Date: December 14, 2015

Title: Comparison of "Push-Up" Pressure Relief and Wheelchair Tilt Pressure Relief to Reduce the Incidence of Pressure Ulcer Formation in Children, Adolescents and Young Adults with a Traumatic Spinal Cord Injury[1]

Clinical Question

P	*(Population/Problem)*	Among children aged 5 to 21 years who sustain a traumatic spinal cord injury
I	*(Intervention)*	does "push-up" pressure relief
C	*(Comparison)*	compared to wheelchair tilt pressure relief*
O	*(Outcome)*	reduce the incidence of pressure ulcers?

***Definitions** for terms marked with * may be found in the Supporting Information section.*

Target Population for the Recommendation

Children, adolescents and young adults with spinal cord injury age 5 to 21 years

Inclusions

- Diagnosis of spinal cord injury of traumatic onset

Exclusions

- Diagnosis of spinal tumors
- Congenital spinal cord injury including but not limited to Myelomeningocele
- Cerebral Palsy
- Scoliosis
- Tethered Cord

Recommendation

There is insufficient evidence and a lack of consensus to make a recommendation on preferred methods of seated pressure relief when comparing push-up pressure relief versus wheelchair tilt pressure relief.

Note: There are five pressure relief methods sited within the literature. It is appropriate to select any one method to achieve seated pressure relief as follows (Local Consensus [5]):

a. A wheelchair push-up, forward lean or lateral lean sustained for a period of 30 seconds to 3 minutes and 30 seconds, every 15 to 30 minutes *(Regan 2009 [1b], Sprigle 2010 [3b], McDonald 2001 [5b], Perry 2010 [5b], Perry 2007 [5b], Perry 2006 [5b]).*

b. A wheelchair tilt *(Sprigle 2010 [3b])* performed for a minimum of 30 degrees of tilt *(Giesbrecht 2011 [4a])*

Note: Consider performing the tilt for 5 minutes, every 30 minutes *(Coggrave 2003 [4b], Local Consensus [5])*

c. A wheelchair tilt *(Sprigle 2010 [3b])* performed for a minimum of 35 degrees of tilt combined with 100 degrees of recline *(Jan 2010 [4a]).*

Note: Consider performing the tilt and recline for 5 minutes, every 30 minutes *(Coggrave 2003 [4b], Local Consensus [5]).*

d. A wheelchair tilt *(Sprigle 2010 [3b])* performed for a minimum of 25 degrees of tilt combined with 120 degrees of recline *(Jan 2010 [4a]).*

Note: Consider performing the tilt and recline for 5 minutes, every 30 minutes *(Coggrave 2003 [4b], Local Consensus [5]).*

e. A wheelchair tilt performed as far as the seating system permits *(Sonenblum 2011 [4a])*

Note: Consider performing the tilt for 5 minutes, every 30 minutes *(Coggrave 2003 [4b], Local Consensus [5]).*

[1] *Please cite as: Raugh L., Cincinnati Children's Hospital Medical Center: Best Evidence Statement for Comparison of "Push-Up" Pressure Relief and Wheelchair Tilt Pressure Relief to Reduce the Incidence of Pressure Ulcer Formation in Children, Adolescents and Young Adults with a Traumatic Spinal Cord Injury, http://www.cincinnatichildrens.org/service/j/anderson-center/default/, BESt 195 pages 1-14, December 14, 2015.*

Discussion/Synthesis of Evidence related to the recommendation

A comprehensive literature search comparing two seated pressure relief techniques (Push-Up Pressure Relief and Wheelchair Tilt Pressure Relief) was performed to investigate which technique, if any, had a superior effect on reducing pressure ulcer formation. No direct comparison of push-up pressure relief versus wheelchair tilt pressure relief was identified within the literature. Pressure relief techniques must be chosen based on sustainability and applicability *(Regan 2009 [1b, Sprigle 2011 [1b])*. For example, a wheelchair push-up may be difficult to sustain for the recommended length of time for tissue oxygenation levels to return to their unloaded levels *(Regan 2009 [1b])* due to muscle weakness, alterations in muscle tone, decreased endurance, decreased function or other medical conditions *(Sonenblum 2014 [4a], Sprigle 2010 [3b])*. Therefore, alternative methods of seated pressure relief may be more efficient, including forward lean, lateral lean, or wheelchair tilt and/or recline *(Giesbrecht 2011 [4a], Guihan 2009 [4b], Perry 2010 [5b], Perry 2007 [5b], Hickey 2000 [5b), Sonenblum 2014 [4a], Sprigle 2011 [1b])*. Wheelchair tilt must be performed *(Sprigle 2010 [3b])* for a minimum of 30 degrees of tilt *(Giesbrecht 2011 [4a])*, a minimum of 35 degrees of tilt combined with 100 degrees of recline *(Jan 2010 [4a])*, a minimum of 25 degrees of tilt combined with 120 degrees of recline *(Jan 2010 [4a])* or at the maximal tilt angle that the wheelchair would allow *(Sonenblum 2011 [4a])* to be considered effective. There was not an undisputed unanimous recommended length of time for the wheelchair tilt and/or recline to be implemented *(Coggrave 2003 [4b], Jan 2010 [4a])*. Although a few of the articles did agree that the historical recommended length of time (30 seconds) for seated pressure relief should be discredited *(Coggrave 2003 [4b], Regan 2009 [1b], Sonenblum 2014 [4a])*. This recommendation is based on more recent blood flow and perfusion studies that cite more lengthy bouts of pressure relief due to the time that the tissues surrounding the ischial tuberosities require to return to their unloaded, fully perfused states *(Sprigle 2011 [1b])*.

Limitations in the study methodologies primarily include limited pediatric research, small sample sizes, limited ability to test deeper tissues *(Jan 2010 [4a], Sonenblum 2011 [4a], Sonenblum 2014 [4a])* and variability among participants regarding biomechanics of tissue perfusion *(Maksous 2007 [4b], Sonenblum 2011 [4a])*.

Although the overall grade of the evidence is low, support exists in the literature to perform some type of pressure relief to decrease the formation of pressure ulcer formation. The impact of pressure ulcers has been studied extensively and consensus states that pressure relief does need to be performed, education needs to occur and further studies in this area are warranted *(Giesbrecht 2011 [4a], Jan 2010 [4a], Regan 2009 [1b], Sonenblum 2011 [4a], Sonenblum 2014 [4a], Sprigle 2010 [3b], McDonald 2001 [5b], Perry 2010 [5b], Perry 2007 [5b], Perry 2006 [5b]).*

In determining the strength of the recommendation, the development group made a considered judgment in a consensus process which was reflective of critically appraised evidence, clinical experience, and these dimensions:			
Given the dimensions below and that more answers to the left of the scales indicate support for a stronger recommendation, the recommendation statement above reflect the strength of the recommendation as judged by the development group. (Note that for negative recommendations, the left/right logic may be reversed for one or more dimensions.)			
1. Grade of the Body of Evidence	☐ High	☐ Moderate	☒ Low
Rationale:			
2. Safety/Harm (Side Effects and Risks)	☒ Minimal	☐ Moderate	☐ Serious
Rationale: Individuals who sustain a traumatic spinal cord injury are at high risk for pressure ulcer formation due to impairments in sensation and mobility *(Guihan 2009 [4b])*. In the pediatric population, the most common sites for pressure ulcer formation are the head, sacrum and heels *(Bernabe 2012 [5b])*. Performing the recommended seated pressure relief techniques described poses minimal risks to the patient and caregivers when accompanied with the appropriate education regarding the correct method.			
3. Health benefit to patient	☐ Significant	☒ Moderate	☐ Minimal
Rationale: Seated pressure relief techniques have the potential to decrease pressure ulcer formation and reduce hospital admissions, thereby reducing secondary effects of illness and immobility.			
4. Burden to adhere to recommendation	☐ Low	☐ Unable to determine	☒ High
Rationale: Pressure ulcers continue to persist in the spinal cord injured population. Exploring the reasoning behind noncompliance with seated pressure reliving techniques is beyond the scope of this document, but warrants further exploration to assist in decreasing the incidence and prevalence of pressure ulcer formation.			
5. Cost-effectiveness to healthcare system	☒ Cost-effective	☐ Inconclusive	☐ Not cost-effective
Rationale: Annual cost to treat pressure ulcers ranges from $1.3 to 3.6 billion *(Byrne 1996 [1b], Baranoski 2006 [5b])*. Healthcare costs could potentially be reduced via pressure ulcer prevention.			
6. Directness of the evidence for this target population	☐ Directly relates	☒ Some concern of directness	☐ Indirectly relates
Rationale: In the pediatric population, the most common sites for pressure ulcer formation are the head, sacrum and heels *(Bernabe 2012 [5b])*.			
7. Impact on morbidity/mortality or quality of life	☐ High	☒ Medium	☐ Low
Rationale: Pressure ulcers have the potential to affect body image, increase pain experiences, extend hospital admissions, cause complications from infection, prevent attainment of functional and social goals, and cause emotional distress *(Preston 2003 [5b], Baranoski 2006 [5b])*.			

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IMPLEMENTATION

Applicability & Feasibility Issues

The healthcare team must educate themselves on the current evidenced based literature regarding pressure ulcer formation and associated preventative strategies. Educating the patients and caregivers about pressure ulcers (precipitating factors, rationale and importance of adhering to the care recommendations) is essential for carry over and independent performance in the home and community *(McDonald 2001 [5b])*. The healthcare team must also determine the most appropriate and effective methods of educating and training to ensure competence and enable compliance *(Hickey 2000 [5b])*. These issues can be addressed through staff education and the development of Knowing Notes* for the patients and caregivers. The barriers to this type of education are compliance with staff, patients and caregivers. Facilitating factors include optimal clinic settings in place for therapists to provide this type of education and training to the patients and caregivers. Challenges include incorporating the evidenced based care recommendation into current work flow which requires appropriate staffing and support and willingness to change in order to embrace current evidence and provide best practice. Additional challenges include ensuring and monitoring compliance and providing this education on a consistent basis.

Obtaining appropriate wheelchairs and wheelchair modifications also need to be taken into consideration in order to carry out some of the seated pressure relief recommendations. Physical limitations may prevent an individual from performing a wheelchair push-up, forward lean or lateral lean, therefore wheelchairs equipped with tilt and recline functionality would be ideal *(Sonenblum 2014 [4a], Sprigle 2011 [1b])*. This issue can be addressed through appropriate referrals to experienced wheelchair fitting and seating clinics. The barriers to obtaining appropriate wheelchairs and wheelchair modifications include lengthy and in-depth healthcare insurance processes and cost. Facilitating factors include experienced physicians, therapists and medical equipment personnel working collaboratively in the wheelchair fitting and seating clinic and the individual participating in some type of healthcare insurance coverage. Challenges include obtaining, fitting and training of the wheelchair in a timely and functionally appropriate manner that encourages adherence to consistent seated pressure maneuvers to prevent pressure ulcer formation.

Relevant CCHMC Tools

Evidenced based guideline: Chronic Care: Self-Management.

Outcome Measures and Process Measures

- A decrease in the number of pressure ulcers among the target population.
- A decrease in the incidence of hospital admissions due to pressure ulcers among the target population.
- Improved scores on the Braden Q*/Modified Braden Q scale* *(Curley 2003 [4a])*.
- The percent of patients able to independently complete the seated pressure relief techniques.
- Improved scores on Quality of Life Measurement Scales.

SUPPORTING INFORMATION

Background/Purpose of BESt Development

Pressure ulcers are a common complication in the spinal cord injured population *(McDonald 2001 [5b])*. Pressure ulcers impose immense financial and emotional burdens and produce barriers to functional independence *(Regan 2009 [1b], Giesbrecht 2011 [4a], McDonald 2001 [5b], Hickey 2000 [5b])*. The 2010 National Spinal Cord Injury Statistical Center Annual Report states that disorders of the skin are the second leading cause of re-hospitalization. It also reports that infectious and parasitic diseases (commonly bloodstream infections, frequently related to pressure ulcers, respiratory infections or urinary tract infections) are the second leading cause of death (*NSCISC 2010 [5a]*). Education and training concerning effective and efficient pressure relief techniques may assist with decreasing the prevalence of pressure ulcer formation.

There is consensus among the literature regarding the utilization of education for prevention of pressure ulcer formation, but various strategies are outlined as a means of attaining this goal. Numerous seated pressure relief techniques exist including forward lean, lateral lean, push-up, and wheelchair tilt and/or recline. Historically, patients were instructed to perform a seated push-up for 15 to 30 seconds every 30 to 60 minutes *(Regan 2009 [1b])*. This method has been found to be ineffective at tissue unloading *(Regan 2009 [1b])*. For successful pressure reduction and tissue re-oxygenation to occur, the chosen seated pressure relief technique must be performed for a period of 30 seconds to 3 minutes and 30 seconds, every 15 to 30 minutes *(Regan 2009 [1b], Sprigle 2010 [3b], McDonald 2001 [5b], Perry 2010 [5b], Perry 2007 [5b], Perry 2006 [5b])*.

A number of government and health care accrediting and regulatory agencies such as The Joint Commission (TJC), the National Quality Forum, the Agency for Healthcare Quality and Research, and Centers for Medicare & Medicaid Services (CMS) agree that prevention is the key to decreasing the occurrence of pressure ulcers *(Makhsous 2009 [2b], Baranoski 2006 [5b])*. By incorporating preventative strategies into patient care guidelines and creating goals aimed at prevention, the goal is that incidence reduction will occur. Bundled interventions such as standardized risk assessments and monitoring, employee education and training, evidenced based best practice initiatives, and strategic planning are all suggested to create enduring pressure ulcer prevention programs *(Niederhauser 2012 [1b])*. These findings validate the crucial need for prevention of pressure ulcer formation *(Hickey 2000 [5b])* through pressure relief training and education with individuals who have sustained a spinal cord injury.

Definitions

Pressure ulcer: A lesion caused by unrelieved pressure that damages underlying tissue *(Baranoski 2006 [5b])*.

"Push-up" pressure relief: A push up performed in the wheelchair to take pressure off the buttocks and boney areas.

Wheelchair tilt pressure relief: Pressure relief performed by tipping the wheelchair backwards to relieve pressure from the sacrum and ischial tuberosities.

Braden Q Scale: A scale for predicting pressure ulcer risk in patients. The risk is stratified as high, moderate and mild based on many factors including mobility, activity, sensory perception, moisture, friction and sheer, nutrition and tissue perfusion and oxygenation (*Curley 2003 [4a]*).

Modified Braden Q Scale: The Braden Q Scale for pediatric use *(Curley 2003 [4a])*.

Knowing Note: Knowing Notes are education materials designed for patients and families at CCHMC.

Search Strategy & Evidence Table – See Appendix

Group/Team Members

Multidisciplinary Team

Team Leader/Author: Jody Raugh, PT, DPT, Division of Occupational Therapy and Physical Therapy
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Other BESt Development Support

Content Reviewers: OT/PT/TR Clinical Effectiveness Team
Support/Consultants: Michelle Kiger, OTR/L, Division of Occupational Therapy and Physical Therapy; Mary Gilene, MBA, Division of Occupational Therapy and Physical Therapy

Conflicts of Interest were declared for each team member and:

☒ No financial or intellectual conflicts of interest were found.
☐ The following conflicts of interest were disclosed:

Note: *Full tables of the LEGEND evidence evaluation system are available in separate documents:*

- Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality (abbreviated table below)
- Grading a Body of Evidence to Answer a Clinical Question
- Judging the Strength of a Recommendation (dimensions table below and Rationale)

Table of Evidence Levels (see note above):

Quality level	Definition
1a† or 1b†	Systematic review, meta-analysis, or meta-synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5a or 5b	General review, expert opinion, case report, consensus report, or guideline
5	Local Consensus

†a = good quality study; b = lesser quality study

Table of Language and Definitions for Recommendation Strength (see note above):

Language for Strength	Definition
It is strongly recommended that… It is strongly recommended that… not…	When the dimensions for judging the strength of the evidence are applied, there is high support that benefits clearly outweigh risks and burdens. (or visa-versa for negative recommendations)
It is recommended that… It is recommended that… not…	When the dimensions for judging the strength of the evidence are applied, there is moderate support that benefits are closely balanced with risks and burdens.
There is insufficient evidence and a lack of consensus to make a recommendation…	

Please cite as: Raugh, J., Cincinnati Children's Hospital Medical Center: Comparison of "Push-Up" Pressure Relief and Wheelchair Tilt Pressure Relief to Reduce the Incidence of Pressure Ulcer Formation in Children, Adolescents and Young Adults with a Traumatic Spinal Cord Injury, http://www.cincinnatichildrens.org/service/j/anderson-center/evidence-based-care/recommendations/default/, BESt 195, pages 1-14, 12/14/15.

This Best Evidence Statement has been reviewed against quality criteria by two independent reviewers from the CCHMC Evidence Collaboration. Conflict of interest declaration forms are filed with the CCHMC EBDM group.
The BESt will be removed from the Cincinnati Children's website, if content has not been revised within five years from the most recent publication date. A revision of the BESt may be initiated at any point that evidence indicates a critical change is needed.

Review History

Date	*Event*	*Outcome*
12/14/15	***Original Publication***	*New BESt developed and published*

For more information about CCHMC Best Evidence Statements and the development process, contact the Evidence Collaboration at EBDMinfo@cchmc.org.

Note

This Best Evidence Statement addresses only key points of care for the target population; it is not intended to be a comprehensive practice guideline. These recommendations result from review of literature and practices current at the time of their formulation. This Best Evidence Statement does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this Statement is voluntary. The clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

APPENDIX: EVIDENCE SEARCH STRATEGY, RESULTS, & EVIDENCE TABLE

Criteria for considering studies for this review

Types of Studies
All types of study designs were considered for inclusion in the systematic review

Types of Participants
Children, adolescents and young adults with spinal cord injury (of traumatic onset) age 5 to 21 years

Types of Interventions
"Push-Up" pressure relief and wheelchair tilt pressure relief were the interventions which were considered for inclusion in the systematic review

Types of Outcomes

- A decrease in the number of pressure ulcers
- A decrease in the incidence of hospital admissions due to pressure ulcers.
- Improved scores on the Braden Q*/Modified Braden Q scale.*
- The percent of patients able to independently complete the seated pressure relief techniques.
- Improved scores on Quality of Life Measurement Scales.

Exclusion Criteria

- Diagnosis of spinal tumors
- Congenital spinal cord injury including but not limited to Myelomeningocele
- Cerebral Palsy
- Scoliosis
- Tethered Cord

Search Strategy

Search Databases	Search Terms	Limits, Filters, & Search Date Parameters	Date of Most Recent Search
☒ MedLine via PubMed or Ovid	• Pediatric, School Age, Adolescent, Spinal cord injury, Trauma, Pressure, Pressure ulcer, Pressure relief, Pressure sore, Physical therapy, Exercise therapy, Physical activities, Physical performance, Positioning, Rehabilitation, Strengthening, Range of motion, Skin integrity, Occupational Therapy, Functional status, Education	Publication Dates or Search Dates: • 01/1996 to 02/2015 ☒ English Language	02/05/2015
☒ CINAHL	• Pediatric, School age, Adolescent, Spinal cord injury, Trauma, Pressure, Pressure ulcer, Pressure relief, Pressure sore, Physical therapy, Exercise therapy, Physical activities, Physical performance, Positioning, Rehabilitation, Strengthening, Range of motion, Skin integrity, Occupational therapy, Functional status, Education	Publication Dates or Search Dates: • 01/1996 to 02/2015 ☒ English Language	02/05/2015

Search Results & Methods
The initial search for evidence identified 29 articles.
24 articles met the inclusion criteria above.

Evidence Table for Included Articles (i.e., articles meeting inclusion criteria)

Citation	Purpose	Research Design and Study Sample	Results/Conclusions	Evidence Level
Baranoski (2006)	To provide the practitioner with updated information about pressure ulcers and their management.	Expert Opinion.	Awareness of the many problems created by pressure ulcers has exploded across the country. A multidisciplinary approach to managing and preventing pressure ulcers can help healthcare providers and patients avoid the devastating consequences of these wounds.	5b
Bernabe (2012)	Identification of at-risk patients, identification of guidelines and interventions to prevent skin breakdown.	Expert Opinion.	Identification of at-risk patients, identification of guidelines and interventions to prevent skin breakdown.	5b
Byrne (1996)	This review focuses on the major risk factors for the development of pressure ulcers in spinal cord injured individuals.	Systematic Review.	This review summarizes the published information on the 15 major risk factors to help make such a prevention program more manageable.	1b
Coggrave and Rose (2003)	The purpose of this study was to describe a specialist seating assessment clinic and a change in clinical practice arising from its work.	Descriptive, Retrospective Review	Results: Mean duration of pressure relief required to raise tissue oxygen to unloaded levels was 1 min 51 s (range 42 s—3 min 30 s). Conclusion: These results confirmed the clinical perception that brief pressure lifts of 15–30 s are ineffective in raising transcutaneous oxygen tension ($TcPO_2$) to the unloaded level for most individuals. Sustaining the traditional pressure relief by lifting up from the seat for the necessary extended duration is neither practical nor desirable for the majority of clients. It was found that alternative methods of pressure relief were more easily sustainable and very efficient.	4b
Curley et al (2003)	The purpose of this study was to: (a) establish the predictive validity of the Braden Q Scale in an acutely ill pediatric population; (b) determine the critical cutoff point for classifying patient risk; and (c) determine the best time to assess patient risk.	Prospective Cohort Study. A sample of 322 patients on bedrest for at least 24 hours without pre-existing pressure ulcers or congenital heart disease were enrolled from three pediatric intensive care units(PICU). The Braden Q score and skin assessment were independently rated and data collectors were blind to the other measures. Patients were observed up to 3 times per week for2 weeks and then once a week until PICU discharge for a median of 2 observations reflecting 887 skin assessments.	Eighty-six patients (27%) developed 199 pressure ulcers; 139 (70%) were Stage I pressure ulcers, 54 (27%) were Stage II pressure ulcers, and 6 (3%) were Stage III pressure ulcers. Most pressure ulcers (57%) were present at the first observation. Using Stage II pressure ulcer data obtained during the first observation, a Receiver Operator Characteristic (ROC) curve for each possible score of the Braden Q Scale was Constructed. The area under the curve (AUC) was 0.83. At a cut-off score of 16, the sensitivity was 0.88 and the specificity was0.58. The Braden Q Scale was then modified to eliminate 4 sub-scales with an AUC 0.7. With 3 subscales (mobility, sensory perception, tissue perfusion/oxygenation) the AUC of this Modified Braden Q Scale was maintained at 0.84. At a cutoff score of 7, the sensitivity was 0.92 and the specificity was 0.59. The performance of the Braden Q Scale in a pediatric population is similar to that consistently reported for the Braden Scale in adult patients. The Modified Braden	4a

			Q Scale, with 3 subscales, provides a shorter yet comparable tool.	
Giesbrecht et al (2011)	The objective was to systematically measure the relative reduction in interface pressure (IP) at the ischial tuberosities (IT) and sacrum through 101 increments of tilt in a manual wheelchair among individuals with motor complete spinal cord injury (SCI).	Repeated measures study. A total of 18 adults with ASIA A or B level of injury were recruited through an out-patient SCI clinic.	Results: Tilt angle had a highly significant effect on pressure reduction at the IT (P.0.000) and the cosine relationship between these variables was expressed as quadratic. Reduction in sacral pressure did not occur until 301 tilt, with increased loading at smaller tilt angles. Pressure reduction at the IT and sacrum was not significantly different for tetraplegic and paraplegic participants. Conclusion: Small tilt angles are more suitable for postural control than pressure management. A minimum tilt of 301 is required to initiate unloading the sacrum and to achieve a clinically important reduction in pressure at the IT. Larger tilt angles resulted in more substantial pressure reduction than previously reported. Tilt-in-space appears to have similar benefits for individuals with paraplegia and tetraplegia.	4a
Guihan et al (2009)	The objective of this study was to identify and report SCI therapists' practices in the area PrU management in the SCI population, as a first step toward understanding patient outcomes and identifying best practices for SCI therapists in PrU management.	Cross-sectional survey administered to therapists attending a conference of the Therapy Leadership Council in SCI.	Results: In general, therapist involvement with wound care was initiated by physician order (e.g., electrical stimulation) or post-surgery protocols. ''Usual practice'' after tissue healing included progressive range of motion; initial remobilization (first sitting after wound healing); progression of sitting time including assessment of skin tolerance; instruction in pressure relief maneuvers/techniques; and instruction in safe transfers. Practices in prevention of a new ulcer included education and evaluation of seating posture/positioning. Conclusions: Results indicate that centers may delegate responsibilities for management of ulcers differentially by discipline. A limitation was that we were unable to determine whether these centers were the same or different for OT and PT respondents. Although sample size was small and some sites had multiple respondents, the survey showed a growing role for OTs and PTs in PrU treatment. Because 75% of each discipline reported that there were usual practices, including patient education and remobilization protocols, this area requires further study to determine the clinical outcomes in terms of preventing PrUs and recurrence.	4b
Hickey et al (2000)	The purpose of this article is to address risk factors for pressure ulcer development in pediatric SCI and describe a developmentally based prevention program.	Expert Opinion.	Pressure ulcers are significant problems for children and adolescents with SCI. An aggressive prevention program must be instituted, must be developmentally based, and must be individualized for each patient and family. The prevention program must progressively respond to the specific needs of each patient and family throughout childhood, adolescence, and adulthood.	5b

Jan et al (2010)	To investigate the efficacy of wheelchair tilt-inspace and recline on enhancing skin perfusion over the ischial tuberosity in wheelchair users with SCI.	Repeated-measures, intervention, and outcomes measure design. Wheelchair users with SCI.	Results: Combined with 100° recline, wheelchair tilt-in space at 35° resulted in a significant increase in skin perfusion compared with the upright seated position (no tilt/recline; P_.05), whereas there was no significant increase in skin perfusion at 15° and 25° tilt-in-space (not significant). Combined with 120° recline, wheelchair tilt-in-space at 15°, 25°, and 35° showed a significant increase in skin perfusion compared with the upright seated position (P_.05). Conclusions: Our results indicate that wheelchair tilt-in space should be at least 35° for enhancing skin perfusion over the ischial tuberosity when combined with recline at 100° and should be at least 25° when combined with recline at 120°. Although smaller angles of wheelchair tilt-in-space and recline are preferred by wheelchair users for functional purposes, wheelchair tilt-in-space less than 25° and recline less than 100° may not be sufficient for effective pressure reduction for enhancing skin perfusion over the ischial tuberosity in people with SCI.	4a
Makhsous et al (2009)	To evaluate whether an individualized cyclic pressure-relief protocol accelerates wound healing in wheelchair users with established pressure ulcers (PrUs).	Randomized Control Trial. Forty-four subjects, aged 18–79 years, with a Stage II or Stage III PrU, were randomly assigned to the control (n = 22) or treatment (n = 22) groups.	Results: At the end of 30 days, both groups demonstrated a general trend of healing. However, the treatment group was found to take significantly less time to achieve 30% healing for the wound measurement compared with the control group. The percentage improvement of the wound area and PUSH scores were greater in using cyclic seating (45.0 F 21.0, P < .003; 29.9 F 24. 6, P < .003) compared with standard seating (10.2 F 34.9, 5.8 F 9.2). Conclusions: The authors' findings show that cyclically relieving pressure in the area of a wound for seated individuals can greatly aid wound healing. The current study provides evidence that the individualized cyclic pressure-relief protocol helps promote pressure wound healing in a clinical setting. The authors concluded that the individualized cyclic pressure relief may have substantial benefits in accelerating the healing process in wheelchair users with existing PrUs, while maintaining the mobility of individuals with SCI during the PrU treatment.	2b
Makhsous et al (2007)	To investigate the relieving effect on interface pressure of an alternate sitting protocol involving a sitting posture that reduces ischial support	Longitudinal Study. Twenty able-bodied persons, 20 persons with paraplegia, and 20 persons with tetraplegia.	Results: In WO-BPS posture, the concentrated interface pressure observed around the ischia in normal posture was significantly repositioned to the thighs. By cyclically repositioning the interface pressure, the alternate protocol was superior to the normal plus pushup protocol in terms of a significantly lower average interface pressure over the buttocks.	4b

			Conclusions: A sitting protocol periodically reducing the ischial support helps lower the sitting load on the buttocks, especially the area close to ischial tuberosities.	
McDonald (2001)	To explore a pressure ulcer preventative regimen.	Expert Opinion.	Perform a risk assessment, be aware of physical and psychosocial factors that may affect comprehension and education, and there are 9 steps in a preventative regimen.	5b
Niederhauser et al (2012)	To enhance the learner's competence in pressure ulcer prevention through a literature review of comprehensive programs. Examine the evidence supporting the combined use of interventions to prevent pressure ulcers in acute care and long term care facilities. Objectives: 1. Analyze the findings of the pressure ulcer prevention program studies found in the literature review. 2. Apply research findings to clinical practice.	Systematic Review. January 1995- December 2010. Searched MEDLINE and CINAHL. Intervention implemented in acute care settings or long term care facilities, incorporated more than one intervention component, involved a multidisciplinary team, included information about outcomes related to the interventions.	The majority of studies reported positive outcomes from their PrU prevention initiatives; however, P values assessing statistical significance were rarely reported. Positive outcomes, such as increased staff awareness and knowledge, as well as change in attitudes toward PrU prevention, were noted in several of the articles. However, reports of these outcomes were mostly anecdotal and were not validated by any formal evaluation.	1b
NSCISC (2010)	Statistical Resource.	Statistical Resource.	Statistical Resource.	5a
Perry et al (2006)	This protocol covers the steps used by the healthcare team for evaluating patient risk for pressure ulcer development.	Guideline.	Recommends use of a standardized risk assessment tool, visual inspection of the skin, and recognition that the patient's degree of risk for pressure ulcer development varies as the patient's medical condition changes. Reassessment occurs throughout the care episode. Also recommends use of a Skin Safety Plan and effective use of communication.	5b
Perry et al (2010)	This ICSI Health Care Protocol is designed to assist clinicians by providing an analytical framework for the evaluation and treatment of patients (Pressure Ulcer Prevention and Treatment Protocol), and is not intended either to replace a clinician's judgment or to establish a protocol for all patients with a particular condition.	Guideline.	The following system changes were identified by the work group as key strategies for health care systems to incorporate in support of the implementation of this protocol. 1. Develop a process of communicating to all health care team members (who need to be aware) of patients at high risk for pressure ulcers, previous history of pressure ulcers, and those with active prevention plans. 2. Develop a process for educating staff, patients and caregivers about risk assessment and skin inspection techniques, along with skin safety strategies. 3. Develop a process and/or visual/electronic medical record cue on each admission documentation record for the completion of a skin inspection and risk assessment. 4. Establish system wide mechanisms and wound treatment, support and education for the successful implementation of pressure ulcer prevention and wound treatment plans. 5. Address barriers to implementing	5b

			pressure ulcer prevention plans. 6. Form a skin care/pressure ulcer treatment team with defined roles. 7. Develop a process to ensure consistent assessment of the patients with pressure ulcers using the following components: • History and physical • Wound description/staging • Etiology of pressure • Nutritional status • Bacterial colonization/infection • Psychosocial needs	
Perry et al (2007)	To decrease the incidence and/or progression of pressure ulcer development.	Guideline. All patients who enter acute health care facilities - both inpatient and outpatient	Does suggest performing weight shifts (chair push ups, elevating legs, or shifting side to side, for example) every 15 minutes for pressure relief, standing if able, using chair cushions.	5b
Preston (2003)	The key to preventing pressure ulcers is to accurately identify at-risk individuals so that preventive measures may be implemented.	Expert opinion.	Pressure ulcer prevention in SCI individuals requires an interdisciplinary approach. Health care providers in all disciplines must remain acutely aware of risk assessment, prevention, and management of this common complication in caring for individuals with SCI.	5b
Regan et al (2009)	To systematically review evidence on the prevention and treatment of pressure ulcers in those with a spinal cord injury (SCI).	Systematic Review. For this evidence-based review, the following data sources were used: MEDLINE/PubMed, CINAHL, EMBASE, and PsycINFO. Study Selection: To be selected for inclusion in the current review, there had to have been an intervention, studies had to have 3 or more subjects, and 50% or more of the participating group had to have an SCI.	Of the 26 articles selected for inclusion in the systematic review, 7 were randomized controlled trials (RCTs) that dealt with treatment for pressure ulcers, and there was 1 RCT on prevention. Despite the cost-effectiveness of prevention, little research exists on preventative interventions, and what does exist are mostly level 4 evidence. More research is needed for both prevention and treatment, but especially the former.	1b
Sonenblum and Sprigle (2011)	The overall goal of this research was to improve the use of seated tilt to increase function, health and quality of life for people using power wheelchairs. Specifically, the objective of this study was to evaluate the biomechanical responses to seated full body tilt in persons with spinal cord injury (SCI).	Longitudinal Study. Laser Doppler Flowmetry and interface pressure measurement were employed to measure changes in blood flow and loading at the ischial tuberosities across different amounts of tilt. Eleven participants with SCI were studied in a laboratory setting.	Results showed that biomechanical responses to tilt were highly variable. Pressure reduction at the ischial tuberosity was not present at 15_, but did occur with tilts to 30_ and greater, and could be explained by the tilt position and upright pressure. Unlike pressure, blood flow increased with all tilts from an upright position, but did not increase when tilting from 15_ to 30_. Only 4 of 11 participants had increases in blood flow of _10% at 30_ tilt, whereas 9 participants did during maximum tilt (i.e., 45_e60_). Conclusions: Based on the results of this study, tilting for pressure reliefs as far as the seating system permits is suggested to maximize the potential for significant blood flow increases and pressure relief. The use of interim small tilts is also supported, as they also provide some benefit.	4a
Sonenblum et al (2014)	To investigate the effectiveness and interactions of 2 methods of	Case-Control Study. Wheelchair users with a	Pressure relief maneuvers had a significant main effect on the ischial IP (P<.001); all	4a

	pressure ulcer prevention, wheelchair cushions and pressure relief maneuvers, on interface pressure (IP) and blood flow of the buttocks.	spinal cord injury or disorder, 18 years or older, be 2 years post injury, used wheelchair as their primary mobility device, and be able to maintain pressure relief positions for at least 60 seconds.	maneuvers except for the small frontward lean resulted in a significant reduction in IP compared with upright sitting. Blood flow significantly varied across postures (P<.001) with flow during upright sitting and small forward leans being significantly lower than during the full and intermediate leans in both the forward and sideward directions. Conclusions: The results of the study highlight the importance of positioning wheelchair users in a manner that facilitates in-seat movement. Regardless of the cushion being used, the pressure relief maneuvers resulted in very large reductions in IPs and significant increases in buttock blood flow. Only the small frontward lean was shown to be ineffective in reducing pressure or increasing blood flow. Because these pressure relief maneuvers involved postural changes that can occur during functional activities, these pressure relief maneuvers can become a part of volitional pressure relief and functional weight shifts. Therefore, clinical instruction should cover both as a means to impart sitting behaviors that may lead to better tissue health.	
Sprigle et al (2010)	The objective of this study was to show that the amount of force reduction at the seat would differ across these 3 methods (tilt, recline and standing) within their respective clinical ranges.	Prospective Cohort Study. Six able-bodied (AB) subjects (2 men, 4 women) with a median age of 25 years, and 10 subjects (8 men, 2 women) with spinal cord injury (SCI) with a median age of 35.5 years.	Normalized seat loads had strong linear relationships with the angles of change in tilt, recline, and standing for both groups. Maximum decreases in seat load occurred at full standing and full recline in the SCI subjects and in full standing in the AB subjects. Loads linearly increased on the back during tilt and recline and linearly decreased during standing for both groups.	3b
Sprigle and Sonenblum (2011)	This article reviews the evidence supporting clinical interventions that address the magnitude of pressure and the duration of that pressure.	Systematic Review.	Made very vague and generic comments regarding, weight shifting, turning frequency, support surfaces and interfaces pressures. No specific recommendations were made.	1b