of common special mattresses are suggested.

Edlich, R. F., K. L. Winters, et al. (2006). "Scientific basis for the selection of absorbent underpads that remain securely attached to underlying bed or chair." *Journal of Long-Term Effects of Medical Implants* 16(1): 29-40.

The occurrence of pressure ulcers in patients is very high in certain high-risk groups. These special high-risk groups include elderly patients, patients with spinal cord injuries, or any individual with an impaired ability to reposition. Prevention of pressure ulcers is by far the best treatment of this condition, warranting certain interventions and preventive measures. One major risk factor to be minimized is the exposure of skin to

moisture. Underpads are often used to protect the skin of patients who are incontinent. These products effectively absorb moisture and present a quick-drying surface to the skin. The construction of an underpad should accomplish three goals. First, its backing should have a low coefficient of friction to prevent frictional skin injuries. Second, an inner absorbent core should rapidly contain moisture and disseminate it throughout the entire pad. Third, the core and coverstock should successfully work together to retain moisture and prevent wet-back or fluid return. The purpose of this study was to determine the performance of three commercially available underpads in reducing the development of pressure sores in patients at high risk. In this study we selected three underpads that could be securely attached to either the underlying bed or the chair. The three performance parameters examined were absorbent capacity, wet-back prevention, and holding security of the underpads. Measurements of these performance parameters can be easily replicated in other laboratories. The results of these studies provide a scientific basis for selecting and purchasing an underpad to prevent pressure ulcers in patients. In this comprehensive evaluation, we assess an absorbent underpad with polyethylene flaps and two absorbent underpads with adhesive. The absorbent capacity results showed Tranquility SlimLine Peach Sheet to be the most absorbent. The wet-back results showed Tranquility SlimLine Peach Sheet to be the only underpad with no wet-back, with no fluid returning through the coverstock. The Tranquility SlimLine Peach Sheet Underpad has four adhesive strips attached to each of the four ends of the underpad surface. These 5 cm long strips secure well to the seat of a wheelchair or chair. In contrast, they do not maintain secure attachment to a bed sheet, making the bed sheet vulnerable to urine or stool penetration. When the clinical staff used the Tuckable<sup>®</sup> on the bed surface, they were all impressed by the secure fit of the plastic wings, which easily tucked around the mattress. The wings remained in place throughout the night. Realizing the stability of the Tuckable<sup>®</sup> underpads, the clinical staff suggested that the Tuckable<sup>®</sup> underpad be placed first on the bed, then the Tranquility SlimLine Peach Sheet can be placed on top of the Tuckable<sup>®</sup> underpad, using the four adhesive strips to attach it to the surface of the Tuckable<sup>®</sup> underpad. All of the staff were impressed that the adhesive strips remained securely attached to the Tuckable<sup>®</sup>. This clinical decision was found to be very cost efficient, because the Tuckable<sup>®</sup> could remain in place more than a week without changing. Even though we have developed a unique scientific basis for the selection of underpads for use on either chairs or beds, it can be a financial challenge to the patient or healthcare setting to use these products, because Medicare provides no reimbursement for underpads, an invitation to pressure ulcer formation. In the absence of responsible federal government policy, we are making recommendations for the selection of a cost-conscious and responsible company that sells incontinence products - Home Deliver Incontinent Supplies Co., Inc., (HDIS), Olivette, Missouri. copyright 2005 by Begell House, Inc.

Ferrell, B. (1990). "Low-air-loss beds improve rate of healing for decubitus ulcers." *American Family Physician* 42(2): 444.

Ferrell, B. A., D. Osterweil, et al. (1993). "A randomized trial of low-air-loss beds for treatment of pressure ulcers." *Journal of the American Medical Association* 269(4): 494-497.

Objective. - To assess the effectiveness of low-air-loss beds for the treatment of pressure ulcers in nursing homes. Design. - Prospective, randomized, clinical trial. Setting. - Three teaching nursing homes in Los Angeles, Calif. Subjects. - Eighty-four nursing home residents with trunk or trochanter pressure ulcers (Shea stage [greater-than or equal to]2). Interventions. - Subjects were randomly assigned to use either a low-air-loss bed (n=43) or a 10-cm corrugated foam mattress (n=41) throughout the healing of their ulcers. Outcome Measures. - Ulcers were assessed twice weekly using surface area and two observational scales (median follow-up, 37.5 days; range, 4 to 571 days). Results. - Groups were similar with respect to demographics, medical variables, wound care, and early dropouts. Results indicate more than a threefold improvement in median rate of healing for low-air-loss beds compared with foam mattresses (9.0 vs 2.5 mm<sup>2</sup>/d; P=.0002). This finding was true for deep as well as superficial ulcers (deep ulcers, 9.9 vs 0.7 mm<sup>2</sup>/d; P=.02; superficial ulcers, 9.0 vs 3.2 mm<sup>2</sup>/d; P=.004). Cox regression models revealed that the bed, ulcer depth, and fecal continence had independent effects on healing. After controlling for fecal continence, the deep and superficial subgroups using low-air-loss beds remained 2.5 times more likely to heal in a given length of time compared with those using foam mattresses (combined cure probability ratio, 2.66; 95% confidence interval, 1.34 to 5.17; P<.004). Conclusion. - Low-air-loss beds provide substantial improvement compared with foam mattresses despite other factors in pressure ulcer healing.

Finnegan, M. J., L. Gazerro, et al. (2008). "Comparing the effectiveness of a specialized alternating air pressure mattress replacement system and an air-fluidized integrated bed in the management of post-operative flap patients: A randomized controlled pilot study." *Journal of Tissue Viability* 17(1): 2-9.

Frantz, R. A. and G. C. Xakellis (1989). "Characteristics of skin blood flow over the trochanter under constant, prolonged pressure." *American Journal of Physical Medicine and Rehabilitation* 68(6): 272-276.

Although laboratory studies have documented that externally applied pressure disrupts circulation, in clinical practice little is known about the characteristics of blood flow over bony prominences as a function of time. The purpose of this study was to describe the pattern of blood flow over the trochanter when subjected to a constant interface pressure for a prolonged period of time. A quasi-experimental design was used to measure skin blood flow over the left trochanter in a sample of 19 healthy adults. With the use of laser doppler flowmetry, the pattern of blood flow was monitored continuously while subjects lay on a supportive air mattress. Measurement of blood flow was described for three periods: preload with subjects supine, loading with subjects in the left lateral position and hyperemia after subjects returned to the supine position. Rate of blood flow under loading showed a gradual increase from preload. There was a marked initial increase in flow during hyperemia that gradually tapered off, but failed to reach preload levels within 30 min. Individual blood flow tracings revealed an inconsistent pattern of response to loading, suggesting the presence of a range of physiological response to compressive surface pressure. Given the individual variation in response to a common external pressure, further research is recommended to evaluate the pattern of blood flow over bony prominences subjected to known interface pressure.

Garcia Fernandez, F. P., P. L. Pancorbo Hidalgo, et al. (2006). "Resources for prevention and treatment of pressure ulcers: The situation in Andalusia (Spain). [Spanish]." *Gerokomos* 17(1): 47-57.

Objectives: To quantify the availability of material resources for Pressure ulcers (PU) prevention and treatment in health care centres from Andalusia (Spain). Methods: Eleven hospitals, 36 primary care centres and 14 nursing homes were included by random stratified sampling. All the centres belonged to the public health or social services of Andalusia (Spain). A self-administered questionnaire was send out to nursing managers of the units or centres. The questionnaire has questions about epidemiological index, protocols, risk assessment scales, specific record use and materials and products for prevention and local treatment of PU. A descriptive analysis of the results was carried out. Results: Sixty valid questionnaires were obtained (response rate was 65,9%). A 100% of the nursing homes, a 96,4% of the hospital units and a 9,5% of the primary care centres have some unit of pressure-relief surfaces (PRS). Nursing homes are the best equipped centres (with static and dynamic PRS, and also for bed and chair); in hospital units the equipment is very variable between hospitals; while primary care centres lack this devices. The most usual PRS are static mattresses and overlays and air overlays. Products for local prevention most commonly used are: moisturizing milks and hyper-oxygenated fatty acids; although some centres are still using iodine povidone for this purpose. On the matter of PU treatment, the nurse who care the patient mostly decides the product to use. For cleaning the ulcer almost all the centres have the saline solution, however an important number of centres consider also several antiseptics as PU cleaning products. The number of dressings and products available is higher in nursing homes (8 products as average) than in hospitals (4 products as average). Products and dressing available in most centres are: hydrocolloids, hydrogels, topical antibiotics, healing cream and enzymatic cream. Conclusions: The availability of prevention resources, such as PRS, is good in nursing homes, but insufficient, in quantity and in kind of support surfaces, in many hospital units. Primary care centres have not this devices. Products for PU prevention and treatment available in hospitals and nursing homes fit in with guidelines current recommendations: nevertheless, antiseptics are still been used for PU prevention and cleaning in some few centres. All the centres have dressings for treatment of wounds in moist environment. The types of dressings first marketed are present in more centres. The range of dressings available in hospitals is small, whereas in nursing homes is wider.

Goetz, L. L., G. S. Brown, et al. (2002). "Interface pressure characteristics of alternating air cell mattresses in persons with spinal cord injury." *Journal of Spinal Cord Medicine* 25(3): 167-173.

Objectives: To examine interface pressure characteristics for two alternating air cell mattresses used for pressure ulcer prevention and treatment in a spinal cord injury population. Design: Prospective evaluation of Dynamic Flotation System (DFS) mattress and the Pegasus Airwave Mattress. Subjects acted as their own controls. Setting: Veterans Affairs Medical Center Spinal Cord Injury Unit. Participants: Convenience sample of 15 subjects with spinal cord injuries. Interventions: Minimum, maximum, and average interface pressures, and interface pressure range were measured by use of a force-sensing array system. The sacrum was chosen as the area of interest. Recordings

lasted 9.5-10 minutes. Analyses were performed on 19 subjects in the supine and 45-degree upright positions for both mattresses. Results: Maximum and average interface pressures and interface pressure ranges were significantly higher, whereas minimum interface pressures were significantly lower on the Pegasus vs the DFS. For either mattress, the 45-degree position resulted in significantly greater interface pressures. There was no consistent correlation found between interface pressures and body mass index. Conclusions: Interface pressure characteristics of these two mattresses are very different, and neither mattress retains performance in the 45-degree position. Which interface pressure characteristic is most clinically relevant remains undetermined. Avoidance of the 45-degree sitting position is recommended.

Goossens, R. H. M. and C. J. Snijders (1995). "Design criteria for the reduction of shear forces in beds and seats." *Journal of Biomechanics* 28(2): 225-230.

Both with respect to the aspect of pressure sores and of comfort, the inclination of backrest and seat are, amongst other factors, important design criteria. In this study the combination of seat and backrest inclination which reduces shear forces on the seat in passive seating forms the centre of attention. A biomechanical model was developed to predict these combinations and a new measurement apparatus was used for verification of the model on 10 healthy subjects (age 24.4 S.D. 2.1 yr, height 1.77 S.D. 0.08 m, mass 66.3 S.D. 11 Kg). For chairs it was found that when little shear is accepted, a fixed inclination between seat and backrest can be chosen between 90degrees and 95degrees. For beds a parabolic relationship was found between seat and backrest inclination with a maximum seat inclination of 20degrees at a backrest inclination of 50degrees. When lying with the knees bent to a position with equal inclination of thighs and shanks, the model predicts a shear force on the seat that shoves the person into the bed for every combination of seat and backrest inclination.

Gotte, H. J. and T. Vaterrodt (1998). "Patients in the minimally conscious state ('Wachkoma') - Positioning systems in practice. [German]." *Rehabilitation* 37(4): 177-180.

With a view to optimizing the positional management of patients with severe neurological damage, five positioning systems with different operating principles were submitted to suitability trials in a clinical neurological rehabilitation setting. The patients included were in the 'Wachkoma', the minimally conscious state (i.e., in neurological early rehabilitation phase B). The experience collected by the various professions involved in positional management over a trial period of six months is summarized in the present report, indicating that none of the positioning systems used has been suitable for all patients alike. Hence, various items were compiled in a checklist to enable better estimation of each system's suitability in light of the individual patient, with muscle tone, body weight, skin condition, degree of mobilization and spontaneous movement the essential criteria in patient assessment. This checklist now permits identifying the positioning systems suitable for the individual patient in an economical manner, and lengthy positioning trials can be dispensed with to a large extent.

Grey, J. E., S. Enoch, et al. (2006). "Pressure ulcers." *British Medical Journal* 332(7539): 472-475.

Haalboom, J. R. E. (1994). "Anti-decubitus mattresses. [Dutch]." *Nederlands Tijdschrift voor Geneeskunde* 138(26): 1309-1310.

Haalboom, J. R. E. (2000). "The guideline 'Decubitus' [pressure ulcer] of the Dutch College of General Practitioners; reaction from internal medicine. [Dutch]." *Nederlands Tijdschrift voor Geneeskunde* 144(14): 645-646.

The guideline on pressure ulcers by the Dutch College of General Practitioners is good in the aspects of simplicity and giving very practical advice. It can be used as a guideline for prevention as well as treatment of pressure ulcers. Some aspects, however, are insufficiently dealt with. There is no summing up of the differences in anti-pressure ulcer devices such as mattresses and cushions. Use is made of the international classification of pressure ulcers in 4 stages, but also of a kind of rating in three colours (red-yellow-black), of which it is known that it underestimates the severity of pressure ulcers. There is an advice to use the knowledge of surgeons, dermatologists and nursing home doctors in difficult cases in the home care, where training and deployment of nurses specialised in this specific field might be preferable. Nevertheless, the guideline is well documented and useful in general practice.

Hamers, J. P. H. and A. R. Huizing (2005). "Why do we use physical restraints in the elderly?" *Zeitschrift für Gerontologie und Geriatrie* 38(1): 19-25.

The use of physical restraints in the elderly is a common practice in many countries. This paper summarizes the current knowledge on the use of restraints in home care, hospitals and nursing homes. Between 1999-2004 the reported prevalence numbers range from 41-64% in nursing homes and 33-68% in hospitals; numbers of restraint use in home care are unknown. Bed rails and belts have been reported as the most frequently used restraints in bed; chairs with a table and belts are the most frequently reported restraints in a chair. It is evident that physical restraints in most cases are used as safety measures; the main reason is the prevention of falls. In the hospital setting, the safe use of medical devices is also an important reason for restraint use. Predictors for the use of physical restraints are poor mobility, impaired cognitive status and high dependency of the elderly patient and the risk of falls in the nurses' opinion. Furthermore, there are indications that restraint use is related to organizational characteristics. Finally, many adverse effects of restraint use have been reported in the literature, like falls, pressure sores, depression, aggression, and death. Because of the adverse effects of restraints and the growing evidence that physical restraints are no adequate measure for the prevention of falls, measures for the reduction of physical restraints are discussed and recommendations are made for future research. copyright Steinkopff Verlag 2005.

Hedman, T. L., T. T. Chapman, et al. (2007). "Two simple leg net devices designed to protect lower-extremity skin grafts and donor sites and prevent decubitus ulcer." *Journal of Burn Care and Research* 28(1): 115-119.

Burn therapists routinely are tasked to position the lower extremities of burn patients for pressure ulcer prevention, skin graft protection, donor site ventilation, and edema reduction. We developed two durable and low-maintenance devices that allow effective positioning of the lower extremities. The high-profile and low-profile leg net devices were simple to fabricate and maintain. The frame was assembled using a three-

quarter-inch diameter copper pipe and copper fittings (45 degrees, 90 degrees, and tees). A double layer of elasticized tubular netting was pulled over the frame and doubled back for leg support to complete the devices. The devices can be placed on any bed surface. The netting can be exchanged when soiled and the frame can be disinfected between patients using standard techniques. Both devices were used on approximately 250 patients for a total of 1200 treatment days. No incidence of pressure ulcer was observed, and graft take was not adversely affected. The devices have not required repairs or replacement. Medical providers reported they are easy to apply and effectively maintain proper positioning throughout application. Neither device interfered with the application of other positioning devices. Both devices were found to be an effective method of positioning lower extremities to prevent pressure ulcer, minimize graft loss and donor site morbidity, and reduce edema. The devices allowed for proper wound ventilation and protected grafted lower extremities on any bed surface. The devices are simple to fabricate and maintain. Both devices can be effectively used simultaneously with other positioning devices. copyright 2007 The American Burn Association.

Hofman, A., R. H. Geelkerken, et al. (1994). "Pressure sores and pressure-decreasing mattresses: Controlled clinical trial." *Lancet* 343(8897): 568-571.

Pressure sores are a problem, especially in elderly patients. Our study was designed to determine the effectiveness in pressure-sore prevention of a new interface-pressure decreasing mattress. In a prospective randomised controlled clinical trial we tested the Comfortex DeCube mattress (Comfortex, Winona, USA) against our standard hospital mattress in 44 patients with femoral-neck fracture and concomitant high pressure-sore risk score. In addition both groups were treated according to the Dutch consensus protocol for the prevention of pressure sores. On admission and 1 and 2 weeks after admission, pressure sores were graded. The two groups were similar in patient characteristics and pressure-sore risk factors. At 1 week, 25% of the patients nursed on the DeCube mattress and 64% of the patients nursed on the standard mattress had clinically relevant pressure sores (grade 2 or more). At 2 weeks the figures were 24% and 68%, respectively). The maximum score over the several body regions of the pressure-sore grading, measured on a 5-point scale, was significantly different in favour of the DeCubed mattress at 1 week ( $p = 0.043$ ) and 2 weeks ( $p = 0.0067$ ) postoperatively. We show that the occurrence of pressure sores and their severity can be significantly reduced when patients at risk are nursed on an interface-pressure decreasing mattress.

Holscher, T. G., R. H. M. Goossens, et al. (1994). "A new low-cost anti-decubitus mattress for home care: Requirements and development." *Journal of Rehabilitation Sciences* 7(2): 53-58.

An anti-decubitus mattress is introduced. Primary requirements were low costs, low pressure and shear in lying and sitting, favourable heat and humidity exchange and adaptation to body weight. The different media a mattress may consist of, are described. After analysis of physical properties air has been chosen because of equally distributed pressure along the body contour. Details of the construction of the mattress and the control system are described. A market research revealed that the price of the complete system has to be lower than Dfl 5000 (approximately US\$ 3000). The present article describes how one of the main goals of the research has been achieved: a low-cost

mattress. In part 2 pressure and shear are analysed in lying and sitting and a comparison is made with cheap as well as expensive anti-decubitus mattresses.

Holscher, T. G., R. H. M. Goossens, et al. (1995). "A new low-cost anti-decubitus mattress for home care a comparison with other mattresses." *Journal of Rehabilitation Sciences* 8(3): 72-75.

Introduction. The aim of the study was to compare a new anti-decubitus mattress with other low-cost mattresses. Methods. Interface pressure measurements were made in supine and in sitting position. Results. The new mattress has significant lower interface pressures than other low-cost mattresses in both positions, and that there is no significant difference with an expensive anti-decubitus bed like the air-fluidized type. Measurements of shear between body and cover show that the shear is far below 10 kPa. This limit is known as a limit above which shear may play an important role in the causation of decubitus ulcers. Conclusion. The goals of the research have been achieved: the development of a low-cost anti-decubitus mattress with, in supine position, interface pressures comparable to the well-known and expensive beds; in sitting position interface pressures are also below the capillary pressure of 4.2 kPa.

Hook, O., L. Gabrielsson, et al. (1982). "Prophylaxis and treatment of decubitus ulcers with a rocking bed." *Scandinavian Journal of Rehabilitation Medicine* 14(1): 33-37.

In order to prevent pressure sores a new rocking bed has been devised. It has a frame on which beds of different sizes can be put. This rocking bed thus can be used in hospitals as well as homes.

Husserl, F. E. (1998). "A novel use of spent peritoneal dialysis bags: An inexpensive waterbed [4]." *Peritoneal Dialysis International* 18(6): 657.

Iglesias, C., J. Nixon, et al. (2006). "Pressure relieving support surfaces (PRESSURE) trial: Cost effectiveness analysis." *British Medical Journal* 332(7555): 1416-1418.

Objective: To assess the cost effectiveness of alternating pressure mattresses compared with alternating pressure overlays for the prevention of pressure ulcers in patients admitted to hospital. Design: Cost effectiveness analysis carried out alongside the pressure relieving support surfaces (PRESSURE) trial; a multicentre UK based pragmatic randomised controlled trial. Setting: 11 hospitals in six UK NHS trusts. Participants: Intention to treat population comprising 1971 participants. Main outcome measures: Kaplan Meier estimates of restricted mean time to development of pressure ulcers and total costs for treatment in hospital. Results: Alternating pressure mattresses were associated with lower overall costs ([pounds]283.6 per patient on average, 95% confidence interval - [pounds]377.59 to [pounds]976.79) mainly due to reduced length of stay in hospital, and greater benefits (a delay in time to ulceration of 10.64 days on average, - 24.40 to 3.09). The differences in health benefits and total costs for hospital stay between alternating pressure mattresses and alternating pressure overlays were not statistically significant; however, a cost effectiveness acceptability curve indicated that on average alternating pressure mattresses compared with alternating pressure overlays were associated with an 80% probability of being cost saving. Conclusion: Alternating

pressure mattresses for the prevention of pressure ulcers are more likely to be cost effective and are more acceptable to patients than alternating pressure overlays.

Kano, K., M. Muto, et al. (1995). "Prevalence of methicillin-resistant *Staphylococcus aureus* in relation to the disease and risk factors. [Japanese]." *IRYO - Japanese Journal of National Medical Services* 49(2): 124-127.

The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) was determined in relation to the disease and four risk factors (being bedridden, tubal feeding, decubitus, vesical indwelling catheterization) selected mainly from ADL (activities of daily living) in a National Sanatorium where bedridden inpatients of advanced age were common. It was found that 14.8% of all inpatients were positive for MRSA, and that 63.4% of the positive patients were bedridden. This indicates that the prevalence of MRSA is particularly among bedridden patients of advanced age.

Keong, N., D. Ricketts, et al. (2004). "Pressure sores following elective total hip arthroplasty: Pitfalls of misinterpretation." *Annals of the Royal College of Surgeons of England* 86(3): 174-176.

Objective: To assess the reliability of reporting protocols regarding pressure sores. Methods: Retrospective data were collected regarding pressure sore rates following total hip arthroplasty operations carried out during 2001 at two orthopaedic units in an NHS hospital (Princess Royal Hospital) and in a local private hospital. Results: Preliminary results presented in audit and interim reports indicated an alarmingly high pressure sore rate across the two sites (17/172 [9.9%] NHS, 23/71 [32.4%] private hospital). On analysis, the data collection system was revealed to be flawed. Grade 1 areas (erythema with no ulceration) were included, leading to a dramatic discrepancy between reported and confirmed pressure sores. Re-analysis showed the confirmed pressure sore rates to be much lower (2.3% NHS, 1.0% private hospital). Conclusions: This audit suggests that both poor data collection and education lead to inaccurate audit. This may lead to subsequent inappropriate management and inappropriate NHS star ratings.

Kondoyannis, P. and E. Niotis (1979). "'Sand Bed'. [Greek]." *Hellenic Armed Forces Medical Review* 13(2): 261-263.

A new type of bed is reported for the prevention of decubitus ulcers on patients who are bed-ridden for a prolonged time. The authors describe the advantages and disadvantages of the 'Sand Bed' in connection with the usual nursing of these patients, and the indications as well as contraindications of the 'Sand Bed'.

Krouskop, T. A., R. Williams, et al. (1985). "Effectiveness of mattress overlays in reducing interface pressures during recumbency." *Journal of rehabilitation R&D* 22(3): 7-10.

This study evaluates the pressure-reduction characteristics of seven mattress overlays. Thirty subjects were evaluated on each support surface to determine the interface pressures that are generated under the most common pressure sore sites. The results of this study indicate that there is great variability in the effectiveness of traditional mattress overlays. The most effective overlays are the Roho and Akros DFD mattresses; whereas 2-inch thick convoluted foam provides no significant protection for the trochanter when the subjects were lying on their sides (lateral position).

Lepisto, M., S. Lauri, et al. (2004). "Pressure ulcer patients in long-term care. A follow-up study." *Reviews in Clinical Gerontology* 14(2): 91-103.

Lieverse, R. J. (1990). "Death after concealed hemorrhage in patients on a Clinitron bed. [Dutch]." *Nederlands Tijdschrift voor Geneeskunde* 134(49): 2402-2403.

McNabb, L. J. and J. Hyatt (1987). "Effect of an air-fluidized bed on insensible water loss." *Critical Care Medicine* 15(2): 161-162.

Air-fluidized beds are increasingly used for patients with burns, decubitus ulcers, trauma, and generalized debility (1-5). Fluidized beds provide a medium that is more dense than water for patients to float on by pumping air through silicone-coated microspheres separated from the patient by a monofilament polyester sheet. A continuous stream of warm air flowing across the patient increases insensible evaporative water loss and may lead to dehydration. The air-fluidized bed has a wide range of operating temperatures (82degrees to 102degreesF), but surprisingly few data are available on the amount of water loss at different bed temperatures. This lack of information is probably secondary to difficulties in obtaining accurate fluid balance measurements in patients (6). Our objective was to construct a nomogram of insensible water loss for the fluidized bed using healthy volunteers under controlled conditions. We then prospectively compared this nomogram to data obtained from hospitalized patients.

Morris, A. M. (1990). "Prevention of pressure sores." *Lancet* 336(8709): 260.

Neuhauser, G. (2003). "Water beds for babies. [German]." *Padiatrische Praxis* 64(1): 46.

Nicholson, G. P., J. T. Scales, et al. (1999). "A method for determining the heat transfer and water vapour permeability of patient support systems." *Medical Engineering and Physics* 21(10): 701-712.

The formation of pressure ulcers can be exacerbated by a breakdown in the integrity of the patient's skin caused by poor maintenance of the skin microclimate. Patient support systems (PSSs - specialised beds, mattresses, chairs, cushions and pads) play an important role in the dissipation of heat and moisture away from the skin/support interface which is necessary in order to maintain the physiological skin microclimate. This paper reports a laboratory method and theory for the simultaneous measurement of the heat and water vapour dissipating properties of PSSs. The results demonstrate that the method is extremely selective, exhibiting very significant differences between the PSSs tested. It also shows that assessing PSS covers independently does not necessarily indicate the overall performance of the complete PSS. (C) 2000 IPEM.

Nicol, K. and D. Rusteberg (1993). "Pressure distribution on mattresses." *Journal of Biomechanics* 26(12): 1479-1486.

Measurements of pressure distribution are usually performed on a hard base, such as those in gait analysis or tire research; measurements on soft surfaces are avoided because of technical problems. A sensor mat was developed which consists of 512 pressure sensors, glued to arbitrary locations of a fabric. The mat can be bent to spherical

and saddle shapes so that it can be utilised on soft and flexible surfaces like chairs and beds. Performance of eight hospital mattresses concerning decubitus prophylactics and support in supine and side position was studied in four subjects representing extreme body build. It was found that one particular mattress served well for three subjects, whereas no mattress was suitable for the high and heavy type. It was concluded that measurement of pressure distribution is a valuable tool for designing and selecting.

Nixon, J., G. Cranny, et al. (2006). "Randomised, controlled trial of alternating pressure mattresses compared with alternating pressure overlays for the prevention of pressure ulcers: PRESSURE (pressure relieving support surfaces) trial." *British Medical Journal* 332(7555): 1413-1415.

Objective: To compare whether differences exist between alternating pressure overlays and alternating pressure mattresses in the development of new pressure ulcers, healing of existing pressure ulcers, and patient acceptability. Design: Pragmatic, open, multicentre, randomised controlled trial. Setting: 11 hospitals in six NHS trusts. Participants: 1972 people admitted to hospital as acute or elective patients. Interventions: Participants were randomised to an alternating pressure mattress (n = 982) or an alternating pressure overlay (n = 990). Main outcome measures: The proportion of participants developing a new pressure ulcer of grade 2 or worse; time to development of new pressure ulcers; proportions of participants developing a new ulcer within 30 days; healing of existing pressure ulcers; and patient acceptability. Results: Intention to treat analysis found no difference in the proportions of participants developing a new pressure ulcer of grade 2 or worse (10.7% overlay patients, 10.3% mattress patients; difference 0.4%, 95% confidence interval -2.3% to 3.1%, P = 0.75). More overlay patients requested change owing to dissatisfaction (23.3%) than mattress patients (18.9%, P = 0.02). Conclusion: No difference was found between alternating pressure mattresses and alternating pressure overlays in the proportion of people who develop a pressure ulcer.

Parish, L. C. and P. T. Lowthian (2008). "Dilemmas about the decubitus ulcer: Skin-fold ulcerations and apposition lesions." *Expert Review of Dermatology Expert Reviews Ltd.* 3(3): 287-291.

Skin lesions are often difficult to diagnose, and even decubitus ulcers (bedsores) can have different manifestations. Two such variations are 'skin-fold' ulcerations and those caused by the prolonged apposition of skin surfaces. When pressure is applied to apposed or folded skin, surface ulcers can occur. There is evidence that such lesions are particularly found on debilitated elderly subjects with easily tented skin, as well as on similar patients with chronic contractures. A careful consideration of skin-fold causation helps in preventing ulceration problems, especially where pelvic skin is involved. The effective treatment and/or management of underlying factors, such as pelvic deformities, contractures, dehydration and incontinence, should also help prevent both skin-fold ulcers and apposition lesions. copyright 2008 Expert Reviews Ltd.

Perez, E. D. (1993). "Pressure ulcers: Updated guidelines for treatment and prevention." *Geriatrics* 48(1): 39-41+43-44.

Pressure ulcers are prevalent and associated with high rates of morbidity and mortality in older patients. Four primary forces - pressure, shearing, friction and moisture -

contribute to their formation. A number of factors place patients at risk, including immobility, age-related skin changes, malnutrition, and cognitive impairment. Turning schedules, special bed surfaces, and other preventive measures have been shown to significantly reduce the effects of these factors. When an ulcer does form, treatment is based on the degree of tissue damage and includes pressure-reducing devices, systemic measures and local care with debridement, occlusive dressings and sometimes surgery.

Phillips, E. M. and C. K. Fine (2003). "Case study in acute spinal cord injury complicated by obesity and a pressure ulcer." *Topics in Spinal Cord Injury Rehabilitation* 9(2): 45-49.

Reddy, M., S. S. Gill, et al. (2006). "Preventing pressure ulcers: A systematic review." *Journal of the American Medical Association* 296(8): 974-984.

Context: Pressure ulcers are common in a variety of patient settings and are associated with adverse health outcomes and high treatment costs. Objective: To systematically review the evidence examining interventions to prevent pressure ulcers. Data Sources and Study Selection: MEDLINE, EMBASE, and CINAHL (from inception through June 2006) and Cochrane databases (through issue 1, 2006) were searched to identify relevant randomized controlled trials (RCTs). UMI Proquest Digital Dissertations, ISI Web of Science, and Cambridge Scientific Abstracts were also searched. All searches used the terms pressure ulcer, pressure sore, decubitus, bedsore, prevention, prophylactic, reduction, randomized, and clinical trials. Bibliographies of identified articles were further reviewed. Data Synthesis: Fifty-nine RCTs were selected. Interventions assessed in these studies were grouped into 3 categories, ie, those addressing impairments in mobility, nutrition, or skin health. Methodological quality for the RCTs was variable and generally suboptimal. Effective strategies that addressed impaired mobility included the use of support surfaces, mattress overlays on operating tables, and specialized foam and specialized sheepskin overlays. While repositioning is a mainstay in most pressure ulcer prevention protocols, there is insufficient evidence to recommend specific turning regimens for patients with impaired mobility. In patients with nutritional impairments, dietary supplements may be beneficial. The incremental benefit of specific topical agents over simple moisturizers for patients with impaired skin health is unclear. Conclusions: Given current evidence, using support surfaces, repositioning the patient, optimizing nutritional status, and moisturizing sacral skin are appropriate strategies to prevent pressure ulcers. Although a number of RCTs have evaluated preventive strategies for pressure ulcers, many of them had important methodological limitations. There is a need for well-designed RCTs that follow standard criteria for reporting nonpharmacological interventions and that provide data on cost-effectiveness for these interventions. copyright2006 American Medical Association. All rights reserved.

Reus, U., H. Huber, et al. (2005). "Nursery care and sore ulcers. [German]." *Zeitschrift fur Gerontologie und Geriatrie* 38(3): 210-217.

Purpose: To detect the frequency and circumstances of sore ulcers in comparatively unselected patients of the German nursing care insurance who claimed for compensation. Setting Setting: Cross-sectional/case-control. Methods: Data sampling and descriptive analysis. Assembled data were biometric data, level of the need of care, grade of sore ulcer, duration of sore ulcer, bedding materials and frequency of wound dressings

of sore ulcer. Results: In 97 622 out-patients and 32 059 patients from nursing care units, there were 3.2 and 6.4% sore ulcers, respectively, with diverse grades of severity present. Despite the difference in frequency of sore ulcers, no distinction in the nursing quality could be shown between out-patients and patients from nursery care units. Our data possibly suggested a lack with regard to evidence-based prophylaxis and treatment of sore ulcers in both groups. Conclusions: For both out-patients and patients from nursing care units, prophylaxis and treatment of sore ulcers could possibly be improved. Further studies will be needed to reveal the short-comings in nursing-care and to map out strategies for improvement. copyright Steinkopff Verlag 2005.

Rithalia, S. (2005). "Assessment of patient support surfaces: Principle, practice and limitations." *Journal of Medical Engineering and Technology* 29(4): 163-169.

Pressure ulcers cause great pain and suffering to patients as well as unnecessary strain on nursing staff. Their treatment is both costly and time consuming. Every effort therefore should be directed towards their prevention. Understanding of the aetiology of pressure ulcers is still incomplete and assessment of devices aimed at prevention is difficult. Over the years, numerous parameters, including interface pressure and transcutaneous blood gas measurements, have been used to evaluate mattresses and cushions. However, the quality of the data gathered is variable and its clinical interpretation remains unsatisfactory. It could be said that the science of evaluation of support surfaces is still at a formative stage, as clinical validation of many of the approaches has yet to be carried out. copyright 2005 Taylor & Francis Group Ltd.

Rithalia, S. V. S. (1995). "Comparison of performance characteristics of the Nimbus and Airwave mattresses." *International Journal of Rehabilitation Research* 18(2): 182-185.

Rithalia, S. V. S. (1997). "Assessment of pressure relief characteristics in alternating pressure air cushions." *International Journal of Rehabilitation Research* 20(2): 205-208.

Rithalia, S. V. S. and M. Gonsalkorale (2000). "Quantification of pressure relief using interface pressure and tissue perfusion in alternating pressure air mattresses." *Archives of Physical Medicine and Rehabilitation* 81(10): 1364-1369.

Objective: To examine whether the interface pressure (IP) relief provided by alternating pressure air mattresses (APAMs) is matched with maintenance of tissue perfusion over the points of contact by measuring transcutaneous oxygen and carbon dioxide (tcPO<sub>2</sub>, tcPCO<sub>2</sub>). Design: Comparative analysis of 2 APAMs with a 2-parameter continuous time-based method for quantifying pressure relief (PR) and transcutaneous gas measurement for assessing tissue perfusion. Setting: Rehabilitation research facility in a university hospital. Participants: Eleven able-bodied adult postgraduate student volunteers. Main Outcome Measures: Two full-replacement APAM systems were used. For each mattress the mean maximum and minimum interface pressures; mean peak air pressures in the mattresses; interface pressure durations below 30, 20, and 10mmHg over a 60-minute period; mean maximum tcPCO<sub>2</sub> and minimum tcPO<sub>2</sub>; and mean area under the tcPO<sub>2</sub> and tcPCO<sub>2</sub> curves were measured for each subject. Results: IP on the sacrum was held below thresholds of 30, 20, and 10mmHg longer on a 2-cell, low pressure

system than on a 3-cell, high pressure system ( $p < .001$ ). Integrated over time,  $tcPO_2$  levels also indicated that the 2-cell system retained oxygen levels closer to the unloaded baseline than did the 3-cell system ( $p < .01$ ).  $tcPCO_2$  levels did not rise significantly ( $p > 0.1$ ) compared with the baseline measurement in both mattresses. Conclusions: PR was sensitive to the design of the APAM, especially its inflation pressure, cycle time, and inflation sequence. If future trials demonstrate that PR values and transcutaneous blood gas measurements correlate significantly with the clinical incidence of pressure sore formation, then this technique may prove useful in assessing the effectiveness of alternating pressure support surfaces.

Rosenthal, M. J., R. M. Felton, et al. (2003). "Healing of Advanced Pressure Ulcers by a Generic Total Contact Seat: 2 Randomized Comparisons with Low Air Loss Bed Treatments." *Archives of Physical Medicine and Rehabilitation* 84(12): 1733-1742.

Objective: To compare a therapeutic seat with low air loss bed treatment for healing rates of stage III and IV pressure ulcers. Design: Randomized prospective cohort study. Setting: Long-term care facilities. Participants: Two hundred seven subjects with stage III or IV pressure ulcers. Intervention: Two separate randomized control studies of advanced pressure ulcers that compared wound healing on 3 different support surfaces. Subjects were allocated to low air loss bed, upgraded bed overlay (only in study 1), or 4h/d sitting on an experimental generic total contact seat. The seat was designed using prosthetics principles aimed at distributing pressure off bony prominences onto less pressure-sensitive areas. Subjects were followed for 6 months or until they were totally healed. Main Outcome Measures: Number of subjects who totally healed, time to total healing, and pressure ulcer status score after 4 weeks of treatment. Interface pressures and functional capacity were also measured at 4 weeks. Results: In study 1, 3 subjects worsened on the bed overlay condition and were withdrawn from the study. None worsened on low air loss or generic total contact seat. At 4 weeks in both studies, pressure ulcer status score was lowest for the generic total contact seat ( $P < .0001$ ), compared with the other surfaces. Subject populations were similar, so to analyze total healing, results from both studies were combined. Total healing of pressure ulcers occurred as early as 4 weeks in some subjects using the generic total contact seat. Even at 8 weeks, total healing was primarily seen with use of that seat, on which interface pressures, function, and seating tolerance were best. Conclusions: Faster healing and better function indicate that treatment using the generic total contact seat is superior to low air loss bed therapy, which is standard care for advanced pressure ulcers.

Ryan, D. W., V. Allen, et al. (1997). "An investigation of interface pressures in low air loss beds." *International Journal of Clinical Practice* 51(5): 296-298.

Prospective randomised trials indicate that the low air loss bed is a successful method of treatment for pressure sores. To study the properties of these beds interface pressures were measured in two different low air loss beds. Ten healthy volunteers had eight readings at six different body sites taken supine and sitting. Occipital and heel pressures for both products exceeded 4.7 kPa, the accepted capillary closing pressure, while pressures at other sites were below this. These findings suggest that pressure relief alone is not the sole reason for the clinical acceptance of low air loss beds in the treatment of pressure sores.

Seiler, W. O., S. Allen, et al. (1986). "Influence of the 30degrees laterally inclined position and the 'super-soft' 3-piece mattress on skin oxygen tension on areas of maximum pressure. Implications for pressure sore prevention." *Gerontology* 32(3): 158-166.

Senet, P. and S. Meaume (2000). "Decubitus ulcers. [French]." *Revue du Praticien* 50(17): 1965-1969.

Small, C. F. (1980). "Flat circular punch testing of clinical support surfaces." *Engineering in Medicine* 9(1): 9-16.

There is a real need for a mattress cover which is both extensible and waterproof. Although the proofed nylon cover in growing hospital use represents an improvement over previous covers, the results of indentation testing show that its use greatly increases the overall stiffness of the support system. An inextensible cover will result in no increase in stiffness only if it is sufficiently unrestrained that it moves freely into an indentation. The waterproof cover intended for use with the Polyflotation mattress (not available for testing) is very loose, so that the action of the surface grooves may be unaffected, but the NHS Specification Working Group on Mattresses and Other Related Items (1968) recommended that mattress covers be slightly interference fit to the mattresses to prevent wrinkling. Wrinkles in a mattress cover which is also hot and sticky, as they so often are, can be extremely uncomfortable and may even cause superficial bed sores, but even a small release of the tight fit of the proofed nylon cover should significantly improve the compliance of the bed. Although the flat circular punch test is unsuitable for many support systems, it shows considerable promise as a means of evaluating the indentation behaviour of most of the beds in clinical use. The results of testing will not permit the prediction of stress distributions experienced by a patient lying on the bed, but the compliance of particular beds may be easily compared and the effect of adding different covers can be determined.

Small, C. F. (1980). "Mechanical compliance evaluation of clinical support surfaces." *Journal of Biomechanics* 13(4): 315-322.

The mechanical compliances of a number of support systems, including beds in general clinical use and mattresses specifically designed to help prevent pressure sores, were determined from indentation tests using flat, circular punches of 5, 10, 15, 20 and 40 cm dia. The Scimedics Polyflotation foam mattress was found to be more compliant (less stiff) overall than either of the two Dunlopillo foam mattresses conforming to NHS contract specifications. Mattresses of T38 Temper Foam displayed such a degree of time-dependance as to render them unsuitable for general clinical use. A horsehair mattress and interior-sprung mattress were both more compliant than any of the foams with indentors 15-40 cm dia. An Aquatherapy Aqua-Pedic water mattress was found to have mechanical characteristics no better than the horsehair or interior-sprung mattresses except with the largest indenter. The use of waterproofing covers on foam and hair mattresses resulted in decreases in support system compliance which were extreme at small punch sizes.

Solis, I., T. Krouskop, et al. (1988). "Supine interface pressure in children." *Archives of Physical Medicine and Rehabilitation* 69(7): 524-526.

The effectiveness of using 2-inch and 4-inch convoluted foam overlays to protect children from developing pressure sores was investigated in 13 healthy children ranging in age from ten weeks to 13.5 years. Interface pressures were measured under the occipital, sacral, and scapular areas of children as they lay on a standard mattress, then on 2-inch and 4-inch foam overlays. The differences in pressures between the occiput and scapula, occiput and sacrum, and scapula and sacrum were significant ( $p < .001$ ), with the highest pressures recorded under the occipital area. Occipital pressures decreased from 45.7mmHg on the standard mattress to 22.3mmHg on the 4-inch overlay in ages 0 to 2, 54.3mmHg to 30.5mmHg in ages 2 to 10, and 78.0mmHg to 42.4mmHg in ages 10 to 14. Sacral pressures were highest in older and larger children, increasing from 17mmHg in ages 0 to 2 to 34mmHg in ages 10 to 14, and when body surface area was greater than  $1\text{m}^2$ . These results indicate that the site of greatest pressure changes with increasing age from the occipital area to the sacral area. Therefore, different pressure relief considerations are necessary in treating pediatric patients than in managing pressure under adults.

Stockton, L. and S. Rithalia (2008). "Is dynamic seating a modality worth considering in the prevention of pressure ulcers?" *Journal of Tissue Viability* 17(1): 15-21.

Stoneberg, C., N. Pitcock, et al. (1986). "Pressure sores in the homebound: One solution." *American Journal of Nursing* 86(4): 426-428.

Swart, M. E. (1985). "New design of an anti-decubitus lying-down support." *International Journal of Rehabilitation Research* 8(3): 273-280.

Reviewed is a new lying-down support which is developed and designed in order to prevent decubitus. The new design is based upon the new anti-decubitus theory about tissue deformation: the principle of minimal deformation of the supported body-tissues. Reviewed are the main problems of decubitus prevention in the lying situation. A comprehensive explanation of the operation of the new lying-down support is given. Attention is paid to the anti-decubitus quality, the users-friendliness for medical attendants, nursing attendants and the patient himself, the maintenance-friendliness and the cost-price. User aspects safety aspects and the cost factor are discussed in detail.

Swart, M. E. (1985). "Physico-mechanical aspects of decubitus prevention." *International Journal of Rehabilitation Research* 8(2): 153-160.

Reviewed is the theory of tissue deformation as a cause of decubitus, as developed in cooperation with two Dutch Rehabilitation Institutes and two Dutch Rehabilitation Research Institutes. Also reviewed are the conditions of the prevention of decubitus concerning the support of the human body in the lying situation. The consequences of the new anti-deformation theory for the lying-support are discussed. A classification is given of the existing lying-down support systems. Examples of the three categories of existing lying-down support systems are given and discussed in general.

Theaker, C. (2002). "Pressure sore prevention in the critically ill: What you don't know, what you should know and why it's important." *Current Anaesthesia and Critical Care* 13(4): 201-205.

The critically ill are particularly vulnerable to pressure sore development. These expensive and often painful complications have been largely ignored for many years and the entire problem has been managed by nursing staff. Current methods for identifying patients at risk are inadequate and subjective. Scoring systems have been known to over-predict those at risk and this maybe because they frequently originate from elderly care settings. Additionally, their relevance to the critically ill has not yet been established. The use of pressure-relieving devices has become commonplace; however, there is a paucity of data from controlled clinical studies. No uniform approach to measuring the effectiveness of these devices exists. What is certain, though, is that a voluminous amount of work needs to be conducted in order to verify their continued use. It is increasingly apparent that the complex nature of pressure sore development means that it is unrealistic to expect a single discipline to manage the problem effectively. A multidisciplinary team approach is the most appropriate way to improve management in this vital area. copyright 2002 Elsevier Science Ltd. All rights reserved.

Vale, L. and D. W. Noble (2006). "Overlays or mattresses to prevent pressure sores?" *British Medical Journal* 332(7555): 1401-1402.

Volker, H. U. (1999). "Decubitus ulcers. Pressure relief is of the essence. [German]." *MMW-Fortschritte der Medizin* 141(45): 30-33.

With an incidence of between 3 and 34%, decubitus ulcers are common chronic wounds, many of which can be avoided by prophylactic measures. The most effective preventive measure is relieving pressure on the endangered part of the body, and this is most easily achieved by regularly changing the patient's position in bed. Since, however, this is not always possible for staff-shortage or illness-related (e.g. fractures of the spine) reasons, modern pressure-relieving systems are being increasingly used. The range of options extends from simple foam plastic underlays to water-filled cushions to pneumatic cushions or beds filled with tiny glass beads. Selection of the most appropriate system is often difficult. For effective prophylaxis, determination of the individual risk of developing a bedsore with the aid of special scales makes good sense. In this way, the measures required can be adapted to the particular needs of the individual patient. New approaches to decubitus ulcer prevention and wound management may help to ensure effective care of the endangered or affected patient.

Wang, F. and H. Sun (2003). "Rehabilitation guidance after total hip joint replacement." *Chinese Journal of Clinical Rehabilitation* 7(2): 332.

Young, J. and D. Cotter (1990). "Pressure sores: Do mattresses work?" *Lancet* 336(8708): 182-183.