FACILITATORS AND BARRIERS TO PRESSURE INJURY PREVENTION AMONG WHEELCHAIR USERS WITH UPPER MOTOR NEURON LESIONS: A NARRATIVE REVIEW

John A. Damiao, PhD, OTR/L
Pace University, NY

INTRODUCTION

A majority of PI related research is focused on the spinal cord injury and elderly populations, while individuals with upper motor neuron lesion (UMNL) related diagnoses, such as cerebral vascular accident (CVA), cerebral palsy (CP), traumatic brain injury (TBI), and neurodegenerative disorders (multiple sclerosis, amyotrophic lateral sclerosis, etc.) are greatly underrepresented in the literature. Research in the area of PI management particularly in terms of wheelchair seating and cushions should be targeted to the unique needs of this population.

Purpose

The purpose of this review is to report on the available evidence regarding PI management for this population, guided by the research question: *What facilitators and barriers impact adherence to pressure injury reduction practices, specifically seating assessment and interventions, and skin protection behaviors, among wheelchair users with quadriplegia or upper motor neuron lesions?* The aim is to consolidate what is known about the unique characteristics of those with quadriplegic SCI and UMNLs, and fill a gap in the PI management knowledgebase for this specific population.

METHODS

A concept map was created to identify terminology that will link what is known regarding pressure relieving management and the context specific application of these practices to the population with UMNLs. The literature was searched through the PubMed/MEDLINE database, including the Medical Subject Headings (MeSH) system in PubMed to identify related terms.

RESULTS

A review of the search terms resulted in 5589 journal articles published between 2010 and 2020. The titles were reviewed resulting in 52 abstracts screened, and 36 selected for full article review. Of these 36 articles, only 15 met inclusionary criteria of the present study and research question, and are included for review. These studies have been categorized into the following areas: a) positioning, and b) tilt/recline.

Positioning

Increased muscle tone, spasticity and postural deformities can significantly impact positioning needs of those with UMNLs. Four articles included in the present review address positioning, most specifically in regard to the asymmetrical hip flexion common in those with cerebral palsy (CP). Agustsson et al. suggest 22% of adults with CP, out of a sample of 714, presented with asymmetrical hip flexion of less than 90 degrees unilaterally.[1] These individuals were more likely to present with pelvic obliquity (OR 2.6, 95% CI:1.6–2.1), asymmetrical trunk (OR 2.1, 95% CI:1.1–4.2), scoliosis (OR 3.7, 95% CI:1.3–9.7), and windswept hip distortion (OR 2.6, 95% CI:1.2–5.4), all of which can negatively impact PI management.

Studying a similar group of 72 children aged 2-20, Lampe and Mitternacht, further describes the challenges of proving this population with seating systems to correct deformities while also providing pressure relief, which are often competing goals.[2] The authors describe this process as one in which providing sufficient postural support in order to promote upright positioning and function competes with effective pressure relief, particularly in a population with inability to reposition themselves, and often lack the cognitive or communication skills to direct caregivers or control technology for making positional adjustments. The authors describe and advocate for the use of soft seating surfaces in order to promote accommodation and pain reduction, but also using pressure mapping to assist in the clinical decision-making process in which a fine balance between postural support and pressure relief are optimized while minimizing the negative impacts. This study does not provide statistical inferential conclusions; rather, several case examples are provided with descriptive data illustrating how pressure mapping was utilized to

help make clinical decisions for reduction of pain and selection of appropriate seating surfaces with individuals with complex seating needs.

A different means of approaching complex positioning and pressure relieving needs is through the use of highly contoured seating or custom-contoured seating in which seating systems are custom fabricated to match the user's exact shape. Tasker et al., compared the pain relieving and pressure relieving capacity of three types of seating systems all composed of the same type of foam material.[3] The comparisons consisted of a custom-contoured seat cushion, an off-the-shelf design contoured cushion, and a flat baseline cushion. Results suggest the custom-contoured shape provided the best pressure relief and comfort, signifying the importance of cushion shape beyond material construction.

Post-stroke (CVI) individuals also present with positional challenges that impact posture and PI risk. Two separate studies describe those with flaccid hemiplegia as demonstrating greater pressure in the ITs and sacral areas when compared to those with spastic hemiplegia and healthy controls, thus emphasizing the need for increased focus on the pressure relief of those with flaccid muscle tone.[4]

In a within-subjects comparison study of 28 participants post CVI, Ukita et al. noted the tendency of this population to lean onto their affected side during sitting, placing increased pressure on the ischial tuberosities (ITs) of the affected side.[5] The authors sought to compare the change in postural alignment and seat pressure when comparing sitting in a wheelchair with a standard backrest set to 96 degrees of recline, to that of a modified backrest in which the pelvic lumbar, lower thoracic and upper thoracic recline was set to 100°, 110° and 121° respectively.

Furthermore, this experimental backrest provided further lateral support of the pelvic lumbar region in the form of a pelvic-lumbar slackened strap (similar to a contoured backrest), with the purpose of promoting midline alignment of the lower trunk. Neither backrest perfectly corrected postural alignment, however, the experimental backrest with increased progressive recline and pelvic lumbar strap promoted increased return to midline and decreased asymmetry in seat pressure distribution. This data was collected while participants performed a simulated functional upper extremity activity requiring reaching, starting from the non-affected to the affected side and back to starting position.[6] While this study focused on the effects of a novel type of backrest, the improved results of increased recline on decreasing pressure relief is similar to what other research in this area suggests, as is described in the next section.

Tilt/recline

A large portion of the present search results are focused on the optimization of wheelchair tilt and seat to back recline angles needed for optimal pressure relief. While these studies used varying tools to measure pressure relief, the results appear to mostly corroborate the general outcome. Both tilt and recline play a critical role in pressure relief particularly for individuals unable to perform their own weight shifting routines. By using *skin perfusion* (microcirculatory blood flow) as a means to determine 'effective' pressure relief, Jan, et al. reported a minimum recline angle of 100° was needed when paired with at least 35° of tilt; whereas at least 120° of recline was needed when using as little as 15° of tilt.[7] In a later study, Jan, et al. measured skin *and muscle perfusion* citing the added importance of muscle perfusion in outcome measures of pressure relief.[8] The results indicate greater levels of tilt (25°) and recline (120°) significantly increasing muscle perfusion over baseline sitting, which is more than what is needed for skin perfusion.

In addition to recline, the addition of lumbar and femur supports to the seating system has been studied among healthy participants. These supportive devices appear to help redistribute the weight of the participants away from the ischial tuberosities. While not statistically significant, the combination of a lumbar and femur support provided the lowest IT pressure interface, with any amount of recline.[9,10]

Zemp et al. suggest any combination beyond 15° tilt and 5° recline substantially (although not statistically significant) reduces seat interface pressure.[11] They emphasize the reality that wheelchair users seldom take the time to regularly conduct periodic 'full' tilt and recline weight shifting regimens. The authors suggest, by studying the impact minimal tilt and recline angles may have on pressure reduction, may provide useful information for wheelchair use in a realistic context. For example, if a wheelchair user is able to maintain a 20° tilt and 10° recline throughout a significant portion of the day, this may promote improved PI management as compared to suggesting

intervals of 45° of tilt at many intervals, which is a non-functional position for most wheelchair users. They also suggest that significant levels of recline alone are capable of significantly reducing pressure, but this comes at the expense of shear forces, particularly when returning to an upright position.

Conversely, Giesbrecht et al., found among a group of 18 participants with paraplegia and quadriplegia a minimum of 30° of tilt is needed to significantly reduce pressure when not combined with additional recline.[12] Furthermore, the authors found increased pressure on the ITs and sacrum during minimal levels of tilt, describing the only benefit being postural support. There were no differences in the reaction to pressure among the different participant SCI levels. While these findings may appear contradictory to the study by Zemp et al., it highlights the importance at least minimal amounts of recline play in the process of redistributing pressure away from the ITs and sacrum when combined with tilt.[13] The negative impacts of shear can negatively impact any benefits of using significant amounts of recline as a sole means for pressure relief and thus should always be paired with tilt.

DISCUSSION

A common approach to PI management among wheelchair users is adoption of routine weight shifting in order to provide periodic pressure relief. However, individuals with quadriplegia or UMNLs characterized by severe motor impairments will have limited or complete inability to perform weight shifting manually due to lack of neuromotor control of the upper extremities. Power tilt or recline seating is a feature commonly added to power wheelchairs to provide users a means to perform routine tilting in order to temporarily decrease the pressure on the buttocks. One of the issues in the application of power tilting features is that this technology is often limited to power wheelchairs. However, those with cognitive impairments are rarely prescribed power wheelchairs since their use requires safety awareness, navigational concepts, and impulsivity control. These individuals are often dependent upon manual wheelchairs propelled by caregivers, leaving them with little or no volitional mobility options at all. Thus, cognitive impairment can be a barrier to pressure relief management.

Health promoting behaviors and self-care support play crucial roles in PI management specifically for individuals with limited physical or cognitive ability to perform independent self-care routines such as skin checks, weight shifting, repositioning, and control of devices. Education and training of patients and caregivers to seek medical advice as soon as issues arise, as well as promotion of regular skin checks, repositioning, weight shifting, cushion checks, and general education on the specific properties, activities, behaviors and routines appear to be essential for PI risk management, although the research is mixed regarding its effectiveness.

Limitations

One of the main limitations of this review is the inclusion of literature with able-bodied participants. Research with participants who represent the population of interest are increasingly scarce in this area of study due to the challenges associated with ethics board review approvals and the ethical implications of putting at-risk individuals in study conditions that may actually do harm. Studies commonly substitute able-bodied subjects for study participation with the hopes that outcomes can be generalized to the population of interest. However, individuals with severe mobility impairments are inherently different in many ways, particularly in ways that impact study outcomes. Another limitation involves the abundance of efficacy, but scarcity of effectiveness research studies.

CONCLUSION

This narrative review searched the literature for research on the topic of PI prevention among wheelchair users with quadriplegia and UMNLs. Results were limited, specifically due to the unique characteristics associated with the complexities experienced by this population such as tone, deformities, and behaviors. Furthermore, much of the research available has been conducted on able-bodied participants which significantly impacts generalizability of findings. What does appear consistent throughout the results of this search is the need to perform a thorough seating evaluation by skilled and experienced clinicians in order to match the best devices, seating configurations and seating angles to the unique needs of the individual, while also providing comprehensive and ongoing self-care and caregiver training, along with resources to continue to seek health care services on an ongoing basis.

One area of consistency in terms of pressure management facilitators is the use of recline and tilt to promote effective PI relief, especially for those unable to perform independent weight shifting routines. While most studies differ in the exact prescription of what is effective pressure relieving tilt or recline angles, a common reported range

is tilt angles of 25-35° and recline of 10-20°. It is also clear that large angles of recline introduces dangerous levels of shear on the buttocks, particularly when returning to an upright position. Thus, recline should be used sparingly, and in combination with tilt.

The results of this review further highlight the need for future research to help identify improved methods for PI prevention and management for populations with limited independence in self-care skills. This includes higher levels of evidence in regard to specific caregiver training and resource regimens, most effective technologies and devices for PI management, and studies of actual PI incidence and prevention effectiveness, specifically for tilt and recline as a means for weight redistribution.

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