

Sleep related vehicle accidents

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Abstract

Objectives—To assess the incidence, time of day, and driver morbidity associated with vehicle accidents where the most likely cause was the driver falling asleep at the wheel.

Design—Two surveys were undertaken, in south-west England and the midlands, by using police databases or on the spot interviews.

Subjects—Drivers involved in 679 sleep related vehicle accidents.

Results—Of all vehicle accidents to which the police were summoned, sleep related vehicle accidents comprised 16% on major roads in southwest England, and over 20% on midland motorways. During the 24 hour period there were three major peaks: at around 0200, 0600, and 1600. About half these drivers were men under 30 years; few such accidents involved women.

Conclusions—Sleep related vehicle accidents are largely dependent on the time of day and account for a considerable proportion of vehicle accidents, especially those on motorways and other monotonous roads. As there are no norms for the United Kingdom on road use by age and sex for time of day with which to compare these data, we cannot determine what the hourly exposure *v* risk factors are for these subgroups. The findings are in close agreement with those from other countries.

Introduction

Sleep related vehicle accidents in the United States,¹ Israel,³ Germany,⁴ and Sweden⁵ account for many accidents on non-urban roads and cause greater driver mortality and morbidity than other types of accident because of the greater speed on impact. There are clear effects of time of day, with peaks in the early morning and mid-afternoon.¹⁻⁵ To date, no comparable data exist for the United Kingdom; the national database for vehicle accidents does not identify sleep related vehicle accidents.⁶ We report on two studies from different regions of the United Kingdom covering all accidents to which police were called.

Methods

SLEEP RELATED VEHICLE ACCIDENTS

Sleep related vehicle accidents were identified by the following criteria: (a) breathalyser/blood alcohol levels below the legal driving limit; (b) the vehicle either ran off the road or ran into the back of another vehicle; (c) no signs of the brakes being applied beforehand (for example, no skid marks); (d) no mechanical defect in the vehicle (or burst tyre); (e); good weather conditions and clear visibility; (f) elimination of "speeding" and "driving too close to the vehicle in front" as causes; (g) the police officer(s) at the scene suspected sleepiness as the prime cause; (h) for several seconds immediately before the accident the driver could have seen clearly the point of run off or the vehicle hit. The driver may or may not have admitted to having fallen asleep.

Criteria (a) to (h) had to apply for the data to be acceptable as a sleep related vehicle accident. Criterion (h) also implies prolonged inattention rather than momentary distraction, but this cannot be assumed.

STUDY ONE

Data were supplied by Devon and Cornwall Constabulary for accidents on all roads in the south west of England, during the period 1987-92 inclusive, and to which the police were called. The police officers involved were not sensitised to look for sleep related vehicle accidents, and the data had been entered into the local database before any specific interest in such accidents.

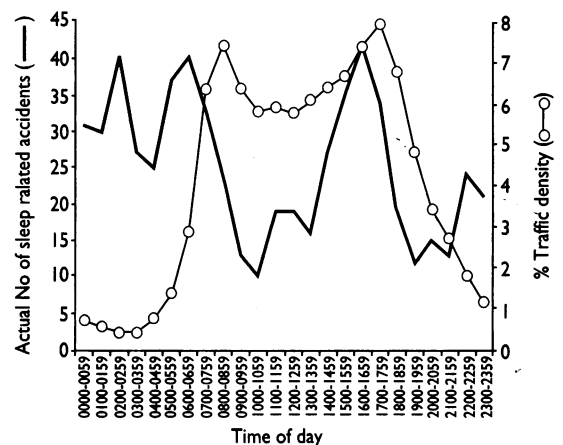
STUDY TWO

We collected data in conjunction with six midlands police forces (central motorway group (Birmingham), and the constabularies of Leicestershire, Northamptonshire, Staffordshire, Warwickshire, and West Mercia), covering only motorways, during the months of August 1991 and 1992, and April 1994. In these surveys the police had been briefed about sleep related vehicle accidents and had been supplied with a short structured interview check list, to be administered (when possible) to all drivers involved in all accidents (sleep related or not).

Results

STUDY ONE

There were 606 sleep related vehicle accidents, comprising 16% of all vehicle accidents: 399 (66%) occurred on A roads, 55 (9%) on the motorway (only one motorway in this region), 97 (16%) on B roads, and 55 (9%) on minor roads. Figure 1 shows the numbers of sleep related vehicle accidents by time of day. Three peaks are evident: at around 0200-0259, 0600-0659 and 1600-1659. Traffic flow rates are not available for the individual roads where the accidents occurred. As a guide, however, figure 1 also shows hourly flow rates as a percentage of total flow over 24 hours (based on data supplied by the police), which are typical not only for this region but for the United Kingdom generally.⁶ Considering the low traffic density at 0200-0259, the surge in sleep related vehicle accidents at this time is even more profound. The circadian propensity for



Study one—incidence of sleep related vehicle accidents ($n=606$) by hour of day. Also shown are general hourly traffic flow rates for these roads. Each hour's flow rate is given as percentage of total number of vehicles per 24 hours (for example, about 8.0% of total daily flow occurs between 1700 and 1759). This hourly distribution of traffic flow is typical for the United Kingdom.

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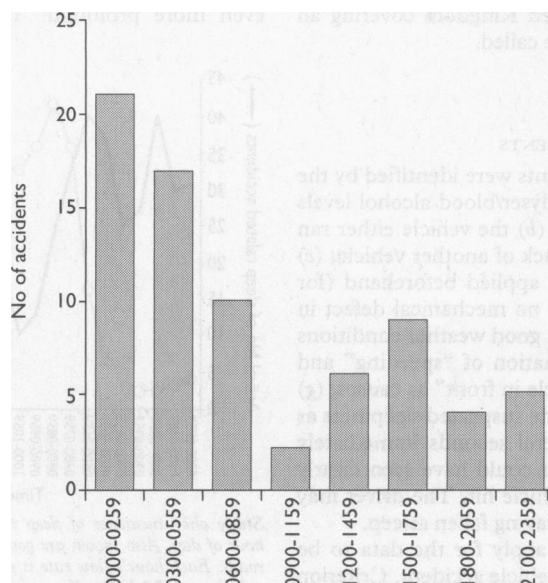
Age of driver (years)	Study one (n=606)	Study two (n=73)
<20	79 (13)	9 (13)
21-25	115 (19)	18 (24)
26-30	79 (13)	16 (22)
31-35	61 (10)	10 (13)
36-40	61 (10)	7 (10)
41-45	55 (9)	4 (6)
46-50	36 (6)	1 (1)
51-55	36 (6)	4 (6)
56-60	18 (3)	1 (1)
61-65	18 (3)	3 (4)
66-70	18 (3)	0
71-75	12 (2)	0
≥76	18 (3)	0

sleep in the mid-afternoon^{7,8} may account for the afternoon rise in these accidents. There were low incidences of sleep related vehicle accidents during 0900-1059 and 1900-2059 which are times of day when people naturally feel most alert.^{7,8} The peak times for all road accidents in the United Kingdom are around the rush hours of 0800-0900 and 1700-1800,⁶ which are distinct from the peaks associated with sleep related vehicle accidents.

Table 1 gives details of sleep related vehicle accidents by age; drivers under 30 years seem particularly at risk. Most (82%) of the drivers involved in these accidents were men. We do not know the age by sex by time of day distributions of drivers on these roads. Death or serious injury (that is, emergency to hospital) to the driver occurred in 139 (23%) of sleep related vehicle accidents (contrasting with 15% of accidents not related to sleep to which the police were summoned), slight injury in 255 (42%), and no injury in 212 (35%). Of the vehicles involved, 491 (81%) were cars, 55 (9%) light trucks (<1.5 tonnes unladen), 42 (7%) heavy goods vehicles (>1.5 tonnes), 12 (2%) motor bikes, and six (1%) not known; these percentages (excluding the latter) are typical of the general prevalence of vehicle types on roads. A fifth of sleep related vehicle accidents occurred on a Saturday (largely because of more late night driving) compared with 16% (97) for Friday, 15% (91) for Sunday, and 11-13% (67-79) for each of the other nights.

STUDY 2

Seventy three sleep related vehicle accidents were identified, comprising 23% of all accidents to which police were called. Sixty seven of the drivers were men. The vehicles involved were: 61 (84%) cars, six (8%) heavy goods vehicles, and six (8%) light trucks. There were no deaths, but 16 accidents (22%) resulted in serious injury to the driver, 35 (48%) in slight injury, and 22 (30%) in no injury. Figure 2 shows the distribution over the day, in periods of three hours (the data were insufficient for an hourly display). The characteristics are similar to those of figure 1, especially the 0000-0259 peak, the late morning trough, and a mid-afternoon surge. Again, drivers under 30 years were prominent (table 1), with nearly three quarters of their sleep related vehicle accidents happening during 0000-0700, compared with 35% for drivers over 30 years. During 0200-0500, all sleep related vehicle accidents (n=14) involved drivers under 30 years. Of particular note is that of the six such accidents



Study two—midlands motorways. Time of day of sleep related vehicle accidents (n=73).

Key messages

- A total of 679 sleep related vehicle accidents were identified from road accidents in south-west England and the midlands to which the police were called
- Such accidents accounted for about 16% of road accidents in general and over 20% for motorways
- There were clear time of day (circadian) effects with the most vulnerable times being around 2-7 am and in the mid-afternoon
- Young male drivers accounted for half these accidents, but it is unknown whether these men are more exposed or are particularly at risk
- The morbidity and mortality associated with sleep related accidents is higher, probably because of the greater speed on impact

involving heavy goods vehicles, three happened within four hours of the start of the journey—that is, before the first statutory rest pause for that day.

Discussion

These surveys have shortcomings, especially as the information was collected at scenes of accidents by police officers, often under fraught and distressing circumstances. Concerning the classification of sleep related vehicle accidents and potential observer bias, the only people who consistently attended these accidents were the police, and we have to rely on their observations. Criteria (a) to (h) (above), however, do embody clear guidelines, and it is more likely that we have underreported rather than overreported the incidences of sleep related vehicle accidents as we excluded data that were only strongly suggestive (for example, "tyre blowout" given as the cause of an accident when the evidence points to the blowout being due to the vehicle hitting the kerb after drifting across the road). In study two the police officers may have been sensitised to sleep related vehicle accidents and the incidence was higher. But this study concerned only motorways, which are particularly monotonous, whereas study one covered all major trunk roads and only one motorway.

The validity of our findings concerning the time of day of sleep related vehicle accidents is endorsed by the similarity with numerous laboratory based reports on the circadian rhythm of alertness-sleepiness,^{8,9} including the low incidence of sleepiness around 1000 and 1800 and the data on accidents obtained from a variety of sources worldwide.⁹

We cannot determine the exposure v risk factors for sleep related vehicle accidents by age, by sex, by time of day as no appropriate norms for road use exist (a formidable undertaking as any normative survey would entail stopping vehicles on motorways). About half of deaths and serious injury in drivers in the United Kingdom occur in young adults,⁶ but it is not known what proportion of such accidents are sleep related vehicle accidents and whether this proportion is greatest for this age group. Young adults remaining awake in the early morning, however, probably experience greater sleepiness than do older people¹⁰ and may not realise their vulnerability. Thus the high incidence of sleep related vehicle accidents for young adults in the early morning may be a mixture of higher risk and exposure.

From our data we have drawn several conclusions. There is considerable vulnerability in driving at times when one is normally asleep, especially around

0200-0300. Sleep related vehicle accidents are more common in the mid-afternoon compared with the rest of the normal waking day. Male drivers under 30 years are the main victims of these accidents. Death or serious injury to drivers may well be greater than for the "average" accident. Sleep related vehicle accidents comprise about 16-23% of road accidents, the higher proportion being relevant for motorways. Because of the profound influence of the circadian rhythm of sleepiness on sleep related vehicle accidents, they can occur after even a short period of driving. These conclusions are borne out by those from other countries.¹⁻⁵ A recent report from the United States concludes that in addition to the human suffering caused by sleep related vehicle accidents there are considerable financial costs.¹¹ More public awareness needs to be drawn to the dangers of driving while sleepy.¹²

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Sarcoidosis presenting after resection of an adrenocortical adenoma

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Patients with Cushing's syndrome have grossly raised concentrations of circulating corticosteroids. Treatment may result in unmasking of steroid dependent conditions. We report a case of sarcoidosis presenting after resection of an adrenocortical adenoma.

Case report

A 42 year old white woman presented in 1993 with a six year history of weight gain (30 kg), depression, amenorrhoea, and hirsutism. She had a past history of hypertension and diabetes. She was obese (133 kg; body mass index (weight over height squared) 43.4) with a centripetal distribution of fat, moon face, buffalo hump, hirsutism, and chemosis. Blood pressure was 190/120 mm Hg and there was no other physical abnormality. Routine haematological and biochemical profiles were normal. A random blood glucose concentration was 11.3 mmol/l.

The patient was admitted for investigation. Both low dose and high dose dexamethasone suppression tests showed loss of diurnal variation and failure of suppression of cortisol secretion. In the presence of a low adrenocorticotrophic hormone concentration this suggested an adrenal source for the Cushing's syndrome. This was confirmed by computed tomography, which disclosed a 2 cm mass lesion in the left adrenal gland. Left adrenalectomy was performed and histological examination confirmed an adenoma. The patient was discharged taking hydrocortisone 20 mg in the morning and 5 mg at night and glibenclamide 10 mg daily.

She was readmitted six weeks later. Since the operation her weight had fallen by 14 kg. Blood pressure was 140/80 mm Hg and the glibenclamide had been stopped because of recurrent hypoglycaemia. She had, however, developed several new symptoms. These included polyarthralgia affecting wrists, elbows,

and knees and partially responding to ibuprofen prescribed by her general practitioner. Clinical examination of the joints showed nothing abnormal. She had also noted multiple subcutaneous nodules over her arms and legs. These nodules measured up to 6 cm diameter and were non-tender, firm, and attached to overlying skin and subcutaneous tissues. They had not been present before surgery. Biochemical and haematological investigations disclosed only a raised corrected calcium concentration (2.9 mmol/l; normal 2.2-2.5 mmol/l). The histological appearance of a biopsy sample of a nodule on the patient's forearm was "non-caseating granuloma" compatible with sarcoidosis. This diagnosis was supported by a raised serum angiotensin converting enzyme value of 109 U/l (upper limit of normal 65). And though the chest x ray picture was normal, lung function tests showed a low V_{25} (maximal expiratory flow at 25% of forced vital capacity) with a normal transfer coefficient, suggesting small airways narrowing; in a non-smoker this may be a feature of sarcoidosis.

The patient was treated with prednisolone 20 mg daily, and within three days her joint symptoms had disappeared and serum calcium concentration had fallen to 2.6 mmol/l. One month later the skin nodules had disappeared.

Comment

To our knowledge this is the first report of sarcoidosis being detected in a patient after resection of an adrenocortical adenoma. We suggest that the activity of the sarcoidosis was suppressed before surgery by the high circulating cortisol concentrations, removal of which after adrenalectomy unmasked the sarcoidosis. This is supported by the lack of evidence of sarcoidosis before operation and the rapid resolution of symptoms and restoration of normocalcaemia on the reintroduction of exogenous steroids. We emphasise that this case illustrates the suppressive rather than curative effects of steroids on sarcoidosis. The aetiology of the patient's Cushing's syndrome was not related to pre-existing sarcoidosis, as this characteristically spares the adrenal gland¹ and there was no histological evidence of granulomatous infiltration.

This case should raise awareness of the possibility of unmasking steroid dependent conditions after treat-

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