Wheelchair tie down and occupant restraint systems (WTORS)

Information from a MASS Webinar “Securely seated in a vehicle” held on 4 May 2016

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
- 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)
Risks associated with remaining seated in wheelchairs during vehicle transport

When travelling in a motor vehicle, it is considered safest for wheelchair occupants to transfer out of their wheelchair to a vehicle seat and to use the vehicle seatbelt system or a child safety seat that complies with local legislation.

- The vehicle seat is an important part of the occupant restraint system and plays a key role in reducing the risk of serious injury to occupants during vehicle crashes.
- The vehicle seat needs to allow and facilitate proper positioning of belt restraints over the skeletal regions of the occupant to provide effective support and not to add to occupant loads during a crash.

Risks associated with remaining seated in wheelchairs during vehicle transport

- People with physical disabilities must often remain in their wheelchairs whilst travelling in motor vehicles as drivers or passengers (AS 3696.19:2013).
- Since many wheelchairs were not designed for this purpose, wheelchair-seated occupants are often at higher risk of injury in crashes than are people seated in seats provided by the vehicle manufacturer (AS 3696.19:2013).
- This is because the wheelchair crash testing is more limited compared to those of vehicles, and do not include side impact or roll over tests.
Risks associated with remaining seated in wheelchairs during vehicle transport

- A large percentage of injuries and fatalities are caused in non-collision events, such as abrupt vehicle turning manoeuvres and hard braking (RESNA, n.d)

- These injuries and fatalities are due to:
  - lack of proper wheelchair securement that result in the wheelchair moving within the vehicle or tipping over, and/or
  - non-use or improper use of belt restraints by wheelchair passengers that result in the wheelchair occupant coming out of the wheelchair seat and resulting in injuries from contact with the vehicle interior (RESNA, n.d)

Wheelchair Suitability for Transport

It is recommended for people who remain seated in their wheelchair for transport that the wheelchair complies with AS/NZS 3696.19:2009 “Wheeled mobility devices for use as seats in motor vehicles”.

- As all manual and powered wheelchairs (including scooters) that met this standard have been ‘crash tested’ as forward-facing seats in motor vehicles by children and adults with a body mass ≥ 22 kg.

- It specifies wheelchair design requirements, performance requirements and associated test methods, and requirements for wheelchair labelling, presale literature, user instructions and user warnings.

- Wheelchair products that comply will have additional features that provide increased levels of occupant security and safety whilst their occupants are riding in motor vehicles. However, a wheelchair’s failure to comply cannot be used to limit motor vehicle transportation for wheelchair users. (AS 3696.19:2013).
Wheelchair Suitability for Transport

Where a seating system is provided for a wheelchair that was not included as part of the wheelchair during the AS/NZS 3696.19 crash test, the following considerations should be made:

- Seating components should be as light as possible consistent with clinical function and secured to the wheelchair
- A backrest that reaches to shoulder height
- A substantial headrest or head support
  - top of the head support should be no lower than the most prominent point on the back of the head, positioned as close as possible to the back of the head, well padded, firmly attached to the seating system and able to withstand substantial horizontal load

Wheelchair Suitability for Transport

- The minimum restraint requirement recommended is a three-point belt restraint.
- Seating systems that are not part of the wheelchair supplied by the wheelchair manufacturer should be attached to the wheelchair frame without having to drill, weld or glue the fixture to the frame.
- Back support angle during travel should be not greater than 30° to the vertical (where practical).
- Seat reference plane during travel should be greater than 0° to the horizontal (where practical).
- Postural support devices should be removed where they may cause injury during an accident (where practical).

(AS/NZS 3696.19)
MASS Mobility Aids

- All power wheelchairs and tilt in space manual wheelchairs on the current MASS SOA have been crash tested
- For manual wheelchairs and buggies confirm with supplier if they have been crash tested. MASS will require documentation for VOSS approval
- VOSS will only approve funding for applicants to be transported in a wheelchair that has been crash tested with appropriate tie downs in place.

Transport of children seated in buggies in a vehicle should be considered as the last option due to:
- Crash testing parameters (not completed with dummy under 22kgs)
- Difficulty fitting a suitable occupant restraint

Travelling in Tilt and/or Recline

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? If an individual has to be transported with a wheelchair backrest angle greater than 30 degrees a risk assessment is recommended

Risks associated with travelling in tilt and/or recline:
- Occupant restraint not being in the appropriate position
- Tilt mechanism fails during an accident forcing the wheelchair upright the impact may result in serious injury to the occupant
- The footprint of the wheelchair may not comply with recommended clear space requirements

(Bingham, n.d.)
Travelling in Tilt and/or Recline

Risks associated with travelling in tilt and/or recline (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
- The spacing of other occupants and adjacent restraint positions may be compromised

- Tilt in space preferable to recline during transport due tendency to submarine in recline.
- If the person is travelling in tilt and/or recline ensure the risks are explained and documented (TranSPOT, 2010)

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
- Effective wheelchair securement requires compatibility of the wheelchair tiedown system available in the vehicle and the method of securement provided on the wheelchair (3696.19:2009)
- WTORS should comply with AS/NZ 10542 and be used as per manufacturer’s instructions
- 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
Interior Space for Clear Zones

When a wheelchair is secured in a vehicle AS/NZS10542.1: 2015 provides 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 pelvis and upper torso vehicle restraint: 650mm.
- Posterior to head: 400mm
- Internal height: 1500mm

WTORS: Four point tie downs

- Crash tested wheelchairs have four designated points for attaching the four tie-down straps, with two in front and two in the back.
- A tilt-in-space wheelchair should have a rear tiedown to the wheelchair chassis in addition to the seat assembly (3696.19:2009).
- Wheelchair tie-down securement points should be clearly labelled using the karabiner symbol

VOSS will only approve funding for applicants to be transported in a wheelchair that has been crash tested with appropriate tie downs in place.
WTORS: Four point tie downs

In instances where attachment points are not provided, AS3696:2009 recommends:

- Rear attachment points: a point close to the intersection of the seat frame and backrest frame
- Forward attachment points: around the main frame and as close to the top of the caster as possible (3696.19:2009).

WTORS: Using Four point tie downs

Rear tiedowns

Attach the rear wheelchair tie down straps to floor anchor points:
- Directly behind the securement points on the wheelchair, and
- A side view angle of 30-45° relative to the horizontal is desirable (AS/NZS10542.1: 2015)

Front tiedown

Attach the front wheelchair tiedown straps to floor anchor points:
- Wider than the wheelchair to avoid interference with the wheelchair foot supports and to increase lateral stability during vehicle movement (AS/NZS 10542.1: 2015)
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 (beneficial for drivers)
- 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

AS/NZS10542.1: 2015 states the docking system shall:
- provide a head restraint if the docking tiedown device includes a back restraint
- provide auditory and visual indicators for the wheelchair user and vehicle driver when the wheelchair has been successfully secured and released
- include a manual override to release the wheelchair in the event of loss of power that is accessible by an attendant
- remain in the locked position until manually released, in the event of loss of power to any power operated mechanisms
- allow for accessible operation by the occupant of any electrical or mechanical devices that are necessary to engage or disengage the docking components;
- prevent inadvertent release during normal or emergency vehicle operation.
WTORS: Wheelchair docking systems

Universal docking interface geometry (UDIG): ISO 10542-1:2015 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.

The criteria used to formulate the specifications for the universal docking interface geometry (UDIG) are that it should:

- not impede the proper use and positioning of occupant restraints
- not preclude the use of other types of tiedown devices, such as four-point strap systems or clamping systems
- permit the retrofitting of UDIG adaptors to existing wheelchairs
- require minimal structural design modifications to most common wheelchairs
- enable effective wheelchair securement in a wide range of private and public motor vehicles
- facilitate the design of UDIG adaptors, wheelchair securement points and docking tiedown devices that will withstand the wheelchair securement loads consistent with the frontal-impact test
- minimize any increase to the mass of the wheelchair
- minimize any loss of aesthetics or function of the wheelchair;
- not interfere with other wheelchair features and functions.
Occupant securement in a vehicle
AS/NZS 10542.1:2015

- When an individual remains in their wheelchairs during vehicle transport, it should be specified if the individual requires:
  - use of the occupant restraint and anchorages provided with the vehicle, or
  - Provision of a belt-type occupant restraint with the wheelchair tiedown that is designed to anchor to the vehicle or to parts of the wheelchair tie down
- NB Specification of a vehicle-equipped belt-restraint system is primarily for situations in which the WTORS is intended for use by drivers but, even in this situation, it is recommended that the WTORS manufacturer provide a complete system, including both wheelchair tiedown and occupant restraint, for after-market installation in the vehicle.

Occupant Protection and Securement

- **AS/NZS 10542.1:2015 states** WTORS that include both pelvic and upper-torso belt restraint systems.
- 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 straightforwardly in forward-facing seating positions of passenger vehicles.
- Both pelvic and upper-torso restraints reduce the the extent of head and chest excursions, and possibility of head and chest impacts with vehicle components.
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.
- 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.
- Upper-torso anchor points are height adjustable and should be set at or above the wheelchair occupant’s shoulders so as not to impose downward loads on the spine in the event of a frontal collision.

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.
- 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.
VOSS Applications

- VOSS MASS 40 Driver Application
- VOSS MASS 40 Passenger Application
- Wheelchair accessible vehicle checklist
  - To be updated to 10542.1:2015 (currently in information from 2009 edition as per Department Transport and Main Roads)
  - New checklist for wheelchair docking systems in development

References

References


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