Executive Summary

Musculoskeletal Disorders and Commercial Motor Vehicle Driver Safety

Presented to

The Federal Motor Carrier Safety Administration

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Prepared for

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Evidence reports are sent to the Federal Motor Carrier Safety Administration's (FMCSA) Medical Review Board (MRB) and Medical Expert Panels (MEP). The MRB and MEP make recommendations on medical topics of concern to the FMCSA.

The FMCSA will consider all MRB and MEP recommendations; however, all proposed changes to current standards and guidelines will be subject to public notice and comment and relevant rulemaking processes.

Policy Statement

This report was prepared by ECRI Institute under subcontract to MANILA Consulting Group, Inc., which holds prime GS-10F-0177N/DTMC75-06-F-00039 with the Department of Transportation's Federal Motor Carrier Safety Administration. ECRI Institute is an independent, nonprofit health services research agency and a Collaborating Center for Health Technology Assessment of the World Health Organization. ECRI Institute has been designated an Evidence-based Practice Center by the U.S. Agency for Healthcare Research and Quality. ECRI Institute's mission is to provide information and technical assistance to the healthcare community worldwide to support safe and cost-effective patient care. The results of ECRI Institute's research and experience are available through its publications, information systems, databases, technical assistance programs, laboratory services, seminars, and fellowships. The purpose of this evidence report is to provide information regarding the current state of knowledge on this topic. It is not intended as instruction for medical practice, or for making decisions regarding individual patients.

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Purpose of Evidence Report

Of all occupations in the United States, workers in the trucking industry experience the third highest fatality rate, accounting for 12 % of all worker deaths. About two-thirds of fatally injured truck workers were involved in highway crashes. According to statistics from the U.S. Department of Transportation (DOT), there were 4,932 fatal crashes involving a large truck in 2005 for a total of 5,212 fatalities. In addition, there were 137,144 nonfatal crashes; 59,405 of these were crashes that resulted in an injury to at least one individual (for a total of 89,681 injuries).

The purpose of this evidence report is to address several key questions posed by the Federal Motor Carrier Safety Administration (FMCSA). Each of these key questions was developed by the FMCSA so that the answers to these questions provide information that would be useful in updating its current medical examination guidelines. The four key questions addressed in this evidence report are as follows:

Key Question 1: Does amputation of an extremity increase crash risk and/or affect driving ability?

Key Question 2: Does inflammatory arthritis (e.g., rheumatoid arthritis, similar condition) increase crash risk and/or affect driving ability?

Key Question 3: Does decreased angle of rotation at the level of the spine and neck (as might be the result of ankylosis and/or other vertebral injury) increase crash risk and/or affect driving ability?

Key Question 4: Do vehicle modifications and/or appropriate limb prosthetics decrease crash risk in disabled individuals?

Identification of Evidence Bases

Separate evidence bases for each of the key questions addressed by this evidence report were identified using a process consisting of a comprehensive search of the literature; an examination of abstracts of identified studies in order to determine which articles would be retrieved; and the selection of the actual articles that would be included in each evidence base.

A total of seven electronic databases (MEDLINE, PubMed (pre MEDLINE), EMBASE, PsycINFO, CINAHL, TRIS, and the Cochrane Library) were searched (through August 14, 2007). In addition, we examined the reference lists of all obtained articles with the aim of identifying relevant articles not identified by our electronic searches. Hand searches of the "gray literature" were also performed. Admission of an article into an evidence base was determined by formal retrieval and inclusion criteria that were determined *a priori.*

Grading the Strength of Evidence

Our assessment of the quality of the evidence took into account not only the quality of the individual studies that comprise the evidence base for each key question; we also considered the interplay between the quality, quantity, robustness, and consistency of the overall body of evidence.

Analytic Methods

The set of analytic techniques used in this evidence report was extensive. Random- and fixed-effects meta-analyses were used to pool data from different studies.(1-5) Differences in the findings of studies (heterogeneity) were identified using the Q-statistic and I^2.(6-8) Sensitivity analyses, aimed at testing the robustness of our findings, included the use of cumulative fixed- and random-effects meta-analysis.(9-11) The presence of publication bias was tested for using the "trim and fill" method.(12-14)

Presentation of Findings

In presenting our findings we made a clear distinction between qualitative and quantitative conclusions, and we assigned a separate "strength-of-evidence" rating to each conclusion format. The strength-of-evidence ratings assigned to these different types of conclusions are defined in Table 1.

Table 1. Strength of Evidence Ratings for Qualitative and Quantitative Conclusions

Strength of Evidence	Interpretation
Qualitative Conclusion	
Strong	Evidence supporting the qualitative conclusion is convincing. It is highly unlikely that new evidence will lead to a change in this conclusion.
Moderate	Evidence supporting the qualitative conclusion is somewhat convincing. There is a small chance that new evidence will overturn or strengthen our conclusion. ECRI Institute recommends regular monitoring of the relevant literature for moderate-strength conclusions.
Minimally acceptable	Although some evidence exists to support the qualitative conclusion, this evidence is tentative and perishable. There is a reasonable chance that new evidence will either overturn or strengthen our conclusions. ECRI Institute recommends frequent monitoring of the relevant literature.
Unacceptable	Although some evidence exists, the evidence is insufficient to warrant drawing an evidence-based conclusion. ECRI Institute recommends frequent monitoring of the relevant literature.
Quantitative Conclusion (Stability of Effect-size Estimate)	
High	The estimate of treatment effect in the conclusion is stable. It is highly unlikely that the magnitude of this estimate will change substantially as a result of the publication of new evidence.
Moderate	The estimate of treatment effect in the conclusion is somewhat stable. There is a small chance that the magnitude of this estimate will change substantially as a result of the publication of new evidence. ECRI Institute recommends regular monitoring of the relevant literature.
Low	The estimate of treatment effect included in the conclusion is likely to be unstable. There is a reasonable chance that the magnitude of this estimate will change substantially as a result of the publication of new evidence. ECRI Institute recommends frequent monitoring of the relevant literature.
Unstable	Estimates of the treatment effect are too unstable to allow a quantitative conclusion to be drawn at this time. ECRI Institute recommends frequent monitoring of the relevant literature.

Evidence-based Conclusions

Key Question 1: Does amputation of an extremity increase crash risk and/or affect driving ability?

Whether amputees who drive a commercial motor vehicle (CMV) are at an increased risk for a crash cannot be determined at the present time.

Our searches did not identify any studies that examined crash risk or a surrogate marker for crash risk among CMV drivers who have undergone an amputation.

While evidence suggests that driving performance in some amputees (drawn from the general driver population) may be compromised, there is currently no compelling evidence to support the contention that such individuals are at an increased risk for a motor vehicle crash when compared to comparable individuals who do not have an amputation (Strength of Evidence: Minimally Acceptable).

Direct Evidence: To date, only two studies have examined the impact of amputation on crash risk, and neither provided evidence that individuals with an amputation who drive a motor vehicle are at increased risk for a motor vehicle crash.

Indirect Evidence: A single, moderate-quality study found that individuals with an amputation below the knee of the right leg demonstrated some reductions in foot-pedal reaction time. The use of adaptive driving techniques, however, appeared to eliminate this reduction.

Key Question 2: Does inflammatory arthritis (e.g., rheumatoid arthritis, similar condition) increase crash risk and/or affect driving ability?

Whether the presence of an arthritide is associated with an increased risk for a crash among CMV drivers cannot be determined at this time.

Our searches did not identify any studies that examined crash risk (or a surrogate marker for crash risk) among individuals who drive a CMV and have an arthritide.

Although arthritides appear to be associated with reduced driving performance and are cited as a reason for giving up driving by some individuals, it remains unclear whether those among the general driver population who choose to drive with arthritis are at an increased risk for experiencing a crash (Strength of Evidence: Minimally Acceptable).

Direct Evidence: Three included studies (Median Quality: Moderate) directly examined the relationship between the arthritides and crash risk using a case-control design. None of these studies provided evidence to support the contention that arthritis is associated with an increased risk for a motor vehicle crash. Because of the small size of the included studies, and their consequent low power to detect an increase in crash risk, we cannot conclude that no association between arthritides and crash exists. It remains unclear whether drivers with arthritis are at an increased risk for a crash.

Indirect Evidence: Because the findings of the only studies to have examined the risk for a crash among individuals with arthritis are inconclusive, we looked for other sources of evidence that may provide some insight into the relationship between arthritis and driver safety. Our searches identified four such studies. One study found that elderly individuals with arthritic disorders were more likely to fail a driving test. Another study found that many individuals with rheumatoid arthritis (RA) gave up driving as a direct consequence of their disorder, thus suggesting that this arthritide does impact driving ability. A third study found that rheumatoid or osteoarthritis (OA) had a deleterious impact on driving ability. Individuals with RA appeared to experience the highest percentages of driving disabilities, with the disorder affecting several important driving tasks, including steering and cornering, mirror adjustment, use of the gears, and use of the handbrake. Individuals with OA experienced the second highest percentages of driving disabilities, with OA impacting driving tasks such as reversing (where it exceeded the RA percentages) and steering/cornering. In addition the latter group experienced significant problems with attaining seat comfort. The final study demonstrated that individuals who underwent an exercise-based rehabilitation program designed to improve mobility showed improvements in range of motion (ROM) and in one driving task (observing) when compared to similar individuals who did not receive rehabilitation training.

Key Question 3: Does decreased angle of rotation at the level of the spine and neck (as might be the result of ankylosis and/or other vertebral injury) increase crash risk and/or affect driving ability?

While it is plausible that the presence of a disorder that limits spinal/cervical (ROM), such as ankylosing spondylitis, cervical spondylosis, degenerative disc disease, osteoporosis, or spinal stenosis, may have a deleterious impact on driving ability, one cannot determine whether these disorders are associated with an increased risk for a motor vehicle crash at this time (Strength of Evidence: Minimally Acceptable).

Three studies met the inclusion criteria for Key Question 3. No included studies directly assessed the impact of restricted spinal/cervical ROM on crash risks.

Indirect Evidence: The first included study used a cross-sectional design to establish that functional limitations introduced with spinal and/or cervical structural changes may be a factor in reduced driving performance, including a diminished ability to turn the head while driving. The second included study used a prospective crossover design to determine the relationship between cervical immobility (as imposed by the use of a cervical orthosis) and driver performance. It was found that the orthosis did alter driving performance, including a decrease in lateral acceleration and slower driving speed overall. The final included study used a cohort study design to determine whether increased functional impairment to the cervical spine was associated with increased decision time at T-intersection. This study found an inverse association between the degree of functional impairment and driving performance: the greater the functional impairment reported, the longer the decision time associated with negotiating a T-intersection. The longest decision time was among impaired drivers in the older age group (age 60-80).

Key Question 4: Do vehicle modifications and/or appropriate limb prosthetics decrease crash risk in disabled individuals?

Because no studies met the inclusion criteria for Key Question 4, we are precluded from drawing an evidence-based conclusion pertaining to the relationship between vehicle modifications and appropriate limb prosthetics and decreased crash risk at this time.

None of the studies identified by our searches fulfilled the inclusion criteria for this key question. The primary reason for exclusion was that no identified study examined a decrease in crash risk associated with the use of vehicle modifications or appropriate limb prosthetics.