EXAMINING THE FMCSA VISION STANDARD AND VISION WAIVER PROGRAM FOR COMMERCIAL MOTOR VEHICLE DRIVERS

DTMC75-14-D-00011L Task Order 7006

Detailed Evaluation of Vision and Safety Letter Report

DRAFT

Prepared by:

Karlene Ball, Gerald McGwin, and Cynthia Owsley

University of Alabama at Birmingham

Submitted:

April 16, 2018

INTRODUCTION

One of the main objectives of the current study was to determine the safety efficacy of current Department of Transportation (DOT) visual performance standards, the vision waiver, and the availability and efficacy of additional tests used to measure visual performance components essential for safe CMV driving.

Specifically, the study aimed to:

1. Evaluate the availability and efficacy of commercially available visual performance tests to measure visual performance components critical to safe CMV driving tasks.
2. Evaluate the crash risks of drivers operating under the vision waiver with specific visual conditions, such as monocular vision, red-green color deficiency, loss of visual field, cataracts, and diplopia using crash rate comparisons between CMV drivers with and without these conditions.
3. Compare crash risks of CMV drivers with 20/40 vision and those with visual acuity higher than 20/40.
4. Derive the best predictive model to determine the potential impact on CMV crashes of changing the visual acuity standard.

To address these aims, the proposed work involved the acquisition of a comprehensive dataset from Road Ready, Inc., which includes all data obtained during the DOT medical exam of commercial motor vehicle (CMV) drivers dating back to 2005 (Appendix A). However, it was later determined that only variables related to the visual function measures would be provided. These variables are highlighted in Appendix A. This dataset was linked to crash data provided by FMCSA through the MCMIS (Motor Carrier Management Information System) (Appendix B). MCMIS is an information system that captures data from field offices through SAFETYNET, CAPRI, and other sources. MCMIS utilizes an Oracle database with a web interface. It is a source for FMCSA inspection, crash, compliance review, safety audit, and registration data.

METHODS

Participants

From the Road Ready, Inc. dataset, of the 189,749 records there were 18,501 records that were missing driver identification number and/or an exam completion date and therefore excluded from the analysis. Of the remaining 171,248 records, there were 366 with a duplicate exam completion date for the same participants, these records were also omitted. Of the 58,831 records in the collision dataset, 33,451 records were duplicates and therefore excluded. The remaining 25,380 crash records represented collisions occurring among 20,805 unique individuals. When the examination and collision datasets were merged and collisions occurring prior to the exam date were excluded, a total of 19,468 drivers had at least one collision record available for analysis.

Variables

Road Ready, Inc. provided a subset of the variables available from the DOT medical exam of commercial motor vehicle (CMV) drivers (the variables provided are highlighted in the overall list of medical exam data in Appendix A). From the examination dataset provided, age and gender were extracted as well as the variables from the results of visual function testing, including visual acuity (Snellen acuity for each eye without correction, as well as with their current correction, and both eyes without correction as well as with current correction), and horizontal field of view (either less than or greater than 70 degrees) for each eye. Color recognition was reported in terms of whether or not a driver could recognize and distinguish among traffic control signals and devices showing red, green, and amber colors. Finally the there was a measure indicating whether or not the driver had monocular vision.

In addition to the visual function measures, the “notes fields” of the dataset which contained generic text notes from the examiner were searched for any mention of eye disease. Specifically the

notes were electronically searched for mention of cataract, glaucoma, age-related macular degeneration (AMD), and diabetic retinopathy (under a variety of spellings), which are the most common vision-impairing eye conditions in adults > 40 years old in the US. To determine whether or not these comments on eye disease from the text fields should also be included in the analysis with the other visual function measures, the prevalence of these comments was then compared to the prevalence of these conditions based on U.S. population estimates for persons aged 40 years and older. The prevalence of these terms in the examiner notes was approximately ten times lower than one would expect in the U.S. population (see below). Therefore it was not deemed fruitful to analyze mention of eye disease in the notes section further relative to collision rate.

Cataract	0.6%	17.1%
Glaucoma	0.2%	1.9%
AMD	0.01%	1.5%
Diabetic Retinopathy	0.01%	5.4%

Statistical Analysis

For each participant the number of person-days a given individual was driving was calculated from their examination date until December 31, 2016; each participant's number of collisions over the same time period was also calculated. Poisson regression was used to estimate rate ratios (RRs) and 95% confidence intervals for the association between demographic and vision characteristics and motor vehicle collision occurrence obtained from the FMCSA.

While comparing those CMV drivers with waivers to those without was a primary goal of the project, the Road Ready, Inc. dataset had insufficient numbers of drivers with waivers (N=53) to perform a meaningful analysis. Of these 53 drivers, only one had a collision.

RESULTS

Table 1 presents the descriptive statistics as well as collision rates, RRs, 95% CIs and p-values for age and gender. In general, the collision rates are lower for drivers aged 30 and older compared to younger drivers (who served as the reference group); the oldest drivers had the lowest collision rates. The collision rate among males was 43-percent higher than that of females (who served as the reference group for sex).

TABLE 1. Collision Rates, Rate Ratios and 95% Confidence Intervals for Age and Gender

	No. (%) of Participants	Collision Rate per 100 000 Person Days	Rate Ratio (95% Confidence Interval)	p-value
Age				
<30	28 129 (16.5)	5.0	1.00	
30-39	46 192 (27.0)	4.7	0.94 (0.90-0.98)	0.0039
40-49	52 929 (31.0)	4.8	0.96 (0.92-1.00)	0.0629
50-59	34 331 (20.1)	4.9	0.98 (0.94-1.03)	0.4315
60+	9 276 (5.4)	4.3	0.87 (0.81-0.94)	0.0006
Sex				
Female	7943 (4.7)	3.4	1.00	
Male	162914 (95.4)	4.8	1.43 (1.32-1.55)	<0.0001

Table 2 presents the descriptive statistics as well as collision rates, RRs, 95% CIs and p-values for the visual function measurements and characteristics. Analyses were also repeated while adjusting for age and gender, which had no impact on the significance of any p values and had no bearing on the results. Participants with worse than 20/40 visual acuity in their better eye with their current correction had significantly elevated collision rates; there was no such association for the worse eye. Compared to participants whose visual acuity was better than 20/40 in both eyes with their current correction, those with 20/40 for worse acuity in both eyes had a slight but significantly increased collision rate. Participants with worse than 20/40 visual acuity in one eye with their current correction had lower collision rates. With respect to horizontal field of view, participants with <70 degrees in the right or left eye had significantly or borderline significantly elevated collision rates, respectively. Those who were

impaired in both eyes had elevated collision rates; those with just one eye impaired did not. The strongest association was observed for participants with color vision impairment whose collision rate was 1.39-times higher than that of unimpaired drivers. There was no significant association between monocular vision and collision occurrence.

TABLE 2. Collision Rates, Rate Ratios and 95% Confidence Intervals for Visual Function Measurements and Characteristics

	No. (%) of Participants	Collision Rate per 100 000 Person Days	Rate Ratio (95% Confidence Interval)	p-value
Acuity - Better Eye				
20/40 or better	162 685 (88.7)	4.8	1.00	
Worse than 20/40	8 159 (11.3)	5.2	1.10 (1.02-1.18)	0.0092
Acuity - Worse Eye				
20/40 or better	151 610 (95.2)	4.8	1.00	
Worse than 20/40	19 234 (4.8)	4.8	1.00 (0.96-1.05)	0.8627
Acuity - Both Eyes				
Both eyes 20/40 or better	15 1610 (88.7)	4.8	1.00	
One eye worse than 20/40	11 075 (6.5)	4.5	0.95 (0.89-1.01)	0.0795
Both eyes worse than 20/40	8 159 (4.8)	5.2	1.09 (1.02-1.17)	0.0122
Horizontal Field of View				
Right eye				
<70 degrees	2 441 (1.4)	5.5	1.15 (1.04-1.27)	0.0057
>70 degrees	168 414 (98.6)	4.8	1.00	
Left eye				
<70 degrees	2 827 (1.7)	5.2	1.09 (0.99-1.20)	0.0737
>70 degrees	168 028 (98.4)	4.8	1.00	
Neither eye	167 741 (98.2)	4.8	1.00	
Either eye	960 (0.6)	4.4	0.92 (0.77-1.11)	0.3761
Both eyes	2 154 (1.3)	5.5	1.16 (1.04-1.29)	0.0059
Recognizes Colors				
Yes	170 645 (99.9)	4.8	1.00	
No	210 (0.1)	6.6	1.39 (1.03-1.88)	0.0294
Monocular Vision				
No	170 393 (99.7)	4.8	1.00	
Yes	462 (0.3)	4.3	0.89 (0.69-1.16	0.3936

DISCUSSION

Not surprisingly, the youngest CMV drivers, younger than 30 years of age, were the age group with the highest collision rate. This is a common finding among commercial drivers. Relative to this youngest age group, the oldest CMV drivers at sixty years and older had the lowest collision rate, and also represented the fewest number of drivers in this sample (5.4% of those driving). In addition, female drivers had significantly fewer collisions than the male drivers. Female drivers were also a small subset (<5%) of the drivers represented in the sample.

With respect to the visual function measures, those with worse than 20/40 visual acuity in their better eye had a significantly higher collision rate than those with 20/40 or better visual acuity in their better eye. GwThese results were seen again in that those with both eyes better than 20/40 had a significantly lower collision rate than those with both eyes worse than 20/40 visual acuity. Similarly, collision rates were elevated for those drivers with reduced horizontal field of view, particularly when both eyes exhibited the impairment. These results are consistent with the driving research literature of drivers of personal vehicles which has indicated statistically significant, but relatively weak relationships between collision involvement and visual acuity and horizontal field of view impairment. Despite the statistical significance of these results, given the large sample size, the absolute risk is very low.

With respect to color vision, those drivers who did not recognize colors on a traffic control device had a significantly elevated collision rate relative to those who did not exhibit impaired color vision. In this instance, drivers with color vision impairment had a collision rate 1.39 times higher than that of those with normal color vision as measured by this test. These findings, however, could be a

surrogate for retinal disease or anterior segment conditions of the eye that impact color vision; eye condition data were not systematically available in the dataset to allow the test of this hypothesis.

Finally, with respect to monocular vision, there was no evidence that those with this condition were at increased risk of collision. In fact, those with monocular vision had a collision rate of 4.3 relative to 4.8 for those with binocular vision.

Strengths and Limitations

The strengths of this analysis included the large number of medical exams provided in the database, and the ability to link these exams with the MCMIS dataset provided through FMCSA. There were, however, several limitations. First, it was not possible to evaluate the impact of diagnosed eye disease given the very infrequent mention of such conditions in the examiner notes. It is impossible to know how to interpret the mention of eye disease in these notes since specific prompts for reporting the presence of eye disease were not used in the examination, and this was not standardized across examiners. Additionally, other health conditions which could potentially impact visual function and collision risk, such as diabetes, heart disease, and hypertension, were not available to evaluate as confounders in the analyses. Finally, there were very few waivers reported for any of the drivers in the dataset (n = 52 drivers). Only one of these 52 had a collision. Thus there were not enough drivers with waivers in the sample for a valid comparison.

Recommendation

Based on the sample and variables provided, there appears to be no grounds for changing the vision standards at this time. Making the standards more stringent would most likely reduce the CMV workforce with very little impact on safety given that the relationships themselves were weak and the

absolute risk, given the size of the dataset was very low. It is not known whether the number of waivers provided for CMV drivers is as low as indicated by this dataset, but with the data provided it was not possible to evaluate the impact of that program on driving safety.

APPENDIX A: MEDICAL EXAM DATA ELEMENTS

Data Element	Definition
Driver's License State (DLState)	[Max field length 2] Issuing State/Province of driver's license.
Completion Date (Completion Date)	[Max field length] Date exam was completed. (MM/DD/YYYY)
Exam Date	Date exam was initiated (MM/DD/YYY)
Driver's License Class (CLClassID)	[Max field length 1] Class of driver's license. (2=A, 3=B, 4=C, 5=D, 6=Other)
Gender	[Max field length 6] Gender of driver.
Age (Age)	[Max field length 3] Age of driver.
Height (Height)	[Max field length 5] Height in inches of driver.
Weight (Weight)	[Max field length 3] Weight of driver in pounds.
Blood Pressure (Blood Pressure)	[Max field length 13] Blood pressure of driver. (Systolic/Diastolic)
Systolic Blood Pressure (Systolic)	[Max field length 6] Systolic blood pressure of driver.
Diastolic Blood Pressure (Diastolic)	[Max field length 6] Diastolic blood pressure of driver.
Heart Rate (Heart Rate)	[Max field length 3] Heart rate of driver.
Urine Sugar (UrineSugar)	[Max field length 15] Sugar concentration of driver's urine from urinalysis.
Urine Blood (UrineBlood)	[Max field length 5] Concentration of blood in driver's urine from urinalysis.
Urine Protein	[Max field length13] Concentration of protein in driver's urine from urinalysis.

Data Element	Definition
(UrineProtein)	
Urine Specific Gravity (UrineSPGR)	[Max field length 6] Specific gravity of driver's urine from urinalysis.
Head or Brain Injuries (HeadBrainInjuries)	[Max field length 1] Indicates whether or not driver has or has ever had head or brain injuries or illnesses.
Seizures or Epilepsy (SeizureEpilepsy)	[Max field length 1] Indicates whether or not driver has or has ever had seizures, epilepsy.
Eye Disorders (EyeDisorders)	[Max field length 1] Indicates whether or not driver has or has ever had eye problems, except glasses or contacts.
Ear Disorders (EarDisorders)	[Max field length 1] Indicates whether or not driver has or has ever had ear and/or hearing problems.
Heart Disease (Heart Disease)	[Max field length 1] Indicates whether or not driver has or has ever had heart disease, heart attack, bypass, or other heart problems.
Heart Surgery (Heart Surgery)	[Max field length 1] Indicates whether or not driver has or has ever had pacemaker, stents, implantable devices, or other heart procedures.
High Blood Pressure (HighBloodPressure)	[Max field length 1] Indicates whether or not driver has or has ever had high blood pressure.
Shortness of Breath (ShortnessOfBreath)	[Max field length 1] Indicates whether or not driver has or has ever had chronic (long-term) cough, shortness of breath, or other breathing problems.
Lung Disease (LungDisease)	[Max field length 1] Indicates whether or not driver has or has ever had lung disease.
Kidney Disease (KidneyDisease)	[Max field length 1] Indicates whether or not driver has or has ever had kidney problems, kidney stones, or pain/problems with urination.
Diabetes (Diabetes)	[Max field length 1] Indicates whether or not driver has or has ever had diabetes or blood sugar problems.
Diabetes Control, Insulin (DiabetesControlInsulin)	[Max field length 1] Indicates whether or not driver has or has ever had diabetes or blood sugar problems controlled by insulin.

Data Element	Definition
Sleep Disorders (SleepDisorders)	[Max field length 1] Indicates whether or not driver has or has ever had sleep disorders, pauses in breathing while asleep, daytime sleepiness, loud snoring.
Frequent Alcohol Use (FrequentAlcoholUse)	[Max field length 1] Indicates whether or not driver currently drinks alcohol.
Right Eye Uncorrected Vision (RtEyeUnCorrected)	[Max field length 2] Visual acuity of driver's right eye, uncorrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Left Eye Uncorrected Vision (LtEyeUncorrected)	[Max field length 2] Visual acuity of driver's left eye, uncorrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Both Eyes Uncorrected Vision (BothEyesUncorrected)	[Max field length 2] Visual acuity of both of driver's eyes, uncorrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Right Eye Corrected Vision (RtEyeCorrected)	[Max field length 2] Visual acuity of driver's right eye, corrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Left Eye Corrected Vision (LtEyeCorrected)	[Max field length 2] Visual acuity of driver's left eye, corrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Both Eyes Corrected Vision (BothEyesCorrected)	[Max field length 2] Visual acuity of both of driver's eyes, corrected. (2=20/10, 3=20/13, 4=20/15, 5=20/20, 6=20/25, 7=20/30, 8=20/35, 9=20/40, 10=20/50, 11=20/70, 12=20/100, 13=20/200, 14=20/400, 15=No Vision)
Color Recognition (Recognizes Colors)	[Max field length 1] Indicates whether or not driver can recognize and distinguish among traffic control signals and devices showing red, green, and amber colors.
Requires Vision Correction (RequiresVisionCorrection)	[Max field length 1] Indicates whether or not driver was referred to ophthalmologist or optometrist.
Monocular Vision (MonocularVision)	[Max field length 1] Indicates whether or not driver has monocular vision.
HFOV, Right (HFOVRightID)	[Max field length 1] Indicates Horizontal Field of View for the driver's right eye. (1= >70 degrees, 2= <70 degrees)

Data Element	Definition
HFOV, Left (HFOVLeftID	[Max field length 1] Indicates Horizontal Field of View for the driver's left eye. (1= >70 degrees, 2= <70 degrees)
Hearing Distance, Right (Hearing DistanceRight)	[Max field length 1] Indicates results of Whisper Test. Distance (in feet) from driver at which a forced whispered voice can first be heard by the right ear. (2= >=5 feet, 3= 4 feet, 4= 3 feet, 5= 2 feet, 6= 1 foot, 7= audiometry, 8= 0 feet)
Hearing Distance, Left (HearingDistanceLeft)	[Max field length 1] Indicates results of Whisper Test. Distance (in feet) from driver at which a forced whispered voice can first be heard by the left ear. (2= >=5 feet, 3= 4 feet, 4= 3 feet, 5= 2 feet, 6= 1 foot, 7= audiometry, 8= 0 feet)
Physical Examination: Abdomen (abdomen)	[Max field length 1] Indicates whether or not driver's abdomen appears normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Ear (ear)	[Max field length 1] Indicates whether or not driver's ears appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Extremities/Joints (Extremities)	[Max field length 1] Indicates whether or not driver's extremities and joints appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Eyes (eyes)	[Max field length 1] Indicates whether or not driver's eyes appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Cardiovascular (Heart)	[Max field length 1] Indicates whether or not driver's cardiovascular system appears normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Lungs/Chest (lungs)	[Max field length 1] Indicates whether or not driver's lungs and chest appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Mouth/Throat (Mouth)	[Max field length 1] Indicates whether or not driver's mouth and throat appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Neurological system (Neurological)	[Max field length 1] Indicates whether or not driver's neurological system, including reflexes, appears normal or abnormal. (0=Normal, 1= Abnormal)

Data Element	Definition
Physical Examination: Back/Spine (Spinal)	[Max field length 1] Indicates whether or not driver's back and spine appear normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Genito-Urinary System (Urinary)	[Max field length 1] Indicates whether or not driver's genito-urinary system, including hernias, appears normal or abnormal. (0=Normal, 1= Abnormal)
Physical Examination: Vascular System (Vascular)	[Max field length 1] Indicates whether or not driver's vascular system appears normal or abnormal. (0=Normal, 1= Abnormal)
Comments (Comments)	Driver's comments to positive medical history.
Physician Comments (PhysicianComments)	Physician's comments to driver's positive medical history.
Exam Comments (ExamComments)	Examiner's comments on physical examination.
Other Testing Comments (OtherTestingComments)	Comments from testing lab.

APPENDIX B: CRASH DATA ELEMENTS

Data Element	Definition
Crash Carrier Name	Carrier
Incident Date	Crash date
Crash ID	MCMIS assigned ID
Report State	State crash was reported
Driver Last Name	Driver's last name
Driver First Name	Driver's first name
Driver Middle Name	Driver's middle name
License Number	Driver's license number
License State	Driver's license state of issue
Date of Birth	Driver's date of birth
Driver Condition	Blank field
Location	Location of crash (road, intersection, etc.)
City	City of crash
State	State crash occurred in
Fatalities	Number of fatalities
Injuries	Number of injuries
Tow Away	Indicates whether or not vehicle was towed from scene as a result of disabling damage suffered in the crash
Vehicle Configuration	CMV vehicle configuration (number of units, axles, tires, etc.)
Federal Recordable	Indicates whether or not the crash was DOT reportable
Cargo Body Type	CMV cargo body type (Logging, tank, dump, etc.)
First Harmful Event	DOT report initial crash event (collision with MV, collision with fixed object, noncollision equipment failure, noncollision ran off road, etc.)