

Pressure Ulcer Review: Selected Annotations, Critiques, and Bibliography

Prepared for the Paralyzed Veterans of America, Department of Health Policy
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INTRODUCTION

The issue of secondary conditions is fast becoming a priority across many disciplines (i.e., physical medicine and rehabilitation, physical therapy, occupational therapy, psychology, social work) in the fields of research and training. Health problems that accompany spinal cord injury or other physical disabilities have been identified and treatments sought for the last several decades. However, the notion of secondary conditions and the development of preventive strategies to avoid them was addressed only recently by Marge (1988). This concept of secondary conditions rather than isolated health problems was brought to center stage by the Institute on Medicine report *Disability in America* (Pope & Tarlov, 1991) and through epidemiology and state capacity grants made available from the Disability Prevention Program at the Centers for Disease Control.

Since then, numerous researchers and clinicians have been working to address factors that set the occasion for the onset of secondary conditions. Factors studied include aging (Whiteneck, et al., 1993); rural isolation (Seekins, 1991); environmental-behavioral factors (White, Mathews, & Fawcett, 1989); lack of skills or knowledge (Seekins et al., 1993; Maynard et al., 1991; Lanig, Chase, Butt, Hulse, & Johnson, 1996); and depression (Elliott, Witty, Herrick & Hoffman, 1991) among others. While the onset of a specific secondary condition could be due to anyone of these factors, more than likely, the interplay of a combination of factors set the occasion for a secondary condition

to occur. For example, a pressure ulcer might be due to any combination of environmental factors (type of clothing, wheelchair and wheelchair cushion type); social factors (working versus being isolated, strong social support); behavioral factors (performing regular pressure reliefs, eating nutritious meals, performing good hygiene); resource factors (adequate insurance and accessible housing); and biological factors (bone structure, and skin resiliency to pressure).

As the previous paragraphs suggest, there are a myriad of ways to approach and better understand the nature and causes of secondary conditions. Unfortunately, our experiential and knowledge base for preventing and reducing these secondary conditions is still very elementary. In a sense, we have a Pacific Ocean problem, yet a Lake Tahoe understanding for addressing the problem.

AIMS

The purpose of this document was to gather selected journal articles on one secondary condition, pressure ulcers. The Paralyzed Veterans of America Health Policy team selected this topic area from among several (pressure ulcers, urinary tract infections, joint problems, deconditioning and weight gain, and bowel dysfunction). Our charge was to identify relevant articles with a special emphasis on behavioral interventions that stressed prevention or reducing risk of developing pressure sores.

PROCEDURES

A literature search was performed using electronic databases such as MEDLINE, HealthPLAN-CD, and PsycLIT. Key search words used included pressure sores, decubitus ulcers, pressure ulcers, bed sores, and risk factors; also prevention, secondary conditions, long term care, skin care, health maintenance, nutrition, patient education, and pressure relief were used. A document compiled by the National Pressure Ulcer Advisory Panel, *A Selected Bibliography: Pressure Ulcer Assessment, Prevention and Treatment* was also reviewed for content and references. Once the articles were identified, they were gathered and triaged for relevance to this document. A secondary sort was performed that assigned the articles into one of several categories: case study, clinical, discussion, experimental research, non-experimental research, review, and technology. It was noted that in several cases the articles were relevant to one or more of the above categories, so they should not be interpreted as being mutually exclusive. Thus, the categorical assignment was made on the primary emphasis of the article. While articles written more than 30 years ago were included, the majority of articles selected were published from 1990 to present to provide a current overview.

After sorting articles by category, they were reviewed to determine whether they would be simply referenced or annotated. Those articles considered to have strong behavioral intervention components, or that we thought were of special merit, received a more in-depth analysis and critique. To ensure uniformity of reviews and annotations, all of the contributing editors independently reviewed a specific article and met together to discuss the critiques. This led to a model critique and annotation that was used as an exemplar for the critiques and annotations of other articles assigned to team members. While we performed an extensive literature review, we offer the caveat that the review was not exhaustive. That is, we fully expect that there still may be quality articles on pressure ulcer prevention from this time period that we have not identified.

The following table shows how the 124 articles we included in this document were distributed.

Category	Number of Articles Assigned	Number of Articles Annotated	Number of Articles Analyzed and Critiqued
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Case Study	2		
Clinical	15	3	1
Discussion	61	10	
Experimental Research	23	12	11
Non-Exp. Research	13	5	2
Review	5	1	
Technology	5		
TOTAL	124	31	14

We have included two items in this document which we believe adds to the range of items reviewed. The first is an annotation of the Arkansas Spinal Cord Commission's *Identifying Secondary Conditions in Arkansans with Spinal Cord Injuries: Final Report*. Published this past July, the report provides an overview and detailed results of an extensive survey of 650 Arkansans with SCI. The annotation focuses on findings from the study regarding pressure ulcers. The second item included is a review of *Don't Just Sit There: A Skin Care Curriculum* that critiques a training package including manuals and videos geared to teach patients in rehabilitation about skin care and pressure sore prevention. Both resources are likely to interest any readers concerned about the secondary condition of pressure ulcers.

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CATEGORY DEFINITIONS

Case Study: An analysis taken with either an individual or group that may involve manipulation of variables or observation of some identified events.

Clinical: Research that is primarily conducted within medical or laboratory settings.

Discussion: An article which provides a descriptive overview of a particular problem, procedure, or outcome.

Experimental Research: Research in which one or more independent variables are manipulated in the experiment or study.

Non-Experimental Research: Research in which the relationship between variables are studied or in which descriptive information is gathered on selected variables. (No direct observable manipulation of variables is made.)

Review: An evaluation of a comprehensive body of work covering a specific topic.

Technology: Evaluative article that focuses primarily on the outcomes of using a specific assistive device.

ANNOTATIONS

Arkansas Spinal Cord Commission. (July, 1996). *Identifying secondary conditions in Arkansans with spinal cord injuries. A Final Report.* Little Rock, AR: Author.

The Arkansas Spinal Cord Commission produced a comprehensive report on the results of a survey of 650 Arkansans with spinal cord injury. The purpose was to identify which secondary conditions were experienced and to determine the prevalence of these conditions. The goal was to target populations for the development of specific interventions. The report includes a detailed explanation of the methodology, a list of significant findings, and an analysis of the results from sixteen different areas of concern such as skin, cardiovascular system, and mobility and use of equipment. Pressure sores emerged as the eighth most common secondary condition out of 12, with 32.7% of survey respondents reporting a pressure sore within the previous year. Twenty-one per cent of respondents had a pressure sore at the time of the survey. Results also revealed that individuals with urethral catheters have more pressure sores than those who use other means of bladder management. Tables of pressure sore data report incidence according to demographics, interference of pressure sores in the persons' activities, level of the persons' concern with developing pressure sores, prevention methods, and incidence of pressure sores in relation to various factors: use of tobacco, bladder management, bowel incontinence, and depression. Four areas were identified for intervention projects including the development of a rehabilitation program that stresses healthy lifestyles and prevention of secondary conditions that can be maintained in the community setting. This document is noteworthy due to its timeliness, thoroughness, readability, and because of the agency's use of Participatory Action Research (PAR) in involving clients in the design of the survey instrument.

Ayello, E. A. (1993). A critique of AHCPR's "Preventing Pressure Ulcers — A Patient's Guide" as a written instructional tool. *Decubitus*, 6(3), 44-50.

This article critiqued the patient's guide released by the Agency for Health Care Policy and Research of the Public Health Service. Patient education was defined as "a process assisting people to learn and incorporate health-related behaviors into everyday life." The author evaluated the guide against criteria for evaluating written tools. The evaluation was organized by examining individual components: teaching strategies, technical quality, use of visuals, use of illustrations, quality and accuracy of content, and reading level. The guide was commended for adhering to a number of criteria. However, an explanation of the areas in which it did not meet the criteria is more instructive. The author noted that the majority of the guide is printed in 12-point type, but that 14-point is the minimum size recommended for persons with low reading levels. Captions or headings for most illustrations were omitted, which makes it difficult for readers to connect the illustrations with the corresponding text. Some illustrations of body parts did not include the whole body making it difficult for the reader to identify the body part out of context. In evaluating accuracy of the text, the author noted that phone numbers and an agency title in the resource listing had changed and that clinicians would be responsible for updating this information for patients. The most serious criticism was that the guide was evaluated between an 8th and 9th grade reading level, but that a 5th or 6th grade reading level is recommended for the general population. The author noted the usefulness of the manual and recommended that future revisions address these problems to enhance the product.

Bergstrom N., Braden, B., Kemp, M., Champagne, M., & Ruby, E. (1996). Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic

characteristics, diagnoses, and prescriptive interventions. *Journal of the American Geriatrics Society, 44, 22-30.*

This article presented results from a study that assessed the incidence of pressure ulcers among a randomly selected population of patients in three types of care settings (tertiary care hospitals, nursing homes, and Veteran's Administration Medical Centers [VAMCs]). Investigators also collected information on various demographic factors of those who developed ulcers versus those who did not. No experimental manipulations were performed on study participants. This was a descriptive study, the data were gathered from patient records (i.e., age, race, gender, and primary diagnosis, and preventive prescriptions) or taken by research staff trained in scoring of the Braden Scale for Predicting Pressure Sore Risk, recording skin assessment information, and staging of pressure ulcers. Analysis of the data revealed that of the 843 participants, 12.8% developed a pressure ulcer at some point during the four week study period, 32.4% were Stage I and 67.3% were Stage II. The incidence of pressure ulcers varied between settings, 23.9% of ulcers were developed by persons in nursing homes, 8.5% of persons were in tertiary care settings, and 7.4% were in VAMCs. Among all settings, those who developed a pressure ulcer were older than those who did not, but the difference in age approached significance only in the nursing home population. Among the sample who developed an ulcer, 16% were women while 11% were men. When assessing the total sample, white participants had a significantly higher incidence of ulcers (15%) than black (5%) or other participants (0%). Braden scores were significantly lower for participants who developed pressure ulcers in the total sample and in VAMCs and nursing homes. Among the total sample, primary diagnoses for those who developed an ulcer were neoplasms (24%) and cardiovascular disease (17%), while primary diagnoses among nursing home residents were orthopedic conditions (23%) and neoplasms (22%). Prescription of preventive measures such as turning schedules and pressure reduction surfaces was higher for participants who were determined to have higher levels of risk. However, data were not taken on the care staff's performance of preventive prescriptions.

Dealey, C. (1995). Mattresses and beds: A guide to systems available for relieving and reducing pressure. *Journal of Wound Care, 4(9), 409-412.*

This discussion paper reviews the various types of commercial mattresses and overlays that are available to reduce pressure while individuals are lying in bed. The article describes the various types of products available, suggests questions for consideration when selecting equipment, and provides a flow chart based on Waterlow scores to suggest which products might be most appropriate for patients. While the article described each of the support systems available, there were no direct comparisons between the products as to their flexibility, level of maintenance, cost, or level of effectiveness. This article would be useful for the lay person or for professionals not familiar with this type of equipment.

Ferguson, A. C., Keating, J. F., Delargy, M. A., & Andrews, B. J. (1992). Reduction of seating pressure using PES in patients with spinal cord injury: A preliminary report. *Paraplegia, 30, 474-478.*

This article describes a preliminary study that evaluated the use of functional electrical stimulation (FES) in reducing ischial pressure among persons with spinal cord injury. Nine participants (5 paraplegics and 4 quadriplegics) underwent three months of PES quadriceps conditioning prior to the study. After this time, pressure reduction readings at the left and right ischia were compared between resting and stimulated conditions. The results showed that the difference between resting and stimulated pressures were statistically significant for all but one participant. An analysis of these results suggested that the strength of stimulated muscles and the weight of the participants appeared to affect pressure reduction and that those with more quadriceps

spasticity tended to have greater “knee moments.” The authors conclude that PES may be a useful method of pressure sore reduction if these results can be reproduced over longer periods of time.

Finucane, T. E. (1995). Malnutrition, tube feeding and pressure sores: Data are incomplete. *Journal of the American Geriatrics Society*, 43, 447-451.

A literature search of articles published between 1985 and 1994 on malnutrition and pressure sores and the effectiveness of tube feeding in improving pressure sore outcomes was conducted via a Medline search. This search yielded 22 studies for review. The author found the data linking pressure sores and measures of nutritional status were inconclusive due to reporting of contradictory results. A review of studies looking at nutrient intake and pressure sore development and outcomes were also inconclusive, with contradictory results reported between studies. An even more narrow review of studies looking at nutrient intake via tube feeding and pressure sore outcomes revealed that tube feeding was not shown to be an effective therapy. The article offers two explanations for these findings. One is that poor nutritional status may be an indicator of poor overall health and that improving nutrient intake may not affect health outcome. The second is that secondary effects of tube feeding (incontinence, moisture, restricted mobility) may actually have adverse consequences that worsen pressure sores.

Flam, E., Isayeva, E., Kipervas, Y., Shklyarevsky, V., & Raab, L. (1995). Skin temperature and moisture management with a low air loss surface. *Ostomy and Wound Management*, 41(9), 50-56.

This study compared the effect of a low air loss system to that of a standard hospital mattress on skin temperature and skin moisture levels. Ten healthy volunteers were recruited to participate. All participants laid supine on each system for three hours. Mechanical recorders were affixed to skin surface areas to constantly measure skin temperature and skin moisture levels. Results showed a 1.2° lower skin temperature on the low air loss system than the standard hospital mattress and average moisture retention levels were 87% lower with the low air loss system. The authors indicated that skin temperature and moisture levels are related to skin damage, with higher levels of either variable increasing risk of skin damage. Therefore, use of the low air loss system may be indicated for some patients to prevent pressure sores.

Fowler, E. & Pelfrey, M. (1993). Survival skills: A patient teaching model for the prevention of pressure ulcers. *Ostomy/Wound Management*, 39(8), 18-20, 22-24.

This article describes the Patient Education Model developed to assist health care providers in teaching pressure ulcer prevention to patients and primary caregivers before discharge. The model consists of three parts: Patient Education Plan, Teaching Guide, and Patient Teaching Guide. The Patient Education Plan is designed to teach primary care providers and patients information about self-care skills. The Teaching Guide is a scripted step-by-step instruction guide that complements the plan and includes definitions of important terms and preferred teaching methods. The Patient Teaching Guide is a take home resource guide that reinforces the one-on-one lessons learned while in the hospital. It is written at an elementary reading level and has many illustrations of activities involved in good skin care. The article includes a sample form or illustrated teaching guide from each part of the model.

Fuhrer, M. J., Garber, S. L., Rintala, D. H., Clearman, R., & Hart, K. A. (1993). Pressure ulcers in community-resident persons with spinal cord injury: Prevalence and risk factors. *Archives of Physical Medicine and Rehabilitation*. 74, 1172-1177.

This study was conducted to gather prevalence and risk factor data on pressure ulcers from persons living with spinal cord injury in a community setting. Participant data for 140 individuals, 100 men and 40 women was collected at a single point in time. Thirty-three percent of the participants presented with at least one pressure ulcer, 46% of those with an ulcer had more than one, and 27.6% of all the ulcers were of Stage III or IV severity. Of all ulcers, 69.4% were in the pelvic region and 29.9% were in the lower extremities. Those individuals with ulcers had less voluntary motor control than those without ulcers and were less independent in various activities of daily life. Those who exhibited more severe ulcers were more likely to have a lower Craig Handicap Assessment and Reporting Technique (CHART) score in the area of occupation.

Garber, S. L., & Dyerly, L. R. (1991). Wheelchair cushions for persons with SCI: An update. *The American Journal of Occupational Therapy, 45(6), 550-554.*

Researchers at Texas Institute of Rehabilitation Research (TIIR) in Houston, TX investigated patterns of wheelchair cushion prescription by occupational therapists for persons with spinal cord injury (SCI) and the participants' continued use of and satisfaction with these cushions. During Phase I, a chart review of 197 persons with SCI was conducted to determine what types of wheelchair cushions had been prescribed. Cushion types were divided into three categories: (1) air-filled (Bye-Bye Decubiti and Roho), (2) flotation (miscellaneous gels), and (3) foam (Stainless Comfy Hard Foam and Temper Foam). During Phase II, 30 individuals of the original sample were contacted 18 months later to determine whether they continued using this cushion and their satisfaction with it. The chart reviews revealed that 77.6% of all cushion prescriptions were for Jay and Roho cushions; 48% of prescriptions were for Jay cushions and 29% were for Roho cushions. Twenty-one (70%) of the individuals contacted 18 months later reported they still used the prescribed cushion. All cushion types were represented among the nine discarded cushions. Reasons that persons cited for discarding their cushions were discomfort, skin breakdown, mechanical failure, alternative solution found, modification in living arrangement, or change in wheelchair. Three (33%) of the persons who no longer used the original cushion had developed skin problems as a result of sitting and nine (43%) individuals who continued using the cushion experienced skin breakdowns as a result of sitting. Those who continued using their prescribed cushion said they were generally satisfied with it.

Garber, S. L., & Krouskop, T. A. (1982). Body build and its relationship to pressure distribution in the seated wheelchair patient. *Archives of Physical Medicine and Rehabilitation, 63* 17-20.

This study measured the effects of body build, including height, weight, sex and age, on several measurements of pressure exerted by participants seated in wheelchairs. The authors used an electro-mechanical sensing device (PEP) to measure pressure exerted on bony prominences and soft tissues, gradient pressure, and maximum distribution of pressure for 70 participants while seated on four different pressure-reducing cushions. Results showed that those judged to have a thin body build exerted more maximum pressures over a bony prominence than those with average or obese body builds. They also showed that somewhat higher pressures occurred in thin participants on the selected cushions in all three areas measured.

Garber, S. L., & Krouskop, T. A. (1984). Wheelchair cushion modification and its effect on pressure. *Archives of Physical Medicine and Rehabilitation, 65, 579-583.*

This study compared 6 polyurethane foam cushions that had been modified with wedge cuts to determine whether this technique had any effect on reducing the pressure exerted over bony prominences for users of various body builds. Wedging modifications were achieved by cutting the

underside of a wheelchair cushion transversely across the full width of the cushion. Pressure was measured using a Pressure Evaluation Pad (PEP). The results did not indicate any one of the wedging configurations were better than the others. However, individual data suggest that for some persons wedging may help to redistribute weight and thus relieve pressure over bony prominences.

Gunnewicht, B. R. (1995). Pressure sores in patients with acute spinal cord injury. *Journal of Wound Care, 4(10), 452-54.*

This study examined the prevalence and severity of pressure sores in patients admitted to a spinal treatment unit and compared findings to similar studies. Newly spinal cord injured patients admitted to a ward of a spinal injury unit in Great Britain during a one year period beginning in February 1993 were included (N=38). Data on onset, site, and grade of pressure sores was gathered from admission notes, and clinical staff also monitored patients for these same variables. The authors report results similar to findings by Mawson, Biundo, and Neville (1988) regarding prevalence rates and most common sites of pressure sore development. However, the authors of the Gunnewicht study acknowledged limitations of their study and noted the limited usefulness of the findings. Due to the use of different classification systems by various researchers, it is difficult to compare results across studies. It is likely that the vigilance and clinical judgement of those performing skin checks varied and that pressure sore occurrences were under-reported due to fear that reporting high figures might lead to reprisals, criticisms, or point to deficiencies in care practices. These problems highlight the importance of using reliable and valid measures so that comparisons between studies can be done.

Jiricka, M. K., Ryan, P., Carvalho, M. A., & Bukvich, J. (1995). Pressure ulcer risk factors in an ICU population. *American Journal of Critical Care, 4(5), 361-367.*

This study explores the contribution of risk factors, such as sensory perception, moisture, activity, mobility, friction and shear, nutrition and circulation, to the development of pressure ulcers among intensive care unit patients. Few investigations regarding pressure ulcer development have been conducted with this population. The authors studied 85 adults admitted to an intensive care unit for multiple trauma, injuries sustained from motor vehicle accidents, gunshot and stab wounds, and gastrointestinal bleeding. Patients were enrolled in the study within 24 hours of admission to the ICU and data were collected every other day until the patient was discharged from the unit. Demographic information was collected in addition to data from the Braden scale, the Skin Assessment Tool, and the Decubitus Ulcer Potential Analyzer (DUP A). The results showed that while age, gender, history of diabetes mellitus, and smoking history did not seem to influence development of a pressure ulcer, a patient's race and his or her length of stay in the ICU did-- patients who were white and who had a longer ICU stay tended to have skin breakdown. Those who had a second surgical procedure were also more likely to develop a pressure ulcer. Forty-eight patients (56%) had a pressure ulcer at some time during their ICU stay; 37(44%) did not.

Sensory perception and moisture were significant risk factors for predicting pressure ulcer development with the Braden Scale. Moisture and circulation were significant risk factors for pressure ulcer development when the DUP A was used. The authors provided no information on how staff members were trained to conduct assessments or whether reliability measures were taken. A shortcoming of the study noted by the authors was that this was a sample of convenience and generalization of the results is limited. Since most of the participants were admitted due to trauma, many of them arrived after being subjected to emergency transport on long boards, lengthy surgical procedures, and therapeutic circulatory intervention, which contributed to the high incidences of pressure sore development.

Krouskop, T. A., Cullen, B., & Garber, S. L. (1992). Custom selection of support surfaces for wheelchairs and beds: One size does not fit all. *Dermatology Nursing*, 4, 191-194, 204.

This article provides guidelines for selecting support surfaces that meet consumer needs in preventing pressure sores, maintaining good seating posture, and preventing pain. The authors stress the need for custom prescription of these devices. Factors identified as important to consider in selection include the individual's level of sensation, residual motor function, presence of spasticity and/or incontinence, and environment and lifestyle. A cautionary note was made regarding the use of products that redistribute weight onto other sites; the authors strongly recommend that a determination be made of the site of displaced pressure before these types of products are prescribed. The need for a competent supplier is also noted as an important factor in selection. Points to consider are product warranties, availability of information about product performance life and fail safety designs, and constraints on product use.

LaMantia, J. G., Hirschwald, J. F., Goodman, C. L., Wooden, V. M., Delisser, O., & Staas, W. E. (January-February, 1987). A program design to reduce chronic readmissions for pressure sores. *Rehabilitation Nursing*, 12(1), 22-25.

The purpose of this study was to evaluate the effectiveness of a behavioral modification program (the Pressure Sore Reduction Program or PSRP) in educating persons with spinal cord injury (SCI) about managing skin problems and teaching them to perform specific skin care activities. Forty-two persons admitted to an inpatient rehabilitation setting for surgery on existing skin problems agreed to participate. The participants earned points for attending classes and therapy sessions and for participating in goal-setting activities. Points could be exchanged for individual or group rewards. Failure to accumulate a specified point quota resulted in discharge from the program. Twenty-eight persons completed the program and 14 (34%) did not due to contract violations, medical instability, or personal choice. Program success was determined by the state of healed skin three months and one year after the program. Three months later 26 of those who completed the program were evaluated, 24 (78%) remained healed and 2 (11%) had reopened the skin. A year later 23 persons of this group were assessed, 15 (65%) remained healed and 4 (17.5%) had reopened the skin. Of the 14 who had dropped out of the program, 11 were assessed three months later, five (35.7%) remained healed and six (42.8%) had reopened the skin. A year later, six persons of this group were assessed, two (20%) remained healed and four (40%) had reopened the skin. The results suggest persons who completed the PSRP program were more successful in managing skin problems and maintaining intact skin than those who did not.

Malament, I. B., Dunn, M. E., & Davis, R. (1975). Pressure sores: An operant conditioning approach to prevention. *Archives of Physical Medicine and Rehabilitation*, 56, 161-165.

The purpose of this study was to increase the number and regularity of pressure reliefs for five veterans with spinal cord injury in a physical rehabilitation setting. A pressure sensitive pad that was attached to a computer monitored the frequency and duration of wheelchair push-ups. An alarm system was used as a stimulus to increase pressure reliefs. This early study shows that assistive technology (AT) is potentially useful in reducing the occurrence of pressure sores. Two of five case studies presented indicated a modest success with the research objectives. The research contained some threats to internal and external validity and should be reviewed with caution as to the optimism of the proclaimed results. However, this was a very early study (1975) using this technology and its foundation paved the way for other behavioral studies with more advanced technology and behavioral designs.

Merbitz, C. T., King, R. N., Bleiberg, I., & Grip, I. C. (1985). Wheelchair push-ups: Measuring pressure relief frequency. *Archives of Physical Medicine and Rehabilitation*, 66, 433-438.

This study links assistive technology (AT) with standard clinical protocol to increase the frequency of wheelchair push-ups of seven paraplegics in a physical rehabilitation setting. The assistive technology (AT) used is a pressure sensitive pad attached to a computer that monitors each patient's frequency and duration of wheelchair push-ups to relieve weight off of their buttocks. This study shows AT has potential for helping to reduce the occurrence of pressure sores. Several case studies are presented, with two cases indicating positive effects; the other case studies presented are inconclusive and suggest that more research in this area is warranted.

Olshansky, K. (1994). Essay on knowledge, caring, and psychological factors in prevention and treatment of pressure ulcers. (1994). *Advances in Wound Care*, 7, 64-68.

This author attempts to reconstruct the way researchers and clinicians approach pressure ulcer prevention, noting that the efforts in this country are misdirected and the approach needs to be reconsidered. The author presents his argument and from that recommends a strategy for achieving this shift in emphasis from assessing patients to assessing caregivers. Also, the author makes a strong plea for holding facilities accountable for adherence to preventive programs and holding them responsible when patients develop pressure ulcers. Noted, too, was the importance of determining patient risk groups as either passive or active and indicates that prevention strategies for these groups are different. The author argues that prevention activities for individuals in the passive group are the responsibility of caregivers and health care facilities and that they must be both knowledgeable and dedicated to pressure ulcer prevention. For individuals in the active group, the author argues the individual is responsible for preventing pressure ulcers and indicates that psychological factors are related to etiology of pressure ulcers. Based upon this assertion, the author recommends that mental health professionals be an integral part of the treatment team for this group.

Patterson, J. A., & Bennett, R. G. (1995). Prevention and treatment of pressure sores. *Journal of the American Geriatrics Society*, 43, 919-927.

This article discussed the challenges of pressure sore prevention and treatment in the nursing home setting. The authors noted since the advent of diagnostic related groups (DRGs), admissions to nursing homes have been primarily of people who are more seriously ill, which puts them at increased risk for pressure sore development. However, during this time, pressure sore development among patients has been held as a marker of a facility's quality of care. The factors involved in the development and treatment of pressure sores were outlined: epidemiology, extrinsic and intrinsic risk factors and pathophysiology, prevention, assessment, treatment, infectious complications, surgical intervention, and future treatment options. While the article was directed toward an institutional population, inclusion of information about wound-care products and the philosophies behind them make it a useful overview for those interested in prevention and treatment of pressure sores in the community.

Public Health Service. Agency for Health Care Policy and Research. (1993). Clinical Practice Guidelines: Pressure ulcers in adults: Prediction and prevention. *Dermatology Nursing*, 5 (1), 17-33,41.

This article sets forth clinical guidelines for the prediction, prevention, and treatment of pressure sores. Development of these guidelines validated pressure ulcers as a serious medical

problem. In 1989, the Agency for Health Care Policy and Research (AHCPR) was established through the addition of a new title IX to the Public Health Service Act. Their goal was to improve health care services and access to such services. The Office of the Forum for Quality and Effectiveness in Health Care was established and charged with developing, reviewing, and periodically updating a variety of clinically relevant guidelines. This group was responsible for selecting pressure ulcers as one of seven topics for guideline development.

Devised by a panel of experts listed in the article, the guidelines set forth a systematic progression of goals regarding pressure ulcer prevention and treatment of stage I ulcers in at-risk adults. Each goal is followed by clinical recommendations rated A, B, or C based on the strength of evidence to support the recommendations (i.e., A= good research-based evidence; B= fair research-based evidence; C= based on expert opinion and panel consensus) and with rationale that includes extensive literature citations. Tables outlining the Norton and Braden scales, and a glossary of terms are also provided. This article is useful as a current overview of recommended clinical practices in the prevention and treatment of pressure ulcers.

Public Health Service. Agency for Health Care Policy and Research. (1992). Preventing pressure ulcers: A patient's guide. *Decubitus*, 5, 34-35, 38, 40.

This is an easy-to-read, brief outline of the etiology of pressure ulcers. Pressure ulcers are described from a biological perspective. The article lists the most common pressure points that need to be monitored for persons with restricted mobility (i.e. those on bed rest or those who use wheelchairs) and outlines risk factors associated with pressure ulcers and key steps for preventing and managing ulcers. Also described are specific skin care techniques, personal care management, and injury prevention.

Ramundo, J. M. (1995). Reliability and validity of the Braden Scale in the home care setting. *Journal of Wound, Ostomy and Continence Nursing*, 22(3), 128-134.

Of three published risk tools available for the prevention of pressure ulcers, the Braden Scale has been most often used and tested. Research has primarily been focused on acute and skilled nursing care settings; however, few studies have been conducted in the home care setting. Validity of the Braden Scale was examined in assessing risk for developing pressure sores among 48 patients living at home and admitted to a community-based, suburban home-care program. The scale was tested on two dimensions: sensitivity and specificity. Sensitivity was defined as the accuracy of the test in identifying at-risk patients that eventually acquired a pressure ulcer. Specificity was defined as the accuracy of the test in predicting patients not at risk and that did not eventually acquire a pressure ulcer. Procedures included an assessment by agency nurses on the day of the admission and on a weekly basis thereafter for four weeks or until the patient was discharged or acquired a pressure ulcer. Results showed 100% sensitivity of the Braden Scale in identifying patients at risk, but only 34% specificity. This indicated the Braden Scale had validity in identifying patients at risk but had limited predictive ability. The authors noted several problems with reliability of the study, including the performance of reliability assessments on different days which allowed for a change in the patient's condition and dependence on information from caregivers that may have been unreliable.

Roberts, A. H., Dinsdale, S. M., Matthews, R. E., & Cole, T. M. (1969). Modifying persistent undesirable behavior in a medical setting. *Archives of Physical Medicine and Rehabilitation*, 50, 147-153.

This article presents a behavioral modification approach to increase the daily performance of twelve specified hygiene behaviors ranging from emptying a leg bag to cleaning and lining a prosthesis in the evening before going to bed. This case-study design followed one subject, a 29-

year-old male who had severe recurrent problems with pressure sores. Poor hygiene was identified as one of the chief contributing factors. The behavior modification program used a token-economy system which gave one coupon for each specified hygiene task performed each day. The coupons were then redeemed for cups of coffee. Actual results of how the token economy worked in terms of carrying out the specified hygiene tasks were not presented in this study. However, outcome data on how the behavioral program affected the percentage of time dealing with stump irritations or with decubitus ulcers were presented. The program had achieved a very low level of dealing with skin problems compared to baseline levels.

Rodriguez, G. P. & Garber, S. L. (1994). Prospective study of pressure ulcer risk in spinal cord injured patients. *Paraplegia*, 32, 150-158.

The study followed 60 men with spinal cord injury over a period of two years who had a history of pressure ulcers. Forty of the participants were included in the experimental group and 20 were included in the control. Both groups underwent an interview and 24-hour urine screening at the beginning and upon completion of the study. In addition to these observations, the experimental group was contacted every four to six weeks to gather data. During the course of the study, 34% of the sample developed a pressure ulcer. Results of urine excretion tests revealed that collagen metabolite levels were significantly higher for those who developed a pressure ulcer during the study period than those who did not. Those who developed ulcers tended to have injury levels above T6 and were more likely to be unemployed, not attending school, and to have had a greater number of ulcers previously. Thirty-six percent of participants who developed ulcers smoked, 26% of non-smokers developed ulcers. There were no significant differences found with regard to health beliefs about risks, severity of ulcers, or prevention for those who developed ulcers and those who did not.

Rosenthal, M. J., Felton, R. M., Hilman, D. L., Lee, M., Friedman, M., & Navach, J. H. (1996). A wheelchair cushion designed to redistribute sites of sitting pressure. *Archives of Physical Medicine and Rehabilitation*, 77, 278-282.

This article presents data from a comparative study of the interface pressure exerted on five anatomical locations of wheelchair users by four different cushion systems (the Total Contact Seat [TCS], the Roho seat, a Bye-Bye Decubiti, and a Jay cushion). Forty-seven participants were observed while sitting on each of the four systems and pressure was tested at six points in time over a 30-minute period. Two methods were used to assess pressure; one used an air pressure pad with an internal electric contact sensor to determine interface pressure, the second method was a pressure-controlled contact circuit. Results of these observations revealed the TCS system to be most effective in reducing pressure to these sites. Upon initial participant placement on the cushion the average pressure exerted on the left ischial tuberosity was 23 ± 7 while the lowest of the other three cushions at this point in time was 42 ± 13 . At the end of the 30-minute period, the TCS system showed a pressure of 33 ± 14 at the site while the lowest of the other three showed a pressure of 59 ± 4.8 .

Rottkamp, B. C. (1976). An experimental nursing study: A behavior modification approach to nursing therapeutics in body positioning of spinal cord-injured patients. *Nursing Research*, 25(3), 181-186.

This formative study evaluated the performance of changes in body positioning among 9 persons with SCI in a rehabilitation setting. Comparisons were made between those who were taught to change position via a behavioral program and those who were taught by the traditional nursing method. The behavioral program taught participants by modeling (using diagrammed illustrations of body positions and demonstrations), manual and verbal prompting, and

reinforcement. No information was provided about the traditional teaching method. Results showed those in the behavioral program performed more changes in body position, self-initiated more changes in position, and had less need for assistance when performing these changes than those in the traditional nursing program. However, program components were not isolated to determine which was most effective in achieving successful outcomes. More research is needed to determine which behavioral techniques were most successful in increasing body positioning activities.

Sugarman, B. (1985). Infection and pressure sores. *Archives of Physical Medicine and Rehabilitation*, 66, 177-179.

This article examined the role of infections upon visible and developing pressure ulcers. Two groups of spinal cord injured patients were followed, those admitted to the hospital because of a spinal cord injury (n=209) and those who were admitted due to a pressure sore or infection (n= 58). Whole body scans were done to detect whether hidden or underlying infections were present under or near visible pressure sore wounds and to determine where pressure sores might develop in the future (e.g., trochanter or ischial tuberosities). The body scans resulted in interesting data. At least one decubitus ulcer extending visibly beneath the dermis was present in 119 of the 209 (57%) persons of Group I and in 100% of the 58 patients in Group II. The majority of those from groups I and II (n=49) who had pressure sores that did not heal or whose sores had appeared to heal but still had fevers actually had underlying "deep infections." In the majority of these 49 patients the unchecked infection caused osteomyelitis of the bones beneath the pressure sores.

While this study does not have a primary prevention focus for deterring the onset of pressure sores, it provides excellent clinical information about the role that infections can play in causing and preventing the healing of pressure sores.

White, G. W., Mathews, R. M. & Fawcett, S. B. (1989). Reducing risk of pressure sores: Effects of watch prompts and alarm avoidance on wheelchair push-ups. *Journal of Applied Behavior Analysis*, 22(3), 287-95.

This study evaluated a program that used assistive technology (AT) to improve the frequency of wheelchair push-ups of two adolescents with spina bifida across settings. The AT included the Beep 'n' Lift program that provided both antecedent (i.e. instructions, audible, prompts) and consequent (i.e. alarm avoidance) events to increase frequency of lift-offs as well as an automatic recording device attached to the subjects' wheelchairs to provide written evidence of lift-off behavior. In both cases, the Beep 'n' Lift program used in its complete form greatly increased the frequency of push-ups over the baseline, while components of it used individually were less effective. Results of this study, including data from a social validation procedure, indicated the usefulness of AT in increasing the number of wheelchair push-ups and possibly prevention of pressure sores.

Yarkony, G. M. (1994). Pressure ulcers: A review. *Archives of Physical Medicine and Rehabilitation*, 75, 908-917.

This article reviewed 175 references on pressure ulcers from 1916 to 1994. The author was thorough in covering issues of etiology, persons at risk, description of pressure ulcers, pathology, complications, medical management, treatment of ulcers, growth factors, surgical repair, and prevention of pressure ulcers. The article outlined what has been learned over the years about pressure ulcers and then constructed a rationale as to what needs to be addressed in the future based on what is currently known.

The article began with the statement that information gathered up to this point on the incidence and prevalence of pressure ulcers is not uniform due to factors such as variations among

facility type where investigations are conducted, variations in underlying medical conditions, and age of persons studied. Pressure ulcers are noted to occur for two reasons. The first is due to the “parabolic relationship” between pressure and time. This relationship is also influenced by factors such as impaired mobility and sensation, incontinence, atrophy of soft tissues that lead to an increase in the interface pressure at bony prominences. The second reason for pressure ulcer development is due to shearing forces that cut off large areas of vascular supply. Persons at risk for pressure ulcer development are noted to be those who are immobilized for some period of time, persons who are malnourished or vitamin deficient, and elderly persons (especially those in care facilities) because of ischemia, aging skin, and body build.

Yarkony noted four scales currently in existence to describe pressure ulcer: the Shea Classification, the Yarkony-Kirk, another developed by the National Pressure Ulcer Advisory Panel, and a fourth developed by the International Association of Enterostomal Therapy. He noted, however, that there have not been any studies that have compared the scales to determine which is best at evaluating and treating an ulcer. He listed and evaluated various methods for measuring the size and depth of ulcers. Acetate tracings are noted to be the most accurate in describing the wound area, but also used are photographic methods, the Kundin measuring device, use of dental impression materials, analyzing photos taken over polyester grids with computers, sinography, and the pressure sore status tool developed by Bates-Jenson. Use of this technique was noted as being complex and requiring training.

Yarkony discussed pressure ulcer complications such as infection, abscesses, septicemia, and osteomyelitis. Methods described for treating ulcers include irrigation techniques such as aspiration and use of antibiotics. The best strategy for identifying osteomyelitis was noted as the use of a plain x-ray. When the author addressed management, he made a strong recommendation that the entire person needs to be treated, not simply the ulcer. Stages of wound healing were identified and described as the inflammatory phase, proliferation phase, and maturation phase. Yarkony discussed the issue of adequate nutrition at some length.

A critical point made by Yarkony was that there have not been any definitive studies done that identify the most effective ways to treat pressure ulcers. However, he listed a number of steps in treating the ulcer: (a) removing pressure on the site, (b) debridement of the necrotic tissue, (c) wound healing can be done in moist environments, with the use of growth factors, and when needed (d) surgery. Prevention techniques listed and discussed include: performance of pressure reliefs, bed positioning, turning, use of bed surfaces such as foam, low air loss beds, air fluidized beds, air mattress overlays and water beds, as well as wheelchair cushions made with gel, foam, air, or water-filled.

Zernike, W. (1994). Preventing heel pressure sores: A comparison of pressure relieving devices. *Journal of Clinical Nursing*, 3, 375-380.

This study compared four heel pressure-relieving devices (foam splints, eggshell foam, duoderm, and heel protector boots) to determine which was most effective in reducing changes to skin integrity. Participants were 41 elderly patients admitted with femur fractures to the orthopedic ward of a hospital. Upon admission to the study, participant risk for developing a pressure sore was evaluated with the Douglas -Norton Risk Assessment Scale. Skin integrity was assessed every two to three hours daily over 12 days on four dimensions (condition, color, sensation, and wound status) to determine if any changes in status occurred. Based upon changes to skin integrity noted over the 12 day period, the results revealed eggshell foam and foam splints as the most effective in reducing changes to skin integrity. The authors recommend this research should be repeated with a larger sample of participants to determine if the results can be replicated.

CRITIQUES

Bergstrom N., Braden, B., Kemp, M., Champagne, M., & Ruby, E. (1996). Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnoses, and prescriptive interventions. *Journal of the American Geriatrics Society, 44*, 22-30.

Research Question: The authors were interested in answering five primary questions regarding the incidence of pressure ulcer development.

- 1) What is the incidence of pressure ulcers among randomly selected patients in nursing homes, Veteran's Administration Medical Centers (VAMC's), and tertiary care hospitals?
- 2) Are demographic characteristics different between individuals who develop and who do not develop pressure ulcers?
- 3) Is the primary diagnosis an independent predictor of pressure ulcer development when functional concepts such as level of mobility and activity are controlled?
- 4) Do preventive measures predict who will and will not develop pressure ulcers when level of risk and demographic characteristics are controlled?
- 5) Do level of risk and demographic characteristics predict prescription of turning or pressure reduction surfaces?

Participants: A random sample of 843 participants was drawn from a population of newly admitted patients to six care facilities located in three cities. Participants were adults older than 19, free of pressure ulcers at the time of the initial assessment, and admitted for care to the facility within 72 hours of recruitment. Of the 843 participants, 539 (67.9%) were male and 666 (79%) were white.

Settings: All observation and data collection occurred in the nursing homes, tertiary care hospitals, or Veteran's Administration Medical Centers (VAMC's) where participants had been admitted for care. The sites were located in Omaha, NE; Durham, NC; and Chicago, IL.

Independent Variable(s): This investigation did not manipulate any variables.

Dependent Variable(s): Risk for pressure sore development was evaluated using the Braden Scale for Predicting Pressure Sore Risk and skin assessments were conducted via use of a skin assessment tool developed by Bergstrom (1989) that rated ulcers as belonging to one of four stages.

Procedures & Reliability: Participants were assessed on the first day of the study and then every 48 to 72 hours for up to four weeks or until they were discharged (if less than four weeks had passed). Patient records were used to determine demographic information as well as preventive prescriptions for turning schedules and pressure reduction surfaces.

Research Design: A prospective cohort study.

Research Results: One hundred eight (12.8%) of participants developed pressure ulcers; 23.9% occurred in nursing homes, 8.5% in tertiary care hospitals, and 7.4% in VAMCs. Of pressure ulcers, 32.8% were Stage I, 67.3% were Stage II, none were Stage III or IV. Among the entire sample, those who developed an ulcer were more often women (16% versus 11% of men) and white (15% versus 5% of black).

In VAMCs and tertiary care hospitals, those who developed a pressure ulcer were older, but the age difference was not statistically significant, whereas nursing home residents who developed ulcers were significantly older than those who did not. Braden scores (predicting risk) were significantly lower for those who developed pressure ulcers and for those with a Stage II pressure ulcer.

Discussion & Conclusions: This study provided estimates of pressure ulcer incidence in a four week period among individuals in a care facility. The incidence rate revealed that a large number of persons receiving care in a medical setting are prone to develop pressure ulcers and that greater precaution should be taken to reduce the incidence of these health problems. Because definitive answers about best practices to prevent pressure ulcers are not available, future studies should

investigate what prevention activities are most effective in reducing ulcer occurrences and experimental manipulations should be done to assess effective prevention performance levels.

Comments & Critiques: This investigation provides a sample of pressure ulcer incidence in a clinical population, but the results from the study do not provide any indication of incidence within a community setting. This is an important point because it is likely that within care facilities, the adherence to preventive practices and performance of skin checks is higher than in the community. If true, the incidence of pressure ulcers is likely to be higher for persons residing in the community. Another point should be made regarding the generalizability of results of the severity of pressure ulcer occurrences. It is not surprising that more severe ulcers were not observed because participants had skin checks every 48 to 72 hours which greatly decreased the chances of a pressure ulcer becoming severe. Such diligent monitoring may not generally be done in these facilities, nor in the community setting. It is difficult to know how severity ratings obtained in this study truly compare to other care facilities.

Although the authors were interested to determine which patients were written preventive prescriptions and the types of strategies (i.e., turning schedules and bed mattresses), it is not clear what information this data provides readers. The investigators did not directly observe actual performance of these strategies and therefore, cannot know that prescription of practices translated into performance.

Other Pertinent References:

Bergstrom, N., & Braden, B. (1992). A prospective study of pressure sore risk among institutionalized elderly. *Journal of the American Geriatric Society, 40*, 747- 758.

Brandeis, G. H., Morris, J. N., Nash, D. J., & Lipsitz, L. A. (1990). The epidemiology and natural history of pressure ulcers in elderly nursing home residents. *Journal of the American Medical Association, 264*, 2905-2909.

Public Health Service. (1992). Panel for the prediction and prevention of pressure ulcers in adults. Pressure ulcers in adults: Prediction and prevention. *Clinical Practice Guideline, Number 3*. Rockville, MD: Agency for Health Care Policy & Research. U.S. Department of Health and Human Services, AHCPR Publication No.92-0047.

Spector, W. D., Kapp, M., Tucker, R., & Stemberg, I. (1988). Factors associated with presence of decubitus ulcers at admission to nursing homes. *Gerontologist, 28*, 830-834.

Flam, E., Isayeva, E., Kipervas, Y., Shklyarevsky, V., & Raab, L. (1995). Skin temperature and moisture management with a low air loss surface. *Ostomy and Wound Management, 41(9)*, 50-56.

Research Question: What is the difference in skin temperature and skin moisture level for individuals using a low air loss (LAL) support system mattress as compared to a standard hospital mattress (SHM)?

Participants: Ten healthy volunteers.

Settings: Not stated. It is assumed to be a hospital setting as the comparison was between the LAL system and a standard hospital mattress (SIIM).

Independent Variable(s): Type of bed surface: (1) a low air loss surface (LAL) consisting of a series of interconnected air cells or pillows kept inflated by a separate power unit and covered with a loose-fitting waterproof coverlet or (2) a standard hospital mattress with a 50% cotton/50% polyester hospital bed sheet.

Procedures & Reliability: Ten healthy volunteers were recruited for this study. Those who had known dermatitis or inability to recline in ambient temperatures (74-76°F) were excluded. Baseline skin moisture levels were gauged by two methods, the Moisture Vapor Transmission Rate (MVTR) which measured moisture vapor rising from the skin, and by measuring electrical conductance of the

skin, which correlates with skin moisture level. Participants laid supine on each support system for three hours with the room temperature kept between 74° and 76° (ambient temperatures). Skin temperatures and moisture levels were measured continuously using ice-point calibrated thermocouples. Each system was tested at the same time of day with a washout period between each evaluation. No other information was available on reliability.

Research Design: This was a comparison design.

Research Results: Overall, skin temperatures were 1.2° cooler on the LAL system than on the SHM. The average skin moisture retention level was 87% lower on the LAL than on the SHM system.

Discussion & Conclusions: Previous research has shown that a small increase in the skin temperature can cause a substantial increase in the sweat rate and that an increase in skin moisture increases the shear force and damage to the skin. Lower skin temperatures have been found to improve retention of the mechanical strength of the skin. Findings from this study that the LAL reduced both skin temperature and skin moisture retention level suggest that a constant temperature can be kept below the sweat inducing range and may contribute to maintaining integrity.

Comments & Critiques: Although the results indicate that the type of system contributed to lower skin temperatures and moisture levels, it is possible that other variables contributed to the differences. If the systems had varying comfort levels, participants may have moved more on one than on the other which would have affected skin temperature and moisture levels. However, there was no report of whether participant movement was measured on the support surfaces. Reliability of the electronic equipment was not discussed, and it is not clear whether the equipment needed to be recalibrated. Because “healthy” volunteers were used, the generalization of findings to other populations may be limited. Factors such as restricted mobility, poor circulation, alterations in the nervous system, and altered skin integrity may affect skin temperature and moisture on these difference mattress systems.

Other Pertinent References:

Flam, E. (1990). Skin maintenance in the bed-ridden patient. *Ostomy and Wound Management*, 28, 49-54.

Flam, E. (1991). A new risk factor analysis: a comparison of cutaneous interface environments of low air loss beds. *Ostomy and Wound Management*, 33, 28-34.

Fuhrer, M. J., Garber, S. L., Rintala, D. H., Clearnan, R., & Hart, K. A. (1993). Pressure ulcers in community-resident persons with spinal cord injury: Prevalence and risk factors. *Archives of Physical Medicine and Rehabilitation*, 74, 1172-1177.

Research Question: This investigation was undertaken to address three issues: 1) to gather representative information about the number, severity, and location of pressure sores, 2) to identify variables that account for individual differences among persons in the community with respect to prevalence and severity of pressure sores, and 3) to confirm that risk factors associated with prevalence are not identical to factors related to severity.

Participants: Of a possible 661 persons with spinal cord injury residing in 13 urban and rural counties of Texas (which included Galveston and Houston), 140 were randomly chosen to participate.

Settings: Participants of the study were living in the community, but assessments were performed at two sites. Participants were brought into The Institute for Rehabilitation and Research (TIRR) in Houston, TX where they were given a full-day medical assessment and they were interviewed and filled out questionnaires in their own home.

Independent Variable(s): No manipulation of variables was performed, this was a descriptive study.

Dependent Variable(s): Measures were taken on 4 variables. Severity of pressure sore was classified into one of four stages (as recommended by Shea, 1975), extent of paralytic involvement was gauged by the ASIA Total Motor Index Score and two variables from Young and Burns (1982) which assessed the level of SCI and the completeness of the injury, disability was assessed using a preliminary version of the Functional Independence Measure (FIM), and the degree of handicap was measured with the use of the Craig Handicap Assessment and Reporting Technique (CHART).

Procedures & Reliability: Participants were made aware of the study via distribution of flyers, placing articles in area newspapers and publications for disabled persons, and public service announcements on television and radio. Potential participants were also contacted by mail or telephone from lists of names obtained through area hospitals and organizations for persons with disabilities. Participants were interviewed in their homes and sent questionnaires to fill out. Additionally, each participant spent a full day at TIRR where they underwent a full medical examination. Participants were reimbursed for all travel expenses for this day and overnight accommodations were provided for those who had traveled a long distance for the exam. Every participant was given \$100 upon completion of the exam.

No information was provided regarding who performed in-home interviews, who administered the ASIA Total Motor Index Score, CHART, and FIM. Information was also not provided regarding how these persons were trained to administer the scales. Reliability for scores from the CHART was obtained through a re-administration of the test to 135 participants one week later. Reliability of other tests was not addressed.

Research Design: This was a descriptive study of a large group of individuals at one point in time.

Research Results: The mean age of participants was 36.2 years old, 68% were white, 20% were black, and 10% were Hispanic. Forty-six (32.9%) participants presented with 93 lesions on the day of the medical examination. Eighty-seven (93.5%) of these ulcers were given severity ratings: 34.5% were Stage 1, 37.9% were Stage II, and 27.6% were Stage III or IV. There was not a large enough Hispanic population in the sample to include in the assessment between race and severity; the remaining available data revealed a larger proportion of blacks had more severe ulcers than whites. There was also a significant difference noted with regard to severity on the dimension of occupation, mobility, and age. Those who experienced more severe ulcers had a lower mean occupation score and a lower mean mobility score on the CHART. Those with ulcers of Stage I or II had a mean age of 22.1 years while those with a Stage III or IV ulcer were 27.7 years. The location of ulcers was primarily noted in the pelvic region (60.9%), in lower extremities (29.9%), and miscellaneous areas (9.2%). Those with pressure ulcers had significantly less voluntary motor control than those without ulcers and had lower mean scores on the FIM that indicated less independence in daily activities. Although over half of the individuals who presented with a pressure sore had more than one, at the time of the exam data on the variables collected did not show any differences between the groups who had one and those who had more than one.

Discussion & Conclusions: Results of the investigation indicate that one in three persons living with a spinal cord injury in the community has a pressure ulcer at any particular time. The majority of ulcers seen in this sample were either Stage I or II; however, 26.7% of the sample did have a Stage III or IV ulcer. Those who presented with more severe ulcers had lower CHART scores on dimensions of occupation and mobility. Differences were revealed between those who had ulcers and those who did not with regard to neurological status; those who had significantly less voluntary motor control were more likely to have a pressure ulcer. Ethnicity was also associated with ulcer severity; blacks had more severe ulcers than whites. This result is hypothesized due in part to their darker pigment that makes it more difficult to detect initial skin discoloration that is indicative of a pressure sore.

As the authors note, one shortcoming of this study was that data gathered could not be used to establish an estimate of annual incidence. The information is only able to provide an estimate of prevalence at one point in time. A question that was not asked in this investigation, but that may have provided useful information to understanding prevention and management practices would have been whether the participant was aware of any skin problems at the time of their medical exam. The authors note that little research has been done to determine how individuals manage pressure ulcers once they have been discovered. Based on prevalence of pressure ulcers reported in this study, it would be worthwhile for future researchers to determine whether persons are able to accurately detect pressure ulcers, the techniques they use to manage pressure ulcers, and the things they do to prevent the occurrence of pressure ulcers.

Comments & Critiques: The data presented in this investigation are based upon estimates of occurrence at only one point in time. This information does not allow estimates to be made of annual prevalence rates.

Other Pertinent References:

Fuhrer, M. I. (1990). Setting the conceptual landscape. In: PL Graicter, FM Maynard, eds. *Proceedings of the First Colloquium on Preventing Secondary Disabilities Among People with Spinal Cord Injuries*. Atlanta: US Department of Health and Human Services.

Whiteneck, G. G., Charlifue, S. W., Gerhart, K. A., Overholser, I. D., & Richardson, G. N. (1992). Qualifying handicap: A new measure of long-term rehabilitation outcomes. *Archives of Physical Medicine and Rehabilitation*, 73(6), 519-26.

Young, I. S. & Bums, P. E. (1981). Pressure sores and the spinal cord injured: Part II. *Spinal Cord Injury Digest*, 3, 11-26-40.

Garber, S. L., & Krouskop, T. A. (1982). Body build and its relationship to pressure distribution in the seated wheelchair patient. *Archives of Physical Medicine and Rehabilitation*, 63, 17-20.

Research Question: What are the effects of patient factors (body build, height, weight, sex, and age) on the location, magnitude, and distribution of the pressure exerted by patients seated in wheelchairs?

Participants: Seventy patients, 55 males and 15 females, with a prior history of decubitus ulcers. Sixty-seven with spinal cord injury, 60% were quadriplegic and 40% were paraplegic, the three others with spina bifida, hemiplegia, and multiple sclerosis. Ages ranged from 16 to 66 years.

Settings: Not stated, although it appeared to be an inpatient and/or outpatient rehabilitation facility.

Independent Variable: None, this was a comparison study.

Dependent Variable(s): Pressure exerted on the buttocks and upper thighs was measured by PEP contour maps.

Procedures & Reliability: The participants were divided into three body build types; thin, average, and obese, based on measurements of height, weight, sex, and age. Thin was defined as weighing less than 90% of ideal weight, and obese was defined as more than 110% of ideal weight. An electro-mechanical sensing device (a Pressure Evaluation Pad or PEP) was placed under a seated wheelchair-user to record and report the amount of pressure under bony prominences. Comparisons were made between four different pressure-reduction cushions, the E&J Polyurethane Foam, the Bye-Bye Decubiti, the Aqua Seat and 3-inch T-41 Temper Foam. Pressure patterns for each of the 70 participants were compared by looking at pressure gradient and overall weight distribution. There was no mention of any calibration, or need to do so, of the PEP.

Research Design: A comparison design.

Research Results: No relationship between the sex of the participant and the maximum pressure exerted over either a bony area or soft tissue distribution was found; results of measurement of both

men and women were similar. However, a significant relationship between body build and pressure was found. More than half of the thin participants (n=30) had the maximum pressure located over a bony area, whereas only a third of the average-weight participants (n=29) and about a quarter of the obese participants (n=11) had the maximum pressures exerted on this area. While there was marked individual variation in maximum pressures among wheelchair cushions, such variation appeared too independent of body build. No single cushion appeared to be optimal for any body build type. However, data indicated that somewhat higher pressures occurred in thin participants on the selected cushions in all three areas measured.

Discussion & Conclusions: The authors noted that the PEP had been shown in previous studies to be a valid indicator of pressure exertion. This study indicates that the PEP may be useful for individualizing cushion prescriptions for people with severe disabilities. Although males appear to have a higher clinical incidence of tissue breakdown than females, the data from this study do not provide an explanation as to why. Because pressure exertion does not seem to differ between sexes, a study of behavioral factors might provide some clues as to the differences in prevalence. No particular cushion managed pressure optimally for any body type. Body build appears to be only one factor involved in pressure exertion. The authors suggest that further research in nutrition, metabolism, and tissue resiliency is indicated.

Comments & Critiques: This study provided useful information on the effect that body build and cushion type has upon pressure reduction in preventing pressure ulcers.

Other Pertinent References:

Cochran, G. V. (Spring, 1980). Comparison of sitting pressure on wheelchair cushions as measured by "air cell" transducers and miniature electronic pressure transducers. *Bulletin of Prosthetic Rec.*, 17, 10-33.

Garber, S. L., Krouskop, T. A., & Carter, R. E. (1978). System for clinically evaluating wheelchair pressure-relief cushions. *American Journal of Occupational Therapy*, 32, 565-570.

O'Leary, I. P. & Lyddy, I. E. (1979). Nondistorting transducer for measuring pressure under load bearing tissue. *Proceedings of the 5th Annual Conference on Systems and Devices for the Disabled*. Houston: The Institute for Rehabilitation Research, 239-243.

Souther, S. G., Carr, S. D., & Vistnes, L. M. (1974). Wheelchair cushions to reduce the pressure under bony prominences. *Archives of Physical Medicine and Rehabilitation*, 55, 460-464.

Garber, S. L., Krouskop, T. A. (1984). Wheelchair cushion modification and its effect on pressure. *Archives of Physical Medicine and Rehabilitation*, 65, 579-583.

Research Question(s): Does the "wedging" technique (removing wedges of foam from the underside of a wheelchair cushion by cutting the foam transversely across the full width of the cushion) of modifying foam cushions have any effect on relieving pressure among users with various body types?

Participants: Thirty patients being seen on an inpatient or outpatient basis at rehabilitation facility for persons with spinal cord injuries. Twelve persons were paraplegic, with an average age of 29 and 18 persons were quadriplegic with an average age of 27. The age range of participants was between 18 to 53 years. Twenty-two (73%) of the sample were men. Body types of the quadriplegic participants were classified as follows: 6 were thin, 10 were average, and two were obese. Classification of the paraplegic participant body types revealed six were thin and six were average.

Setting: The study was conducted in association with a rehabilitation program.

Independent Variable: Six foam cushions, one unaltered foam cushion and five altered. Of the five "wedged" cushions, two were modified with four 2 1/2 cm. deep wedge cuts located anteriorly or posteriorly, two were modified with four 4 cm. deep wedge cuts located anteriorly or posteriorly, and 1 was modified with four 5 cm. deep wedge cuts located posteriorly.

Dependent Variable: The relationship of pressure (mm/Hg) exerted on participant's bony prominences. Reliability was measured by taking three readings of the Pressure Evaluation Pad (PEP) for each participant while seated on each of the six cushions.

Procedures & Reliability: Body type was determined using standard actuarial tables which considered gender, height, and weight. All 130 participants were evaluated on each of the six test cushions. Maximum pressures exerted over bony prominences were taken with the Pressure Evaluation Pad for participants seated on each cushion. Pressures exerted on the bony prominences were compared to participants' body type to determine how each cushion performed for each body type.

Research design: Comparison group design.

Research Results: For the group as a whole, there were minimal differences between the pressures exerted and the six cushion types. Only minimal differences were found in pressures exerted between men and women on each of the cushions and between quadriplegic and paraplegic participants. Slight differences were observed between cushions for those of different body builds.

Discussion & Conclusions: Although wedging of the foam cushions did not appear to affect maximum pressures exerted on bony prominences for the group of persons studied, the authors noted that for some participants marked reductions were produced by one or more modified cushions as compared to the unmodified cushion. However, detail of these observations were lost by averaging participant data. This indicates that no single cushion design works optimally for everyone, but that there are individual variations among users and that cushions should be prescribed individually.

Comments & Critiques: Although this study presented some useful preliminary data on the effectiveness of cushion wedging to redistribute pressure placed on bony prominences, much interesting and useful information about individual characteristics was lost by averaging the data. It was also not clear how long participants were seated on each of the cushions when pressure testing was done and it seems possible that over extended periods of time (which approximate actually sitting times on the cushions) more differences between cushions may have been noted. This study gauged the pressure exerted on only one site; future research should examine pressures exerted over areas other than ischial tuberosity to determine whether wedging has any effect on those sites.

Other Pertinent References:

Garber, s. L., Krouskop, T. A., & Carter, R. E. (1978). Body build and its relationship to pressure distribution in the seated wheelchair patient. *American Journal of Occupational Therapy*, 32, 565-570.

LaMantia, I. G., Hirschwald, I. F., Goodman, C. L., Wooden, V. M., Delisser, O., Staas, W. E. (January-February, 1987). A program design to reduce chronic readmissions for pressure sores. *Rehabilitation Nursing*, 12(1), 22-25.

Research Question: What effect does a behavioral program have on the maintenance of intact skin at 3 months and one year following surgery for skin problems.

Participants: Forty-two SCI paraplegics at zero to five years post-injury. All had pressure sores.

Settings: Rehabilitation hospital clinical setting.

Independent Variable(s): The Pressure Sore Reduction Program (PSRP) which is a three phase program requiring participants to attend classes and therapy as well as perform personal care activities to manage existing skin problems and maintain skin integrity.

Dependent Variable(s): Status of skin at three months and one year after program completion, compliance with the behavioral modification program as measured by attendance at classes and a coping group, patient/team meetings, and performance of personal care behaviors.

Procedures & Reliability: Before entrance into the study, participants were evaluated by a team (nurse, social worker, and psychologist) to determine their medical status, goals, and motivation level. No description was given on the assessment tools used for these measurements. After persons were deemed eligible, a behavioral contract was written which described expectations for program participation and was signed by the participant and team members. The participant was informed that four violations of the contract would result in their discharge. All participants attended classes, therapy, and other activities that included personal care activities. Points were given for these activities and a failure to accumulate point quotas resulted in discharge. A pre- and post-test was administered to determine the importance of learning on maintenance of healthy skin. Follow-up was conducted at three months and one year to assess skin integrity. No description was provided about the method used to assess skin status no was information provided about the reliability of any measures taken throughout the study.

Research Design: This was a comparison design.

Research Results: Twenty-eight of the original 42 participants completed the PSRP program and 14 dropped out due to failure of accumulating point quotas, medical reasons, or personal choice. Three months later 26 of those who completed the program were evaluated, 24 (78%) remained healed and two (11%) had reopened the skin. A year later, 23 persons of this group were assessed, 15 (65%) remained healed and four (17.5%) had reopened the skin. Of the 14 who had dropped out of the program, 11 were assessed three months later, five (35.7%) remained healed and six (42.8%) had reopened the skin. A year later, six persons of this group were assessed, two (20%) remained healed and four (40%) had reopened the skin.

Discussion & Critiques: This study presented a possible ethical concern regarding participant discharge from the program. The authors stated that participants were discharged for failure to accumulate point quotas; however, it was not clear whether discharge was simply from the behavioral program or from the rehabilitation site. Because all participants had undergone surgery for skin conditions, early release from the rehabilitation facility seemed unreasonable especially if their medical condition had not stabilized. Early release from rehabilitation at this time may have resulted in poorer skin integrity. It is not clear how investigators measured the occurrence of target behaviors such as class or therapy attendance or performance of personal care activities. While the authors reported that program participants were more successful in maintaining skin integrity, it is not clear which program components contributed to this success. It is also not possible to speculate what behaviors participants maintained 3 months and one year after the program because there were no follow-up observations of participant performance of self-care behaviors. Future research should attempt to determine what behavioral components are successful to maintaining skin integrity and whether this type of program can teach persons to perform skin care practices over time.

Other Pertinent References:

- Bandura, A. (1969). *Principles of behavior modification*. New York: Holt-Rinehart- Winston.
- Bandura, A. (1971). Psychotherapy based upon modeling principles. In A. E. Bergin & S. L. Garfield (Eds.), *An empirical analysis*, 653-672. New York: John Wiley and Sons.
- Krouskop, T. A., Noble, P. C., Garber, S. L., & Spencer, W. A. (1983). The effectiveness of preventive management in reducing the occurrence of pressure sores. *Journal of Rehabilitation R & D*, 20(1),74-83.
- LaMantia, J. G., Hirschwald, J. F., Goodman, C. L., Wooden, v. M., & Staas, W. E. Jr. (1986). Pressure sore readmission program: a method to reduce chronic readmissions for pressure sore problems. *Abstracts Digest*. Chicago: The American Spinal Injury Association. 12th Annual Scientific Meeting of ASIA.

Malament, I. B., Dunn, M. E., & Davis, R. (1975). Pressure sores: An operant conditioning approach to prevention. *Archives of Physical Medicine and Rehabilitation*, 56, 161-165.

Research Question: What are the effects of using an avoidance learning procedure, which includes a 30-second alarm, on the number of 4 sec or greater duration pushups every 10 minutes?

Participants: Five male spinal cord injured veterans who had ischial pressures sores in the process of healing. (Only 2 patients completed the training, two others were discharged from the hospital early, and one was judged not to need the program.)

Settings: Veteran's Administration hospital. (The wheelchair with alarm and counter attached to it moved from setting to setting within the hospital.)

Independent Variable(s): A device which had an electronic timer on it and counted the frequency of wheelchair push-ups of the wheelchair users. There were no descriptions of whether standardized instructions regarding performance of push-ups and the frequency and duration were given to the patients. (Reliability measures of independent variables were not reported.)

Dependent Variable(s): The frequency of wheelchair push-ups, the duration of push-ups, and the number of alarms that occurred if the alarm was switched on or off. (The counter independently monitored wheelchair lifts regardless of whether the alarm was on or not). There were no reports of the intervention's effect on the severity or grade of pressure sores. (Reliability measures of the dependent variables were not reported).

Procedures & Reliability: All participants in this study received an electronic timer device with a 30 sec 68-80 db alarm that sounded if the participant did not do a four second or greater duration wheelchair pushup in each ten minute interval. The participant was able to avoid the alarm by performing a four second or longer lift. The electronic timer was attached to a pressure sensitive device placed under each participant's wheelchair cushion and continuously scored sitting or wheelchair push-ups. During the intervention, the participant was told an alarm would sound for 30 seconds if he remained seated for 10 minutes without relieving pressure from the seat cushion, but that he could avoid the alarm by doing a push-up within every 10 minute interval. The procedures do not state whether the behavioral data was given as feedback to participants. There was no correspondence reliability (e.g., calibration) taken between what the timing device recorded and the frequency and duration of wheelchair push-ups performed.

Research Design: This was a multiple case-study with a single-subject design.

Research Results: Participant 1 increased the number of push-ups performed in a measured interval during the study, thereby decreasing the number of alarms which sounded. Participant 2 showed similar results but the data were much more variable and the wheelchair push-ups were not under the control of the alarm avoidance procedure until well into the intervention phase (55 one-hour sessions). Two of the participants were removed from the study due to early discharge and one participant was considered to perform the criterion behavior acceptably and needed no intervention.

Discussion & Conclusions: The electronic timer device proved to be an effective, but not sufficient device for eliciting wheelchair push-ups on a regular basis. This formative study offered no clear evidence linking the relationship between maximal lengths of sitting without pressure releases to the development of pressure sores.

Comments & Critiques: Like the Merbitz et al. study (1985), this article did not address whether the electronic unit and alarm unit were calibrated (checked to determine if the electronic counters accurately measured the participants' performance of wheelchair push-ups). The authors did not indicate if feedback from the counter was given to the participants so that they could increase their frequency of wheelchair push-ups, nor was a description given of what standard instructions the patients received about preventing pressure sores. The authors suggested that the maximum sitting time without a pressure relief should be no more than 10 minutes; however, there was no rationale

for this, nor explanation of why four seconds was designated as the appropriate length for wheelchair push-ups done every 10 minutes. The article did not reveal how skin inspections for the presence of pressure sores were performed. This is of ethical concern because the study participants either had pressure sores which could have become worse or had a history of ischial pressure sores. The researchers did not obtain social validation information from the participants (e.g., “Did they like the intervention?” “Would they recommend it to others who have problems with pressure sores?”). The follow-up data on this early study for participants 1 and 2 were taken only over a time period of two hours per day for two days. When one considers the long-term nature of this target behavior (essentially over a lifetime to prevent pressure sores), the follow-up period seems insufficient to determine whether the intervention actually changed the frequency and duration of the participants' wheelchair push-ups over the long run.

From an innovation and operant analysis, this was an early study that provided a foundation for other later studies (e.g., Merbitz et al., 1985; White et al., 1988) to follow. It offers a simple behavioral approach to helping to teach people with spinal cord injuries to perform regular pressure reliefs to avoid onset of skin problems.

Other Pertinent References:

Fordyce, W. E., & Simmons, B. C. (1968). Automated training system for wheelchair pushups. *Public Health Reports*, 83,527-528.

Merbitz, C. T., King, R. N., Bleiberg, I., & Grip, I. C. (1985). Wheelchair push-ups: Measuring pressure relief frequency. *Archives of Physical Medicine and Rehabilitation*, 66, 433-438.

Research Question: What are the effects of using a pressure relief monitoring device, written and/or oral feedback and an electrical timer on the frequency of pressure reliefs by wheelchair users?

Participants: Seven newly-injured SCI paraplegic patients.

Settings: Rehabilitation hospital setting implied and home visits while in wheelchair with the TLC attached.

Independent Variable(s): Written and/or oral feedback on patient's lifting performance and an electronic timer. (Reliability measures of independent variable not reported.)

Dependent Variable(s): The frequency of wheelchair push-ups and the duration between push-ups; staff also logged regular skin inspections for pressure sores. (Reliability measures of dependent variables not reported).

Procedures & Reliability: All participants in this study received standard care and instructions from nursing staff to perform regular pressure reliefs. The timer-logger-communicator (TLC) was attached to each participant's wheelchair and when a weight > than 20 kg was applied to a large air bladder, it forced air through a tube to smaller bladder which activated a switch to a pocket computer that continuously scored sitting or wheelchair push-ups. This behavioral data was inspected daily and feedback was provided to participants on a weekly or more frequent basis if the participants desired. There was no correspondence reliability (e.g., calibration) taken between TLC recordings and performance of actual wheelchair push-ups.

Research Design: This is a multiple case-study design.

Research Results: The treatment effects were variable and inconclusive. Participant A showed the most dramatic effects with the use of an electric timer and written and oral feedback. For participant B, frequency of wheelchair push-ups were increasing at the time when the treatment was initiated. There was no generalization of effects in non-clinical settings for participant B. Participant C received standard treatment but refused regular feedback and counts for push-ups. He developed a Grade II pressure sore later in the study. No clear trend could be detected from duration of sitting time without pressure reliefs. Cases D, E, F, & G were inconclusive.

Discussion & Conclusions: The TLC is an innovative device that tracks patients' wheelchair push-ups across time and settings. The permanent printed record offers evidence that can be used for discussion between clinician and patient to discuss future behavior patterns. This formative investigation offered no clear explanation between length of sitting without pressure releases and the formation of pressure sores.

Comments & Critiques: This article did not address whether the TLC unit was calibrated (that is, was it checked to see if the data on the print-out matched the actual behavior of interest). Participant feedback was not described making replication difficult for other researchers. Additionally, no information was offered as to the recommended minimal duration of a pressure relief. The article did not include the procedures used to inspect the skin for presence of pressure sores and reliability of the pressure sore checks was not offered. On the positive side, this was an early study and followed up on much less sophisticated work. It offers a behavioral approach to helping to teach people with disabilities to self-monitor and perform regular pressure reliefs to avoid onset of skin problems. In the discussion, the authors suggested that the maximum allowable sitting time without a pressure relief was 20 minutes, however there was no rationale provided.

Other Pertinent References:

Chawla, J. C., Andrews, B., & Bar, C. (1978-1979). Using warning devices to improve pressure-relief training. *Paraplegia*, 16, 413-419.

Fordyce, W. E., & Simmons, B. C. (1968). Automated training system for wheelchair pushups. *Public Health Reports*, 83, 527-528.

Malament, I. B., Dunn, M. E., & Davis, R. (1975). Pressure sores: Operant conditioning approach to prevention. *Archives of Physical Medicine and Rehabilitation*, 56, 161-165.

Roberts, A. H., Dinsdale, S. M., Matthews, R. E., & Cole, T. M. (1969). Modifying persistent undesirable behavior in a medical setting. *Archives of Physical Medicine and Rehabilitation*, 50, 147-153.

Research Question: What are the effects of a behavioral modification program using a token economy with backup reinforcers upon the self-practice of regular hygiene to maintain healthy skin?

Participants: There was only one participant, a 29-year-old male who was hydrocephalic and paralyzed from birth. The participant was in and out of hospitals for several years with regularly occurring severe pressure sores, which eventually necessitated major surgery (hemicorporectomy).

Settings: The rehabilitation hospital setting and later in a nursing home setting.

Independent Variable(s): The study employed a token economy reward system for the completion of any of twelve daily personal hygiene tasks.

Dependent Variable: The dependent variable of interest was the percent of time occupied with stump irritation or decubitus ulcer.

Procedures & Reliability: The fixed-ratio reinforcement schedule allowed coupons to be issued immediately after the occurrence of any of the 12 designated daily hygiene tasks. Coupons were then traded for cups of coffee (one coupon per cup), which the participant loved to drink. No reliability data were presented.

Research Design: Case-study approach using a single-subject design.

Research Results: The behavior modification program that reinforced good hygiene behavior had an effect upon the amount of time engaged in personal hygiene tasks and number of hospitalizations.

Discussion & Conclusions: This approach to helping a person with a severe disability perform regular personal hygiene has many positive features. First, it was successful in achieving the desired targeted behavior. The participant had a long history of non-compliance in carrying out regular hygiene behavior, which eventually resulted in multiple major surgeries for pressure sores.

Eventually, the participant was able to secure a job in a sheltered workshop and had developed a higher quality of life. This early application of learning principles was robust for its time and the development of the field at that time.

Comments & Critiques: The article was clear and presented the behavior modification program in an understandable fashion. The outcome data on the percent of time occupied with stump irritation or decubitus ulcer was presented, yet the process data (the number of regular daily hygiene tasks carried out each day) and the immediate goals of the intervention program were not presented. Nor was any reliability data presented on whether the issue of coupons or redemption of coupons was administered in a systematic fashion.

The authors did request social validation information from the participant who stated that he did not like the program at first, but then liked it better later on because he believed it helped him. He also stated that people responded more positively to him since the program started.

Other Pertinent References: None.

Rodriguez, G. P. & Garber, S. L. (1994). Prospective study of pressure ulcer risk in spinal cord injured patients. *Paraplegia*, 32, 150-158.

Research Question: This study asked two questions. The first was whether the urinary excretion of collagen metabolic substances (glucosylgalactosyl hydroxylsine [Glu-gal Hyl] and galactosyl hydroxylsine [gal-Hyl], calcium, and creatinine) in persons with spinal cord injury could predict the presence or absence of pressure sores. The second was whether the Health Beliefs Model developed by Yu-Tzu and Catanzaro (1987) could predict adherence to pressure ulcer prevention strategies.

Participants: Sixty-two male participants who were more than six months post-injury and had at least one Stage II pressure ulcer in the past but whose skin was free of skin problems at the time of recruitment were included in the study.

Settings: The authors do not inform readers where the interviews and urine samples were taken. Participants were living in the community, and it is not clear whether testing occurred in the participants homes or if they were brought into the PM&R Department at Baylor College of Medicine for data collection.

Independent Variable(s): This was a descriptive study; no intervention was applied to participants. Those in the experimental group were contacted every four to six weeks to go through the battery of urine testing and interviews.

Dependent Variable(s): Glu-gal, gal- Hyl, calcium, and creatinine concentrations were all taken via a 24-hour urine sample and demographic information, number of previous ulcers and how participants managed them, knowledge about prevention practices, and information about their family and living situation, employment and educational status and activities were collected via an interview.

Procedures & Reliability: Forty-two were placed in the experimental group and 20 in the control group. The study was conducted over the course of two years. Control group participants were given an initial interview which included collecting demographic information as well as information about their knowledge base regarding pressure ulcer prevention techniques and general health belief data. At the time of this interview, the control group participants also provided a 24-hour urine sample. The same procedure of interview and urine sample was taken again at the end of the study period. Participants of the experimental group also went through the interviews and urine sample tests at the beginning and end of the study, however, they also completed a questionnaire at these times that inquired about their skin-care practices over the last three days as well as about any changes in their living arrangements. Data from the experimental group participants was gathered on a random schedule every four to six weeks. Confirmation of the participant's medical history was obtained via medical charts when available, however the authors did not present information

regarding the availability of these records. The authors did not give further description of methods that may have been used to check the reliability of the prevention practices reported by participants. The authors gave a short description of how collagen metabolite substances were quantified, citing Rodriguez & Claus-Walker (1984) as the source where a more lengthy description of the process could be found.

Research Design: A prospective cohort study.

Research Results: Of the initial 62 persons in the sample, only 47 remained at the end of the two-year period. Those who developed ulcers over the study period were about equal for the control and experimental groups; of those who developed an ulcer, 25% were from the control group and 28% were from the experimental group. Between those who developed an ulcer (n=16) and those who did not (n=31) there were not found to be any significant differences with relation to age, age at onset of injury, race, and years since injury. However, those who developed an ulcer tended to have had more ulcers previously (4.64 versus 2.15), to have injury levels above T6, were more likely to be unemployed, not attending school, and to have higher concentrations of glu-gal Hyl in their last urine sample. Fluctuations in this indicator reached more than two to three times the usual level of those who did not develop an ulcer. Although not statistically significant, 36% of participants who developed ulcers smoked, while 26% of non-smokers developed ulcers.

No significant differences existed between those who developed an ulcer and those who did not with regard to the importance of prevention strategies and their beliefs about the risks of or seriousness of developing an ulcer. A difference did exist between perception of developing an ulcer and previous past occurrences, those who had fewer ulcers believed they were less likely to develop an ulcer.

Discussion & Conclusions: This investigation succeeded in gathering some interesting preliminary information regarding an association between levels of collagen metabolites excreted in the urine of persons with spinal cord injury and the incidence of developing a pressure ulcer. Urine samples revealed that increased collagen metabolite levels occurred before the ulcers developed. If trends found in these data can be replicated, then it may eventually be possible to predict the occurrence of pressure ulcers. However, it is not clear that prediction by this method will improve prevention. It may be the case that by the time collagen metabolites have increased, tissue damage has already occurred. Replication and extension of this investigation should be done to more clearly understand the relationship between increased levels of collagen metabolites in urine samples and the development of pressure ulcers.

Comments & Critiques: This was a useful study in gathering data on the level of collagen metabolites in urine samples of persons with spinal cord injury and on their knowledge of prevention practices and general health beliefs. However, there were a number of shortcomings of this study that should be acknowledged with regard to methodology and using participant beliefs as a dependent variable versus participant behaviors. The first concern was that the authors did not present data for the number ulcers participants had before their entrance into the study nor was information provided about how many reports of ulcer occurrences were confirmed from medical records. A second problem was that the authors purported in their introduction to want to predict adherence to prevention strategies, however they did not collect data on actual prevention or management practices performed by participants. Without this information the investigators cannot determine that knowledge of practices translated into actual performance of practices. The authors also did not obtain any information with which they could compare performance of prevention behaviors between those who developed ulcers versus those who did not. Without data regarding prevention practice behaviors, the authors could not begin to determine what prevention techniques that participants rated as important (i.e., use of wheelchair cushions, hygiene, weight shifts, skin

inspections, etc.) actually proved to be most effective. This point was a criticism the authors themselves also made in their introduction regarding previous research.

Other Pertinent References:

Gosnell, D. I. (1973). Assessment tool to identify pressure sores. *Nursing Research*, 22, 55-59.

Krouskop, T. A., Noble, P.C., Garber, S. L., & Spencer, W. A. (1983). The effectiveness of prevention management in reducing the occurrence of pressure sores. *Journal of Rehabilitation Resource Development*, 20, 71-83.

LaMantia, I. G., Hirschwald, I. F., Goodman, c. L., Wooden, v. M., Delisser, O., Staas, Ir., W. E. (1987). A program design to reduce chronic readmissions for pressure sores. *Rehabilitation Nursing*, 12, 22-25.

Young, I. S. & Burns, P. F. (1981). Pressure sores and the spinal cord injured. *CI Digest*, 3, 11-23.

Rosenthal, M. J., Felton, R. M., Hileman, D. L., Lee, M., Friedman, M., & Navach, J. H. (1996). A wheelchair cushion designed to redistribute sites of sitting pressure. *Archives of Physical Medicine and Rehabilitation*, 77, 278-282.

Research Question: Four different wheelchair seat cushions were compared on various dimensions to determine which design was best for redistributing pressure onto anatomic sites that are better able to handle pressure.

Participants: Forty-seven individuals who use wheelchairs for mobility and were being seen on an outpatient basis at a veteran's medical facility participated.

Settings: A Veterans Administration Medical Center (VAMC) in California.

Independent Variable(s): Researchers compared their design for a wheelchair cushion, the Total Contact Seat (TCS) to 3 other models, the Roho seat, a Bye-Bye Decubiti, and a Jay cushion. The TCS seat cushion design used a prosthetic fitting technique to redistribute pressure onto anatomic sites that can better handle pressure.

Dependent Variable(s): Interface pressure exerted upon five anatomical sites (right and left trochanters, right and left ischial tuberosities, and coccyx) of an individual sitting on a wheelchair cushion at six points in time during a 30-minute period.

Procedures & Reliability: Participants were fitted in a standard 46-cm wheelchair adjusted to their height, weight, and girth and placed on four different types of seat cushions, one at a time for 30 minutes per cushion. Between each cushion test, participants sat in their own wheelchair for a 30-minute interval. Two methods were used to measure load distribution (pressure) on five anatomical locations during six points in time over a 30-minute period while the participant sat on the wheelchair cushion. One method investigators used to determine pressure at each anatomical site was an air pressure pad that had an internal electric contact sensor; the second method was use of a pressure-controlled contact circuit. Reliability of these instruments was obtained by using several calibration methods. The authors did not specify how often or when these checks occurred, but reported reliability of measures to be 85-90%.

Research Design: A repeated measures randomized design.

Research Results: Investigators found that interface pressures were lowest on the TCS system at all anatomical sites over the 30-minute period.

Discussion & Conclusions: All seat cushion models tested reduced the interface pressure on the anatomical sites observed. All the models performed their best upon initial placement of participants and pressures increased over the 30-minute observation periods. According to the data presented, the TCS system performed significantly better than the other systems. Possible contributors to better pressure reduction performance of the TCS system were design features that did not allow participants to slide into pressure sensitive zones and lessen compression of their soft tissue due to

engineering techniques which allowed weight to be rolled forward onto the inferior pubic rami and away from ischial tuberosity.

Comments & Critiques: This was an interesting preliminary comparative study of the effectiveness of various wheelchair cushions to reduce pressure exerted on different anatomical sites. The data presented in this article suggest that design features of the TCS system can reduce the pressure exerted at various anatomical sites even better than existing cushion systems. Further research needs to be done with this system which confirms these findings and further extends the application of the system. Although the data look promising for this system, the authors did not present pressure data for all of the anatomical sites observed. The only data presented was that obtained from the left ischial tuberosity and of one other site (thigh). Readers were informed that all other anatomical sites were lower for this system than for other systems, but the authors did not present this data. A number of questions that were not answered by their study are: (a) how do each of these systems perform when participants use them in their own wheelchairs, (b) how well do the cushions operate when exposed to normal pressures exerted over time periods that are similar to actual daily usage, and (c) what is the maximum allowable pressure for each anatomic site that decreases the pressure sore development?

Other Pertinent References:

Bowker, P., & Davidson, L. M. (1979). Development of a cushion to prevent ischial pressure sores. *British Medical Journal*, *2*, 958-961.

Krouskop, T. A. (1983). A synthesis of the factors that contribute to pressure sore formation. *Medical Hypothesis*, *62*, 300-306.

Velez-Campos, & L., Mahoney, P. (1987). DRG's and pressure sores. *Journal of Enterostomy Therapy*, *14*, 243-247.

Rottkamp, B. C. (1976). An experimental nursing study: A behavior modification approach to nursing therapeutics in body positioning of spinal cord-injured patients. *Nursing Research*, *25*(3), 181-186.

Research Question: What are the effects of a behavior modification approach on frequency of and patient participation in changes of body position?

Participants: Ten SCI patients with varying sensory-motor abilities.

Settings: Rehabilitation hospital clinical setting,

Independent Variable(s): Behavior modification program consisting of: modeling (diagrammed illustrations, demonstration of body position techniques), shaping by manual and verbal prompts, practice, and reinforcement.

Dependent Variable(s): Frequency of and patient participation in changes of body position.

Procedures & Reliability: Four phases of training included modeling (diagrammed illustrations coupled with demonstrations), shaping, practice, and then implementation of a body-positioning schedule were used to train patients about body positioning behavior. Participants had to satisfy certain criteria in each phase before proceeding to the next. Phase Four was an exception because the study terminated. The 10 SCI patients were divided into experimental and control groups, with five matched participants in each group. The authors state that nursing attendants were assigned to perform reliability observations; yet, reliability was not defined in this study.

Research Design: This was a multiple case-study design.

Research Results: In the pre-treatment experimental group, four patients had lesions (pressure ulcers). In the pre-treatment control group, zero patients had lesions. In the post-treatment experimental group, two patients had lesions. In the post-treatment control group, two patients had lesions, with one patient experiencing a total of six lesions. A comparison of pre- and post-treatment effects showed that the experimental group had more body changes on a daily basis post-treatment,

an increase in patient-initiated body changes, and a decreased need of assistance from staff. Authors offered that participants gave positive feedback, such as “I feel better since the program.”

Discussion & Conclusions: The authors identified a number of limitations of the study including the small sample size, inability to achieve perfect matches in each group, lack of uniformity in implementing experimental treatment procedures, and the complexity of the clinical setting regimens. Authors attached importance to the need for rehabilitation settings to address the issue positioning-positioning because of the effect on patient self-care. Statements from staff were included that highlighted positive effects on patient self-care and motivation to plan for discharge. More research was indicated that could control for greater uniformity of treatment implementation and variability of characteristics among the sample groups. Behavioral treatments in nursing self-care should be more systematically implemented in rehabilitation hospitalization and other rehabilitation services.

Comments & Critiques: Reliability was not clearly described in this study. There was no indication of the type of recording apparatus used and it was unclear as to how often measurements were taken. This was possibly due to an individual implementation procedure whereby intervention occurred on a need basis, which could be viewed both positively and negatively. This type of intervention allowed the maximum of self-initiation of the procedures; however, it contributed to the lack of uniformity in treatment implementation. A significant drawback of this study is that no follow-up was conducted with the participants in either the clinic setting or post-rehabilitation, community settings. No baseline information was provided on several important measures, though pre- and post-comparisons were made for frequency of changes in body positions, self-initiated changes in body positions, and amount of assistance needed.

Other Pertinent References:

Abramson, A. S. (May, 1967). Modern concepts of the management of the patient with spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, 48, 113-121.

Edberg, E. L. and others. (March, 1973). Prevention and treatment of pressure sores. *Physical Therapy*, 53, 246-252.

Kaplan, L. and others. (1966). *Comprehensive follow up study of spinal cord dysfunction and its resultant disabilities*. New York, New York University Medical Center. Institute of Rehabilitation Medicine.

Pratt, R. (1971). Nursing management of acute spinal paraplegia. Part 3. Prevention of pressure sores and contractures. *Nursing Times*, 67, 567-569.

Sugarman, B. (1985). Infection and pressure sores. *Archives of Physical Medicine and Rehabilitation*, 66, 177-179.

Research Question: What is the relationship between infection and the onset of pressure sores or the healing of pressure sores?

Participants: Two groups of persons with SCI were followed and evaluated. Those in group I were 209 persons admitted to the SCI unit and evaluated every week after their admission.

Group II were 58 consecutive patients who were evaluated at the same time because of at least one pressure sore or presumed infection.

Settings: SCI service at a VA Medical Center

Independent Variable(s): None. This was a non-experimental study

Dependent Variable: The presence of an infection and its effect upon the development of a pressure sore or the prevention of a pressure sore from healing.

Procedures & Reliability: Whole body bone scans were imaged with a scintillation camera equipped with a regional scan two to four hours after injection of Tc methylene diphosphonate to detect whether hidden or underlying infections were present under or near visible pressure sore

wounds or where pressure sores most often occur (e.g., trochanter or ischial tuberosities). These scans were followed with whole body scans approximately 6 hours after the injections of 4-5 mci of Ganitrate.

Research Design: A comparison design between patients who showed no current signs of pressure sores and those admitted because of at least one pressure sore or presumed infection.

Research Results: The body scans showed some very interesting results. At least one decubitus ulcer extending visibly beneath the dermis was present in 119 of the 209 (57%) of persons in group I and in 100% of the 58 patients in group II at one time during the evaluation process. The majority of those patients from groups I and II (n=49) who had pressure sores that did not heal had underlying "deep infections." For most of these patients, the unchecked infection had caused osteomyelitis of the bones beneath the pressure sores.

Discussion & Conclusions: The author indicated that not all pressure sores are as straightforward as they might appear. Based on the results, he asserts that some pressure sores are not caused by pressure at all, but rather deep-seated infections that caused tunneling in the cavity underlying the skin surface. "Pathogenesis of these sores is not always clear. For example, did infected joints cause tracts to develop and create cutaneous sores, or did sores burrow deep into the joints?"

Comments & Critiques: Overall, this study was thorough. While it did not address primary prevention of the onset of pressure sores, it illuminated the role of infections in the development of pressure sores and their resistance to healing.

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Research Question: What are the effects of antecedent (i.e., instructions, audible prompts) and consequent (i.e., alarm avoidance) events, used both separately and combined, on the frequency of push-ups for pressure relief by wheelchair users?

Participants: Two 11-year-old youths with spina bifida tested as having a low to normal range of functioning and who used wheelchairs as their primary means of locomotion.

Settings: A treatment facility, with both residential and school settings; a private home and neighborhood grade school for one participant for a portion of the study.

Independent Variable(s): Instruction on performance of wheelchair push-ups; prompting with a watch beeper; alarm avoidance.

Dependent Variable(s): The frequency of wheelchair push-ups of three seconds or more and the length of time between push-ups of acceptable duration. Staff checks to record skin condition throughout the study.

Procedures & Reliability: The complete intervention, known as the "Beep 'n' Lift," included three components. Both participants in this study received instruction and demonstration of wheelchair push-ups, including an opportunity to ask questions and to practice with the instructor. Both were given a watch beeper with clear instructions to perform wheelchair push-ups when the watch emitted a 30 to 35 dB beep every half hour. Both also had a programmable alarm attached to his or her chair that, when activated emitted a pulsating 86 dB noise for six seconds after a 30-minute interval in which the participant did not do a push-up of at least three seconds. An automatic recording device attached to the chairs of both participants was used to measure the frequency and duration of wheelchair push-ups of three seconds or longer, and of periods of prolonged sitting. Alternating experimental conditions, including baseline, Beep 'n' Lift, alarm avoidance only,

prompting with beeper only and follow-up, within participants were used to test the effectiveness of various intervention components.

Each day's wheelchair push-up data was divided into 30 minute intervals and was collected three times weekly. The computer and alarm also were serviced three times weekly. The computers were calibrated 24 times during the study, with the reliability of scoring of the computer printout tapes also measured by two independent observers. Two nurses trained in observing and scoring pressure sores independently checked participants for skin condition before the study began and before each change of experimental condition. Interobserver agreement was assessed to provide 100% agreement in all conditions. A social validation procedure, involving both participants and a panel of rehabilitation professionals, was used to assess the appropriateness of the intervention from the participants' perspectives and the significance of the intervention's effects from the perspective of rehabilitation experts.

Research Design: This was a multiple baseline design across participants.

Research Results: For both participants, use of the complete Beep 'n' Lift intervention increased the average percentage of intervals with appropriate wheelchair push-ups 3.2 times over baseline, suggesting that the combination of instructions, prompts, and avoidance procedures was effective for both participants. Using prompts only, without alarm, produced an average percentage of appropriate intervals of nearly twice the baseline, but only two-thirds as effective the complete intervention. Similarly, use of alarm avoidance only increased the average percentage of appropriate intervals to over twice the baseline level but was only approximately half as effective as the complete intervention. In the three day follow-up period occurring one month after the main portion of the study, one participant had an occurrence of appropriate push-ups in 68% of the intervals, while the other participant had an occurrence of appropriate intervals in an average of 45% of the intervals observed. No pressure sores were observed on either participant during the study. Both participants and panelists indicated their overall approval of the Beep 'n' Lift program, although the participants rated the alarm consequence as moderately unacceptable.

Discussion & Conclusions: The Beep 'n' Lift program used as a whole can substantially improve the frequency of push-ups by wheelchair users. Used separately, the beeper prompt and the alarm avoidance component produced results over twice the baseline level, but less effectively than the complete program. While there is no consensus on the length and frequency of push-ups needed to prevent pressure sores, the use of three second lifts every 30 minutes in this study and the finding of no observable skin breakdown suggest probable clinical significance. The social validation procedures used demonstrate the usefulness and acceptability of the intervention by both participants and medical experts.

Comments & Critiques: Reliability was assured several ways in this study: by carefully documenting the calibration and servicing of equipment throughout the study; by ensuring adequate instruction and demonstration to participants; and by assessing interobserver agreement regarding observation of skin condition. Sensitivity to the appropriateness of the intervention was also demonstrated by inclusion of a social validation procedure. While it produced much useful data, an increase in the number of participants might have provided additional data to explain further the discrepancy in the rates of push-ups by participants during the three day follow-up periods. The authors suggest a number of valid directions for research that are likely to increase the ability of wheelchair-users to prevent pressure sores.

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Research Question(s): Which of the four types of pressure-relieving devices was most effective in preventing heel pressure sores?

Participants: Forty-one chronically ill elderly patients admitted with fractured femurs into an orthopedic ward. The average age was 82 and 83% were female.

Setting: An orthopedic hospital ward in Brisbane, England.)

Independent Variable(s): Four heel pressure-relieving devices: foam splints, eggshell foam, duoderm, and heel protector boots.

Dependent Variable(s): Skin integrity was assessed by rating the skin on four criteria: skin condition, color, sensation, and wound status. Risk for developing a pressure sore was assessed with the Douglas -Norton Risk Assessment Scale, which was adapted for use at Royal Brisbane by combining the Douglas Pressure Sore Risk Calculator and the Norton Scores.

Procedures & Reliability: Upon admission to the study all participants were given the Douglas-Norton Risk Assessment Scale to evaluate their risk for developing a pressure sore. Participants were then randomly assigned to one of the four pressure relieving devices. Skin condition was monitored by nurses every two to three hours daily for 12 days. During these skin checks nurses performed their regular skin care procedures which included repositioning and providing direct pressure relief. Skin integrity scores were totaled and averaged over the entire 12 day period. No description was provided regarding the reliability of nurses' observations and scoring of skin integrity nor for the performance of standard pressure relieving care activities.

Research Design: Comparison design with no controls.

Research Results: The results revealed that eggshell foam and foam splints were most effective in reducing alterations to skin integrity. Duoderm and heel protector boots appeared to be ineffective in relieving heel pressure. Duoderm was discontinued six weeks into the study because two of six participants (33%) developed blisters on their unbroken legs. At this time heel protector boots were introduced into the study, and two of five participants (40%) given this device developed blisters on their affected heels of the broken leg.

Discussion & Conclusions: This study indicates that some heel pressure-relieving devices are more effective in preventing changes to skin integrity than others. This information is important for those working with elderly, chronically ill populations whose mobility is restricted in trying to prevent pressure sores from developing.

Comments & Critiques: Although results of this study suggest that some pressure relieving devices are more effective in reducing changes to skin integrity, a number of reasons warrant that the findings should be interpreted cautiously. The first cause for concern is that there were no data presented of skin condition scores before the pressure-relieving devices were applied; the data reported were only that of changes in skin integrity after devices had been used for 12 days. Without baseline data, readers cannot directly compare pre and post scores, but must rely upon the authors' reports of skin changes. Compounding this concern is that reliability was not reported gauging the accuracy of measuring changes in skin integrity, nor was reliability reported for the performance of "standard care" for participants. A second concern is that the authors report the nurses checked participants skin every two to three hours and provided direct pressure relief and repositioned the

heels, however, checks on the regularity and uniformity of these procedures were not reported. A third reason for cautious interpretation of the results is that a true random sampling was not achieved in providing participants with pressure-relieving devices due to unanticipated problems with one of the devices six weeks into the study. Finally, the omission of detailed descriptions of the pressure-relieving devices inhibits replicability.

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