

# PERSONAL TRANSPORTATION AND DRIVING OPTIONS

## INTRODUCTION

It is imperative that an individual with SCI/D receive at minimum a comprehensive evaluation when exploring personal transportation options. These options are ever-changing and through assessment by a qualified professional, an individual with SCI/D can be assured of receiving current information on trends in the industry. This Chapter refers to driving possibilities only and does not cover other alternative transportation, such as trains, planes and bus transportation.

A Certified Driver Rehabilitation Specialist (CDRS) is an individual certified to provide services in the field of driver rehabilitation through the Association for Driver Rehabilitation Specialists (ADED). CDRS are found in both rehabilitation hospitals as well as the private sector and are governed by a best practices guideline as provided through ADED. Occupational Therapists who have been certified through the AOTA (American Occupational Therapy Association) as "Driving Generalist" or "Driving Specialist," are also qualified to provide these services. It is vital that whoever is providing these services stay abreast of both transport and independent driving venues and must provide accurate direction in all program and vehicle options.

## DRIVER REHABILITATION PROGRAM

### Evaluation, Training, Vehicle Modification and Follow-up Services

The following details a list of the services that may be appropriate for individuals with SCI/D. Since SCI/D can affect each individual with varying neuromuscular deficits and clinical symptoms, this overview is only a guide and reinforces the necessity of assessment by qualified professionals.

### Vehicle Assessment for Passenger Transportation Only

- Clients who opt not to or are unable to drive independently
- Funding source needs to be taken into consideration



- Sedan, SUV, Truck or Van based options
- Vehicle selection is often determined by:
  - type of mobility device utilized, for example the use of power versus manual wheelchair
  - tolerances such as wheelchair seating height, width and length (final wheelchair measurements must be utilized), folding or rigid wheelchair frame
  - wheelchair base for respective tie-down system, if applicable
  - special considerations such as ventilator dependency
  - available caretaker and their capacity to assist
  - usable space inside of vehicle
  - transfer ability/upper extremity health
  - skin integrity
  - client age

### Vehicle Assessment for Passenger Only with Future Driving Considerations

- Level of injury indicates the potential to drive in the future (in many instances C5 and lower).
- Vehicle initially modified to only aid in the transport of client
- Choice of vehicle is determined while considering the possibility of the client as a future driver/operator as well as aforementioned considerations in section A (eye level, future transfer ability, future wheelchairs, etc).
- Funding source considerations for passenger tie down, and for future driving modifications
- Modifications, structural and otherwise, prescribed with the intent to enable this person to drive

independently if possible with future addition of driving controls (such as lowering entire floor area of minivan or (sometimes) full size van, instead of mid-section only, power operated wheelchair ramp instead of manual ramp and power operated entry door instead of manual door).

### **Van Assessment for Those Receiving Full Driving Consideration**

- Comprehensive evaluation provided by an occupational therapist or a CDRS (Certified Driver Rehabilitation Specialist).
- The ideal model has all evaluations completed in house by a CDRS with either a traffic safety or allied health professional background.
- If an outside source is being utilized, strong consideration should be given to a CDRS.
- Clinical Assessment
  - Interview and compiling a record of the medical and driving history and developing a rapport with the client, licensing and funding source considerations
  - Vision screen; acuity, fields, depth, color and other oculomotor skills
  - Physical/Functional status; available extremities, strength, range of motion, trunk balance (static), spasticity, transfer skills
  - Cognitive/perceptual testing
  - Assessment of mobility assistive device, appropriateness and compatibility with overall requirements of the potential driving scenario
  - Discussion of potential vehicle options and the modifications/adaptations that may be required for independent community access for the individual.
- Static Behind the Wheel Evaluation
  - Evaluation vehicle made available for assessment
  - Independent function is primary in observation
  - Entry and egress options trialed
  - Independent access to the driver station whether driving from the wheelchair or a transfer seat
  - Capacity to achieve a viable and safe operator position

- Ability to secure and release mobility device
- Assess transfer to an adapted transfer device such as a six way transfer seat base
- Ability to operate seat belt and torso strap
- Access and interface with primary control functions
- Access and interface with secondary control functions
- Preparations to advance to the dynamic phase of assessment
- Dynamic Behind the Wheel Evaluation
  - Start in low impact setting and may advance to on road. A low impact setting is a driving environment that is not complex, such as a driving range, parking lot or side street.
  - Motion will often produce the need for ongoing or frequent adjustments, for example, sometimes with impaired balance the wheel can be more difficult to turn
  - Assess into the vehicle (wheelchair) and the operator's interaction (trunk stability)
  - Assess active range of motion and endurance in motion. Determine capacity to move into driver training phase
  - Develop a preliminary vehicle choice, adaptation and modification recommendation

### **Sedan Assessment for Those Receiving Full Driving Consideration**

- Greatly determined by an individual's capacity to manage the transport of any assistive mobility device, whether it be power, power assist or manual, with the use of the sedan vehicle
  - wheelchairs
  - scooters
  - walkers, crutches, canes, braces, prostheses and splints
  - assistive technology is available on a limited basis for mobility device management in a sedan setting
- Capacity to ambulate short distances may be required in some instances
  - must be timely in completion of requirement
  - must not jeopardize safety in the complete circuit

- Quality of movement and endurance must be scrutinized. Capacity to transfer into and out of vehicle and manage any devices must be completed in a timely manner and not jeopardize safety issues.
  - Lifestyle and vocational goals are strongly considered
  - Assistive technology is available on a limited basis for assisting in the ingress and egress process in a sedan setting.
  - Consider weather/climate
- Evaluation process very similar to the aforementioned in the van section
  - Clinical
  - Static
  - Dynamic

### **Recommendations/Summary/Program Direction**

- Upon completion of the dynamic assessment a comprehensive report is generated and recommendations made. The summary of all results is shared with the individual, and in the final process, a report is generated to be distributed to the client, referring source and any third-party payer.
- Determination of whether driving is an appropriate activity for this individual is formulated by the assessment team.
- If driving is inappropriate, a discussion may include appropriate goals that may improve potential for future success;
  - Seating assessment to improve interface with vehicle or to improve clients interface with wheelchair
  - Therapeutic intervention to improve physical status, wheelchair management skills, transfer training, trunk stability
  - Medications
  - Surgeries such as Baclofen pumps/tendon transfers etc.
  - Vocational counseling or other alternatives to determine the availability of funding sources
  - Alternative transportation options available for community access if driving is not an option today and in the future (i.e. public transit options, transport services, rentals, etc.)

- Driver Training
  - Training is necessary in most instances where adaptation/modification is made.
  - Training is tailored to suit individual needs and previous experiences.
  - Most states have medical review and licensing requirements that must be addressed.
  - Comprehensive training should include multiple traffic scenarios and roadway conditions.
  - Speeds to meet local requirements through freeway operations. Can the client achieve, adjust to, and handle the speeds required in multiple traffic scenarios and densities from local roadways in addition to freeway driving?
  - An ongoing assessment of needs is based on the driver's independence.
  - Upon completion of the training program and licensure with any appropriate equipment restrictions, a final prescription/document for adaptation/modification of the appropriate vehicle of choice is developed.
- Discussion of Mobility Equipment Vendors and their role
  - Best options include those vendors that are members of National Mobility Equipment Dealers Association (NMEDA).
  - NMEDA vendors are held to standards of practice and many are certified in various levels of adaptation/modification processes based on complexity.
  - Vendors will provide vehicle options, adaptations and modifications based upon the evaluator's recommendations or final prescription.
  - Vendor, client, funding source and evaluator(s) will collaborate to ensure the project is completed with integrity.
- Upon procurement of vehicle for driving/transportation:
  - Many funding sources will require an inspection of all adaptations and modifications by a qualified outside source.
  - In all instances the evaluator should provide a vehicle inspection to ensure the prescription has been adhered to throughout the process.

- In all instances the evaluator should provide a functional assessment of the driver's independence and capacity to operate the vehicle on the road.
- Completion of any follow-up training as indicated by the functional assessment should be completed as soon as possible, by a qualified trainer.
- Evaluator may have a temporary brake installed or use a brake stick.

## DRIVER REHABILITATION PROGRAM

### Description of Injury Levels and Potential Assistive Driving Technology

#### C1-4 Motor Complete Injury

- Not a driving candidate in majority of instances, unless injury has significant motor function in the C5 and C6 Myotomes
- Transport Van Consultation
  - Minivan or Full-size van, SUV Pickup Truck options for wheelchair accessibility
  - Home site considerations for parking
  - Caregiver assistance available
  - Type of wheelchair and special considerations
  - Entry/egress clearances of the vehicle
  - Location of the individual in vehicle
  - Wheelchair securement and occupant restraint system options

#### C5 Motor Complete Injury

- Driving Considerations to include:
  - Driving a van, SUV or Pickup Truck modified for wheelchair accessibility
  - Driving vehicle from a power wheelchair (vehicle within the vehicle), with power securement (tie down) system
  - Supplemental support for trunk stability and extremity support (laterals, chest straps, backrest, arm rests, shoulder block, etc)
  - Ingress/egress clearances
  - Independent to and from safe operator's position
- Primary Driving Controls
  - Hi-Tech or power assisted controls for acceleration, braking and steering functions

with orthotic interfaces. Examples include: a joystick to operate any combination of gas/ brake and steering, a small satellite steering wheel, an electronic gas/brake lever, etc.

- Modification to vehicle system resistances. Examples include low/reduced effort braking, moderate/maximum reduced effort steering.
- Location of controls critical in maximizing clients available range of motion, strength and endurance
- Secondary Driving Controls
  - Remote operation of ignition, gear selector, horn, wiper/washer, headlamps, turn signals; Remote location of consoles, pads, buttons to allow for activation within a client's AROM, or voice commands, (some of which must be capable of activation while driving or while the vehicle is in motion).

#### C6 Motor Complete Injury

- Driving Considerations
  - Driving a van modified for wheelchair accessibility
  - Driving from a power wheelchair and in some instances a manual chair
  - Driving from a manual w/c dependent upon seating system arrangement. Does the seating system provide adequate support for the demands of driving and/or a secure position for vehicle operation?
  - Is the wheelchair compatible with a wheelchair tie down system for a driver?
  - On rare occasions may be capable of appropriate transfer to a transfer seat base in the van

#### Supplemental Support for Trunk Stability

- Primary Driving Controls
  - Some hi-tech driving considerations in most instances (see C5 section for examples).
  - Can include a reduction in required effort through modification of an existing system in the vehicle such as steering or brakes.
  - Low tech is a mechanical adaptation added to an existing control without a reduction in effort. Examples for gas/ brake are mechanical hand controls that can be mounted on the right or left side of the steering wheel or the right (and

occasionally the left) side floor in the driver's area. Gas/brake controls (hand controls) can be grouped by their movement, such as: push/rock, push/pull, push/twist, push/right angle, etc. There are many different types of handles/orthotics for the hand controls themselves and for the steering wheel. Common examples of steering wheel orthotics (or steering devices) include: spinner knobs, bi-pins, tri-pins, palm cuffs, V grips, etc.

- Potential for operation of low-tech or mechanical controls with or without modification to vehicle system resistances
- Location/positioning is critical and orthotic interfaces may be needed.
- Secondary Driving Controls
  - Refers to anything aside from acceleration, braking and steering such as gear selector, lights, horn, directional signals, parking brakes, windows, radio, climate control etc.
  - Remote secondary controls required in some instances but may be limited. Examples are buttons mounted near the elbow, hand, head that allow the client to operate turn signals, high beams, wipers, horn etc while still driving the vehicle. Voice command controls are also examples of secondary controls that may be indicated for this population.
  - Fitting in the vehicle to determine capacities and needs, which includes the need to position the client in the driver's station or position and through demonstration determine what they can or cannot activate or operate independently without adaptation or modification to a control.
  - Mechanical adaptations may preclude the need for power assist in some instances. Examples can be longer lever arms on hand controls to make the motion have less resistance (but this will require greater range of motion). Another example can be steering wheel extensions, to get the steering wheel closer to the client for positioning needs (sometimes necessary for a client with shorter arms and a protruding stomach).
  - In some instances, an adaptation to a control can be completed without having to utilize an electronic device to achieve independent

operation of that control such as extensions on the original equipment in the vehicle. Examples are extended handles for gear selectors/turn signals/keys, pegs/small sticks for window operation or climate control operation.

## C7 Motor Complete Injury

- Driving Considerations
  - Many in accessible vans but potential for sedan driving
  - More manual or power assist wheelchairs used here
  - Seating issues may prevent driving from the manual wheelchair; Inappropriate support for the demands of driving, patient safety and wheelchair securement compatibility (not enough torso support sometimes requires added equipment).
  - Some drive from transfer seats drivers in a van or truck
  - Wheelchair management skills and transfer capacities are indicators for use of sedan
  - Power assistive devices available for some to assist in wheelchair management in sedan scenario, such as car top wheelchair carriers.
  - Supplemental trunk support still likely to be needed to provide the necessary support allowing for a consistent and safe interface with the adaptations to the vehicle's primary controls which are acceleration/braking and steering.
  - Wheelchair lifts for non- modified pickup trucks/vans. These can put the wheelchair into a side door or the bed of a pickup truck.
- Primary Control Considerations
  - Hi-tech less prevalent if not eliminated
  - Mechanical controls and intact factory resistances (see examples listed under C6).
  - Potential need for orthotic interface with controls (see examples listed under C6)
- Secondary Control Considerations
  - Potential for adaptations to actuators per vehicle and clients' needs, such as climate controls, wipers/washers and headlamps
  - Some custom assistive devices are found in these instances without power requirements.



- These are control adaptations that are customized on a specific client- needs basis by a qualified fabricator who works for a mobility equipment dealer.

## C8 and Below Motor Complete Injury

- Driving Considerations
  - Access to sedan or non-structurally modified vehicle driving in many instances
  - Wheelchair management still a major issue with power assistive devices still available
  - Trunk stability still requires supplemental support in many instances
  - Primary and Secondary control of vehicle with mechanical interface at the original equipment manufacturers settings

When an individual presents with a SCI/D defined as incomplete, personal transportation requirements can vary greatly from the information that has been provided in this guideline. It is imperative that a comprehensive evaluation be provided to determine each individual's capacities from a motor activity return perspective, regardless of diagnosis, to ensure that appropriate recommendations are developed and safety is addressed. This assessment is a necessity for consideration of personal transportation and driving.

## Figures

Below you will find picture examples of some of the adaptive devices available to allow persons with limited mobility to drive independently. These pictures are meant to be representative of some of the different types of devices available and are not an endorsement of any one product.

**Figure 1:** This is a side entry lowered floor minivan with a foldout wheelchair ramp. These are typically equipped with power sliding doors, power ramps and kneeling rear suspension, which are all required to enable a wheelchair user to drive independently. There are lower cost conversions for wheelchair users who do not drive, with manual sliding doors, manual wheelchair ramps but these cannot be used for independent drivers. Rear entry versions are also available to transport wheelchair users who do not drive though side entry models are more popular.

**Figure 2:** Figure 2 shows a full size van with lowered floor, raised top, power door openers and platform style wheelchair lift. Generally, raised tops are installed to increase headroom and entry height for

persons in wheelchairs to be transported in their wheelchairs or for persons who can transfer to a six way power transfer seat. Lowered floors are installed for persons who will drive from their wheelchairs. Lowered floors also provide increased headroom and entry height but also compensate for people in tall power wheelchairs to bring their eye level to an appropriate height to see out of the windshield while driving from their wheelchair. Lowered floor minivans provide the same result.

**Figure 3:** Figure 3 shows a six way power transfer seat in the driver's location of a lowered floor, wheelchair accessible minivan. This seat moves up and down, forward and back and swivels toward the center of the vehicle (transfer site) enabling the wheelchair user to transfer between a wheelchair and the transfer seat by being able to move from the driving position to a position next to the wheelchair at the same height for a safe transfer. The OEM seat is installed onto the transfer base and retains all OEM adjustments and functions. It is operated via 3 toggle switches which are visible in the photo. Optional pendant cord equipped with the same 3 functions is also available. They are typically installed in the driver's location but can also be installed in the front passenger location.

**Figure 4:** Figure 4 shows a side entry truck conversion. This allows for driver's side entry with a wheelchair lift system for the person to stay in their wheelchair without transferring to drive.

**Figure 5:** Figure 5 shows a quick release, removable mechanical left foot accelerator pedal with built in guard covering the OEM accelerator pedal to avoid accidental acceleration. This enables a driver with impaired right lower extremity function to use the left foot to accelerate. A more permanently mounted electronic version is also available, which is activated via a switch on the instrument panel each time the vehicle is started.

**Figure 6:** Figure 6 shows the electronic servo assist accelerator and brake hand control with tri-pin handle for drivers with impaired hand function. It can be installed for left or right hand operation. This device is useful for drivers who do not have sufficient upper extremity function to operate a mechanical hand control. The electronic servo multiplies force for acceleration and braking, requiring only a few inches of travel on the handle. The tri-pin is equipped with a switch that, when rocked to the left, activates a menu

## PERSONAL TRANSPORTATION AND DRIVING OPTIONS



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5



Figure 6



Figure 7



Figure 8



Figure 9



Figure 10



Figure 11



Figure 12

of secondary controls including turn signals, horn, headlight dimmer, windshield wipers and washers, cruise control. Generally it is installed in vans for persons who drive from their wheelchairs.

**Figure 7:** Figure 7 demonstrates a push/rock style accelerator and brake hand control installed for left hand operation with a steering spin knob and a quick release removable pedal guard which prevents the driver with impaired lower extremity function from inadvertently placing their feet onto or under the OEM accelerator and brake pedals. In this photo, they are installed in a sedan, for persons who are able to transfer independently between a wheelchair and a sedan or ambulate to the sedan.

**Figure 8:** Figure 8 shows a set of push/turn style accelerator and brake hand controls which are installed for right hand operation. These are equipped with a brake hold button for use during gear selection and can be equipped with an electronic secondary control pad to operate turn signals, wiper/washer, etc



Figure 13



Figure 14

**Figures 9 - 11:** These three photos show a set of push/rock accelerator and brake hand controls installed for left hand operation with a steering spin knob mounted on the steering wheel (figure 9), a tri-pin steering spinner mounted on the steering wheel (figure 10) and a palm grip spinner device (figure 11).

**Figure 12:** Figure 12 shows a steering spin knob equipped with electronic button switches

to operate secondary controls such as turn signals, wiper/washer, horn and headlight dimmer.

**Figure 13:** Figure 13 shows push rock mechanical hand controls

**Figure 14:** Figure 14 shows Viegel Classic Push twist mechanical hand controls. With this style of hand control pushing in brakes and turning the handle accelerates. The hand controls are slim in profile allowing seat adjustment close to the hand controls.

**Figure 15:** Figure 15 shows another style of steering spinner device equipped with switches to operate secondary controls including turn signals, wiper/washer, horn, headlight dimmer.

**Figure 16:** Figure 16 shows a remote electronic gear selector for people with impaired hand function who cannot operate the OEM gear selector. It can be mounted to the left or right of the driver.

## CONCLUSION

The preliminary, individualized evaluation of an individual with SCI is imperative when investigating transportation and driving options. For many individuals with SCI, community re-integration is not achievable without either the ability to drive or to access appropriate transportation. Thorough patient assessment and evaluation of driving and transportation options make it possible for those persons to get back on the road again!

## References

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