DRIVER FATIGUE AND COMMERCIAL DRIVING

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Abstract

Managing fatigue among professional drivers is most likely to be successful if it involves the development of systems of management which are both practical and based on sound research into causes, effects and countermeasures to fatigue while driving. However there are often distinct differences in the conditions under which fatigue is researched and the conditions under which professional drivers experience fatigue, in addition to the differences in the driving tasks undertaken by different categories of commercial driver. This paper reviews recent research conducted into driver fatigue, describes the conditions under which they were conducted and comments on how relevant the findings are to the task of developing systems of fatigue management for commercial drivers. By way of illustration, the similarities and differences between drink driving and driving while fatigued are also discussed.
INTRODUCTION

Types of drivers and approaches to fatigue

Driver fatigue is acknowledged to be an issue among all types of drivers, but the degree to which countermeasures are directed at drivers varies.

Broad spectrum approaches which affect all drivers include mass media publicity, installation of audible edgelines (also known as raised reflective pavement markers, or RRPMs), construction of roadside rest areas and provision of community services such as the ‘Driver Reviver’ sites, which distribute coffee and provide an opportunity of a rest break. Fatigue in private vehicle drivers is not addressed in any other way.

Fatigue in heavy vehicle drivers is also addressed by enforcement and/or voluntary compliance regimes (which are essentially another form of enforcement), plus targeted publicity, and there are in-vehicle engineering approaches to detecting fatigue and taking action such as warning the driver.

Fatigue in other commercial drivers is not subject to the structured management approach used for heavy vehicle drivers, and unless fleet management systems incorporate fatigue management, they are essentially as unrestricted as private vehicle drivers. In fact, their likelihood of driving while fatigued is greater than for private vehicle drivers, both because of the hours they drive for work and the financial incentives to drive even though fatigued, e.g. taxi drivers.

Strategies for developing countermeasures for commercial drivers

The diverse nature of commercial drivers presents problems for developing countermeasures to fatigue. Rather than extending driving hour and fatigue management legislation to all kinds of commercial driver, governments have chosen to pursue three lines of attack:

1. Enforcement and voluntary compliance countermeasures for heavy vehicle drivers.
2. Encouraging fleet managers to use fleet management approaches which incorporate fatigue management. This applies to both heavy vehicle and light vehicle fleets.
3. Increasing their broad spectrum activities, which would be expected to reduce the fatigue problem among all drivers.

Table 1 presents this classification of driver types and approaches. It is acknowledged that it oversimplifies the situation.
Table 1: Driver types and countermeasure strategies to address commercial driver fatigue

<table>
<thead>
<tr>
<th></th>
<th>Enforcement and/or voluntary compliance</th>
<th>Fleet management incorporating fatigue management</th>
<th>Broad spectrum approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy vehicle drivers</td>
<td>Fleet</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Non-fleet</td>
<td>✔</td>
<td>✗</td>
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<tr>
<td>Other commercial vehicle drivers</td>
<td>Fleet</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Non-fleet</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Private vehicle drivers</td>
<td></td>
<td>✗</td>
<td>✗</td>
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</table>

Reconciling research and practical considerations

It should be emphasised that feasibility and pragmatism have been dominant concerns of governments in their approach to fatigue in commercial drivers. It is important to bear this in mind when considering how research into fatigue and road safety can inform the development of fatigue countermeasures for commercial drivers.

On the one hand, countermeasures are more likely to be successful if they are based on sound research into the causes and effects of fatigue and evaluations of other countermeasure. On the other hand, the countermeasures need to be practical, and reasonably acceptable to both those affected and the community at large, which involves balancing competing needs such as commercial efficiency, public safety, costs to government, freight costs and constraints of civil liberties.

There is, in addition, another dimension to be considered, one which is often overlooked. That is, the relationship between what is actually studied in fatigue research, and how this relates to driving while fatigued. The following section discusses the nature of these differences and some of their implications. These implications are illustrated by using the example of random breath testing (RBT) as a kind of ‘gold standard’ approach to a countermeasure.
THE RELATIONSHIP BETWEEN RESEARCH INTO FATIGUE AND ACTUAL DRIVING WHILE FATIGUED

Generic approach to researching impairment and developing countermeasures

Fatigue is an impairing factor, like alcohol or drugs. In work on any kind of performance and the effects of impairment, it is possible to discern the following three conceptual research steps and two conceptual countermeasure options. It should be noted that they are not usually explicitly stated, and may remain notional depending on circumstances.

A. Research steps

1. **Performance → Outcome**
   
The formulation of a link between the performance of the task itself, and some outcome, measured by successes, hit rate, crash risk, etc.

2. **Impairing factor → Impaired performance → Changed outcome**
   
   A qualitative effect – the presence or influence of the impairing factor leads to impaired performance, which leads to a changed outcome, e.g. antihistamine use by construction workers leads to unsteadiness and thence to falls and injuries.

3. **Level of impairing factor → Degree of impaired → Degree of changed performance → outcome**
   
   A quantitative effect, relating the quantity of impairing factor to quantitative changes in performance and outcome, e.g. relating level of antihistamine to level of unsteadiness, which in turn is related to probability of falls and injuries.

B. Countermeasure options

4. **(Level of) impairing factor → (Degree of) changed outcome**
   
   This countermeasure approach ignores the performance involved and relates the presence (or level of) impairment directly to the (level of) change in outcome, e.g. aiming to reduce (the level of) antihistamine use in order to reduce (the level of) falls and injuries.

5. **(Degree of) impaired performance → (Degree of) changed outcome**
   
   This countermeasure approach ignores (level of impairment) and relates performance directly to (level of) the outcome measure, e.g. aiming to detect and sideline workers with (a certain level of) unsteadiness to reduce (the level of) falls and injuries.
Underlying the success of the research and countermeasure development process is satisfaction of the following criteria:

a) The *impairing factor* needs to be susceptible of clear definition.

b) The ways used to measure the impairing factor need to be valid (measure what they are supposed to measure) and reliable (give consistent results).

c) If the countermeasures involve measurement of the level of impairing factor, the ways used to measure the impairing factor need to be simple and practical.

d) The ways used to measure performance need to be valid and reliable.

e) If the countermeasures involve measurement of the level of performance, the ways used to measure performance need to be simple and practical.

f) The outcome needs to be clearly defined and measurable.

**Differences between fatigue research and the generic approach**

In terms of the above outline, the desired research basis for development of fatigue countermeasures would be:

1. Non-fatigued driving $\rightarrow$ Baseline fatigue crash risk

2. Fatigue $\rightarrow$ Fatigued driving $\rightarrow$ Increased fatigue crash risk.

   Making the general case for the impact of fatigue on crash risk. This has been approached in a variety of ways, with consistency between results despite uncertainties of definition and classification.

3. Level of fatigue $\rightarrow$ Degree of fatigue impairment $\rightarrow$ Level of increase in of driving fatigue crash risk

   Quantifying fatigue, performance and risk. This has not yet been achieved to a convincing level due to issues of validity and relevance of research.

4. Reduce (level of) fatigue $\rightarrow$ Reduce (level of) fatigue crash risk

   Apart from the focus on driving hours and hours of work for heavy vehicle drivers, countermeasures aimed at reducing the level of fatigue are educative and qualitative in nature, without enforcement or engineering support.

5. Reduce impaired driving (above level) $\rightarrow$ Reduce (level of) fatigue crash risk

   Countermeasure development based on technological solutions has been carried out in this area for many years without notable success.
The limited success of research and countermeasure development with respect to fatigue can be explained by reference to points a)-f) above:

a) *Fatigue should be a clearly defined concept* – this is not the case. Fatigue is variously defined as sleepiness, time on task, time awake, some combination of hours asleep and awake over a period, and so on\(^1,2,3\).

b) *Measures of fatigue should be valid and reliable* – given a lack of clear definition of fatigue, no measure can be proven valid. However, for most of the definitions mentioned above, measurement is internally valid and reliable.

c) *Countermeasures involving measurement of fatigue should be simple and practical* – measures relating to driving hours, hours awake and so forth are reasonably simple, however they may not be practical, as the experience with log books has shown. Other measures of fatigue (questionnaires, physiological measures) are frequently impractical.

d) *Measures of driving performance should be valid and reliable* – this is not the case, as there is a lack of agreement as to what constitutes ‘good’ driving or ‘safe’ driving, and hence validity cannot be determined. Measures such as steering reversals, lane following etc can be reliably measured but their meaning in terms of road safety is unclear. More remote measures such as laboratory tasks are doubly questionable, as it is not clear how they relate to the driving task itself, let alone how the driving task relates to crash risk.

e) *Countermeasures involving measurement of driving performance should be simple and practical* – some technology-based solutions such as warning devices triggered by defined behaviours can be designed to be simple and practical, though some are not. In-vehicle solutions tend not to be practical outside certain fleet contexts due to expense and lack of supporting regulation or management.

f) *Fatigue crash risk should be clearly defined and measurable* – the more stringent the requirement to demonstrate fatigue involvement in crashes, the smaller the number of fatigue crashes identified. There is also a lack of agreement about the surrogate measures of fatigue involvement in crashes\(^4,5\).

**An illustration: comparison with RBT**

To illustrate the constraints placed on fatigue countermeasures by the above shortcomings, it is illuminating to look at random breath testing (RBT). RBT is considered by many to be an exemplar of best practice in drink driving countermeasures, combining enforcement (techniques and management), education (through publicity support) and engineering (breath testing technology) in a highly effective mix.
Table 2: Comparison between characteristics of fatigue research and countermeasure development and drink driving research leading to RBT

<table>
<thead>
<tr>
<th>Fatigue</th>
<th>Drink driving/RBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impairment concept clearly defined</td>
<td>Various definitions used, no clear agreement</td>
</tr>
<tr>
<td>Measures of impairment valid and reliable</td>
<td>No clear concept rules out validity, except within terms of the various definitions used</td>
</tr>
<tr>
<td>Countermeasures based on measurement of impairment simple and practical</td>
<td>Simple, may be impractical if related to hours driving or awake. Questionnaires, physiological measures, etc are frequently impractical</td>
</tr>
<tr>
<td>Measures of driving performance valid and reliable</td>
<td>Link between performance and crashes not established, especially laboratory tasks</td>
</tr>
<tr>
<td>Countermeasures based on measurement of driving performance simple and practical</td>
<td>Some technology-based solutions may meet this(^6)</td>
</tr>
<tr>
<td>Crash risk from impairment clearly defined and measurable</td>
<td>Varying definitions and estimates, lack of agreement on surrogate measures</td>
</tr>
</tbody>
</table>

It can be seen that RBT is based on the countermeasure option:

**Level of impairing factor → Degree of changed outcome**

This occurred due to replacement of the vaguer “impairment” concept with a specific definition based on BAC, due in turn to the physiological characteristics of alcohol and its effects, and technology: the invention of the Breathlyzer and various hand held devices have made RBT possible.
By contrast, there is no clear operational definition of fatigue. However, if a decision is made to select a particular quantitative measure as an indicator of fatigue (such as driving hours or time on task), countermeasures based on this quantitative measure become feasible. Unfortunately it is always possible to question the relationship between such measures and crash risk, given the difficulties in defining and measuring fatigue crashes.

**Measured vs actual performance**

Much research has focused on the measurement of driver performance, and some positive comments were made in Table 2 about the development of technology to measure performance related to fatigue. However there are reasons for being cautious about the potential value of such research.

Technology of this kind was developed to test for alcohol impairment through the 1970s and 1980s, but problems such as high inter-subject variability, training effects, high type 1 and/or type 2 error rates, sensitivity to a number of causes of impairment and motivational factors, and lack of a clear link between performance and crash risk, prevented their adoption. This occurred even in the context of studies linking performance on these tasks to BAC levels. Even simulator studies present situations to drivers which differ noticeably from real driving.

The recent Australian studies showing similar patterns of effects of time awake and BAC on laboratory tasks 3,7,8 deserve special comment in this regard. As the experience of cannabis studies shows, finding impaired performance in the laboratory does not necessarily translate into increased crash risk, even when on-road performance is impaired, because of the ability of drivers to compensate for some kinds of impairment. While it is not being argued that fatigue is the same as cannabis, the point needs to be made that the number of hours awake it takes for task performance to approach performance at 0.05 BAC on a laboratory task might be quite different to the number of hours awake it takes for on-road crash risk to approach the same crash risk as 0.05 BAC.

As has been alluded to above, there are two distinct disjunctures in the chain linking performance on these laboratory tasks to crash risk. The first is that the laboratory tasks are abstracted from the driving task, and it is impossible to state what combination of laboratory task results would be equivalent to (say) a 10 per cent decrease in performance of normal driving. The second disjuncture is that, even if such a statement could be made, it is impossible to state the increase in crash risk which results from a 10 per cent decrease in driving performance.

In summary, the laboratory studies on the correspondence between BAC and hours awake are well conducted, thorough and highly suggestive, but caution is needed when translating the results into policy recommendations.
IMPLICATIONS FOR DEVELOPMENT OF FATIGUE COUNTERMEASURES FOR COMMERCIAL DRIVERS

The discussion above might be construed as a rather negative look at fatigue research, but it is not intended to be. There have been considerable advances in research and practice in the area of fatigue, and it is likely that the pace of these advances will accelerate.

However, at this point in development it is important to consider the implications of current research knowledge for development of countermeasures for commercial drivers. Two scenarios have been adopted below. The first is an “ideal” situation, which assumes an abundance of will. The second is considered to be a more likely context.

An “ideal” situation

In the absence of a clear definition of fatigue, and given the usefulness of a definition based on something like hours of work or hours awake, such a definition could be adopted and extended to all commercial drivers through legislation, taking into account important recent results. At the same time, efforts could be intensified into research for a physiological indicator of fatigue which could serve the same purpose as BAC does for drink driving – a quantity which is easy to measure and demonstrably linked to crash risk. In terms of the standard classification of countermeasures:

**Enforcement**
- for all commercial drivers, based on a quantifiable measure
- using both standard enforcement and voluntary compliance methods.

**Engineering**
- automated methods of recording the measure of fatigue in a way that facilitates enforcement and compliance
- research into physiological indicators of fatigue and technologies which would facilitate their use.

**Education**
- targeted through licensing authorities, voluntary compliance schemes and fleet management programs
- to support enforcement, encourage voluntary compliance and educate drivers on the link between fatigue and crashes.

A more likely context

It is more likely that fatigue among commercial drivers will addressed cautiously and incrementally. This would mean working more slowly towards a standard quantitative measure of fatigue, and identifying particular subgroups of commercial drivers who are not heavy vehicle drivers, but for whom fatigue is considered to be an important issue (at political or community level). Current strategies would be pursued at the same time:
**Enforcement**
- continued promotion of current enforcement and voluntary compliance methods
- inclusion of targeted commercial driver groups outside the current schemes
- work towards adoption of a quantifiable measure of fatigue.

**Engineering**
- continued broad spectrum approaches such as installation of audible edgelines and construction of roadside rest areas
- work towards automated methods of recording the measure of fatigue in a way that facilitates enforcement and compliance
- research into physiological indicators of fatigue and technologies which would facilitate their use.

**Education**
- continued broad spectrum approaches such as mass media publicity and ‘Driver Reviver’
- encouragement of fleet management programs with a fatigue component for commercial drivers outside enforcement and voluntary compliance schemes
- education targeted through licensing authorities, voluntary compliance schemes and fleet management programs, to support enforcement, encourage voluntary compliance and educate drivers on the link between fatigue and crashes.

**CONCLUSION**

Commercial drivers are currently in two main groups with respect to fatigue. Heavy vehicle drivers are subject to enforcement and voluntary compliance regimes which other commercial vehicle drivers escape.

In addressing how commercial vehicle driver fatigue might be approached, standard approaches to countermeasure development based on research were discussed. The purpose was to point out some shortcomings in fatigue research which have implications for countermeasure development.

However, it was noted that there have been impressive developments in fatigue research and practice over the past few years, and recommendations were made regarding fatigue among commercial drivers. The substance of the recommendations is that the ambit of fatigue enforcement and compliance programs needs to be increased to incorporate more types of commercial driver, which research which will lead to more effective enforcement and management methods needs to be pursued.
REFERENCES


