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Medical Fitness to Drive Guidelines
Literature Review Update
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Table of Contents

Foreword 3
1. General 4
1.1. General Considerations 4
1.2. Assessment 5
1.3. Occupational Health – Professional Drivers 9
1.4. Older people 11
2. Neurology and Rehabilitation 22
2.1. Neurology/epilepsy 22
2.2. Dementia 28
2.3. Parkinsons 33
2.4. Acquired Brain Injury 34
2.5. Rehabilitation 37
2.6. Spinal cord injury 38
3. Substance Abuse Disorders 40
4. Psychiatry 71
4.1. General 71
4.2. Neurodevelopmental 75
4.2.1. Attention Deficit Hyperactivity Disorder 75
4.2.2. Autism Spectrum Disorder 76
5. Vision 79
6. Sleep Conditions 83
6.1. Obstructive Sleep Apnoea (OSA) 83
6.2. Other sleep disorders 85
7. Cardiology 86
8. Diabetes and endocrine 89
9. Temporary surgical and medical problems 91
9.1. Orthopaedic/injuries 91
10. Miscellaneous 95
10.1. Hospitalisation 95
10.2. Pharmacology 96
10.3. Gastroenterology 98
10.4. Allergies 99
References 100

Foreword

Dear colleagues,

Each year the National Office for Traffic Medicine prepares a literature review to provide support to the members of our Working Group and the Office in the annual update of the guidelines on medical fitness to drive, Sláinte agus Tiomáint. The annual update reflects the increasing growth in research on medical fitness to drive as well as the importance of assuring healthcare practitioners and the public that the guidelines are based on evidence and data to the greatest extent possible.

Analysis of the papers requires a degree of perspective in interpretation and also consideration of the importance of access to transport as a vector of well-being and health. For example, the first paper on self-declaration (1) can be read as an over 90% accuracy in self-reporting or focus on the 8.3% who did not declare – but in context, outside medical examiners missed 30% of conditions in a study from the USA where all truck drivers undergo a medical examination as opposed to self-declaration (14).

As expected, there is a high number of papers related to substance use disorders – alcohol and drugs – which represent the single most significant medical and public health condition implicated in increased risk of crashes, death and injuries and an area due increased attention in clinical encounters with patients who drive.

The relatively large number of papers on older drivers continues a carry-over from a misplaced belief that older drivers have an increased crash risk, whereas they have a relatively good safety profile but the increase in frailty in later life is associated with an increased risk of death and severe injury for a given severity of crash compared to younger people.

The range of conditions covered marks an increase in attention across the spectrum of healthcare, including temporary conditions such as joint surgery and hospitalisation. The research is also reassuring in including an important emphasis on the importance of driving and transportation in supporting well-being.

Prof Desmond O'Neill MD FRCPI
Director, National Office for Traffic Medicine

1. General

1.1. General Considerations

Discrepancy between medical conditions self-reported by bus drivers and medical records

BACKGROUND: Medical incapacity at the wheel is a rare but high-profile factor in accident causation. The UK Driver and Vehicle Licensing Agency (DVLA) does not require a review of medical records on the application for a bus licence, but applicants sign a self-declaration of medical history. There is debate over what, if any, verification of medical information is required for doctors who complete the medical assessment. AIMS: To assess how self-declaration compares against General Practitioner (GP) patient records for a series of bus drivers undergoing driver licensing assessment in a 12-month period. METHODS: Review of GP reports received for bus driver medicals undertaken in a 12-month period between 1 July 2022 and 30 June 2023. RESULTS: Of the 145 medicals undertaken, 12 (8.3%) GP reports contained undeclared medical conditions that required further evaluation and may have impacted on fitness to drive. CONCLUSIONS: Studies into the contribution of medical incapacity at the wheel to vehicle accidents are sparse, as, thankfully, are the events themselves. Nevertheless, given the updated General Medical Council guidance to doctors on confidentiality and public protection responsibilities, and evidence to suggest that doctors' knowledge of the DVLA guidelines is poor, it might be pertinent for the DVLA to reconsider its approach to driver self-reporting in some circumstances, given the discrepancy highlighted here (1).

Recent Advances in Vehicle Driver Health Monitoring Systems

The need for creative solutions in the real-time monitoring of health is rapidly increasing, especially in light of health incidents in relation to drivers of motor vehicles. A sensor-based health monitoring system provides an integrated mechanism for diagnosing and managing in real time, enabling the detection, prediction, and recommendation of treatment and the prevention of disease onset. The real-time monitoring of driver's health represents a significant advancement in the assurance of driver safety and well-being. From fitness trackers to advanced biosensors, these devices have not only made healthcare more accessible but have also transformed how people interact with their health data. The purpose of this scoping review is to systematically collect and evaluate information from publications on driver health monitoring systems to provide a comprehensive overview of the current state of research on wearable or remote sensor technologies for driver health monitoring. It aims to identify knowledge gaps that need to be addressed and suggest future research directions that will help to fill these gaps. This approach involves the topic of vehicle safety and healthcare and will contribute to the advancement of this field. By focusing on the real-time monitoring of health parameters in an automotive context, this review highlights the potential of different types of technologies to bridge the gap between health monitoring and driver safety (2).

Comprehensive analysis of trends, distribution, and odds of wrong way driving fatal crashes on divided highways in the United States (2004-2020)

INTRODUCTION: This study presents a comprehensive analysis of wrong-way driving (WWD) fatal crashes on divided highways in the United States over a 17-year period, from 2004 to 2020. The study aims to uncover trends, distribution patterns, and factors contributing to these fatal crashes. Data were extracted from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) database. METHODS: Descriptive statistical analysis was used to reveal general crash characteristics, while trends were updated through an examination of the annual occurrence of WWD fatal crashes. The study further employed binomial logistic regression to compute odds ratios, identifying significant contributing factors. These factors encompassed temporal variables, crash characteristics, and driver characteristics. The odds ratios shed light on the relationship between WWD fatal crashes and other fatal crashes, allowing for the identification of key elements that drive WWD incidents. RESULTS: On average, 302 WWD fatal crashes occurred annually, resulting in 6,953 fatalities during the study period. The frequency of WWD fatal crashes remained relatively stable, with a slight increase over time. According to the model, variables include day of week, time of day, month, lighting conditions, weather conditions, roadway profile, collision type, passenger presence, driver age, gender, license status, and driver injury severity were found to significantly impact the occurrence of WWD fatal crashes. One significant finding is that road profiles like sag curves or hillcrests can increase the likelihood of WWD fatal crashes. PRACTICAL APPLICATION: The findings of this study contribute to an improved understanding of WWD fatal crashes on divided highways, thereby aiding in the development of strategies for prevention and mitigation (3).

1.2. Assessment

Serial Trichotomization to Determine Fitness to Drive: Results from a Cohort of Clients Referred to a Neurology Program

IMPORTANCE: Determining cognitive fitness to drive is challenging. A previous study used serial trichotomization with five cognitive tests to determine whether drivers should continue driving, undergo further evaluation, or stop driving. OBJECTIVE: To examine agreement between serial trichotomization and fitness-to-drive determinations made by occupational therapists. DESIGN: Drivers referred for cognitive screens completed all tests used in the previous study. Occupational therapists provided fitness-to-drive recommendations (safe, indeterminate, or unsafe) using all clinical information available. We examined the agreement between the tests' results (using cut points from the previous study) and occupational therapists' recommendations. SETTING: Outpatient neurology program at a chronic care and rehabilitation hospital. PARTICIPANTS: 279 clients (M age = 66.35 yr; SD = 13.25). OUTCOMES AND MEASURES: Tests included the Trail Making Tests A and B, the Clock Drawing Test (CDT), the Montreal Cognitive Assessment, and the Motor-Free Visual Perception Test, using a road

test as the gold standard. The previous study used dual cut points with 100% sensitivity and specificity to reduce false positives and false negatives. RESULTS: Weighted κs ranged from .03 (95% confidence interval [CI] [-.01, .08]) for the CDT to .54 (95% CI [.46, .62]) for the Trail Making Test, Part B. Although the agreement between serial trichotomization and the final recommendations was moderate (κ = .59; 95% CI [.50, .67]), serial trichotomization appeared useful for identifying unsafe drivers. CONCLUSIONS AND RELEVANCE: These results remind us of the variability inherent in stand-alone cognitive tests, even within a serial trichotomization framework, and the importance of clinical judgement and road tests in decision making about driving. PLAIN-LANGUAGE SUMMARY: It can be challenging for occupational therapists to accurately determine a client's cognitive fitness to drive. Many occupational therapists lack the time, have limited training, or do not have access to comprehensive driving evaluation tools. A serial testing approach can support occupational therapists in assessing a client's cognitive fitness to drive. This study used an approach based on a series of five cognitive tests to determine whether a client should continue driving, undergo further evaluation, or stop driving. The series of tests were used to classify drivers as safe, indeterminate, or unsafe. In principle, a driver would take the second test only if the driver was classified as indeterminate on the basis of first test, and so on. By applying the tests in sequence, few drivers should remain classified as indeterminate at the end of the series of tests. This serial approach has the potential to streamline the decision-making process for occupational therapists by classifying the more extreme unsafe cases while still providing an accurate assessment of cognitive fitness to drive (4).

It is Time for Evidence-Based Consensus and Italian Guidelines for Medical Driving Assessment

European Union (EU) and non-EU countries have adopted different medical procedures for the issuance and renewal of a driver's license showing relevant matters of concern. In Europe, EU directives have been only partially supplemented with national laws, and there is a paucity of evidence-based criteria and methods for fitness-to-drive assessment. For instance, there is no agreement on standards for establishing which is the competent authority charged with the medical examination. Furthermore, license conditions, restrictions, or vehicle modifications, which appear as "limited use" codes on the driver's license are not regulated. This may generate confusion and deformity when it comes to the medico-legal evaluation, with potential ethical implications due to lack of transparency and equity and legal disputes between citizens and competent authorities. In this article, Italian experts on fitness-to-drive medical assessment highlight some major issues concerning the medical driving assessment activity in the EU. The Italian experience is shown as a case study, which is representative of other EU member states, for launching a call for evidence-based consensus documents and scientific guidelines on this topic, which may be helpful to international regulators and medico-legal stakeholders (5).

It Is Time for Medicare to Cover Driving Safety Assessments

This viewpoint advocates for Medicare coverage of driving assessments for older Individuals (6).

Examining Visual Processing Reaction Time of Vision CoachTM as a Predictor for Driving Fitness

IMPORTANCE: Visual processing speed reaction time is a critical component for fitness-to drive decisions. OBJECTIVE: To examine Vision CoachTM reaction times of medically-at risk drivers and healthy controls to determine the relationship with outcomes of a comprehensive driving evaluation. DESIGN: Predictive validity design. SETTING: University research centre. PARTICIPANTS: Of the sample (N = 419), 272 (64.9%) were healthy controls (M age = 49.4 yr, SD = 21.9, range = 21-87) with 196 (72.1%) women, and 147 (35.1%) were medically-at-risk participants (M age = 62.2 yr, SD = 15.7, range = 16-90) with 52 (35.4%) women. OUTCOME AND MEASURES: Reaction time was measured in seconds; there was an average of three trials using the full field with 60 random appearing lights. RESULTS: A significant difference was found between age groups for the healthy controls and the medically-at-risk participants, with no gender main effect or interactions between variables, suggesting that age-related changes and having a medical condition slowed processing speed. The receiver operating characteristic area under the curve scores for the three populations (all medically-at-risk participants, participants 16 to 64 yr old, and participants older than 65 yr) were 0.886, 0.894, and 0.783, respectively, suggesting moderate to good prediction power for fitness to drive. CONCLUSIONS AND RELEVANCE: Vision Coach can be used as a screening tool to differentiate between drivers who will likely pass or likely fail a comprehensive driving evaluation and drivers who need further evaluation. PLAIN LANGUAGE SUMMARY: With the growing number of older adults living longer and with more medical conditions, it is important for occupational therapists to have screening tools to determine fitness to drive. An on-road assessment is the gold standard for determining fitness to drive. However, the number of older adults with cognitive impairment is increasing, which can lead to a decline in processing speed while driving. As processing speed declines, it can take longer for a person to make decisions, which results in increased driving risk. Occupational therapists need a screening tool to assess processing speed, particularly for people with cognitive impairment. In this study we found that the Vision CoachTM demonstrates good sensitivity and specificity in assessing visual processing speed reaction time as well as determining who will likely pass or fail a comprehensive driving evaluation and who should be referred for further evaluation (7).

Testing a New Care Model: Implementing a Virtual Driving Assessment in Primary Care

This article explores the implementation of a Virtual Driving Assessment (VDA) in primary care to enhance adolescent driving readiness and safety. Topics discussed include the integration of the VDA into routine preventive care visits, the development of strategies to increase its utilization, and the impact of the assessment on improving adolescent driving skills and safety outcomes. We demonstrated that implementing a novel virtual driving assessment in

adolescent primary care preventative visits is feasible and desired by adolescents. Our findings describe a model for integrating driving support into primary care to address a leading cause of family stress as well as adolescent morbidity and mortality. As the science develops, we expect the tool to provide increasingly tailored decision support to families to promote safe driving initiation (8).

Evaluation of a driving clinical decision pathway for generalist occupational therapists: Pilot test of practice change

BACKGROUND: Few evidence-based resources exist to support generalist occupational therapists address driving in practice. This pilot study aimed to evaluate whether a driving clinical decision pathway can assist generalist occupational therapists to address driving with clients. METHODS: Using a before (Timepoint-1) and after (Timepoint-2) design, data were collected at a multi-site outpatient community rehabilitation service. Medical record audits documenting how driving was addressed in practice and descriptive surveys of therapist's perceptions of pathway use were collected at Timepoints 1 and 2. A driving clinical decision pathway was implemented over 6 months. Descriptive statistics and content analysis were used to analyse and compare data over time. RESULTS: Timepoint-1 data from 102 client medical records, and 13 clinician surveys were compared against Timepoint-2 data from 144 records and 8 surveys. Following implementation of the pathway, the number of assessments used by generalist occupational therapists increased three-fold, to inform driving process recommendations which increased two-fold. Clinicians' self-reported knowledge, skills and confidence also increased two-fold. CONCLUSION: A comprehensive driving clinical decision pathway provided clinicians with increased structure and support to guide practice change and promote role fulfilment in addressing return to driving with adults following a change in health status (9).

Smart Driving Technology for Non-Invasive Detection of Age-Related Cognitive Decline

Alzheimer's disease (AD) and Alzheimer's Related Dementias (ADRD) are projected to affect 50 million people globally in the coming decades. Clinical research suggests that Mild Cognitive Impairment (MCI), a precursor to dementia, offers a critical window of opportunity for lifestyle interventions to delay or prevent the progression of AD/ADRD. Previous research indicates that lifestyle changes, including increased physical exercise, reduced caloric intake, and mentally stimulating activities, can reduce the risk of MCI. Early detection of MCI is challenging due to subtle and often unnoticed cognitive decline and is traditionally monitored through infrequent clinical tests. In this research, the Smart Driving System, a novel, unobtrusive, and economical technology to detect early stages of neurodegenerative diseases, is presented. The system comprises a multi-modal biosensing array (MMS) and AI algorithms, including driving performance and driver's biometrics, offering insights into a driver's cognitive function. This publication is the first work reported towards the ultimate goal of developing the Smart Driving Device and App, integrating it into vehicles, and validating its effectiveness in detecting MCI through comprehensive pilot studies (10).

1.3. Occupational Health – Professional Drivers

A framework for countermeasures design to support professional drivers' fitness-to-drive

This paper presents a new conceptual framework, and stepwise approach to populate it, for informing countermeasure development to support fitness-to-drive for professional drivers. Professional drivers are vital to the transport network; however, the job is demanding, and drivers are vulnerable to impairments which may impact safe driving. Countermeasures are any action or activity that mitigates the impact or frequency of occurrence of driver impairment. The framework proposes countermeasures to be delivered across three time points: Operational (during shift), Tactical (immediately after shift) and Strategic (outside of on-shift) and at multiple system levels, e.g., driver, manager, enforcement etc. The framework was successfully pilot tested with three different professional driver use cases: autonomous shuttles, taxi, and garbage truck drivers. This structured approach to countermeasure design offers potential to improve driver health and enhance road safety. The work was conducted within PANACEA, an EU project, grant agreement number 953426 (11).

Who's Behind the Wheel? Work and Health Backgrounds of New Transit Bus Operators.

OBJECTIVE: Investigate new bus operators' (N = 293) occupational and health backgrounds to inform how transit authorities can support their future health and job success. METHODS: New bus operators completed surveys and direct measurements that addressed demographics, work history, and 10 health risk factors. RESULTS: Participants averaged 42.76 years of age and were predominantly male (73.5%). Many (45.7%) came from minority backgrounds and most (66.3%) had no prior commercial driving experience. Transportation and material moving occupations were operators' most common prior jobs followed by protective service, and sales and related occupations. Study-specific criteria classified operators as having low (49.5%), medium (37.9%), and high (12.6%) health risk levels. CONCLUSIONS: About half of the sample had medium-to-high health risks and most lacked commercial driving experience. Such information may help employers proactively support new bus operators' health and job success (12).

The comparison of STOP-BANG and no-apnea questionnaires in screening obstructive sleep apnea among commercial drivers

OBJECTIVE: No-apnoea questionnaire (NAQ) and STOP-BANG questionnaire (SBQ) are widely used for obstructive sleep apnoea (OSA) screening. This investigation aimed to compare the SBQ with the NAQ as an OSA screening tool among commercial drivers. METHODS: We included eligible commercial drivers who came to the Occupational Health clinic between March 2018 and March 2019. Participants filled out the SBQ, NAQ, and ESS questionnaires. The SBQ scores eight factors to assess OSA risk, with a score of ≥3 indicating high risk. The NAQ scores age and neck circumference for OSA risk, with ≥3 indicating significant risk. The

ESS measures daytime sleepiness, with a score of ≥10 indicating excessive sleepiness as the most common symptom of OSA. The patients' scores were evaluated based on the set criteria. A McNemar test was used to determine the differences between SBQ and NAQ. The number of at-risk patients was measured for each screening test, and the correlation between the two screening methods was evaluated by measuring Cohen's kappa coefficient. RESULTS: A total number of 581 commercial drivers, with a mean age of 44.39 ± 9.16 years, participated. The mean SBQ score was 1.82 ± 0.78, with 17.7% of participants being at high risk of OSA. The mean NAQ score was 3.48 ± 1.94, with 65.7% of participants being at high risk of OSA. About 48.6% of commercial drivers were at high risk, according to the NAQ but not SBQ. In contrast, 0.5% of participants were at high risk, according to SBQ, but not NAQ. Regarding ESS scores, among those identified as high risk for OSA by the SBQ, 13.6% exhibited an ESS score greater than 10. Similarly, within the high-risk group identified by the NAQ, this proportion was 14.1%. Cohen's kappa coefficient was 0.17, which is considerably low. A McNemar test also indicated that the SBQ and the NAQ didn't have equivalent diagnostic outcomes (P-value < 0.001). CONCLUSIONS: The NAQ identified more professional drivers at risk for OSA compared to the SBQ, suggesting that objective-based questionnaires may be more effective for screening in safety-sensitive jobs like commercial driving. However, further validation with polysomnography and cost-benefit considerations are needed to determine the most efficient and sustainable screening approach (13).

Retrospective quality review of Department of Transportation (DOT) commercial drivers' medical examination forms

OBJECTIVE: This study aimed to evaluate the quality of completion among both drivers and medical examiners in filling out Commercial Driver's (CD) Medical Examination Report Forms. METHODS: This was a cross-sectional retrospective study of abstracted data from the year 2019. CD Medical Examination Report Forms, collected from a single nationally based employer and initially reviewed by corporate medical directors, were evaluated by the study team for completeness of documentation provided by both drivers and medical examiners (MEs). Relevant findings included unanswered questions, inconsistency between responses, and lack of necessary elaboration for positive responses. RESULTS: Among 1603 examinations, MEs completed the Medical Examination Report Form incompletely or incorrectly in 30% of examinations (n = 484). Drivers inconsistently filled out their health history with elaborations 38.7% of the time. Most commonly, they failed to elaborate on positive health history responses in 28.7% of examinations, but other types of errors were noted as well. CONCLUSIONS: A considerable proportion of drivers or examiners (n = 890, 55%) failed to adequately or correctly complete CD Medical Examination Report forms (14).

1.4. Older people

Road traffic safety for older adults: an emerging public health challenge in Thailand

BACKGROUND: Road safety for older adults should receive more attention in low-income and middle-income countries with rapidly ageing populations. METHODS: Using injury surveillance data from Khon Kaen Regional Hospital in northeastern Thailand, we calculated the proportion of older adults in the total number of patients who were fatally and non-fatally injured in road traffic crashes in each year from 2001 to 2020 and the proportion of road user type in the fatal and non-fatal patients by age groups for the entire study period to examine the extent to which older adults were involved in the crashes and with what mode of transportation. RESULTS: During the 20-year period, there were 5046 fatal and 180 353 non-fatal patients of whom 509 (10%) and 6087 (3%) were aged 65 years or older, respectively. From 2001 to 2020, this proportion increased from 3% to 20% among the fatal patients and from 1% to 6% among the non-fatal patients. Of the fatal and non-fatal patients aged 65 years or older, 50% and 54% were involved in road traffic crashes while driving motorcycles and 28% and 22% while riding bicycles or walking, respectively. Compared with patients aged 65-74 years, those aged 75 years or older tended to be bicyclists or pedestrians in the crashes, though as high as 40% of them were motorcycle drivers. CONCLUSION: Older adults are increasingly injured in road traffic crashes as vulnerable road users in Thailand. Therefore, road safety efforts should consider their presence on the road (15)

Association between driving and depression in older adults: findings from an ancillary study of a prospective cohort

BACKGROUND: Depression is prevalent among older adults, particularly those with somatic comorbidities, and is linked to cognitive decline and reduced quality of life. Driving may act as a protective factor by enhancing cognitive function and social engagement. However, few prospective studies have investigated this association. This study aimed to assess whether driving was associated with a lower risk of new-onset depression and lower antidepressant medication. METHODS: This ancillary study of the prospective S.AGES cohort (Sujets AGÉS-Aged Subjects) which included 3,434 participants (mean age 77.6 ± 6.2 years) with somatic comorbidities (chronic pain, type 2 diabetes, or atrial fibrillation) enrolled between 2009 and 2014. Driving status was recorded at baseline, and participants were monitored for 36 months. Depression was measured by the Geriatric Depression Scale (GDS), and antidepressant prescription was recorded at follow-up. Time-to-event analyses were performed on propensity-matched cohorts comparing drivers and non-drivers for new onset depression (GDS ≥ 5/15) and antidepressant use. RESULTS: In the first cohort (126 drivers and 126 matched non-drivers), drivers had a significantly lower risk of new-onset depression (hazard ratio [HR] = 0.58 [0.40-0.86]). In the second cohort (368 drivers and 368 non-drivers), drivers had a lower risk of antidepressant use (HR = 0.49 [0.29-0.84]). DISCUSSION: Driving at baseline was associated with a reduced risk of depression and antidepressant prescription in older adults with somatic comorbidities, highlighting the potential importance of maintaining mobility and driving to support mental health in this population. TRIAL REGISTRATION: The

study was registered at ClinicalTrials.gov NCT01065909 with a first registration date of February 8, 2010 (16).

Validation of the Candrive Older Driver Risk Stratification Tool for Assessing Medical Fitness-to-Drive in Older Australian Drivers

BACKGROUND: Assessing older drivers' fitness-to-drive is challenging, with decisions impacting mobility and health. This study aimed to validate the Candrive older driver risk stratification tool for screening medical fitness-to-drive in an independent cohort of older adults from the Ozcandrive 8-year prospective study. METHODS: A convenience sample of drivers aged 75 and older residing in Melbourne, Australia completed the Candrive assessments. Their vehicles were instrumented to collect vehicle and global positioning system data, including trip distance. The first 4 years of Ozcandrive data were analysed. The primary outcome measure was self-reported at-fault collisions, adjusted per 10 000 km driven. Collision risk status was modelled using Generalized Estimating Equations with Poisson regression using predetermined Candrive risk stratification tool predictor variables. RESULTS: A total of 257 older drivers (70.8% male) were recruited with an average age at study enrolment of 79.7 years (standard deviation = 3.5). Of the 755 adjusted person-years of driving, 74.1% were in the Low-risk category (vs original sample, Candrive: 74.8%) and 10.5% were in the Low-Medium risk category (Candrive: 9.3%). Only 15.4% were in the Medium-High risk category (Candrive: 15.9%), where the relative risk for self-reported at fault collisions was 1.79 (95% confidence interval = 1.06-3.03) compared to the Low-risk category. CONCLUSIONS: This study demonstrates an association between self-reported at fault collisions and Candrive risk stratification tool scores. This result is promising given the primary outcome measure differed from the original Candrive study that used police-reported, at-fault collisions, and supports Candrive risk stratification tool's use by healthcare providers when initiating fitness-to-drive conversations (17).

An online driving decision aid for older drivers reduces ambivalence and regret about driving decisions: Randomized trial

BACKGROUND: Decisions about driving cessation can be stressful for older adults. We tested effects of a driving decision aid (DDA) on psychosocial outcomes among older drivers during two-year follow-up. METHODS: Multisite randomized controlled trial of licensed drivers ages ≥70 with at least one diagnosis associated with increased likelihood of driving cessation, without significant cognitive impairment. The intervention was the online Healthwise® DDA, addressing "Is it time to stop driving?"; controls received National Institute on Aging web-based information for older drivers. Outcomes were assessed at baseline, 6, 12, 18, and 24 months. Primary outcomes were the Decision Regret Scale, Decisional Conflict Scale (assessing decisional ambivalence or uncertainty), and PROMIS Depression (4a) Scale. Self-reported Life-Space Assessment (assessing community mobility), crashes and driving outcomes were also assessed. Using intention-to-treat analyses, we tested whether DDA (vs. control) effects on each outcome differed during follow-up using a study group by time

interaction. Longitudinal outcomes were modelled using generalized linear mixed models, accounting for repeated measures, age, site, and baseline visit before vs. during COVID. RESULTS: We enrolled 301 participants (age at enrolment: mean 77.1 (range 70-92) years; 51% identifying as female). During follow-up, the DDA group had less decisional conflict (p(interaction) = 0.010) and decision regret (p(interaction) = 0.012). The DDA had its greatest effect on decisional conflict immediately post-intervention (adjusted mean ratio [aMR] = 0.87; 95%CI: 0.79, 0.97) and on decision regret at 12-month follow-up (aMR = 0.45; 95%CI: 0.27, 0.72). Odds of depression were similar between groups during follow-up (p(interaction) = 0.237). The intervention did not negatively affect life space, crashes, or other driving outcomes. CONCLUSIONS: In older drivers, the Healthwise® DDA reduced uncertainty and regret about driving decisions during longitudinal follow-up, without adversely affecting community mobility or crash risk. Use of DDAs in clinical and other settings may reduce the distress older adults often experience when making decisions about driving cessation (18).

Associations between Driving Status, Frequency of Transport use after Driving Cessation, and Social Frailty among Middle-Aged and Older Adults

BACKGROUND: The use of transport other than cars is a modifiable factor in the association between driving cessation and social frailty. Clarifying this relationship may serve as a new preventive measure against social frailty among current non-drivers. This study examined the potential association of driving status and transport use with social frailty, as well as between the frequency of transport use and social frailty, among current non drivers. METHODS: This study included 977 middle-aged and older adults (average age, 65.3±4.8 years). The participants were classified as transport users (more than a few times a week) and transport non-users (less than a few times a month). Based on driving status and transport use, the groups were further classified into current driver, current non driver/transport user, and current non-driver/transport non-user groups. The relationships between driving status, transport use, and social frailty were examined using multiple logistic regression. RESULTS: The current non-driver group and the transport non-user group were significant association with a higher social frailty. The current non-driver/transport user group showed no association with social frailty compared with the current driver group. The odds ratio for the social frailty rate for The current non-driver/transport non-user group was 2.14 (95% confidence interval, 1.25-3.73). CONCLUSIONS: Participants who neither drive nor take transport showed significant associations with increased social frailty. Compared with current driver/transport use, current non-driver/transport non-use was associated with social frailty (19).

Evaluation of the effectiveness of three different interventions on older driver safety over a 12-month period: study protocol for a randomised controlled trial

INTRODUCTION: The growing population of older drivers presents challenges for road safety attributed to age-related declines and increased crash fatality rates. However, enabling older people to maintain their health and independence through continued safe driving is

important. This study focuses on the urgent need for cost-effective interventions that reduce crash risk while supporting older drivers to remain driving safely for longer. Our study aims to evaluate the effectiveness of three behavioural interventions for older driver safety. These include an online road-rules refresher workshop, tailored feedback on driving performance and two tailored driving lessons. METHODS AND ANALYSIS: A single-blind three-parallel group superiority randomised controlled trial will be conducted with 198 urban licensed drivers aged 65 years and older, allowing for 4% attrition. This sample size provides 80% power to detect a difference with an alpha of 0.05. Participants will be selected based on a standardised on-road test that identifies them as moderately unsafe drivers. Interventions, spanning a 3-month period, aim to improve driving safety. Their effectiveness will be assessed through a standardised on-road assessment of driving safety at 3 months (T1) and 12 months postintervention (T2). Additionally, monthly self-reported driving diaries will provide data on crashes and incidents. This trial has the potential to identify cost-effective approaches for improving safety for older drivers and contribute to evidence-based health policy, clinical practice and guidelines. ETHICS AND DISSEMINATION: Ethical approval was obtained by the University of New South Wales Human Research Ethics Committee (HC190439, 22 August 2019). The results of the study will be disseminated in peer-reviewed journals and research conferences. TRIAL REGISTRATION NUMBER: ACTRN12622001515785 (20).

Internal Factors that Influence Coping in Older Drivers' Transition to Non-Driving

Quality of life outcomes are associated with the transition to non-driving and depend on effective coping. We examined the relationship between internal factors associated with effective coping and longitudinal changes in travel behaviour among drivers aged ≥70 using data from a randomized controlled trial evaluating a driving decision aid. We measured attitudes using the Assessment of Readiness for Mobility Transition (ARMT) and personality using the Ten-Item Personality Inventory (TIPI). We analysed associations between attitudes and personality with drivers' change in a) alternative transportation use and b) driving behaviour over time. Older drivers with high versus low attitudinal readiness for mobility transition were more likely to use alternative transportation over time (adjusted odds ratio = 6.37; 95% confidence interval: 1.45-28.1). We found no association between personality characteristics and alternative transportation use or driving behaviour over time. Attitudinal readiness may be a key predictor of effective coping during the transition to non-driving (21).

Possibility to Grasp the Older Drivers' Conditions from the Triennial Nationwide Survey of Japan for Elderly Welfare

The percentage of older drivers is increasing worldwide. Older adults are driving for their daily lives, including drivers who should not drive, "must-watch drivers", for health conditions, etc. The "Public Survey of Long-Term Care Prevention and Needs in Spheres of Daily Life (Needs Survey)", including the "Kihon Checklist (KCL)", is a triennial nationwide survey conducted by welfare administrations in Japan. The objective of this study was to demonstrate that the Needs Survey can capture situations (e.g., driving avoidance) of older drivers obtained by

previous studies, many of which are one-time surveys. As for our methods, we administered a survey with a format of questions used in previous studies combined with KCL to all older adults in Tsurui Village, a rural community in Japan, obtained 393 responses, around half of them, and conducted a logistic regression analysis to estimate whether they were driving or not and a multiple regression analysis for the frequency of driving avoidance. The former analysis showed that KCL could detect must watch drivers with relatively deteriorated health among not-so-old adults, adding to another one with relatively not-so-bad health among much older adults, and the latter analysis showed that the KCL scores could be an alternative to the self-rating of driving ability used in previous studies. In conclusion, KCL in the Needs Survey is recommended to be a valuable survey for regularly assessing the driving conditions of older drivers nationwide (22).

Association between the presence of passengers and at-fault crash risk among older drivers with and without cognitive decline

INTRODUCTION: Older drivers, especially those with cognitive decline, should be supported in continuing to drive safely, given their lowered driving abilities, limited alternative transportation options, and the adverse health outcomes associated with driving cessation. One potential strategy to reduce crash risk is having passengers as co-pilots. Therefore, we investigated whether the presence of passengers was associated with at-fault crash risk among older drivers with different cognitive statuses. METHODS: Using nationwide police-reported crash data linked with driver licensing data, which includes cognitive assessment results at license renewal, for all licensed drivers aged 75 years or older in Japan, we conducted a culpability analysis among those involved in car-to-car crashes from 2014 to 2020. The analysis compared the exposure status (presence of passengers at the time of crash) between drivers responsible for the crash and drivers not responsible. We used logistic regression to estimate at-fault crash risk associated with passengers, controlling for potential confounders, separately for male or female drivers with suspected dementia, slight cognitive decline, or no cognitive decline. RESULTS: Our crash data included 108,945 responsible and 56,783 non-responsible drivers. Among male drivers, 15% to 16% of responsible drivers and 29% to 33% of non-responsible drivers were accompanied by passengers at the time of crash, depending on their cognitive status. Among female drivers, 10% to 11% of responsible drivers and 26% to 27% of non-responsible drivers had passengers. The strength of the association did not vary largely across cognitive statuses among both male and female drivers, with adjusted odds ratios ranging from 0.36 to 0.43 for males and from 0.30 to 0.32 for females. CONCLUSION: The presence of passengers was associated with lower at-fault crash risk among older drivers, regardless of their cognitive status. PRACTICAL APPLICATIONS: Our findings suggest the potential role of passengers in enhancing the safety of older drivers (23).

News Coverage of Older Drivers' Fatal Car Crashes: Is It Over-represented?

BACKGROUND: Japan's stringent licensing policies for older drivers have not been questioned, possibly due to negative perceptions of older drivers potentially influenced by media

coverage of their car crashes. We examined whether older drivers' fatal crashes are over-represented in news articles. METHODS: To examine the news coverage of fatal crashes that occurred between January 2016 and December 2020, we extracted driver- and crash-related data from articles reporting fatal crashes in the two best-selling newspapers, Yomiuri and Asahi. We obtained the corresponding data of police-reported fatal crashes during the same period. We calculated the proportion of newspaper-reported fatal crashes to police-reported fatal crashes by at-fault driver's age group and crash characteristics. RESULTS: Of 12,987 police-reported fatal crashes, 5,888 (45%) and 2,909 (22%) crashes were reported in Yomiuri and Asahi newspapers, respectively. Excluding 2,098 crashes where at-fault drivers or their ages were not identifiable, Yomiuri reported 39%, 35%, and 31%, and Asahi reported 20%, 16%, and 14% of fatal crashes caused by drivers aged <30 years, 30-69 years, and 70 years or older, respectively. Crashes that caused more fatalities or killed children tended to be reported regardless of at-fault drivers' age groups. Compared with young and middle-aged drivers, older drivers' fatal crashes involving child fatalities were more often reported, whereas their single fatal crashes ending in their own deaths were less often reported. CONCLUSION: Older drivers' at-fault fatal crashes were not over represented in the news coverage of overall fatal crashes, and their crashes killing themselves were under-reported (24).

Personal responsibility as a guiding principle for the regulation of driving licenses in old age
The discussion about the fitness of older people to drive is currently very heated. Restrictions, threats of punishment and bans on the one hand, as well as mandatory tests and increased controls on the other, proved to be unhelpful and not solution-oriented in the discussion. On the other hand, creative suggestions from the areas of traffic medicine, traffic psychology, police and driving schools receive very little attention. The special issue presented here deals with selected questions on the topic of "fitness to drive and mobility in old age" in 10 articles. In order to do justice to the complexity of the problem, the contributions come from various medical disciplines, psychology and the judiciary (25).

Mediating role of frailty/pre-frailty on the association between exercise participation and traffic crashes among Japanese community-dwelling older drivers
BACKGROUND: Driving is essential for maintaining independence. This study aimed to assess the mediating role of frailty status in the association between exercise participation and traffic crashes among Japanese community-dwelling older drivers. METHODS: This 2-year longitudinal study included data of 3,934 Japanese community-dwelling older drivers aged ≥ 65 years in Kasama City who did not require long-term care and participated in a postal survey in 2019 and 2021 at baseline and follow-up, respectively. The participants who exercised at least one-three times per month at baseline were classified as exercisers. Frailty status was assessed using the seven-domain Kihon Checklist. A self-reported history of traffic crashes was collected during the follow-up survey. The effect of exercise participation on traffic crash involvement was analysed using logistic regression after adjusting for covariates.

Mediation analyses were performed to determine the mediating effects of frailty status. RESULTS: A total of 357 (23.7%) and 1,147 (76.3%) older drivers were classified as exercisers and non-exercisers, respectively. Logistic regression analyses showed that exercise participation significantly reduced the risk of traffic crash involvement at follow-up (odds ratio [OR] = 0.586; 95% confidence interval [CI], 0.359-0.956) and was significantly associated with a lower risk of frailty/pre-frailty (OR = 0.479; 95% CI, 0.372-0.617). Although there was no significant association between exercise participation and traffic crash involvement at follow-up (OR = 0.631; 95% CI, 0.384-1.037), frailty/pre-frailty was associated with a significantly higher risk of traffic crash involvement compared with robustness (OR = 1.649; 95% CI, 1.061-2.563). The Sobel test revealed that frailty/pre-frailty mediated the association between exercise participation and traffic crash involvement at follow-up (p =.01). Additionally, among the seven domains of the Kihon Checklist, the physical domain mediated the association between exercise participation and traffic crash involvement at follow-up (p =.01). CONCLUSIONS: Exercise participation could significantly lower the risk of traffic crashes, with frailty/pre-frailty acting as a mediating factor. Our findings indicated that managing frailty is crucial for both public health and crash prevention, emphasizing the need for promoting these measures among older drivers (26).

Public Discourse Toward Older Drivers in Japan Using Social Media Data From 2010 to 2022: Longitudinal Analysis

BACKGROUND: As the global population ages, concerns about older drivers are intensifying. Although older drivers are not inherently more dangerous than other age groups, traditional surveys in Japan reveal persistent negative sentiments toward them. This discrepancy suggests the importance of analysing discourse on social media, where public perceptions and societal attitudes toward older drivers are actively shaped. OBJECTIVE: This study aimed to quantify long-term public discourse on older drivers in Japan through Twitter (subsequently rebranded X), a leading social media platform. The specific objectives were to (1) examine the sentiments toward older drivers in tweets, (2) identify the textual contents and topics discussed in the tweets, and (3) analyse how sentiments correlate with various variables. METHODS: We collected Japanese tweets related to older drivers from 2010 to 2022. Each quarter, we (1) applied to the Japanese version of the Linguistic Inquiry and Word Count dictionary for sentiment analysis, (2) employed 2-layer nonnegative matrix factorization for dynamic topic modeling, and (3) applied correlation analyses to explore the relationships of sentiments with crash rates, data counts, and topics. RESULTS: We obtained 2,625,807 tweets from 1,052,976 unique users discussing older drivers. The number of tweets has steadily increased, with significant peaks in 2016, 2019, and 2021, coinciding with high profile traffic crashes. Sentiment analysis revealed a predominance of negative emotions (n=383,520, 62.42%), anger (n=106,767, 17.38%), anxiety (n=114,234, 18.59%), and risk (n=357,311, 58.15%). Topic modeling identified 29 dynamic topics, including those related to driving licenses, crash events, self-driving technology, and traffic safety. The crash events topic, which increased by 0.28% per year, showed a strong correlation with negative emotion (r=0.76,

P<.001) and risk (r=0.72, P<.001). CONCLUSIONS: This 13-year study quantified public discourse on older drivers using Twitter data, revealing a paradoxical increase in negative sentiment and perceived risk, despite a decline in the actual crash rate among older drivers. These findings underscore the importance of reconsidering licensing policies, promoting self-driving systems, and fostering a more balanced understanding to mitigate undue prejudice and support continued safe mobility for older adults (27).

Predictors of driving errors contributing to crashes in older adults across age groups, 2010 to 2020

INTRODUCTION: Given the largely autocentric nature of the United States, drivers continue to operate vehicles with varying levels of driving ability and self-restriction as they advance into older age. This study explores the associations of vehicle actions and traffic control devices with older drivers' driving errors contributing to crashes, incorporating age group as effect modifiers of these relationships. METHOD: This study includes crashes reported to the Iowa Department of Transportation from 2010 to 2020. Analysis was completed for drivers involved in a crash who were aged 45 years and older (n = 254,912). Driving errors were identified based on driver contributing factors reported in the Iowa crash data. A multivariable logistic regression model was built to model predictors of driving errors, focusing on crash-related vehicle actions and traffic control devices. Additionally, interaction terms were incorporated to examine the moderating effect of age groups (45-64; 65-74; 75-84; 85+). RESULTS: Driving errors increased with age, especially in the middle-old age group (75-84). A higher probability of driving errors was observed in changing lanes, merging, and turning, with right turns showing the most substantive increase in the middle old age group compared to the other age groups. Stop and yield signs were associated with a higher probability of driving errors, increasing monotonically with age. The middle-old age group exhibited a notable increase in driving errors at uncontrolled or traffic signalled locations compared to the other age groups. CONCLUSIONS: The significant increase in driving errors at and beyond the middle-old age group may demonstrate higher age-related declines in safe driving compared to younger age groups. PRACTICAL APPLICATIONS: Careful evaluations for older drivers' fitness to drive during license renewal periods are needed once drivers reach the middle-old age. Additionally, effective combinations of advanced technologies, traffic systems, and policies are necessary to reduce the burdens associated with aging (28).

Applications of Self-Driving Vehicles in an Aging Population

The proportion of older adult drivers is increasing and represents a growing population that must contemplate reducing driving and eventually stopping driving. The advent of self-driving vehicles opens vast possibilities with practical and far-reaching applications for our aging population. Advancing technologies in transportation may help to overcome transportation barriers for less mobile individuals, transcend social and geographical isolation, and improve resource and medical access. Herein, we propose various applications and benefits that self-

driving vehicles have in maintaining independence and autonomy specifically for our aging population to preserve aging (29).

Considering multi-scale built environment in modeling severity of traffic violations by elderly drivers: An interpretable machine learning framework

The causes of traffic violations by elderly drivers are different from those of other age groups. To reduce serious traffic violations that are more likely to cause serious traffic crashes, this study divided the severity of traffic violations into three levels (i.e., slight, ordinary, severe) based on point deduction, and explore the patterns of serious traffic violations (i.e., ordinary, severe) using multi-source data. This paper designed an interpretable machine learning framework, in which four popular machine learning models were enhanced and compared. Specifically, adaptive synthetic sampling method was applied to overcome the effects of imbalanced data and improve the prediction accuracy of minority classes (i.e., ordinary, severe); multi-objective feature selection based on NSGA-II was used to remove the redundant factors to increase the computational efficiency and make the patterns discovered by the explainer more effective; Bayesian hyperparameter optimization aimed to obtain more effective hyperparameters combination with fewer iterations and boost the model adaptability. Results show that the proposed interpretable machine learning framework can significantly improve and distinguish the performance of four popular machine learning models and two post-hoc interpretation methods. It is found that six of the top ten important factors belong to multi-scale built environment attributes. By comparing the results of feature contribution and interaction effects, some findings can be summarized: ordinary and severe traffic violations have some identical influencing factors and interactive effects; have the same influencing factors or the same combinations of influencing factors, but the values of the factors are different; have some unique influencing factors and unique combinations of influencing factors (30).

Great to use as a conversation starter: End user views on the acceptability and feasibility of a prototype decision aid for older drivers

BACKGROUND: Conversations about driving with older adults are often emotionally laden and decisions about retiring from driving can be challenging. Tailored tools, such as evidence-based decision aids could support conversations and decisions about driving for older adults. This study aimed to explore the acceptability and feasibility of a prototype decision aid for older drivers from the perspective of end-users. METHOD: This qualitative cross-sectional study utilized an online survey with 106 adults living in Australia. The 36- page web-based decision aid prototype was developed for older drivers living in New South Wales, Australia, using a co-design approach with multiple stakeholders. RESULTS: Respondents were healthcare professionals, older adults, family members, or friends of older adults and other professional groups. Decision aid acceptability was high. The presentation of the aid was highly regarded by older adults and healthcare professionals. The length and comprehensiveness were salient characteristics and could impact utility for healthcare

professionals and older adults. Personal stories, risks, and incentives for driving retirement were important content to include. Various benefits of the decision aid were highlighted: supporting conversations and decision making about driving decisions and planning for future mobility changes. CONCLUSIONS: The older driver decision aid was a supported approach by healthcare professionals and family members to guide conversations and decision-making about driving with older adults. The decision aid triggered older adults to reflect upon their current driving, think about ways to stay safe on the road, or plan for alternatives to driving in the future. PRACTICAL APPLICATIONS: The older driver decision aid could be a useful tool for Australian healthcare professionals and family members when approaching a conversation and decision-making about driving with older adults. Using the decision aid may prompt older adults to reflect upon various aspects of decisions about driving early in the decision pathway (31).

Personality, functional performance, and travel patterns related to older drivers' risky driving behaviour: A naturalistic driving study

Older drivers are among the most vulnerable demographics within the road traffic system. The rising number of elderly motorists has raised public concern regarding their driving safety. It is crucial to understand the factors influencing risky driving behaviours among older drivers to enhance their safety. This study aimed to analyse the personality, functional performance, and travel patterns related to older drivers' risky driving behaviour. The analysis utilized a sample of 58 older drivers, aged 65 years and above (mean age = 72.41 years; 40 males and 18 females) from the Nagoya metropolitan area. Risky driving behaviours and travel patterns were assessed using naturalistic driving data. Bivariate correlation analysis revealed that impulsivity and diminished contrast sensitivity were significantly correlated with more frequent risky driving behaviours. Additionally, both low driving exposure and high-risk driving routes (i.e., more frequent left and right turns, driving more on minor roads) were significantly correlated with an increased risk of harsh events. Moreover, a strong association was observed between driving exposure and driving route, indicating that the driving route of lower mileage drivers tend to be riskier. When the relationship between driving exposure and risky driving behaviours was adjusted for driving route, the strength of the correlation diminished from 0.35 to 0.16, rendering it insignificant. This partial correlation analysis suggests that the increased driving risk among low-mileage drivers can be partially attributed to their high-risk driving routes. The findings of this study provide further evidence regarding the role of personality in explaining older drivers' risky driving behaviour and the explanation of older drivers' low-mileage bias (32).

Medication Changes Among Older Drivers Involved in Motor Vehicle Crashes

IMPORTANCE: Although older adults may use potentially driver-impairing (PDI) medications that can produce psychomotor impairment, little is known about changes to PDI medication use among older adults from the time before to the time after a motor vehicle crash (MVC).

OBJECTIVE: To quantify use of and changes in PDI medications among older adults before and after an MVC. DESIGN, SETTING, AND PARTICIPANTS: This cohort study used linked Medicare claims and police-reported MVC data on 154 096 person-crashes among 121 846 older drivers. Eligible persons were drivers aged 66 years or older, involved in a police-reported MVC in New Jersey from May 1, 2007, through December 31, 2017, and with continuous enrolment in Medicare fee-for-service Parts A and B for at least 12 months and Part D for at least 120 days prior to the MVC. Data were analysed from January 2022 to May 2024. MAIN OUTCOMES AND MEASURES: Use of benzodiazepines, nonbenzodiazepine hypnotics, opioid analgesics, and other PDI medications in the 120 days before and 120 days after the MVC. Because each person could contribute multiple MVCs during the study period if they met eligibility criteria, the unit of analysis was the number of person-crashes. The proportion of person-crashes after which PDI medications were started, discontinued, or continued was quantified as well. RESULTS: Among 154 096 eligible person-crashes, the mean (SD) age of the drivers was 75.2 (6.7) years at the time of the MVC. Of 121 846 unique persons, 51.6% were women. In 80.0% of the person-crashes, drivers used 1 or more PDI medications before the crash, and in 81.0% of the person-crashes, drivers used 1 or more PDI medications after the crash. Use of benzodiazepines (8.1% before the crash and 8.8% after the crash), nonbenzodiazepine hypnotics (5.9% before the crash and 6.0% after the crash), and opioid analgesics (15.4% before the crash and 17.5% after the crash) was slightly higher after the MVC. After the MVC, drivers in 2.1% of person-crashes started benzodiazepines and 1.4% stopped benzodiazepines, drivers in 1.2% of person crashes started nonbenzodiazepine hypnotics and 1.2% stopped nonbenzodiazepine hypnotics, and drivers in 8.4% of person-crashes started opioid analgesics and 6.3% stopped opioid analgesics. CONCLUSIONS AND RELEVANCE: This cohort study suggests that most older drivers involved in MVCs did not use fewer PDI medications after crashes than before crashes. Qualitative research of perceived risks vs benefits of PDI medications is necessary to understand the reasons why MVCs do not appear to motivate clinicians to deprescribe PDI medications as a strategy to avert potential harms, including additional MVCs (33).

2. Neurology and Rehabilitation

2.1. Neurology/epilepsy

Awareness and driving safety during awake interictal epileptiform discharges in idiopathic generalised epilepsies: A systematic review

Idiopathic generalised epilepsies (IGEs) are a family of epileptic syndromes that commonly occur in childhood or adolescence and can persist into adulthood. Whilst people with IGE may consider themselves seizure free, they often experience interictal epileptiform discharges (IEDs) that may be associated with unrecognised periods of impaired awareness. As such, the presence of long IEDs associated with unrecognised loss of awareness pose a major challenge in allowing these individuals to drive safely, particularly since not all IEDs are associated with impaired awareness. Here we conduct a systematic review of the literature to characterise factors associated with impaired awareness during IEDs in adults. This review includes articles written in English and was limited to patients with IGE ≥16 years with evidence of IEDs on EEG. The outcomes assessed included electroclinical descriptions of IED manifestations and fitness to drive assessments in people with IGE. The systematic literature search yielded 6 studies that met the inclusion criteria. A quality assessment of the cohort studies included was conducted using a modified Newcastle Ottawa Scale. Prior research has utilised driving simulations and prolonged video EEG monitoring for fitness to drive assessments delivering positive outcomes. They have shown that the clinical manifestation of IEDs is dependent upon the discharge duration. Furthermore, it has been shown that IED morphology can be described as generalised spike or polyspike wave discharges. Additionally, expert opinion has demonstrated significant variability in practice concerning driving clearance for patients with IGEs, with only a minority utilising prolonged EEG monitoring. This review highlights our current inability to reliably predict the cognitive status of a people with IGE during IEDs. However, emerging research on the use of machine learning algorithms to analyse IED waveforms appears promising, offering a potential solution to this issue (34).

Effects of frequently prescribed antiseizure medications on motor vehicle driving performance: Narrative review based on a tiered approach for the assessment of clinically meaningful driving impairment in the Ministry of Health, Labour, and Welfare guideline.

Patients with epilepsy often require long-term treatment with antiseizure medications, and their impact on daily activities, particularly driving, is of significant concern. The recently published "Guideline for Evaluating Effects of Psychotropic Drugs on the Performance to Drive a Motor Vehicle" in Japan provides a framework that can be referred to for not only the evaluation of new drugs but also the re-evaluation of approved drugs. This study conducted a literature review regarding the effects of carbamazepine, valproate, lamotrigine, lacosamide, and levetiracetam, which are frequently prescribed for epilepsy, on driving performance following the guideline's tiered evaluation approach. Analyses of pharmacological, pharmacodynamic, and adverse events suggested that these drugs primarily affect arousal function. Driving studies showed that acute administration of

carbamazepine, but not chronic monotherapy with carbamazepine, valproate, lamotrigine, and levetiracetam, significantly impairs driving performance. Epidemiological studies have not identified a definitive association between these drugs and traffic accidents. Initial administration of these five antiseizure medications may affect driving performance, warranting special attention, but the influence appears to diminish with continued use. Nevertheless, while long-term administration of these five drugs may not have a clinically meaningful effect on driving performance, safe driving is not guaranteed for each individual patient, and appropriate individualized guidance is important in clinical practice (35).

Lived experience of driving in individuals with functional neurological disorder

BACKGROUND: Functional neurological disorder (FND) is a common neurological diagnosis that encapsulates a range of incapacitating clinical presentations. These include functional seizures, movement disorders, and sensory disturbances. Safe driving requires both cognitive skills and physical abilities, which may be impacted by FND symptoms. The primary objective of this study was to gain deeper insights into the challenges faced by people with FND when driving. METHODS: A qualitative study and interpretative phenomenological analysis were conducted. Individuals experiencing functional seizures and/or movement disorders completed both questionnaires and semi-structured interviews about FND symptoms, driving behaviour, and crashes. RESULTS: A total of 26 patients with FND participated in this study. Based on the interviews, four key themes were identified: (1) driving difficulties experienced by individuals with FND; (2) strategies utilized by people with FND to overcome difficulties experienced while driving; (3) barriers preventing driving challenges being addressed in this population; and (4) crashes and perceived dangerous driving events experienced by individuals with FND. All participants reported that driving a car provoked FND symptoms and this affected their driving ability. FND sufferers reported using a number of strategies such as limiting how far they drive and relying on advanced driver assistance system features to help manage their associated symptoms, such as fatigue and/or pain. Several participants reported crashes and perceived dangerous driving events since developing FND. CONCLUSION: Individuals experiencing FND often employ self-regulation techniques, yet the extent to which these methods enhance driving safety remains uncertain. The variable nature of the disorder makes judging an individual's driving risk particularly difficult. The themes emerging from the interviews highlighted the need for further empirical research to inform guidelines and best practice when determining the impact of FND on an individual's driving safety (36).

A Delphi study of current practices and establishing consensus regarding assessment of fitness to drive among patients with brain tumours

PURPOSE: Evaluating fitness to drive among patients with brain tumours remains a challenge for clinicians. Due to difficulties in conducting prospective driving studies in this patient cohort, a Delphi study was performed to formulate new driving guidelines for patients with brain tumours. METHODS: The survey questions, which were designed by utilising Australian driving guidelines and previous Delphi studies, established panellists' expertise, and then

used a 9-point Likert scale to formulate new driving guidelines. An expert group of panellists comprising medical oncologists, radiation oncologists, neurosurgeons, and neurologists were chosen based on membership to professional societies with validation in part one of the survey. Two rounds of anonymised surveys were performed using REDCap for data entry, and a novel automated methodology on R for data analysis. RESULTS: 46 statements regarding fitness to drive were developed. Among the 37 surveys distributed, there were 26 responses (70.3% response rate) from round one, and 17 responses (65.4% response rate) for round two. Among the 46 statements, 19 (41.3%) achieved consensus. In addition to establishing a framework for assessing patients, there was notable consensus agreement for stable imaging required as part of evaluation and the need for continual reassessment. CONCLUSION: Despite clinicians being aware of driving guidelines, determining fitness to drive among patients with brain tumours remains a challenge. This Delphi study identified consensus agreement for the need for stable imaging, and continually reassessing fitness to drive. These novel findings could be translated into future driving guidelines and consensus statements can be integrated into clinical practice (37).

First-ever seizure and eligibility for commercial motor vehicle driving

BACKGROUND: After a first-ever seizure, 6 months of seizure freedom is usually required before returning to driving a private motor vehicle, after which the annual risk of seizure recurrence has fallen to ≤20%. Stricter criteria apply for commercial driver's licence (CDL) holders, and a longer period of seizure freedom sufficient for the annual risk of recurrence to be <2% is recommended. However, CDL guidelines are based on little data with few studies having long-term follow-up. METHODS: 1714 patients with first-ever seizures were prospectively studied. Seizure recurrence was evaluated using survival analysis. The annual conditional risk of seizure recurrence was calculated for patients with first-ever unprovoked and acute symptomatic seizures, and according to the presence or absence of clinical, electroencephalogram (EEG) and neuroimaging risk factors for recurrence. RESULTS: The annual risk of recurrence for unprovoked first seizures did not fall below 2% until after 9 years of seizure freedom. The annual risk after 5 years of seizure freedom was still 3.9% (95% CI 1.8% to 6.1%) including for those without epileptiform abnormalities on EEG and with normal imaging. For acute symptomatic first seizures, the annual recurrence risk was 4.5% (95% CI 2.3% to 6.7%) after 1 year and fell below 2% only after 4 years of seizure freedom. CONCLUSIONS: For unprovoked and acute symptomatic first-ever seizure and CDL, a higher-than-expected annual seizure risk persists beyond the currently recommended seizure-free periods, even in those without risk factors for recurrence. Our data can inform decisions regarding a return to driving for CDL holders after first-ever seizure (38).

Navigating the road ahead: Assessing international guidelines for commercial drivers with epileptic seizures

OBJECTIVES: To evaluate the availability and consistency of commercial driving eligibility criteria for patients with seizures. METHODS: We systematically evaluated commercial

driver's license regulations for patients with epilepsy, first acute symptomatic seizure and first unprovoked seizure in different countries. Government driving authority websites and published guidelines were accessed and if not available, local neurologists were contacted. RESULTS: Information on commercial driving eligibility was available for 112 countries: 85 (76 %) via government websites or published guidelines and 27 (24 %) via direct contact with local neurologists. For epilepsy, 85 countries had clear guidelines: 42 countries requiring a seizure-free period of between 5 and 10 years, 43 applying a lifetime ban. Twenty-seven responding countries had no guidelines. For first acute symptomatic seizure (information available for 101 countries), 33 countries either required an individualised assessment or specified a seizure-free period ranging between 6 months and 10 years, 38 had a lifetime ban and 30 had no guidelines. For first unprovoked seizure (information available for 103 countries) 35 countries required seizure freedom for 1 to 10 years, 38 enforced a lifetime ban and 30 had no guidelines. There was considerable variation in the requirements for MRI, EEG, treatment with anti-seizure medication, and/or neurologist input. CONCLUSIONS: A marked lack of uniformity in commercial vehicle license guidelines exists for patients with seizures, likely in part reflecting the paucity of long-term data to inform evidence-based policy (39).

Electroencephalographic compatibility with fitness to drive: A nationwide survey among Swiss neurologists

OBJECTIVE: The Swiss guidelines for driving with epilepsy require that electroencephalogram (EEG) findings must be compatible with the fitness to drive (FTD) without specifying any criteria. This nationwide survey investigated how Swiss neurologists implement this requirement in clinical practice. METHODS: An online survey, including 19 EEG examples and statements about the compatibility of the EEG with FTD, was distributed to all members of the Swiss Society of Clinical Neurophysiology and all Swiss neurological clinics with residency programs. Descriptive statistics and Fleiss' Kappa for inter-rater agreement were performed. RESULTS: 102 participants (37% female, 45% <45 years) completed the survey, with 15% primarily working in a specialized epileptology centre (EPI), 55% in a hospital setting without epileptological focus (HOS), and 30% in private practice (PP). Most participants of all three groups regarded EEG normal variants as compatible with FTD, while hyperventilation-induced rhythmic slowing and some pathological patterns (e.g., frontal and temporal intermittent rhythmic delta activity [FIRDA, TIRDA], focal interictal epileptiform discharges [IED], focal seizure) were evaluated more heterogeneously. The EEG inter-rater agreement for EPI was 0.4; 0.31 for PP; and 0.24 for HOS. No consensus was found for acceptable duration for generalized or focal IEDs. Among all participants, evaluation by an epilepsy centre (85%) and reaction-time testing (67%) were evaluated as the most useful additional examinations. However, reaction-time testing is rarely or never performed by 58%. Most supported EEG results as part of the FTD assessment and demanded more research (both 82%). SIGNIFICANCE: Our survey indicates considerable heterogeneity among Swiss neurologists when evaluating the EEG findings for FTD. Inter rater agreement in all three groups was fair, with highest agreement among epileptologists. We noted a discrepancy between the

usefulness and actual application of reaction-time testing. More training and research are warranted to achieve rater-independent consistency for FTD evaluation. PLAIN LANGUAGE SUMMARY: In Switzerland, neurologists must consider the findings from EEG (brain waves) exams to evaluate driving safety in people with epilepsy. We surveyed Swiss neurologists, asking their opinions on this matter. We found that opinions differ among individual doctors, with the highest agreement among epilepsy specialists. We also found that some additional tests, such as reaction-time testing, are perceived as useful but are rarely performed. The participating neurologists supported considering EEG results for driving fitness assessments but favoured more precise guidelines and research (40).

Characteristics of motor vehicle crashes and fatality risk among drivers with epilepsy

OBJECTIVE: Among motor vehicle crashes (MVCs), little is known about whether the characteristics and collision features involving drivers with epilepsy differ from those involving drivers without any history of epilepsy. We assessed MVC features and the effect of epilepsy diagnosis on the risk of severe crash-related injuries among drivers. METHODS: A total of 33 174 MVC events among people with epilepsy (PWE) and 663 480 MVC events of age- and sex-matched non-PWE (1:20) were selected. Crash-related features that involved drivers with and without epilepsy were compared, including driver eligibility, medical history of comorbidities and medications, road and environmental conditions, and accident causes. Cox and logistic regression analyses were used to examine the risks of fatality and severe injury among drivers with and without epilepsy. RESULTS: PWE involved in MVCs were more likely to have lower socioeconomic status, comorbidities, scooter drivers without a qualified driver's license, driving under the influence of alcohol, and be involved in single vehicle accidents than non-PWE. Drivers with epilepsy also had a higher risk of fatality within 30 days of MVC, with an adjusted hazard ratio (aHR) of 1.37 (95% confidence interval [CI], 1.20-1.57) and a higher risk of hospital admission within 3 days after MVC (aHR, 1.33; 95% CI, 1.29-1.38) compared to that of non-PWE. SIGNIFICANCE: The characteristics of MVCs of drivers with epilepsy were distinct from those of non-affected drivers. And higher fatality and injury rates were observed among drivers with epilepsy, which should be considered in further policymaking regarding safe driving of PWE (41).

First seizure while driving: Clinical features and prognosis

OBJECTIVES: Patients with epilepsy are ineligible to drive until seizure free for an appropriate period given the risk of a seizure-related motor vehicle accident. Driving restrictions also apply to patients after their first-ever seizure. However, it is unclear whether a longer period of non-driving is required if the first seizure occurred while driving. The association of a seizure with driving may have been by chance or due to a specific factor or trigger increasing the likelihood of a seizure. More data is required to inform driving restrictions. METHODS: This study was based on prospectively collected data of consecutive adults with a first-ever seizure seen at a hospital-based first seizure clinic between 2000 and 2015. We examined the clinical, EEG and imaging features of patients who were eligible to drive, comparing patients

with their first seizure while driving (FSWD) to those who had an awake first seizure at other times (FSOT) to explore possible differences clinical features and likelihood of seizure recurrence, evaluated using survival analysis. RESULTS: 57 patients with a FSWD were compared to 1335 patients with FSOT. 80 % of FSWD resulted in loss of control of the vehicle, 64 % with a crash and almost half of patients sustaining an injury. Fifty of 57 FSWD were related to an unprovoked first seizure. FSWD patients had a higher cumulative likelihood of having a second seizure than FSOT patients (50.1 % vs 36.2 % at 1 year, 57.9 % vs 41.7 % at 2 years and 65.1 % vs 47.8 % at 5 years; p = 0.003), with the conditional risk of seizure recurrence only falling consistently below 2.5 %/month at twelve months after the first seizure. Independent predictors of seizure recurrence on multivariable analysis were epileptogenic lesion on imaging, unprovoked (vs acute symptomatic) first seizure, epileptiform abnormality on EEG, focal seizure; and for those with unprovoked first seizure, FSWD and higher Rankin score were also predictors. CONCLUSIONS: First seizure whilst driving is an independent predictor of seizure recurrence for unprovoked seizures, supporting a longer period of seizure freedom before returning to driving (42).

Seizures, Driver Licensure, and Medical Reporting Update: An AAN Position Statement

This consensus position statement of the American Academy of Neurology, American Epilepsy Society, and Epilepsy Foundation of America updates prior 1994 and 2007 position statements on seizures, driver licensure, and medical reporting. Key consensus positions include the following: (1) in the United States, national driving standards promulgated through a system such as the Uniform Law Commission would reduce confusion and improve adherence with state driving standards; (2) state licensing criteria for medical conditions should be promulgated by regulations and guidelines based on enabling legislation rather than in statutes themselves and should be developed by medical advisory boards working in collaboration with departments of motor vehicles; (3) licensing criteria should be equitable, non-discriminatory, objective, and compatible with comparable risks in other populations; (4) a minimum seizure-free interval of 3 months should ordinarily be required before driving in all cases and should be extended in individual cases based on review of favourable and unfavourable features by medical advisory boards; (5) individuals with exclusively provoked seizures attributable to provoking factors that are unlikely to reoccur in the future may not require a seizure-free interval before resuming driving; (6) individuals with previously well-controlled epilepsy who experience seizures due to short-term interruptions of antiseizure medications in the setting of hospitalization or practitioner directed medication-titration may not require a seizure-free interval before driving once previously effective levels of antiseizure medications have been resumed; (7) patients and practitioners should pause driving during tapering and following discontinuation of an antiseizure medication if another such medication is not introduced; (8) individuals whose cognition or coordination is impaired due to medications used to prevent seizures should refrain from driving; (9) health care practitioners should be allowed but not mandated to report drivers who pose an elevated risk; but (10) neither a decision to report a patient suspected of being at elevated risk nor a

decision declining to report a patient suspected of being at elevated risk should be subject to legal liability; (11) nations, states, and municipalities should provide alternative methods of transportation and accommodations for individuals whose driving privileges are restricted due to medical conditions (43).

Characteristics of patients diagnosed with psychogenic non-epileptic seizures (PNES) who request reinstatement of their driving privileges

RATIONALE: Patients who experience seizures, including PNES, are usually advised to discontinue driving, or have their driving privileges revoked until a determined period of seizure-freedom is achieved. In this retrospective study, patients with PNES who requested driving privileges or reported having resumed driving were compared to those who did not on measures of depression, anxiety, PTSD, and cognitive flexibility/motor speed. METHODS: Diagnosis of PNES was confirmed with video-EEG. Demographic and clinical data and requests for reinstatement of driving privileges (requiring 6 or more months seizure freedom) and reports of decisions to resume driving were noted. Tests of motor speed and hand eye coordination and self-report questionnaires of depression, anxiety and PTSD administered as part of neuropsychological assessment were analysed. RESULTS: A total of 403 patients with PNES evaluated in 2010-2020 were identified. Of those, 365 patients were eligible for inclusion, and of those, 60 applied for driving privileges or reported that they resumed driving. When the two groups were compared, the group that applied for driving privileges or decided to resume driving was significantly less depressed ($p = 0.001$) when tested than the group that did not. Furthermore, a significant difference was seen in measures of motor performance between those who requested to resume driving and those who did not (DKEFS T1, $p = 0.006$, DKEFS T2, $p = 0.001$, DKEFS T3, $p = 0.002$, DKEFS T4, $p = 0.001$; GPT dominant, $p = 0.05$, GPT non-dominant, $p = 0.003$). CONCLUSION: Driving a motor vehicle is a useful measure of improvement for PNES because patients with seizures are required to discontinue driving until seizure-freedom is achieved. This study revealed that lower levels of depression and better fine motor functioning were associated with reported seizure-freedom and driving resumption. Depression is commonly associated with diminished performance (slower motor response times and impaired fine motor movements) on tests of motor functioning, both of which may result in less interest in pursuing permission to resume driving. These findings suggest that mood symptoms (and associated performance on measures of motor speed and coordination) may have prognostic significance in patients diagnosed with PNES. This also suggests that timely treatment of depression in newly diagnosed patients with PNES may be indicated (44).

2.2. Dementia

The Influence of Personality Traits on Driving Behaviours in Preclinical Alzheimer Disease

INTRODUCTION: Alzheimer disease (AD) has a long preclinical phase in which AD pathology is accumulating without detectable clinical symptoms. It is critical to identify participants in this

preclinical phase as early as possible since treatment plans may be more effective in this stage. Monitoring for changes in driving behaviour, as measured with GPS sensors, has been explored as a low-burden, easy-to-administer method for detecting AD risk. However, driving is a complex, multifaceted process that is likely influenced by other factors, including personality traits, that may change in preclinical AD. METHODS: We examine the moderating influence of neuroticism and conscientiousness on longitudinal changes in driving behaviour in a sample of 203 clinically normal older adults who are at varying risk of developing AD. RESULTS: Neuroticism moderated rates of change in the frequency of speeding as well as the number of trips taken at night. Conscientiousness moderated rates of change in typical driving space. CONCLUSIONS: Personality traits change in early AD and also influence driving behaviours. Studies that seek to utilize naturalistic driving behaviour to establish AD risk need to accommodate interpersonal differences, of which personality traits are one of many possible factors. Future studies should explicitly establish how much benefit is provided by including personality traits in predictive models of AD progression (45).

The Neuropsychological Assessment Battery Driving Scenes Test in a Dementia Clinic

OBJECTIVE: In dementia research, the Driving Scenes test from the Neuropsychological Assessment Battery has been shown to relate to memory, dementia diagnosis, and functional impairment. The aim of the current study was to examine Driving Scenes and its component scores, and their relationships with cognition and daily functioning, in a mixed dementia clinic sample. METHOD: One hundred U.S. military veterans between the ages of 55 and 88 were administered a full neuropsychological protocol that included Driving Scenes. RESULTS: The Driving Scenes score and its sub scores were strongly related to memory skills, and there were additional sub score associations with language and visuospatial functions. Driving Scenes uniquely predicted reported bill payment difficulties and tendency to get lost while driving, which were not predicted by other performances across cognitive domains. CONCLUSION: Driving Scenes is a clinically and functionally relevant measure of memory. Although the Driving Scenes total score remains useful in dementia evaluations, component scores and error scores contribute additional practical information (46).

Enhancing guidelines for managing cognitively impaired drivers: Insights from Western evidence for Asian adaptation

INTRODUCTION: The global incidence of dementia is increasing, and cognitively impaired drivers are at a higher risk of crashes compared to healthy drivers. Doctors face challenges in assessing these at-risk drivers, with questionable adherence to existing guidelines. This study aimed to review and compare guidelines for managing cognitively impaired drivers from various countries. METHOD: A scoping review was conducted to identify relevant guidelines, which were then descriptively compared with Singapore's guideline. RESULTS: Eleven guidelines from 8 countries: US (n=2), Canada (n=2), UK (n=2), Ireland, Belgium, Australia, New Zealand and Singapore were reviewed. All guidelines support driving assessments and conditional licensing in ordinary (i.e. non-professional) drivers with dementia. Canada stands

out for not allowing co-piloting and geographical restrictions in conditional licensing practice. Few guidelines provide indemnity for doctors reporting to licensing authorities, and communication about the impact of dementia on car insurance is rarely addressed. Most Western guidelines include evidence-based approaches, provisions for drivers with mild cognitive impairment and early discussions on transitioning from driving. A clinic-based functional screening toolbox and 2 clinical algorithms (1 with and 1 without the Clinical Dementia Rating scale) were identified as having universal applicability. Singapore's guideline, by comparison, is outdated and lacks both developmental rigour and guidance on managing mild cognitive impairment and transitioning drivers out of driving. CONCLUSION: Comprehensive, evidence-based guidelines from Western countries provide valuable resources that can help Singapore design or update its guideline (47).

Common driving behaviours in older adults with dementia: Insights from a systematic literature review

Dementia impairs driving skills, but the specific driving behaviours affected are not fully understood. This project reviewed the literature on driving behaviours more common among people with dementia compared to age-matched healthy controls. A search of Scopus, Medline All, and Embase databases (1994 to September 2024) identified relevant studies. Articles were included if they addressed driving behaviours among drivers with dementia during on-road tests, simulator experiments, or naturalistic driving, and included comparisons with non-dementia controls. Of 2359 citations, 26 studies were included: 3 used naturalistic driving, 14 driving simulators, and 9 used on-road tests. Drivers with dementia showed higher standard deviations of mean speeds, more traffic light tickets, greater out-of-lane drifting, and increased variability in mean headway distance compared to controls. Findings highlight distinct driving behaviour patterns among drivers with dementia. However, these results should be interpreted cautiously due to methodological limitations, including small samples, lack of confounding factors, and non-validated settings. HIGHLIGHTS: Drivers with dementia exhibit distinct driving patterns that consistently set them apart from cognitively intact drivers. Compared to age-matched controls, drivers with dementia are more likely to demonstrate greater variability in mean speeds, accumulate more traffic light violations, exhibit higher instances of lane drifting, and show increased variability in mean headway distance. Driving simulators, on-road tests, and naturalistic driving methods have been used to study driving in individuals with dementia, although most evidence comes from simulator studies, which may not fully reflect real-world driving conditions (48).

Driving with cognitive impairments: Results of the population-based Digital Dementia Registry Bavaria - digiDEM Bayern

BACKGROUND: In Germany, the number of drivers aged 65 and over is increasing. However, the risk of physical and cognitive impairments that affect the ability to drive rises with increasing age. Those who give up driving are often confronted with constraints of their autonomy and quality of life. The study aims to identify socio-demographic and health related

determinants of non-driving in people with mild cognitive impairment (MCI) or mild to moderate dementia. METHODS: The data basis is the baseline survey of the multicentre, prospective registry study "Digital Dementia Register Bavaria - digiDEM Bayern". The categorisation of people with MCI and people with mild to moderate dementia is based on the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). A diagnosis may exist but is not a requirement. In addition to descriptive analyses, a binary logistic regression was conducted, and average marginal effects (AMEs) were interpreted. RESULTS: Out of 1,005 participants with a valid driving license, 410 people (40.8%) participate in road traffic as drivers. The probability that people use a car increases with age, peaking at around 70 years and then decreasing. Being female, living in an urban environment, and having a care degree are associated with a lower probability of driving a car, whilst no existing MCI or dementia diagnosis, higher cognitive abilities, and better independence in everyday life (ADLs) are associated with a higher probability. CONCLUSION: The decision to continue driving a car depends on several factors, including age, sex, place of residence, and cognitive and physical abilities. Regular assessments of the fitness to drive should take place, and alternative mobility options should be offered to ensure road safety and maintain the quality of life of people with cognitive impairments for as long as possible. The professional and private environment of people with cognitive impairments plays a crucial role in dealing appropriately with these issues (49).

Australian occupational therapists' perspectives about the management of driving safety concerns for older people with dementia and mild cognitive impairment

INTRODUCTION: Driving safety may be compromised in people with dementia or mild cognitive impairment (MCI). Occupational therapists assess and screen for driving safety in older people with cognitive impairment. However, little is known about their perspectives relating to these assessments. Aims included to (1) obtain perspectives from driver-trained and non-driver-trained occupational therapists about the management of driving safety concerns for older people with dementia and MCI; (2) understand factors influencing clinician's behaviour relating to driving assessment; and (3) gain perspectives regarding resources to support fitness-to-drive assessment. METHODS: Semi-structured interviews were conducted with occupational therapists recruited from driving assessment services, hospitals, and community settings in Australia. Data were analysed inductively using content analysis, followed by a deductive approach with two authors mapping subcategories to the domains of the Theoretical Domains Framework and Capability, Opportunity and Motivation-Behaviour model. CONSUMER AND COMMUNITY INVOLVEMENT: No consumers were involved in the design or study analysis. FINDINGS: Participants (n = 17) reported inconsistencies in how the fitness-to-drive assessment is managed, with driving safety concerns often missed or avoided. Perceived barriers to fitness-to-drive assessment included: (i) clinician's capabilities: limited knowledge about fitness-to-drive assessment, and difficulties having complex discussions with patients with cognitive impairment; (ii) motivational factors: lack of confidence, fear of damaging therapeutic relationship with

patients, and desire to maintain a sense of professional identity; and (iii) environmental factors: lack of processes to support health professionals with identifying cognitive concerns, lack of clarity of who takes responsibility for managing driving safety concerns, time constraints for completing in-office assessments and limited access to practical occupational therapy driving assessments. Participants expressed a desire for an evidence-based clinical pathway to improve the knowledge and communication skills of clinicians from non-driving specialist settings. CONCLUSION: Findings identify the need for an evidence-based pathway to support health professionals in managing driving safety concerns for people with dementia and MCI. PLAIN LANGUAGE SUMMARY: Dementia and mild cognitive impairment (MCI) are brain conditions involving difficulty with memory and thinking, with dementia diagnosed when the changes are more severe. These conditions are not a normal part of getting older, but they are much more common in older people. Research has found that some, but not all, people with dementia and MCI show unsafe driving behaviours. As people with dementia and MCI are often unaware that their driving is unsafe, health professionals, such as doctors and occupational therapists, should be involved in deciding if, or when, they should stop driving. In this study, occupational therapists were asked to provide their opinions about how driving safety concerns for older people with dementia and MCI are managed by health professionals. Occupational therapists reported that there is variation in how concerns are managed, with driving problems often getting missed or avoided. They reported that this can happen because health professionals may not feel confident in their decision-making abilities, or they may feel that discussing driving concerns will cause the person to get upset or angry with them. They also reported that health professionals may not always know that a person has dementia or MCI, and if they do know, it is not always clear which health professional should take on the responsibility of considering the person's driving safety. The occupational therapists wanted a resource to support health professionals in providing more consistent care for patients relating to driving safety (50).

Mild cognitive impairment, Alzheimer's disease dementia, and predictors of driving cessation: A 7- year longitudinal prospective study

Background: Patients with dementia face driving difficulties and, at some point, cease driving. Objective: We sought to identify predictors of driving cessation among patients with mild cognitive impairment (MCI) or mild Alzheimer's disease dementia (AD). Methods: We enrolled in this longitudinal study patients with MCI, AD (Clinical Dementia Rating < 2) and cognitively normal (NC) individuals. At baseline evaluation, participants underwent a neurological, neuropsychological and driving simulator assessment. Re-evaluations after 48 and 84 months included a structured interview with the patients and their caregiver. Primary endpoints were driving cessation, death and progression to dementia.Results109 individuals were included (32 NC, mean age 65.8 years/47 MCI, mean age 69.1 years/30 AD, mean age 72.8 years). Dangerous driving events during follow-up were referred for 45% and 59% of MCI and AD patients, respectively. 18 MCI (38%, mean time to cease 35 months) and 25 AD (83%, mean time to cease 15 months) patients ceased driving during follow-up. 36% of MCI patients

progressed to dementia during follow-up. Cox Regression multivariate analysis revealed age (Hazard Ratio-HR 1.080), semantic verbal fluency-SVF (HR 0.822) and Tandem Walking Test modified with simultaneous reverse number counting-mTWT (HR 1.099) as significant predictors of driving cessation. Simulator accident probability reached statistical significance only in the univariate model (HR 1.040). Conclusions: Age, SVF and mTWT are significant predictors of driving cessation among MCI and AD patients. Driving simulator may be a promising component of driving evaluation. Large-scale studies are prerequisite for the implementation of a multi-disciplinary driving fitness evaluation protocol (51).

Alzheimer's disease mortality among taxi and ambulance drivers: population based cross sectional study

OBJECTIVE: To analyse mortality attributed to Alzheimer's disease among taxi drivers and ambulance drivers, occupations that demand frequent spatial and navigational processing, compared with other occupations. DESIGN: Population based cross-sectional study. SETTING: Use of death certificates from the National Vital Statistics System in the United States, which were linked to occupation, 1 January 2020-31 December 2022. PARTICIPANTS: Deceased adults aged 18 years and older. MAIN OUTCOMES MEASURES: Among 443 occupations studied, percentage of deaths attributed to Alzheimer’s disease for taxi drivers and ambulance drivers and each of the remaining 441 occupations, adjusting for age at death and other sociodemographic factors. RESULTS: Of 8 972 221 people who had died with occupational information, 3.88% (348 328) had Alzheimer's disease listed as a cause of death. Among taxi drivers, 1.03% (171/16 658) died from Alzheimer’s disease, while among ambulance drivers, the rate was 0.74% (10/1348). After adjustment, ambulance drivers (0.91% (95% confidence interval 0.35% to 1.48%)) and taxi drivers (1.03% (0.87% to 1.18%)) had the lowest proportion of deaths due to Alzheimer's disease of all occupations examined. This trend was not observed in other transportation related jobs that are less reliant on real time spatial and navigational processing or for other types of dementia. Results were consistent whether Alzheimer's disease was recorded as an underlying or contributing cause of death. CONCLUSIONS: Taxi drivers and ambulance drivers, occupations involving frequent navigational and spatial processing, had the lowest proportions of deaths attributed to Alzheimer's disease of all occupations (52).

2.3. Parkinsons

A Randomized Controlled Trial on Automated Vehicle Technologies for Drivers with Parkinson's Disease

A randomized controlled trial study of self-driving in-vehicle technologies on driver fitness for people with Parkinson’s disease. This study investigated the effects of in-vehicle information systems (IVIS) and advanced driver-assistance systems (ADAS) on the driver fitness of individuals with Parkinson’s disease (PD). Notably, 107 drivers with PD drove a vehicle equipped with IVIS and ADAS. The results showed that activating these systems led to fewer

speeding errors on the highway. The study identified correlations between bradykinesia, executive function, visuospatial ability, and increased errors with deactivated systems, where memory impairments correlated with increased driving errors during system activation. Although IVIS and ADAS had a positive overall effect, challenges related to memory decline existed when these technologies were in use (53).

Exploring the Impact of Parkinson's Disease on Driving: A Population-Based Survey
BACKGROUND: Persons with Parkinson's disease (PD) experience progressive motor and non-motor symptoms which may influence their ability to drive a car. This is experienced as a massive challenge by many affected individuals, for whom being able to drive a car is vital to maintain functional independence. OBJECTIVES: We assessed how the diagnosis of PD affected the possession of a driving license, how people with PD had adapted their driving style, and to what extent they had communicated about their driving ability with their healthcare professionals. We also evaluated their knowledge on insurance- and Driver and Vehicle Licensing Agency (DVLA)-related implications. METHOD: A cross-sectional 10- item survey was completed by 540 participants of a population-based cohort of persons with PD in the Netherlands (PRIME-NL study). RESULTS: Participants had a mean age of 70 years and disease duration of 7.3 years. 84% possessed a valid driving license. Of those who gave up their license, this was done mostly (78%) on a voluntarily basis. Forty percent of those with a driving license adjusted their driving style. Over 50% of respondents had not discussed the impact of PD on their driving ability with their healthcare professionals. Although not compulsory by Dutch law, 52% of the respondents had informed the DVLA about their diagnosis. CONCLUSION: This study highlights the need for information and support from healthcare professionals to proactively address driving in their clinical practice. This will help persons with PD in their efforts to maintain their driving license for as long as possible (54).

2.4. Acquired Brain Injury

Changes in lifespace and participation in community-based occupations of people with acquired brain injury: A mixed methods exploration 6 months following occupational therapy driving assessment
INTRODUCTION: Changes arising from acquired brain injury may influence how individuals engage in valued community-based occupations such as driving. 'Lifespace' describes the area within which a person lives their life and represents opportunity for participation in out-of-home occupations. This study explored lifespace trajectory from pre to 6 months post-occupational therapy driver assessment, to understand how, why, where, and with whom access and participation in community-based occupations is influenced by assessment outcome. METHODS: Adults with acquired brain injury referred for occupational therapy driver assessment were recruited to the mixed methods study involving a travel diary, lifespace assessment, and semi-structured interviews. Qualitative analysis was guided by interpretive description. CONSUMER AND COMMUNITY INVOLVEMENT: No consumer and

community involvement RESULTS: Overall, 38 participants (55.3% male) aged 26 to 65 years reported increased lifespace 6 months following the conduct of an occupational therapy driver assessment. There was increased engagement in leisure pursuits (175%), work (23%), and social participation (21%) with reduced participation in health management (- 50%) and instrumental activities of daily living (-15.4%) occupations post-OTDA. However, lifespace was significantly related to driver status, with those who had returned to driving more likely to access their community with greater frequency and less support ($p < 0.001$). Non-drivers experienced a deteriorating restricted lifespace. Analysis of semi-structured interviews ($n = 12$) created three broad themes that largely differed according to driver status: (i) 'Being me'-reconstructing occupational identity, (ii) opportunities for participation and the influence of choice, and (iii) 'Having connection' and impacts on wellbeing. CONCLUSION: Driver status influences the trajectory of lifespace following participation in an occupational therapy driver assessment after acquired brain injury. Drivers experienced increased lifespace with greater opportunities to control engagement in community-based occupations with flexibility and spontaneity. Non-drivers reported diminished lifespace and occupational participation trajectories and require further support to facilitate occupational adaptation to increase opportunities for engagement in away-from-home occupations. PLAIN LANGUAGE SUMMARY: After an acquired brain injury (ABI), many people find it harder to go out and do activities away from home. A common change is losing the ability to drive. An occupational therapy driver assessment (OTDA) checks if someone is ready to drive again. This study looked at how getting back to driving, or not, affected involvement in community activities. People who returned to driving reported doing more activities, more often, and with less help. They spent more time on leisure, work, and social activities. Those who did not drive went out less, visited fewer places, and relied more on others. When they did go out, it was mostly for essential tasks like shopping and health appointments. For those not able to drive, extra services and supports are needed to help build skills. This is the first study to look at how driving is connected to taking part in community activities after a brain injury. More research is needed to confirm findings (55).

On-road driving remediation following acquired brain injury: a randomized controlled trial
OBJECTIVE: To investigate the relationship between on-road driving remediation and achieving fitness to drive following acquired brain injury. DESIGN: Randomized controlled trial. SETTING: Tertiary hospital outpatient driver assessment and rehabilitation service, Australia. PARTICIPANTS: Thirty-five participants (54.3% male), aged 18-65 years, 41 days-20 years post-acquired brain injury (including stroke, aneurysm, traumatic brain injury) recommended for on-road driving remediation following occupational therapy driver assessment were randomly assigned to intervention ($n = 18$) and waitlist control ($n = 17$) groups. INTERVENTION: Intervention group received on-road driving remediation delivered by a qualified driving instructor in a dual-control vehicle. The waitlist control group completed a 6 week period of no driving-related remediation. MAIN MEASURE: Fitness to drive rated following the conduct of an on-road occupational therapy driver assessment with

a qualified driving instructor where outcome assessors were blinded to group allocation. RESULTS: The intervention group were significantly more likely to achieve a fit to drive recommendation than no driving specific intervention (p = 0.003). CONCLUSION: Following comprehensive assessment, individualized on-road driving remediation programs devised by an occupational therapist with advanced training in driver assessment and rehabilitation and delivered by a qualified driving instructor are significantly associated with achieving fitness to drive after acquired brain injury (56).

Neuropsychology's Role in Assessment of Medical Decision-Making Capacity, Home Safety, and Driving Ability

Individuals with neurologic illness/injury often experience changes in their daily functioning. Clinical providers caring for these individuals are frequently called upon for input as patients and their families navigate challenging decisions to ensure safety. This article reviews 3 areas in which recommendations from clinicians are often requested: medical decision-making, home safety, and driving. Strategies for making recommendations in these areas is offered including discussion of how neuropsychology evaluations can provide useful information to aid in making recommendations (57).

Driving after Concussion: Symptom Clusters and Neurocognition Uniquely Relate to Post-concussion Driving Performance

PURPOSE: This study aimed to identify clinical concussion assessment outcomes that uniquely capture simulated driving performance among acutely concussed individuals, relative to controls. METHODS: Cross-sectional design. Twenty-eight college students within 72 hours of concussion and 46 non-concussed controls participated in the study. We collected the following clinical concussion assessment outcomes: four concussion symptom clusters, seven computerized neurocognitive domain scores, Standardized Assessment of Concussion total score, Balance Error Scoring System total score, and tandem gait completion time. The following simulated driving outcomes were included (count): total collisions, speed exceedances, centreline crossings, and road edge excursions. We used separate generalized linear mixed regression models fit using a Poisson distribution with group, assessment, and interaction effects. RESULTS: Higher migrainous symptoms (P < 0.001), cognitive-fatigue symptoms (P = 0.041), poorer visual memory (P = 0.015), and slower reaction time (P = 0.023) in concussion group were associated with higher risk of committing speed exceedances, relative to controls. Conversely, better performance on the continuous performance test (P = 0.046) and Standardized Assessment of Concussion (P = 0.045) in concussion group was associated with higher risk of committing speed exceedances relative to controls. Poorer performance on psychomotor speed (P = 0.001), reaction time (P = 0.031), cognitive flexibility (P = 0.004), and executive function (P = 0.003) was associated with higher risk of committing centreline crossings in concussion group, relative to controls. Conversely, better performance on the continuous performance test (P = 0.035) and higher affective symptoms (P = 0.013) were associated with higher risk of committing centreline crossings and road edge excursions,

respectively, relative to controls. CONCLUSIONS: Our results highlight key symptom clusters and computerized neurocognitive outcomes that uniquely inform poorer simulated driving performance in acutely concussed individuals. Symptom clusters and computerized neurocognitive function might be helpful when discussing with patients about return to driving decisions post-concussion (58).

Return to Driving Following Moderate-to-Severe Traumatic Brain Injury: A TBI Model System Longitudinal Investigation

OBJECTIVE: To examine longitudinal patterns of return to driving (RTD), driving habits, and crash rates associated with moderate-to-severe traumatic brain injury (TBI). SETTING: Eight TBI Model System sites. PARTICIPANTS: Adults (N = 334) with TBI that required inpatient acute rehabilitation with follow-up of 197 and 218 at 1 and 2 years post-injury, respectively. Data collection at 2 years occurred almost exclusively during the pandemic, which may have affected results. DESIGN: Longitudinal and observational. MAIN MEASURES: Driving survey completed during rehabilitation and at phone follow-up 1 and 2 years after injury. RESULTS: The rate of RTD was 65% at 1-year follow-up and 70% at 2- year follow-up. RTD at both follow-up time points was positively associated with family income. The frequency of driving and distance driven were diminished compared to before injury. Limitation of challenging driving situations (heavy traffic, bad weather, and at night) was reported at higher rates post-injury than before injury. Crash rates were 14.9% in the year prior to injury (excluding crashes that resulted in TBI), 9.9% in the first-year post-injury, and 6% during the second year. CONCLUSION: RTD is common after TBI, although driving may be limited in terms of frequency, distance driven, and avoiding challenging situations compared to before injury. Incidence of crashes is higher than population-based statistics; however, those who sustain TBI may be at higher risk even prior to injury. Future work is needed to better identify characteristics that influence the likelihood of crashes post-TBI (59).

2.5. Rehabilitation

Determinants of successful driving rehabilitation training in licensed individuals with disabilities

Previous studies have provided that self-driving can enhance the mobility of people with disabilities and their quality of life. The National Rehabilitation Centre has been providing driving rehabilitation education for people with disabilities since 1994, as part of a welfare service project aimed at guaranteeing their right to free movement. However, there is no analysis of the status and results of driving rehabilitation education and evaluations in South Korea, and research on these programs is lacking. This study aims to analyse the on-road driving rehabilitation education and evaluation results conducted by the National Rehabilitation Centre from 2019 to 2021. It seeks to identify the characteristics of the prior license holders with disabilities and the factors influencing the need for additional driving rehabilitation education. Out of a total of 676 prior license holders, 532 were included in the

analysis regarding the need for additional driving rehabilitation education. The results of this study indicate that women were 2.07 times more likely than men to require additional driving rehabilitation education. Conversely, the likelihood of requiring additional driving rehabilitation education was lower for those with better driving senses (0.17 times), less tension (0.46 times), and less impact from their disability (0.45 times). For prior license holders, it was found that demographic characteristics (excluding gender) or the nature of their disabilities had less significant impacts compared to the driver's response level, the type of driving license held, and the number of assistive devices used. These findings can be used for developing effective driving education programs for people with disabilities and designing strategies to enhance license acquisition rates, thereby improving their mobility rights (60).

2.6. Spinal cord injury

Outdoor mobility and driving among persons living with spinal cord injury in Sweden: a cross-sectional study

INTRODUCTION: Persons living with spinal cord injury (SCI) often lacks access to outdoor mobility, which can significantly impact their ability to participate in activities outside the home, to take part in their community, and to have meaningful occupations and relationships with loved ones. PURPOSE: To better understand the importance of outdoor mobility for persons with SCI, the aim of this cross-sectional study was to explore transport modes, car adaptations, and their perceived function and safety. METHOD: A web-survey, addressing outdoor mobility and driving, was distributed among people with different physical impairments. Of 274 responses, a total of 93 reported living with SCI and were selected for this study. RESULTS: Public transportation was often underutilized due to inaccessibility and distance. In total, 88 persons (95%) owned a car. Almost everyone used their car weekly (97%) and the annual average driving distance was 17,400 km (SD 22,820 km). Most of the car owners had a station wagon (63%) or van/minibus (27%) and larger vehicles were more common among those needing extensive adaptations ($p = 0.014$). DISCUSSION: The results corroborate earlier findings on public transport for persons living with SCI and the importance of their having a suitably modified vehicle. The results also offer insights into outdoor mobility and car driving among persons with SCI in Sweden that can support accessibility planning and promote innovations in transport options. Persons living with SCI and other physical impairments could benefit from a comprehensive, national-level knowledge base that encompasses outdoor mobility and car adaptations and their implications for these populations. Accessible environments and transportation significantly enhance mobility, occupational opportunities, leisure activities, self-esteem, and autonomy for persons with physical impairments. Outdoor mobility and driving must be prioritized in rehabilitation centres. There is a need for re-learning driving and sufficient training with adaptive equipment. Adaptive driving equipment and vehicle modifications are essential for persons with physical impairments, but the high costs require financial support throughout life to not diminish community engagement. Further studies and efforts are needed to explore safe

driving, new technologies, and accessibility challenges for persons with physical impairments, ensuring equitable transportation (61).

3. Substance Abuse Disorders

Detection of ketamine in the oral fluid of drivers in northeastern France during the years 2020-2023

BACKGROUND AND OBJECTIVES: Ketamine is a psychoactive substance used for its stimulant and hallucinogenic properties. As the use of ketamine may lead to impaired driving, we aimed to assess the occurrence of ketamine in the driving population tested positive for narcotics in roadside checks using oral fluid analysis. Oral fluid concentrations of ketamine and norketamine were examined to determine the percentage of drivers susceptible to ketamine impairment. METHODS: A retrospective descriptive study was conducted over a 32-month period in 2020-2023 on drivers who tested positive to the DrugWipe®5S saliva test in our region of northeastern France. Mass spectrometry was used to confirm the DrugWipe®5S result and to determine oral fluid concentrations of ketamine and norketamine. RESULTS: During the entire study period, 3364 drivers were tested positive at the roadside using the DrugWipe®5S rapid test. After mass spectrometry, 3043 drivers were finally confirmed as true positives. Ketamine was detected in 88 drivers who were 80.7% male, 95.4% polydrug users and were 27.5 ± 7.1 years old, representing 2.6% of the total driver population. Ketamine concentrations were 821 ± 2264 and 7.8 ± 12.3 ng/mL in the presence and absence of norketamine, respectively. Finally, 26.1% of the ketamine-positive drivers had a ketamine oral fluid concentration potentially associated with impaired driving. CONCLUSION: Ketamine and norketamine should be added to the list of drugs to be tested in oral fluid for driving under the influence of drugs. Besides blood or urine, oral fluid could be an interesting alternative biological matrix for addiction medicine (62).

Association of driving with blood delta-9-tetrahydrocannabinol: a systematic review

IMPORTANCE: Driving under the influence of cannabis increases the risk of motor vehicle collisions. In some jurisdictions, deterrence rests on the ability to detect delta-9-tetrahydrocannabinol (THC) in blood. Recent evidence suggests that there may be a nuanced relationship of blood THC to driving. OBJECTIVE: The purpose of this systematic review was to summarize all published papers investigating the presence of a linear relationship between blood THC and driving, primarily measured by simulated driving in the lab. OUTCOMES: The main outcomes assessed included "weaving"/lateral control (e.g., standard deviation of lateral position), speed, car following (following distance; coherence), reaction time, and overall driving performance. RESULTS: Of the 4845 records from the literature search, only 12 met the inclusion criteria. Ten of these reported no significant linear correlations between blood THC and measures of driving (8 out of 9 for "weaving"/lateral control, 4 out of 5 for speed, 2 of 3 for car following tasks (coherence/headway maintenance task), 1/1 for reaction time, 3/3 for overall driving performance). The studies that did find an association between driving and blood THC employed complex driving situations. CONCLUSIONS: This synthesis has important implications for road safety given driving situations can be complex due to challenging road situations and increases in potency of cannabis over the past years. Current

methods of detection of impairment may be suited to some types of situations but more large-scale studies on the relationship of blood THC and driving are needed that systematically vary driving complexity and cannabis potency (63).

Toxicology findings from drivers suspected of drug-impaired driving in Ontario (2008-2019)
OBJECTIVE: This study examines the results of toxicological tests performed on blood and urine samples collected from suspected drug-impaired drivers in Ontario from 2008 to 2019. The report examines the results of toxicological analysis of the samples submitted, the characteristics of those drivers from whom samples were collected, and the temporal and situational circumstances that led to police investigations and sample collection to better understand drug-impaired driving behaviour and to assist in the development and implementation of countermeasure strategies and programs. METHODS: Blood and urine samples were sent to the Centre of Forensic Sciences where they were analysed using standardized comprehensive toxicological analysis to test for a wide variety of potentially impairing drugs. Demographic and temporal information for each case from which a sample was collected were also examined to describe the circumstances and characteristics of these driving incidents. RESULTS: During the 12-year period examined, 5,388 samples collected from suspected drug-impaired drivers were analysed. The number of samples collected increased substantially following the implementation of the Drug Evaluation and Classification Program (DECP) in July 2008, the enactment of legislation facilitating the collection of blood samples from suspects, and the legalization of cannabis for nonmedical purposes in 2018. The number of samples submitted shows temporal correlation with the number of police officers certified as Drug Recognition Experts (DRE) in the province. Over the 12-year period of this study, cannabis was the most frequently detected substance in drivers (52.8% of cases), followed by cocaine (44.3%) and methamphetamine (24.8%). In 80% of cases, more than one substance was detected. CONCLUSIONS: Examining the characteristics of suspected drug-impaired drivers, the temporal circumstances, and the drug findings throughout the large geographic area of Ontario and over the extended period of this study enhances our understanding of drug-impaired driving behaviour. These characteristics can assist in the development and/or evaluation of enforcement strategies and enhanced countermeasure activities (64).

Bromazolam in impaired driving investigations
The designer benzodiazepine bromazolam is increasingly encountered in forensic casework, including impaired driving investigations. A series of suspected impaired driving cases that tested positive for bromazolam are described herein along with information about driving performance, driver appearance, and observed behaviour. Bromazolam was indicated in casework either through screening by liquid chromatography-time of flight mass spectrometry (LC-TOF-MS) and/or a positive benzodiazepine immunoassay screen. Blood samples were forwarded for quantitative confirmatory analysis using a liquid chromatography-tandem mass spectrometry (LC-MS-MS) method with a reporting limit of

2.0 ng/mL Bromazolam was reported in 98 impaired driving cases from samples reported between January 2021 and December 2023, with the earliest detection from September 2020. Mean and median blood concentrations were 125 ± 145 and 84 ng/mL respectively, with a range of 4.2-990 ng/mL. Additional positive findings were reported in almost all cases, with the highest result (990 ng/mL) being the only case in which bromazolam was the only finding. Fentanyl was the most frequent drug found in combination with bromazolam. Driving behaviours reported in these cases included erratic driving, errors in Standardized Field Sobriety Tests, and symptoms consistent with central nervous system depressants, including slurred speech, incoordination, and lethargic behaviour. Based on its prevalence and demonstrated impairing effects, bromazolam should be included in the scope of impaired driving testing as long as it continues to be prevalent in the drug supply (65).

Assessing the impact of cannabis use on freeway driving performance and practices: A comparative analysis with placebo and alcohol-influenced driving

OBJECTIVE: The objectives of this study were 1) to identify the effects cannabis has on driving performance and individual motor practices when on the freeway compared to placebo and 2) to bring context to the effects of cannabis on driving by comparing effect sizes to those of alcohol. METHODS: Data for analysis was collected from a study of fifty-three participants with a history of tetrahydrocannabinol (THC) cannabis use who completed three visits in randomized order (placebo (0% THC), 6.18% THC, and 10.5% THC). Data for the alcohol analysis was from a subset of eighteen of these participants with a history of recent alcohol use that completed a fourth alcohol visit that targeted a .05 g/210L breath alcohol content (BrAC) during the drive. Comparisons were made using an analysis of variance approach with the SAS General Linear Models Procedure. Cohen's d effect sizes were calculated for the cannabis and alcohol conditions relative to placebo for both the full sample and alcohol subset. RESULTS: Standard deviation of lane position (SDLP) for cannabis significantly increased compared to placebo and the effect size was comparable to that of alcohol at .05 BrAC. Lane departures for cannabis significantly increased relative to placebo as did the time out of the lane. Cannabis use resulted in an increased amount of time at 10% or more below the speed limit for the 6.18% THC condition. Relative to alcohol, cannabis produced more time at slower speeds and less time at speeds more than 10% above the speed limit. CONCLUSIONS: Multiple factors of lateral and longitudinal vehicle control on the freeway showed statistical significance. Drivers under the influence of cannabis exhibited higher rates of driving errors but also showed more cautious behaviours such as generally lower speeds on the freeway. Compared with alcohol, effect sizes varied. For longitudinal control, there were larger effect sizes for alcohol with speed effects in opposite directions, but relatively equivalent effect sizes for lateral control and driving errors associated with lane keeping (66).

Prevalence of Impairing Substance Use in Injured Drivers

IMPORTANCE: Impaired driving is an important public health issue, but its prevalence is challenging to monitor. OBJECTIVES: To report the prevalence of alcohol, cannabis,

recreational drugs, and sedating medications in injured Canadian drivers, identify demographic and collision factors associated with drug or alcohol use, and compare the prevalence of drug-involved driving in different parts of Canada. DESIGN, SETTING, AND PARTICIPANTS: This cross-sectional study prospectively obtained blood samples from injured drivers treated in 15 Canadian trauma centres and measured blood levels of tetrahydrocannabinol (THC; the main impairing compound in cannabis), alcohol, stimulants, opioids, and depressants from January 2019 to June 2023. Data were analysed from April to May 2024. EXPOSURE: Blood levels of THC, alcohol, stimulants, opioids, and depressants. MAIN OUTCOMES AND MEASURES: Demographic and collision details were extracted from medical records. The crude prevalence for each substance class among all injured drivers and in selected subgroups was computed. Logistic regression models identified factors associated with substance use. RESULTS: Of 8328 injured drivers (mean [SD] age, 43 [18] years; median [IQR] age, 40 [28-57] years; 5605 male [67.3%]; 2723 female [32.7%]), 4568 (54.9%) tested positive for an impairing substance and 1798 (21.6%) tested positive for 2 or more substance classes. Depressants, as a class, were detected in 2368 drivers (28.4%). THC was the most commonly detected single substance (1354 drivers [16.3%]), followed by alcohol (1341 drivers [16.1%]). Stimulants (1057 drivers [12.7%]) and opioids (905 drivers [10.9%]) were also detected. Substances were detected less often in drivers aged 75 years or older (195 of 455 drivers [42.9%]) and younger than 19 years (149 of 304 drivers [49.0%]). THC was most common in drivers aged 19 to 24 years, alcohol in drivers aged 19 to 34 years, stimulants in drivers aged 35 to 44 years, opioids in drivers aged 55 to 64 years, and depressants in drivers aged 65 to 74 years. Males had similar prevalence of substance use as females (3141 males [56.0%] vs 1427 females [52.4%]); more males used alcohol (adjusted odds ratio [aOR], 1.53; 95% CI, 1.21-1.92), cannabis (aOR, 1.66; 95% CI, 1.48-1.86), and stimulants (aOR, 1.53; 95% CI, 1.34-1.75), but males were less likely to have used a depressant (aOR, 0.54; 95% CI, 0.47-0.62). Rural drivers were more likely to use alcohol (aOR, 1.51; 95% CI, 1.29-1.76), stimulants (aOR, 1.32; 95 CI, 1.03-1.70), depressants (aOR, 1.28; 95% CI, 1.09-1.51), opioids (aOR, 1.26; 95% CI, 1.08-1.47), any substance (aOR, 1.40; 95% CI, 1.20-1.63), or multiple classes of substances (aOR, 1.55; 95 CI, 1.23-1.95). There was substantial geographic variation in the prevalence of substance use in injured drivers. CONCLUSIONS AND RELEVANCE: These findings suggest that impaired driving is a substantial road safety concern in Canada. Continued monitoring is required to develop targeted interventions and to evaluate the effectiveness of prevention measures (67).

Four-year evaluation of drug-impaired driving drug concentrations

Drug-impaired driving is a significant public health and safety concern in the USA. To help assess current patterns of drug use in drivers, we evaluated 4 years of drug positivity in a large cohort of suspected impaired drivers. Samples collected between January 2017 and December 2020 were tested via a method compliant with the National Safety Council's Alcohol, Drugs, and Impairment Division's Tier I scope of recommended drugs. In 2017, NMS Labs received 17 346 driving under the influence of drugs cases, 17 471 in 2018, 19 050 in

2019, and 16 539 in 2020. The most common drug class detected was cannabinoids in ∼50% of the cases each year. The most common drugs detected over the 4 years were delta-9 tetrahydrocannabinol (delta-9 THC), ethanol, amphetamine/methamphetamine, fentanyl, and alprazolam. Delta-9 THC increased in positivity over the study, having been identified in 45% of cases in 2017, 46% in 2018, 46% in 2019, and 49% in 2020. Ethanol was found in 59% of cases in 2017, 59% in 2018, 61% in 2019, and 53% in 2020. Delta-9 THC and ethanol were the most common drug combination, found together in ∼19% of the cases every year of the study. Statistically significant increases in the average concentration of the following drugs were observed: fentanyl (5.7 ng/mL in 2017 to 9.6 ng/mL in 2020), methamphetamine (301 ng/mL in 2017 to 381 ng/mL in 2020), and delta-9-THC (6.4 ng/mL in 2017 to 7.3 ng/mL in 2020). Other findings included increases in the maximum reported concentrations between 2017 and 2020 for amphetamine (1400 to 2700 ng/mL), methamphetamine (5550 to 13 000 ng/mL), and fentanyl (56 to 310 ng/mL). Statistically significant concentration decreases were noted for several central nervous system depressants, notably prescription benzodiazepines, and several prescription narcotic analgesics (68).

"Stoned on the road": A systematic review of cannabis-impaired driving educational initiatives targeting young drivers in Canada

BACKGROUND: With recreational cannabis legalized across Canada, concerns persist about youth driving under the influence of cannabis (DUIC). However, the extent of DUIC education and prevention efforts aimed at young Canadians remains unclear. This systematic review examines recent Canadian initiatives (2017 onwards) focused on reducing DUIC among youth. Specifically, we investigate (1) the types of initiatives and target audiences, (2) content and delivery methods, (3) sustainability, and (4) evidence of impact. METHODS: A comprehensive search was conducted across MEDLINE, PsycINFO, CINAHL, SCOPUS, and EMBASE (January 1, 2017-July 10, 2023), along with various grey literature sources. Initiatives were included if they targeted DUIC behaviour among youth aged 16 to 24, were developed and delivered in Canada by reputable organizations or individuals with institutional support, and aimed to address DUIC behaviour or its enabling conditions. Data extraction and quality appraisal were performed. RESULTS: Fifteen Canadian initiatives were identified: seven educational programs and eight awareness campaigns, encompassing national and regional levels. Delivery methods included in-person workshops, digital tools, online programs, and smartphone applications. While some initiatives increased awareness and influenced perceptions of DUIC, evidence of behaviour change remained limited. Challenges related to sustainability, particularly concerning long-term funding and digital platform maintenance, were noted. CONCLUSIONS: This research highlights the progress made in addressing youth DUIC in Canada. Examining current DUIC educational initiatives is crucial for refining strategies, shaping policy, and allocating resources to prioritize the safety of young Canadians. Future efforts should focus on assessing behavioural impacts and ensuring financial sustainability and program longevity (69).

Developing a mobile-based brief intervention to reduce cannabis-impaired driving among youth: An intervention mapping approach

Behaviour change interventions delivered via smartphones have the potential to reduce youth cannabis use and driving under the influence of cannabis (DUIC). Countless smartphone applications (either downloadable or web-based) are available to help reduce substance use and impaired driving. However, most are developed without evidence-based content and theory, and many have poor user engagement. This study aims to: (1) describe the systematic development and theoretical foundations of a youth DUIC smartphone intervention, and (2) describe the pre-testing among a sample of youth and adult cannabis educators (prior to efficacy testing). A 6-step Intervention Mapping approach was utilized to combine theory, evidence, and user feedback to develop and implement the 'High Alert' intervention. This evidence-based and iterative process entailed: (1) conducting a needs assessment, (2) identifying intervention objectives, which map on the following DUIC determinants: knowledge, attitudes, risk perception, perceived norms, and self-efficacy, (3) selecting intervention theory and design, (4) developing of the intervention, (5) implementation, and (6) evaluation. Application of Intervention Mapping resulted in a smartphone web-based application that could support reductions in cannabis use and DUIC. The 'High Alert' intervention was created to include four modules with contents focusing on educating youth on the dangers and legal risks of DUIC, limiting risky situations, avoiding riding with an impaired driver, planning a safe ride home, and promoting safer cannabis use. Future research will test the efficacy of the intervention in reducing risky cannabis use and DUIC among youth (70).

Alcohol and Drug Testing in Motor Vehicle Crashes

Alcohol-impairment is a leading cause of motor vehicle crash injuries and fatalities. It has also come to light in recent years that driving under the influence of drugs is becoming more and more prevalent and also contributes to motor vehicle crash injuries and fatalities. This review describes the effects of alcohol and commonly used drugs (hallucinogens, stimulants, etc) on driving capabilities, and the matrices and tests used to detect these analytes in motor vehicle drivers, pedestrians, and motorcycle drivers (71).

Substance use and driver fatality in Norway: An expanded case-control study

OBJECTIVE: Using alcohol or psychoactive drugs before driving a motor vehicle may increase the risk of crash involvement, injury, and death. This is better documented for alcohol than for drugs. The aim of this study was to expand a previous case-control study on substance use and driver fatality by doubling the number of cases and controls, and hence improve the statistical power and enable the analysis of combined substance use. METHODS: We collected data on alcohol and drug use from all 1197 drivers of cars and vans who were fatally injured in road traffic crashes in Norway between 2005 and 2020 ('cases') by analysing blood samples or reviewing other information on substance use. We also collected data on alcohol and drug use among 17,219 drivers in random road traffic ('controls') by analysing oral fluid samples.

Substance use was converted to dichotomous variables (no use/use). We used unconditional logistic regression to estimate adjusted odds ratios (aORs) with 95% confidence intervals (CIs) of driver fatality for mutually exclusive substance groups, adjusted for sex, age, geographic region, urban centrality class, and time interval of the week. RESULTS: Compared to no substance use, the aOR (95% CI) for driver fatality was for alcohol 91 (61-137), stimulants (primarily amphetamines) aOR 22 (9-56), benzodiazepines and z-hypnotics (BZDs) aOR 4.0 (2.7-5.9), tetrahydrocannabinol (THC) aOR 3.4 (1.7-6.7), and opioids aOR 1.4 (0.4-4.9). The aOR for any polysubstance use was 168 (96-297). The combinations of BZDs with stimulants or THC were associated with markedly higher aORs for driver fatality than the use of single substance groups. CONCLUSIONS: Alcohol and polysubstance use are the most important predictors of fatal injury, followed by stimulants (72).

Haven't I waited long enough? The role of wait times and subjective impairment in cannabis-related driving behaviour

BACKGROUND: Driving under the influence of cannabis (DUIC) poses a significant public health threat. This study explores DUIC through a multifaceted lens, examining correlates of various wait times between cannabis use and driving, subjective perceptions of impairment, and differences between medical and non-medical cannabis users. METHOD: Cross-sectional data from 979 cannabis users in Israel were collected through an online survey. DUIC risk was measured using reported wait times (categorized as low, moderate, and high risk) and driving while feeling cannabis effects. Logistic and multinomial regression identified correlates of DUIC risk. RESULTS: 23 % of the respondents drove within two hours of use (high risk), 37 % waited 3 to 6 h (moderate risk), and 40 % waited over 7 h (low risk). Multinomial regression showed that being male (RRR = 2.11, $p < 0.001$), having a medical cannabis license (RRR = 4.14, $p < 0.01$), more frequent cannabis and alcohol co-use (RRR = 1.18, $p < 0.05$), and more frequent cannabis use (RRR = 1.21, $p < 0.001$) were associated with moderate risk compared to low risk. Being male (RRR = 1.89, $p < 0.01$) and reporting higher cannabis use frequency (RRR = 1.70, $p < 0.001$) was associated with high DUIC risk. Cannabis use frequency was a significant predictor of subjective DUIC (AOR = 1.26, $p < 0.001$). CONCLUSION: Findings highlight the need for targeted prevention efforts, particularly for male and frequent cannabis users. The complex relationship between medical cannabis use and DUIC risk warrants further investigation to inform evidence-based policies and interventions (73).

Acute methamphetamine and alcohol usage alters gaze behaviour during driving: A randomised, double-blind, placebo controlled study

BACKGROUND: Methamphetamine is frequently co-consumed with alcohol, yet combined effects on visually guided behaviours have not been experimentally assessed. This study examined whether methamphetamine and alcohol-induced changes in gaze behaviour can be accurately detected and indexed during a simulated driving task to establish characteristic patterns relevant to traffic safety. METHODS: In a randomised, placebo-controlled, cross over study design, the effects of acute oral methamphetamine (0.42 mg/kg) were assessed with

and without low doses of alcohol (target 0.04% blood alcohol content) on gaze behaviour during driving. Twenty healthy adults (mean age 29.5 years (SD ± 4.9), 40% female) completed four, 1-h simulated drives with simultaneous eye monitoring using the SensoMotoric Instruments cap-mounted eye tracker over a 4-week experimental paradigm. Gaze entropy measures were used to quantify visual scanning efficiency, expressed as gaze transition entropy and stationary gaze entropy. Fixations, recorded as duration (milliseconds, ms) and rate (count) per minute, were examined in 10-min bins over the duration of the drive. Driving performance was assessed by the standard deviation of lateral position, standard deviation of speed and steering variability. RESULTS: Methamphetamine increased the rate and duration of fixations and produced a less dispersed but more disorganised pattern of gaze during highway driving while preserving performance. Alcohol alone impaired both oculomotor control and driving performance, even when consumed at levels well below the legal limit stipulated in many international jurisdictions. CONCLUSIONS: Methamphetamine-affected drivers display inefficient exploration in a limited visual range during driving. Eye-tracking metrics thus show potential for indexing intoxication due to psychoactive substance usage (74).

The relationship between clinical impairment and blood drug concentration: Comparison between the most prevalent traffic relevant drug groups

AIM: The aim of the present study was to investigate the relationship between blood concentrations of four different drug classes; ethanol, benzodiazepines, amphetamines and tetrahydrocannabinol (THC) and driver impairment as assessed by a clinical test of impairment (CTI). METHODS: Data was retrieved from a national database on CTI assessments and accompanying blood drug concentrations from apprehended drivers. All drug concentrations in blood were quantified using Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS), and compared to the results of the CTI which were categorized as either "not impaired", "mildly impaired", "moderately impaired", or "considerably impaired". RESULTS: A total number of 15 514 individual mono drug-cases collected over 9 years was included. 89 % were men and the median age was 34 years. In addition, 3 684 individual cases with similar age and gender distribution where no drugs were detected, were included as a reference group. For ethanol and benzodiazepines the percentage of clinically impaired cases increased markedly from lower to higher concentration windows, from 60 % to 97 % for ethanol and from 38 % to 76 % for benzodiazepines. The corresponding increase for amphetamines and THC was modest, from 43 % to 58 % for amphetamines and from 41 % to 55 % for THC. The correlation between drug concentration and degree of impairment was high for ethanol (Spearman´s rho=0.548, p<0.001) and relatively high for benzodiazepines (Spearman´s rho=0.377, p<0.001), but low for amphetamines (Spearman´s rho=0.078, p<0.001) and THC (Spearman´s rho=0.100, p<0.001). CONCLUSION: The percentage of impaired drivers increased with increasing blood drug concentration for all four drug classes, most pronounced for ethanol and benzodiazepines and much less for amphetamines and THC. The median blood drug concentration increased with increasing magnitude of

impairment for ethanol and benzodiazepines, while this was much less pronounced for amphetamines and THC. The ranges of drug concentrations, however, were wide for all four drug classes in all impairment categories as assessed by individual clinical examination (75).

Trends in Driving Under the Influence of Alcohol and Cannabis Among Young Adults in Washington State From Before to During the COVID-19 Pandemic

Objectives. To examine trends in young adult self-reported driving under the influence of alcohol (DUI-A), cannabis (DUI-C), and simultaneous alcohol and cannabis use (DUI-AC) in a state with legalized nonmedical cannabis use from before to during the COVID-19 pandemic. Methods. We used logistic regression and annual statewide data from the Washington Young Adult Health Survey to assess DUI behaviours from 2016 to 2021. Results. Both prepandemic yearly changes in prevalence and deviations from those trends during the pandemic years were small and not statistically significant. However, prevalence estimates were alarming: 12.0% of participants reported DUI-A, 12.5% reported DUI-C, and 2.7% reported DUI-AC. Exploratory moderation analyses indicated a relative increase in DUI-A during 2020 among 4-year college students relative to young adults not attending 4-year colleges. Conclusions. Young adults in Washington State continued to engage in risky DUI behaviours during the pandemic. College students may have increased their likelihood of DUI A during COVID-19. Public Health Implications. Young adults, for whom vehicle crashes remain a leading cause of death, showed little change in DUI behaviours during the COVID 19 pandemic. There is continued need for young adult DUI prevention efforts (76).

Development and present status of impaired driving legislation in the United Kingdom

This article traces the development and present status of legislation pertaining to driving under the influence of alcohol (DUI) and other drugs (DUID) in the United Kingdom (UK). The Road Safety Act of 1967 represented a paradigm shift in the way that traffic offenders were prosecuted for driving after consumption of alcohol. This new legislation defined punishable concentrations of alcohol (ethanol) in samples of the driver's blood (80 mg%) or urine (107 mg%). The creation of these statutory concentration limits meant that it was no longer necessary to prove that a suspect was under the influence or impaired by alcohol at the time of driving. Also in 1967, a police officer in uniform was permitted to administer a roadside breath alcohol screening test to help make a decision whether a suspect should be arrested for further investigation. In 1983, the British government introduced a statutory breath alcohol concentration limit of 35 μg/100 mL and evidential quality breath analysers were approved for use by the police as an alternative to sampling blood or urine for analysis. Evidence of driving under the influence of drugs other than alcohol depended on the results of a clinical examination and questionnaire done by a police surgeon. This was supported by evidence presented by the arresting police officers or other witnesses. In 2015, a radical change occurred in the legislation pertaining to drug-impaired driving where instead of relying on clinical evidence of impairment, concentration limits in blood for 17 psychoactive substances were defined by statute. These consisted of eight commonly encountered

recreational drugs of abuse and nine prescription medications (opiates and benzodiazepines), all classified as controlled substances (77).

Evaluation of Cannabis Per Se Laws: A Semi-Mechanistic Pharmacometrics Model for Quantitative Characterization of THC and Metabolites in Oral Users

Recreational cannabis use has increased notably in the United States in the past decade, with a recent surge in oral consumption. This trend has raised concerns about driving under the influence. Current cannabis-impaired driving laws lack standardization, with some states implementing blood Δ9-tetrahydrocannabinol (THC) per se limits (1, 2, and 5 ng/mL). However, these limits have been criticized for their inaccuracy and unreliability, highlighting the need for legal refinement. Addressing this issue requires understanding the complex pharmacokinetics (PK) and pharmacodynamics (PD) of THC, cannabis's primary psychoactive component, which can be characterized using a population PK model. However, existing PK models mainly focus on inhalation data and do not account for the growing number of oral cannabis users. To bridge this gap, a semi-mechanistic population PK model was developed using data from 10 published studies following intravenous or oral administration of cannabis to characterize THC and its metabolites in oral users. Simulated THC plasma concentrations for doses from 2.5 mg to 100 mg in frequent and occasional users were used to evaluate the effectiveness of existing per se limits. Results showed that the 1 ng/mL limit was least effective due to a high risk of false positives, while the 2 and 5 ng/mL limits remain inconclusive due to limited PD data linking blood THC levels to impairment. These findings suggest that the existing per se laws may not fully address the complexity of cannabis impairment, underscoring the need for further research and refinement of cannabis-impaired driving laws (78).

Is cannabis a slippery slope? Associations between psychological dysfunctioning, other substance use, and impaired driving, in a sample of active cannabis users

Cannabis is a gateway drug that can lead to the engagement of other substances. Psychological dysfunctioning and dependence have been highlighted as primary components to substance misuse. The purpose of this study was to investigate what aspects of cannabis use and psychological dysfunctioning are associated with the engagement of other substances and impaired driving. Subject to screening, 200 active adult cannabis users completed an online survey. Existing data involving non-cannabis users (N = 833) were also implemented as comparative data. The comparisons suggested that cannabis users were far more likely to have used other drugs in the past 12 months, compared to non-cannabis users. Bivariate correlations and multiple regressions indicated that the degree of cannabis use and likely dependence, psycho-social motives for using cannabis, emotion dysregulation, and psychopathology were positively associated with the frequency of using and driving on other substances. Finally, an ANOVA demonstrated that outside of age, there were no apparent differences in substance use behaviours, motives for using cannabis, and psychological dysfunction, between medicinal and black-market cannabis users. These findings highlight the

potential benefits of incorporating self-regulatory concepts into current road safety initiatives, which aim to reduce the interconnected issue of substance misuse and impaired driving behaviours (79).

The driving-related attitudes, beliefs and behaviours of cannabis users in the Australian Capital Territory following decriminalisation

INTRODUCTION: In January 2020, the government of the Australian Capital Territory (ACT) decriminalised the possession and cultivation of cannabis for personal use. This study explored the driving-related attitudes, beliefs and behaviours of ACT residents who are legally cultivating and consuming cannabis. METHODS: A two-part cross-sectional study was conducted. Part-1: Cannabis users residing in the ACT were invited to complete an online survey. Part-2: Survey respondents who reported 'currently growing' cannabis were invited to submit a sample of their home-grown cannabis for phytocannabinoid analysis. Data from Parts 1 and 2 were used to estimate participants' usual Δ(9)-tetrahydrocannabinol (THC) intakes. RESULTS: N = 385 cannabis users completed all or part of the online survey and N = 52 submitted cannabis samples for phytocannabinoid analysis. Most participants (N = 224/330; 67.9%) reported waiting ≥7 h following cannabis use before driving. However, 21.5% (N = 71/330) reported waiting ≤3 h. These individuals had the highest cannabis and THC intakes of the sample (where known). Further analyses revealed that individuals who expressed less concern about roadside drug testing and the effects of non-medicinal and medicinal cannabis on driving, and who used cannabis more frequently, in larger amounts, and exclusively for non-medicinal purposes were more likely to report shorter 'wait times'. DISCUSSION AND CONCLUSION: A small proportion of cannabis users in the ACT appear to be driving shortly (i.e., ≤3 h) after consuming considerable quantities of cannabis and THC. This behaviour puts them at risk of driving while impaired and incurring legal sanctions. Interventions alerting these individuals to these possible risks are, therefore, warranted (80).

A randomized, placebo-controlled, double-blind, pilot study of cannabis-related driving impairment assessed by driving simulator and self-report

AIMS: In the context of increasing cannabis use, understanding how cannabis affects specific driving behaviours is crucial in mitigating risks and ensuring road safety. DESIGN AND SETTING: The current study included 38 adults aged 18-40 years, administered a single 0.5 g acute dose of vaporized cannabis (5.9% Tetrahydrocannabinol (THC), 13% THC or placebo) in a randomized, within-subject, double-blind, counterbalanced design. Throughout each of the three, 8-h assessment days, at 4 time points, participants underwent simulated driving tests, including lane-keeping, car following, and overtaking tasks, capturing 19 behavioural metrics. An SPSS linear mixed model assessed the main effects of dose, time, and dose × time. FINDINGS: During lane-keeping, participants exhibited reduced steering reversal rates up to 5.5 h following 13% THC and 3.5 h for 5.9%. For car following, participants showed reduced pedal peak-to-peak deviation and reversal rates, persisting for 1- 3 h post-dose (only at 13% THC). During overtaking, following 13% THC, subjects demonstrated a shorter median gap to

passed cars, lower time-to-potential collision, and more time in the oncoming lane. Drug effects on driving metrics improved gradually, to varying degrees over time. Approximately 66% of participants reported willingness to drive, despite subjective awareness of being impaired and objectively worse driving performance. CONCLUSIONS: Our study reveals for the first time long-lasting cannabis-induced impairments across multiple driving behaviours, that extend beyond the typical 3-h window explored in most previous research. The observed discrepancy between participants' willingness to drive and their actual impairment highlights an important public safety concern. In addition, the lack of correlation between cannabinoid metabolite concentrations and driving performance challenges the reliability of blood THC levels as impairment indicators, emphasizing the need for a multifaceted approach to assessing cannabis-impaired driving risk (81).

Driving Under the Influence of Alcohol and Cannabis by Sexual Identity, Race, Ethnicity, and Gender: A Nationwide Analysis Using the 2016 to 2019 National Survey on Drug Use and Health

BACKGROUND: Sexual minority populations experience higher rates of substance use and related problems, but little is known about their specific involvement in driving under the influence (DUI) of alcohol (DUIA) and cannabis (DUIC) incidents. METHODS: Using data from the 2016 to 2019 National Survey on Drug Use and Health, we used logistic regression models to estimate the interactive effects of sexual identity, race/ethnicity, and gender on past-year DUIA among adults who used alcohol and DUIC among adults who used cannabis, accounting for covariates. Using model estimates and linear combinations, we calculated the predicted probabilities of each outcome and compared sexual identity differences within and across race/ethnicity and gender. RESULTS: With few exceptions, the predicted probabilities of DUIA and DUIC were significantly higher among sexual minority women than heterosexual women of similar race/ethnicity. The results were more variable among men with the probabilities of DUIA and DUIC being significantly higher for some groups of sexual minority men and some groups having probabilities equal to or lower than similar heterosexual men. Some of the largest sexual minority gaps in DUIA and DUIC were observed among Hispanic and Other lesbian women and Black gay men. CONCLUSIONS: Sexual minority individuals are more likely to report DUI than their heterosexual counterparts; however, the risk of DUI among sexual minority populations varies by racial/ethnic and gender subgroup. Our findings indicate the importance of applying an intersectional framework when addressing substance-use-related disparities and when designing effective DUI prevention interventions for sexual minority populations (82).

Driving under the influence of drugs - The failed quest of finding medical signs indicative to driving impairment

Motor vehicle accidents (MVA) are the leading cause of death in childhood and young adult age. One of the most important factors behind MVA is driving under the influence of alcohol (DUIA) and drugs (DUID). The importance of DUID is rising together with the increasing drug

abuse. The legal approaches to DUID are based on impairment, impairment per se or zero tolerance. In case of impairment, the negative effect of the substance on the driving abilities has to be proven by a forensic expert, which can be challenging. This study compares the medical signs registered during blood sampling with the concentrations of substances detected by toxicological examination to find medical signs indicative of impairment. Statistical analysis did not find a correlation between substance concentration and measured parameters (pupil diameter, blood pressure and pulse rate). No connection was found between substance concentrations and the appearance of medical signs. The results indicate that pupil dilation, heart rate, and blood pressure could not be used as indicators of possible driving impairment by drugs, and no medical sign could reliably indicate the driving impairment by substances other than ethanol (83).

Feasibility and acceptability of a web intervention to prevent alcohol and cannabis-impaired driving among adolescents in driver education

BACKGROUND: Adolescents increasingly view cannabis as a substance with limited harm. Their propensity to engage in risky driving, combined with their relative driving inexperience, places adolescents at heightened risk for harm resulting from impaired driving. Driver education provides an opportunity to help prevent and reduce these risks, yet few interventions address cannabis-impaired driving, especially impairment from simultaneous use of both cannabis and alcohol. METHODS: We adapted a single-session primary care brief intervention (CHAT) for driver education programs. First, we conducted two focus groups with adolescents aged 15-17 years (n = 6; n = 5) enrolled in driver education programs in Michigan and Colorado. Their feedback was integrated into a prototype of an online intervention called webCHAT that focuses on preventing alcohol and cannabis-impaired driving. Next, we recruited a new sample of adolescents who user tested webCHAT (n = 8) and provided qualitative and survey feedback. We analysed qualitative data using classic content analysis and grouped themes according to the feasibility and acceptability of webCHAT. RESULTS: Participants suggested that webCHAT should have adolescent narrators in short, informal, and interactive videos. In satisfaction surveys (n = 8), 88% of participants would recommend webCHAT to a friend and 88% reported that they learned helpful skills regarding impaired driving. General acceptability was also reflected in interviews (n = 6; 100% would recommend the intervention to a friend, 100% indicated overall positive impressions, and 67% stated it was easy to use). Participants reported that it was helpful to learn about the negative effects of both cannabis and alcohol on driving behaviour, voicing that webCHAT would help adolescents make more informed decisions. CONCLUSIONS: Soliciting adolescent perspectives is critical when developing interventions targeting cannabis use because of increasingly permissive attitudes and perceptions of minimal risk associated with use. The current study highlights how feedback can help increase both the feasibility and acceptability of interventions (84).

State Driving Under the Influence of Drugs Laws

Drug-impaired driving is a growing problem in the U.S. States regulate drug-impaired driving in different ways. Some do not name specific drugs or amounts. Others do identify specific drugs and may regulate cannabis separately. We provide up-to-date information about these state laws (85).

Visual function and vehicle driving performance under the effects of cannabidiol: A randomized cross-over experiment

AIMS: This study aimed to determine the effect of vaporized cannabidiol (CBD) on visual function and vehicle driving performance, given the growing popularity of CBD use worldwide. DESIGN: Randomized, double-blind, placebo-controlled cross-over experimental study. SETTING: Laboratory of Vision Sciences and Applications, University of Granada, Spain. PARTICIPANTS: Thirty participants were recruited through advertisements placed in the local newspaper and distributed among the university community. They had a mean age of 26.2 (6.2) years, and 70% were male. All of them were occasional users of CBD or cannabis, and held valid driving licenses. INTERVENTIONS: Three experimental sessions, conducted one week apart, in which a placebo, 15% CBD (16 mg) or 30% CBD (32 mg) was vaporized. MEASUREMENTS: The primary endpoint for driving performance was the overall driving performance score (ODPS). Secondary outcomes included visual function variables such as static and dynamic visual acuity, stereoacuity, contrast sensitivity, motion detection and other driving performance parameters such as mean speed, lateral vehicle control or reaction time. FINDINGS: Comparisons revealed no statistically significant changes in ODPS after vaporizing CBD at 15% or 30% compared with the placebo ($\chi(2) = 0.479$; $P = 0.787$). Visual function remained largely unchanged, with only a statistically significant decrease in motion detection ($\chi(2) = 7.980$; $P = 0.018$). Similarly, no statistically significant differences were found in driving performance secondary outcomes, such as the standard deviation of lateral lane position ($\chi(2) = 0.068$; $P = 0.966$), distance travelled outside the lane ($\chi(2) = 2.530$; $P = 0.282$), reaction time ($\chi(2) = 1.000$; $P = 0.607$), or collisions ($\chi(2) = 0.987$; $P = 0.610$). Additionally, correlations between ODPS and visual function did not yield statistically significant results. CONCLUSIONS: Consumption of vaporized cannabidiol in 16 mg and 32 mg doses does not appear to affect simulated vehicle driving performance and visual function (86).

The use of prescription medication and other drugs by New Zealand drivers with illegal blood alcohol levels

OBJECTIVE: This study examined the prevalence of the use of prescription medicines and other drugs by a selected subgroup of New Zealand drivers. The use of potentially impairing prescription drugs by the driving population is largely unknown. The population studied was drivers who were stopped by police, failed a breath alcohol test, elected to provide a blood sample for laboratory analysis, and had blood alcohol levels exceeding the legal limit. METHOD: Blood samples taken from 3,050 drivers during the period 2011 to 2015 were analysed for the presence of alcohol (ethanol) and a range of both prescription and illicit drugs

using liquid chromatography with time-of-flight mass spectrometric detection (LC TOFMS) and an immunoassay screen for cannabis use. RESULTS: One thousand two hundred thirty-five of these drivers had used alcohol in combination with potentially impairing drugs (41%) and alcohol only was detected in 1,815 of the samples (59%). Five hundred of the drivers had used prescription medication (16%), 816 had used cannabis (27%), and 81drivers had used other illicit recreational drugs (2.7%), all in combination with alcohol. The top 7 prescription medicines used in combination with alcohol were citalopram, fluoxetine, and venlafaxine (antidepressants); quetiapine (antipsychotic); diazepam (sedative); and tramadol (opioid). CONCLUSIONS: Drug use did not correlate with the amount of alcohol consumed, and the use of multiple drugs in combination with alcohol was prevalent. Although this is a biased population sample, the results indicate the possible use of impairing prescription medication in the wider driving population and the need for more awareness of the potential impairment by all types of prescription medication (87).

The acute effects of vaporized cannabis on drivers' hazard perception and risk-taking behaviours in medicinal patients: A within-subjects experiment

INTRODUCTION: As the medically prescribed use of cannabis flower continues to increase, there is a need to understand how vaporized cannabis can acutely affect driving-related skills and risk-taking behaviours in medicinal populations. METHOD: Given this, the present study examined the acute effects of vaporized cannabis flower on measures of hazard perception, driving-related risk-taking behaviours, and subjective perceptions of driving skills in a sample of adult medicinal cannabis patients. Participants (N = 38, M age = 43) attended both a baseline (no cannabis) and intervention appointment (with cannabis consumption), where they completed video-based tasks and self-report measures of driving ability. RESULTS: After vaporizing one dose of their prescribed cannabis flower, participants exhibited no significant changes in performance on any of the video-based tasks (hazard perception skill, gap acceptance, following distance or speed) compared to baseline. However, cannabis consumption resulted in significant reductions in perceived hazard perception task performance and on-road traffic conflict prediction ability. Furthermore, there was a lack of association between objective and subjective hazard perception performance at both time points. PRACTICAL APPLICATIONS: These results suggest that while acute prescribed cannabis consumption may reduce appraisals of selected skills, overall hazard perception ability and driving-related risk-taking behaviour may remain unchanged (88).

Special Report from the CDC: Driving under the influence of alcohol, marijuana, or other illicit drugs among drivers aged ≥16 years - National Survey on Drug Use and Health, 2016-2019

INTRODUCTION: This study describes the prevalence of driving under the influence of alcohol (DUIA), marijuana (DUIM), or other illicit drugs (DUID) in the United States over time. METHOD: This study analysed data from 2016-2019 National Survey on Drug Use and Health public-use files. The study sample was limited to drivers aged ≥16 years. Prevalence in 2019

and 2016-2019 trends were assessed overall, by sociodemographic characteristics, and by seatbelt use. RESULTS: The 2019 overall prevalence of DUIA, DUIM, and DUID during the past year was 8.3%, 5.3%, and 0.9%, respectively. DUIA, DUIM, and DUID prevalence was highest for drivers who were male (10.6%, 7.0%, and 1.2%, respectively), not heterosexual (12.3%, 14.7%, and 3.5%, respectively), and did not always wear a seatbelt (12.1%, 11.5%, and 3.1%, respectively). DUIA and DUIM were highest among drivers aged 21-25 years; DUID was highest among drivers aged 21-25 or 26- 34 years. From 2016 to 2019, overall DUIA decreased slightly, DUIM increased (4.5% to 5.3%), and DUID did not change; trends differed across sociodemographic groups. CONCLUSIONS: DUI is a pervasive public health issue. There are ≥10,000 DUIA crash deaths in the United States annually; proven interventions exist to prevent these deaths. Decision makers can save lives and make our roadways safer by implementing proven strategies to reduce DUIA, including lowering the legal blood alcohol concentration (BAC) for driving. Improved data and more research are needed to understand DUIM and DUID burden and determine effective prevention strategies, especially in the context of increasing DUIM. PRACTICAL APPLICATIONS: There were groups for which changes in behaviour patterns were found, which could guide prevention efforts. For drivers who did not always wear a seatbelt, DUIA decreased while DUIM increased. A similar pattern was noted for drivers aged 26-34 years; additionally, DUID increased in this group (89).

Elucidating the acute effects of medically prescribed oral and vaporised delta-9-tetrahydrocannabinol on cognitive functions important for driving

INTRODUCTION: This program of research investigated the acute effects of orally ingested (Study 1) and vaporised (Study 2) cannabis containing delta-9-tetrahydrocannabinol (THC) on cognitive functions relevant for driving in two samples of medicinal cannabis patients (Study 1 N = 41 oral users; Study 2 N = 37 flower users). METHOD: Participants completed counterbalanced baseline (no cannabis) and cannabis consumption (post-cannabis) appointments scheduled approximately 1 week apart. During each session, participants were administered a cognitive battery assessing information processing speed, sustained and divided attention, inhibitory control and mental flexibility. In the post-cannabis condition, the battery was completed 90 min after consuming one dose of cannabis oil (Study 1) or 15 min after vaporising one dose of cannabis flower (Study 2). RESULTS: In both samples, acute cannabis oil and flower administration did not induce a change in information processing speed, divided and sustained attention, or inhibitory control performance (after excluding participants with a positive drug indication at the start of either session), highlighting the moderating role of tolerance. However, significant reductions in TMT B performance were observed. Further, TMT ratio was significantly reduced post consumption of cannabis oil. DISCUSSION AND CONCLUSIONS: TMT B may be sensitive to acute cannabis consumption in medicinal cannabis patients. However, further research is needed to determine the nature and duration of these effects, and whether such effects vary depending on the population studied (e.g., regular vs. new users) (90).

Evaluating risks, monitoring cannabis use, and planning to get home safely: Exploring self-regulation processes associated with cannabis use and driving

OBJECTIVE: Preventing Cannabis-impaired driving involves understanding how users assess risk, monitor their use, and plan to get home safely. While extant research has shown substantial heterogeneity in patterns of cannabis use among different user groups, far less research has examined self-regulation among users. The current study aims to identify sub groups of individuals who used or have used cannabis based on how they perceive risks, monitor their impairment, and plan to avoid driving under the influence of cannabis (DUIC) to examine how the different profiles relate to DUIC outcomes. METHODS: Participants were a Canadian sub-sample in the province of British Columbia who participated in the 2022 International Cannabis Policy study and reported ever using or currently using cannabis (N = 886, M(age) = 43.58, SD(age) = 13.67; 63% female). Risk perception, impairment monitoring, planning ability, DUIC-related behaviours, Cannabis use and related problems were assessed through an online self-reported survey. RESULTS: Latent profile analysis identified three groups of self-regulators based on their level of risk perception, monitoring, and plan to avoid DUI. The majority (51%) of participants showed moderate self-regulation with average levels of risk perception, monitoring, and planning. A "highly self-regulated" group (20%) had the highest risk perception, monitoring, and planning. A "low self-regulated" group (29%) had the lowest risk perception, less confidence in monitoring, and lower DUI planning. There were significant differences between the profiles and DUIC outcomes. Cannabis users (including both historical and current users) with high self-regulation were less likely to be passengers of drivers under the influence and more likely to intervene to stop friends from driving while impaired, compared to those with low or moderate self-regulation. However, there were no profile differences in reports of having ever driven under the influence of cannabis. CONCLUSIONS: Differences in risk perception, monitoring, and planning are associated with self-regulatory abilities. Understanding diverse self-regulation patterns among people who have used cannabis can help identify and mitigate risky behaviours, including DUI (91).

Evaluating possible 'next day' impairment in insomnia patients administered an oral medicinal cannabis product by night: a pilot randomized controlled trial

Cannabis and its major constituents, Δ(9)-tetrahydrocannabinol (THC) and cannabidiol (CBD), are being widely used to treat sleep disturbances. However, THC can cause acute cognitive and psychomotor impairment and there are concerns that driving and workplace safety might be compromised the day after evening use. Here, we examined possible 'next day' impairment following evening administration of a typical medicinal cannabis oil in adults with insomnia disorder, compared to matched placebo. This paper describes the secondary outcomes of a larger study investigating the effects of THC/CBD on insomnia disorder. Twenty adults [16 female; mean (SD) age, 46.1 (8.6) y] with physician-diagnosed insomnia who infrequently use cannabis completed two 24 h in-laboratory visits involving acute oral administration of combined 10 mg THC and 200 mg CBD ('THC/CBD') or placebo in a

randomised, double-blind, crossover trial design. Outcome measures included 'next day' (≥9 h post-treatment) performance on cognitive and psychomotor function tasks, simulated driving performance, subjective drug effects, and mood. We found no differences in 'next day' performance on 27 out of 28 tests of cognitive and psychomotor function and simulated driving performance relative to placebo. THC/CBD produced a small decrease (-1.4%, p=.016, d=-0.6) in accuracy on the Stroop-Colour Task (easy/congruent) but not the Stroop Word Task (hard/incongruent). THC/CBD also produced a small increase (+8.6, p=.042, d=0.3) in self-ratings of Sedated at 10 h post-treatment, but with no accompanying changes in subjective ratings of Alert or Sleepy (p's>0.05). In conclusion, we found a lack of notable 'next day' impairment to cognitive and psychomotor function and simulated driving performance following evening use of 10 mg oral THC, in combination with 200 mg CBD, in an insomnia population who infrequently use cannabis (92).

Effects of state opioid prescribing laws on rates of fatal crashes in the USA

BACKGROUND: State opioid prescribing cap laws, mandatory prescription drug monitoring programme query or enrolment laws and pill mill laws have been implemented across US states to curb high-risk opioid prescribing. Previous studies have measured the impact of these laws on opioid use and overdose death, but no prior work has measured the impact of these laws on fatal crashes in a multistate analysis. METHODS: To study the association between state opioid prescribing laws and fatal crashes, 13 treatment states that implemented a single law of interest in a 4-year period were identified, together with unique groups of control states for each treatment state. Augmented synthetic control analyses were used to estimate the association between each state law and the overall rate of fatal crashes, and the rate of opioid-involved fatal crashes, per 100 000 licensed drivers in the state. Fatal crash data came from the Fatality Analysis Reporting System. RESULTS: Results of augmented synthetic control analyses showed small-in-magnitude, non-statistically significant changes in all fatal crash outcomes attributable to the 13 state opioid prescribing laws. While non statistically significant, results attributable to the laws varied in either direction-from an increase of 0.14 (95% CI, -0.32 to 0.60) fatal crashes per 100 000 licensed drivers attributable to Ohio's opioid prescribing cap law, to a decrease of 0.30 (95% CI, -1.17 to 0.57) fatal crashes/100 000 licensed drivers attributable to Mississippi's pill mill law. CONCLUSION: These findings suggest that state-level opioid prescribing laws are insufficient to help address rising rates of fatally injured drivers who test positive for opioids. Other options will be needed to address this continuing injury problem (93).

Event-level influences of alcohol, cannabis, and simultaneous use on perceived driving risk

Alcohol-impaired driving is highly prevalent and a leading cause of death. Cannabis is commonly used among people who drink alcohol, and using alcohol and cannabis simultaneously is associated with a greater frequency of alcohol-impaired driving. Laboratory studies demonstrate the harmful effects of simultaneous use on driving ability compared to alcohol use alone, yet driving under the influence of cannabis is perceived as a low risk. We

tested the influences of alcohol, cannabis, and their simultaneous use on perceived driving impairment and willingness to drive in daily life. Participants were 88 adults aged 18-44 (M(age) = 25.22 years, 60.2% female, 85.2% White) who reported using alcohol and cannabis simultaneously at least twice per week. They completed 14 days of ecological momentary assessment and reported their alcohol and cannabis use, perceived driving impairment, and willingness to drive "right now" and "1 hr from now" on an average of 5.14 surveys per day. Adjusting for the total amount of alcohol consumed, results from multilevel models include greater perceived driving impairment when using alcohol ($b = 0.39$, $SE = 0.05$, $p < .001$) and cannabis ($b = 0.37$, $SE = 0.03$, $p < .001$) separately, but greater odds of being willing to drive right now (OR = 2.29, 95% CI [1.38, 3.81], $p = .001$) and in 1 hr (OR = 3.69, 95% CI [2.15, 6.34], $p < .001$) when using alcohol and cannabis simultaneously compared to using alcohol by itself. Simultaneous use of cannabis may attenuate the impact of alcohol on the decision to drive and may contribute harmfully to in-the-moment decisions to drive under the influence of alcohol (94).

Rapid nanomolar detection of cocaine in biofluids by electrochemical aptamer-based sensor with low temperature effect for drugged driving screening

Cocaine is one of the most abused illicit drugs, and its abuse damages the central nervous system and can even lead directly to death. Therefore, the development of simple, rapid and highly sensitive detection methods is crucial for the prevention and control of drug abuse, traffic accidents and crime. In this work, an electrochemical aptamer-based (EAB) sensor based on the low-temperature enhancement effect was developed for the direct determination of cocaine in bio-samples. The signal gain of the sensor at 10 °C was greatly improved compared to room temperature, owing to the improved affinity between the aptamer and the target. Additionally, the electroactive area of the gold electrode used to fabricate the EAB sensor was increased 20 times by a simple electrochemical roughening method. The porous electrode possesses more efficient electron transfer and better antifouling properties after roughening. These improvements enabled the sensor to achieve rapid detection of cocaine in complex bio-samples. The low detection limits (LOD) of cocaine in undiluted urine, 50% serum and 50% saliva were 70 nM, 30 nM and 10 nM, respectively, which are below the concentration threshold in drugged driving screening. The aptasensor was simple to construct and reusable, which offers potential for drugged driving screening in the real world (95).

Drink and drive? Understanding the dynamics of youth risk taking

We exploit a reduction in the minimum legal drinking age (MLDA) in New Zealand from 20 to 18 to study the dynamics of youth risk-taking. Using the universe of road accidents over 15 years and an event history approach, we find no evidence that lowering the drinking age increased alcohol-related accidents among teens. Complementary results of a cohort analysis suggest that reducing the drinking age even led to a short-term decline in risky driving among

youths directly affected by the MLDA change but had no longer-run impacts on youth risky driving and drinking behaviours (96).

Analysing fatal crash patterns of recidivist drivers across genders and age Groups: A hazard-based duration approach

Identifying factors that significantly affect drivers that are repeatedly involved in traffic violations or non-fatal crashes (defined here as recidivist drivers) is very important in highway safety studies. This study sought to understand the relationship between a set of variables related to previous driving violations and the duration between a previous non-fatal crash and a subsequent fatal crash, taking into account the age and gender of the driver. By identifying the characteristics of this unique driver population and the factors that influence the duration between their crash events strategies can be put in place to prevent the occurrence of future and potentially fatal crashes. To do this, a five-year (2015-2019) historical fatal crash data from the United States was used for this study. Out of 15,956 fatal crashes involving recidivist drivers obtained, preliminary analysis revealed an overrepresentation of males (about 75%). It was also found that the average duration between the two crash events was about a year and a half, with only an average of one month difference between male and female drivers. Using hazard-based duration models, factors such as number of previous crashes, previous traffic violations, primary contributing factors and some driver demographic characteristics were found to significantly be associated with the duration between the two crash events. The duration between the two events increased with driver's age for drivers who were involved in only one previous crash and the duration was shorter for those that were previously involved in multiple crashes. Previous DUI violations, license suspensions, and previous speeding violations were found to be associated with shorter durations, at varying degrees depending on the driver's age and gender. The duration was also observed to be longer if the fatal crash involved alcohol or drug use among younger drivers but shorter among middle-aged male drivers. These findings reveal interesting dynamics that may be linked to recidivist tendencies among some drivers involved in fatal crashes. The factors identified from this study could help identify crash countermeasures and programs that will help to reform such driver behaviours (97).

Investigating the factors influencing Repeatedly Crash-Involved Drivers (RCIDs): A Random Parameter Hazard Based Duration approach

Repeatedly Crash-Involved Drivers (RCIDs) pose significant challenges to traffic safety, contributing disproportionately to crash occurrences and their severe consequences. While existing research has explored factors influencing crash involvement, the literature often neglects the influence of a driver's crash history and inter-crash intervals on their evolving crash risk. Additionally, many traditional models fail to address unobserved heterogeneity, limiting their ability to capture the complex interplay of factors contributing to repeated crash involvement. This study investigates the factors influencing RCIDs using a hybrid methodology that integrates machine learning with a Random Parameter Hazard-Based Duration Model

(HBDM). Machine learning techniques are employed to identify the most critical factors affecting RCID involvement, which are then incorporated into the HBDM framework. By leveraging machine learning's capacity to analyse complex relationships within high-dimensional data and the HBDM's ability to address unobserved heterogeneity, this approach provides a comprehensive understanding of RCID behaviour. Key findings reveal that male drivers, individuals with histories of distracted or alcohol-impaired driving, and those with prior traffic violations exhibit heightened crash risks. Roadway conditions, vehicle age, and regional variations also emerge as significant contributors. Drivers with extensive crash histories demonstrate dynamic risk profiles, with cumulative hazard estimates indicating increased crash likelihood over time for those with multiple prior incidents. Additionally, unobserved heterogeneity (Theta) emphasized latent, driver-specific risk factors, especially in higher-tier drivers, highlighting the complex nature of crash repeating. These findings offer a more nuanced understanding of RCIDs and underscore the need for targeted interventions that account for both observable risks and more profound, unmeasured influences on driver behaviour (98).

Charge combinations and conviction rates among alcohol-influenced drivers involved in motor vehicle crashes in Iowa

INTRODUCTION: Alcohol impairment is a major contributor to road traffic crashes and has increased across the United States in recent years. In 2022, over 13,000 people were killed in drunk driving crashes. Enforcement of impaired driving laws is an essential strategy to reduce alcohol-impaired driving and subsequent crashes. However, little is known about conviction outcomes related to alcohol-involved crashes. The aim of this study is to examine the association between charge combinations and conviction rates among alcohol-influenced drivers involved in crashes. METHODS: Data for this study included 2016-2019 Iowa Department of Transportation crash data linked to charges and convictions from the Iowa Court Information System. The study sample included drivers with reported BAC ≥ 0.08 g/dl and/or driver condition reported as under influence of alcohol. Charges were divided into three categories: alcohol, moving, and administrative/miscellaneous. Two logistic regression models were built with any conviction and alcohol conviction as the outcomes. The main predictor was charge combination. RESULTS: The study sample included 8,238 alcohol impaired drivers, of whom 6,846 (83.1%) were charged with any type of traffic offense and 6,253 (75.8%) were charged with alcohol-related traffic offenses. Among charged drivers, 96.2% were convicted on any traffic charge and 87.7% were convicted on an alcohol charge. Drivers with a combination of alcohol, administrative, and moving violation charges had higher odds of any conviction (OR = 2.6, 95% CI = 1.7-4.3) compared to drivers with only alcohol charges. CONCLUSIONS: Charging impaired drivers with multiple types of charges was associated with increased odds of conviction on any charge but not on alcohol charges, which had high conviction rates overall. PRACTICAL APPLICATIONS: Results from this study can help guide law enforcement to ensure appropriate charges are made in all relevant categories and

optimal combinations of charges are administered to impaired drivers to increase odds of conviction (99).

Self-underestimation of BAC as a predictor of risky driving in heavy drinkers

BACKGROUND: Alcohol-related driving fatalities persist as a public health issue in the United States. Recent studies have focused on the role of driver risk-taking in DUI occurrences and consequent driving fatalities. This laboratory study examined simulated driver risk-taking under an acute dose of alcohol and a placebo to test the degree to which individual differences in risk-taking were predicted by drivers' self-appraisal of their intoxication and the degree to which alcohol impaired their inhibitory control. METHODS: Eighty young adult drivers (41 men and 39 women) received 0.65g/kg alcohol (target BAC=80mg/dL) or a placebo in a counterbalanced order on two different days and performed a simulated driving test that measured driver risk-taking as reduced distance to other vehicles. A cued go/no-go task measured drivers' inhibitory control, and their perceived intoxication was assessed via self-reported intoxication and BAC estimation. RESULTS: Compared with placebo, alcohol increased driver risk-taking, impaired inhibitory control, and increased perceived intoxication. The riskiest drivers under alcohol were those with the lowest estimations of their BAC. Tolerance to the subjective effects of alcohol might explain this relationship as the under estimators had heavier drinking histories. DISCUSSION: The findings indicate that risky driving under alcohol could result in part from BAC underestimation, possibly owing to the development of alcohol tolerance. Sustained heavy drinking might reduce perceived intoxication and, consequently, the perceived need to compensate for potential impairing effects of alcohol while driving. The evidence suggests that drivers' proclivity to risk-take under alcohol might depend largely on their self-appraisal of intoxication (100).

One month follow-up outcomes of a transdermal alcohol concentration-based contingency management intervention to reduce heavy drinking among driving while intoxicated arrestees

BACKGROUND: High rates of driving while intoxicated persist, and recidivism is common. Recently, we demonstrated that 8 weeks of transdermal alcohol concentration (TAC)-based contingency management (CM) reduced heavy drinking (≥5 [men] or ≥4 [women] standard drinks) in 145 DWI arrestees under pretrial supervision. Here, we report 1-month (postintervention) follow-up outcomes for a subgroup of participants who were not Mandated to wear transdermal alcohol monitors. METHODS: After the intervention, Non-Mandated participants (n = 100, 69%) returned for a 1-month follow-up visit and self-reported drinking during the previous month. Also, a fingerstick blood sample was used to measure the alcohol use biomarker phosphatidylethanol (PEth). PEth was measured by HPLC-MS/MS, with levels <20 ng/mL indicating low or no drinking. Multiple logistic regression models compared drinking outcomes (≤1 drinking day or ≤1 heavy drinking day) between the CM and Control groups (controlling for age, sex, White/non-White and drinking frequency prior to study entry). RESULTS: Analyses showed that CM group participants were more likely

to self-report ≤1 day of any drinking than those in the Control group (OR = 3.07, p = 0.03) and more likely to have ≤1 heavy drinking (OR = 4.13, p = 0.04). PEth results were consistent with the self-report, even though a nonsignificant trend toward a greater likelihood of having PEth levels <20 ng/mL was observed in the CM compared with the control group (OR = 2.29, p = 0.11). CONCLUSIONS: Outcomes observed after an 8-week TAC-based CM intervention appeared to persist for 1 month after a TAC-based CM intervention. Participants in the CM intervention group were more likely to have fewer drinking days and fewer heavy drinking days, as evidenced by self-reported drinking that was consistent with PEth levels <20 ng/mL (101).

Implementation of the new acts on driving under the influence of alcohol and clinical outcomes for patients severely injured in road traffic crashes

OBJECTIVE: Driving under the influence (DUI) of alcohol is a major risk factor for fatal road traffic injuries (RTIs) worldwide. This study aimed to investigate the relationship between the implementation of new acts on DUI of alcohol and the clinical outcomes of patients with severe RTIs in Korea. METHODS: This is a community-based cross-sectional study using a nationwide severe trauma registry in Korea. In 2018, 2 acts with the Yoon Chang-Ho Act (Yoon's Act) were passed to strengthen the punishment for drunk driving fatal RTIs (first Yoon's act) and lower the blood alcohol concentration limit to restrict driver's licenses (second Yoon's act). The first Yoon's act was implemented on December 18, 2018, and the second Yoon's act was implemented on June 25, 2019. The study periods were categorized as pre-Act-1, pre-Act-2, Act-1, and Act-2 according to the application of Yoon's Act, and the study outcome was in-hospital mortality. Multivariable logistic regression analysis was conducted to estimate the relationship of the new acts and in-hospital mortality. RESULTS: Among a total of 20,376 patients with severe RTIs and 7,928 patients (drivers) with RTIs (hereafter drivers), the in-hospital mortality rates were 20.8% and 17.0%, and alcohol-related RTIs accounted for 9.7% and 8.1%, respectively. Severe RTIs tended to increase with each period (25.5 cases/day, 24.5 cases/day, 26.8 cases/day, and 30.4 cases/day, P for trend <.01). In-hospital mortality significantly decreased during the Act-2 period compared to the pre-Act-2 period for all patients with severe RTIs (adjusted odds ratio = 0.54, 95% confidence interval 0.43-0.67) and drivers with RTIs (adjusted odds ratio = 0.50, 95% confidence interval 0.34-0.73). CONCLUSIONS: Implementation of the new acts on DUI of alcohol was associated with lower odds for in-hospital mortality for patients with severe RTIs. Further studies are needed to evaluate the long-term impact of the new acts on reducing alcohol-related RTIs (102).

Drunk Driver Detection Using Multiple Non Invasive Bio signals

This study aims to decrease the number of drunk drivers, a significant social problem. Traditional methods to measure alcohol intake include blood alcohol concentration (BAC) and breath alcohol concentration (BrAC) tests. While BAC testing requires blood samples and is impractical, BrAC testing is commonly used in drunk driving enforcement. In this study, the multiple biological signals of electrocardiogram (ECG), photoplethysmogram (PPG), and

electrodermal activity (EDA) were collected non-invasively and with minimal driver restraint in a driving simulator. Data were collected from 10 participants for approximately 10 min at BrAC levels of 0.00%, 0.03%, and 0.08%, which align with the latest Korean drunk driving standards. The collected data underwent frequency filtering and were segmented into 30 s intervals with a 10 s overlap to extract heart rate variability (HRV) and pulse arrival time (PAT). Using more than 10 machine learning algorithms, the classification accuracy reached 88%. The results indicate that it is possible to classify a driver's level of intoxication using only non-invasive biological signals within a short period of about 30 s, potentially aiding in the prevention of drunk driving (103).

Two programs, too many names? A critical review of ride-sharing and safe-ride programs as alternatives to impaired driving

INTRODUCTION: Alternative transportation programs are widely promoted as a viable strategy for prevention of alcohol-impaired driving (AID) and crashes, with ride-sharing and safe-ride being two major approaches. The scientific literature on these programs frequently uses the terms "ride-sharing" and "safe-ride" interchangeably, though their meaning is not synonymous. This critical review set out to clarify the main characteristics of these programs to advance research, dissemination of the findings, and knowledge transfer in the alternative transportation field for AID and crash prevention. METHOD: A systematic literature search of six databases using the PRISMA-S checklist identified studies of ride-sharing and safe ride programs to prevent AID or crashes. Inclusion criteria comprised studies published in academic and grey literature between 1980 and 2023. A six-step thematic analysis of included studies identified the defining characteristics of each program. RESULTS: The 32 included studies evaluated for-profit ride-sharing/ride-hailing programs (n = 21) and safe-ride programs (n = 11). No studies on non-profit ride-sharing programs were identified. Analyses revealed two main themes. Operational strategies were most important for distinguishing between for-profit ride-sharing and safe-ride programs, with differences in these subthemes: purpose (revenue generation vs. AID reduction), management (private vs. private plus other strategies), funding (self-financing vs. external), and promotion (convenient transportation vs. dangers of AID). Service offerings, the second theme, highlighted differences in program costs, availability, accessibility, service capacity, coverage, and types of vehicles used. DISCUSSION: The scientific literature on ride-sharing was limited to for-profit ride-sharing, suggesting that referring to them as "ride-hailing" in future studies would be more accurate. Both operational strategies and service offerings highlight the advantages and disadvantages of ride-hailing and safe-ride programs in the context of AID. Some programs referred to as ride-sharing programs have the same operational strategies as safe-ride programs, suggesting these be classified as safe-ride programs for conceptual coherence (104).

Self-reported drink driving, enforcement, crashes, and crash reporting: A 6-country comparison

OBJECTIVE: The objective of this study was to compare drink driving and related road safety issues in 2 urban areas of 6 countries and develop an equation for estimating the rate of crash underreporting to the police in urban areas of countries that lack this information. METHODS: This study is a secondary analysis of 1 to 2 waves of surveys in pairs of matched medium-sized cities in Belgium, Brazil, China, Mexico, South Africa, and Ohio, United States; the surveys supported evaluation of local alcohol harm reduction efforts. Data were from 2017 to 2019 except 2023 for Mexico. Mailed surveys in Ohio and household interviews elsewhere of quota samples matched to census data yielded 23,240 completed interviews. Relevant questions covered drinking, driving under the influence of alcohol (DUI), DUI enforcement, and, except in South Africa, road crashes. GLM regression provided an equation for estimating police reporting rates of urban injury and no-injury crashes from a country's purchasing-power parity-adjusted gross domestic product (GDP) per capita. RESULTS: The percentage of drivers driving unlicensed was 30% in Mexico and South Africa, 15% in Brazil, 8% in China, and <1% elsewhere. Among adults who both drove and drank, self-reported urban DUI rates ranged from 12% in China to 53% in South Africa, with 4 countries between 18% and 26%. Among those reporting DUI, the percentage stopped by police for doing so was 14% in Belgium, 15% in Brazil, 25% in China, 31% in Mexico, 45% in South Africa, and only 3% in Ohio. The surveys yielded data on 380 urban crashes. Past-year crash involvement was 2% to 3% in Belgium and China and 5% to 6% elsewhere. The 10% injury rate in Ohio crashes was significantly below the 24% to 35% rates elsewhere. Injury crashes were almost universally reported except in Brazil (60% reported). Only 49% to 56% of non-injury crashes were reported, except in Ohio (73%). Perceived alcohol-involved crash rates of 18% to 19% in Belgium and Ohio were significantly lower than the 32% reported in Brazil, 41% in China, and 57% in Mexico. In the regression, GDP per capita and injury involvement were positively associated with police crash reporting. CONCLUSIONS: Our equation more closely approximates urban police crash reporting rates than prior studies that assumed that they matched U.S. data. DUI enforcement is weak/ineffective in urban Ohio. With suggested adjustments, our survey questions should be usable in other international road safety and DUI studies (105).

The Interplay Between Negative Alcohol Expectancies and Locus of Control and Its Association with Motivation to Change Alcohol Use Among Repeat Alcohol-Impaired Drivers

BACKGROUND: Alcohol-impaired driving is a costly public health problem with a high rate of recidivism. OBJECTIVES: This investigation aimed to examine the associations among negative alcohol expectancies (NAE), locus of control (LoC), and motivation to reduce alcohol use among repeat alcohol-impaired drivers. METHODS: Fifty-nine participants with ≥ 2 previous driving under the influence (DUI) arrests were recruited from a correctional treatment facility or the community. Participants completed NAE, LoC, Motivation to Change alcohol use, and psychiatric disorders (e.g., alcohol and/or substance use disorder) assessments. RESULTS:

Both proximal (β = -0.37, p = 0.022) and distal (β = -0.40, p = 0.011) NAE were negatively associated with Motivation to Change. External LoC was associated with lower Motivation to Change among repeat alcohol-impaired drivers (β = -0.42, p = 0.006). The association of distal NAE with Motivation to Change was moderated by LoC (β = -0.48, p < 0.002): those with greater internal LoC had greater Motivation to Change when they focused more on distal NAE, whereas those with greater external LoC exhibited weaker Motivation to Change as they perceived more distal NAE. CONCLUSION: The relationship between NAE and motivation to change among repeat alcohol-impaired drivers can be better explained by considering their association with LoC. Distal NAE can help repeat alcohol-impaired drivers have stronger motivation to change especially when they have greater internal LoC. Treatment programs for repeat alcohol-impaired drivers can be improved when they focus on the enhancement of both internal LoC and the awareness of long-term negative outcomes of alcohol use (106).

Alcohol perceptions and driving decisions among adolescents: Exploring the role of peer and parental influences in Virginia

OBJECTIVE: This study aims to explore the role of peer and parental influences on adolescent driving behaviours, particularly concerning distracted and alcohol-impaired driving, in light of the significant number of road accidents and fatalities involving young drivers. METHODS: A cross-sectional study was conducted using data from the IMPACT program. Adolescents aged 14 to 19 in the Richmond area were recruited from local high schools through convenience sampling. Parental consent was obtained via media release forms provided by Virginia Commonwealth University (VCU), with students having the option to opt out of participation. Self-report surveys were administered during IMPACT program events and captured via REDCap. The surveys included demographic information, driving history, driving behaviours, alcohol attitudes, drinking and driving behaviours, and a driving knowledge section. RESULTS: The mean age of participants was 15.230 years (SD = 1.545). Gender distribution was as follows: Female 53.1% and male 42.1%. Racial distribution included White/Caucasian (48.9%), Black/African American (22.4%), and multiple races (8.8%). Peer influence on drinking and driving was significant (P = .038). Driving under the influence was associated with both parental and peer influence (P < .050). A positive correlation was found between peer digital distraction and car crashes (coefficient = 0.038, P = .038). Additionally, parental alcohol-impaired driving was linked to decreased positive attitudes among adolescents toward driving under the influence (coefficient = -0.024, P = .000). Though parent distracted driving positively influenced adolescent driving behaviour, this effect was not statistically significant (coefficient = 0.008, P = .320). CONCLUSION: The findings indicate a significant reduction in risky behaviours such as drinking and driving and an increase in seat belt use among adolescents. There is heightened awareness regarding the dangers of texting and driving. A multifaceted approach was effective in improving attitudes and practices related to driving safety (107).

Driving Under the Influence of Alcohol in People With Major Depressive Episodes and Alcohol Use Disorder

OBJECTIVES: Alcohol use disorder (AUD) and depression are the most commonly reported psychiatric comorbid conditions. We examined trends in the past-year prevalence of driving under the influence of alcohol (DUIA) among people with major depressive episodes (MDE), AUD, or both in the United States. METHODS: We analysed 543,573 individuals aged 18 years or older from the 2005 to 2019 National Surveys on Drug Use and Health (NSDUH). Multivariate logistic regression models were applied to examine the adjusted past year prevalence of DUIA. To assess trends in DUIA over time, average annual percent change (AAPC) was calculated. RESULTS: From 2005 to 2019, DUIA prevalence among US adults with MDE declined significantly from 18.1% to 9.4% (AAPC = -4.9). Decreasing trends in DUIA were also observed among those with AUD (from 55.4% to 37.8%, AAPC = - 3.0) and among those with co-occurring MDE and AUD (from 58.3% to 38.8%, AAPC = - 3.1). Compared to those with no MDE or AUD, individuals with AUD and those with co-occurring MDE and AUD had significantly lower AAPCs across all examined sociodemographic subgroups except Non-Hispanic Other and those without a high school diploma. CONCLUSIONS: From 2005 to 2019, DUIA prevalence declined significantly with varying rates of decrease across different diagnostic and sociodemographic groups. Focused public health efforts are needed to engage high-risk groups that have shown a tendency toward less expedient reductions in DUIA (108).

Prevalence of alcohol-impaired driving: a systematic review with a gender-driven approach and meta-analysis of gender differences

BACKGROUND: A growing number of studies investigated the factors that contribute to driving under the influence (DUI) of alcohol in relation to gender. However, a gendered approach of the scientific evidence is missing in the literature. To fill this gap, a gender driven systematic review on real case studies of the last two decades was performed. In addition to the gender of the drivers involved, major independent variables such as the period of recruitment, the type of drivers recruited, and the geographical area where the study was conducted, were examined. Afterwards, a meta-analysis was performed comparing alcohol positive rates (APR) between male and female drivers in three subgroups of drivers: those involved in road traffic accidents, those randomly tested on the road, and volunteers. METHODS: Three databases were searched for eligible studies in October 2023. Real-case studies reporting APR in man and women convicted for DUI of alcohol worldwide were included. Univariate analysis by ANOVA with post-hoc tests identified the independent variables with a significant impact on the dependent variable APR, according to a relationship subsequently investigated by standard multiple linear regression. The meta-analysis of random effects estimates was performed to investigate the change in overall effect size (measured by Cohen's d standardized mean difference test) and 95% confidence interval (CI). RESULTS: Among papers addressing driver gender, univariate analysis of independent variables revealed a higher Alcohol Positive Rate (APR) in men, particularly in drivers involved in crashes, with a noticeable decrease over time. Analysing the gender of drivers involved in

crashes, the meta-analysis showed that men had a significantly higher APR (30.7%; 95%CI 26.8-35.0) compared to women (13.2%; 95%CI 10.7-16.1). However, in drivers randomly tested, there was no significant difference in APR between genders (2.1% for men and 1.4% for women), while in volunteers, there was a statistically significant difference in APR with 3.4% (95%CI 1.5-7.6) for men and 1.1% (95%CI 0.5-2.7) for women. CONCLUSION: Despite a progressive decrease in the epidemiological prevalence of alcohol-related DUI over time, this phenomenon remains at worryingly high levels among drivers involved in road traffic accidents in both genders, with a higher prevalence in men. It's important for policymakers, professionals, and scientists to consider gender when planning research, analysis, interventions, and policies related to psychoactive substances, such as alcohol or other licit drugs. Forensic sciences can play a vital role in this regard, enabling a thorough analysis of gender gaps in different populations (109).

Driving a car under the influence of alcohol in Germany: Results from a trip-based self-report measurement

INTRODUCTION: Driving under the influence of alcohol comprises a serious road safety issue. A comprehensive investigation is challenging and a high number of unreported cases of driving under the influence of alcohol is suspected. Existing methods, including roadside surveys or period-based self-reports, are either difficult to implement or may lack informative value. METHOD: This paper describes a newly developed questionnaire-based survey conducted in a nationwide online survey in Germany that measures the prevalence of driving under the influence of alcohol via self-reports concerning randomly selected trips from 7 days prior. The trip-based data collection includes details about the reported car ride. Expected low case numbers are addressed by additionally recording the last trip driven under the influence of alcohol from the previous week. RESULTS: Within the previous 7 days, 6.3% of the surveyed drivers had driven under the influence of alcohol. Further analyses aligned with familiar patterns from prior research: Age, sex, daytime, and days of the week significantly predict driving under the influence of alcohol. However, attitudes toward stricter rules are also identified as a factor. CONCLUSIONS: The proposed survey design enables the current findings to surpass results of previous surveys and yields data comparable to roadside survey results. The questionnaire proved feasible in conducting the survey and gathered valid findings that correspond to international research and traffic crash data. For Germany, in particular, and in alignment with familiar patterns related to times and days, the findings point to the likelihood that particularly males and younger drivers will drive under the influence of alcohol. PRACTICAL APPLICATIONS: The proposed survey concept adds a new variant to the set of instruments for recording driving under the influence of alcohol by determining a trip-based prevalence, thus offering new insights into driving under the influence in alcohol of Germany (110).

Choosing to drive from alcohol serving establishments (ASEs)

OBJECTIVE: The prevalence of Driving Under the Influence (DUI) of alcohol or drugs has become a prominent factor in the occurrence of severe road crashes worldwide. Driving often occurs after visiting, and presumably drinking, at Alcohol-Serving Establishments (ASEs), and is thus of interest as a possible source of DUI events. METHODS: We apply statistical and machine learning models to the Victorian Integrated Survey of Travel and Activity (VISTA) to identify factors that contribute to driving in trips from ASEs in Australia's state of Victoria. RESULTS: Our results highlight that approximately 10% of individuals who travelled to ASEs as car passengers switched to driving after leaving there. It was also observed that travel distance shorter than 1 km and activity duration between 3 and 4 h positively impacts the mode switching from car driver to other modes in ASEs trips. Further findings illustrate a decline in driving after midnight, with an increase in the use of public transport and taxis. Individuals prefer driving for long-distance ASEs trips and walking for short distances. Going home also increased the likelihood of driving, whereas engaging in other social activities did not. Longer stays at ASEs and leaving vehicles overnight reduce the propensity to drive, likely due to increased alcohol consumption during these times. CONCLUSIONS: These findings suggest behavioural adjustments that can mitigate driving under the influence. Specifically, people may walk for short-distance trips and use public transport or taxis for longer ASEs trips (111).

Penalizing underage alcohol use is associated with lower mortality for young drivers: Use/lose laws and their association with motor vehicle collision mortality

BACKGROUND: Motor vehicle collisions (MVC) continue to be a leading cause of mortality for youth in the United States. Since 2010, seven states have revoked mandatory laws that suspended licenses for underage alcohol use, also known as use/lose laws. This study analysed whether each state's policy change was associated with increased youth MVC mortality. METHODS: State mortality data for youth ages 15 years to 20 years in MVCs involving a young driver (i.e., ages 15-20 years) were obtained from the Fatality Analysis Reporting System. Population data was retrieved from the Centres for Disease Control and Prevention's Wide-ranging ONline Data for Epidemiologic Research. Motor vehicle collisions mortality rates were calculated for each state with a law change per 1,000,000 persons. For difference-in-difference analysis, each state's youth MVC mortality rates from 3 years prior to the law change were compared with rates from 3 years post-law changes, relative to a national average compiled of states with no law changes. RESULTS: From 2010 to 2020, seven states revoked one or more of their mandatory use/lose laws. For all states, young driver MVC mortality rates significantly increased after removal of use/lose legislation (South Dakota: 5.4 excess deaths per million (EDPM), Indiana: 5.6 EDPM, Georgia 28.0 EDPM, Oregon: +41.9 EDPM, Pennsylvania: +10.4 EDPM, Delaware: +45.4 EDPM, Illinois +29.2 EDPM, all $p < 0.001$). CONCLUSION: Examining mortality rates at the state reveals a significant negative association between penalizing underage alcohol use and young driver MVC deaths. Future legislation and health outcomes analysis should consider state-level differences to retain and develop

effective policies that reduce injury-related mortality. LEVEL OF EVIDENCE: Prognostic and Epidemiological; Level IV (112).

Trends and disparities in alcohol-DWI license suspensions by suspension duration, North Carolina, 2007- 2016

PURPOSE: To examine trends and potential disparities in North Carolina (NC) driving while impaired by alcohol (alcohol-DWI) license suspensions from 2007-2016. Specific objectives included: 1) examining personal (e.g., race/ethnicity) and contextual (e.g., residential segregation) characteristics of alcohol-DWI license suspensions by suspension duration; and 2) examining trends in annual suspension rates by race/ethnicity, sex, and duration. METHODS: We linked NC administrative licensing and county-level survey data from several sources from 2007-2016. Suspensions were categorized by duration: 1 to <4 years and 4 years or longer (proxies for initial and repeat suspensions, respectively). We calculated counts, percentages, and suspensions rates (per 1,000 person-years) with 95% confidence intervals, examined trends in annual suspension rates by race/ethnicity, sex, and suspension duration. RESULTS: We identified 220,471 initial and 41,526 repeat license suspensions. Rates among males were three times that of females. 21-24-year-old (rates: 6.9 per 1,000 person-years for initial; 1.5 for repeat) and Black (4.1 for initial; 1.0 for repeat) individuals had the highest suspension rates. We observed decreases in annual initial and repeat suspension rates among males, but only in repeat suspensions for females during the study period. A substantial decrease in annual initial suspension rates was observed among Hispanic individuals relative to other racial/ethnic groups, while annual repeat suspension rates exhibited large decreases for most racial/ethnic groups. The highest overall suspension rates occurred in counties with higher proportions of the population without health insurance and with the highest levels of Black/White residential segregation. CONCLUSIONS: Potential disparities by race/ethnicity and sex existed by alcohol-DWI license suspension duration (i.e., initial vs. repeat suspensions) in NC. Contextual characteristics associated with suspensions, including a high degree of residential segregation, may provide indications of underlying structures and mechanisms driving potential disparities in alcohol-DWI outcomes (113).

Predicting the Risk of Driving Under the Influence of Alcohol Using EEG-Based Machine Learning

Driving under the influence of alcohol (DUIA) is closely associated with alcohol use disorder (AUD). Our previous study on machine learning (ML) algorithms revealed a very high accuracy of decision trees with neuropsychological features in predicting the risk of DUIA despite limited data availability. Thus, this study aimed at comparing six well-known ML algorithms based on electroencephalographic (EEG) signals to differentiate adults with AUD and DUIA (AUD-DD) from those with AUD without DUIA (AUD-NDD) and controls. Fifteen AUD-DD and 10 AUD-NDD participants were recruited from a single tertiary referral centre. Fourteen social drinkers without DUIA served as controls. Their EEG signals related to driving conditions were gathered using a VR headset with eight electrodes (F3, F4, Fz, C3, C4, Cz, P3, and P4). Based

on the labelled features of EEG asymmetry and theta/beta ratio (TBR), comparisons between different algorithms were conducted. Fz and Cz electrodes exhibited differences in TBR across the three groups (all $p < 0.02$), while there were no significant differences between AUD-DD individuals and social drinkers. In contrast, asymmetries of between-group differences were not observed (all $p > 0.09$). K-nearest neighbours (KNN) with TBR showed the highest accuracy (83 %) in distinguishing AUD-DD individuals from controls, while logistic regression (LR), support vector machines (SVM), and naive Bayes (NB) with EEG asymmetric features demonstrated high accuracy in identifying DUIA (all 80 %) in AUD adults. LR, SVM, and NB with asymmetry may be employed in predicting DUIA among AUD adults, while KNN with TBR may be used for identifying DUIA in the general population (114).

Assessing the Deterrent Effects of Ignition Interlock Devices

INTRODUCTION: Ignition interlock devices installed after conviction for driving under the influence of alcohol (DUI) have been shown to reduce subsequent DUI arrests (specific deterrence). However, there is little evidence on how interlock-device penalties might affect general deterrence, that is, deterring people from driving after consuming alcohol prior to a DUI conviction. METHODS: A discrete choice experiment was conducted and data were analysed in 2023 with 583 U.S.-based adults who consume alcohol at least once in the past week to assess the deterrent effects of five different penalties (fine, jail time, interlock device, license suspension, alcohol treatment) for alcohol-impaired driving under randomized sequential scenarios of high (20% chance of being caught) and low (1%) police enforcement. Participants resided in 46 states. RESULTS: Deterrent effects of an interlock penalty, operationalized as having to install an interlock device for 1 year, are large and on par with a 20-fold increase in police enforcement activity (from 1% chance of being caught to 20%), or a $2,000 increase in the DUI fine under the status quo enforcement regime. On average, a 1-year interlock penalty had the same deterrent effect as a 10-day increase in jail time. CONCLUSIONS: Wider use of interlock devices as a DUI penalty could have large deterrent effects, independent of their ability to physically prevent the motor vehicle of an intoxicated driver from starting. The deterrent effect documented here adds to evidence on interlock devices' overall effectiveness as well as their potential to shift DUI penalties away from criminalization (jail time) and toward immobilization and rehabilitation (115).

4. Psychiatry

4.1. General

Major Depressive Disorder and Driving Behaviour Among Older Adults

IMPORTANCE: Depression and antidepressant use are independently associated with crash risk among older drivers. However, it is unclear what factors impact daily driving that increase safety risk for drivers with depression. OBJECTIVE: To examine differences in naturalistic driving behaviour and safety between older adults with and without major depressive disorder (MDD). DESIGN, SETTING, AND PARTICIPANTS: A prospective longitudinal cohort study was conducted among older adults (≥65 years) from the Driving Real-World In-Vehicle Evaluation System Project collected from July 1, 2021, to December 30, 2023. The sample included 85 participants with MDD and 310 participants without. Neurological, clinical, mood, and neuropsychological tests were collected annually. Daily driving behaviour was recorded using a commercial data logger. Statistical analysis was performed from January 31 to June 24, 2024. EXPOSURE: MDD and antidepressant usage. MAIN OUTCOMES AND MEASURES: Linear mixed models with propensity score weighting compared slopes of driving behaviours over time (trips taken at night, speeding, hard braking, entropy, and radius of gyration) between groups. RESULTS: In a sample of 395 participants, 85 were classified as individuals with MDD (mean [SD] age, 69.6 [6.1] years; 60 [70.6%] female; 8 [9.4%] non-Hispanic Black and 77 [90.6%] non-Hispanic White) and 310 as individuals in the control group without depression (mean [SD] age, 70.1 [5.1] years; 153 [49.4%] female; 40 [12.9%] non-Hispanic Black and 270 [87.1%] non-Hispanic White). Adults with MDD had greater depressive symptoms (mean [SD], 8.35 [5.35] vs 2.33 [2.72]; difference, 6.02; 95% CI for difference, 5.17 to 6.85; P < .001), comorbidities (mean [SD], 4.08 [2.07] vs 2.79 [1.67]; difference, 1.29; 95% CI for difference, 0.87 to 1.70; P < .001), used more antidepressants (mean [SD], 0.94 [0.81] vs 0.27 [0.54]; $\chi 21 = 65.8$; P < .001), and had a higher number of medications (mean [SD], 3.80 [3.27] vs 1.98 [2.21]; $\chi 21 = 21.0$; P < .001) compared with controls at baseline. Longitudinal analysis demonstrated an association between adults with MDD and hard braking (mean [SE], $3.17 \times 10\text{-}4$ [$7.30 \times 10\text{-} 5$] vs $6.70 \times 10\text{-}5$ [$4.00 \times 10\text{-}5$]; difference, $2.50 \times 10\text{-}4$; 95% CI for difference, $1.74 \times 10\text{-}4$ to $4.61 \times 10\text{-}4$; P < .001) and hard cornering events per trip (mean [SE], 0.80 [0.64] vs 0.57 [0.25]; difference, 0.23; 95% CI for difference, 0.08 to 1.06; P = .04), greater distances driven from home (mean [SE], 31.19 [7.35] vs 7.76 [3.80] km; difference, 23.43; 95% CI for difference, 0.28 to 15.2; P < .001), more unique destinations visited (mean [SE], 0.34 [0.10] vs -0.27 [0.03]; difference, 0.61; 95% CI for difference, 0.14 to 0.54; P < .001), and higher random entropy (mean [SE], 0.01 [0.01] vs -0.02 [0.00]; difference, 0.03; 95% CI for difference, -0.03 to -0.01; P < .001) over time. CONCLUSIONS AND RELEVANCE: In this longitudinal cohort study of older drivers, adults with MDD demonstrated distinct and riskier driving behaviours than those in the control group without depression, with higher rates of hard braking, cornering, and unpredictability in driving patterns over time. Routine depression screening and tailored interventions are essential for enhancing driving safety and maintaining

independence among older adults with MDD. Comprehensive care approaches addressing both mental and physical health are crucial for this vulnerable population (116).

Association between driving and depression in older adults: findings from an ancillary study of a prospective cohort

BACKGROUND: Depression is prevalent among older adults, particularly those with somatic comorbidities, and is linked to cognitive decline and reduced quality of life. Driving may act as a protective factor by enhancing cognitive function and social engagement. However, few prospective studies have investigated this association. This study aimed to assess whether driving was associated with a lower risk of new-onset depression and lower antidepressant medication. METHODS: This ancillary study of the prospective S.AGES cohort (Sujets AGÉS-Aged Subjects) which included 3,434 participants (mean age 77.6 ± 6.2 years) with somatic comorbidities (chronic pain, type 2 diabetes, or atrial fibrillation) enrolled between 2009 and 2014. Driving status was recorded at baseline, and participants were monitored for 36 months. Depression was measured by the Geriatric Depression Scale (GDS), and antidepressant prescription was recorded at follow-up. Time-to-event analyses were performed on propensity-matched cohorts comparing drivers and non-drivers for new onset depression (GDS ≥ 5/15) and antidepressant use. RESULTS: In the first cohort (126 drivers and 126 matched non-drivers), drivers had a significantly lower risk of new-onset depression (hazard ratio [HR] = 0.58 [0.40-0.86]). In the second cohort (368 drivers and 368 non-drivers), drivers had a lower risk of antidepressant use (HR = 0.49 [0.29-0.84]). DISCUSSION: Driving at baseline was associated with a reduced risk of depression and antidepressant prescription in older adults with somatic comorbidities, highlighting the potential importance of maintaining mobility and driving to support mental health in this population. TRIAL REGISTRATION: The study was registered at ClinicalTrials.gov NCT01065909 with a first registration date of February 8, 2010 (117).

Driving a motor vehicle and living with a mental health condition: The personal and professional experiences of consumer lived experience staff

INTRODUCTION: Driving a motor vehicle is an important activity for people living with a mental health condition, as it can support engagement in the community as part of recovery. There is little research exploring mental health consumers' experiences with driving and no found research on the role of mental health lived experience staff in assisting consumers with safe driving. It is essential to learn about consumers' experiences of driving to know the supports they find useful in understanding their driver responsibilities and self-regulating their driving through periods of changing health and wellness. This study explored the personal and professional experiences of lived experience consumer staff related to driving a motor vehicle while also living with a mental health condition. METHOD: The research was guided by the interpretive paradigm and codesign principles. Qualitative data were derived from semi-structured interviews with (n = 9) lived experience consumers working in a public mental health service. Data were thematically analysed. CONSUMER AND

COMMUNITY INVOLVEMENT: Our research team involved consumer and occupational therapy coresearchers. FINDINGS: Five main themes were identified: (1) Driving means freedom and independence, (2) A nuanced understanding about the impact of mental health on driving, (3) I/we can manage: A range of strategies, (4) Driving is not something mental health staff tend to discuss, and (5) Do not beat around the bush, just talk about it. CONCLUSION: Consumers want support and direct conversations about driving and their mental health, medication side effects, and strategies to gain their licence, maintain, or return to driving. Alongside mental health clinicians, consumer lived experience staff could play a vital role in supporting safe driving (118).

Suicidal thoughts, risky driving, and crashes among U.S. adolescents

INTRODUCTION: Motor-vehicle crashes and suicide are two of the leading preventable causes of death among teenagers. METHOD: To investigate the association between suicidal thoughts and crashes we analysed cross-sectional survey data on suicidal thoughts, risky driving behaviour, and crash involvement. RESULTS: We found evidence of a positive correlation between suicidal thoughts with crash involvement and each of the risky driving behaviours measured in the survey. PRACTICAL APPLICATIONS: This is the first time this association between suicidal thoughts and crashes has been described in this population (119).

Lived experience of driving in individuals with functional neurological disorder

BACKGROUND: Functional neurological disorder (FND) is a common neurological diagnosis that encapsulates a range of incapacitating clinical presentations. These include functional seizures, movement disorders, and sensory disturbances. Safe driving requires both cognitive skills and physical abilities, which may be impacted by FND symptoms. The primary objective of this study was to gain deeper insights into the challenges faced by people with FND when driving. METHODS: A qualitative study and interpretative phenomenological analysis were conducted. Individuals experiencing functional seizures and/or movement disorders completed both questionnaires and semi-structured interviews about FND symptoms, driving behaviour, and crashes. RESULTS: A total of 26 patients with FND participated in this study. Based on the interviews, four key themes were identified: (1) driving difficulties experienced by individuals with FND; (2) strategies utilized by people with FND to overcome difficulties experienced while driving; (3) barriers preventing driving challenges being addressed in this population; and (4) crashes and perceived dangerous driving events experienced by individuals with FND. All participants reported that driving a car provoked FND symptoms and this affected their driving ability. FND sufferers reported using a number of strategies such as limiting how far they drive and relying on advanced driver assistance system features to help manage their associated symptoms, such as fatigue and/or pain. Several participants reported crashes and perceived dangerous driving events since developing FND. CONCLUSION: Individuals experiencing FND often employ self-regulation techniques, yet the extent to which these methods enhance driving safety remains uncertain. The variable nature of the disorder

makes judging an individual's driving risk particularly difficult. The themes emerging from the interviews highlighted the need for further empirical research to inform guidelines and best practice when determining the impact of FND on an individual's driving safety (120).

Depression, anxiety and stress in taxi drivers: a systematic review of the literature

PURPOSE: Mental health is a global public health challenge, with mental disorders being a major cause of morbidity. Particularly, taxi drivers face unique challenges related to long working hours, economic instability, and hazardous working conditions. To summarise the existing scientific literature on mental disorders in taxi drivers and identify associated variables. METHODS: PubMed, Scopus and Web of Science databases were examined from inception to April 2024 following the PRISMA guidelines. Two authors independently selected original studies. We included observational studies published in English or Spanish or Portuguese, which assessed the mental health of taxi drivers. The Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies of the National Heart, Lung, and Blood Institute (NHBLI) was used to assess the quality of the articles. RESULTS: From an initial pool of 618 studies, eleven met the inclusion criteria and were included in the present systematic review. The findings indicate a considerable prevalence of mental health issues among taxi drivers in comparison to the general population. The prevalence of depression ranged from 14.3 to 60.5% and were driven by a number of factors, including perceived mental strain, lack of respect from operators, a stressful personal life, insufficient sleep, poor working conditions, work-family conflict and low work engagement. Anxiety was reported by 24.1-47% of drivers, with a lack of sufficient sleep being identified as a primary contributing factor. The prevalence of stress ranged from 19 to 55%, with key contributing factors including discrimination, smoking, limited language proficiency, sleep disorders and younger age. Furthermore, 33% of drivers displayed elevated levels of psychological distress, frequently linked to traumatic experiences and occupational hazards. CONCLUSIONS: Rates of depression, anxiety, stress and psychological distress are higher in taxi drivers than in general population, therefore prevention strategies should target this group (121).

Antipsychotic treatment adherence and motor vehicle crash among drivers with schizophrenia: a case-crossover study

BACKGROUND: Among individuals with schizophrenia, antipsychotic medications improve performance across several cognitive and functional domains. We sought to assess whether antipsychotic adherence reduces the risk of a motor vehicle crash. METHODS: We performed a case-crossover study using population-based administrative health and driving data from British Columbia, Canada. We included individuals with schizophrenia who were involved as a driver in a police-attended motor vehicle crash during a 15-year interval (2001- 2016) and who filled prescriptions for antipsychotic medication as an outpatient in the 2 years before the crash. We measured adherence to antipsychotic treatment by using prescription fill data to calculate the medication possession ratio (MPR) in the 30 days before the crash (the pre-crash interval) and in a 30-day control interval ending 1 year before the crash. We used

conditional logistic regression to evaluate the association between MPR and motor vehicle crash after adjusting for potential confounders. RESULTS: Among 1130 eligible motor vehicle crashes involving drivers with schizophrenia, the mean antipsychotic MPR was 0.69 in the pre-crash intervals and 0.76 in the control intervals. We found that perfect adherence to antipsychotic medication was associated with half the odds of a crash relative to complete nonadherence (adjusted odds ratio 0.50, 95% confidence interval 0.38- 0.66). The findings were consistent among subgroups defined by sex, age, and history of alcohol or drug misuse. INTERPRETATION: Better adherence to antipsychotic medications was associated with lower crash risk. Physicians and fitness-to-drive policy-makers might consider antipsychotic treatment adherence as a condition for maintaining an active driver's licence among individuals with schizophrenia (122).

4.2. Neurodevelopmental

4.2.1. Attention Deficit Hyperactivity Disorder

Driving performance and ocular activity following acute administration of 10 mg methylphenidate: A randomised, double-blind, placebo-controlled study

BACKGROUND: Methylphenidate is a routinely prescribed treatment for attention deficit/hyperactivity disorder with misuse potential owing to its perceived performance enhancing and euphoric properties. Although clinically effective, there is limited understanding of how methylphenidate affects safety-sensitive tasks such as driving when used by healthy individuals. AIM: Explore the acute effects of 10 mg methylphenidate on driving performance and gaze behaviour. METHODS: Twenty-five fully licensed, healthy adults (mean age = 33.5 ± 7.8 years, 64% male) took part in two 40-min simulated highway drives with simultaneous eye movements monitored using a proprietary automotive-grade driver monitoring system (Seeing Machines). Driving performance was assessed using the standard deviation of lateral position, standard deviation of speed and steering variability. Visual scanning efficiency was determined using ocular metrics, such as fixation duration and rate, gaze transition entropy, and stationary gaze entropy, were assessed to determine visual scanning efficiency. RESULTS: Methylphenidate significantly improved driving performance by reducing lane weaving and speed variation, particularly in the latter half of the drive. Although a significant reduction in fixation duration was observed, all other ocular metrics remained unchanged. CONCLUSIONS: Methylphenidate mitigates performance decrements typically associated with prolonged and monotonous driving. The absence of pronounced oculomotor effects suggests that a single 10 mg dose of methylphenidate has no deleterious impact on visual scanning behaviour during driving tasks with low-to-moderate cognitive demand. Future research should investigate the effects of methylphenidate under various dosing and driving conditions to better understand its impact (123).

Reducing Driving Risk Factors in Adolescents with Attention Deficit Hyperactivity Disorder (ADHD): Insights from EEG and Eye-Tracking Analysis

Adolescents with attention deficit hyperactivity disorder (ADHD) face significant driving challenges due to deficits in attention and executive functioning, elevating their road risks. Previous interventions targeting driving safety among this cohort have typically addressed isolated aspects (e.g., cognitive or behavioural factors) or relied on uniform solutions. However, these approaches often overlook this population's diverse needs. This study introduces the "Drive-Fun" innovative intervention (DFI), aimed at enhancing driving skills among this vulnerable population. The intervention was tested in a pilot study including 30 adolescents aged 15-18, comparing three groups: DFI, an educational intervention, and a control group with no treatment. Assessments included a driving simulator, EEG, and Tobii Pro Glasses 2. Evaluation was conducted pre- and post-intervention and at a 3-month follow up. Results indicated that the DFI group significantly improved in the simulated driving performance, attentional effort, and focused gaze time. The findings underscore that holistic strategies with personalized, comprehensive approaches for adolescents with ADHD are particularly effective in improving driving performance. These outcomes not only affirm the feasibility of the DFI but also highlight the critical role of sensor technologies in accurately measuring and enhancing simulator driving performance in adolescents with ADHD. Outcomes suggest a promising direction for future research and application (124).

4.2.2. Autism Spectrum Disorder

Outcomes from a Driving and Community Mobility Intervention Designed for Novice Drivers with Autism from the Perspective of the Participants and Their Parents

To examine change in driving and community mobility outcomes for teens and young adults with autism as a result of participating in an occupational therapy intervention designed as a Bootcamp as perceived by the participants and their parents. Matched questionnaires were completed by novice drivers with autism as well as their parents prior to and immediately after the intervention. The intervention consisted of a 5-day (32 h) intervention using interactive driving simulators, role playing, and highly interactive learning experiences. Sixty-seven participants and their parents completed the pre and post surveys. Of these, 52 (80%) were male and 13 (20%) were female, with a mean age of 17.8 ± 3.03 years. Wilcoxon signed rank tests was used for the Likert scale questions and paired t test for ratio level data. Results demonstrated participants perceived significant improvement in knowledge, skills and abilities related to both driving and community mobility. There were also significant differences in perception from the parents' perspective, but not as evident as the participants. Only a few significant changes were perceived in terms of executive functioning, which support accuracy of the results. Findings also showed significantly improvement in anxiety and confidence. As driving and community mobility is critical for young adults with autism to be successful in adult roles, intervention for improving knowledge, skills, and abilities in this complex daily task is essential. This study demonstrates statistically significant outcomes of a

driving and community mobility occupational therapy intervention from the perspective of the participants and their parents (125).

Examination of Driving Performance Across Autistic Drivers: A Meta-analysis

OBJECTIVE: It is becoming evident that the unique challenges faced by autistic drivers are contingent on the driving context and specific skills required. This meta-analysis examined the driving performance of both autistic and nonautistic drivers, aiming to clarify the reasons behind inconsistencies in published findings and identify the relative strengths and challenges faced by autistic drivers. METHOD: This study was performed within a theoretical model of driving skills to break down the complex process of driving and identify specific strengths and challenges displayed by autistic drivers. Data were extracted from included studies, and a meta-analysis using random-effects models was conducted. Risk of bias was assessed, and sensitivity analyses were also conducted. RESULTS: The results from 16 studies suggested that autistic drivers show a small yet significant deficit in their overall driving performance compared with nonautistic drivers. Autistic drivers showed significant challenges and variation in performance at the operational level of driving compared with the tactical level of driving. Variation across driving performance was found to be related to licensure status but not age. CONCLUSION: This paper was able to build upon prior work by clarifying strengths and challenges that are evident in autistic drivers and their driving performance. Notable differences were found to be most related to operational driving skills. These differences may subside with driving experience compared to nonautistic peers. Future studies should further assess potential reasonings for the variation seen across driving performance by examining the interplay of related factors (126).

The Driving Profile of Autistic Drivers and Their Driving Experiences: A Systematic Review

A developmental milestone that both contributes to and facilitates a successful transition into adulthood is the ability to drive. Yet only one in three autistic adolescents successfully obtain a driver's license by age 21 compared to over three-fourths of non-autistic adolescents. Of those who receive their license, there is inconsistency in driving attitudes, experiences and skills. The current study aimed to (1) provide a systematic review of the driving profile of autistic drivers and (2) structurally organize driving performance within a theoretical driving model - Michon's Hierarchical Model of Driving. Following PRISMA guidelines, four databases were systematically searched to identify published articles related to autistic drivers. To be included, all studies met the following inclusion criteria: included autistic sample or people representing or working with autistic individuals, peer-reviewed, published between 2000 and 2021 and contained empirical data reporting on an aspect related to driving or motor vehicle transportation. A systematic search yielded 37 articles that met inclusion criteria. Based on the differential results derived from this review, it appears that autistic drivers are not generally at greater risk of negative driving outcomes; instead, they face unique challenges based on the skills necessary to navigate specific driving contexts. However, due to the inconsistency across results, the actual driving performance in autistic drivers remains

unclear. Future research should focus on quantifying these results using an evidenced-based, theoretical framework to identify consistent strengths and challenges in driving performance across autistic drivers (127).

Exploring the Intersection of Autism, Theory of Mind, and Driving Performance in Novice Drivers

This study explores the intersection of Theory of Mind (ToM) abilities and driving performance among novice drivers, with a focus on autistic individuals. The purpose is to investigate how ToM deficits may impact driving behaviours and decision-making, ultimately informing the development of tailored interventions and training programs for autistic drivers. We conducted a series of driving simulations using a custom-built driving simulator, capturing multimodal data including driving performance metrics, attention allocation, and physiological responses. Participants were categorized based on NEPSY scores, which assess ToM abilities, and self-reported autism spectrum disorder (ASD) diagnosis. Driving tasks were designed to simulate real-world scenarios, particularly focusing on intersections and merging, where ToM skills are crucial for safe navigation. Our analysis revealed differences in driving behaviours among participants with varying ToM abilities as determined through the NEPSY. Participants with lower NEPSY scores exhibited less smooth driving behaviours, increased risk-taking tendencies, and differences in attention allocation compared to those with higher scores. Alternatively, individuals with ASD displayed comparable driving patterns overall. ToM abilities influence driving behaviours and decision-making, particularly in complex social driving scenarios. Tailored interventions addressing ToM deficits and stress management could improve driving safety and accessibility for autistic individuals. This study underscores the importance of considering social cognitive factors in driving education and licensure pathways, aiming for greater inclusivity and accessibility in transportation systems (128).

5. Vision

Diurnal variation of visual functions for driving with and without orthokeratology: A multicentre study

PURPOSE: To investigate orthokeratology-related diurnal variations in visual acuity, contrast sensitivity, mesopic (twilight) vision, and glare sensitivity, and to verify compliance with requirements for driver licensing. METHODS: In this prospective, multicentre, controlled study, fifty myopic (range, -1.00 to -4.50 D) and non-presbyopic glasses or soft contact lens wearers (age range, 16-39 years) were fitted with orthokeratology (OK) contact lenses. Before and after completion of OK lens fitting, measurements of visual acuity, contrast sensitivity, mesopic vision and glare sensitivity were performed at three times of the day, morning, afternoon and evening using a standardized binocular vision testing device (Oculus Binoptometer 4P). Monocular and binocular visual acuity were tested according to ISO 8596 and compared to requirements of cars and motorcycles drivers in different countries. RESULTS: Compared to the prior correction, binocular visual acuity (logMAR) with orthokeratology was statistically significant better in the morning (0.04 ± 0.12; $p < 0.05$) and afternoon (0.04 ± 0.10; $p < 0.05$), while the difference was not statistically significant in the evening ($p = 0.512$). Furthermore, there was no statistically significant difference in contrast sensitivity in the morning ($p = 0.813$), afternoon ($p = 0.742$) or evening ($p = 0.945$). For both mesopic vision and glare sensitivity, there was no statistically significant difference between the contrast levels achieved with orthokeratology compared to the prior correction in the morning ($p = 0.083$; $p = 1.000$), afternoon ($p = 0.054$; $p = 0.125$) or evening ($p = 0.195$; $p = 0.635$). With orthokeratology, no statistically significant diurnal variation was found for binocular visual acuity, contrast sensitivity, mesopic vision or glare sensitivity ($p > 0.05$). CONCLUSIONS: These results provide evidence, that visual functions of OK lens wearers are stable throughout the day and comparable to the prior correction. Although the visual standards for driving are not uniform within countries, the requirements for visual acuity are met in all of the countries. Mesopic vision and glare sensitivity, which are suggested as other aspects to influence driving performance, also appear to be constant over the course of the day (129).

National Consensus on the Assessment of Visual Function for Driving in Switzerland

PURPOSE: To establish a national consensus on assessing visual function for fitness to drive in Switzerland. METHODS: The minimum medical requirements for visual function for fitness to drive are regulated by Swiss Federal Law, namely, by the Traffic Licensing Ordinance (TLO). The medical examination techniques relevant in this context and their assessment are not further specified therein, which leads to legal inequality among drivers and uncertainty among examiners. We established a study group of representatives of the Traffic Medicine Section of the Swiss Society of Forensic Medicine and the Traffic Commission of the Swiss Society of Ophthalmology to develop a national consensus on assessing visual function for fitness to drive in Switzerland. In structured meetings, the authors discussed medical

examination techniques and available international and local recommendations on this topic, with respect to Swiss legislation. In the event of a contrary opinion, the topic was discussed again in a follow-up session until we reached an agreement. We defined consensus as complete agreement on the subject under discussion. RESULTS: The study group held five in-person meetings between March 2019 and January 2023. The authors developed recommendations intended for all professional groups assessing driving fitness. We prepared an aid for daily practice on how to examine the minimum medical requirements for visual function listed in the TLO Annex 1, using standardized test procedures and considered how to interpret the findings obtained, accounting for aspects of traffic medicine and ophthalmology. CONCLUSIONS: A consensus on the assessment of visual function for fitness to drive in Switzerland is crucial to ensure legal equality for drivers and legal certainty for examiners. Regular review of the consensus is imperative if we are to consider future legal developments and new scientific evidence in assessing fitness to drive (130).

Hard braking events in bioptic drivers with central vision impairment

PURPOSE: Some individuals with central vision impairment can obtain or maintain driving privileges using bioptic telescopes. Previous work has often demonstrated an increased collision risk for bioptic drivers, but some on-road studies find similar safety to that of normally sighted drivers. The purpose of this study was to compare exposure-controlled hard braking and speeding events measured with naturalistic recording in visually impaired bioptic drivers and normally sighted control drivers. METHODS: Visual acuity was measured for each eye individually and through the bioptic when indicated. Contrast sensitivity was measured binocularly with the Mars chart. Binocular integrated visual fields were constructed from monocular 24-2C SITA Faster plots. A commercially available GPS recorder was installed into drivers' personal vehicles for at least 6 weeks. Total mileage, instances of hard braking, travel over 65 miles per hour (mph) and posted speed limit violations were counted. Exposure-controlled rates were calculated for each of these safety events. Driver characteristics and hard braking events were compared using median tests, and Spearman correlation was used to assess the relationships among vision measurements and driving safety events. RESULTS: Twenty licensed bioptic drivers and 20 control drivers were enrolled. Bioptic drivers were significantly more likely to perform hard braking manoeuvres than controls. Among bioptic drivers, hard braking frequency was not predicted by visual acuity, contrast sensitivity or binocular integrated visual field deviation. Bioptic drivers with poorer contrast sensitivity were more likely to travel above 65 mph. Speeding events were not related to hard braking. CONCLUSIONS: Bioptic drivers demonstrated nearly three times as many hard braking events per 1000 miles driven, but vision measurements did not predict hard braking. Bioptic drivers with poorer contrast sensitivity were more likely to drive faster than 65 mph. Further work exploring relationships among vision and driving safety in bioptic drivers is warranted (131).

Discrepancy and agreement between subjective symptoms and visual field impairment in glaucoma patients at a driving assessment clinic

We investigated subjective symptoms during driving in 227 glaucoma patients at a driving assessment clinic. Patients underwent testing with the Humphrey Field Analyzer 24-2 (HFA 24-2) and a driving simulator (DS) with eye tracking. Patients reported whether they experienced symptoms during daily driving, such as fear or difficulty seeing under certain conditions. The integrated visual field (IVF) was calculated from HFA 24-2 data. The number of collisions in DS scenarios and eye movements during DS testing was recorded, and factors related to the presence of subjective symptom during driving were analysed using multivariate logistic regression, with subjective symptoms as the dependent variable. Overall, 145 patients (63.9%) did not report subjective symptoms during driving. Rates of these symptoms were 22.9%, 36.6%, and 41.7% for mild, moderate, and severe glaucoma, respectively ($P = 0.030$). Patients with symptoms had worse better-eye mean deviation (MD) ($P = 0.012$) and lower IVF sensitivity in the superior hemifield ($P < 0.002$). Logistic regression revealed a significant association between symptoms and decreased superior IVF sensitivity from 0° to 12° ($P = 0.0029$; OR: 1.07). Our study highlights that many glaucoma patients, even with severe disease, may not be aware of visual symptoms during driving, though superior IVF mean sensitivity contributed to subjective symptoms during driving (132).

Longitudinal Simulated Driving Performance and Rates of Progressive Visual Field Loss in Glaucoma

PURPOSE: The purpose of this study was to evaluate the association between longitudinal changes in driving performance, assessed through driving simulation, and rates of progressive visual field (VF) loss in patients with glaucoma. METHODS: Ninety-five patients with glaucoma underwent Standard Automated Perimetry (SAP) and driving simulations every 6 months. Rates of VF loss were estimated by changes in mean sensitivity (MS) of the integrated binocular VF over time. Driving performance was assessed using a simulator by maintaining lane position on a winding road while responding to peripheral visual stimuli to assess divided attention. Reaction time (RT) recorded the duration between the presentation of the stimuli and the participant's response. Linear mixed models evaluated longitudinal changes in SAP MS and mean RT. Multivariable linear regression models were used to predict driving performance, adjusting for age, cognitive impairment, and driving exposure. RESULTS: Progressive VF loss was associated with a longitudinal increase in mean RT to the divided attention task. In the multivariable model, each 1 decibel (dB)/year faster loss of integrated binocular MS was associated with a 0.024 logarithms (ln) s/year increase in mean RT (95% confidence interval [CI] = 0.007 to 0.042, $P = 0.008$). Baseline MS also significantly influenced driving performance, with each 10 dB worse baseline binocular MS associated with a 0.031 ln s/year increase in mean RT (95% CI = 0.016 to 0.045, $P < 0.001$). CONCLUSIONS: Faster VF progression in patients with glaucoma was associated with worsening performance on a divided attention task during driving simulation. TRANSLATIONAL RELEVANCE: Patients with glaucoma who exhibit faster VF progression may be at greater risk for a decline in driving performance (133).

Validation of the European visual field standards for driving: A driving simulator-based study

PURPOSE: To determine whether we could establish evidence-based pass/fail criteria for perimetry in the context of the European visual field standards for driving. METHODS: This two-centre, cross-sectional study included participants with binocular visual field loss that had led to revocation of a group-1 driving licence. The participants underwent cognitive and binocular visual testing, including the European Driving Test (EDT), a perimetry algorithm that adheres to the European visual field standards. We used a high-fidelity driving simulator to compare the driving ability of these participants with healthy controls. Two driving instructors classified each driving test as passed or failed. Receiver operating characteristic (ROC) analysis and area under the curve (AUC) determined the ability of perimetry to discriminate between passed and failed driving tests. RESULTS: The study included 70 participants with visual field loss and 37 controls. A non-significantly higher proportion of controls passed the driving test (75% vs. 63%; p = 0.22). In ROC analysis, contrast sensitivity performed best (AUC of 0.73), followed by NEI VFQ-25 (AUC of 0.64). Peripheral visual field (AUC of 0.56) and central visual field (AUC of 0.47) performed weaker. Combining the central and peripheral visual field, and their interaction, increased AUC to 0.63. CONCLUSION: Perimetry was a poor predictor of simulator-based driving test result, and we could not establish appropriate pass/fail criteria for the European visual field standards. Because perimetry is not an accurate diagnostic tool for fitness to drive, a practical driving assessment should be performed in case of doubt (134).

6. Sleep Conditions

6.1. Obstructive Sleep Apnoea (OSA)

Evaluating osa risk in drivers: polysomnography and anthropometric measurements

BACKGROUND: Sleepiness significantly contributes to traffic accidents, with obstructive sleep apnoea syndrome (OSA) being the leading medical cause. Effective treatment of OSA has been shown to reduce accident-related deaths and injuries. Turkish legislation has been updated to address driver's license issues for individuals with OSA, but implementation challenges and debates persist. METHODS: Data from 159 patients who applied to obtain or renew their driver's licenses and underwent polysomnography between January 2020 and January 2024 were evaluated retrospectively. RESULTS: The body mass index of 126 patients (79.24%) exceeded 33 kg per meter of height squared. OSA (apnoea hypopnea index greater than 5) was detected in 85.5% of our patients, and the rate of severe OSA was 31.4%. We evaluated the presence of severe OSA using logistic regression analysis. Among the variables, the most important factor was neck circumference Receiver operating characteristic curve analysis identified severe OSA risk thresholds as neck circumference of 42.5 cm or greater and waist circumference of 122 cm or greater. CONCLUSIONS: Considering neck and waist circumference rather than body mass index may facilitate informed decisions based on empirical measurements to identify OSA in driver's license applicants who require overnight polysomnography assessment (135).

How many truck drivers have sleep disorders? Investigation of the effects of lifestyle and stress on insomnia among Japanese male truck drivers

OBJECTIVES: This study aimed to investigate how many male truck drivers have sleep disorders and what factors are most associated with chronic insomnia symptoms. METHODS: A cross-sectional study of 505 truck drivers in Akita prefecture was conducted using a self-administered questionnaire and health checkup data. We defined insomnia based on the International Classification of Sleep Disorders, third edition, sleep apnoea syndrome (SAS) with a simple 4-variable screening tool, and restless legs syndrome (RLS) with RLS/Willis-Ekbom disease diagnostic criteria. Investigated factors included sleep duration, driving characteristics, caffeine types (foods and beverage) and amounts, caffeine intake timing, State-Trait Anxiety Inventory (STAI), individual stress, and other covariates. RESULTS: The prevalence of suspected SAS was 23.2% (n = 154), and that of RLS was 0.8% (n = 5). After excluding those, chronic insomnia symptoms were present in 36/505 drivers (7.1%). After adjusting for covariates, a logistic model demonstrated that drinking habits [odds ratio (OR), 6.21; 95% CI, 1.07-35.8], caffeine intake before sleep (OR, 2.65; 95% CI, 1.09-6.45), sleep duration on days off (OR, 1.44; 95% CI, 1.01-2.05), and STAI score (OR, 12.8; 95% CI, 2.53-64.2) were significantly associated with chronic insomnia symptoms. STAI was significantly positively correlated with individual stress, such as family worries (r = 0.22), relationships with non-partners (r = 0.28), and health (r = 0.23). CONCLUSIONS: Our study revealed that one-fourth of male truck drivers had sleep disorders that require further medical evaluation. For

male truck drivers, lifestyle modification and stress relief may be key to address insomnia (136).

Predictors of driving risk in patients with obstructive sleep apnoea syndrome treated by continuous positive airway pressure: a French multicentre prospective cohort

STUDY OBJECTIVES: To investigate the predictors of persistent driving risk related to sleepiness in patients with obstructive sleep apnoea syndrome (OSAS) treated by continuous positive airway pressure (CPAP). METHODS: Longitudinal analysis of a prospective national database including 5308 patients with OSAS and an indication of CPAP. Near misses related to sleepiness, accidents related to sleepiness, and sleepiness at the wheel (SAW) were assessed before initiation and after ≥90 days of treatment. Multivariable associations with the cumulative incidence of near-misses and accidents under treatment were calculated using Cox models adjusted for age, sex, obesity, sleep duration, SAW, accidents/near-misses history, depressive symptoms, residual apnoea-hypopnea index, and adherence to treatment. RESULTS: Residual SAW under treatment was associated with an eight-fold higher incidence of near-misses related to sleepiness (hazard ratios [HR] = 8.63 [6.08-12.2]) and five-fold higher incidence of accidents related to sleepiness (HR = 5.24 [2.81-9.78]). Adherence ≤4 h/night was also a significant predictor of persistent driving risk (HR = 1.74 [1.12-2.71] for near-misses and HR = 3.20 [1.37-7.49] for accidents). CONCLUSIONS: Residual SAW and treatment adherence ≤4 h/night are easy-to-assess markers to detect persistent driving risk during the follow-up evaluations of patients under treatment. Health professionals, but also policymakers, should be aware of the crucial importance of systematically evaluating these elements during the follow-up evaluations of the patients with OSAS treated by CPAP to better evaluate their driving risk (137).

The comparison of STOP-BANG and no-apnoea questionnaires in screening obstructive sleep apnoea among commercial drivers

OBJECTIVE: No-apnoea questionnaire (NAQ) and STOP-BANG questionnaire (SBQ) are widely used for obstructive sleep apnoea (OSA) screening. This investigation aimed to compare the SBQ with the NAQ as an OSA screening tool among commercial drivers. METHODS: We included eligible commercial drivers who came to the Occupational Health clinic between March 2018 and March 2019. Participants filled out the SBQ, NAQ, and ESS questionnaires. The SBQ scores eight factors to assess OSA risk, with a score of ≥3 indicating high risk. The NAQ scores age and neck circumference for OSA risk, with ≥3 indicating significant risk. The ESS measures daytime sleepiness, with a score of ≥10 indicating excessive sleepiness as the most common symptom of OSA. The patients' scores were evaluated based on the set criteria. A McNemar test was used to determine the differences between SBQ and NAQ. The number of at-risk patients was measured for each screening test, and the correlation between the two screening methods was evaluated by measuring Cohen's kappa coefficient. RESULTS: A total number of 581 commercial drivers, with a mean age of 44.39 ± 9.16 years, participated. The mean SBQ score was 1.82 ± 0.78, with 17.7% of participants being at high risk of OSA. The

mean NAQ score was 3.48 ± 1.94, with 65.7% of participants being at high risk of OSA. About 48.6% of commercial drivers were at high risk, according to the NAQ but not SBQ. In contrast, 0.5% of participants were at high risk, according to SBQ, but not NAQ. Regarding ESS scores, among those identified as high risk for OSA by the SBQ, 13.6% exhibited an ESS score greater than 10. Similarly, within the high-risk group identified by the NAQ, this proportion was 14.1%. Cohen's kappa coefficient was 0.17, which is considerably low. A McNemar test also indicated that the SBQ and the NAQ didn't have equivalent diagnostic outcomes (P-value < 0.001). CONCLUSIONS: The NAQ identified more professional drivers at risk for OSA compared to the SBQ, suggesting that objective-based questionnaires may be more effective for screening in safety-sensitive jobs like commercial driving. However, further validation with polysomnography and cost-benefit considerations are needed to determine the most efficient and sustainable screening approach (138).

6.2. Other sleep disorders

"I know when to stop": sentinels and counterstrategies against drowsy driving in narcolepsy and idiopathic hypersomnia

STUDY OBJECTIVES: To collect prodromal symptoms experienced by participants with narcolepsy and idiopathic hypersomnia (considered "hypersomnolence experts") prior to drowsy driving and counterstrategies used to maintain alertness. METHODS: Systematic, face-to-face interview (using a semi-structured questionnaire), including clinical measures, frequency of car accidents/near misses, and symptoms experienced before impending drowsy driving episodes and counterstrategies. RESULTS: Among 61 participants (32 with narcolepsy, 29 with idiopathic hypersomnia; 56 drivers), 61% of drivers had at least one lifetime accident/near miss. They had a higher sleepiness score (14 ± 4 vs. 11 ± 5, p < .04) than those without an accident/near miss, but no other differences in demographics, driving experience, medical conditions, symptoms, sleep tests, and treatment. All but three participants experienced prodromal symptoms of drowsy driving, which included postural and motor changes (86.9%: axial hypotonia-e.g. eyelid droop, stereotyped movements), cognitive impairment (53.3%: automatic steering, difficulty concentrating/shifting, dissociation, mind wandering, dreaming), sensory (65%: paraesthesia, pain, stiffness, heaviness, blunted perceptions such as a flat dashboard with loss of 3D, illusions and hallucinations), and autonomic symptoms (10%, altered heart/breath rate, penile erection). Counterstrategies included self-stimulation from external sources (pain, cold air, music, drinks, and driving with bare feet), motor changes (upright posture and movements), and surprise (sudden braking). CONCLUSIONS: Drowsy driving symptoms can result from "local" NREM, entry in N1 sleep, and hybrid wake/REM sleep states. These rich qualitative insights from participants with narcolepsy and idiopathic hypersomnia, as well as sophisticated counterstrategies, can be gathered to reduce the crash risk in this population, but also in inexperienced healthy drivers (139).

7. Cardiology

How to assess fitness to drive in patients with cardiac rhythm disturbances through an applicable decision support system

Disturbances in cardiac rhythm affect a significant fraction of the population; they can have an ample range of repercussions on one person's quality of life, from negligible to lethal. As an implication, arrhythmias concern many private, commercial and public-passenger-vehicle driving licence holders. In their practice, medical professionals can be asked to assess an arrhythmia patient's fitness to drive effectively. Due to the subject's complexity (requiring an extent of multidisciplinary competencies), the current guidances' heterogeneity and the possible ethical conflicts, the decision-making process becomes challenging and of particular concern to the doctor. To offer an applicable decision support system to doctors of various backgrounds to implement in their practice when asked to assess for fitness to drive in a patient with a suspected disease, a formulated diagnosis or subjected to therapy for cardiac rhythm disturbances, we started gathering the issues concerning the fitness assessment of drivers (or candidates) who present with any condition, symptom or treatment possibly or knowingly caused by cardiac rhythm disturbances. Subsequently, we reviewed the English based literature, including various countries' published medical standards. Then, the overview was revised by local medical experts in clinical arrhythmology, electrophysiology and traffic medicine to reach a consensus statement at a local level. The result is an easily consultable operational protocol that lists conditions, symptoms or treatments caused or possibly caused by cardiac rhythm disturbances; the certifications required for the assessment of the driver (or candidate); the orientation about the fitness or unfitness to drive under the enlisted medical conditions (distinguishing between private and professional drivers); and the recommended time limits to revise the case. A particular focus is applied to patients subject to the remote monitoring system of an implantable cardiac device, as this innovative approach constitutes a solid and efficient instrument for an accurate evaluation of the patient's cardiovascular situation. Despite some limitations, mainly concerning the lack of information at the moment of the evaluation or the infrequency of the medical condition, this proposal offers a ready-to use solution for doctors who are asked to give their professional (clinical or medico-legal) opinion about the fitness to drive of patients with an arrhythmia problem. As an advantage, the constant cooperation among professionals from different backgrounds, like electrophysiologists and traffic medicine experts, allows a more individual, less predetermined evaluation of the specific case (140).

Incidence of ventricular arrhythmias after implantable cardioverter-defibrillator implantation or replacement, and driving restriction consequences

BACKGROUND: Following implantation/replacement of an implantable cardioverter defibrillator, patients are legally subjected to variable lengths of driving restrictions based on the indication (1 and 3 months after primary and secondary prevention, respectively; 1 week after device replacement). AIM: To assess the incidence of ventricular arrhythmia during the

theoretical driving restriction period in a large cohort of patients. METHODS: Patients who underwent implantable cardioverter-defibrillator implantation for primary or secondary prevention or device replacement between 2015 and 2021 were included retrospectively. The primary endpoint was the occurrence of ventricular arrhythmia during the theoretical driving restriction period, as defined by guidelines. RESULTS: A total of 914 patients were analysed, including 654 first implantations (438 and 216 for primary and secondary prevention, respectively) and 260 device replacements. The primary outcome occurred in 2/438 patients (0.004%) during the 1-month period following device implantation for primary prevention and in 25/216 patients (11.5%) during the 3-month period following device implantation for secondary prevention; it did not occur in the 1-week period following device replacement. The monthly calculated risk of harm remained below the accepted threshold of 0.005% for each group. CONCLUSIONS: Primary prevention patients, such as those who have undergone device replacement, have a low risk of ventricular arrhythmia, which could lead to a reduction in their driving restriction period. Secondary prevention patients experienced a higher risk of recurrent ventricular arrhythmia, supporting the 3-month driving restriction period (141).

Motor Vehicle Driving-Related Anxiety in Patients Undergoing Cardioverter Defibrillator Implantation and Cardiac Resynchronization Therapy With Defibrillators

BACKGROUND: Reducing anxiety about motor vehicle driving in patients receiving implantable cardioverter defibrillators and cardiac resynchronization therapy with defibrillators is important not only for improving quality of life but also for preventing vehicle collisions owing to driver distraction. This study aimed to clarify the driving-related anxiety of patients with these defibrillators and the factors that predict such anxiety. METHODS: We conducted a cross-sectional survey using a self-administered questionnaire of patients who had been driving a vehicle after device implantation at a general hospital between August 2018 and November 2019. RESULTS: The mean age was 60.8 ± 12.6 years. The reasons for implantation were primary prevention in 47 patients and secondary prevention in 30 patients. A total of 16 patients experienced anxiety about driving and 61 did not. Significantly more younger patients (mean age of 50.4 vs. 63.6 years, $p < 0.001$) and those with implantable cardioverter defibrillators had anxiety (100% vs. 73.8%, $p = 0.02$). Multivariable analysis indicated that age was the only independent factor that predicted driving-related anxiety (odds ratio, 0.937; 95% confidence interval, 0.883-0.993). CONCLUSIONS: Identifying and addressing driving-related anxiety in patients (particularly young patients) with defibrillators is important in preventing motor vehicle collisions and improving quality of life (142).

Motor vehicle crash risk after cardioverter-defibrillator implantation: a population-based cohort study

BACKGROUND: Limited empirical evidence informs driving restrictions after implantable cardioverter-defibrillator (ICD) implantation. We sought to evaluate real-world motor vehicle crash risks after ICD implantation. METHODS: We performed a retrospective cohort study using 22 years of population-based health and driving data from British Columbia, Canada

(2019 population: 5 million). Individuals with a first ICD implantation between 1997 and 2019 were age and sex matched to three controls. The primary outcome was involvement as a driver in a crash that was attended by police or that resulted in an insurance claim. We used survival analysis to compare crash risk in the first 6 months after ICD implantation to crash risk during a corresponding 6-month interval among controls. RESULTS: A crash occurred prior to a censoring event for 296 of 9373 individuals with ICDs and for 1077 of 28 119 controls, suggesting ICD implantation was associated with a reduced risk of subsequent crash (crude incidence rate, 8.5 vs 10.5 crashes per 100 person-years; adjusted HR (aHR), 0.71; 95% CI 0.61 to 0.83; p<0.001). Results were similar after stratification by primary versus secondary prevention ICD. Relative to controls, ICD patients had more traffic contraventions in the 3 years prior to ICD implantation but fewer contraventions in the 6 months after implantation, suggesting individuals reduced their road exposure (hours or miles driven per week) or drove more conservatively after ICD implantation. CONCLUSIONS: Crash risk is lower in the 6 months after ICD implantation than among matched controls, likely because individuals reduced their road exposure in order to comply with contemporary post implantation driving restrictions. Policymakers might consider liberalisation of post implantation driving restrictions while monitoring crash rates (143).

Cardioverter-Defibrillator Implantation as a Risk Factor For Motor Vehicle Crash

BACKGROUND: Limited empirical evidence informs fitness-to-drive recommendations after implantable cardioverter-defibrillator (ICD) implantation. Cohort designs can be deceptive because ICD recipients differ from control individuals and may temporarily cease driving after implantation. OBJECTIVES: This study sought to generate evidence to inform medical driving restrictions after ICD implantation. METHODS: We used population-based data to identify all drivers involved in a serious motor vehicle crash in British Columbia, Canada, from 1997 to 2019. Exposure was defined as ICD implantation in the 6 months before a crash. One analysis used a case-crossover design to control for relatively fixed individual characteristics like driving experience. Another analysis used a responsibility design to account for road exposure (miles of driving per week). Both analyses used logistic regression with adjustment for potential confounders. RESULTS: In the case-crossover analysis of crash-involved ICD recipients, ICD implantation occurred in 212 of 3,299 precrash intervals and in 485 of 6,598 control intervals, suggesting no temporal association between ICD implantation and subsequent crash (6.4% vs 7.4%; adjusted OR [aOR]: 0.86; 95% CI: 0.71-1.03; P = 0.11). In the analysis of all crash-involved drivers with determinate crash responsibility, 14 of 22 drivers with recent ICD implantation and 532,741 of 1,035,433 drivers without recent ICD implantation were deemed responsible for their crash, suggesting no association between ICD implantation and crash responsibility (crude proportion responsible, 64% vs 51%; aOR: 2.20; 95% CI: 0.94-5.30; P = 0.08). CONCLUSIONS: The 6-month interval after ICD implantation is not associated with increased odds of crash nor with increased likelihood of crash responsibility. Contemporary driving restrictions in the first weeks after ICD implantation appear to adequately mitigate the potential increase in crash risk (144).

8. Diabetes and endocrine

Diabetes and Driving: A Statement of the American Diabetes Association

Many people with diabetes in the U.S. will seek or currently hold a license to drive. For many, a driver's license is essential for everyday life. Considerable discussion has focused on whether, and the extent to which, diabetes may be a relevant factor in determining driver ability and eligibility for a license. This statement addresses such issues in relation to current scientific and medical evidence. A diagnosis of diabetes on its own is not sufficient to make judgments about an individual driver's ability or safety. This statement provides an overview of existing licensing rules for people with diabetes in the U.S., addresses the factors that affect driving ability, identifies general guidelines for assessing driver fitness and determining appropriately tailored licensing restrictions, and provides practical guidance for health care professionals regarding clinical interventions and education for people with diabetes (145).

Continuous glucose monitoring with low-glucose alerts in insulin-treated drivers with diabetes: A randomized crossover study

AIMS: This study aimed to evaluate the effectiveness of continuous glucose monitoring (CGM) with low-glucose alerts for preventing hypoglycaemia in insulin-treated drivers with diabetes. METHODS: This single-centre, open-label, randomized crossover study involved 30 insulin-treated participants with diabetes who drove cars at least thrice weekly in Japan. Participants underwent two 4-week periods: an alert period using CGM with active low glucose alerts and a no-alert period using blinded CGM without low-glucose alerts, separated by an eight-week washout period. The primary outcome was the percentage of time below range (TBR; <3.9 mmol/L). RESULTS: Twenty-seven of the 30 participants completed the CGM analysis. Although the TBR did not differ between the alert and no-alert periods among all participants, it significantly decreased during the alert period compared with the no-alert period among the participants with type 1 diabetes (-4.4 [95 % confidence interval - 8.7, - 0.08]%, p = 0.047). The incidence of low-glucose when driving was significantly lower during the alert period than during the no-alert period (19 % vs. 33 %, p = 0.041). CONCLUSION: Low-glucose alerts improved the TBR in drivers with type 1 diabetes and reduced the incidence of low-glucose while driving among all insulin-treated drivers, suggesting that these alerts may ensure the safety of insulin-treated drivers (146).

Real-World Insights Into Hypoglycaemia Risk While Driving in Teens and Young Adults With Type 1 Diabetes

Background: Clinical guidelines on driving for people with diabetes exist, but there are limited studies analysing glucose data and hypoglycaemia risk while driving. No published studies have analysed teenage or emerging adult drivers with type 1 diabetes (T1D). The primary aim of our pilot study was to explore the glycaemic patterns of young drivers with T1D as they relate to clinical guidelines and identify trends that could be used to improve

road safety. Methods: In this pilot study, we collected continuous glucose monitoring (CGM) data from five drivers with T1D (median age 19, range 17-21 years) over a 1-month period. The driving trips were divided into two categories: (1) Short trips (<60 min) and (2) Long trips (≥60 min). Hypoglycaemia was defined as <70 mg/dL as recorded by CGM for at least four consecutive readings. Trips <10 min were excluded from the analysis. Results: Data on 284 total trips with associated CGM readings were recorded. The average number of trips taken by drivers during the study was 56.8 trips (range 9-82). For short trips (n = 276), no episodes of hypoglycaemia occurred when starting glucose was >90 mg/dL (n = 227). For short trips with starting glucose of 70-90 mg/dL (n = 32), each hypoglycaemic event (n = 5) had a drop in the first CGM glucose value while driving. Seventeen (5.7%) of short trips started with a glucose <70 mg/dL. A total of eight long trips (>60 min) were recorded, all had a starting CGM value of >90 mg/dL, and none had hypoglycaemia events. Conclusions: These real-world findings from a small sample of teenage and young adult drivers with T1D support the American Diabetes Association (ADA) recommendation for starting glucose of >90 mg/dL when driving. Larger studies would be helpful in clearly identifying and improving road safety concerns in young drivers with T1D (147).

Automated Insulin Delivery Effects During Driving Among Older Adults with Type 1 Diabetes in a Randomized Trial

Dysglycemia among drivers with type 1 diabetes (T1D) is associated with impaired driving performance, and glucose levels "above 5 to drive" are often recommended for insulin-treated drivers. Evidence for diabetes treatments that support euglycemia while driving is minimal, particularly for older drivers. In this randomized, crossover trial involving adults aged ≥60 years with T1D, we used continuous glucose monitoring (CGM) during driving to compare the first-generation closed-loop automated insulin delivery (AID) versus a sensor-augmented pump therapy. There were 1894 trips undertaken by 8 drivers (median age 68 years [IQR: 64-70]). During AID versus sensor-augmented pump, time in range >5.0-10.0 mmol/L was greater (100% [0-100] vs. 81% [0-100]; P = 0.033) and fewer trips had any CGM >16.7 mmol/L (3.5% vs. 6.4%; P = 0.006). Three percent of all trips included CGM <3.9 mmol/L, with no between-stage difference (3.0% vs. 3.5%; P = 0.52). System alerts occurred in 10% of all trips, with no between-stage difference (9% vs. 11%; P = 0.078). First-generation AID reduces hyperglycaemic driving among older drivers with T1D, without increasing hypoglycaemia. Developing dedicated "driving-mode" settings could prioritize safety while minimizing distraction (148).

9. Temporary surgical and medical problems

9.1. Orthopaedic/injuries

Prediction of Placental Abruption of Pregnant Women Drivers with Various Collision Velocities, Seatbelt Positions and Placental Positions-Analysis with Novel Pregnant Occupant Model

The aims of this study were as follows: the (a) creation of a pregnant occupant finite element model based on pregnant uterine data from sonography, (b) development of the evaluation method for placental abruption using this model and (c) analysis of the effects of three factors (collision speed, seatbelt position and placental position) on the severity of placental abruption in simulations of vehicle collisions. The 30-week pregnant occupant model was developed with the uterine model including the placenta, uterine-placental interface, foetus, amniotic fluid and surrounding ligaments. A method for evaluating the severity of placental abruption on this pregnant model was established, and the effects of these factors on the severity of the injury were analysed. As a result, a higher risk of placental abruption was observed in high collision speeds, seatbelt position over the abdomen and anterior-fundal placenta. Lower collision speeds and seatbelt position on the iliac wings prevented severe placental abruption regardless of placental positions. These results suggested that safe driving and keeping seatbelt position on the iliac wings were essential to decrease the severity of this injury. From the analysis of the mechanism for placental abruption, the following hypothesis was proposed: a shear at adhesive sites between the uterus and placenta due to direct seatbelt loading to the uterus (149).

Assessing seatbelt use among pregnant drivers in Australia: Correct seatbelt positioning, discomfort, knowledge and information sources

BACKGROUND: Correct seatbelt use during pregnancy is critical for ensuring maternal and foetal safety during a motor vehicle crash. This study aimed to investigate seatbelt use among pregnant vehicle drivers in Australia, focusing on correct seatbelt positioning and the potential influence of comfort and the receipt of seatbelt information. METHOD: An online survey was completed by 1,491 participants (M = 33.2 years, SD = 4.1, Range = 18.0 - 50.0 years). RESULTS: While nearly all participants (99.1%) reported 'always' wearing their seatbelt while driving a vehicle, only 41.4% met the correct seatbelt positioning criteria, defined as positioning the lap belt under the belly and low over the upper thighs and the shoulder belt between the breasts. Despite increased discomfort with seatbelt use as pregnancy advanced, discomfort was not significantly associated with correct seatbelt positioning. Additionally, while most participants had not received information about seatbelt use during pregnancy (87.7%), those who did had better knowledge (96.2% vs. 90.5%, $\chi2(1) = 7.16$, $p < 0.05$), and were more likely to meet all three criteria for correct seatbelt positioning during pregnancy (56.8% vs. 39.3%, $\chi2(1) = 20.26$, $p < 0.001$), than participants who had not received information (90.5%). However, receiving information did not necessarily increase confidence in correct seatbelt use, as participants who had received information were actually less likely

to be confident in their ability to use the seatbelt correctly (3.3% vs. 6.6%, $\chi 2(2) = 8.24$, $p < 0.05$). CONCLUSIONS: These findings highlight a significant gap in correct seatbelt positioning among pregnant occupants and the scope for substantial improvement in correct positioning by providing specific information on seatbelt use during pregnancy. PRACTICAL APPLICATIONS: To improve correct seatbelt, use among pregnant individuals, public health messaging should be enhanced, and obstetrician gynaecologists, nurses and other healthcare professionals should provide clear guidance on correct seatbelt positioning throughout the pregnancy. Future research should focus on developing effective educational strategies, assessing vehicle design improvements for comfort and safety, and exploring other factors influencing correct seatbelt use during pregnancy (150).

Doctor, when can I drive? Characterization of driving behaviour of orthopedic and trauma surgery patients using a prospective questionnaire study

BACKGROUND: Individual mobility in road traffic is of high importance in Germany, both individually and socioeconomically; however, diseases and injuries of the musculoskeletal system in particular can lead to temporary impairments. The aim of this prospective patient survey was to record how patients assessed their driving capability during an injury and the associated immobilization and on what basis the decision on driving capability was made on the part of the patients. MATERIAL AND METHODS: A systematic questionnaire was used to analyse a total of 100 patients with a diagnosis in orthopaedics/trauma surgery and associated joint immobilization. In addition to personal data and the injuries/illnesses, an analysis on risk tolerance was performed and patients were asked about their knowledge regarding driving capability. Finally, it was recorded which patients drove a motor vehicle and for what reasons despite immobilization. RESULTS: Overall, 40.2% reported knowledge of the applicable laws regarding driving capability and 55.6% considered the treating physician to be responsible regarding the decision on driving capability. The patients who drove a motor vehicle reported higher personal and professional dependence on the motor vehicle (personal: 60.6% vs. 45.7%; professional: 48.5% vs. 36.1%). In the group of patients who drove a motor vehicle during immobilization, overall a fracture was less likely to be the reason for immobilization (33.3% vs. 51.0%). CONCLUSION: Overall, the patient population rated their knowledge of the law as low and viewed the treating physician as having the majority of the decision-making responsibility regarding driving capability. The patients who drove a motor vehicle during immobilization reported a higher personal as well as professional dependence on driving a motor vehicle. At the same time the injury severity had an influence on the decision, so that patients with fractures were more likely to avoid driving a motor vehicle. Further studies, particularly at the biomechanical level, are needed to ensure a better basis for the physician in making decisions with respect to the driving capability of orthopaedic and trauma surgery patients (151).

Factors That Influence Returning to Driving Following Primary Total Knee Arthroplasty: A Prospective Investigation

BACKGROUND: It is unclear when a patient can return to driving after total knee arthroplasty (TKA). Currently, most surgeons simply restrict all patients from driving for 4 to 6 weeks after TKA despite variability in patient age, general health, and physical capabilities. The primary objective of this study was to create novel clinical prediction calculators to estimate the return-to-driving time following primary TKA. METHODS: In this study, 167 patients who were undergoing a primary TKA were prospectively enrolled. Subjects received text message surveys every third day postoperatively to determine when they returned to driving. Subjects completed 8 physical performance manoeuvres at their 2, 6, and 12-week postoperative clinical appointments. Additionally, subjects completed return-to-driving surveys and a structured interview. Data on demographic characteristics, operative factors, patient-reported outcomes, and patient factors were collected. Cox proportional hazard and parametric survival models were utilized to create 2 novel calculators for predicting return to-driving time. RESULTS: There were 156 patients (mean age, 67.7 years [range, 39 to 83 years]) who completed the study. The median return-to-driving time was 18 days (interquartile range [IQR], 12 to 27 days). Univariate analysis demonstrated that male patients returned to driving sooner (18 days) than female patients (25.3 days) ($p < 0.001$) and that patients who underwent left-sided surgery returned to driving sooner (20.1 days) than patients who underwent right-sided surgery (24.4 days) ($p = 0.021$). For preoperative factors, age, sex, laterality, and preoperative Knee injury and Osteoarthritis Outcome Score (KOOS) had an effect on return-to-driving time and therefore were included in the novel preoperative clinical prediction calculator. For postoperative factors, age, sex, laterality, preoperative KOOS, and 6 metrics from the physical performance manoeuvres had an effect on return-to driving time and therefore were included in the novel postoperative physical performance based instrument. CONCLUSIONS: Overall, patients undergoing primary TKA returned to driving considerably earlier than previously reported. Patient-related factors and postoperative physical performance significantly affect return-to-driving time. Using the novel preoperative clinical prediction tool, individual patients can be advised when to expect to return to driving. After surgery, the novel postoperative physical performance-based instrument can inform patients when they may be ready to return to driving. LEVEL OF EVIDENCE: Prognostic Level II . See Instructions for Authors for a complete description of levels of evidence (152).

Driving after spine surgery: biomechanics, recovery pathways, and medico-legal insights

Returning to driving is a significant milestone for patients recovering from spine surgery, representing restored independence, mobility, and mental well-being. However, this decision involves numerous challenges, including biomechanical restrictions, the effects of pain management, cognitive recovery, patient-reported outcomes, and diverse medico-legal considerations. This review consolidates current evidence on recovery timelines, biomechanical factors, and the influence of medications on driving ability. It also examines

the role of regional legal frameworks and professional guidelines in shaping decisions by both patients and surgeons. Additionally, it highlights interdisciplinary approaches to enhance post-operative care and discusses the broader relevance of these findings for other medical fields, proposing future research to advance understanding in this area (153).

Factors Influencing Early Return to Driving in a Contemporary Arthroplasty Population

BACKGROUND: As arthroplasty techniques become more advanced, patients recover more rapidly. Is this same trend observed with patients' ability to drive after hip and knee replacement? The purpose of this study was to evaluate the impact of various factors on patients' ability to drive within 4 weeks after primary hip or knee arthroplasty to better counsel patients on their return to driving postoperatively. MATERIALS AND METHODS: This retrospective cohort study investigated 1146 patients who underwent primary joint arthroplasty. These patients were surveyed 3 to 4 weeks after surgery, and 851 patients were included in the analysis. Univariate and multivariate analyses were performed to determine which factors were associated with return to driving. RESULTS: Among the patients, 47.0% (n=382) returned to driving within 4 weeks of their procedure, with a mean postoperative time of 16.0±6.3 days. Factors significantly correlated with an early return to driving based on univariate analysis included younger age at surgery, lower body mass index, male sex, prior daily driving, same-day discharge, higher scores on patient-reported outcome measures, left-sided procedure, unicompartmental knee arthroplasty (UKA), no walking aids, and no use of narcotic pain medication. Multivariate Cox regression analysis revealed that male sex (hazard ratio [HR], 2.19), same-day discharge (HR, 1.86), prior daily driving (HR, 1.81), left sided surgery (HR, 1.62), and type of procedure (UKA: HR, 1.65; total hip arthroplasty by the direct anterior approach: HR, 1.50) were associated with early return to driving. CONCLUSION: Many patient, surgical, and rehabilitation factors can impact the ability of primary arthroplasty patients to return to driving within 4 weeks of surgery. This large cohort incorporating current surgical techniques can support surgeons to better counsel patients on their expected return to driving (154).

10. Miscellaneous

10.1. Hospitalisation

Driving behaviour and driving outcomes after acute and critical illness: A systematic review
BACKGROUND: Adults recovering from hospitalization for acute or critical illnesses often face new or worsening physical and cognitive impairments, which can impact their driving abilities and safety. The purpose of this review is to synthesize evidence on driving behaviours and outcomes in the six months following hospitalization for acute or critical illness to guide patient care, provider recommendations, and future research. METHODS: A comprehensive search was conducted on PubMed, CINAHL, PsycINFO, and Cochrane databases from 1997 to October 20, 2023 with forward and backward searches. Primary empirical research involving vehicle drivers was included. Studies were excluded if they involved fewer than five participants, or if they focused on acute medical conditions with established driving rehabilitation programs. Two reviewers screened abstracts and full texts, resolving discrepancies through discussion. RESULTS: Nineteen studies met the inclusion criteria. Driving behaviour and safety data from these studies were derived from simulators (n = 10), self-reports (n = 8) and administrative/regulatory datasets (n = 1). Simulation studies primarily focused on post-surgical populations, and brake reaction times. Self-report studies highlighted driving suspension, cessation, and perceived safety issues. The heterogeneity of study designs and populations limited formal meta-analyses. DISCUSSION: The evidence on driving safety and behaviour post-hospitalization is heterogeneous and sparse, with some studies indicating no significant change in collision rates and others showing increased risks. Consequently, clinicians face challenges in recommendations on return to driving. There is a need for robust study designs and naturalistic driving studies to examine the specific impacts of hospitalization on driving safety and to develop evidence-based guidelines to address discharge planning to answer questions of "when should I return to driving?" (155).

Driving ability after conscious sedation: a systematic review
INTRODUCTION: Conscious sedation is widely used in medicine but may cause impairment of psychomotor and cognitive function that affect some aspects of a patient's life, such as car driving. This systematic review aims to summarize available evidence (direct or indirect) on driving ability after conscious sedation. EVIDENCE ACQUISITION: A comprehensive search was conducted including MEDLINE/PubMed, EMBASE, SCOPUS, clinicaltrials.gov and the Cochrane Database of Systematic Reviews through June 2022. Randomized and non-randomized controlled trials were included. PRISMA guidelines were followed. Risk of bias was appraised as reported in the Cochrane Handbook for Systematic Reviews of Interventions. EVIDENCE SYNTHESIS: A narrative synthesis of 27 studies (962 subjects) was conducted, because the heterogeneity in terms of interventions and comparators, method and timing of assessment, and outcome measures precluded the feasibility of a meaningful meta-analysis. Conscious sedation was associated with different degrees of impairment in driving ability (real car driving, simulated driving, subjective perception), and psychomotor and cognitive functions

(body sway, sleepiness, adaptive tracking, critical flicker fusion frequency, reaction/attention skills) at 0.5-10 hours after drug administration. CONCLUSIONS: The results obtained from this review should be interpreted as a renewed recommendation to avoid driving after conscious sedation is administered. Yet it is not possible to determine when this ability is recovered, leaving this crucial and essential information to future, well-designed and reproducible research (156).

10.2. Pharmacology

Zopiclone as a Potent Positive Control for Assessing the Residual Effects of Hypnotic Drugs on Next Day Driving Performance: A Systematic Review

AIM: This systematic review aimed to evaluate the efficacy of zopiclone as a potent positive control for the assessment of residual effects of hypnotic drugs on the next day driving performance in clinical trials. METHODOLOGY: Online databases and websites were used to conduct a literature search to identify relevant clinical trials encompassing the use of zopiclone as a positive control and the trials examining the residual effects of zopiclone on the next day driving performance. A total of 22 articles were identified and as per the inclusion criteria, 16 were selected for final data retrieval. RESULTS: The average difference in Standard Deviation of Lateral Position (SDLP) between zopiclone and a placebo ranged from 1.6 to 4.74 cm. On average, this difference was about 2.51 cm, indicating significant impairment in driving ability the day after taking zopiclone. Therefore, current studies demonstrate zopiclone administration impairs driving performance, as indicated by increased standard deviation of lateral position (SDLP) values. Additionally, the reported adverse events included somnolence, dyspepsia, fatigue, headache, dizziness, gastrointestinal disorders, and upper respiratory tract problems. CONCLUSION: Zopiclone can serve as a reliable positive control in future clinical trials assessing the residual effects of hypnotic drugs on next-day driving performance (157).

Residual next-day effects of alprazolam on psychomotor performance and simulated driving in healthy normal adults

The prevalence of drugged driving has increased in the United States. Some drugged driving may be unintentional as prescription medications used as sleeping aids, like zolpidem, cause impairment after the predicted duration of therapeutic action has elapsed. The aim of this study was to determine if nighttime administration of alprazolam, a drug commonly prescribed off-label as a sleeping aid, impacts driving performance the following day. Participants were healthy adults (n = 15) who completed a double-blind, double-dummy, within-subjects inpatient study examining the effects of nighttime administration of alprazolam (0.5, 1, and 2 mg), zolpidem (10 mg), and placebo on driving performance the following day. Alprazolam (1 mg; morning) and zolpidem (nighttime) both served as positive control conditions. Driving simulator measures, cognitive and psychomotor tasks, and questionnaires querying drug effects were collected the afternoon before drug administration and for 5.5 hr the next day and analysed using symmetry and mixed-model approaches.

Morning alprazolam significantly impaired driving performance. Driving impairment was observed up to 12.5 hr after nighttime alprazolam 2 mg and for 8.5 hr after nighttime zolpidem 10 mg. Participant reports on driving ability indicated that they were not aware of their level of impairment. These results suggest that alprazolam used before bed may pose a yet unrecognized public safety risk in the form of next-day drugged driving (158).

Drug driving, sedation, reaction time and blood levels: a prescriber's approach to the Land Transport (Drug Driving) Amendment Act 2022

AIM: To update prescribers about the revised Land Transport (Drug Driving) Amendment Act 2022 (LTAA) and implications for prescribing. METHODS: We reviewed the legislation of the LTAA and the specific drugs identified in it, mainly benzodiazepines and opioids. We also briefly reviewed published evidence on the impact of benzodiazepines and opioids on driving. RESULTS: Both opioids and benzodiazepines are associated with increased accidents in observational (non-controlled) studies, though the odds ratios are small (at most 1.65 for benzodiazepines and around 2.0 for opioids), and accident events are rare. Prescribers are not advised to do blood levels or bedside testing to assess driving fitness. They should consult a peer group or mental health pharmacist when advising patients taking multiple psychoactive medications if they are safe to drive. CONCLUSION: There are no current jurisprudence or guidelines for prescribers on how to interact with the LTAA. Nor is it clear if or how investigations or complaints relating to the LTAA would be handled by the Health and Disability Commissioner (HDC), the Medical Council of New Zealand and/or the Coroner. Until more detailed instructions are published, this article should provide some guidance for professionals who prescribe benzodiazepines or opioids (159).

Driving performance of long-term users of sedating antidepressants and benzodiazepines

OBJECTIVE: Using benzodiazepines and certain antidepressants is associated with an increased risk of motor vehicle crashes due to impaired driving skills. Hence, several countries prohibit people who use these drugs from driving. Traffic regulations for driving under the influence of these drugs are, however, largely based on single-dose studies with healthy participants. The effects of drugs on chronic users may be different because of potential development of tolerance or by adapting behaviour. In this study, we test the effects of anti-depressants, hypnotics, or anxiolytics use on driving performance in patients who use these drugs for different durations and compare the effects to healthy controls' performance. METHODS: Sixty-six healthy controls and 82 medication users were recruited to perform four drives in a driving simulator. Patients were divided into groups that used anti-depressants, hypnotics, or anxiolytics, for shorter or longer than 3 years (i.e. LT3- or LT3+, respectively). The minimum term of use was 6 months. Driving behaviour was measured in terms of longitudinal and lateral control (speed variability and Standard Deviation of Lateral Position: SDLP), brake reaction time, and time headway. Impaired driving performance was defined as performing similar to driving with a Blood Alcohol Concentration of 0.5‰ or higher, determined by means of non-inferiority analyses. RESULTS: Reaction time analyses revealed inconclusive findings in

all groups. No significant performance differences between matched healthy controls, LT3- (n = 2), and LT3+ (n = 8) anxiolytics users were found. LT3+ antidepressants users (n = 12) did not perform inferior to their matched controls in terms of SDLP. LT3- hypnotics users (n = 6) showed more speed variability than their matched healthy controls, while this effect was not found for the LT3+ group (n = 14): the latter did not perform inferior to the healthy controls. Regarding Time Headway, no conclusions about the LT3- hypnotics group could be drawn, while the LT3+ group did not perform inferior compared to the control group. CONCLUSIONS: The small number of anxiolytics users prohibits drawing conclusions about clinical relevance. Although many outcomes were inconclusive, there is evidence that some elements of complex driving performance may not be impaired (anymore) after using antidepressants or hypnotics longer than 3 years (160).

10.3. Gastroenterology

Prior overt hepatic encephalopathy and hyponatremia are more strongly linked to recent driving accidents than measures of minimal hepatic encephalopathy

BACKGROUND: Cognitive impairment in cirrhosis is driven by multiple influencers. Those with cognitive impairment have greater traffic accidents and violations. While the presence of minimal hepatic encephalopathy has been associated with poor driving skills, studies show conflicting results and variable associations with regard to accidents. METHODS: In a prospective study of stable outpatients with cirrhosis without a recent history of overt hepatic encephalopathy (OHE) (<3 months), we assessed, the overall practice of driving, recent (<1 month) self-reported accidents, and factors associated with driving accidents. RESULTS: Of 433 patients, 147 (33.9%) [age, 55 (46-61) years, 97.9% males, 29.9% alcohol-related, 13.6% prior OHE, MELD 11 (10-16), lactulose use 45.5%, rifaximin use 23.1%] reported recent driving (≤1 month), of whom 22 (14.9%) had recent driving accidents. Those with reported accidents had a higher history of prior OHE (31.8 vs. 10.5%, P < 0.05) and lower sodium [131 (129-134) vs. 134 (132-138), P < 0.05]. Psychometric hepatic encephalopathy score (PHES) [-5.5 (-4 to -9), vs. -4 (-3 to -7), P = 0.10], alcohol as an aetiology (22.7 vs. 31.2%, P = 0.68), MELD [12.5 (10-17) vs. 11 (9.7-16), P = 0.36], animal naming test [18 (16-23) vs. 18 (15-22), P = 0.35], outpatient fasting ammonia [93 (63.7-121.5) vs. 81 (67.2-96.2), P = 0.43] were similar. On univariate analysis, prior OHE, sodium levels and PHES [odds ratio (OR): 0.87 (0.75-1.0), P = 0.09], and animal naming test [OR: 0.89 (0.76-1.04), P = 0.10)] showed a trend of association, while on multivariable analysis only prior OHE [adjusted OR: 3.48 (1.07-10.74), P = 0.03] and sodium levels [adjusted OR: 0.89 (0.79-0.99), P = 0.03] were associated with recent driving accidents [model AUC (prior OHE + Na≤130), 0.70 (0.62-0.77)]. CONCLUSION: In stable outpatients with cirrhosis, a remote history of OHE and hyponatremia are most strongly associated with recent driving accidents (161).

10.4. Allergies

Driving under the influence of allergies: the effect of seasonal pollen on traffic fatalities

Traffic fatalities are the leading cause of mortality in the United States despite being preventable. While several policies have been introduced to improve traffic safety and their effects have been well documented, the role of transitory health shocks or situational factors at explaining variations in fatal traffic accidents has been understudied. Exploring daily variation in city-specific pollen counts, this study finds novel evidence that traffic fatalities increase on days in which the local pollen count is particularly high. We find that the effects are present in accidents involving private vehicles and occur most frequently on the weekends, suggesting potentially the missed opportunity to avoid these fatalities. We do not find similar effects for fleet vehicles. These findings remain robust to alternative specifications and alternative definitions of high pollen count. Taken together, this study finds evidence that a prevalent and transitory exogenous health-shock, namely pollen allergies, increases traffic fatalities. Given our lack of evidence of avoidance, these effects are not mechanical and are likely driven by cognitive impairments that arise as a result of seasonal allergies (162).

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