Seating Assessment and Intervention for the Adult Population

Site Applicability

All VCH and PHC sites – acute, rehab, community, long-term care

Practice Level

Profession	Basic Competency
Occupational Therapy (OT)	Assessment and provision of seating (manual and power wheelchair)
Physiotherapy (PT)	In particular practice areas, where seating is part of the PT's job duties, assessment and provision of seating (manual wheelchair)

Need to Know

The goal of a seating assessment is to assess a client for provision of an appropriate wheelchair and seating system, with the aim of providing improved body support, improved occupational performance, and prevention of injury to the user (Batavia, 2010; Waugh and Crane, 2013). It includes an evaluation of the wheelchair user and their occupations, wheelchair technology, and the client's environment (Batavia, Batavia & Friedman, 2001; British Society of Rehabilitation Medicine, 2004). The therapist performing the seating assessment should collaborate with the multidisciplinary team and the client to determine the client's seating needs. Clients requiring a wheelchair should be properly assessed and fit for the wheelchair and seating system that meets their individual needs, by a trained clinician.

Clients requiring increased postural supports to maintain an upright position, and/or expecting to be in a seating system for an extended period of time, are at higher risk of negative health outcomes (Skalsky & McDonald, 2012) and would benefit from a more in-depth seating assessment. The thoroughness of a seating assessment should be based on the client's seating goals and relevant medical history (including level of function, prognosis, and comorbidities) – it should not be based solely on available time or equipment available to the therapist (though it is recognized these may be significant barriers).

The seating assessment results are used to create the parameters of wheeled mobility and seating equipment that may best suit the client's needs in order to achieve the targeted outcomes (defined below), while reducing the risk of injury to the user, unnecessary expense, task duplication, and abandonment of equipment (Batavia et al., 2001).

Before beginning a seating assessment, the therapist should ensure familiarity with the following:

- Anatomy of the musculoskeletal system, especially bony landmarks of the pelvis, spine, lower extremity, and the shoulder
- Knowledge of normal spinal and pelvic alignment and postural deviations (See Appendix A)
- Knowledge of joint ROM and competence in how to measure (See Appendix C)
- Knowledge of seating biomechanics and its practical applications (See Appendix G)
- Knowledge of pressure injury and principles of pressure distribution in sitting (See Appendix G)
- Review professional practice resources specific to seating and mobility, available on VCH intranet
- Their own clinical skills and competency to meet the seating needs of clients within their area of practice, and be prepared, as needed, to develop advanced skills in seating by taking additional training and workshops, use mentorship or consultative resources within VCH and the international wheelchair seating community. (See additional education resources on VCH intranet and Appendix G)

For the purpose of this document, the following **terms and definitions** will be used:

Wheelchair: Wheeled assisted technology device meant to aid individuals in personal mobility – for the purposes of this document, this DOES NOT include scooters or strollers, but does include both manual and power wheelchairs. The wheelchair (not including the seating) is also referred to as the wheelchair base or mobility base.

Seating Primary Support Surfaces: The contact surfaces of the seating support system that are the primary weight bearing components in contact with the client's body. They are used to provide postural control or support, and to maintain skin integrity and comfort. Includes: back support or backrest, cushion, arm supports, and foot supports (Waugh, 2013)

Seating Secondary Support Surfaces (also known as Seating Components): These are the additional contact surfaces or pieces which provide secondary support and aid in postural control. This may include head support, lateral trunk supports, medial and lateral knee supports, lateral thigh supports, and anterior chest supports (Waugh, 2013)

Product Parameters: The specific features of seating or mobility equipment, determined during the seating assessment, as required to meet the client's postural and functional needs. These are not product names, but features, such as dimensions, amount of contour, and firmness.

Client: refers to the person being assessed and can be a patient, resident or client.

Targeted Outcomes: Targeted outcomes are more specific goals than the general reasons for referral, and are established in collaboration with the client or caregiver. These should be measureable (objectively and/or subjectively) and specific to the client.

Targeted Outcomes can be:

- Functional (i.e. improved propulsion, maintain independent transfers, improved maneuverability in the home)
- Physiological (i.e. prevent and/or promote pressure injury healing, improve respiratory function, safe swallowing)

- Psychological (i.e. increased confidence with occupational participation, increased confidence with appearance, increased comfort to address observable responses to discomfort i.e. agitation)

Equipment and Supplies

Assessment Form: Wheelchair Seating for Purchase or Long Term Use (VCH.0657)

Supplies used in the assessment should include:

- Goniometer
- Measuring tape and/or calipers
- Hospital bed, bed, or plinth

Additional supplies that are very helpful if available are:

1. Camera
2. Full-length mirror
3. Footstool for therapist to sit on while assessing client
4. Folded towels and/or pieces of foam for positioning during sitting simulation
5. Inclinometer (can be a smart phone app) to measure angles of slope

Guideline

Seating Assessment

It is important to focus on the client's occupational goals, personal and environmental factors, including the client's medical and equipment history, potential impairments, abilities, range of movement, body size or shape, and their physical and social environment (Batavia, 2010).

Background Information (See Appendix B):

1. **Client goals:** A client's goals for seating and mobility needs to be established to direct the assessment and intervention, and can vary depending on the individual. It is important to consider occupations and discuss what activities the client wishes to participate in using their wheelchair, and what activities are meaningful to them. Goals such as maintaining skin integrity and stability are often highly prioritized as client safety can be impacted.
2. **Relevant Medical History:** A client's prior medical history and current prognosis should be considered when determining a wheelchair and seating system, as they can inform whether the system should be temporary or permanent, and requirements for adjustability.
3. **Equipment History**: A client's current and prior history of equipment used should be noted. This includes types of equipment, brand, specifications, vendor, date received, and pros/cons of current system. Equipment history can inform what type of equipment has worked well for a client and what has not worked well.
4. **Funding Source:** Potential funding sources need to be established as the available funding source may limit options for a client. This should be done in conjunction with the social

worker, if available and appropriate, based on social worker's role on the team. (See professional practice intranet funding page for more information on funding source)

5. **Physical Environment:** A client's physical environment, both at home and in the community where they intend to use the wheelchair, should be considered as it may impact the options available to the client.

Physical Assessment (See Appendix C):

1. **Assessment in Wheelchair:** A visual scan as well as hands on assessment to landmark bony prominences should be done to determine the degree to which a client's posture varies from the standard reference seated posture. (See Appendix A for Standard Reference Posture and Landmarking) This can occur in the client's own wheelchair if they have one, or in a temporary wheelchair. Current seated postures are documented.
2. **Supine Evaluation:** A supine evaluation should then be done to determine possible movements and positions of the body with gravity eliminated. During a supine evaluation, a therapist notes a client's uncorrected supine posture, pelvic deviations, and assesses ease of correction to neutral for the pelvis and passive range of motion in the lower extremities.

   The supine evaluation combined with the sitting simulation (see below) is also termed a MAT assessment (Mechanical Assessment Tool). It can be done on any surface on which a client is supine (i.e. in bed), though a stable and firm surface will provide the most accurate information.
3. **Sitting Simulation:** Information gathered from the assessment in the wheelchair and supine assessments are combined to determine the optimal sitting position and if any additional supports are required in the sitting position. The client is moved into a seated position at the edge of the plinth or bed, and observations are made in relation to:
   - Amount, location, and direction of support (force) required to correct the client's posture in neutral or to accommodate for fixed positions (also called points of control)
   - Reactions and tolerances to correction
   - Balance and trunk inclinations
   - Effects of tone
   - Comfort
   - Upper extremity function.

Body Measurements

Ideal measurements of the wheelchair may vary based on the positioning of the seating primary support surfaces required and the type of wheelchair frame or seating components (i.e. some armrests are positioned wider than the seat pan, which increases the functional seat width of a chair; the mounting hardware of a rigid backrest can take up seat depth, which decreases the functional seat depth of a chair). Thus both body measurements and the seating primary support surfaces of the client need to be considered when prescribing the size of the wheelchair.

At a minimum, the following client's body measurements should be taken and provided to the vendor:

- Hip width
- Trunk width
- Thigh length
- Lower leg length
- Shoulder height or scapula height
- Widest body width

Please see Appendix D for additional information on body measurement.

A properly sized wheelchair and seating system are crucial both in providing optimal supports, and in establishing efficient propulsion patterns if a client is a self-propeller (Koontz et al, 2009). An improperly fitting wheelchair can have a substantially negative impact on a client's skin, posture, pain/discomfort, and overall function. When providing these measurements, it is imperative to be very clear when communicating with family members, vendors, or technicians whether measurements are body dimensions or desired dimensions of the wheelchair frame and seating components.

Intervention and Follow Up

Seating interventions and recommendations are based on client's equipment history/usage, the findings of the supine assessment, sitting simulation, body measurements, and equipment trials, but can vary greatly depending on factors such as the client's tolerance to postural correction, their functional goals, comorbidities, and resources available.

In addition to the results of the physical assessment, other factors which will affect the recommendations for seated posture will include the client's seating goals and occupations conducted in the wheelchair. Depending on their trunk stability, they may need more or less support for certain functional tasks, and may benefit from allowing some deviation from a neutral pelvic position, for the benefit of improved function. For example, posterior tilt is generally the most stable position for someone with trunk weakness and may allow improved balance for upper extremity tasks. In contrast, if a client is stable in a neutral to slight anterior pelvic tilt position, this may afford them to improved function for tasks that require trunk extension or forward lean or reach (i.e. enhanced reach in the kitchen, improved breathing, and improved wheelchair propulsion). In other words, the 'ideal' and most aligned posture is not always recommended, even if it is physically possible, and especially if it will limit function.

The seating and mobility intervention may include adjustment to the current equipment, or prescription, fitting and set-up of new equipment, and should always include education of clients and caregivers on appropriate use. The overriding seating principles which need to be considered at all times during this process include:

1. Issues and solutions are always specific to each individual client, including occupations and environments unique to the client;
2. Prevention, correction, or accommodation of postural asymmetries;
3. Maximize pressure redistribution, and understand how this relates to postural control and skin integrity;

4. Posture is dynamic and changes with functional activities; for clients who have some ability to move around by propelling their chairs, how seating affects mobility and participation in daily activities must be considered
5. For individuals who have significant limitations in their mobility and spend a majority of time in their wheelchair when they are up, seating is only one aspect of positioning, which needs to be considered around the clock to enable optimal postural alignment to increase physical comfort or decrease pain

Targeted Outcomes and Outcome Measures: (See Appendix F for examples of outcome measures) In order to be accountable to our clients, it is important to be able to identify and prioritize goals collaboratively with clients whenever possible and also to identify when interventions have been successful or are complete. This can be done by using an outcome measure, at a minimum of 2 time points (3 is preferred where possible) such as at assessment and after provision of the new equipment (or modifications or adjustments to equipment). Outcome measures can be standardized (such as the Wheelchair Outcome Measure, or WhOM) or unstandardized, such as measures of comfort and satisfaction.

Identifying Product Parameters: (see Appendix E) The seating assessment identifies what is working well and areas for improvement in the current seating and mobility equipment and allows the therapist and client to develop targeted outcomes. Then, the product parameters can be specified. The product parameters are features of the equipment which allow the client to overcome the identified issues, in order to achieve their targeted outcomes. Use of product parameters instead of specific product names encourages both the therapist and the vendor to be clear on the client's needs, and allows the vendor to share their expertise on a range of products which may meet the client's needs.

See Appendix E for examples of Product Parameters.

The clinical reasoning process of determining recommended product parameters based on client strengths, issues, and targeted outcomes is extremely important for achieving relevant, effective, and client centered outcomes, and needs to be an overriding concept at all times when providing seating and mobility interventions. Jumping ahead to recommending specific products without completing this process risks missing potentially more effective options.

Equipment Trials: Wheelchair seating is only effective when it is used correctly and consistently (Folan et al., 2015). Best practice entails that the equipment requested be trialed so that the client can make an informed decision (Rehabilitation Engineering & Assistive Technology Society of North America, 2011) and to assess the physical and functional impact of the equipment for the client in their environments. The targeted outcomes and product parameters, based on the assessment and equipment simulation, should be clearly communicated to the vendor who is providing the equipment for trial. Ideally, the therapist making wheelchair and seating recommendations would be the one to assess the client during the equipment trial. If this cannot be achieved every effort should be made to clearly communicate the recommendations to the next therapist assuming care of the client.

Equipment Fitting and Follow Up: The final set-up and fitting of the new equipment is a crucial part of this process. The therapist who prescribed the wheelchair must assess it to ensure it fits properly and make adjustments as needed. Education to the client and caregivers with regard to how to use the equipment, position the client in the equipment, maintain the equipment, and who and

when to contact with problems, are also all important and it is the responsibility of the prescribing therapist to insure this is completed.

Expected Patient/Client/Resident Outcomes (See Appendix F)

Clients will have a wheelchair and seating system that is individualized to meet their needs and that meets their own identified targeted outcomes.

As outlined in the previous section, expected outcomes will include pre and post measurement of targeted outcomes. Examples of ideal outcomes include:

- Client self-report Pain or Comfort: Client has minimized pain or discomfort related to wheelchair fit and seating system.
- Client self-report participation: Client has improved participation in specified functional activities or engagement in meaningful occupations
- Skin Integrity outcome measurement: Client has minimized risk for developing or worsening of skin injury related to sitting in wheelchair.

Evaluation

Clients in VCH who require a wheelchair to address their seating and mobility goals will have an assessment based on evidence based principles, by a trained clinician. Wheelchairs will be prescribed based on assessment results, the targeted outcomes, client specific personal and environmental factors and in collaboration with the multidisciplinary team.

Documentation

The seating assessment and prescription must be documented in the client's health care record, as per college guidelines and site specific policy, on approved forms or in a progress note. The seating assessment form can be accessed on VCH intranet, on SCM, Form Fast, or other electronic documentation system.

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Appendices

- Appendix A: Standard Reference Posture and Landmarking
- Appendix B: Seating Assessment – Background Information
- Appendix C: Contacts for this DST Template
- Appendix D: Body Measurements
- Appendix E: Product Parameters
- Appendix F: Outcome Measures
- Appendix G: Education Resources and Recommended Readings for Therapists

Appendix A: Standard Reference Posture and Landmarking

Standard Reference Posture: The standard reference posture when evaluating seating is symmetrical (with regard to body segments in the frontal and transverse planes) and neutral (with regard to the sagittal plane). It is a reference position to describe postural deviations, and may not be attainable or appropriate for our clients. Trunk to thigh angle, thigh to lower leg angle, and lower leg to foot angle are all noted to be in a 90-90-90 degree position in the sagittal plane (Waugh & Crane, 2013) (See Figure 1). Spinal standard reference curvature of the spinal column in the sagittal and frontal planes are shown in Figure 2.

Figure 1: Standard Reference Posture in Sitting in the Sagittal Plane

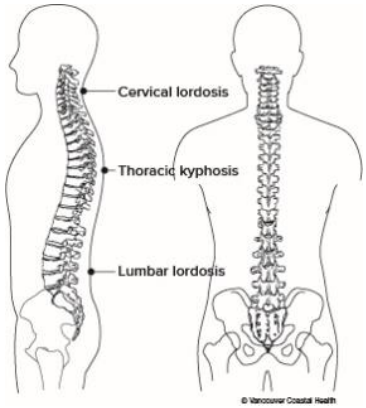

Figure 2: Spinal Standard Reference Posture in the Sagittal and Frontal Planes

Landmarking is necessary to:

- determine deviations from the standard reference posture
- identify locations of weight bearing and pressure
- identify points of control to correct or support posture
- improve the accuracy in communication and documentation when describing posture and seating needs.

Landmarks to identify:

- **Pelvis:** (See Figure 3)
    - Anterior superior iliac spine (ASIS): used to determine pelvic rotation and pelvic obliquity

- Posterior superior iliac spine (PSIS): used to determine anterior or posterior pelvic tilt, in conjunction with the ASIS
- Iliac crest: can be used to track anteriorly to the ASIS or posteriorly to the PSIS if these landmarks are difficult to locate
- Ischial tuberosities (ITs): may be a significant point of pressure in upright seating
- Sacrum (fused vertebrae S1-5): a flat surface which can be blocked or supported in order to stabilize the pelvis. Possible point of pressure.
- Coccyx (at the distal end of the sacrum): a vulnerable point of pressure if sitting in significant posterior pelvic tilt

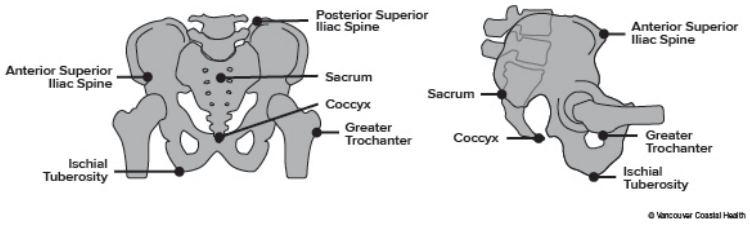

Figure 3: Boney landmarks of the pelvis

- **Spine:** landmarks can be used to describe locations of deviations off midline (i.e. in kyphosis, lordosis, and scoliosis). (See Figure 4)
  - Vertebrae C7:prominent in cervical spine flexion
  - T6/T7: in line with the inferior angle of the scapula in typical anatomy
  - T12: attachment point of the last rib
  - L4/5: in line with the iliac crest in typical anatomy
  - (see Figure 4)

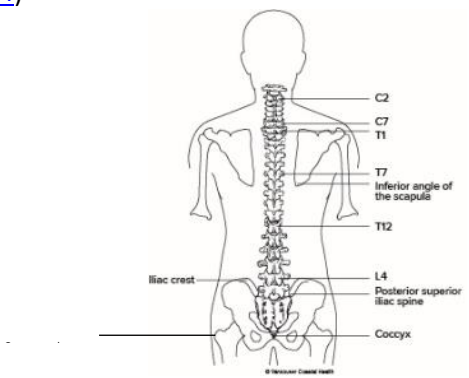

Figure 4: Landmarks of the vertebral column and femur

- **Femur and lower leg:** (see Figure 4)
  - Greater trochanters (GTs) of the femur: can become a point of pressure laterally or posteriorly. Can also be a point of control for stabilizing pelvis
  - Patella, malleoli, and heel: used in conjunction with the greater trochanters as reference points when measuring lower extremity range of motion.

Appendix B: Seating Assessment – Background Information

1. Client goals: It should be noted that clients are often not aware of their seating goals, particularly clients with new medical diagnoses impacting their function (Batavia & Hammer, 1990). Furthermore, goals may be conflicting – for example, freedom of movement can be reduced to gain stability. Determining the client's goals directs the assessment process and focuses the hypothesis formulated when conducting the seating assessment.

2. Relevant Medical History
    - If a client's function is expected to improve or decline, consideration should be given to a temporary system (if there is a funding source available for this) or in obtaining items with increased adjustability (i.e. externally mounted laterals on a backrest as opposed to integrated laterals). Obtaining a permanent system should be done once the client has stabilized or has plateaued in function.
    - A client's diagnosis may provide clues as to what degree of postural support they will require, and the duration of time that they are anticipated to spend in their seating system (i.e. a client with a high level complete spinal cord injury vs a fractured ankle in an otherwise healthy individual would require vastly different support systems).

3. Funding Source
    - If a client is self-funded, the wheelchair and seating options will be restricted to what they are able to afford. In instances where clients have limited funds, used or donated equipment may be worth pursuing.
    - Funders often require wheelchair bases and/or seating systems to be appropriate for 5 years or greater; however, funding sources differ with some considering seating replacement every 2 years (i.e. for the client funded by Ministry of Social Development and Poverty Reduction MSDPR).
    - Some funders (i.e. the Ministry of Social Development and Poverty Reduction) have limits on wheelchair bases, but different limits on seating systems.

Appendix C: Seating Assessment – Physical Assessment

1. **Assessment in Wheelchair (Seating Scan) –** Following a visual scan, landmarking bony prominences, and documentation of the postural description, the therapist begins to formulate a hypothesis of what needs to be further assessed in the supine and sitting simulation portions of the seating assessment (i.e. determining if and how a client could be corrected into neutral).

2. **Supine Assessment**
   a. Body postures can be either fixed or flexible - also known as non-reducible or reducible.
   b. The amount and direction of force required to correct a flexible posture into neutral also needs to be considered as it may not be achievable in the seating system or tolerated by the person.
   c. Understanding the impact of lower extremity positioning on the pelvis and torso is important information gained from this part of the assessment.

Pelvic Mobility: As the pelvis serves as the client's postural base, it is extremely important to determine if the pelvis can achieve neutral, is flexible, and the amount of force required to move it. The pelvis can normally move in 3 planes (see Figure 5 below). Diseases and conditions can cause abnormality in pelvic alignment and mobility issues resulting in temporary or permanent deviation or asymmetry in any one or more of these planes:

- the sagittal plane (amount of anterior-posterior pelvic tilt)
- frontal plane (left-right pelvic obliquity, one side higher than the other)
- transverse plane (left-right pelvic rotation, one side forward)

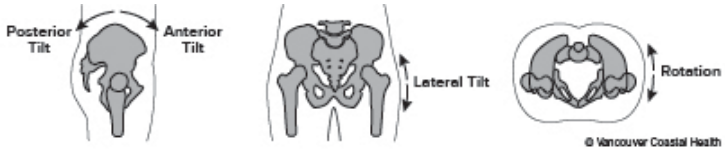

Figure 5: Motions of the pelvis in the sagittal, frontal, and transverse planes

During assessment, the pelvis is moved through all directions of movement with the client's hips and knees flexed in a simulated sitting posture, with pelvic flexibility and symmetry noted.

Lower Extremity Passive Range of Motion: Assessment of the lower limbs is crucial, as the pelvic position may be impacted if the lower extremities lack sufficient range of motion and are not accommodated (Elson and Aspinall, 2008). For example, more than 25% of end range hip flexion is achieved by an individual's pelvis moving into posterior pelvic tilt (Bohannon et al., 1985). As such, when measuring lower extremity range of motion for seating, it is important to pay attention to pelvis compensatory movements. True range of motion of the hip joint is the range of motion achieved without any compensatory movements of the pelvis.

A lack of true lower extremity range can impact the pelvis in the following ways if the seating over-corrects, or does not accommodate this limitation:

Hip flexion or extension: Hip flexion is measured with the knee bent. This angle will help decide the angle needed between the seat and the back support. A lack of true hip flexion range will move the pelvis into a posterior pelvic tilt if overcorrected or not accommodated (see figure 6). Consideration should be given to this prior to setting up dump (i.e. seat slope) in a client's wheelchair, as it can place the individual in an undesired posterior pelvic tilt. Similarly, moving the client's hip into excessive hip extension will force the pelvis into an anterior pelvic tilt if there are limitations in hip extension range of motion (See figure 7)

Figure 6: Lack of true hip flexion pulling pelvis into posterior tilt

Figure7: Sitting in anterior pelvic tilt with limitation in hip extension range

Hip Abduction or Adduction: When applying a force to correct an adducted hip where there is a lack of true hip abduction, it will pull the pelvis into pelvic rotation posteriorly on the same side and anteriorly on the opposite side (See Figure 8). Similarly, if applying a force to correct an abducted hip where there is a lack of true hip adduction, it will pull the pelvis into pelvic rotation, anteriorly on the same side, and posteriorly on the opposite side.

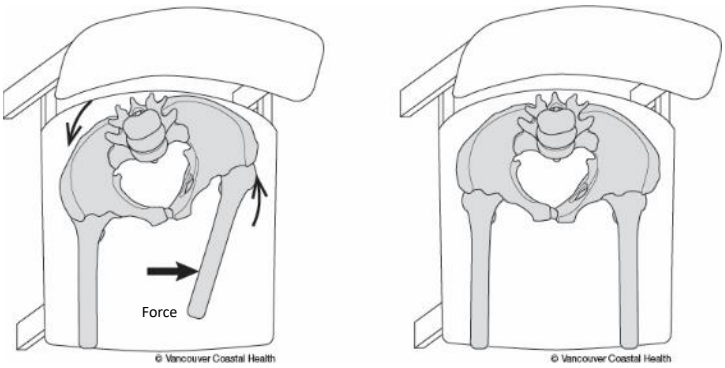

Figure 8: Left image- pelvic rotation; Right image- pelvis in neutral, no rotation

Hip Internal or External Rotation: When applying a force to correct an externally rotated hip position where there is a lack of true hip internal rotation, it will pull the pelvis into a

pelvic obliquity rostrally (higher) on the same side. Similarly, when applying a force to correct an internally rotated hip position where there is a lack of true hip external rotation, it will pull the pelvis into a pelvic obliquity, caudally (lower) on the same side. This video illustrates how hip range of motion impacts pelvic mobility.

As stated above, forcing a client into lower extremity ranges that are not available to them may have extremely negative impacts to their skin, posture, and long term positioning, as the pelvis will be forced to shift to accommodate for tight lower extremities (Elson and Aspinall, 2008). In addition to the true hip ranges impacting the pelvis, other ranges to consider are:

- **Hamstring Length:** As the Biceps Femoris attach to the ischial tuberosities and cross both hip and knee joints, aspects of the seating system that do not accommodate for tightness or spasticity of the hamstring will pull the pelvis into posterior pelvic tilt and may also cause the client to slide forward in sitting (Dewberry et al., 2003). Hamstring length and the angles at which spasticity is triggered are therefore important to measure (with movement at velocity, using a 'quick stretch'), and positioning of the lower leg in the wheelchair needs to take into account avoiding pulling on the hamstrings (i.e. leg rest hanger angles, heel loops, calf pads, elevating leg rests).
- Knee flexion or extension (separate from hamstring length as described above)
- Ankle dorsiflexion or plantarflexion or inversion or eversion

Trunk Alignment: Assessment of trunk alignment in supine is also crucial as it will inform the therapist whether deviation from standard reference posture is fixed or flexible. It is important to observe typical lying position prior to attempting correction into neutral. Observe deviation from neutral with reference to boney landmarks (sternum, ribs, clavicles, acromium), soft tissue and skin creases. Try to correct trunk deviations into neutral and assess whether trunk movement can be achieved segmentally or if it moves in one unit. (See Figure 9 for 2 examples of trunk deviation)

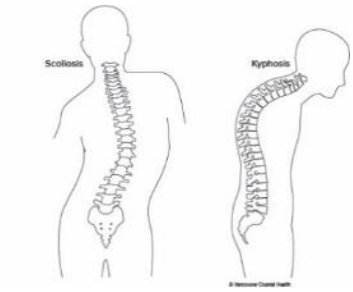

Figure 9: Left- Scoliosis; Right- Abnormal kyphosis in thoracic spine

Head and Upper Extremities

- Head and neck flexion, extension, side flexion, and rotation, and ease of correction into neutral
- Shoulder or elbow or wrist available ranges: Upper extremity range of motion has implications for posture, ease of wheeled mobility, and stability. In the upper extremities, the greatest range of motion demand in the act of propulsion occur in the shoulders, with the wrist and elbow joints stabilizing propulsion (EnableNSW and Lifetime Care & Support Authority, 2011).

3. Sitting Simulation

During the sitting simulation, the impact of gravity, balance, and postural stability are re-introduced when the client is moved into a supported sitting position. The therapist considers where to apply supports based on the client's goals and the assessment findings in the supine evaluation. The location and direction of force applied to either correct or stabilize or support a posture and achieve function and comfort will determine the specific points of control and product parameters.

a. The amount and direction of force required to correct a flexible posture into neutral also needs to be considered as it may not be achievable in the seating system or tolerated by the person.
b. The goal of an accommodative seating system is to optimally distribute pressure and support the client in their fixed posture, while minimizing risk for skin breakdown and further deformity and maximizing function and comfort. Sometimes the client's body can be oriented differently to improve function and alignment, without actually changing body segment positions (i.e. tilting back to improve head position and line of sight with thoracic kyphosis, lateral wedging to orient head more upright with non-reducible scoliosis)
c. If a posture is flexible or requires a tolerable amount of force to hold in neutral, it is anticipated that the seating system can maintain, correct, or partly correct this posture if set up appropriately.
d. If a posture is flexible in one direction but stiff in another, there will be a tendency for the client to move towards the more flexible direction; thus, stabilization of the posture and prevention of further deformity will become a goal (Cherubini & Melchiorri, 2012).

Appendix D: Body Measurements

The following considerations should be taken when considering the relationship between body measurements and recommended wheelchair measurements. Note that body measurements should always be completed on both right and left sides, and as they may differ, the wheelchair may need to be set up differently right to left. In addition, body measurements should be taken in the corrected position, not the uncorrected position.

Hip width: If a client with poor postural control is in a chair that is too wide compared to the client's actual hip width, postural control is lost and the client will be seated in sub-optimal positions (Stephens & Bartley, 2018). A chair that is too wide also hinders arm propulsion and reduces accessibility. If a chair is too tight, there is a risk of excessive tissue compression and pressure injuries (Stephens & Bartley, 2018). The optimal wheelchair seat width should not have unnecessary width and is the narrowest width that allows the user to sit without direct pressure on the hips.

Thigh length: This body measurement helps to determine the seat depth of the wheelchair and cushion. A properly sized seat depth will support a client's posterior thighs, without compressing the popliteal fossa, while still enabling a client to function optimally. A wheelchair that is too deep can pull a client's pelvis forward into posterior pelvic tilt (Stephens & Bartley, 2018). A chair that is too shallow offers insufficient thigh support and reduces the area of contact with the cushion, which can increase pressure on the ITs and/or sacrum. (A therapist should consider a shorter seat depth with clients who foot propel, either bilaterally or unilaterally. This will allow for sufficient room for the client to move into knee flexion for effective propulsion.)

Lower leg length: This body measurement helps to determine footrest placement. Footplates that are placed too low will cause a client to have decreased stability, and may result in sliding forward in the wheelchair or excessive pressure in the posterior thighs (Stephens & Bartley, 2018). In contrast, footplates that are placed too high will result in decreased pressure redistribution in the posterior thighs, increased pressure in the feet, increased pressure to the IT's or coccyx or sacrum, and may result in a client sitting in a position of hip abduction or adduction and external or internal rotation. This measurement is also instrumental in establishing appropriate seat to floor height for clients who foot propel.

Trunk width: Trunk width will have implication for deciding back support width and/or lateral support placement. Chest width is measured underneath the axilla, with consideration given to the points at which seating components (i.e. lateral trunk supports) need to be placed to assist the client in maintaining postural control. At this point, the desired lateral height can also be measured (usually from the seat surface to the top of the lateral support. In general, if a client has reduced or no independent sitting balance, they will require higher lateral supports to maintain midline positioning. Laterals that are placed too low will cause a client to collapse over top of them and laterals that are too wide will cause a client to fall to one side.

Shoulder height or scapula height: If a client is propelling the wheelchair with their upper extremities, the backrest will ideally leave the scapula free to allow the client to move into retraction for optimal propulsion. For a client with good trunk control, this could be achieved with a lower backrest. Alternately, for a client with decreased trunk control, scapular cutouts on the backrest will provide ease of movement in the scapula and postural support to enable optimal propulsion. For a client who does not propel with their arms and who has decreased trunk control (i.e. using tilt), consideration

should be given to redistributing the pressures along their trunk with a higher backrest (i.e. to the level of the shoulder).

Additional information about client body measurements, including measuring a client who is bariatric, can be found on professional practice website.

Appendix E: Product Parameters

Product parameters are specific features that describe the equipment. They can be physical features which affect how the equipment interacts with the client's body, or more general features such as cost. When considering product parameters, it is beneficial to note that the more firm, rigid and angular (as opposed to soft, flexible and curved) a wheelchair seating component is, the more postural control that you can gain (i.e. a rigid backrest with specifically placed angular trunk laterals provides specific biomechanical control, whereas a fabric sling backrest will cause a client to sink into it if they lack independent postural control). In terms of pressure, a soft and flexible seating system can allow more immersion which can provide pressure redistribution, but a rigid and firm seating system that is contoured specifically for the individual can also distribute pressure very effectively and even offload some areas.

Below are some examples of product parameters. This is not a complete list (there are many more possibilities) and they should always be client specific.

General:

- Weight
- Maintenance
- Cost
- Adjustable or growable
- Modifiable
- Durability

Cushion:

- Size: width, depth, height
- Material: foam, air, hybrid, gel
- Contour: deep, mid, shallow, or no contour
- Amount of lateral or medial thigh contouring
- Angular or steep pre-ischial block vs. gentle contour
- Modular- able to add pelvic obliquity build-up (specify left or right and height of build-up)
- Density of material: firm, medium, soft
- Pressure redistribution qualities: low, moderate, high
- Offloading: which areas
- Cover material: slippery, breathable, incontinence proof, tacky, stretchy, removable

Backrest:

- Size: width, height, thickness

- Full height, sub-scapular, helpful to describe by position of backrest on body as well as by measurement of height
- Material: foam, air, gel, combination
- Contour: planar, mild or moderate or deep midline guidance (specify depth by measurement, often 3”, 6” etc)
- Integrated lateral support vs. separate laterals
- Lateral position: height, depth, size of pad, width between laterals
- Lateral shape: curved, flat
- Lateral mounting: to backrest, to back canes, swing-away or fixed or removable or offset or inset
- Backrest angle
- Backrest hardware: removable or fixed, type of adjustment needed (i.e. extra depth, rotation)

Wheelchair:

- Seat width and depth
- Seat-to-floor height (front and rear)
- Overall width
- All specific measurements based on body measurements and functional needs (i.e. leg rest length, hanger angle, foot position
- Specific adjustability required: centre of gravity, seat slope, seat depth, leg and footrest angle
- Dynamic features (manual or power)
- Manual frame: rigid vs. folding; fixed vs. adjustable; frame weight
- Power: type of drive control and position; requirements of electronics (i.e. specific programmability needs now and for future needs; other devices controlled)
- Environmental considerations: maneuverability, door widths, terrain

Appendix F: Outcome Measures

Various tools can be used for outcome measures. Examples specific to wheelchair seating can be found in the Wheelchair Outcome Tool Briefs

The Wheelchair Outcome Measure (WHOM) has been validated with residents of long term care as well as individuals with spinal cord injury.

Other tools, such as the Functional Mobility Assessment, can be applied to clients using wheelchairs (Powers et al., 2014). Non-standardized tools can include measurement scales of comfort and pain, wheelchair propulsion speed or effectiveness, and measurements of skin breakdown.

The Functioning Everyday with a Wheelchair (FEW) is a self-report outcome measure which serves to assess perceived function related to wheelchair use. It has been validated with individuals with spinal cord injury, cerebral palsy, and many other conditions. It could be applied across different wheeled mobility and seating device users.

Appendix G: Education Resources and Recommended Readings for Therapists

1. Free online seating modules:
    - Spinal Seating Professional Development Program
    - Synapse Education Centre - Courses
2. Book chapter: Chapter 6 in Seating Biomechanics and Systems

   Schmeler, M. et al., (2007) Seating Biomechanics and Systems. In Copper, R. (Ed.), Ohnabe, H. (Ed.), Hobson, D. (Ed.). An Introduction to Rehabilitation Engineering. Boca Raton: CRC Press.
3. Article 1: Measure It: Proper Wheelchair Fit is Key to Ensuring Function While Protecting Skin Integrity

   Sprigle, S. (2014). *Advances in Skin & Wound Care,* 27(12), 561-572.
4. Article 2: Understanding the Association Between Pressure Ulcers and Sitting in Adults What Does It Mean for Me and My Carers? Seating Guidelines for people, Carers and Health & Social Care Professionals

   Stephens, M., & Bartley, C.A. (2018). *Journal of Tissue Viability*, 27, 59-73.

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		Developer Lead(s): • Interim Clinical Resource Therapist, Professional Practice Occupational Therapy, VCH • Clinical Resource Therapist, Interdisciplinary Long Term Care Team, VCH **Development Team members:** • Occupational Therapist trans to Assistive Tech, Spinal Cord Program - Rehab, VCH • Regional Clinical Resource Therapist, Occupational Therapy - Regional Professional Practice, VCH