

# NSTSCCE

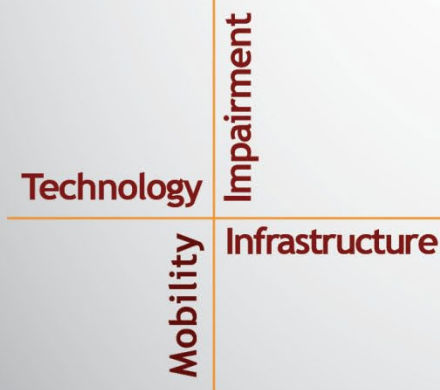
National Surface Transportation  
Safety Center for Excellence

## Temporary Disability

Development of an Evaluation Framework

Alice Werner • Miguel A. Perez

Submitted: July 17, 2024



Housed at the Virginia Tech Transportation Institute  
3500 Transportation Research Plaza • Blacksburg, Virginia 24061

## **ACKNOWLEDGMENTS**

The authors of this report would like to acknowledge the support of the stakeholders of the National Surface Transportation Safety Center for Excellence (NSTSCE): Zachary Doerzaph from the Virginia Tech Transportation Institute; John Capp from General Motors Corporation; Melissa Miles from State Farm Insurance; Terri Hallquist from the Federal Motor Carrier Safety Administration; and Michael Fontaine from the Virginia Department of Transportation and the Virginia Transportation Research Council.

The NSTSCE stakeholders have jointly funded this research for the purpose of developing and disseminating advanced transportation safety techniques and innovations.

## EXECUTIVE SUMMARY

The purpose of this work was to assess the impact of temporary disability on the ease and effectiveness of automobile driving tasks. The main objective of this work was to generate a framework to evaluate the extent to which a given temporary disability, caused by a given primary condition and associated with different symptoms, affects individual driving tasks at any given timepoint following the onset of the temporary disability.

Injuries and medical conditions can limit driving ability—from chronic conditions to temporary conditions. Ultimately, the disability produced by these conditions may result in driving restrictions, reliance on compensatory driving techniques, or both. This can be particularly onerous for individuals that live in areas not well served by public transportation. In an ideal analysis of temporary disability, translating temporary disability into its disruptive impacts on components of the driving task (i.e., functional driving domains) should identify affected driving tasks, the degree of impact on driving tasks, and necessary/useful compensatory driving techniques and vehicle modifications, as well as inform return-to-drive guidelines that are not overly conservative. In reality, however, connections between temporary disability symptoms and their effects of specific driving tasks are either incomplete or completely nonexistent. Given this background, the current effort aimed to propose a preliminary framework and model for the systematic evaluation of effects of temporary disability on functional driving domains through a semi-hierarchical task analysis and identification of different elements of the temporary disability's manifestation that should be considered in such a framework.

A cascading model was developed that first associates a temporary disability event with specific temporary disabilities and then qualifies those disabilities into a set of affected capabilities. Finally, the affected capabilities are translated into impacts on specific driving tasks. The output from the model allows the user to understand the hindrance that a temporary disability event may create on someone's driving so that reasonable return-to-drive guidelines may be generated and/or patients can self-regulate their driving to accommodate for temporarily diminished skills.



## TABLE OF CONTENTS

LIST OF TABLES.....	v
LIST OF ABBREVIATIONS AND SYMBOLS .....	ix
CHAPTER 1. OBJECTIVES .....	1
CHAPTER 2. BACKGROUND.....	3
INTRODUCTION .....	3
PREVIOUS RETURN-TO-DRIVE RESEARCH .....	4
<i>Return-to-Drive Evaluation Methods</i> .....	4
<i>Return-to-Drive and Temporary Disability Cause</i> .....	5
<i>Hierarchical Driving Task Analyses</i> .....	6
CHAPTER 3. METHODS .....	9
CHAPTER 4. RESULTS.....	13
CHAPTER 5. DISCUSSION .....	17
APPENDIX A. MODEL ELEMENTS.....	19
REFERENCES .....	29



## LIST OF FIGURES

<b>Figure 1. Diagram. Cascading model for the assessment of temporary disabilities, affected capabilities, and driving tasks affected by a temporary disability event. ....</b>	<b>11</b>
---	-----------



## LIST OF TABLES

<b>Table 1. Temporary disability association analysis for traumatic fall event of interest. ....</b>	<b>13</b>
<b>Table 2. Affected capability determination for the temporary disabilities resulting from the traumatic fall event of interest. ....</b>	<b>15</b>
<b>Table 3. Affected driving tasks for the affected capabilities resulting from the traumatic fall event of interest.....</b>	<b>16</b>
<b>Table 4. Summary of the affected driving tasks resulting from the traumatic fall event of interest, including task attributes.....</b>	<b>16</b>



## **LIST OF ABBREVIATIONS AND SYMBOLS**

MVC	motor vehicle crash
PTSD	post-traumatic stress disorder
TBI	traumatic brain injury
VTTI	Virginia Tech Transportation Institute



## **CHAPTER 1. OBJECTIVES**

The purpose of this work was to assess the impact of temporary disability on the ease and effectiveness of automobile driving tasks. This research area is important for determining fitness to drive and driving-related recommendations for a person in a state of temporary disability. The main objective of this work was to generate a framework that evaluates the extent to which a given temporary disability, caused by a given primary condition and associated with different symptoms, affects individual driving tasks at any given timepoint following the onset of temporary disability.



## CHAPTER 2. BACKGROUND

### INTRODUCTION

Injuries and medical conditions can limit driving ability—from chronic conditions (like older adults aging into dementia) to temporary conditions (such as recoverable forms of traumatic brain injury [TBI]) (Chen et al., 2008; D’apolito et al., 2013; Dobbs et al., 2005; Marshall & Man-Son-Hing, 2011). For example, visual disturbances and impaired motor function from a concussion (mild TBI) can impede the level of visual and motor function required for driving (Devos, 2017; Fraser & Mobbs, 2022; Preece et al., 2010; Sosnoff et al., 2008).

The importance of examining the impacts of temporary disability on functional driving is multifold. Previous research has found that most people with temporary disability did not use modified vehicles and/or disclose using other driving assistance technology (Jones et al., 2010; Silverstein et al., 2005). Most of these people with temporary disability, and even those with several years of acquired disability (i.e., a long-term disability developed during the person’s lifetime), were unaware of the existence of these driving assistance technologies (Jones et al., 2010; Silverstein et al., 2005). People who would benefit from these technologies may also be unaware of their effectiveness and may be concerned with the return on their investment. In addition, for those individuals who are aware of these options and appreciate their effectiveness, financial concerns may be an issue. These individuals may be unable or unwilling to pay for briefly needed and potentially costly vehicle modifications and assistive driving aids. When considered and applicable, the added expenses of reversing vehicle modifications upon full recovery may also inhibit people from utilizing those options.

For individuals who do not get these modifications or other assistive driving technology, and for individuals who have a temporary disability for which those options are unavailable, their disability may result in driving restrictions, reliance on compensatory driving techniques, or both. A big issue with the driving restriction option is that even a temporary driving restriction can heavily and adversely affect mobility security, financial security, employment, quality of life, and opportunity (e.g., economic, social) (Hutchinson et al., 2020; Klein et al., 2023). Car-centric living environments (i.e., environments where transportation alternatives to driving are lacking, unappealing, and/or infeasible to use) exacerbate these burdens (Karjalainen et al., 2023). In contrast, a potential issue with the reliance on compensatory driving techniques is that their true level of safety is not entirely known (Jones et al., 2010; Metrey, 2023). For example, Metrey (2023) observed an increased prevalence of one-handed driving in time periods immediately following rotator cuff tear repair. While this observation did not lead to any detectable safety issues in prescribed normal driving maneuvers, the extent to which one-handed driving could increase risk in other safety-critical maneuvers remains unknown. Temporary disability pairs this unevaluated safety with a short duration of time afforded to ideate and hone compensatory driving techniques and otherwise adjust to new impairments. On the positive side, as the driving impairment of a temporary disability dissipates, the ability to return to driving becomes increasingly feasible. Nonetheless, the sparseness of high-quality, on-road, return-to-drive research publications strongly suggests that return-to-drive timepoints are not rigorously studied or understood (Metrey, 2023).

The prevalence of temporary disability makes it an especially crucial area of study. Fourteen percent of respondents from linked monthly U.S. Bureau of Labor Statistics-conducted Current Population Surveys (2008–2015) experienced at least one form of temporary or new disability (Ward et al., 2017). Ward et al. (2017) suggest that these temporary disability statistics, however, are underestimates due to expected non-reporting of transient functional declines as temporary disability. On the positive side, Ward et al. (2017) also indicated that 30% of people who had reported disability throughout the course of the surveys recovered from all previously reported disability at some point during the survey duration.

The functional analysis of temporary disability is a complex study area. Signs, symptoms, severity, and episodic frequency profiles, to name just a few major dimensions of functional disability, can vary substantially between and among temporary disability causes and types. For example, a fall can result in various injury profiles and injury severities depending on the manner of the fall: the way a person lands after falling (e.g., distribution of force on the body upon impact with surfaces), applied (e.g., being shoved) and impact forces, fall height, fall velocity, prior organ robusticity (e.g., bone strength), character of impact objects and surfaces (e.g., sharpness and hardness), and number of impacts with objects and surfaces. Falls and motor vehicle crashes (MVCs), for instance, may or may not involve head impact, loss of consciousness, and/or TBI. Moreover, specific symptoms, such as fatigue, headache, visual and motor disturbances, and irritability episode severity and recurrence frequencies resulting from brain injury could vary based on injury cause, nature, localization, severity, and healing stage (Gaddam et al., 2015; Kushner, 1998).

In an ideal analysis of temporary disability, translating temporary disability into its disruptive impacts on components of the driving task (i.e., functional driving domains) should serve to identify affected driving tasks, degree of impact on driving tasks, necessary/useful compensatory driving techniques and vehicle modifications, and to inform return-to-drive guidelines. A fall or MVC resulting in concussion, for example, would affect driving differently (especially regarding complex and cognition-heavy tasks) than would a fall or MVC that did not yield concussion. These injury mechanisms would require different driving modifications and return-to-drive guidelines depending on their outcomes. Likewise, a wrist injury from a fall would impact driving tasks differently than an ankle injury from a fall. Furthermore, an ankle injury may not even impact automatic transmission vehicle driving at all, especially if the injury is on the left ankle. Even an injury to the right ankle in automatic transmission vehicles would likely just require a compensatory modification involving using the non-dominant leg to operate the accelerator and brake pedals, albeit with some extra caution to account for the safety of this compensatory behavior (Jones et al., 2010). In reality, however, connections between the symptoms of temporary disability and their effects on specific driving tasks are either incomplete or completely inexistent.

## **PREVIOUS RETURN-TO-DRIVE RESEARCH**

### **Return-to-Drive Evaluation Methods**

The lack of research and science-backed guidance for resuming various forms of activity, such as driving, is a major barrier with respect to mitigating the effects of temporary disability. Thus, the impact of temporary disability on functional driving domains is a useful research area, ripe for

exploration. Return-to-drive research is typically conducted via surveys, clinical evaluations, driving simulators, and on-road studies. Previous studies via driving simulators and on-road driving have demonstrated increased reaction times and braking distances in cases of TBI (D'Apolito et al., 2017). Schultheis and Whipple (2014) state that driving simulators can be particularly useful for evaluating tasks for which data collection is troublesome, such as those that pose high risk for crash/injury. Regardless, the apparent literature consensus is that on-road studies are optimal evaluation methods given their superior realism and ecological validity (Badger et al., 2022; D'Apolito et al., 2017; Metrey, 2023; Schultheis & Whipple, 2014).

Schultheis and Whipple (2014) further argue that on-road and off-road driving evaluation is a crucial, effective, and recommended way to assess driving performance regardless of the presence or type of temporary disability and should be repeated over time. Yet, research on temporary disability, its impacts on driving performance, and implications for the return to driving is limited, especially via on-road studies. Thus, the currently prescribed driving accommodations and return-to-drive guidelines are highly subjective, varying, and scientifically unfounded. This issue lends to recommendations for lengthy, likely longer-than-necessary, periods for refraining from driving and other activities (Badger et al., 2022; Shinn et al., 2022). Longer-than-necessary driving restriction recommendations can inhibit autonomy of mobility and quality of life, particularly among car-dependent persons (Shergold et al., 2012).

### **Return-to-Drive and Temporary Disability Causes**

Post-surgical return-to-drive is understudied but its exploration has high potential for narrowing ranges for ideal return-to-drive timeframes and for shortening post-surgical driving restriction periods. Metrey (2023) comprehensively describes functional driving with respect to rotator cuff surgery, addressing questions such as how drivers compensate for temporary disability and exploring the quantification and safety of such compensation and driving function (Metrey, 2023). Badger et al. (2022), in turn, determined, from on-road naturalistic-like driving studies, that middle-aged rotator cuff surgery patients can return to drive after two weeks. Similarly, based on patient report data, Shinn et al. (2022) found that minimally invasive spine surgery patients could return to driving after 15 days.

Given this evidence, an important and impactful goal could be to expand these functional driving analyses beyond these specific temporary disability cases to construct comprehensive and systematic processes for prescribing driving restrictions and driving accommodations across temporary disability types and causes. The quest for a systematic approach, however, is hampered by poorly defined return-to-drive benchmarks and lack of validated, standard, and comprehensive evaluation tools (Schultheis & Whipple, 2014). The construction of a systematic approach is further thwarted by disability type causes often being less controlled and straightforward compared to professionally conducted surgeries done according to established procedure with high precision and care. Uncontrolled, stochastic temporary disability causes and types, such as injuries, are likely subject to far more variability and complexity in return-to-drive prognoses and trajectories, and thus must be qualified based on severity and impact variability—especially in cases of head and brain injuries.

Within a non-surgical domain, D'Apolito et al. (2017) reports that return-to-drive in non-evolutive brain damage is a very nuanced and complicated matter based largely on subjective

expert opinion (D'Apolito et al., 2017). In many cases, guidelines require a physician's clearance to return to driving after thorough evaluation (D'Apolito et al., 2017). In cases of mild TBI, the guidelines are variable across the world, from a specific driving suspension period (particularly for cases without loss of consciousness) to driving suspension lasting until full resolution of symptoms (D'Apolito et al., 2017). Brain-injured people often can detect decreases in their driving abilities and develop work-arounds in their driving behaviors and patterns (Schultheis & Whipple, 2014)—a finding that could shorten prescribed driving restriction periods. Metrey (2023) found that such altered driving techniques can be safe within the bounds of normal driving, but not necessarily in emergency situations requiring rapid reaction times. Schultheis and Whipple (2014), in particular, cite the importance of returning to driving for quality of life, specifically among brain injury victims.

In cases of cerebrovascular accidents (i.e., strokes), the recommended return-to-drive time windows are much more variable, while still requiring physician clearance for driving (D'Apolito et al., 2017). These guidelines extend from 15 days on the lower end for transient ischemic attacks to 6 months for non-transient cerebrovascular accidents (D'Apolito et al., 2017). Rutkowski et al. (2021) found that at 3, 6, and 12 months post-stroke, residual fatigue does not significantly affect return to drive, yet about 20% of their participants aged 60 and below had not returned to drive 12 months post-stroke (Rutkowski et al., 2021). Some people, however, returned to driving within a month after stroke (Rutkowski et al., 2021), which further emphasizes the importance of temporary disability functional driving research. Rutkowski et al. (2021) argues that, like with brain injury, stroke-affected people returning to driving may modify their driving habits, patterns, and routines to account for perceived residual driving impairment. MacDonald et al. (2018) discusses the variability in return-to-drive times for concussion based on clinical symptom evaluations. These researchers also point to computerized evaluations as a means of quicker return to drive and to reaction time performance as a key driving fitness measure.

Altogether, these studies suggest that short-term disability involving the brain necessitates on-road testing before return-to-drive, after a particular milestone such as a certain timeframe, or sufficient/full resolution of all, most, or specific symptoms. Yet, it also seems that people will adjust and accommodate for new limitations that arise from temporary disability. If these compensatory driving behaviors are sufficiently safe and effective, they may allow for decreased prescribed temporary-disability-related driving restriction timeframes. Furthermore, while accommodation to driving with compensatory techniques may enable driving and/or quicker return to drive, the safety of these techniques remains in question.

### **Hierarchical Driving Task Analyses**

Most existing hierarchical driving task analyses are very task specific, including evaluations of merging onto a freeway (Kassner et al., 2011), intersection driving (Richard et al., 2006; Plavšić et al., 2010), high-altitude driving (Hao et al., 2019), lane changing (Mattes, 2003), infotainment system use (Reagan & Kidd, 2013), and hazard detection (Yang et al., 2019). Other driving-related task analyses were vehicle-type-specific, generally referring to trucking protocols (Bedinger et al., 2015), transit vehicles (Moe et al., 1973; Miglianico et al., 2018), and autonomous vehicles (Barbera et al., 2004). An additional analysis in the literature surveyed was fairly broad in scope yet noncomprehensive, and focused exclusively on cognitive aspects of

driving tasks (Fastenmeier & Gstalter, 2007). This last analysis, in particular, reinforced the need for human-centered driving task analyses, emphasizing that safe driving hinges on the compatibility between driving tasks and driver abilities (Fastenmeier & Gstalter, 2007).

More specific to temporary disability, one research team developed weighting systems for functional impairment from temporary disability from Netherlands survey and hospital data, but not specifically with respect to driving (Haagsma et al., 2010). Thus, the task of characterizing temporary disability impacts on functional driving tasks remains.

In summary, the stated variation and complexity between and within temporary disability causes, along with the myriad of associated symptoms, impede the construction of a straightforward prescription of driving guidelines and modifications. In an effort to broach this challenge, this work proposes a preliminary framework and model for the systematic evaluation of temporary disability effects on functional driving domains through a semi-hierarchical task analysis and the identification of different elements of temporary disability that should be considered in such a framework.



## CHAPTER 3. METHODS

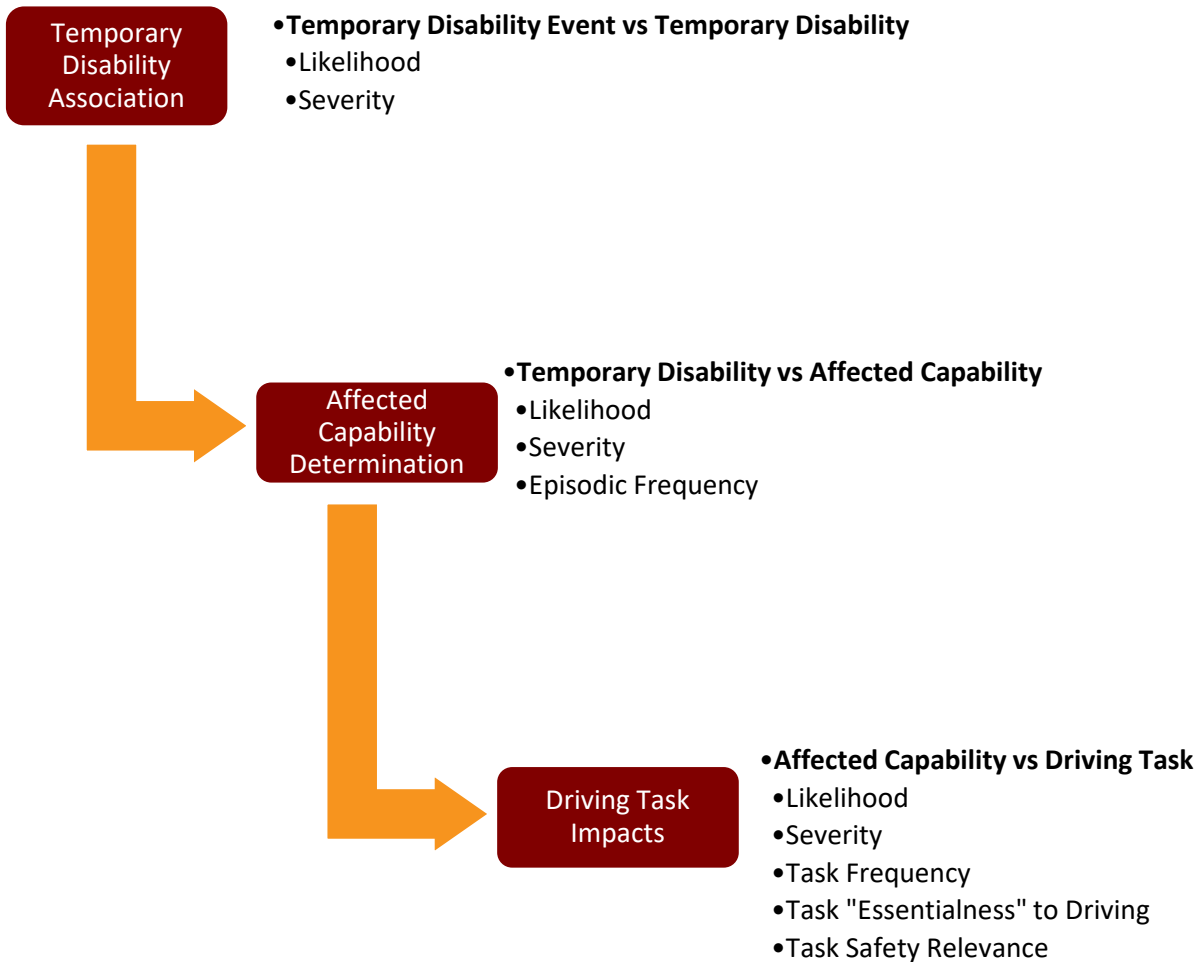
The initial step in translating temporary disability causes into impacts on functional driving tasks involved the identification of primary disability causes, secondary disability causes, affected capabilities, and driving tasks. To achieve this, pertinent primary and secondary disability causes were first derived from the 2011–2021 Top Five Causes of Non-Fatal Injury U.S. Emergency Department Case Estimates (based on the National Electronic Injury Surveillance System-All Injury Program for WISQARS Nonfatal data as aggregated by the National Center for Injury Prevention and Control). Then, comprehensive lists of affected capabilities and driving tasks were constructed. A cascading model is used to depict the remaining steps, with subsequent levels linked by assessments capturing the likelihood and/or extent to which the outcomes of a previous stage affect the metrics of interest in the current stage (Figure 1). This cascading model linked illustrative conditions and temporary limitations, first to the signs and symptoms that they cause, and then to the effect that these signs and symptoms have on the driving task.

Several terms in Figure 1 merit initial definitions:

- **Temporary disability event:** represents the main source of the temporary disabilities being studied. A single temporary disability cause may result in multiple temporary disabilities. Examples include an MVC, a fall, or a specific type of surgery.
- **Temporary disability:** represents a potential outcome of a specific event (i.e., the temporary disability event), particularly an outcome that is abnormal to the person experiencing it and is expected to ease or disappear over time as healing takes place. Examples include musculoskeletal injury, physical pain, and brain injuries.
- **Affected capability:** represents a characteristic of human performance (e.g., vision, hearing, motion, strength) that may be degraded by a temporary disability. Examples include the range of movement or strength of an extremity, visual acuity, or the cognitive capacity of a particular victim of temporary disability.
- **Driving task:** specific element of the traditional manual operation of a motor vehicle whose performance may be degraded by an affected capability. Examples include the proper use of a car horn, turn signals, and steering wheel.
- **Likelihood:** refers to the probability that one circumstance leads to another. In the case of temporary disability association, it refers to the probability that a temporary disability event leads to a specific temporary disability. In the case of the affected capability determination, it refers to the probability that a particular temporary disability leads to a specific human capability being affected. In the case of driving task impacts, it refers to the likelihood that a particular affected capability will affect a specific driving task.
- **Severity:** refers to the expected magnitude of an observable effect. For temporary disability association, it refers to the degree of temporary disability that is expected to result from the temporary disability event. For the affected capability determination, it refers to the degree of constraint in the capability that the temporary disability is expected to cause. For the driving task impact, it refers to the degree to which a specific affected capability will affect a specific driving task.

- **Episodic frequency:** expected frequency of temporary disability impeding an affected capability. While some temporary disabilities may only inhibit affected capabilities intermittently, others may do so chronically.
- **Task frequency:** how often a driving task is required in the driving context.
- **Task “essentialness” to driving:** the extent to which a task is required to successfully complete the goal of achieving transport from an origin to a destination through manual operation of a vehicle.
- **Task safety relevance:** degree to which a specific driving task is related to the safe operation of a vehicle.

It is relevant to note that many of the terms defined above can be assessed quantitatively (e.g., as a probability or frequency) or qualitatively (e.g., as a relative frequency). The model framework was designed to accommodate both possibilities, and the approach chosen will depend on the type of data and expertise available to the user. Given that the research team had only limited access to medical expertise, and to ease the presentation of the model, the examples provided as part of this work use a qualitative approach.



**Figure 1. Diagram. Cascading model for the assessment of temporary disabilities, affected capabilities, and driving tasks affected by a temporary disability event.**

The model is initiated at the **Temporary Disability Association** level. For this model component, a specific temporary disability event (e.g., a specific type of surgery) is assessed based on the likelihood that a temporary disability results from it and the associated expected severity. Sample lists of temporary disability events and temporary disabilities are included in Appendix A and were generated from hospital data and the associated literature, along with medical domain knowledge from the research team. Qualitatively, likelihood was defined as either “impossible,” “improbable,” “likely,” or “very likely.” In turn, severity was defined as either “negligible,” “mild,” “moderate,” or “acute.” These two rating dimensions, likelihood and severity, could then be combined into a single score or heuristics developed to determine which temporary disabilities to consider in the next model stage. For example, a user interested in focusing on worst-case scenario effects may choose to consider all temporary disabilities that were not “impossible” regardless of their severity, while a user interested in a typical scenario may ignore any “impossible” or “improbable” temporary disabilities along with any “negligible” or “mild” severity levels. The model is flexible in this regard, depending on whether a quantitative or a qualitative approach is being used and the intended outcome of the analysis. In

our model implementation, the typical scenario was considered and, therefore, “impossible” or “improbable” temporary disabilities, along with any “negligible” or “mild” severity levels, are excluded from further consideration downstream in the model.

Once the model user decides which temporary disabilities to carry over to the **Affected Capability Determination** stage, the selected temporary disabilities are assessed based on their expected effect on a set of human capabilities (listed in Appendix A<sup>1</sup>). That assessment is made based on the likelihood, severity, and episodic frequency of the expected effects. For the current qualitative model implementation, likelihood and severity are defined using the same categories defined in the previous stage (i.e., from “impossible” to “very likely” and from “negligible” to “acute,” respectively). Episodic frequency, in turn, is defined as either “never,” “occasional,” “frequent,” or “constant.” At this stage, once again, the model provides some flexibility on how to select the affected capabilities to consider in the subsequent model stage, leaving it up to the user to select based on intended purpose. In our model implementation, “impossible” or “improbable” affected capabilities, along with any “negligible” or “mild” severity levels and any “never” or “occasional” episodic frequencies, are excluded from downstream consideration in the model. The result of this stage is a matrix that captures these ratings along different temporary disabilities and affected capabilities. That matrix can then be collapsed across the temporary disabilities to yield a summary level of affected capabilities that supports the decision of which affected capabilities to move on to the next stage. In the current model implementation, that is done by selecting the maximum level observed in each category across the temporary disabilities. This selection was made based on the assumption that, ultimately, the ability of the driver to perform driving functions will only be as good as the most affected of their driving task-associated capabilities allow.

The final stage of the model determines the **Driving Task Impacts** of the selected affected capabilities. For this stage, key functional driving areas and specific tasks (see Appendix A) were compiled from a combination of driving instruction task checklists and research team domain knowledge. Unfortunately, existing formal driving task analyses were too narrowly scoped or overly exhaustive in scope to serve as a reasonable and usable basis for this application. For the current qualitative model implementation, likelihood and severity were defined using the same categories used in previous stages (i.e., “impossible” to “very likely” and “negligible” to “acute,” respectively). Task frequency used the same ratings developed for episodic frequency (i.e., “never” to “constant”). Task “essentialness” to driving was classified as either “unessential,” “somewhat essential,” “very essential,” and “extremely essential,” with a similar approach used for task safety relevance (ranging from “irrelevant” to “extremely relevant.” The result of this stage is a matrix that captures these ratings along the continuum of driving tasks. That matrix can then be collapsed across the affected capabilities to yield a summary level of effect of constrained capabilities on the different driving tasks. In the current model implementation, that is done by selecting the maximum level observed in each category across the affected capabilities. Similar to the logic used in the previous stage, this selection was made based on the assumption that the ability of the driver to perform driving functions will only be as good as the most affected of their driving task-associated capabilities allow.

---

<sup>1</sup> List elements were generated using existing lists of signs and symptoms, along with a systematic head-to-toe assessment of potential impairment paths in the human body.

## CHAPTER 4. RESULTS

The purpose of this section is to exercise the model framework using a relatively simple example of a temporary disability event: a traumatic fall that results in a musculoskeletal injury (i.e., a fracture) of the right wrist. Given the level of medical experience within the research team and the lack of definitive existing data with respect to driving performance after such an injury, the model was populated at a qualitative (rather than quantitative) level. In addition, model elements were selected to flow from one level to the next based on the expected outcomes for a “typical” scenario or case presentation, rather than a “best” or “worst” case situation.

The initial process, at the **Temporary Disability Association** level, examined the extent to which specific temporary disabilities from the list in Appendix A could result from the fall event of interest (Table 1). The assumption is made that the timing of this assessment is after treatment has been received and the patient is expected to be discharged from the medical treatment facility. The presence of a cast on the right wrist is assumed, along with pain management leveraging non-narcotic painkillers.

**Table 1. Temporary disability association analysis for traumatic fall event of interest.**

Temporary Disability	Temporary Disability Event	
	Traumatic Fall	
	Likelihood	Severity
Depression	Improbable	Negligible
Anxiety	Improbable	Negligible
Post-Traumatic Stress Disorder (PTSD)	Improbable	Mild
Brain Injury (Acquired/Traumatic/Concussion/Stroke)	Improbable	Mild
Respiratory Compromise	Improbable	Negligible
Digestive System Upset	Improbable	Negligible
Musculo-skeletal Injury	Very Likely	Moderate
Physical Pain	Very Likely	Moderate
Inflammation	Very Likely	Moderate

Based on the analysis, most of the candidate temporary disabilities would not be expected problems for the traumatic fall event of interest. The three temporary disabilities that would move on to the next phase on the analysis, given their “very likely” likelihood and “moderate” severity, would be the musculoskeletal injury, physical pain, and inflammation. When considered in the **Affected Capability Determination** analysis, the three disabilities showed similar patterns in terms of affected capabilities (Table 2), though musculoskeletal injury tended to result in slightly more severe ratings given the nature of the injury. Note that, for simplicity in the example, the affected capabilities in the table have been simplified from the full list provided in Appendix A to provide examples where effects are present along with those that are not expected to be affected. The final section in Table 2 collapses the ratings across the different disabilities, using the maximum value obtained across the disabilities in each of the evaluation categories. Based on that summary, the movement range, speed, and control, along with the stability and isometric strength (all for the right hand), were the only capabilities affected sufficiently to warrant further consideration in the next model stage.

Those three affected capabilities were then assessed as to their effects on a subset of driving tasks (Table 3), selected from Appendix A to illustrate the spectrum of possibilities. The capabilities were considered only in the assessment of likelihood and severity. The task frequency, “essentialness” to driving, and safety relevance were rated independently from the affected capabilities, and combine with the summary score (i.e., maximum rating across the affected capabilities) for likelihood and severity across all the affected capabilities (Table 4). For simplicity, Table 4 row entries were only included for driving tasks where the effect likelihood was at least “likely” and the severity was at least “moderate.”

The final step in model use was the interpretation of the results, primarily as a prioritization of elements that should be considered by a person experiencing a specific temporary disability event. In the example, the most important driving task that was affected was the appropriate operation of the steering wheel. Proper steering of a vehicle is not only extremely safety relevant, but also extremely essential for driving and must be performed constantly. In the example, vehicle steering was very likely to be affected by the consequences of the temporary disability event at a moderate severity. Securing self and others in the vehicle would also be areas of concern given their extreme safety relevance, albeit the likelihood of an effect was lower than for steering wheel use. The majority of the other driving tasks considered, however, were very unlikely to be affected at any relevant level of severity.

The ultimate use of these results will be dependent on the user and the intended outcomes. A physician discussing the tool’s results with a patient may focus on the driving tasks of concern in their discharge instructions to the patient, or even recommend that driving be restricted (partially or fully) until the affected capabilities are regained. A patient with the temporary disability may use the results to improve their self-awareness of driving tasks that may be hindered by their temporary limitations, and choose to self-regulate accordingly, or at least be mindful of the need for them to develop, practice, and engage in compensatory behaviors (e.g., buckling the seatbelt only using the left hand and using the left hand as the primary steering wheel actuator).

**Table 2. Affected capability determination for the temporary disabilities resulting from the traumatic fall event of interest.**

Affected Capability	Temporary Disability		
	Musculo-skeletal injury		
	Likelihood	Severity	Episodic Frequency
Movement Range (Right Hand)	Very Likely	Acute	Constant
Movement Speed (Right Hand)	Likely	Acute	Constant
Movement Control (Right Hand)	Very Likely	Moderate	Constant
Stability & Isometric Strength (Right Hand)	Very Likely	Acute	Constant
Tactile Sensory Acuity	Improbable	Negligible	Occasional
Tactile Sensory Range	Improbable	Negligible	Occasional
Tactile Sensory Endurance	Improbable	Negligible	Occasional
Cognitive Efficacy	Improbable	Negligible	Occasional
Cognitive Endurance	Improbable	Negligible	Occasional
Cognitive Speed	Improbable	Negligible	Occasional

Affected Capability	Temporary Disability		
	Physical Pain		
	Likelihood	Severity	Episodic Frequency
Movement Range (Right Hand)	Likely	Moderate	Frequent
Movement Speed (Right Hand)	Likely	Moderate	Frequent
Movement Control (Right Hand)	Likely	Moderate	Frequent
Stability & Isometric Strength (Right Hand)	Likely	Moderate	Frequent
Tactile Sensory Acuity	Improbable	Negligible	Occasional
Tactile Sensory Range	Improbable	Negligible	Occasional
Tactile Sensory Endurance	Improbable	Negligible	Occasional
Cognitive Efficacy	Improbable	Negligible	Occasional
Cognitive Endurance	Improbable	Negligible	Occasional
Cognitive Speed	Improbable	Negligible	Occasional

Affected Capability	Temporary Disability		
	Inflammation		
	Likelihood	Severity	Episodic Frequency
Movement Range (Right Hand)	Likely	Moderate	Occasional
Movement Speed (Right Hand)	Likely	Moderate	Occasional
Movement Control (Right Hand)	Likely	Moderate	Occasional
Stability & Isometric Strength (Right Hand)	Likely	Moderate	Occasional
Tactile Sensory Acuity	Improbable	Negligible	Occasional
Tactile Sensory Range	Improbable	Negligible	Occasional
Tactile Sensory Endurance	Improbable	Negligible	Occasional
Cognitive Efficacy	Impossible	Negligible	Never
Cognitive Endurance	Impossible	Negligible	Never
Cognitive Speed	Impossible	Negligible	Never

Affected Capability	Overall Outcome		
	Likelihood	Severity	Episodic Frequency
Movement Range (Right Hand)	Very Likely	Acute	Constant
Movement Speed (Right Hand)	Likely	Acute	Constant
Movement Control (Right Hand)	Very Likely	Moderate	Constant
Stability & Isometric Strength (Right Hand)	Very Likely	Acute	Constant
Tactile Sensory Acuity	Improbable	Negligible	Occasional
Tactile Sensory Range	Improbable	Negligible	Occasional
Tactile Sensory Endurance	Improbable	Negligible	Occasional
Cognitive Efficacy	Improbable	Negligible	Occasional
Cognitive Endurance	Improbable	Negligible	Occasional
Cognitive Speed	Improbable	Negligible	Occasional

**Table 3. Affected driving tasks for the affected capabilities resulting from the traumatic fall event of interest.**

Driving Tasks	Affected Capability		Affected Capability		Affected Capability		Affected Capability	
	Movement Range (Right Hand)		Movement Speed (Right Hand)		Movement Control (Right Hand)		Stability & Isometric Strength (Right Hand)	
	Likelihood	Severity	Likelihood	Severity	Likelihood	Severity	Likelihood	Severity
<b>Conducting Routine Pre- and Post-Drive Fully In-Vehicle Tasks</b>								
Starting and Powering Off Vehicle (ignition/foot brake/clutch)	Likely	Moderate	Improbable	Mild	Improbable	Mild	Improbable	Mild
Shifting Gears	Likely	Moderate	Likely	Moderate	Very Likely	Acute	Likely	Moderate
Adjusting Seat and Posture	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Adjusting mirrors	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Securing Self in Vehicle	Likely	Moderate	Improbable	Mild	Likely	Moderate	Likely	Moderate
Proper Use of Hand-Operated Parking Brake	Likely	Moderate	Improbable	Mild	Likely	Moderate	Likely	Moderate
Proper Use of Foot-Operated Parking Brake	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
GPS Navigation Set-Up	Likely	Mild	Likely	Mild	Likely	Mild	Improbable	Negligible
<b>Conducting Routine Pre- and Post-Drive Non-Fully In-Vehicle Tasks</b>								
Fueling Vehicle	Likely	Mild	Improbable	Mild	Likely	Mild	Likely	Mild
Vehicle Entry/ Exit	Likely	Mild	Improbable	Mild	Likely	Mild	Likely	Mild
Securing Others in Vehicle	Likely	Moderate	Improbable	Mild	Likely	Moderate	Likely	Moderate
Operating Non-Traffic-Related Vehicle Controls	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Cabin Heating/ Cooling Adjustment	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Infotainment Operation	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Operating radio, tape-player, or CD changer	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Other Trip-Related Communication, Interaction, Telecommunications	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Communicating with passengers including for Navigation and Other Alerts	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Communicating with other drivers	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Interacting with Traffic Enforcement	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
<b>Operating Traffic-Related Vehicle Controls</b>								
Proper Use of Car Horn	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Proper Use of Turn/Lane-Change Signals	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Continuous Pedal Adjustment	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Appropriate Use of Cruise Control	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Operating Emergency Flashers	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Operating Wipers	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Operating Defroster	Likely	Mild	Likely	Mild	Likely	Mild	Likely	Mild
Operating Headlights	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible
Gear Shifting Appropriately	Likely	Moderate	Likely	Moderate	Likely	Moderate	Likely	Moderate
Appropriately Operating Steering Wheel	Very Likely	Moderate	Very Likely	Moderate	Very Likely	Moderate	Very Likely	Moderate
Appropriate Use of High Beams and Fog Lights	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible	Impossible	Negligible

**Table 4. Summary of the affected driving tasks resulting from the traumatic fall event of interest, including task attributes.**

Driving Tasks	Affected Capability Summary				Safety Relevance
	Likelihood	Severity	Frequency	Essentialness	
<b>Conducting Routine Pre- and Post-Drive Fully In-Vehicle Tasks</b>					
Starting and Powering Off Vehicle (ignition/foot brake/clutch)	Likely	Moderate	Occasional	Extremely	Irrelevant
Shifting Gears	Likely	Moderate	Frequent	Extremely	Somewhat
Adjusting Seat and Posture					
Adjusting mirrors					
Securing Self in Vehicle	Likely	Moderate	Occasional	Very	Extremely
Proper Use of Hand-Operated Parking Brake	Likely	Moderate	Occasional	Somewhat	Somewhat
Proper Use of Foot-Operated Parking Brake					
GPS Navigation Set-Up					
<b>Conducting Routine Pre- and Post-Drive Non-Fully In-Vehicle Tasks</b>					
Fueling Vehicle					
Vehicle Entry/ Exit					
Securing Others in Vehicle	Likely	Moderate	Occasional	Very	Extremely
Operating Non-Traffic-Related Vehicle Controls					
Cabin Heating/ Cooling Adjustment					
Infotainment Operation					
Operating radio, tape-player, or CD changer					
Other Trip-Related Communication, Interaction, Telecommunications					
Communicating with passengers including for Navigation and Other Alerts					
Communicating with other drivers					
Interacting with Traffic Enforcement					
<b>Operating Traffic-Related Vehicle Controls</b>					
Proper Use of Car Horn					
Proper Use of Turn/Lane-Change Signals					
Continuous Pedal Adjustment					
Appropriate Use of Cruise Control					
Operating Emergency Flashers					
Operating Wipers					
Operating Defroster					
Operating Headlights					
Gear Shifting Appropriately	Likely	Moderate	Frequent	Extremely	Very
Appropriately Operating Steering Wheel	Very Likely	Moderate	Constant	Extremely	Extremely
Appropriate Use of High Beams and Fog Lights					

## CHAPTER 5. DISCUSSION

The proposed framework develops a method for systematically predicting the impacts of any foreseeable temporary disability event on driving tasks, to the extent that such an event can be translated into the specific temporary disabilities it will produce and the capabilities affected by those disabilities can be determined. The outcomes can be used to assess circumstances where specific driving recommendations may be needed for patients. Such recommendations could include driving restrictions, specific instructions and/or training on how to accomplish these driving tasks safely, and/or specific vehicle modifications or other assistive driving technologies that can enable safer completion of driving tasks.

Much of the published literature on temporary disability and driving and on hierarchical task analysis and driving is not applicable, or only loosely applicable, to driving task analysis from the standpoint of temporary disability. Thus, much of the basis for the proposed framework was systematically generated based on publicly available information, previous work, and domain knowledge. A limitation of this approach is that some driving tasks will inevitably be overlooked, and any overlooked driving tasks could in turn limit the applicability or effectiveness of this model. The hierarchical driving task analysis developed here, however, is scoped to be feasibly useful for analyses across the gamut of driving tasks while avoiding excessive vagueness and broadness. The model also does not preclude the inclusion of additional driving tasks that may have been missed and/or an increase or decrease in the granularity of such tasks.

A vast number of additional modifiers could be considered in future versions of the model. For example, in certain cases the age of the person experiencing the temporary disability could have large implications for the extent to which certain capabilities are affected. Similarly, the definition of a temporary disability specifies that it will improve over time. Thus, the proposed model could be used at different assumed timepoints in the recovery process or, perhaps more usefully, adjusted to reflect milestones in that process (e.g., a cast is removed or narcotics are no longer indicated for pain management). Future work should identify which of these and any other modifiers are most relevant and devise ways to systematically incorporate them into the process.

The model was developed to be modular, and it is important to note that at least portions of the different stages could be developed independent of others. For example, the qualification of the frequency, “essentialness,” and safety relevance of the driving tasks could be fully populated by driving experts based on their domain knowledge regardless of what temporary disability event is being studied. Similarly, affected capabilities for which there is enough data and/or general understanding could be assessed as to the likelihood and severity of their effects on specific driving tasks by medical experts. Pre-population of these model elements would then leave framework users with only the main task of assessing which temporary disabilities arise from a specific temporary disability event and the extent to which specific temporary disabilities affect certain capabilities. Data and findings from existing and future work, such as Badger et al. (2022) and Shinn et al. (2022), can help provide the data necessary for these efforts.

This work is expected to close return-to-drive equity and inclusion gaps as some populations are more car-dependent and/or at risk for temporary disability than others. For example, some

marginalized groups are especially prone to physical injury, like older adults, and people with pre-existing or long-term disability. People who live in car-centric areas with poor or non-existent transit and ridesharing service especially depend on returning to drive. Given their limited mobility options, these populations would strongly benefit from fine-tuned return-to-drive guidelines rooted in on-road driving research and that avoid unnecessarily long driving restriction periods.

This work is also expected to spur research that identifies behavioral and vehicular modifications that are suitable to different temporary disabilities. Metrey (2023), for example, identified some behavioral work-arounds observed (e.g., trade-offs between torso and head movements, activation of controls with contralateral extremities) in her return-to-drive research. Systematically conducted future naturalistic or experimental research can validate the framework provided in this work.

Finally, the devised framework and model have broader applicability than just temporary disability or driving task analysis and can be adapted for numerous purposes beyond the scope of this work. For example, the framework could be adjusted for application to other tasks affected by temporary disability. Similarly, this framework can be adjusted to examine the effects of other factors aside from temporary disability on driving tasks. Some such applications could include the assessment of permanent or progressive disability (e.g., muscular dystrophy).

## APPENDIX A. MODEL ELEMENTS

The table below provides sample lists of temporary disability events, temporary disabilities, potential affected capabilities, and driving tasks. While efforts were expended in making these lists as exhaustive as possible, it is likely that some elements may be missing. The elements on these lists are systematically assessed in the model until a final determination of the effect of a temporary disability event on driving tasks is made. The affected capabilities list is particularly extensive as it includes all affected capabilities as they pertain to different affected body parts, with affected capabilities repeated for each relevant body part. Likewise, the driving tasks list attempted to consider all the different elements that may be involved in manually operating a vehicle from origin to destination.

<b>Temporary Disability Events</b>	<b>Temporary Disabilities</b>
<ul style="list-style-type: none"> <li>• Traumatic Motor Vehicle Collision</li> <li>• Traumatic Fall</li> <li>• Surgery</li> <li>• Life Emotional Challenges</li> <li>• Bacterial, Viral, or Fungal Infection</li> <li>• Aberrant Internal Medical Phenomenon</li> </ul>	<ul style="list-style-type: none"> <li>• Depression</li> <li>• Anxiety</li> <li>• Post-Traumatic Stress Disorder (PTSD)</li> <li>• Brain Injury (Acquired/Traumatic/Concussion/Stroke)</li> <li>• Respiratory Compromise</li> <li>• Digestive System Upset</li> <li>• Musculo-skeletal Injury</li> <li>• Physical Pain</li> <li>• Inflammation</li> </ul>
<b>Affected Capabilities</b>	<b>Driving Tasks</b>
<ul style="list-style-type: none"> <li>• <i>Range of Motion</i> <ul style="list-style-type: none"> <li>• Face (Range of Motion)</li> <li>• Eyes (Range of Motion)</li> <li>• Jaw (Range of Motion)</li> <li>• Tongue (Range of Motion)</li> <li>• Lips (Range of Motion)</li> <li>• Neck (Range of Motion)</li> <li>• L arm (Range of Motion)</li> <li>• L Shoulders (Range of Motion)</li> <li>• L Upper Arm (Range of Motion)</li> <li>• L Elbow (Range of Motion)</li> <li>• L Forearm (Range of Motion)</li> <li>• L Wrist (Range of Motion)</li> <li>• L Hand (Range of Motion)</li> <li>• L Palms (Range of Motion)</li> <li>• L Fingers (Range of Motion)</li> <li>• L Thumb (Range of Motion)</li> <li>• R Arm (Range of Motion)</li> <li>• R Shoulders (Range of Motion)</li> <li>• R Upper Arm (Range of Motion)</li> <li>• R Elbow (Range of Motion)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Conducting Routine Pre- and Post-Drive Fully In-Vehicle Tasks</i> <ul style="list-style-type: none"> <li>• Starting and Powering Off Vehicle (ignition/foot brake/clutch)</li> <li>• Shifting Gears</li> <li>• Adjusting Seat and Posture</li> <li>• Adjusting Mirrors</li> <li>• Securing Self in Vehicle</li> <li>• Proper Use of Hand-Operated Parking Brake</li> <li>• Proper Use of Foot-Operated Parking Brake</li> <li>• GPS Navigation Set-Up</li> <li>• Conducting Routine Pre- and Post-Drive Non-Fully In-Vehicle Tasks</li> <li>• Fueling Vehicle</li> <li>• Vehicle Entry/ Exit</li> <li>• Securing Others in Vehicle</li> </ul> </li> <li>• <i>Conducting Low-Frequency Routine Pre- and Post-Drive Non-Fully In-Vehicle Tasks</i> <ul style="list-style-type: none"> <li>• Cleaning Windows and Mirrors</li> </ul> </li> </ul>

- 
- R Forearm (Range of Motion)
  - R Wrist (Range of Motion)
  - R Hand (Range of Motion)
  - R Palms (Range of Motion)
  - R Fingers (Range of Motion)
  - R Thumb (Range of Motion)
  - Back (Range of Motion)
  - Upper Back (Range of Motion)
  - Lower Back (Range of Motion)
  - Torso (Range of Motion)
  - Chest (Range of Motion)
  - Abdomen/Waist (Range of Motion)
  - L Leg (Range of Motion)
  - L Hip (Range of Motion)
  - L Upper Leg (Range of Motion)
  - L Knee (Range of Motion)
  - L Lower Leg (Range of Motion)
  - L Ankle (Range of Motion)
  - L Foot (Range of Motion)
  - L Foot Palm
  - (Range of Motion)
  - L Toes (Range of Motion)
  - R Leg (Range of Motion)
  - R Hip (Range of Motion)
  - R Upper Leg (Range of Motion)
  - R Knee (Range of Motion)
  - R Lower Leg (Range of Motion)
  - R Ankle (Range of Motion)
  - R Foot (Range of Motion)
  - R Foot Palm (Range of Motion)
  - R Toes (Range of Motion)
  - *Movement Strength (Isotonic Strength)*
    - Face (Movement Strength)
    - Eyes (Movement Strength)
    - Jaw (Movement Strength)
    - Tongue (Movement Strength)
    - Lips (Movement Strength)
    - Neck (Movement Strength)
    - L Arm (Movement Strength)
    - L Shoulders (Movement Strength)
    - L Upper Arm (Movement Strength)
    - L Elbow (Movement Strength)
    - L Forearm (Movement Strength)
    - L Wrist (Movement Strength)
    - L Hand (Movement Strength)
    - L Palms (Movement Strength)
  - Performing Vehicle Maintenance and Inspections
  - Renewing Car Insurance and Registration
  - Conducting Non-Routine Pre- and Post-Drive Non-Fully In-Vehicle Tasks
  - Clearing Snow from Vehicle
  - Placing Flares
  - Lifting Hood of Vehicle
  - *Operating Non-Traffic-Related Vehicle Controls*
    - Cabin Heating/Cooling Adjustment
    - Infotainment Operation
    - Operating Radio, Tape Player, or CD Changer
    - Other Trip-Related Communication, Interaction, Telecommunications
    - Communicating with Passengers Including for Navigation and Other Alerts
    - Communicating with Other Drivers
    - Interacting with Traffic Enforcement
  - *Conducting Mobile-Device-Related Secondary Tasks*
    - Navigation Via GPS
    - Talking on a Phone
    - Texting
  - *Conducting Other in Non-Vehicle-Related, Non-Traffic-Related Secondary Tasks*
    - Eating
    - Drinking
    - Lighting Cigarettes
    - Searching Inside of Vehicle
    - Tending to Passengers (e.g., Children, Pets)
    - Primping/Grooming
  - *Operating Traffic-Related Vehicle Controls*
    - Proper Use of Car Horn
    - Proper Use of Turn/Lane-Change Signals
    - Continuous Pedal Adjustment
    - Appropriate Use of Cruise Control
    - Operating Emergency Flashers
    - Operating Wipers
    - Operating Defroster
    - Operating Headlights
-

- 
- L Fingers (Movement Strength)
  - L Thumb (Movement Strength)
  - R Arm (Movement Strength)
  - R Shoulders (Movement Strength)
  - R Upper Arm (Movement Strength)
  - R Elbow (Movement Strength)
  - R Forearm (Movement Strength)
  - R Wrist (Movement Strength)
  - R Hand (Movement Strength)
  - R Palms (Movement Strength)
  - R Fingers (Movement Strength)
  - R Thumb (Movement Strength)
  - Back (Movement Strength)
  - Upper Back (Movement Strength)
  - Lower Back (Movement Strength)
  - Torso (Movement Strength)
  - Chest (Movement Strength)
  - Abdomen/Waist (Movement Strength)
  - L Leg (Movement Strength)
  - L Hip (Movement Strength)
  - L Upper Leg (Movement Strength)
  - L Knee (Movement Strength)
  - L Lower Leg (Movement Strength)
  - L Ankle (Movement Strength)
  - L Foot (Movement Strength)
  - L Foot Palm (Movement Strength)
  - L Toes (Movement Strength)
  - R Leg (Movement Strength)
  - R Hip (Movement Strength)
  - R Upper Leg (Movement Strength)
  - R Knee (Movement Strength)
  - R Lower Leg (Movement Strength)
  - R Ankle (Movement Strength)
  - R Foot (Movement Strength)
  - R Foot Palm (Movement Strength)
  - R Toes (Movement Strength)
  - *Movement Speed*
    - Face (Movement Speed)
    - Eyes (Movement Speed)
    - Jaw (Movement Speed)
    - Tongue (Movement Speed)
    - Lips (Movement Speed)
    - Neck (Movement Speed)
    - L Arm (Movement Speed)
    - L Shoulders (Movement Speed)
  - Gear Shifting Appropriately
  - Appropriately Operating Steering Wheel
  - Appropriate Use of High Beams and Fog Lights
  - *Conducting Continuous/Continual Cognitive-Only Traffic-Related Driving Precautions*
    - Detecting Cues, Signals, Situational Changes, Hazards, and Escape Routes
    - Maintaining Roadway Emergency Preparedness
    - Maintaining Readiness to Act
    - Identifying Road Signs and Exits
  - *Other Largely Cognitive Driving Tasks*
    - Timing Braking Appropriately
    - Determining Right of Way
    - Path Selection
    - Speed Selection
    - Navigation By Recall
    - Understanding Stopping Times and Distances for Various Road Types
    - Anticipating Interchanges
    - Detecting and Remaining Aware of Crosswalks
    - Identifying the Appropriate Lane
    - Anticipating Low Probability, Infrequent, Rapid Onset Driving Situations, Cues, and Signals
    - Anticipating High Probability, Frequent, Slow Onset Driving Situations, Cues, and Signals
    - Detecting Low Probability, Infrequent, Rapid Onset Driving Situations, Cues, and Signals
    - Detecting High Probability, Frequent, Slow Onset Driving Situations, Cues, and Signals
  - *Conducting Continuous/Continual Sensory-Only Traffic-Related Driving Precautions*
    - Reading Dashboard Gauges
    - Reading Signs and Notices
    - Keeping Attention on the Road
-

- 
- L Upper Arm (Movement Speed)
  - L Elbow (Movement Speed)
  - L Forearm (Movement Speed)
  - L Wrist (Movement Speed)
  - L Hand (Movement Speed)
  - L Palms (Movement Speed)
  - L Fingers (Movement Speed)
  - L Thumb (Movement Speed)
  - R Arm (Movement Speed)
  - R Shoulders (Movement Speed)
  - R Upper Arm (Movement Speed)
  - R Elbow (Movement Speed)
  - R Forearm (Movement Speed)
  - R Wrist (Movement Speed)
  - R Hand (Movement Speed)
  - R Palms (Movement Speed)
  - R Fingers (Movement Speed)
  - R Thumb (Movement Speed)
  - Back (Movement Speed)
  - Upper Back (Movement Speed)
  - Lower Back (Movement Speed)
  - Torso (Movement Speed)
  - Chest (Movement Speed)
  - Abdomen/Waist (Movement Speed)
  - L Leg (Movement Speed)
  - L Hip (Movement Speed)
  - L Upper Leg (Movement Speed)
  - L Knee (Movement Speed)
  - L Lower Leg (Movement Speed)
  - L Ankle (Movement Speed)
  - L Foot (Movement Speed)
  - L Foot Palm (Movement Speed)
  - L Toes (Movement Speed)
  - R Leg (Movement Speed)
  - R Hip (Movement Speed)
  - R Upper Leg (Movement Speed)
  - R Knee (Movement Speed)
  - R Lower Leg (Movement Speed)
  - R Ankle (Movement Speed)
  - R Foot (Movement Speed)
  - R Foot Palm (Movement Speed)
  - R Toes (Movement Speed)
  - *Movement Control*
    - Face (Movement Control)
    - Eyes (Movement Control)
    - Jaw (Movement Control)
  - Manually Surveilling Behind for Cues, Signals, Situational Changes, Hazards, and Escape Routes
  - Manually Surveilling Leftward for Cues, Signals, Situational Changes, Hazards, and Escape routes
  - Manually Surveilling Rightward for Cues, Signals, Situational Changes, Hazards, and Escape Routes
  - Manually Surveilling Ahead for Cues, Signals, Situational Changes, Hazards, and Escape Routes
  - Surveilling via Rearview Mirrors (Left, Center, and Right) and Backup Camera
  - Monitoring Blind Spots
  - *Conducting Continuous/Continual Traffic-Related Responsive Driving Precautions*
    - Maintaining Appropriate Following/Stopping Distance
    - Heeding Road Signs and Speed Limits
    - Determining Whether to Brake Fast and Hard or Gradually
    - Applying Defensive Driving Techniques
    - Adjusting Speed to Road and Environmental Conditions
    - Responding Appropriately to Low Probability, Infrequent, Rapid Onset, Driving Situations, Cues and Signals
    - Responding Appropriately to High Probability, Frequent, Slow Onset Driving Situations, Cues and Signals
    - Maintaining Situational Awareness Several Car Lengths Ahead and Behind
    - Abiding by Maximum and Minimum Speeds
    - Maintaining a Safe Speed Range
  - *Conducting Smooth, Controlled Effective, Routine Traffic-Related Driving Maneuvers*
    - Turning Right (with Appropriate Speed and Angle)
    - Turning Right from a Center Lane
    - Turning Right with Merging Required
    - Turning Right from a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street onto a Quiet Street
-

- 
- Tongue (Movement Control)
  - Lips (Movement Control)
  - Neck (Movement Control)
  - L Arm (Movement Control)
  - L Shoulders (Movement Control)
  - L Upper Arm (Movement Control)
  - L Elbow (Movement Control)
  - L Forearm (Movement Control)
  - L Wrist (Movement Control)
  - L Hand (Movement Control)
  - L Palms (Movement Control)
  - L Fingers (Movement Control)
  - L Thumb (Movement Control)
  - R Arm (Movement Control)
  - R Shoulders (Movement Control)
  - R Upper Arm (Movement Control)
  - R Elbow (Movement Control)
  - R Forearm (Movement Control)
  - R Wrist (Movement Control)
  - R Hand (Movement Control)
  - R Palms (Movement Control)
  - R Fingers (Movement Control)
  - R Thumb (Movement Control)
  - Back (Movement Control)
  - Upper Back (Movement Control)
  - Lower Back (Movement Control)
  - Torso (Movement Control)
  - Chest (Movement Control)
  - Abdomen/Waist (Movement Control)
  - L Leg (Movement Control)
  - L Hip (Movement Control)
  - L Upper Leg (Movement Control)
  - L Knee (Movement Control)
  - L Lower Leg (Movement Control)
  - L Ankle (Movement Control)
  - L Foot (Movement Control)
  - L Foot Palm (Movement Control)
  - L Toes (Movement Control)
  - R Leg (Movement Control)
  - R Hip (Movement Control)
  - R Upper Leg (Movement Control)
  - R Knee (Movement Control)
  - R Lower Leg (Movement Control)
  - R Ankle (Movement Control)
  - R Foot (Movement Control)
  - R Foot Palm (Movement Control)
  - Turning Right from a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street onto a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street
  - Turning Right from a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street onto a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street
  - Turning Right from a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street onto a Busy Street
  - Turning Left (with Appropriate Speed and Angle)
  - Turning Left from a Center Lane
  - Turning Left from a Center Lane with Merging Required
  - Turning Left from a Center Lane from a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street onto a Quiet Street
  - Turning Left from a Center Lane from a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street onto a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street
  - Turning Left from a Center Lane from a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street onto a Quiet (Low Traffic, Low Speed Traffic, Simple Environment) Street
  - Turning Left from a Center Lane from a Busy (Heavy Traffic, High Speed Traffic, or Complex Environment) Street onto a Busy Street
  - Merging into Heavy Traffic, High Speed Traffic, or Complex Environment
  - Merging into Low Traffic, Low-Speed Traffic, Simple Environment
  - Backing Up into Heavy Traffic, High Speed Traffic, or Complex Environment
-

- 
- R Toes (Movement Control)
  - *Stability (Isometric Strength)*
    - Face (Stability)
    - Eyes (Stability)
    - Jaw (Stability)
    - Tongue (Stability)
    - Lips (Stability)
    - Neck (Stability)
    - L Arm (Stability)
    - L Shoulders (Stability)
    - L Upper Arm (Stability)
    - L Elbow (Stability)
    - L Forearm (Stability)
    - L Wrist (Stability)
    - L Hand (Stability)
    - L Palms (Stability)
    - L Fingers (Stability)
    - L Thumb (Stability)
    - R Arm (Stability)
    - R Shoulders (Stability)
    - R Upper Arm (Stability)
    - R Elbow (Stability)
    - R Forearm (Stability)
    - R Wrist (Stability)
    - R Hand (Stability)
    - R Palms (Stability)
    - R Fingers (Stability)
    - R Thumb (Stability)
    - Back (Stability)
    - Upper Back (Stability)
    - Lower Back (Stability)
    - Torso (Stability)
    - Chest (Stability)
    - Abdomen/Waist (Stability)
    - L Leg (Stability)
    - L Hip (Stability)
    - L Upper Leg (Stability)
    - L Knee (Stability)
    - L Lower Leg (Stability)
    - L Ankle (Stability)
    - L Foot (Stability)
    - L Foot Palm (Stability)
    - L Toes (Stability)
    - R Leg (Stability)
    - R Hip (Stability)
    - R Upper Leg (Stability)
  - Backing Up into Low Traffic, Low Speed Traffic, Simple Environment
  - Accelerating and Decelerating/ Stopping/Yielding/Braking
  - Lane Changing in Heavy Traffic, High Speed Traffic, or Complex Environment
  - Lane Changing in Low Traffic, Low-Speed Traffic, Simple Environment
  - Proper Passing/Overtaking in Heavy Traffic, High Speed Traffic, or Complex Environment
  - Proper Passing/Overtaking in Low Traffic, Low-Speed Traffic, Simple Environment
  - Performing an Emergency Stop
  - Pulling Over
  - *Conducting Smooth, Controlled Effective, Routine Non-Traffic-Related Driving Maneuvers*
    - Entering, and Parking in, a Marked Parallel Parking Space Along a Curb
    - Exiting a Marked Parallel Parking Space Along a Curb
    - Entering, and Parking in, a Marked Perpendicular Parking Space Along a Curb
    - Exiting a Marked Perpendicular Parking Space Along a Curb
    - Entering, and Parking in, a Marked Perpendicular Parking Space in a Parking Lot
    - Exiting a Marked Perpendicular Parking Space in a Parking Lot
    - Parking at an Incline
    - Parking at an Angle
    - Starting Vehicle on an Incline
    - Starting Vehicle on a Decline
    - Pulling Out from Behind a Parked Car
    - Pulling Out from Between Two Parked Cars
  - *Smooth, Controlled Effective, Handling of Varying Roadway Features and Zones*
    - Correctly Navigating Roundabouts
    - Correctly Navigating Intersections
-

- 
- R Knee (Stability)
  - R Lower Leg (Stability)
  - R Ankle (Stability)
  - R Foot (Stability)
  - R Foot Palm (Stability)
  - R Toes (Stability)
  - *Sensory Acuity*
    - Vision
    - Hearing
    - Taste
    - Olfaction
    - Tactile
    - Proprioception
    - Balance
  - *Sensory Range*
    - Distance, Wavelength, Amplitude, Frequency Ranges, etc.
    - Vision
    - Hearing
    - Taste
    - Olfaction
    - Tactile
    - Proprioception
    - Balance
  - *Sensory Endurance*
    - Vision
    - Hearing
    - Taste
    - Olfaction
    - Tactile
    - Proprioception
    - Balance
  - *Mental/Cognitive Efficacy*
    - Attention/Concentration (Active)
    - Alertness/Awareness (Passive)
    - Working (Short-Term) Memory
    - Processing Speed
    - Spatial Processing
    - Computation
    - Perception
    - Comprehension
    - Judgement/Evaluation
    - Reasoning/Inference
    - Problem-Solving
    - Decision-Making
    - Response-Execution
  - Correctly Navigating Regular Crosswalks
  - Correctly Navigating Raised Crosswalks
  - Handling Potholes and Roadway Debris
  - Handling Speed Humps and Speed Tables
  - Correctly Navigating School Zones
  - Correctly Navigating Construction/Work Zones and Crash Zones
  - Navigating Toll Booths
  - Navigating a Single-Lane Roadway
  - Navigating a Multi-Lane Roadway
  - Navigating Stopped Vehicles in the Road
  - Navigating Stopped Vehicles on Shoulders
  - Navigating Police Checkpoints
  - Navigating Road Closures and Reroutes
  - Driving on Bumpy Terrain
  - Driving Up Inclines
  - Driving Down Inclines
  - Using Interchanges
  - Using Turning Lanes
  - *Smooth, Controlled Effective Handling of Varying Conditions/Situations*
    - Handling Rush Hour (High-Congestion) Traffic
    - Driving at Night
    - Driving on Ice/Snow/Slick Roads
    - Handling Inclement Weather
    - Low Traffic
    - Heavy Flowing Traffic
    - Heavy Stop-and-Go Traffic
    - High-Speed Traffic
    - Navigating Road Closures and Reroutes
    - Handling Multiple and/or Complex Driving Hazards
    - Handling Roadway Debris and Potholes
  - *Smooth, Controlled Effective, Handling of Varying Roadway Types*
-

- 
- Prediction
  - Stress-Tolerance
  - Rage-Tolerance
  - *Mental/Cognitive Endurance*
    - Attention/Concentration (Active)
    - Alertness/Awareness (passive)
    - Working (Short-Term) Memory
    - Processing Speed
    - Spatial Processing
    - Computation
    - Perception
    - Comprehension
    - Judgement/Evaluation
    - Reasoning/Inference
    - Problem-Solving
    - Decision-Making
    - Response-Execution
    - Prediction
    - Stress-Tolerance
    - Rage-Tolerance
  - *Mental/Cognitive Speed*
    - Attention/Concentration (Active)
    - Alertness/Awareness (passive)
    - Working (Short-Term) Memory
    - Processing Speed
    - Spatial Processing
    - Computation
    - Perception
    - Comprehension
    - Judgement/Evaluation
    - Reasoning/Inference
    - Problem-Solving
    - Decision-Making
    - Response-Execution
    - Prediction
    - Stress-Tolerance
    - Rage-Tolerance
  - Curvy Roadways
  - Straight Roadways
  - Unsignalized Roadways (e.g., Highways)
  - Signalized Roadways (e.g., Minor Arterials, Collectors, Local Streets)
  - Tight Alleyways
  - *Applying Appropriate Vigilance and Etiquette Towards Other Road Users*
    - Handling Driving Near Semi-Trucks
    - Handling Driving Near Motorcycles
    - Handling Driving Near Around Bicycles
    - Handling Driving Near Buses
    - Handling Driving Near School Buses
    - Handling Driving Near Pedestrians
  - *Handling Driving Errors, Vehicle Malfunctions, and Crashes*
    - Handling Wheel Dropping Off Pavement at High Speeds
    - Correcting Veering Out of Lane
    - Handling Stalled Engine
    - Handling Sticking Gas Pedal
    - Handling Brake Failure
    - Handling Skidding
    - Handling Tire Blow Outs
    - Handling Imminent Crashes
    - Handling Aftermath of Crashes with Attended Vehicles
    - Handling Aftermath of Crashes with Unattended Vehicles
  - *Handling the Range of Possible Actions of People and Animals*
    - Handling Tailgating
    - Handling Quickly and Closely Approaching Vehicles
    - Handling Your Presence in Others' Blind Spots
    - Handling Drivers Forced to Merge into Your Lane
    - Handling Distracted People
    - Handling Being Passed/Overtaken
    - Handling Approaching Emergency Vehicles
    - Handling Being Pulled Over
    - Handling Other Drivers Not Yielding Right of Way
-

- 
- Handling Others' Reckless Driving Behaviors
  - Handling Animals and People Darting Into the Road
  - Handling Swerving Cyclists and Motorcyclists
-



## REFERENCES

- Badger, A. E., Samuel, L. T., Tegge, A. N., Metrey, M., Perez, M. A., Tuttle, J. R., & Apel, P. J. (2022). Patients who undergo rotator cuff repair can safely return to driving at 2 weeks postoperatively. *JBJS*, *104*(18), 1639-1648. <https://doi.org/10.2106/jbjs.21.01436>
- Barbera, T., Horst, J., Schlenoff, C., & Aha, D. (2004). Task analysis of autonomous on-road driving. In *Mobile Robots XVII* (Vol. 5609, pp. 61-72). Proceedings of SPIE - The International Society for Optical Engineering.
- Bedinger, M., Walker, G. H., Piecyk, M., Greening, P., & Krupenia, S. (2015). A hierarchical task analysis of commercial distribution driving in the UK. *Procedia Manufacturing*, *3*, 2862-2866. <https://doi.org/10.1016/j.promfg.2015.07.786>
- Chen, V., Chacko, A. T., Costello, F. V., Desrosiers, N., Appleton, P., & Rodriguez, E. K. (2008). Driving after musculoskeletal injury: Addressing patient and surgeon concerns in an urban orthopaedic practice. *JBJS*, *90*(12), 2791-2797. <https://doi.org/10.2106/jbjs.H.00431>
- D'Apolito, A. C., Leguiet, J. L., Enjalbert, M., Lemoine, F., & Mazaux, J. M. (2017). Return to drive after non-evolutive brain damage: French recommendations [Review]. *Annals of Physical and Rehabilitation Medicine*, *60*(4), 263-269. <https://doi.org/10.1016/j.rehab.2017.04.001>
- D'Apolito, A. C., Massonneau, A., Paillat, C., & Azouvi, P. (2013). Impact of brain injury on driving skills. *Annals of Physical and Rehabilitation Medicine*, *56*(1), 63-80. <https://doi.org/https://doi.org/10.1016/j.rehab.2012.12.002>
- Dobbs, B. M., Wodzin, E., & Vegega, M. (2005). *Medical conditions and driving: A review of the literature (1960-2000)*. <https://doi.org/https://doi.org/10.21949/1525693>
- Fastenmeier, W., & Gstalter, H. (2007). Driving task analysis as a tool in traffic safety research and practice. *Safety Science*, *45*(9), 952-979. <https://doi.org/10.1016/j.ssci.2006.08.023>
- Fraser, C. L., & Mobbs, R. (2022). Visual effects of concussion: A review. *Clinical & Experimental Ophthalmology*, *50*(1), 104-109. <https://doi.org/https://doi.org/10.1111/ceo.13987>
- Gaddam, S. S. K., Buell, T., & Robertson, C. S. (2015). Chapter 14 - Systemic manifestations of traumatic brain injury. In J. Grafman & A. M. Salazar (Eds.), *Handbook of Clinical Neurology* (Vol. 127, pp. 205-218). Elsevier. <https://doi.org/10.1016/B978-0-444-52892-6.00014-3>
- Haagsma, J. A., van Beeck, F., Polinder, S., Toet, H., & Bonsel, G. J. (2010). Independent comorbidity and health-related quality of life of injury patients in the first year following injury: Comparison of comorbidity adjustment approaches. *Disability Adjusted Life Years and Acute Onset Disorders*, *77*.

- Hao, Z., Da, G., Guohui, S., & Ya, M. (2019). Driving sub-task analysis in high altitude environment. In *2019 1st International Conference on Industrial Artificial Intelligence (IAI)* (pp. 1-4). IEEE.
- Hutchinson, C., Berndt, A., Cleland, J., Gilbert-Hunt, S., George, S., & Ratcliffe, J. (2020). Using social return on investment analysis to calculate the social impact of modified vehicles for people with disability. *Australian Occupational Therapy Journal*, *67*(3), 250-259.
- Jones, C., Abbassian, A., Trompeter, A., & Solan, M. (2010). Driving a modified car: A simple but unexploited adjunct in the management of patients with chronic right sided foot and ankle pain. *Foot and Ankle Surgery*, *16*(4), 170-173.  
<https://doi.org/https://doi.org/10.1016/j.fas.2009.10.007>
- Karjalainen, L. E., Tiitu, M., Lyytimäki, J., Helminen, V., Tapio, P., Tuominen, A., Vasankari, T., Lehtimäki, J., & Paloniemi, R. (2023). Going carless in different urban fabrics: Socio-demographics of household car ownership. *Transportation*, *50*(1), 107-142.  
<https://doi.org/10.1007/s11116-021-10239-8>
- Kassner, A., Baumann, M., & Weber, L. (2011). A hierarchical task analysis of merging onto a freeway—Comparison of driver's and driver model's task representation. *Human Modelling in Assisted Transportation: Models, Tools and Risk Methods*.
- Klein, N. J., Basu, R., & Smart, M. J. (2023). Transitions into and out of car ownership among low-income households in the United States. *Journal of Planning Education and Research*. <https://doi.org/10.1177/0739456x231163755>
- Kushner, D. (1998). Mild traumatic brain injury: Toward understanding manifestations and treatment. *Archives of Internal Medicine*, *158*(15), 1617-1624.  
<https://doi.org/10.1001/archinte.158.15.1617>
- MacDonald, J., Patel, N., Young, J., & Stuart, E. (2018). Returning adolescents to driving after sports-related concussions: What influences physician decision-making. *Journal of Pediatrics*, *194*, 177-181. <https://doi.org/10.1016/j.jpeds.2017.10.032>
- Marshall, S. C., & Man-Son-Hing, M. (2011). Multiple chronic medical conditions and associated driving risk: A systematic review. *Traffic Injury Prevention*, *12*(2), 142-148.  
<https://doi.org/10.1080/15389588.2010.551225>
- Mattes, S. (2003). The lane-change-task as a tool for driver distraction evaluation. *Quality of Work and Products in Enterprises of the Future*, *57*(60), 7.
- Metrey, M. B. (2023). *Effectiveness of compensatory vehicle control techniques exhibited by drivers after arthroscopic rotator cuff surgery* [doctoral dissertation, Virginia Tech].

- Miglianico, D., Moyart, L., & Mouchel, M. (2018). From task analysis to innovation. In *Advances in Human Aspects of Transportation: Proceedings of the AHFE 2017 International Conference on Human Factors in Transportation* (pp. 1046-1056). Springer International Publishing.
- Moe, G. L., Kelley, G. R., & Farlow, D. E. (1973). *Truck and bus driver task analysis* (DOT/HS-800 835). National Highway Traffic Safety Administration.
- National Center for Injury Prevention and Control. (n.d.). *WISQARS leading causes of nonfatal injury*.  
<https://wisqars.cdc.gov/lcnf/?y1=2011&y2=2021&ct=5&cc=0&s=0&g=00&a=lcd1age&a1=0&a2=199&d=0>
- Plavšić, M., Klinker, G., & Bubb, H. (2010). Situation awareness assessment in critical driving situations at intersections by task and human error analysis. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 20(3), 177-191.
- Preece, M. H. W., Horswill, M. S., & Geffen, G. M. (2010). Driving after concussion: The acute effect of mild traumatic brain injury on drivers' hazard perception. *Neuropsychology*, 24(4), 493-503. <https://doi.org/10.1037/a0018903>
- Reagan, I. J., & Kidd, D. G. (2013). Using hierarchical task analysis to compare four vehicle manufacturers' infotainment systems. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 57, No. 1, pp. 1495-1499). Los Angeles, CA: SAGE Publications.
- Richard, C. M., Campbell, J. L., & Brown, J. L. (2006). *Task analysis of intersection driving scenarios: Information processing bottlenecks* (No. FHWA-HRT-06-033). Turner-Fairbank Highway Research Center.
- Rutkowski, N. A., Sabri, E., & Yang, C. (2021). Post-stroke fatigue: A factor associated with inability to return to work in patients <60 years—A 1-year follow-up. *PLoS ONE*, 16(8 August), Article e0255538. <https://doi.org/10.1371/journal.pone.0255538>
- Schultheis, M. T., & Whipple, E. K. (2014). Driving after traumatic brain injury: Evaluation and rehabilitation interventions [Review]. *Current Physical Medicine and Rehabilitation Reports*, 2(3), 176-183. <https://doi.org/10.1007/s40141-014-0055-0>
- Shergold, I., Parkhurst, G., & Musselwhite, C. (2012). Rural car dependence: An emerging barrier to community activity for older people. *Transportation Planning and Technology*, 35(1), 69-85. <https://doi.org/10.1080/03081060.2012.635417>
- Shinn, D., Mok, J. K., Vaishnav, A. S., Louie, P. K., Sivaganesan, A., Shahi, P., Dalal, S., Song, J., Araghi, K., Melissaridou, D., Sheha, E. D., Sandhu, H. S., Dowdell, J. E., Iyer, S., & Qureshi, S. A. (2022). Recovery kinetics after commonly performed minimally invasive spine surgery procedures. *Spine*, 47(21), 1489-1496.  
<https://doi.org/10.1097/BRS.0000000000004399>

- Silverstein, N. M., Gottlieb, A. S., & Van Ranst, E. (2005). Use of video intervention to increase elders' awareness of low-cost vehicle modifications that enhance driving safety and comfort. *Transportation Research Record*, 1922(1), 15-20. <https://doi.org/10.1177/0361198105192200103>
- Sosnoff, J. J., Broglio, S. P., & Ferrara, M. S. (2008). Cognitive and motor function are associated following mild traumatic brain injury. *Experimental Brain Research*, 187(4), 563-571. <https://doi.org/10.1007/s00221-008-1324-x>
- Ward, B., Myers, A., Wong, J., & Ravesloot, C. (2017). Disability items from the current population survey (2008-2015) and permanent versus temporary disability status. *Am J Public Health*, 107(5), 706-708. <https://doi.org/10.2105/AJPH.2017.303666>
- Yang, X., Hyup Kim, J., & Nazareth, R. (2019). Hierarchical task analysis for driving under divided attention. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 63, No. 1, pp. 1744-1748). Sage CA: Los Angeles, CA: SAGE Publications