Work-related road safety

A systematic review of the literature on the effectiveness of interventions

Report submitted to the IOSH Research Committee

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Abstract

Road casualty statistics show that a large proportion of road casualties are accounted for by people who are in some way driving for work, so interventions to improve work-related road safety (WRRS) could have considerable potential. There are a number of different forms that interventions focused on WRRS can take. Although there are many providers of such interventions, there is a lack of understanding as to which interventions are most effective, and to what degree. A systematic review of the literature on WRRS has therefore been carried out in order to make an evidence-based appraisal of the effectiveness of WRRS interventions. Following extensive searches of the Transport Research Abstracting & Cataloguing System, a total of 63 studies are discussed in this report, including six earlier reviews dating from 1999 to 2011.

The review covered six main areas: driver training, group discussions, incentive schemes, publicity, in-vehicle recorders, and organisational approaches. Although the study set out to provide evidence-based advice to practitioners, this proved to be a surprisingly difficult task. Only four interventions were found in studies of a scientifically acceptable standard that showed statistically meaningful reductions in crash risk. Three were in the same investigation, and all were conducted more than a decade ago. Possible reasons for this are discussed. These include changes in recent times in research and procedures from single to multiple interventions, the trend to using attitudinal and behavioural measures as dependent variables, and the increasing acceptance of case studies as evidence for positive change. While it is accepted that there are commercial and practical issues in trying to persuade industry to engage in evaluation studies, the main conclusion of the project is that there is a pressing need for more and better-controlled evaluation work if a better understanding of WRRS issues is to be achieved.

Executive summary

Background

Road casualty statistics show that a large proportion of road casualties are accounted for by people who are in some way driving for work. It has been estimated that between a quarter and a third of all road traffic incidents involve someone who was at work at the time. Thus interventions to improve work-related road safety (WRRS) could have considerable potential in terms of the absolute numbers of lives that could be saved and injuries prevented.

There are a number of different forms that interventions focused on WRRS can take. Although there are many providers of such interventions, there is a lack of understanding as to which interventions are most effective, and to what degree. A systematic review of the literature on WRRS has therefore been carried out that has attempted to answer the following questions:

- Is there a sufficient literature of the highest quality evaluations (ie randomised controlled trials with sufficient sample sizes and using collisions or collision risk as an outcome variable) to make a definitive statement regarding the efficacy of WRRS interventions overall?
- If not, what are the suggested levels of effectiveness of WRRS interventions using weaker study designs?
- In either case, what can be said about the effectiveness of different subcategories of intervention (such as training, incentives, and enforcement through technology)?

The main data source was the Transport Research Abstracting and Cataloguing System, which is the main catalogue of publications held both in the TRL library and by other major transport research organisations. It now comprises 260,000 items, and is the prime literature resource for transport research. Following extensive searches, a total of 63 studies are discussed in this report, including six earlier reviews dating from 1999 to 2011.

Literature on interventions

While organisations are now given a great deal of advice and encouragement to engage themselves more actively in efforts to improve WRRS, very little has been published in the way of guidance on how to achieve this aim. To assist in this process, this report sets out to make an evidence-based appraisal of the effectiveness of WRRS interventions. The main findings from the review are set out below.

Driver training

Traditionally, the first, and often the only, line of attack when attempting to reduce fleet driver accidents has been through driver training. Driver training has proved to be one of the most contentious topics in road safety for well over half a century. A recent review concluded that there was no evidence that pre-licence training had any measurable effect on crash risk, and many of the reports of the effectiveness of post-licence training are largely anecdotal. A review of post-licence driver training carried out for the Cochrane Collaboration in 2003 concluded that there was no evidence that post-licence driver education programmes were effective in preventing road traffic injuries or crashes. In the fleet safety field, properly designed experiments are extremely rare; indeed, only one appears to have been published in a peer-reviewed journal. This was the study published in 1996 using the Swedish telephone company Televerket.[26] In this experiment, four interventions (driver training, group discussions, campaigns and bonuses for accident-free driving) were compared with a control group, and accident rates and costs were compared for a two-year period before and after the interventions. The results for the driver training group showed a statistically significant reduction of 40 per cent in the accident rate after training, though the training procedures employed in the study were far removed from those conventionally used by fleet trainers. While the Swedish study has been widely cited in the literature, and is generally recognised as being highly innovative in terms of both experimental design and in the content of training materials, there has been no documented attempt to take this work forward.

Group discussions

One method that has aimed to raise safety consciousness and thereby bring about behavioural change is the use of group discussions among employees. This method has not been widely used as a WRRS intervention, but is one that would seem to offer promise. The results from the Swedish experiment showed that group discussions were the most successful of the four interventions used in the study, with a statistically significant reduction in accident rates of 56 per cent in the two years after the

measure was introduced. The group discussion approach has a sound theoretical basis, there is at least one empirical study that attests to its effectiveness, and it should be attractive from an economic point of view. It is unfortunate that properly controlled investigations have not been carried out to take forward or even replicate the earlier Scandinavian research studies.

Incentives

The road traffic system operates largely on the principle that bad behaviour should be punished, but good behaviour goes unrewarded. The corporate fleet environment is one where there is the possibility of redressing this balance, and a number of studies have been carried out to look at the effects of incentives or rewards on driver behaviour and accident rates. A bonus, or more properly an incentive system, was one of the four measures studied in the Televerket experiment. There was a significant 23 per cent reduction in the accident rate for the bonus group; there was also some supportive evidence from a UK study that incentives had a beneficial effect. At an anecdotal level, it is known that many organisations operate incentive and reward systems, but there is no published evidence on the effectiveness of such schemes. In summary, it is once again unfortunate that there has been so little follow-up of an intervention that has both theoretical and empirical support, is relatively cheap and easy to implement, and should in principle lend itself to proper investigation.

Publicity

The Swedish study also included a 'campaign' group, which comprised five staff meetings during the course of a year during which videos were shown and publicity material was distributed. The results of the experiment indicated that this was the only one of the four test groups not to show a decrease in accident rate relative to the control group; in fact, it showed a small but non-significant increase. A review of US work covered a range of procedures, such as promise cards, performance feedback, pledge cards and safety reminders. However, there is no hard evidence in the literature that the interventions described above are effective in improving WRRS.

In-vehicle data recorders (IVDRs)

In-vehicle data recording systems have come into widespread use in recent times in occupational settings. They were widely referred to originally as 'black boxes', partly because the early versions were quite large, but mainly because the original use, as in aircraft, was to collect data in the period immediately before a crash. While still used to some extent for accident investigation purposes, advances in technology have led to an increasing role in driver monitoring. When it comes to hard evidence, the picture is a familiar one of potential not being recognised. There is only one properly controlled study in the literature to date that demonstrates a statistically significant reduction in accident involvement in fleets as a result of installing IVDRs. This covered a number of fleets in Belgium and the Netherlands, and drivers were made aware that the data recorded could be used when accident responsibility was being assessed. Once again, it is necessary to use the word 'unfortunate' to describe a situation where an intervention that has great potential for research as well as evaluation appears so infrequently in the literature. The opportunity to collect and use real-time data in real-world situations should not be lightly dismissed.

Organisational approaches

All previous interventions have been concerned directly with change at the employee level in an organisation. A major shift in research emphasis in recent times has been from how individuals respond to interventions to how organisations plan interventions. A recent review lists a dozen or so practices and procedures that have been recommended to organisations for the better management of occupational road risk, but notes that many of these have not yet been scientifically evaluated. Of those that had, it was found that designs were methodologically weak and lacked statistical rigour. It would appear that the limited evaluation literature on the subject offers little in the way of scientific support for interventions at the organisational level to improve WRRS.

Methodological issues

Having reviewed the literature on WRRS interventions, it has to be concluded that it is very probable that there is not a single item in it that would be deemed acceptable for inclusion in a Cochrane review. The basic reason is that randomised allocation – the central tenet of the experimental method – is extremely difficult to achieve in the real world, and particularly in an occupational or commercial setting. There are also numerous other problems that make it difficult to achieve quality in evaluation studies in this area. While past experience has shown that these problems are not insuperable at a practical level, in recent times problems of procedure have arisen that act as barriers to evaluation.

One very obvious feature of changing practices in the last decade has been the shift from single to multiple interventions, in which organisations are encouraged to adopt a 'proactive multiple strategy approach'. Such advice leads inevitably to methodological problems when it becomes impossible to distinguish the unique impact of initiatives when they are implemented in combination with others. Another trend has been the increasing amount of research in the last decade concerned with the investigation of attitudinal and behavioural factors associated with crash involvement. The rationale for this activity is that, if it can be shown that self-reporting measures are predictive of crash involvement, then they would provide a richer and more informative outcome measure than the mere counting of crash frequencies. There are a number of inherent problems with this approach, and it has achieved only limited success to date. A realistic assessment should be that the prospect for developing proxy measures for fleet accidents at present looks challenging.

A third development in the last decade is the rise of the case study. These typically describe success stories within organisations, and have given considerable encouragement to those who wish to adopt the 'best practice' approach. Practitioners readily point to case studies as clear examples of how the organisational approach to fleet safety can achieve positive results. However, there are two issues that should be borne in mind. First, only positive outcomes tend to be reported. There is anecdotal evidence that some large organisations have implemented programmes without achieving any benefits. If the ratio of successful to unsuccessful programmes is unknown, then the value of such interventions must remain unclear. Second, there is the problem of generalisation. Case studies are a very good method of showing what can be achieved by bringing about change, but they provide only limited information on how these results can be transferred to other situations.

Experimentation to establish the effectiveness of remedial measures is extremely difficult. Twenty years ago, this was seen as a challenge; good evaluation work was carried out, and possibilities for further research were identified. These possibilities have never been followed up. Largely as a result of pressure from policy makers and legislators, there has been a major change in emphasis where a concern with policies and procedures has become the main priority for fleet operators. The final barrier to evaluation is that it is no longer seen as being important – at least not in the rigorous scientific sense. In the multifactor approach, changes to crash rates are now seen as only one of many possible key performance indicators. One effect of these barriers to evaluation is the fact that not a single properly controlled evaluation study of WRRS interventions has been carried out in the last decade.

Conclusions

This study set out to provide evidence-based advice to practitioners about the effectiveness of interventions to improve WRRS. This has proved to be a surprisingly difficult task. If one adopts the criterion that an evaluation study should assess whether an intervention has brought about a statistically reliable change in crash rates, then the results are meagre in the extreme. Only four interventions meet this criterion, three were in the same investigation, and all were conducted more than a decade ago.

It is important to bear in mind that the absence of strong evidence of effectiveness does not mean that effectiveness has not been achieved. There have been a number of case studies in recent times that have claimed impressive gains in WRRS through the implementation of large-scale programmes. However, it is known that some unsuccessful case studies go unpublished, and this, combined with the fact that such large-scale programmes tend to be multifaceted, means that such success stories can contribute little in the way of understanding about the effectiveness of different intervention components. Without a return to 'classical' evaluation, work to improve WRRS can only be on an *ad hoc* and less than efficient basis. There are of course commercial and practical issues that remain to be overcome when trying to persuade industry to engage in evaluation studies. Companies may not wish to invest time and money in evaluation studies if they perceive that holistic approaches (even if only supported by case study data) are sufficient for their needs. In addition, companies may be reluctant to have their accident data made public. Nonetheless, the fact remains that there is a pressing need to use controlled evaluation studies to assess which WRRS interventions work, by how much, and through which causal mechanisms.

1 Background

1.1 The problem

Road traffic collisions are a serious public health burden. According to the World Health Organization,[1] they are predicted to be the fifth-highest cause of death by 2030, as compared to being only the ninth-highest cause in 2004.

The statistics show that a large proportion of road casualties are accounted for by people who are in some way driving for work. For example, figures provided by the Department for Transport show that in Britain in 2009, 18 per cent of all drivers and riders aged 15 or over who were involved in a collision where someone was injured were 'driving for work' at the time. An earlier estimate by the Work-related Road Safety Task Group[2] was that between a quarter and a third of all road traffic incidents involved someone who was at work at the time. Thus interventions that improve work-related road safety (WRRS) could have considerable potential in terms of the absolute number of lives that could be saved and injuries prevented.

1.2 Why this review is needed

There are a number of different forms that interventions focused on work-related road safety can take. Although there are many providers of such interventions, there is a lack of understanding as to which types of interventions are most effective, and to what degree. In other fields dealing with health outcomes, systematic reviews of empirical evidence such as those carried out by the Cochrane Collaboration (see www.cochrane.org) have been accepted as being the best way to establish the level of support for any given intervention or treatment. Taking this as a model, a systematic review of the literature on WRRS has been carried out that has attempted to answer the following questions:

- Is there a sufficient literature of the highest quality evaluations (ie randomised control trials with sufficient sample sizes and using collisions or collision risk as an outcome variable) to make a definitive statement regarding the efficacy of WRRS interventions overall?
- If not, what are the suggested levels of effectiveness of WRRS interventions using weaker study designs?
- In either case, what can be said about the effectiveness of different subcategories of intervention (such as training, incentives, and enforcement through technology)?

2 Method

2.1 Inclusion criteria

A preliminary search of the published literature led the authors to believe that there would be very little that would meet the methodological standards required by standard systematic reviews, such as random allocation to treatment or control groups, and proper statistical analysis of effect size. With this in mind, weaker designs were included as long as they were still evaluations of effectiveness on the outcome measures of collisions, behaviours or attitudes. Recently there has been criticism (eg Wåhlberg *et al.*[3]) of the validity of self-reported collisions because of under- and over-reporting (arising from factors such as memory bias and social desirability) and their generally lower than desirable convergence with recorded collisions (although see Boufous *et al.*[4]). This debate is not new, and it is also not settled (see Arthur *et al.*[5] for a useful overview). On balance, there would appear to be a reasonable consensus in the literature that both types of data can be used as outcome measures, even if they both have their limitations (see Maycock *et al.*,[6] Arthur *et al.*,[5] Boufous *et al.*[4]). Therefore studies using recorded collisions and those using self-reported collisions were both considered for inclusion in the review.

In addition, published studies that were not strictly outcome evaluations of effectiveness, but instead used a weaker case-study design, were included. However, due to the inherent limitations of the case-study design (see Coolican[7]), it was decided that detailed descriptions of case studies – for example the precise package of measures used – would be avoided.

In addition to presenting a review of WRRS interventions as described above, the report includes a commentary on how the WRRS field has developed over the last decade or so.

2.2 Search methods and terms

The following search terms were used:

(Work OR Occupational) AND (Road OR Driving) AND (Safety OR Risk) Fleet AND Safety
"Work related road safety"

These search terms were entered into the TRL Knowledge Base. This comprises a number of databases including the Transport Research Abstracting and Cataloguing System (TRACS), which is the main catalogue of publications held both in the TRL library and by other major transport research organisations. It contains bibliographic references and abstracts of English and foreign language articles from journals, books and research reports. It is the English-language version of the worldwide International Transport Research Documentation (ITRD) database and contains abstracts from publications in the USA, Australia, Scandinavia, the Netherlands and Canada, in addition to UK material. The database has been updated daily since 1972 and now comprises 260,000 items. This is the prime literature resource for transport research.

In addition, various searches using Google, Google Scholar, and known lists of 'grey literature' (for example, SIGLE – System for Information on Grey Literature in Europe) were carried out, and work referenced by previous reviews and by included studies were followed up for additional material.

2.3 Data collection

The studies identified from the searches were examined by the two authors for eligibility based on the inclusion criteria. The full text of all relevant articles was obtained and their findings were synthesised by the lead author, reviewed by the second author, and finally checked by a third reviewer not on the report team.

3 Literature review

3.1 Introduction

In recent years, the safety of people who drive for work has received increasing attention from policy makers and road safety professionals. The domain of WRRS is generally taken to be that of any journey undertaken in the context of work (Lang *et al.*[8]). Two points should be borne in mind. First, commuting to the normal workplace is not generally treated as work-related driving. A recent review by Murray[9] found that this is the case in most developed countries, although there are exceptions, including Finland and some Australian states. Second, journeys carried out in privately owned vehicles for work purposes are included as being work-related. These vehicles, sometimes referred to as 'grey fleets', have long been recognised as posing special problems for safety management.

The management of WRRS is important because statistics show that a sizeable proportion of road casualties are accounted for by people driving for work. In Britain, journey purpose has since 2005 been included in the accident reporting process. Figures provided by Department for Transport show that in Britain in 2005, 15 per cent of all drivers or riders aged over 15 and involved in a collision where someone was injured were 'driving for work' at the time. This figure is almost certainly an underestimate, given the recent introduction of the new variable into the reporting process, and the possible reluctance of some light vehicle drivers to report at-work collisions (Lang *et al.*[8]). In 2009 (the most recent year for which data are available), the figure was 18 per cent.

In the context of occupational safety, the contribution of work-related driving is even more striking. Figures from the EU (excluding the UK) show that over one-third of fatal accidents at work occur on the roads (ETSC[10]), while Murray[9] reports a similar proportion in the United States. Occupational safety statistics in the UK are complex, but Lang *et al.*[8] cite data indicating that work-related driving fatalities far outstrip the number of fatal injuries that occur in the 'traditional workplace'.

The efficient management of WRRS therefore has the potential to make a significant contribution to the reduction of death and injury on the roads. To assist in this process, this report sets out to make an evidence-based appraisal of the effectiveness of WRRS interventions. It begins by looking at how work-related driving was seen in the past, and the changes that have taken place in the last two decades. It then goes on to examine in detail the interventions that have been employed to improve WRRS, and to make a critical assessment of their effectiveness. Methodological issues are then discussed before conclusions are presented.

3.2 The past (1970s to mid-1990s)

The term 'work-related road safety' has only appeared relatively recently in the road safety literature. In the latter part of the last century, the view was generally held in the UK that heavy goods vehicles were not a major road safety problem. The freight industry was regulated and monitored, its vehicles were subject to frequent inspection, and its drivers were required to undergo training and testing that was more rigorous than that required of the rest of the driving population. Of more concern to researchers and policy makers was the rapid growth in car ownership during this period, with an expanding driver population that faced only relatively undemanding barriers to entry, and whose members only became of interest to the authorities if they transgressed in a serious way.

Britain was (and still is) unlike most other European countries in that a significant proportion of the total vehicle fleet is made up of cars that are owned or financed by commercial organisations. The drivers of company cars made up an important subgroup of the driving population, and concerns were expressed by policy-makers that they made a disproportionate contribution to casualty statistics. In response to this, there was a flurry of research activity in Britain in the 1990s. The first major study to be reported was by Lynn & Lockwood,[11] who surveyed drivers who regularly drove a company-owned or financed car. Using multivariate analysis, they found that such drivers had an accident liability that was substantially greater than that of 'ordinary' drivers (a multivariate approach allows for the complex interactions between variables under consideration). These results were re-examined shortly afterwards by Downs *et al.*[12] in the context of a review of fleet driver safety. They concluded that:

- fleet car drivers do have an elevated accident liability even when mileage and demographics are taken into account
- this effect can be quantified
- the size of the effect depends on the definition used.

Thus, a broad definition that included drivers of 'perk' cars gave a 29 per cent increase in accident liability, while restricting the analysis to those who drove regularly for work purposes increased the figure to between 40 and 50 per cent. Downs *et al.*[12] also pointed out the diverse nature of the topic. They noted that fleets varied enormously in both size and function, and their statement that 'it could be said that there is no such thing as a typical fleet driver' has been frequently quoted.

Other researchers during this period also raised the issue of diversity. For example, Dimmer & Parker[13] drew attention to the fact that 'company car drivers include a range of road users from senior executives provided with a second car as a perk of the job, through those who drive non-liveried company-owned vehicles both for work and non-work purposes, to those employed to drive fleet cars, vans or other specialist vehicles'. A study by Chapman *et al.*[14] looked at drivers within a single organisation and identified five distinct subgroups. There were differences among these groups in terms of mileage, journey purpose, accident involvement and accident type. These findings point to the fact that any elevated accident liability is unlikely to apply equally to all drivers in an organisation, but will be dependent on the type of vehicle and the purpose of their journeys. This disparate nature of fleet vehicles, fleet drivers and fleet activity has plagued research to the present day.

Grayson,[15] in reviewing the early studies in this field, noted that an elevated accident liability, or 'fleet driver effect', had been identified but not explained. Of all the possible explanations that had been advanced in the past, only exposure in terms of the mileages travelled by fleet drivers was excluded by the statistical modelling; other variables were examined, but the results were inconclusive. Thus the 1990s ended without any clear research evidence that could guide the design of interventions to improve fleet safety.

3.3 The present (mid-1990s to present day)

The last 15 years have been a time of change in the transport field. Relevant to this study are changes in the vehicle fleet, travel patterns, employment practice, legislation and policy, and research orientation.

One important change to the vehicle fleet in the UK has been the marked increase in the number of vans on the roads. A study by Lang & Rehm[16] found that the van population in the UK had grown by a third over the preceding decade, and van traffic had increased by 40 per cent. The significance of this finding is that light goods vehicles and their drivers are far less regulated and monitored than is the case with the heavy goods sector. As far as changes in travel patterns are concerned, the authors point out that 'one of the reasons for the increasing numbers of vans on UK roads in recent years is a significant growth in home shopping, as the majority of home shopping goods are delivered by vans'. This, of course, is to a large extent a result of the growth in internet shopping. Another factor that has implications for the management of safety is a change in employment practice. Outsourcing has become more common, and deliveries are increasingly made by subcontractors or even self-employed drivers.

As far as legislation and policy are concerned, the interface between occupational safety and traditional road safety has not always been an easy one. As long ago as 1974, the Health and Safety at Work etc Act established (where 'reasonably practicable'):

- a requirement for safe plants and their maintenance
- a requirement for employers to provide information, instruction, training and supervision as necessary to safeguard workers
- a requirement for employers to conduct their undertaking in such a way that the health and safety of persons not in employment are not exposed to risks.

These requirements were subsequently strengthened under the Management of Health and Safety at Work Regulations 1999, when employers became responsible for making suitable assessment of the risks to their employees and to other persons, as well as for providing their employees with information on risks to their health and safety and on preventive and protective measures. While these regulations should in principle cover work-related driving, in practice the protection of workers and the public in the context of road traffic law has been carried out by the police and the courts. This is because the general policy has been not to invoke health and safety legislation when there is existing law that protects workers and the public. This situation was felt by many to be unsatisfactory, partly because available legislation was seen as not always being properly enforced, and also because it led to a situation where the full extent of the problem could not be ascertained because the data were not being collected systematically.

In an attempt to remedy this situation, a Work-related Road Safety Task Group was convened. Its report[2] included an estimate that between a quarter and a third of all road traffic incidents involved someone who was at work at the time. Two years later, the Health and Safety Executive and the Department for Transport issued joint guidance on work-related road safety,[17] in which it was made explicit for the first time that a vehicle being driven on the road for work purposes is part of the workplace and therefore subject to health and safety regulation.

This guidance note had wide-ranging effects. For a start, the term 'WRRS' became firmly established in the road safety literature (though it had been used in occupational safety for some time: see eg Bibbings[18]). There was also a noticeable shift in the type of research activity, in that the focus of interest moved from the driver to the organisation. Finally, WRRS has become big business. Organisations are now bombarded with advice and exhorted to adopt a variety of initiatives, frequently on the basis that by doing so they will minimise the threat of enforcement action or litigation. The evidence supporting these initiatives will be examined in the following section.

4 Interventions to improve work-related road safety

4.1 Introduction

While organisations are now given a great deal of advice and encouragement to engage themselves more actively in efforts to improve WRRS, very little has been published in the way of guidance on how to achieve this aim. Since the Downs *et al.*[12] review referred to in the previous section, there have been only five publications that have provided comprehensive reviews of WRRS interventions: those by Haworth *et al.*,[19] Murray *et al.*,[20] Murray[9] and, most recently, by Banks *et al.*[21] and Newnam & Watson.[22] Interestingly, all five emanate from Australia, reflecting a very active research and policy interest there, or, as Murray[9] put it, 'a vibrant occupational road safety theme'. It should be noted that of these five studies, only the Banks *et al.*[21] review can be considered a properly critical review of the literature, the others being largely descriptive in style.

The present study draws upon these six reviews, as well as on a large number of individual studies identified in the search of the literature outlined in Section 3.2.

4.2 Driver training

Traditionally, the first, and often the only, line of attack when attempting to reduce fleet driver accidents has been through driver training. As Downs *et al.*[12] pointed out:

> …fleets should in principle be well-placed to provide evidence on this issue given their high accident rates, the degree of control they have over their drivers, and their potential to collect reliable accident data.

As will be seen, practice has proved to be very different.

Driver training has proved to be one of the most contentious topics in road safety for well over half a century. Advocates of the technique hold that it is virtually self-evident that improving driving skills will have a safety benefit, and this view is widely accepted by the general public. As far as new drivers are concerned, the evidence to support this contention has proved to be elusive. Numerous reviews have been carried out on this topic, and the general consensus is that conventional driver training has little or no effect on road safety in terms of a reduction in risk for new drivers. The most recent review by Helman *et al.*[23] concluded that 'according to the evidence, it [driver training] has no measurable effect on collision risk, and its continued use should therefore be set against much lower expectations of what it can contribute directly to the safety of new drivers'.

Post-licence training, it is often argued, is different. It would appear that many would agree, given the size of the training industry and the importance attached to training in the advice given to commercial organisations. Unfortunately, many of the reports of the effectiveness of post-licence training are largely anecdotal. For example, Haworth *et al.*[19] describe six programmes carried out in the US in the preceding decade, none of which provided adequate evaluation data. They also cite a report from the Herz Corporation in 1995 that claimed to have achieved a 35 per cent reduction in crashes through using defensive driving courses. The effectiveness of the study design was unclear, long-term effects were not studied, and the results are at variance with much of the rest of the literature. Defensive driving courses have been employed in the US for many years based on the seemingly plausible notion that teaching drivers how to avoid accidents will prevent accidents. However, there are theoretical grounds for questioning this, and extensive research has failed to demonstrate that such courses have any consistent effect in reducing accident rates (the classic evaluation paper on this topic is by Lund & Williams[24]).

Post-licence driver training has also been the subject of a Cochrane systematic review; such reviews are widely regarded as representing the 'gold standard' for methodological rigour. The review of post-licence driver training carried out for the Cochrane Collaboration by Ker *et al.*[25] considered only randomised control trials that had been reported up to 2002, and included 24 studies, though noting that 'the methodological quality of included trials was generally poor'. Their conclusion was that:

> This systematic review of randomised control trials provides no evidence that post-licence driver education programmes are effective in preventing road traffic injuries or crashes. Because of the large numbers of randomised participants included in the meta-analysis (close to 300,000) we can exclude, with reasonable precision, the possibility of even modest benefits.

Such precision is in marked contrast to the claims sometimes made by training providers.

There is a certain irony associated with this review in that it was sponsored by a large multinational company that had invested in driver education programmes and wished to establish whether this policy was effective. The authors' view was that 'whilst we cannot claim that our results show that this policy is ineffective, we would argue that … unrealistic expectations about the effectiveness of driver education must be avoided.'

The studies in the Cochrane review were predominantly longitudinal in design. By contrast, the survey of company car drivers by Lynn & Lockwood[11] referred to earlier was cross-sectional in design. They included driver training as a variable in their multivariate analysis of self-reported accidents, and found that trained drivers had an accident liability that was 8 per cent lower than that of untrained ones, though the difference was not statistically significant.

In the fleet safety field, properly designed experiments are extremely rare; indeed, only one appears to have been published in a peer-reviewed journal. This was the study of Televerket, a Swedish telephone company, by Gregersen *et al.*,[26] which Murray *et al.*[20] have described as being 'probably the most quoted – and misquoted – fleet safety study undertaken anywhere to date'. In this experiment, four interventions (driver training, group discussions, campaigns and bonuses for accident-free driving) were compared with a control group, and accident rates and costs were compared for a two-year period before and after the interventions. The results for the driver training group showed a statistically significant reduction of 40 per cent in accident rate after training. This is convincing evidence, but it should be borne in mind that the training procedures used in the study were far removed from those conventionally used by fleet trainers. There were three components to the one-day training programme in the Swedish study: low speed manoeuvring, skid training and commentary driving. These are described in more detail in a later paper by Gregersen,[27] who comments that:

> ...the large accident reduction was unexpected. The most probable explanation is the purpose and content of the training. Specifically, the aim was not primarily to increase the driver's skills in manoeuvring the car, but to create insight about risks in traffic and about the driver's own limitations'.

He went on to express the hope that the study would 'serve as an inspiration to develop such training strategies further in combination with making scientifically correct evaluations'. Televerket was unable to provide a venue for this. Not long after the study, the company was privatised, underwent a major reorganisation, and the opportunity for any longer-term evaluation was lost.

One study that did attempt to follow up this innovative approach to driver training was carried out in Finland by Salminen.[28] Again, a one-day training course was employed, this time in 'anticipatory driving', which focused on the problems of driving on snow and ice and in darkness. The main outcome measure used in the study was an audit of work-related traffic safety in the company. There was a statistically significant improvement in audit scores after the training intervention, and on this basis the author claimed that the anticipatory driving course was successful. Further support was claimed on the basis that drivers reported using what they had learned while on their holidays. Less supportive of this position was the fact that traffic accidents increased after the intervention, albeit based on very small numbers. The results must therefore be considered at best equivocal.

Less equivocal are the results from a recent study by Darby *et al.*,[29] who carried out a retrospective analysis of data from the records of a large organisation – a telephone company, as in the earlier Swedish study. Their analysis showed a statistically significant 64 per cent reduction in claims rates for drivers after undergoing driver training (no information was given on the nature of the training). The analysis was rigorous and the results impressive, but the authors are rightly cautious in presenting their conclusions given the methodological questions that can be raised about the study. First, the drivers that were selected for training had claims rates that were well above the company average, which raises the possibility of regression to the mean effects. Second, the design of the study did not incorporate a control group. Third, and perhaps most important, driver training was only one of a wide range of WRRS interventions introduced during the course of the study (according to the authors, there had been no fewer than 124 safety interventions in the preceding five years).

A decade ago, Downs *et al.*[12] reached the conclusion that 'there is no evidence in the literature in the form of scientifically controlled studies that conventional fleet driver training as practised in the UK is effective in reducing accident rates'. A quote from a recent European report[30] suggests that little has changed: 'There is no scientific evidence in the literature in the form of scientific controlled studies

that conventional fleet driver training as practised in the UK is effective in reducing crashes.' The key word in these two very similar quotes is 'conventional'. As mentioned earlier, the Gregersen *et al.*[26] study has been widely cited in the literature, and is generally recognised as being highly innovative in terms of both experimental design and in the content of training materials. Despite this, there has been no documented attempt to take this work forward, and to build on either the 'insight' approach advocated by Gregersen, or to incorporate the proven benefits of training in the cognitive components of driving, such as hazard perception (Helman *et al.*[23]).

4.3 Group discussions

One method that has aimed to raise safety consciousness and thereby bring about behavioural change is the use of group discussions among employees. This method has not been widely used as a WRRS intervention, but is one that would seem to offer promise. The theory that group decisions can be a force for behavioural change dates back more than 60 years (Lewin[31]), but was only put into practice in the occupational safety field for the first time in the Televerket study of Gregersen *et al.*,[26] when it was one of the four interventions in their comparative study. This component of their investigation drew directly upon work carried out in Japan by Misumi,[32] which in turn was based on the theories of Lewin. Misumi described a study in which bus drivers participated in two discussions about work problems, and then made decisions about a safer driving style. Accidents were reported as declining sharply as a result. However, it should be noted that the drivers were included in the study because of their prior accident involvement, so the possibility of regression to the mean should be borne in mind. The Swedish study largely followed the procedures used by Misumi:

- a 60-minute 'warm-up' period of free discussion
- a 40-minute discussion to identify problems at the workplace
- a 20-minute meeting to discuss results of the previous stage
- small group discussions of the problems and how to resolve them
- a 60-minute plenary session to plan and commit to future action.

The results from the Swedish experiment showed that group discussions were the most successful of the four interventions used in the study, with a statistically significant reduction in accident rates of 56 per cent in the two years after the measure was introduced. This conclusion has often been reported as demonstrating the need for wider employee participation in WRRS. It is, however, worth noting Gregersen's comments in his later paper,[27] in which he explains:

> The group discussion intervention was a complex one … it is not possible to draw any definite conclusions about the reason for the effect without further research to disentangle the effects of the various factors.

Group discussions were also used in the Finnish study by Salminen.[28] The procedures used were based closely on the earlier Swedish investigation, the main difference being that they were conducted over a six-month period. When comparing the numbers of accidents that occurred in the three years before and after the intervention, the quoted result was a striking reduction of 72 per cent. Less often quoted is the fact that this change was based on absolute numbers of 18 before and 5 after. The author rightly points out that 'the number of accidents was rather small … it is important that the results of this study are in line with previous research in Japan and Sweden'.

In a different setting, group awareness sessions formed part of a long series of studies carried out in the US by Ludwig & Geller[33] that aimed to use behaviourist theories to bring about changes in safety behaviour. Given the theoretical background, it is perhaps not surprising that the outcome measures used were based on behavioural rather than accident measures; more importantly, the group discussions formed part of a wider programme, and thus could not be evaluated separately.

In summary, the group discussion approach has a sound theoretical basis, there is at least one empirical study that attests to its effectiveness, and it should be attractive from an economic point of view. The suggestion by Gregersen[27] that the driver training and group discussion approach might profitably be combined has never been reported in the published literature (although it is said to have been taken up by some organisations), and it is unfortunate that properly controlled investigations have not been carried out to take forward or even replicate the earlier Scandinavian research studies.

4.4 Incentives

According to classical psychological theory, positive reinforcement is more effective than negative reinforcement. Thus rats, pigeons and humans all respond better to reward than to punishment.

However, the road traffic system operates largely on the principle that bad behaviour should be punished, but good behaviour goes unrewarded. The corporate fleet environment is one where there is the possibility of redressing this balance, and a number of studies have been carried out to look at the effects of incentives or rewards on driver behaviour and accident rates.

A bonus, or more properly an incentive system, was one of the four measures studied in the Gregersen *et al.*[26] Swedish experiment. There was a significant 23 per cent reduction in accident rate for the bonus group. The authors felt that this was relatively modest compared with the other two successful measures (driver training and group discussions), and questioned whether the level of reward involved was too small given the constraints of Swedish taxation rules. Some evidence on this point comes from the survey of company car drivers in the UK by Lynn & Lockwood.[11] They found that only a few of the companies in their sample provided any rewards or incentives for accident-free driving, but that drivers in such schemes had fewer accidents than those that were not. Though only marginally significant ($p = 0.09$), the effect was a large one, with a 21 per cent difference in accident liability. Interestingly, the sums involved were generally small, and some rewards were non-monetary. The possibility of cultural differences between Swedish and British drivers in this respect has not been investigated further.

Wilde[34,35] has long been an advocate of incentive schemes, and has argued that they should be used more widely, both in occupational settings and to improve driver safety. Schneider[36] describes a long-term (30-year) programme in which professional drivers in a large German company were offered incentives for accident-free driving. The result was a marked reduction in accident rates and costs over the period. However, the author notes that this was only one of a variety of measures used by the company.

The proceedings of an OECD symposium on enforcement and rewards (Koornstra & Christensen[37]) contain several papers discussing incentive schemes from both theoretical and practical viewpoints, but little has appeared in the literature since that time. Newnam *et al.*[38] reported that financial incentives based on insurance premiums had no effect on changing the attitudes of Australian fleet safety managers, though the value of this outcome measure is difficult to assess given the lack of a quantified link between managers' attitudes and drivers' accidents. Banks *et al.*[21] describe a survey of the US trucking industry that found that the safest firms used a range of driver reinforcement schemes to encourage safer driving. The authors point out that failing to investigate less safe firms at the same time considerably weakens this conclusion, and it is hard to see how it could be adduced as 'evidence'.

At an anecdotal level, it is known that many organisations operate incentive and reward systems, but there is no published evidence on the effectiveness of such schemes. Similarly, there is no evidence on disincentive schemes, although these are known to be used – usually as part of a package of measures. In summary, it is once again unfortunate that there has been so little follow-up of an intervention that has both theoretical and empirical support, is relatively cheap and easy to implement, and should in principle lend itself to proper investigation.

4.5 Publicity

The Swedish Televerket study by Gregersen *et al.*[26] included what they termed a 'campaign' group. This was not a conventional publicity campaign, in that it comprised five staff meetings during the course of a year. In these meetings, seasonal problems for driving were discussed, videos were shown, and publicity material was distributed. The results of the experiment indicated that this was the only one of the four test groups not to show a decrease in accident rate; in fact, it showed a small but non-significant increase. To confuse the picture further, the authors noted a small reduction in accident costs, as well as a high drop-out rate for participation in the publicity meetings.

Community road safety campaigns in an organisational setting were also reported in the review by Ludvig & Geller[39] of behavioural change interventions over a 10-year period. Their review covered a range of procedures, such as promise cards, performance feedback, pledge cards, and safety reminders. The contribution of this research is limited by its focus only on behavioural outcome measures, and by the absence of any tests of statistical significance in the results. Further, Murray *et al.*[20] rightly raise concerns that the 10-year study of pizza delivery drivers drew no attention to the use of young staff in a productivity system that could be seen to encourage unsafe driving practices.

In summary, there is no hard evidence in the literature that the interventions described above are effective in improving WRRS.

4.6 In-vehicle data recorders (IVDRs)

It was mentioned earlier in the review that the freight industry has tended to be more regulated and monitored than other areas of work-related driving. One such regulation was the compulsory fitting of tachographs, primarily for the purpose of monitoring driver hours. While an early American study (Larson *et al*.[40]) claimed to have demonstrated a reduction in police vehicle accidents following the installation of tachographs, the investigation was methodologically weak (poor control, inadequate statistics and so on) and the conclusions no more than suggestive. Of greater relevance to the present review are the newer IVDR systems that have come into widespread use in recent times in occupational settings. They were widely referred to originally as 'black boxes' partly because the early versions were quite large, but mainly because the original use, as in aircraft, was to collect data in the period immediately before a crash. While still used to some extent for accident investigation purposes, advances in technology have led to an increasing role in driver monitoring. The special characteristics of IVDRs mean that they can objectively and accurately record the actual behaviour of identified drivers in a naturalistic setting, which should make them ideally suited to learning more about the actual, as opposed to the self-reported, behaviour of such drivers. There is the further possibility that such devices could be used in the training of fleet drivers and to assess the effects of training interventions by continued monitoring of drivers.

An examination of the evaluations that have been made of this potentially valuable intervention type provides the by now familiar picture of enthusiastic promotion and limited hard evidence. A European report[41] talks of the possibilities of 'empowering drivers to manage their own safety by giving instantaneous in-vehicle feedback', but then goes on to observe that 'not all companies want to reveal data as their technology gives them a comparative advantage over their competitors'. Concerns over data sensitivity (both on the part of technology providers and users) may go some way to explaining the lack of published evaluations using such promising technologies.

As far as evaluation is concerned, the report describes a 'well-documented field test' in which the Berlin police department equipped all its patrol vehicles with IVDRs and claimed a 20 per cent reduction in accidents in the following year. However, there was no control group included. The report then goes on to state that:

> ...it became clear how important human leadership is in connection with the event recorders. Only if staff or its representative body is involved early on and an awareness of joint responsibility for the operational success can be achieved … can distrust and tensions be avoided. However, positive impacts tend to fade out if monitoring and management efforts are not maintained at a high level.

This cautiousness is mirrored in an unpublished UK review on the topic, which noted numerous limitations in the available information:

- several reviewed studies looked at only small samples, and over short periods of data collection
- the context of the installation, feedback and any external reference to the IVDR system may exert its own distinct influences on driver behaviour
- some IVDR systems claimed to measure risk without demonstrating predictive validity
- several studies may have been subject to a regression to the mean effect when IVDR systems were fitted in response to a high accident rate, and may thus have over-estimated the safety effects of IVDRs.

The European report also refers to positive results from programmes in the Netherlands and Switzerland, but the information provided is anecdotal at best. When it comes to hard evidence, the picture is a familiar one of potential not being recognised. A study by Toledo & Lotan[42] showed that 'risky' manoeuvres among fleet drivers were reduced following the use of IVDR systems, but that effects on behaviour tended to diminish over time. There is only one properly controlled study in the literature to date (Wouters & Bos[43]) that demonstrates a statistically significant reduction in accident involvement in fleets as a result of installing IVDRs. This was an output from an EU project (SAMOVAR[44]), in which accident data recorders were installed in a number of fleets in Belgium and the Netherlands, and drivers were made aware that the data recorded could be used when accident responsibility was being assessed.

It should be noted that this study used what might be termed the first generation of IVDRs. Despite technological advances in the capabilities of such devices, there appears to have been little in the way of serious attempts to employ IVDRs in an evaluation context. One exception is the study by Toledo *et al*.[45] While essentially a demonstration project, the investigation included an analysis of crash rates before and after the installation of IVDRs and found a statistically significant reduction in crash rates

overall (but not in at-fault crashes). The authors commendably point to the relatively short periods of time involved, and to the fact that the results are somewhat at variance with their earlier work as far as the stability of the effect is concerned. They suggest that 'further research is needed to better understand the temporal and long term impact of the installation and to develop feedback management schemes … to maximise its impact'.

Once again, it is necessary to use the word 'unfortunate' to describe a situation where an intervention that has great potential for research as well as evaluation appears so infrequently in the literature. The opportunity to collect and use real time data in real world situations should not be lightly dismissed.

4.7 Organisational approaches

All previous interventions have been concerned directly with change at the employee level in an organisation. As indicated earlier, a major shift in research emphasis in recent times has been from how individuals respond to interventions to how organisations plan interventions. With the increasing recognition of employer responsibility and duty of care, there has been a move to what has been termed 'work-related driver safety management approaches' (Haworth *et al.*[19]). Associated with this has been a growth in what might be termed 'management-speak', so that the literature is now replete with best practice guidelines, safety policies and procedures, benchmarking, safety climate measures, theoretical frameworks, matrices, case studies, human behaviour interfaces, proactive multidimensional inputs, and even the 'holistic' approach.

'Best practice' is a case in point. Logically, the use of the word 'best' should imply that sets of practices have been compared, their worth assessed in some way, and that one set has emerged as superior to the others. In reality, these procedures are assembled largely on an *a priori* basis; 'good practice' would be a more appropriate term, but presumably has less commercial appeal. Furthermore, the use of the word 'best' runs the risk of conveying the implicit message that nothing more needs to be done once such practices have been put into place.

What is missing in this plethora of initiatives is a commitment to evaluation. The Banks *et al.*[21] review lists a dozen or so practices and procedures that have been recommended to organisations for the better management of occupational road risk. They then add a cautionary note: 'as many of these recommended initiatives have not yet been scientifically evaluated, enthusiastic endorsement of these guidelines is cautioned'. Using their selection criteria, they found only four organisational interventions that have been subjected to any form of evaluation: policy development, driver selection, web-based tools and remuneration policy. Banks *et al.*[21] found that evaluations of policy development were weak in design and lacked statistical rigour, while the only study on driver selection (from the US) lacked adequate controls. Similarly, while the web-based risk management tool was found in a case study to be associated with a reduction in crashes (White & Murray[46]), its inclusion in a package of measures meant that confounding effects could not be discounted. The same criticism applied to the fourth intervention, remuneration policy. While a US study claimed that incremental increases in driver pay led to slightly larger decreases in crash risk, there was no reported control for other changes that were introduced at the same time.

The recent review by Newnam & Watson[22] refers to intervention strategies 'commonly adopted by proactive organisations', but gives no information about any evaluation of these strategies. It may be noted that neither of these reviews mentions the topic of safety climate, or safety culture, which may seem surprising, given the frequency with which these terms have appeared in the literature over the last decade. One possible explanation is that safety climate/culture has tended to be seen as a desirable attribute of an organisation, rather than as an intervention in its own right. Only one study could be found in the WRRS literature that has investigated the relationship between safety climate and safety; this was an early exploratory study by Wills *et al.*[47] The results showed that there were no significant differences in fleet safety climate scores between drivers who had been involved in accidents and those who had not. Later work by the same authors[48] has focused on driver behaviour or, rather, self-reported driver behaviour.

It would appear that the evaluation literature – such as it is – offers little in the way of support for interventions at the organisational level to improve WRRS. This conclusion may seem at first sight to be at variance with a number of case studies that have claimed marked improvements in safety outcomes as a result of instituting changes in organisational policies and procedures. This issue will be discussed in the next section. The results from the review of the evaluation studies are summarised in Table 1.

Table 1
Summary of results from intervention studies *(continued on pages 21–23)*

Study	Type	Participants	Measures
A. Driver training			
Lynn & Lockwood[11]	Cross-sectional survey	2,417 'regular' business drivers	Accident liability over 3 years
Herz 1995, cited in Haworth *et al*.[19]	Case study	Half of fleet drivers	Crash rates
Gregersen *et al.*[26]	Quasi-experiment	988 drivers in test group, 988 in control	Accidents per 10,000 km over 2 years
Salminen[28]	Before/after; no control	179 drivers (including 'volunteers')	External safety audit, accident numbers
Darby *et al.*[29]	Retrospective analysis	378 drivers	Claims per year
B Group discussions			
Gregersen *et al*.[26]	Quasi-experiment	916 drivers in test group, 988 in control	Accidents per 10,000 km over 2 years
Ludwig & Geller,[33] cited in Haworth *et al*.[19]	Before/after; test/control	Varying numbers	Seat belt usage
Salminen[28]	Before/after; no control	172 drivers	Accident numbers over 3 years
C Incentives			
Schneider[36]	Case study	Not stated	Accidents per 100,000 km over 30 years
Gregersen *et al*.[26]	Quasi-experiment	900 drivers in test group, 988 in control	Accidents per 10,000 km over 3 years
Lynn & Lockwood[11]	Cross-sectional survey	2,417 'regular' business drivers	Accident liability over 3 years
Mejza *et al.* 2003, cited in Banks *et al.*[21]	Survey	Not stated	Success?
Newnam *et al.*[38]	Before/after; no control	24 fleet managers	Attitude change
D Publicity			
Gregersen *et al*.[26]	Quasi-experiment	915 drivers in test group, 988 in control	Accidents per 10,000 km over 3 years
Ludwig & Geller,[33] cited in Haworth *et al*.[19]	Before/after; with controls	Varying numbers	Behaviour modification

Confounds*	Results	Comments
Multivariate analysis – fully controlled	Trained drivers had an accident liability 8% lower than non-trained drivers	Rigorous data analysis, but result non-significant; possible self-selection bias
No information	35% reduction in crash rates	Low quality: no information on matching groups, no statistics, no data on long-term effects
Matched control group; exposure in measure	Significant 40% reduction in accident rate	High quality: quasi-experimental design and analysis. Unconventional training content
No information	Significant improvement in audit scores; 21% increase in accidents	Low quality: no control group, main outcome measure not validated, no measure of exposure, accident numbers small
Multifactor study	Significant 64% reduction in claims rate after training	Rigorous data analysis; only high-risk drivers studied, no control group, training only one of several interventions
Matched control group; exposure in measure	Significant 56% reduction in accident rate	High quality: quasi-experimental design and analysis
Multifactor studies	Increase in seat belt wearing rates	Short term effect; no control for confounding factors
No information	72% decrease in traffic accidents; 15% decrease in other accidents	Low quality: no control group, no measure of exposure, accident numbers small (18 vs 5)
No information	75–85% reduction in accident rates	Low quality: no control, incentive scheme only one of several measures (multifactor)
Matched control group; exposure in measure	Significant 23% reduction in accident rate	High quality: quasi-experimental design and analysis
Multivariate analysis – fully controlled	Drivers in incentive schemes had accident liability 21% lower than those not in the schemes	Rigorous data analysis, but result only marginally significant ($p = 0.09$)
No information	Successful trucking companies used incentive schemes	Low quality: no comparison with unsuccessful companies
No information	Incentives (via insurance premiums) had no effect on managers' attitudes	Theoretically sound, but outcome measure lacks validity
Matched control group; exposure in measure	Non-significant 22% increase in accident rate	High quality: quasi-experimental design and analysis
No information	Increases in targeted behaviours	Behaviour measures lack validity, no statistical testing

* Confounds: whether confounding variables were considered.

Table 1
continued

Study	Type	Participants	Measures
E. In-vehicle data recorders			
Berlin police department 1998, cited in ETSC[41]	Before/after; no control	380 vehicles	Accident numbers
Wouters & Bos[43]	Quasi-experiment	3,100 vehicle years in 6 fleets	Accident numbers
Toledo & Lotan[42]	Before/after	33 car drivers	'Risk index' from recorders
Toledo *et al.*[45]	Before/after	191 truck drivers	'Risk index', crashes
F. Organisational			
Wills *et al.*[47]	Survey	323 drivers	Behaviour, offences and crashes
White & Murray[46]	Case study	Not stated	Collision rates over 3 years

Confounds	Results	Comments
No information	20% reduction in accidents after fitting recorders	Low quality: no control, no exposure measure
Matched controls	Significant 20% reduction in accidents over 6 fleets	High quality: quasi-experimental design and analysis
No information	Significant correlations between index and crash history; feedback improved behaviour in the short term	Sound demonstration project rather than evaluation
No information	Significant 38% reduction in crash rates in the 7 months after installation	No proper control, no change in at-fault crash rates
Multiple regression analysis	No relation between safety climate and offences or crashes	Possible self-selection bias
No information	13–30% reduction in crash numbers	Low quality: no control, no exposure measure, multifactor approach

5 Methodological issues

5.1 Introduction

Reference was made in an earlier section to a Cochrane review of driver training, and to the fact that such reviews are regarded as the 'gold standard' for methodological rigour. Having reviewed the literature on WRRS interventions, it has to be concluded that it is very probable that there is not a single item in it that would be deemed acceptable for inclusion in a Cochrane review. This is not as damning as it sounds, for it is also very probable that only a very small part of the entire road safety literature would be eligible. The basic reason is that randomised allocation – the central tenet of the experimental method – is extremely difficult to achieve in the real world, and particularly in an occupational or commercial setting. There are also numerous other barriers to achieving quality in evaluation studies in this area. As Downs *et al.*[12] noted:

> At a practical level, it is possible that organisations are reluctant to disclose the scale of their accident problem, or may regard the information as commercially sensitive and inappropriate for publication. It is also possible that accident data is not always collected in a sufficiently reliable and consistent way that would permit statistical analysis.

They then go on to note the difficulties in establishing proper control groups, the statistical problem of regression to the mean, the possibility of selection bias, and the problem of potentially confounding effects.

Without in any way underestimating these problems, they are not insuperable. Robson[49] describes a number of established procedures that are suitable for use in what he terms 'real world research', and the Swedish study by Gregersen *et al.*[26] showed that experimentation (or, more strictly, quasi-experimentation) is a feasible proposition. Despite this, the evaluation scene for WRRS is a depressing one. The recent study by Banks *et al.*[21] identified 20 peer-reviewed articles covering 19 WRRS initiatives. Of these, only six were found to be effective in the post-intervention period. The phrase 'the article did not indicate if the changes in outcome were significant' was used by the authors eight times. On six further occasions, it was found that the intervention under consideration had been introduced as part of a package of measures, and so its unique contribution could not be assessed. The authors found only four instances in the last 20 years of a well-controlled study in which an intervention resulted in a significant reduction in accident rates. This hardly seems to justify the assertion made by Rowland *et al.*[50] that 'research has shown that appropriately designed, industry-based road safety interventions can reduce the number and severity of work-related road incidents'.

In their conclusions, Banks *et al.*[21] raise the possibility that their selection criteria may have been too rigorous, and that including non-peer reviewed publications might have broadened the scope. This approach was adopted in the review by Newnam & Watson;[22] while it drew attention to a number of research publications, it was not able to identify any additional studies that had assessed the effectiveness of interventions. This must raise the possibility that evaluation research has somehow gone out of fashion in WRRS.

5.2 The multidimensional approach

One very obvious feature of changing practices in the last decade has been the shift from single to multiple interventions. In the predominantly Australian literature during this period, this has often been justified by drawing marked distinctions between procedures and practices. These distinctions sometimes seem more apparent than real, and merit further attention.

The first distinction is the one that has been drawn between the 'silver bullet' approach and the multidimensional approach. Thus, Rowland *et al.*[50] state that:

> Historically in terms of exploring and implementing fleet safety interventions, organisations have often taken a 'silver bullet' approach aimed at developing a single countermeasure or intervention strategy to encompass and address all work-related road safety issues.

They later maintain that 'past research has revealed that a single reactive approach is ineffective in improving long term work-related vehicle/road safety' but cite no evidence to support this position. Their preferred option is that organisations should adopt a 'proactive multiple strategy approach'. Such advice leads inevitably to the methodological problems encountered by Banks *et al.*[21] in their review, when they held that 'as many of the studies reviewed investigated the effects of initiatives

when implemented in combination with other initiatives, it was not possible to distinguish the unique impact of some initiatives'. Another way of putting this might be to say that proper evaluation becomes extremely difficult when the silver bullet is replaced by the blunderbuss.

A second distinction has been drawn between what is termed the 'asset management approach' and its alternative, the 'human behaviour interface'. Asset management is regarded as a reactive approach, concerned only with the frequency and severity of fleet accidents (Freeman *et al.*[51]). It is criticised for being simplistic and for not providing information on underlying attitudinal and behavioural factors that can be gained by using the alternative approach. If this is a plea for better data collection, it is commendable; otherwise, the distinction is a somewhat artificial one.

The third distinction that has been made is between 'data-driven' and 'theory-led' approaches to WRRS (Newnam & Watson[22]). The argument set out by these authors is that:

> Although anecdotal and data-driven research has provided significant insight into the extent of the work-related driving problem, it is limited in that it does not provide the theoretical foundation for establishing the development and improvement of interventions designed to reduce death and injury in the work vehicle.

Leaving aside the question of whether anecdotal data can really provide 'significant' insight into this problem, it is not unreasonable to ask why effective interventions can only be achieved by applying top–down theory. The study by Broughton *et al.*[52] is relevant here. Unconstrained by theoretical preconceptions, it employed rigorous data analysis in order to identify aspects of behaviour that were significantly associated with accident risk, and thereby propose possible interventions to improve WRRS.

5.3 Intervening variables

According to Freeman *et al.*,[51] '… practitioners and researchers are beginning to direct an increasing level of focus towards developing and utilising self-report measurement scales to determine whether practical relationships exist between self-reported attitudes and behaviours as well as subsequent crash involvement'. They add that 'one of the most prominent reasons for this focus is that vehicle accidents have been found to be attributable to employees' attitudes and behaviours'. In support of this contention they cite the study by Chapman *et al.*,[14] which is somewhat surprising, given that the study in question did not include any attitudinal measures. Nonetheless, an increasing amount of research in the last decade, mainly from Australasia but also from the UK, has been concerned with the investigation of attitudinal and behavioural factors associated with crash involvement. The rationale for this activity is that, if it can be shown that self-report measures are predictive of crash involvement, then they would provide a richer and more informative outcome measure than the mere counting of crash frequencies – which is the asset management approach referred to above.

Implementations that have been employed include the Driver Behaviour Questionnaire (DBQ), the Driver Attitude Questionnaire (DAQ), the Driver Stress Index (DSI), the Safety Climate Questionnaire (SCQ), as well as scales measuring risk taking and driving skills. The most widely used of these tools has been the DBQ, and claims have been made that its measures are significantly associated with, and predictive of crash involvement in, a fleet setting, eg Sullman *et al.*,[53] Xie & Parker[54] and Rowland *et al.*[55] 'Prediction' is a complex issue, and some authors (eg Freeman *et al.*[51]) have expressed reservations about the effectiveness of this approach. A number of issues of both theoretical and empirical concern have been raised:

- the DBQ was developed and, more importantly, standardised on the general driving population
- when used in a fleet driving context, its factor structure has been inconsistent
- studies have tended to show that the DBQ can only explain relatively small proportions of the variance in crash involvement
- association does not imply causation
- the fact that a measure contributes to a predictive equation does not mean that it can act as a proxy measure for the dependent variable in question.

There are two empirical studies that are of particular relevance here. The first is by Wåhlberg *et al.*,[3] which looked at the predictive value of the DBQ, and concluded that 'it may not be as successful in predicting accidents as is often claimed'. The second is the study by Broughton *et al.*,[52] in which multivariate analysis found that reported violations as measured by the DBQ did not contribute to their models of accident liability (a finding that has been little reported in the literature). A realistic

assessment should be that the prospect for developing proxy measures for fleet accidents does not at present look particularly promising.

5.4 Case studies

If evaluation studies appear to be out of fashion in the WRRS field, then one type of investigation that is in vogue is the case study. A number of these have appeared in the literature in recent times (eg Lang *et al.*,[8] White & Murray[46] and Murray *et al.*[56]). They typically describe success stories in organisations, and have given considerable encouragement to those who wish to adopt the 'best practice' approach. Robson[49] writes approvingly of case studies as a way of understanding social change, and is used as a model by Murray *et al.*[56] There can be no doubt that some of these case study outcomes are very impressive. The Murray *et al.* study describes in detail the changes put into practice by a major company with the aim of improving its WRRS, and cites as evidence a halving of its collision rate and the fact that it 'gained wider benefits by adopting a holistic approach'.

However, these success stories need to be put into a wider context. Where fleet safety is concerned, the majority of positive outcomes relate to large organisations that are well motivated and have shown a commitment to achieve and maintain improvements in WRRS. The picture painted by Murray *et al.*[57] in their study of small enterprises is a very different one, when they stated that:

> Crash outcomes were purposefully not included as one of the initial project targets… [because] participants would be secretive about such data… It was better to concentrate on more proactive outcomes, particularly the implementation of processes and systems.

Practitioners readily point to case studies as clear examples of how the organisational approach to fleet safety can achieve positive results. However, there are two issues that should be borne in mind regarding case studies. First, as noted above, only positive outcomes tend to be reported. There is anecdotal evidence that some large organisations have implemented programmes without achieving any benefits. If the ratio of successful to unsuccessful programmes is unknown, then the value of such interventions must remain unclear. Second, there is the problem of generalisation. Case studies are a very good method of showing what can be achieved by bringing about change, but they provide only limited information on how these results can be transferred to other situations. One recurring theme in the literature has been the disparate nature of commercial fleets, and this very fact tends to weaken the predictive validity of case studies.

5.5 Barriers to evaluation

This section considers methodological problems that have impinged on WRRS in the past, continue to do so in the present, and act as barriers to evaluation. The first, and most obvious, is that it takes place in the real world, and therefore experimentation to establish the effectiveness of remedial measures is extremely difficult. Twenty years ago, this was seen as a challenge; good evaluation work was carried out, and possibilities for further research were identified. These possibilities have never been followed up. Largely as a result of pressure from policy makers and legislators, there has been a major change in emphasis where a concern with policies and procedures has become the main priority for fleet operators. While Murray *et al.*[20] stress the need for 'proactive key performance indicators', they also accept that much of the activity in the UK in the last decade has been concerned with identifying and disseminating best practice, rather than with evaluation. They also go on to argue that:

> Even where safety gains in a pure academic or statistical sense cannot be proved, a safety programme has very high face validity, helps provide protection from regulations … and offers a range of PR and business development opportunities.

Those convinced by this argument could well be led to question the need to invest time and resources in evaluation research that could have uncertain outcomes.

The second barrier is the near universal use of multifactor interventions. While case study evidence is highly supportive of such an approach, what is lacking is an understanding of the relative effectiveness of the component parts of any intervention package. Concern with procedure in the UK has often led to multifactor interventions being adopted on a largely pragmatic basis. This contrasts with the situation in Australia, where the multifactor approach is employed with enthusiasm and buttressed by a range of theoretical and conceptual frameworks. In the UK, it would seem that the concern is more with action than research; in Australia, it appears to be more with research than evaluation.

Another barrier to evaluation has been the lure of intervening variables. To most road safety researchers, accident statistics are the ultimate criterion by which any safety countermeasure should be assessed. In the WRRS field, however, there has been increasing pressure to move to other more 'explanatory' measures, such as behaviour and attitudes, partly because of the ease with which such data can be collected. There are a number of inherent problems with this approach, and it has achieved only limited success to date.

The final barrier to evaluation is that it is no longer seen as being important – at least not in the rigorous scientific sense. In the multifactor approach, changes to crash rates are now seen as only one of many possible key performance indicators. As an example, in the Wolseley case study by Murray *et al.*[56] there were 11 other measures cited as outcomes in addition to a reduction in collision rate, the majority of them non-quantifiable.

One effect of these barriers to evaluation is the fact that not a single properly controlled evaluation study of WRRS interventions has been carried out in the last decade.

5.6 The content of interventions

One methodological issue that has not been addressed to any real extent in the literature is that of the formulation and content of intervention measures. 'Methodology' is all too often seen as being only concerned with experimental design and statistical analysis. In its proper sense, methodology is the study of the principle guiding the search for knowledge, and as such is also concerned with problem identification and the selection of the most appropriate means by which to address problems. Most of the literature that has been discussed so far has been concerned only with the application of intervention measures; with a few exceptions, there has been little in the way of assessing how appropriate these measures are to the problem in hand, or, more importantly, of attempts to gain a better understanding of the problem itself.

Earlier in the review, it was noted that the 1990s ended with a good understanding of the fleet driver problem, but with no real evidence that could guide the design of interventions to improve WRRS. Little has changed in the intervening period. Although Newnam & Watson[22] argue that research in this area has been data-driven, this is difficult to sustain. A careful examination of the literature should lead to the clear conclusion that WRRS is in fact data-poor, particularly in respect of an understanding of the basic problem and the factors that are associated with it.

National authorities faced with a rising accident problem spend time and resources to identify the areas of greatest risk so that intervention measures could be deployed most effectively. By contrast, the WRRS response has tended to be either to employ the 'silver bullet' of driver training, or else to engage in multifactor organisational approaches. Even when problems have been well identified, the findings have sometimes been discounted. For example, Wishart *et al.*[58] identified seven main crash types in their research on fleets, but held that such categorisation is merely part of their disparaged 'asset management' approach, which, they maintain, can only be concerned with short-term financial gain rather then providing the information for what is really needed – 'large scale behavioural intervention and workplace culture change'. This is a clear example of theory taking precedence over data.

The traditional road safety approach would be to employ the procedures of accident analysis and risk factor identification to look in detail at the problem areas, and then direct interventions to the optimal effect. The key issue is the need for a good understanding of the problem through the collection of good quality reliable data. It may be that this does happen in some enlightened organisations, but it does not appear in the literature.

However, there is some evidence that can contribute to this debate. Safety measures are most effective when directed at high risk targets, so the identification of risk factors should be central to the development of effective countermeasures. At a subjective level, Salminen & Lähdeniemi[59] sent a questionnaire to some 5,000 occupational drivers that included nine 'risk factors'. Responses showed that time pressure, tiredness and use of mobile phones were selected most as being factors that were felt to increase risks while driving.

Robb *et al.*[60] carried out a Cochrane-style systematic review of risk factors for work-related crashes and injuries. While noting that methodologically sound studies were relatively rare in the literature, the authors pointed out that the most consistent evidence related to fatigue and sleep-related factors, and suggested that these could be major causes of work-related traffic injuries.

In France, Fort *et al.*[61] used a case-control design to investigate the risk factors associated with occupational road accidents. They identified a number of factors relating to scheduling and fatigue management as contributing to increased risk of accidents.

Finally, Broughton *et al.*[52] included a number of potential risk factors in their multivariate analysis of work-related injury accidents. They also identified fatigue-related factors, time pressures and in-car distractions such as mobile phones as significantly increasing the risk of accidents.

Thus, four studies using different procedures arrived at very similar conclusions. If one were to look for a unifying concept, the most obvious candidate would be that of driver stress. A considerable body of theoretical and practical work has been carried out on this topic in the last two decades, and increasingly attention is being paid to the issue of driver stress in the occupational setting (see for example Dorn *et al.*[62] and Öz *et al.*[63]). It seems clear that the data-driven approach can not only provide insight but also draw upon wider research evidence for guidance on how and where to target interventions most effectively.

6 Summary

This study set out to provide evidence-based advice to practitioners about the effectiveness of interventions to improve WRRS. This has proved to be a surprisingly difficult task, largely due to the nature of the literature. Since 1999, there have been six reviews of the literature. All six experienced difficulty in finding well-controlled evaluation studies. If one adopts the not unreasonable criterion that an evaluation study should assess whether an intervention has brought about a statistically reliable change in crash rates, then the results are meagre in the extreme. Only four interventions meet this criterion, three were in the same investigation, and all were conducted more than a decade ago.

In 1996, Gregersen *et al.*[26] described the results of a major investigation in which four interventions were compared, together with a control. Three of the interventions were shown to have a significant effect in reducing accident rates. In 2000, Wouters & Bos[43] were able to show that the installation of 'black box' recorders could reduce accident involvement among fleet drivers. These four interventions are the only ones in the literature that show scientific credibility. In the last decade, there have been no serious evaluation studies undertaken, and the claims of improvement in WRRS have been largely anecdotal in nature.

It is important to bear in mind that the absence of strong evidence of effectiveness does not mean that effectiveness has not been achieved. There have been a number of case studies in recent times that have claimed impressive gains in WRRS through the implementation of large scale programmes. Two notes of caution must be sounded, however. The first is that it is in the nature of things that only success stories get reported. There is some anecdotal evidence that programmes have been carried out in some large organisations without making any impact on existing problems. The second is that the current practice is to use a broad package of measures, which means that the effectiveness of each individual component is therefore impossible to assess. Without a return to 'classical' evaluation, work to improve WRRS can only be on an ad hoc and less than efficient basis. There are of course commercial and practical issues that remain to be overcome when trying to persuade industry to engage in evaluation studies. Companies may not wish to invest time and money in evaluation studies if they perceive that holistic approaches (even if only supported by case study data) are sufficient for their needs. In addition, companies may be reluctant to have their accident data made public. Nonetheless, the fact remains that there is a pressing need to use controlled evaluation studies to assess which WRRS interventions work, by how much, and through which causal mechanisms.

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