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Advances in Vehicle Technology and Their Implications for Life Care Planning: The Perspective of a Driver Rehabilitation Specialist

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Abstract

The purpose of this article is to provide insight on the evolving trend in vehicle technologies. In-Vehicle Information Systems and Advanced Driver Assistance Systems have the potential to offset limitations in driving for individuals with disabilities. Driver Rehabilitation Specialists serve as a prime resource for life care planners in addressing the driving needs of individuals throughout their lifespan. Driver Rehabilitation Specialists can assist life care planners in developing a life care plan that encompasses the most current practices based on empirical evidence. Knowledge of evolving trends in vehicle technologies and the potential impact on the individual's community mobility relative to driving has future implications to enhance life care plans.

Community mobility considerations are critical when providing services to individuals whose independence has been impacted by disability. Driving is typically the primary means of community mobility and provides a great sense of independence (Dickerson, Reisetter & Gaudy, 2013). When disability imposes limitations on driving, assessment and intervention by a Certified Driver Rehabilitation Specialist (CDRS) or Driver Rehabilitation Specialist (DRS) may be required. A CDRS is typically an experienced Occupational Therapist who has passed a certification exam administered by the Association for Driver Rehabilitation Specialists (ADED). A Driver Rehabilitation Specialists (DRS) may also be an Occupational Therapist experienced in assessing and providing driving intervention, but has not taken a certification exam (Stressel, Hegberg & Dickerson, 2014). To be eligible for the certification exam, one must meet experience requirements (they can be found at www.aded.net). It should also be noted that a CDRS/DRS may not be an occupational therapist, but may have an educational background in the health professions or may be a driving school instructor with additional training in driver evaluation and rehabilitation. Hereafter, for the purposes of this article, CDRS and DRS will be identified solely as Driver Rehabilitation Specialist (DRS).

The primary duties of a DRS include evaluating individuals, providing interventions, and making appropriate driving-related recommendations. A comprehensive driving evaluation (CDE) consists of a clinical assessment and a behind-the-wheel assessment, which may take up to four hours to complete. The clinical assessment is typically comprised of a clinical battery of tests that assess functional range of motion, strength, balance, vision, cognition, and visual perception, all of which are critical components of driving. The behind-the-wheel assessment involves the individual having their driving performance evaluated on a pre-determined route. These can take place in a driving simulator, depending on the needs and abilities of the individual. The gold standard assessment involves an on-the-road assessment, using a vehicle equipped with auxiliary brake and/or accelerator. The auxiliary brake and accelerator give the DRS control of the vehicle in the event that an individual makes, or is about to make, a significant error while driving. Behind-the-wheel assessment may also take place in a driving simulator, if the individual demonstrates limitations as a result of clinical testing suggesting that the individual may not be fit to drive on the road. The costs of a CDE depend upon the needs of the individual. For example, the needs of an individual with a high-level spinal cord injury are much more complex than the needs of individual who is being evaluated post-right knee replacement. Typical costs of the complete evaluation are approximately $500.00, but depend upon various factors including the depth of individual's needs and the facility where the tests are administered.

Findings from the assessment and intervention may require the individual to drive with adaptive equipment (AE). Adaptive equipment can be as modest as a spinner knob which can be applied to a steering wheel for ease of turning and may cost approximately $100.00 dollars (including installation). Adaptive equipment can also be as complex as having switches applied to the headrest of the driver's seat to complete primary functions of driving i.e.,. accelerating, braking, and/or turning (Hegberg, 2012). This equipment may cost thousands of dollars to install. There are multiple factors that determine the cost of adaptive equipment installation. The brand, installation of device, and vehicle make and model are primary factors that impact cost. Other costs, such as installation and labor, vary among vendors. Adaptive equipment recommendations can be an essential aspect of a life care plan that is being developed for an individual with mobility limitations. Table 1 outlines various AE that can be considered for individuals with various disabilities in the life care plan development process, as well as the typical installation time for the item/ service.

Table 1. Common driving-related adaptive equipment

Type of Adaptive Equipment (AE)	Purpose of AE	Typical Installation Time
Push/pull hand control	Compensates for bilateral lower extremity impairments that limit accessing accelerator and brake pedal	Approximately one day
Spinner knob	Facilitates ease of turning steering wheel when using one handed technique	Approximately one hour
Left foot accelerator pedal	Compensates for right lower extremity impairments that limit accessing accelerator and brake pedal	Approximately one day
Panoramic rear-view mirror	Compensates for decreased peripheral vision decreasing blind spots	Approximately one hour

The National Mobility Equipment Dealers Association is a non-profit organization established in 1989 whose mission it is to aid in the improvement of the mobility equipment industry in order to help people with disabilities become more mobile (www.nmeda.com). This organization also provides a quality assurance program for adaptive equipment dealers and installers and is the only nationally recognized accreditation program in the United States. This program ensures that the equipment dealer and installer are adhering to the highest standards of safety and reliability, from the level of insurance they have, to the tools they use.

Upon completion of the evaluation, the DRS determines the best AE to offset the individual's limitations. This is done in collaboration with the individual. After determining the type of AE to be used, the DRS and the individual work together to set a training schedule. Training typically involves the individual receiving instruction on how to use and practice using the AE in progressive driving environments i.e., clear parking lots to driving on highway roads. The overarching outcome of training is for the individual to be independent in using the AE to drive in various driving environments i.e., parking lots, residential areas, highway roads etc. The amount of time needed for training is individualized and can be driven by the individual's adjustment to use of AE, demonstrating the safe use of the AE and carry over skills learned from previous AE training sessions.

After the assessments are completed, the DRS will provide recommendations which may conclude that the individual continues to drive, retire from driving, or be provided with training or modifications for driving. Recommendations may also be made for the individual to restrict driving. For example, the DRS may recommend that an individual only drive during daylight hours or within a familiar driving environment, due to low vision or decreased memory respectively. These critical recommendations for driving not only impact the individual themselves but also family members. The assessment results are essential in determining the needs of a person with a disability throughout their life span and may change over time, necessitating re-assessment. It is the responsibility of the DRS to communicate the need for re-assessment and timeframes as part of their recommendations. Case management professionals, such as life care planners, need to consider not only the initial assessment-related recommendations but also the need for future re-assessment and/ or equipment replacement in order to help the individual both achieve and maintain the highest level of independence possible.

Driving Technology

Over the years, there has been a growing trend of vehicles being marketed with features that alert the driver to mitigate car crashes and complete dynamic driving tasks (DDT). Dynamic driving tasks are the operational and real-time functions of driving such as parallel parking, stopping as a pedestrian walks out unexpectedly, or correcting lane position if the driver drifts out of the lane (Society of

Automotive Engineers, 2016). Features that enable completion of DDT are known as Advanced Driver Assistive Systems (ADAS). Features that alert the driver to avoid potential hazards or mitigate car crashes are known as In-Vehicle Information Systems (IVIS). In-Vehicle Information Systems often alert the driver to potentially hazardous situations via sounds, displays, and/or haptic feedback (Gietelink, Ploeg, DeSchutter & Verhaegenm, 2006). An example of IVIS is a lane departure warning. This warning may be an audible sound, haptic feedback and/or illuminated symbol on the dashboard and/or on a side mirror that alerts drivers when they veer out of their lane. Advanced Driving Assistance Systems utilize environmental sensors to improve driving comfort and safety by assisting the driver in recognizing and reacting to potentially dangerous traffic situations and autonomously intervening. Demonstration of the functionality of IVIS and ADAS systems can be found at www.mycardoeswhat.org. This site is part of a national campaign to educate drivers on IVIS and ADAS which can mitigate car crashes. Mycardoeswhat.org is regulated by the National Safety Council in conjunction with the University of Iowa, both of which are leaders in transportation safety and research.

Evolving trends in vehicle technology will inevitably impact how a DRS assesses an individual's driving, the interventions used, and recommendations made. For example, if an individual sustains an injury resulting in limitations in neck/ head rotation, turning their head to check blind spots when changing lanes or parking may be difficult. However, driving a car with technology that can detect and prevent a collision can be highly beneficial for these individuals. A study conducted by Saito and Raksincharoensak (2016) found that the use of an Autonomous Emergency Braking system can improve the safety performance of older drivers. These advances in vehicle technology can be built into the life care plan to help minimize the impact of a disability upon one's ability to independently drive safely and effectively.

From 2014-2016 there has been a growth of 48% of cars (94 million to -139 million) on the road around the world that are equipped with IVIS and ADAS. According to McKinsey and Company (2018), a publisher of vast industrial and technological content from around the world, this trend is expected to continue. It is best practice for the DRS to stay abreast of the trends in vehicle technology and best evidence to make the most appropriate recommendations for individuals who need these items. A life care planner who is knowledgeable of the impact of these evolving vehicle technologies can create a life care plan that not only the uses of the latest technology but also meets the needs of their individuals.

Along with the previously listed duties of the DRS, another critical duty is to educate stakeholders i.e., including clients, vehicle modifiers, and life care planners. When working with a life care planner, the DRS can provide valuable information that will inform the life care planner about the type of equipment or vehicle features that are appropriate for the individual. The DRS will determine if the vehicle technology can offset the need for adaptive equipment. The DRS must also decipher if the vehicle technology will provide additional benefits or challenges in conjunction with adaptive equipment. This information will assist the life care planner in ensuring that the individual's needs are met throughout the lifespan for independence in community mobility. Over one's life span, consideration must also be given to the wear and tear that comes the use of any mechanical device (Weed & Berens, 2004). The life care planner and DRS can collaborate to determine not only the initial equipment required by the individual, but also the need for replacement and/ or maintenance as the equipment ages and technology changes.

Current Research

Researchers are putting forth efforts to investigate the efficacy and effectiveness of IVIS and ADAS, as little is known about the impact that these technologies will have on people with and without disabilities throughout the life span. Most research on IVIS and ADAS studies have been conducted in driving simulators. Researchers suggests vehicles with ADAS features be tested in a real-world on-road context before being commercially distributed and driven by consumers (Guo, Blythe, Edwards, Pavkova & Brennan, 2013). Given the date of this publication and the advancement in vehicle technology it can be generalized that vehicle manufactures are following the recommendations of researchers.

Currently the Institute for Mobility, Activity and Participation (I-MAP) of the Department of Occupational Therapy at the University of Florida is engaging in research activities to increase public knowledge regarding the impact of IVIS and ADAS. The I-MAP team has partnered with the American Automobile Association (AAA) to update a matrix of smart features (IVIS and ADAS) for vehicles primarily for older drivers. The matrix is a brochure that lists features of every vehicle make and model on the market and the age-related changes that each feature offsets (http://seniordriving.aaa.com). This project built on previous work conducted in 2007 and 2011, where the University of Florida and AAA developed a Smart Features for Older Drivers Project. Specifically, in the 2011 version, the project team developed a 2016 vehicle checklist on which each vehicle was rated on its potential benefits for the declining abilities, due to normal age-related changes, for older adults. Occupational therapists on the team identified core components of the aging process that can affect driving, which included decreased leg strength, short stature, arthritic hands, limited upper body range of motion, diminished vision, and cognitive decline—and matched that to vehicle features that could potentially offset such limitations. Because of the potential benefits for older drivers, Smart Features for Older Drivers Version 3 will address such age-

related declines, and match those to IVIS and ADAS of the 2019 vehicles.

The matrix will serve as a medium to assist drivers in identifying the Smart Features of every vehicle make and model and how these features can mitigate age-related changes. For example, a vehicle with active parallel park assist may benefit a driver with arthritic shoulders, as this feature will decrease/eliminate the amount of range of motion and strength needed to turn the steering wheel to complete parallel parking. The third version of the matrix is necessary to reflect the current trends and features in vehicle technology, as the second version was published in 2016. The third version will reflect the features of all 2019 vehicles with the latest IVIS and ADAS features. Although the Smart Features for Older Drivers matrix is a tool for older drivers, the benefits of the listed vehicle features may be generalizable to other populations whose driving abilities are impaired.

In conjunction with the Smart Features for Older Drivers matrix, the I-MAP team is in the process of completing a scoping review of current literature. A scoping review was deemed appropriate as the impact of IVIS and ADAS on older drivers has not been extensively reviewed. A scoping review methodology was chosen due to the exploratory nature of the research question within an emerging evidence base. The scoping review was conducted to include the following phases: Synthesize knowledge to inform evidence-based practice, map key concepts within an emerging research area, clarify definitions and conceptual boundaries, establish important sources of evidence, find research gaps, and identify potential interventions and outcomes of interest (Arksey & O'Malley, 2005; The Joanna Briggs Institute, 2015).

The overarching aim of this project is to identify the impact of IVIS and ADAS on the driving tasks of adults ages 65 and older. The data gathered from the scoping review and the implications from the perspectives of the I-MAP team which includes Occupational Therapists and a Certified Driver Rehabilitation Specialists will facilitate the identification and classification and rating the importance, potential benefit, and usability of vehicle IVIS and ADAS for older drivers. Information will be widely disseminated through national, professional, and stakeholder networks.

Research efforts that focus on the latest vehicle technologies and the impact on individuals with and without disabilities may shape future recommendations for an individual's independence in driving. Understanding the implications of these findings ensures that best evidence leads to the implementation of best practices. As advances in vehicle technology prove to offset limitations of individuals with disabilities, the DRS can play a vital role in educating stakeholders such as life care planners on the services we provide. The result is that we continue to strive to facilitate maximal independence for those who need driving-related accommodations.

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