Vehicle options to transport a person in a wheelchair

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However, this may not be possible due to:

- The person being unable to sit in a seat without additional support, and/or
- Outgrown child safety seats
- Vehicle transfers too difficult due to size/growth, and/or because of the nature of their disability (TranSPOT, 2010)

At times, relevant recommendations and available equipment for safe transport may contradict the individual's seating and positioning and needs. In such cases, a risk assessment will be completed as part of the decision making process and requires careful documentation (BPG, 2013)
Roles and Responsibilities of the Clinician

Consumers should be able to expect that rehabilitation professionals will be knowledgeable about best practices in transportation safety, will discuss and include transportation safety issues in their wheelchair and seating evaluations, and when needed, provide justification for the additional cost of transportation-related features of these products (RESNA, n.d.)

Roles and responsibilities of the Clinician:
- Works within their area of expertise
- Keeps up to date with current and new information relating to transportation safety, including relevant legislation and Standards/guidelines
- Informs stakeholders of their responsibilities
- Provides relevant documentation and training to those involved in the transportation of the wheelchair occupant
- Verifies that the wheelchair occupant and support team understand the function of WTORS (Wheelchair Tie-down and Occupant Restraint Systems)
- Works with other specialists in the design and development of custom made equipment, bearing in mind factors relating to transportation safety, and takes a key role in relevant risk management (BPG, 2013)

Relevant Australian Standards

- AS/NZS 10542.2:2009 Technical systems and aids for disabled or handicapped persons – Wheelchair tie down and occupant-restraint systems. Part 2: Four point strap type tie down systems
- AS/NZS 1754:2010 Child restraint system for use in motor vehicles
ISO 10542-1 Technical Systems and aids for disabled or handicapped persons – Wheelchair tiedown and occupant restraint systems Part 1: Requirements and test methods for all systems

- Wheelchair tie-down and occupant restraint systems (WTORS)
- Primary purpose of ISO 10542-1 is to reduce the risk of serious injuries to wheelchair-seated occupants involved in frontal collisions and it is anticipated additional parts of ISO 10542 will be developed to address different impact conditions and directions.
- Every WTORS include a both a pelvic and upper torso belt type occupant restraint since this approach to occupant protection has been shown to be the most effective in frontal crashes, vehicle rollovers, and a large percentage of side impacts and can be implemented relatively strain forwardly in forward facing seating positions of passenger vehicles.
- Four point strap type tie-down system was considered to be the most effective and universal method for securing a wide range of wheelchairs occupied by passengers.

Wheelchair Suitability for Transport
Wheelchair Suitability for Transport

- Transport considerations should be factored, where possible, into the initial phase of the wheelchair and seating assessment process.
- It is recommended for people who remain seated in their wheelchair for transport that the wheelchair complies with AS/NZS 3696.19 "Wheeled mobility devices for use as seats in motor vehicles". As wheelchairs that met this standard have been 'crash tested'.
- When a seating system is integrated into the wheelchair frame, then the frame/seating system combination should comply with AS/NZS 3695 19:2009.
- If a separate seating system is used, the wheelchair frame should meet AS/NZS ISO 16840.4:2014 for both to be considered 'crash tested'.

Information relating to the safe transportation of wheelchairs should be provided by wheelchair manufacturers/suppliers in their pre-sales literature and user manual, including how to transport the wheelchair when unoccupied.

Wheelchair tie-downs

- Wheelchair tie-down securement points should be clearly labelled using the karabiner symbol.
- A wheelchair having tie down points does not mean it has been occupant crash tested:
  - tie-downs to restrain unoccupied vs occupied wheelchairs (e.g. TiLite)
- Suitability of the tie down system depends on the attachment points and load capacity of both the wheelchair and vehicle:
  - check the vehicle you are using has a tie down system compatible with attachment points and strong enough for the weight of the wheelchair.
- If there are no specific tie down points on the wheelchair it should not be used for vehicle transportation.
Recommendations for Safety during Transport

- Back support at shoulder height but definitely no lower than the spine of the highest scapula
- Back support angle of positions occupant 30° or less from the vertical
- Wheelchair or vehicle head support mount to prevent neck hyperextension in rear impact situations:
  - NB wheelchair head supports are not designed to withstand the same forces as a vehicle mounted head support
  - The occupant’s need for head support may increase when in transport due to vehicle motion and being unable to withstand forces of cornering or changes in speed
  - The top of the head support should be no lower than the most prominent point on the back of the head (above the top of the ears), positioned as close as possible to the back of the head, well padded, firmly attached to the seating system

Recommendations for Safety during Transport

- Head support cont.
  - Vehicle mounted back and head restraints are commercially available with some combined WOTRS.
  - Halos and anterior head supports are not recommended for use when travelling in a vehicle

- Postural supports integrated into the seating system where possible
- Wheelchair cushions of minimal weight and secured to wheelchair
Recommendations for Safety during Transport

- Ancillary items (e.g. trays) removed from wheelchair during transport and secured/stowed separately, exceptions may exist e.g.
  - The potential risk of injury is increased while travelling without a tray if it is required for postural support. In this situation additional padding on the tray is or a light weight foam travel tray securely fastened to the wheelchair.
  - Alternatives to a tray for postural support may include more supportive armrests or a harness to assist in maintaining optimal trunk postural position during travel.
- Power wheelchair controls turned off during transport
- Chin controls swung aside or stored securely in the vehicle
- Communication devices and mounts removed and stored

Travelling in Tilt

People travelling in wheelchairs are to be as upright as possible, it is recommended the backrest should be a minimum of 30° from the vertical position using combination of tilt and recline (BPG, 2013)

Which is the greater risk to the client?

Risks associated with travelling in tilt:
- In the event of an accident there is potential impact of injury from the occupant restraint not being in the appropriate position
- If the tilt mechanism fails during an accident forcing the wheelchair upright may result in the impact causing serious injury to the occupant (especially abdominal injury)
- The footprint of the wheelchair may not comply with recommended clear space requirements
- The spacing of other occupants and adjacent restraint positions may be compromised

Travelling in Tilt

Risks associated with travelling in tilt (cont.)

- The tie down system may not be in an appropriate position/site for securing and access may be impeded
- If the seat back is reclined, there is a risk of the occupant sliding under the lap belt

Tilt in space preferable to recline during transport due to the tendency to submarine in recline.

Alternatives to consider:

- Soft tray or bolster
- Anterior neck support
- Seek advise on which tilt mechanism might be the strongest or is there way to lock the mechanism during transport
- If the person is travelling in tilt – ensure the risks are explained and documented (TranSPOT, 2010)

Selecting a Wheelchair Accessible Vehicle
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Wheelchair and occupant dimensions:
- Wheelchair dimensions
- Occupant seated height
- Consider the weight added to the vehicle

Vehicle dimensions and features:
- External height and length – will it still fit in garage
- Adequate clear space around the wheelchair
- Manual/automatic transmission
- Rear or side access
- Lift or ramp entry

Selecting a Wheelchair Accessible Vehicle

Considerations for the wheelchair occupant:
- Where would the wheelchair passenger like to be positioned in the vehicle
- How will the wheelchair and occupant be restrained?
- Visibility from the wheelchair position
- Position of the wheelchair passenger in relation to other fittings in rear compartment, e.g. air conditioning vents
- Positioning of rear compartment seats in relation to the wheelchair position

Other occupants:
- No. of other passengers to travel in the vehicle with the wheelchair passenger – how many seats do I need?
- Ease of access from driver's compartment to passengers

Other:
- Price and availability
- Special fittings (TranSPOT, 2010)
Vehicle Modifications for Transport of a Person in a Wheelchair

Commonly Prescribed Modifications

Two types of vehicle modifications:
- Vehicles that require some structural changes to allow wheelchair access, e.g. lowered floors, and securement
- Vehicles that use automatic lifts and manual ramps to access the vehicle

Other Modifications:
- Entry access: Side or rear entry
- Roof, floor and window modifications
- Wheelchair and occupant restraint systems
- Seating modified for wheelchair access
- Suspension stiffened to allow extra weight of power chairs and additional weight from conversion
- Accessory storage
Wheelchair Access

Ingress, Access and Egress:
- Each wheelchair vehicle entrance door should have a minimum vertical height, a minimum clear door opening width, have no or a very small lip or protrusion at the door, and be equipped with straps/locking devices to hold the door open when a lift is in use
- Consider access from the ground to the vehicle entrance, i.e. portable ramps, hoists and platform lifters may be used (latter less manual handling but usually more costly)

Consider type wheelchair will be used:
- Some mid wheel drive PWC have castors that are not in alignment with the other four wheels and therefore cannot access vehicles using channel or track ramps
- Some abrupt changes can cause contact with the wheelchair foot supports, anti tip wheels, and/or the underside of chairs with low ground clearance (BPG, 2013)

Interior Space for Clear Zones

ISO 10542-1: 2012 provides forward and rearward clear zones to reduce the potential for injurious head impact with the vehicle interior or other passengers or objects in a crash
- In front of head using pelvic vehicle restraint only: 950mm
- In front of head using pelvic and upper torso vehicle restraint: 650mm.
- Posterior to head: 400mm
Lowered Floor Conversions

- Lowered floor conversions required for smaller vehicles to enable greater entry door and internal height clearance for people to travel in their wheelchairs
- The rear bumper and floor is cut and replaced with a lowered floor and ramp system, and the tailgate is modified to accommodate a new bumper
- Features:
  - Easy to use: access via a fold out ramp
  - Increase ease to enter/exit vehicle
  - Increased visibility
  - Increased headroom
  - Flexible choice of seating configurations

Wheelchair Access: Ramps

- Option of portable or fixed ramps that attach to towbar or vehicle floor
- Ramp gradient 1:4 or 1:6 for assisted use

Considerations:
- Required length to ensure a 1:4 or 1:6 gradient
- Ramp width
- Load capacity – combined weight of wheelchair and occupant
- Fixture of the ramp to the vehicle surface
- Weight of ramp and ease of use - physical effort to deploy and stow the ramp
- Slip resistance
- Edge barriers
- Storage space in the vehicle and impact upon visibility when driving
Wheelchair Access: Platform Lifts

Underfloor Lifts
- Advantages: save internal space within vehicle, clear view through rear window, does not impact upon seating configuration
- Disadvantages: Can become dirty and slippery leading to increased maintenance

External Lifts
- Advantages: save internal space within vehicle, clear view through rear window, does not impact upon seating configuration
- Disadvantages: Can become dirty and slippery, leading to increased maintenance requirements

Internal Lifts
- Advantages: Less visible than externally fitted lifts and not prone to environmental damage.
- Disadvantages: Rear access may be problematic in some parking situations, may take up too much space in smaller vehicles, impede on rear clearance zone

Platform options: solid, vertical split and horizontal split
Floor on side entry vehicles lowered or for rear entry configuration the floor is not lowered but rather removed with a composite or steel tub inserted
Features:
- Ease of use
- Operated by hand held control
- Manual back up
- Can be reinstalled when upgrading vehicle

Twin pillar platform lifts from www.mobilityengineering.com.au
Wheelchair Access: Platform Lifts

Considerations:
- Available space in the vehicle
- Vehicle entry height and internal height
- Lifting range – height of entry from the ground
- Space required to both deploy and stow the platform lift
- Ease of operation – some electrically operated models still have a manual component; position of controls
- Impact of stowed platform on driver visibility
- Wheelchair dimensions
- Combined weight of wheelchair and occupant (SWL of lift)
- Height of person in wheelchair
- Number of passengers
- Rear view clearance

Wheelchair tie-down and occupant restraint systems (WTORS)
Wheelchair tie-down and occupant restraint systems (WTORS)

- Secure the wheelchair firmly to the floor of the vehicle using either four point strap or docking system
- Occupied wheelchair should face forward during transportation
- Wheelchair user must be restrained independently over the wheelchair using an occupant restraint system, i.e. lap/sash belts attached to the vehicle are used separate to any postural supports
- WTORS should comply with AS/NZ 10542 and use as per manufacturer’s instructions
- Check the restraints are appropriate for the weight of the wheelchair and user. Heavy duty restraints are required for combined wheelchair and occupant weight >120kgs.

WTORS: Four point tie-downs

- Uses four strap assemblies to secure the wheelchair to the vehicle, attaching the wheelchair at four separate securement points and to the vehicle at four separate anchor points
- Can be used to secure many types and styles of wheelchair
- There must be four labelled, easily accessible securement-point brackets with specific geometry that allows for one-hand attachment of one or two tie-down hooks from tie down-strap assemblies by a driver or caregiver reaching from one side of the wheelchair
- Not all wheelchair tie-down systems are suitable for all wheelchairs, e.g. some wheelchairs exceed weight limits for wheelchair tie-down systems or if the wheelchair has over side tubing that required additional straps to fit the tie down point
WTORS: Using Four point tie-downs

- Crash tested wheelchairs have four designated points for attaching the four tie-down straps.
- Tie-downs should never be attached to removable elements, e.g. leg rest hangers or wheels.
- Position the wheelchair so that the floor anchor points for the rear tie-down straps are directly behind the securement points on the wheelchair. A side view angle of 30-45° relative to the horizontal is recommended.
- If possible, attach the front wheelchair tie-down straps to floor anchor points that are wider than the wheelchair to avoid interference with the wheelchair foot supports and to increase lateral stability during vehicle movement.

http://www.resna.org/sites/default/files/legacy/conference/proceedings/2006/WheeledMobility/Fuhrman/Figure1.jpg

WTORS: Using Four point tie-downs

Difficulty arises because of factors common to wheelchairs, such as:

- Frames and wheels are not designed to withstand the high forces generated in many crash situations.
- Poor access to the structural frame, where tie-down securement points should be located, to attach tie-down hooks and straps.
- Wheelchair or seating components (i.e. armrests) that interfere with the routing of occupant seatbelt restraints for proper placement on the body and require intrusion into the personal space of the wheelchair-seated passenger to position appropriately.
WTORS: Four point tie-down

Options:
- Automatic (self tensioning) or manual retractors, or a combination of the two
- Track mounted or disk mounted

**Track Mounted**
- Suitable for vehicles carrying more than one user or different users on regular basis
- To enable the tie-downs to be tensioned at 45-50° angle to the floor, it may be preferable to opt for vertical rather than horizontal configuration.

**Disc Mounted**
- Space saving option for when only one user will be travelling
- Limitation: wheelchair can only be restrained in one position

WTORS: Wheelchair docking systems

- Components on the wheelchair engage with a docking station mounted to the vehicle floor when the wheelchair is moved into position in the vehicle
- Generally wheelchair and vehicle specific
- Advantages: quick, no manual effort, and allows the wheelchair occupant to secure and release their own wheelchair independently
- Disadvantages: higher cost, need to attach securement adapters to the wheelchair to lock into the vehicle mounted docking station which increases the overall mass and can reduce ground clearance
WTORS: Wheelchair docking systems

- Docking tie-downs are helpful for wheelchair seated drivers who want to operate a private vehicle independently.
- Securement of the wheelchair generally occurs automatically during engagement with the device in the vehicle, but release of the wheelchair usually requires operation of a mechanical lever or electrical switch.
- Powered docking tie-down device uses external power to secure and/or release the wheelchair.
- Universal docking interface geometry (UDIG): ISO 10542-1:2012 provides specifications for the size, shape and location of wheelchair securement points, including surrounding clear zones, intended for engagement with different docking tie-down devices in a wide range of vehicles.

Occupant Protection and Securement
Occupant Protection and Securement

- Wheelchair postural securements (i.e. pelvic straps, harnesses) are not positioned in a way to apply forces to the strong parts of the skeletal system and thus restrain the occupant safely.
- They must be used in conjunction with a crashworthy lap/shoulder belt system.
- The pelvic or lap portion of the wheelchair occupant restraint system anchors to structural regions of the vehicle, or the wheelchair tie-down straps.
- The upper anchor point of the shoulder belt is attached to the structural points on the sidewall of the vehicle with the lower end of the shoulder belt connecting to the pelvic belt near the hip.

Occupant Protection and Securement

- The lap belt should fit low over the hips, touch the top of the thighs, and ideally be angled between 45-75° to the horizontal when viewed from the side.
- To ensure effective fit it may be necessary to feed the lap belt between the arm support and passenger.
- A shoulder belt should first cross the collarbone, the chest and then connect to the lap belt near the opposite hip. It should have a straight run from the point of contact with the occupant to the upper anchorage point, which should be at or above shoulder level.
References

- Department of Communities and Social Inclusion (2013). Clinical considerations for prescribers: Motor vehicle transport of people in wheelchairs.
- Tiernan, J. (n.d). Transportation of people seated in wheelchairs: Best practice guidelines. Retrieved from [http://www.aoti.ie/attachments/e820b08d-5085-4f89-8f12-7e3d66970f41_PDF](http://www.aoti.ie/attachments/e820b08d-5085-4f89-8f12-7e3d66970f41_PDF)
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<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharon Clark</td>
<td>Principal Advisor DLA and VOSS</td>
<td><a href="mailto:Sharon.Clark2@health.qld.gov.au">Sharon.Clark2@health.qld.gov.au</a></td>
</tr>
<tr>
<td>Veronica Case</td>
<td>Principal Advisor Mobility Aids</td>
<td><a href="mailto:Veronica.Case@health.qld.gov.au">Veronica.Case@health.qld.gov.au</a></td>
</tr>
<tr>
<td>Kristen Morris</td>
<td>Rehabilitation Engineer</td>
<td><a href="mailto:Kristen.Morris@health.qld.gov.au">Kristen.Morris@health.qld.gov.au</a></td>
</tr>
<tr>
<td>Leena Fraser</td>
<td>Clinical Advisor – North Queensland</td>
<td><a href="mailto:Leena.Fraser@health.qld.gov.au">Leena.Fraser@health.qld.gov.au</a></td>
</tr>
<tr>
<td>Stephen Hales &amp; Susan Robison</td>
<td>Clinical Educators</td>
<td><a href="mailto:Stephen.Hales@health.qld.gov.au">Stephen.Hales@health.qld.gov.au</a>, <a href="mailto:Susan.Robison@health.qld.gov.au">Susan.Robison@health.qld.gov.au</a></td>
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