# ROAD TRAFFIC, DETERMINATION OF FITNESS TO DRIVE

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## Sobriety Tests and Drug Recognition

**R Tunbridge**, Transport Research Laboratory, Wokingham, UK
**S G Collier**, National Drug Recognition Training Unit, Northampton, UK



### Introduction and Background

This article covers the topics of drug recognition training (DRT) and standardized field sobriety tests (SFST), which have recently been introduced as means of aiding the identification of drivers under the influence of drugs.

The description given here is based on the practice applied in the UK; however, this was developed from well-established techniques used since the 1980s in the USA. The current legal context of sobriety testing in the UK is also described. Furthermore, similar adaptations of the US techniques have been widely applied across Europe and also in Australia.

The article starts with a brief but necessarily detailed background on the issue of drugs and driving, and associated legal issues, as these have provided the raison d'être for the development of DRT and SFST. These intimately related, but essentially separate issues are then covered in depth.

#### Driving under the Influence of Drugs – Background

The topic of drugs and driving has recently become regarded as a significant road safety issue.

Until the mid-1980s there were very few studies showing evidence that impaired driving due to drugs was a significant problem. A Transport Research Laboratory (TRL) study to measure the incidence of drugs in fatal road accident casualties showed that the incidence of medicinal drugs (5.5%) and illicit drugs (3%) was relatively low in comparison to alcohol, which was found in 35% of cases.

However, much recent evidence has suggested that illicit drug taking in the UK has increased considerably since the mid-1980s. A further study of incidence of drugs in road fatalities was therefore commissioned by the Department for Transport. This began in October 1996 and was completed in June 2000.

Interim results from this study in 1997 showed a sixfold increase in the incidence of illicit drugs found in drivers. This increase was confirmed by separate studies of drug driving undertaken in Scotland in 1997.

This alarming increase in the level of drug-related driving prompted the UK government to seek initiatives to combat it. One particular issue was a recognition of the general lack of police training in recognizing drug-impaired drivers; this hindered the detection of such drivers and thereby any effective countermeasures.

In response to this deficiency, the UK Home Office sent two police officers to the USA to study the Drug Evaluation and Classification (DEC) program which involved a system of training drug recognition experts (DREs). This system was subsequently adapted for use by UK police forces to train traffic officers in recognizing drug-impaired drivers.

The training system developed for the UK has two principal components: DRT (Drug Recognition Training) and field impairment testing (FIT). DRT is a system to identify the signs and symptoms associated with the effects of drugs. The system classifies drugs into six main groups. These are similar to those used for chemical analysis.

The second (FIT) is a systematic standardized method of examination to determine impairment.

This system is intended for use at the roadside by police or at the police station by forensic physicians (FPs). Together with DRT and other observations made on the driver, FIT provides a strong indication of whether a driver is impaired. The DEC system from which it is derived has been in use in the USA since the 1980s and is a widely accepted method for assessing drug-impaired drivers.

However, before introduction of DRT and FIT in the UK, evaluation trials of the UK version were

conducted in six police force areas in the summer of 1999. These trials showed that, of those drivers who failed a FIT test and were required to give an evidential blood sample, 92% proved positive for drugs that may impair driving performance. This is similar to routine results obtained by DREs in the USA. In addition, in two-thirds of cases the correct drug group was identified. It was concluded that DRT and FIT represent easily applied techniques that police can use to detect persons impaired through drugs. Apart from recommending wider police training in the use of these techniques, the evaluation also recommended that FPs receive training in FIT. Subsequent to an Association of Chief Police Officers (ACPO) conference in August 2000, an increasing number of traffic officers have received training in these techniques.

### Driving under the Influence of Drugs – Legal Issues

Since the wider introduction of the technique of impairment testing subsequent to August 2000, the subject of driving under the influence of drugs has gained considerable momentum.

At the heart of a prosecution for driving whilst unfit through drink or drugs, there is a requirement to provide evidence that a person was unfit to drive. Recent changes in UK legislation will help to make that determination simpler for the police officer. The Railways and Transport Safety Act 2003 made sweeping changes to Section 6 of the Road Traffic Act 1988, in respect of police powers to request roadside tests. This has given police officers mandatory powers to undertake roadside DRT and FIT as well as to test drivers for the presence of appropriate drugs in a sample of saliva or sweat when an appropriate device has been approved.

In the past the legislation has only provided guidance in defining terms used within the Acts, and for the purpose of Section 4, Road Traffic Act 1988 defines unfit to drive as "the person's ability to drive properly is for the time being impaired." Throughout any unfitness case, there is a need for the prosecution to prove that impairment was due to some causal connection with drink or drugs and that proper control of the vehicle was impaired. This has been a fundamental concept in UK legislation since the early 1920s and has barely changed.

The introduction of the Railways and Transport Safety Act in July 2003 changed the way in which police officers deal with suspected drugged drivers. Whereas the previous Section 6 of the Road Traffic Act only dealt with the provision of a breath specimen, it now covers both the impairment tests and, when one becomes available, a roadside drug-screening device.

Not only does the offense reinforce Section 4, by the introduction of the term "is unfit to drive because of a drug," but it still does not make it an offense to drive with a drug in the body: the person must be seen to be under the influence of the drug. There is no reference in the Act as to what this "influence" is and it has been left for this reference to be made within the Codes of Practice which are required to be adhered to by officers performing the tests. Table 1 includes the basic wording of the Railways and Transport Safety Act as it applies to drug-impaired driving.

In the following section, the FITs proposed for application under the new Act are described in some detail.

It is important to consider, however, that although these tests have been widely used in the USA for some time and are being increasingly used in countries across Europe, including the UK, they do not provide an unequivocal determination of driver impairment.

Legal challenges have been made to the use of such tests in the USA and several commentators in the UK have also expressed reservations as to their use.

Currently, the word "impairment" is not defined within the Road Traffic Act 1988. However, when a police officer is considering an arrest for the offense within section 4 of the Act (driving whilst unfit through drink or drugs), an assessment of whether a driver is

**Table 1** Section 6 Road Traffic Act 1988, as amended by Section 107 & Schedule 7 Railways & Transport Safety Act 2003

*Section 6(1)*

A constable in uniform, may require a person to co-operate with any one or more preliminary tests, administered to the person by the constable or another constable.

*Section 6(2–7)*

If a constable in uniform reasonably suspects, that a person is, or has been, driving, attempting to drive, or is in charge of a motor vehicle on a road or other public place, and

(a) Has alcohol or a drug in his body or is under the influence of a drug.

(b) While having alcohol or a drug in his body or is unfit to drive because of a drug.

(c) And is committing or has committed a moving traffic offence.

(d) Or has been involved in an accident and the constable has reasonable cause to believe that the person driving was attempting to drive or in charge of that motor vehicle.

And without reasonable excuse fails to co-operate with a preliminary test, shall be guilty of an offence.

NB – Note that the offence extends only to a motor vehicle and not a mechanically propelled vehicle.

*Section 6B(1)*

A constable administering a preliminary impairment test, shall observe the person in the performance of tasks specified by the constable, and makes such observations about the persons physical state as the constable thinks expedient.

Data from Levine B (1999) Principles of Forensic Toxicology. American Association for Clinical Chemistry, USA.

impaired is based upon all the available evidence. This includes:

- proof of driving and the circumstances that led to the driver being stopped by the police, e.g., a traffic offense, an accident, or erratic driving
- the interview with the driver, e.g., the manner of speech, demeanor, etc.
- evidence that may come from any independent witnesses
- application of drug recognition techniques
- administration of a field impairment test
- the professional judgment of the police officer as to whether or not the driver is impaired.

Further safeguards against a wrongful conviction, following arrest on suspicion for an offense under section 4, are built into the police station procedures. Before an officer can require a blood or urine sample from a suspect, an FP must determine and advise the officer that the driver has a condition that might be due to some drug (Section 7 (3) (c) Road Traffic Act 1988). The examination by the FP is used to determine whether the apparent impairment of a driver might be due to some other condition (e.g., disease, injury, or infirmity). Without the advice of the FP, an officer cannot require a driver to provide a specimen of blood or urine for analysis.

Therefore, although the application of FIT at the roadside may indicate a degree of impairment, it would not be used in isolation of the other available evidence.

In summary, the determination of impairment is the decision of the court, based on the evidence placed before it, which may be provided by bystanders, police officers, an FP, and finally the results of any toxicological analysis undertaken. The provisions of the Railways and Transport Safety Act have not changed this legal requirement.

### Field Impairment Testing

The Railways and Transport Safety Act 2003 requires a Code of Practice for the administration of impairment tests for drivers. Although the FITs described below have been applied in a formalized way since their introduction in 2000, there were minor differences in the application of these tests in Scotland, and England and Wales. In the Railways and Transport Safety Act 2003 the tests are described as preliminary impairment tests and the Code of Practice will describe them as such. In all other respects they will be identical to the FIT described above. The FIT assessment used in the UK and Europe is essentially identical to the US SFST assessment except that the first test in the SFST, which is an assessment of horizontal and vertical gaze nystagmus, is replaced by examination of the pupils. This was thought to be more appropriate for European conditions.

Many of the most reliable and useful psychophysical tests utilize the concept of divided attention to ascertain if a person's ability to drive is impaired. Driving is a complex divided-attention task composed of many subconscious and conscious actions. The typical mental and physical activity that a driver must be able to do is to carry out tasks that divide the person's attention. Impairment tests that simulate divided-attention characteristics have a good chance of identifying the impaired driver. The best of these tests exercises the same mental and physical functions that a person needs to drive safely, i.e.:

- information-processing
- short-term memory
- judgment and decision-making
- balance
- clear vision
- small-muscle control
- coordination of limbs.

Drug consumption can substantially degrade a person's ability to divide attention. Under the influence of drugs or alcohol, drivers often ignore the less critical components of the driving task in order to concentrate their attention on the more vital driving tasks. However, different drugs affect different aspects of the skills required for safe driving in different ways. Alcohol has a more detrimental effect on the control processes of driving, e.g., hazard perception, whereas cannabis first affects detrimentally the automatic process of driving, e.g., steering ability. Any test that requires a person to demonstrate two or more of these capabilities simultaneously is potentially a good psychophysical test. The tests must also be relatively simple to perform when sober, but sufficiently complex to divide the person's attention when not sober.

The preliminary impairment test process is a systematic and standardized method of examining a subject to determine whether or not that person is impaired. A trained officer will never reach a conclusion based upon one element of the examination, but instead on the totality of facts that emerge.

The tests carried out by a police officer or FP involve examination of the person's eyes, the pupillary examination, followed by four psychophysical tests:

1. the modified Romberg balance test
2. the walk-and-turn test
3. the one-leg-stand test
4. the finger-to-nose test.

A brief description of the tests is given below.

**The pupillary examination** In the UK police officers are not currently permitted to carry out any tests on the eye other than pupil comparison. In the USA the SFSTs make use of horizontal and vertical gaze nystagmus tests, which have been shown to be sensitive to impairment by alcohol and certain other drugs.

The size of a person's pupils is compared against a standard pupil size chart. Under normal circumstances the size of pupils is between 3 and 6.5 mm. The tests can be conducted in most lighting conditions, although they should not be conducted in direct sunlight.

In order to instruct the person as to the nature of the pupillary examination and how the individual is expected to perform, this and the following divided-attention tasks are carried out according to formalized wording. This is given in the National Manual of Guidance form, Drink Drive, F (MG/DD/F) (see Table 2).

It is accepted that both pupil dilation and constriction are not only drug-induced, and that there may be some medical conditions, or the use of prescribed medicines, that may cause the size of a person's pupils to change. Drug recognition officers are acquainted with these medical causes as part of their training.

**The psychophysical tests** The four psychophysical or divided-attention tests adopted by the UK police follow systematic administration, documentation, and interpretation.

The tests require a reasonably smooth and flat surface. To be able to perform the tests, the subject should be free of any physical disability. Such disabilities may include inner-ear disorders, obesity, and disabilities due to aging. However, it will not preclude any of the tests being carried out as long as they are taken into consideration when the evaluation is made.

The observational indicators of impairment for the walk-and-turn test and the one-leg-stand test have been validated through various trials and studies in the USA carried out since 1977. These studies validated the observations made by DREs and SFST officers in both laboratory and field conditions.

**The modified Romberg balance test** The Romberg (or Rhomberg) test is an indicator of the state of the suspect's "internal clock" and ability to balance. The administration of certain drugs will either speed up or slow down the suspect's internal clock and may cause the suspect to sway from side to side, back to front, or round in a circle.

The test comprises two stages: the instructions stage and the performance stage. During the instructions stage the suspect is asked to stand up straight with feet together, both heels and toes, with hands down by the sides. The performance stage involves the subject standing in the start position, but with the head tilted backwards slightly and eyes closed. During the test the subject must estimate the passage of 30 s.

The officer should time the test for 30 s and record the results. Any estimation of between 25 and 35 s is considered to be acceptable for most people; however experience has shown that this is not always the case and the officer should review the results in the light of evidence seen in the other tests. Some authorities consider estimations between 20 and 40 s to be acceptable. The test should be terminated if it cannot be completed in safety or the actual time exceeds 90 s.

The major observations which need to be recorded for this test are:

1. the subject's inability to follow instructions
2. an inability to stand still or steady with feet together
3. body/eyelid tremors
4. body sway
5. the amount of time that has passed between start and end of the test
6. any statement or unusual sounds made by the subject while performing the test.

**The walk-and-turn test** This test requires the subject to stand with the heel of one foot touching the toe of the other foot. The individual is asked to walk along a real or imaginary line and must turn in the prescribed manner. It is a test that divides attention between balancing and information-processing.

The test comprises two stages: the instructions stage and the walking stage.

During the instructions stage, the subject is told to stand with the right foot in front of the left, touching heel to toe. The subject must remain in that position while the rest of the instructions for the test are given. Experience has shown that the subject, "if significantly impaired," will find it progressively difficult to remain in that position and will step out of the position.

The walking stage involves the subject walking nine heel-to-toe steps along the line, turning about in the manner demonstrated and then taking another nine heel-to-toe steps back along the line. During the walking the subject should count each step out loud and not stop while walking.

Both stages are important parts of the test and evidence often comes to light during both stages. Of all of the preliminary impairment tests, this test is generally considered amongst drug recognition experts to provide the most comprehensive observational indicators of impairment.

**Table 2** THE PRELIMINARY IMPAIRMENT TESTS – INSTRUCTIONS TO SUBJECT – (Reproduced by permission of the Home Office)

*(Important Note – the words reproduced below relate to the current MG/DD/F, following the enabling legislation for Section 107 and Schedule 7 Railways & Transport Safety Act 2003, which amends Section 6 Road Traffic Act, this form of words will change to reflect the new legislation.)*

**Additional Warning**

*I would like you to perform a series of tests to enable me to ascertain whether there are grounds to suspect your ability to drive is impaired by drink or drugs.* ****(I must tell you that you are not under arrest and you need not remain with me.)** *You are not obliged to participate in the tests but if you do participate, the results may be given in evidence. The tests are simple and part of my evaluation will be based on your ability to follow instructions. If you do not understand any of the instructions, please tell me so that I can clarify them."* ** **Not to be read if the person has already been arrested**

*"Do you understand?"* ***YES/NO**

*"Do you agree to participate in these tests?"* **YES/NO**

*"As I explain the tests to you, if you have any medical condition or disability which may affect your ability to undertake the test or its result, please tell me before the test is started."*

*"Do you understand?"* ***YES/NO**

*"Do you have any medical condition or disability that you wish to tell me about before I start the tests?"* ***YES/NO**

**PUPILLARY EXAMINATION**

*"I am going to examine the size of your pupils, comparing them to this gauge, which I will hold up to the side of your face. All I require you to do is look straight ahead and keep your eyes open".*

*"Do you understand?"* ***YES/NO**

**Indicate 'L' and 'R' on the pupil gauge for pupil size as appropriate**

**Note condition of eyes: Watery –** ***YES/NO Reddening –** ***YES/NO**

**ROMBERG TEST**

*"Stand up straight with your feet together and your arms down by your sides. Maintain that position while I give you the remaining instructions. Do not begin until I tell you to do so. When I tell you to start, you must tilt your head back slightly and close your eyes* ***(demonstrate but do not close your eyes).*** *Keep your head tilted backwards with your eyes closed until you think that 30 seconds has passed, then bring your head forward and say 'Stop'".*

*"Do you understand?"* ***YES/NO**

**WALK AND TURN TEST**

**Identify a real or imaginary line. Do not use a kerb or anywhere the subject may fall.** *"Place your left foot on the line. Place your right foot on the line in front of your left touching heel to toe* (demonstrate). *Put your arms by your sides and keep them there throughout the entire test. Maintain that position whilst I give you the remaining instructions".*

*"Do you understand?"* **YES/NO*** *"When I say start, you must take nine heel to toe steps along the line. On each step the heel of the foot must be placed against the toe of the other foot* ***(demonstrate).*** *When the ninth step has been taken, you must leave the front foot on the line and turn around using a series of small steps with the other foot. After turning you must take another nine heel to toe steps along the line. You must watch your feet at all times and count each step out loud. Once you start walking do not stop until you have completed the test".* ***(demonstrate complete test)***

*"Do you understand?"* ***YES/NO**

**Table 2** Continued

**ONE LEG STAND**

*"Stand with your feet together and your arms by your sides. Maintain that position while I give you the remaining instructions. Do not begin until I tell you to start."*

*"Do you understand?"* ***YES/NO**

*"When I tell you to start you must raise your right foot six to eight inches off the ground, keeping your leg straight and your toes pointing forward, with your foot parallel to the ground* ***(demonstrate).*** *You must keep your arms by your sides and keep looking at your elevated foot while counting out loud in the following manner, 'one thousand and one, one thousand and two' and so on until I tell you to stop."*

*"Do you understand?"* ***YES/NO**

***Repeat procedure with each foot***

**FINGER AND NOSE TEST**

*"Stand with your feet together and your arms in this position.* ***(demonstrate extending both hands out in front, palms side up and closed with the index finger of both hands extended).*** *Maintain that position while I give you the remaining instructions. Do not begin until I tell you to start. When I tell you to start you must tilt your head back slightly* ***(demonstrate)*** *and close your eyes. When I tell you which hand to move, you must touch the tip of your nose with the tip of that finger and lower your hand once you have done so* ***(demonstrate).****"*

*"Do you understand?"* ***YES/NO**

**Call out the hands in the following order, left, right, left, right, right, left.**

Data from Levine B (1999) Principles of Forensic Toxicology. American Association for Clinical Chemistry, USA.

There are eight validated observations for this test. The first two observations are checked strictly during the instructions stage and can only be accumulated once. The next six observations are checked during the performance stage:

1. lack of balance during instructions
2. starts walking too soon
3. misses heel to toe (to document this observation a gap of at least $1\frac{1}{2}$ cm (0.5 in.) is necessary)
4. steps off the line
5. stops walking (includes pauses to regain balance)
6. raises arms to balance (a movement of more than 15 cm (6 in.) is required)
7. takes the wrong number of steps (mistakes in the verbal count do not justify an observation)
8. turns improperly (this observation should be documented if the subject staggers, stumbles, or falls during the turning movement, or if the subject turns in any other way than instructed).

**The one-leg-stand test** This test requires the subject to stand on one leg whilst the other leg is extended out in front and 15–20 cm (6–8 in.) off the ground. The test requires the subject to divide attention between balance and counting and again comprises two stages.

The instructions stage requires the subject to stand in the modified position of attention as seen in

previous tests and to remain in this position until the instructions are completed.

During the balance and counting stage, the subject, when told to start, raises the right foot 15–20 cm (6–8 in.) off the ground, keeping the leg straight and the toes pointing forward. During this time the individual should count out loud in the following manner "one thousand and one, one thousand and two" and so on until told to stop.

There are four validated observational indicators to this test:

1. places foot on ground
2. raises arms (more than 15 cm (6 in.)) to balance
3. sways, whether from front to back or side to side. This requires a very noticeable sway or rotational movement of the subject's elevated foot or body
4. hopping.

The test may be terminated if the subject cannot complete it safely. The observer should take note of any body tremors or any statement made by the subject during the test.

**The finger-to-nose test** The finger-to-nose test is a test of coordination and depth perception. Certain drugs may cause the subject to have an altered depth perception, whilst others will cause slow and lethargic movement, whereby the subject will misjudge the location of the nose completely.

This test requires the subject to bring the tip of the index finger up to touch the tip of the nose, with the head tilted backwards and eyes closed. The finger-to-nose test differs from other tests in that the examiner will continue to instruct the subject throughout the test.

During the instructions stage the subject is told to stand upright with feet together. He/she must extend both hands with the index finger extended and the rest of the fist closed.

During the command stage the subject is told to touch the tip of the nose with the tip of the finger as indicated by the examiner, in the following sequence, left, right, left, right, right, left.

The finger-to-nose test is not considered to the same extent of validated observational indicators as the other tests. However, experience has shown that individuals who are impaired sometimes miss the tip of their nose and sometimes fail to use the hand indicated. The examiner may see the following:

1. Where did the tip of the finger touch? This shows the subject's depth perception when attempting to touch the nose. Was the speed of bringing the finger to the nose slow or fast, for example was the subject "fishing" for the end of the nose, or did the subject poke the face as a result of misjudging the nose in space?
2. Was the correct hand used?
3. Was there body sway?
4. Was the subject able to follow instructions?

The formal administration of these tests as required by the UK Home Office is shown in Table 2.

## Drug Recognition Training

For the purposes of drug influence recognition training, the World Health Organization provides the most concise definition of a drug: "Any substance that, if taken into a living organism, may modify one or more of its functions."

Drugs can be categorized according to many factors, one of which is the visible signs and symptoms that result from a person taking a substance. For the purpose of drug influence recognition there are six main drug groups:

1. cannabis
2. opiates
3. central nervous system (CNS) stimulants
4. CNS depressants
5. hallucinogens
6. inhalants.

### Cannabis

Cannabis derives primarily from the various species of the plant *Cannabis sativa*.

The principal psychoactive ingredients in cannabis are:

1. delta-9-tetrahydrocannabinol ($\Delta^9$ THC), commonly referred to as THC
2. delta-8-tetrahydrocannabinol ($\Delta^8$ THC) is also a psychoactive, but minor, constituent of cannabis
3. 9-carboxy-THC (THC-COOH) is the most common and rapidly produced metabolite but it is not psychoactive.

**Possible effects of cannabis** From the viewpoint of driving, studies with cannabis show that it first seems to affect all tasks requiring psychomotor skills and continuous attention. Thus, tracking tasks, which are very sensitive to short-term changes in attention, are sensitive to cannabis impairment. Alternatively, integration processes and higher cognitive functions are not as time-critical. A short attention lapse can be compensated for by increased activity later.

In the case of the overall driving task, it seems that the negative effects of these short-term distortions can be reduced by lowering the difficulty, and hence

the time-critical aspects, of the task. This would explain the frequently reported observation that drivers under the influence of cannabis drive at notably reduced speeds.

A recent study suggests that drivers under the influence of cannabis were aware of their impairment and attempted to drive more cautiously, but reacted more slowly to other driving tasks, e.g., braking. It confirmed that cannabis has a measurable effect on psychomotor performance and tracking ability.

**Onset and duration of effects** Subjects will begin to feel and exhibit the effects of cannabis intoxication within seconds of inhaling the smoke; peak plasma levels are reached between 7 and 10 min. The impairment effects usually peak 25 min after smoking. Substantial effects have usually worn off after 1 h, but some measurable impairment may continue up to 4 h.

Blood tests may well disclose the presence of THC long after the effects have worn off. The common immunoassay tests for THC look for the metabolites of the drug, principally THC-COOH. Blood tests may disclose the presence of this metabolite at least 3 days after smoking and some urine tests may indicate the presence of THC metabolites for 28–45 days.

**Cannabis – expected roadside observations**

- smell – characteristic
- poor coordination and balance
- impaired perception of time and distance
- whites of eyes (sclera) markedly reddish
- increased appetite
- disorientation
- poor attention span
- relaxed inhibitions
- pupils possibly dilated.

### Opiates (Opioids)

The term opiate is derived from drugs obtained from the opium poppy (*Papaver somniferum*). Morphine is found in opium and is a natural alkaloid. Heroin (diamorphine) is the most widely abused opium derivative.

A second subcategory of synthetic opiates is produced from a variety of nonopiate substances. The best known of these is methadone.

**Possible effects of opiates** The effects that an opiate user will experience and exhibit depend on the tolerance that the user has developed for the drug.

People develop tolerance for opiates fairly rapidly. An opiate user who has developed tolerance and who has taken his/her normal dose for the drug may exhibit little evidence of intellectual or physical impairment. For example, a heroin addict who may have taken the usual dose may be able to drive without apparent detrimental effect and perform adequately on the impairment tests. Cancer patients who are treated with opiates also may not exhibit impairment, owing to marked tolerance development.

**Onset and duration of effects** Dependent upon the particular substance, opiates can be injected, smoked, or taken orally. The onset will be within seconds if injected or smoked, although longer if taken orally. The psychological effects include a feeling of pleasure or euphoria; and relief from pain.

The duration of the effects will vary greatly depending on the substance, the manner of consumption, and tolerance of the user. Generally, opiate effects will last 4–6 h, except methadone, which lasts up to 12 h. Opiates are detectable in the blood for the period of time of influence. Certain opiate derivatives, e.g., heroin, are converted back to morphine after ingestion. As the physical effects begin to disappear, withdrawal signs start to emerge. These withdrawal signs can become severe if the user does not take another dose.

**Opiates – expected roadside observations**

- constricted pupils (characteristic of opiates)
- hippus may be present during withdrawal
- sleepy appearance (ptosis)
- slow reflexes
- low, slow speech
- possible facial itching
- dry mouth
- possible euphoria
- cold skin.

### Central Nervous System Stimulants

CNS stimulants can be defined as those drugs that speed up the activity of the CNS (Table 3).

**Cocaine** Cocaine is a substance that occurs in the leaves of several species of plant, including a plant bush (*Erythroxylon coca*) found in South America.

In common use, it is usually found in powder form, although in recent years, crack (named after the crackling sound it makes as it is being produced) is also prevalent. Cocaine powder is usually snorted or injected although, as with crack, it can be smoked.

**Table 3** Central nervous system stimulants: onset and duration of effects

| *Stimulant* | *Means of administration* | *Onset* | *Duration* |
|---|---|---|---|
| Amphetamine Methamphetamine | Injected | Seconds | 4–8 h |
| Ecstasy | By mouth | 20–30 min | 4–6 h |
| Cocaine | Smoked | Seconds | 5–10 min |
| Cocaine | Injected | Seconds | 45–90 min |
| Cocaine | Snorted | 30 s (not as fast as smoked or injected cocaine) | 30–90 min |

**Amphetamines** Medically used amphetamines are generally produced in tablet and capsule form and are used to treat various conditions, from hyperactivity to appetite control.

The illicit form common to the UK is amphetamine sulfate, which is usually found in powder form and can be injected, smoked, or inhaled. Methamphetamine and dexamphetamine are also widely abused.

**Ecstasy and ecstasy analogs** The two most common ecstasy analogs are 3,4-methylenedioxymethamphetamine (MDMA; ecstasy) and methylenedioxyamphetamine (MDA).

**Possible effects of CNS stimulants** Cocaine and amphetamines produce euphoria. A feeling of "super" strength and absolute self-confidence may also be present. With cocaine, but not with amphetamine, there will also be an anesthetic effect, i.e., a dulling of pain.

Stimulant users tend to become hyperactive, extremely nervous, and unable to stand still.

**Onset and duration of effects** Stimulants can be snorted, injected, or smoked, with the normal method of ingestion for amphetamine sulfate being injection, while ecstasy is taken in tablet form.

In general, cocaine is a fairly fast-acting, but short-duration drug. Because of this a user can present some difficulty to the trained officer. The suspect may be markedly impaired when arrested, but by the time he/she is seen by the FP, the effects of the cocaine may have worn off. It is therefore imperative that a full record is made at the time of the arrest so the examiner can see that there is a change in the suspect's demeanor.

**Central nervous system stimulants – expected roadside observations**

- dilated pupils
- eyelid tremors
- restlessness/anxiety
- inability to keep quiet
- euphoria
- easily irritated
- grinding teeth (bruxism)
- impaired perception of time.

### Central Nervous System Depressants

CNS depressants can be defined as those drugs that slow down the activity of the CNS. They first affect those areas of the brain that control a person's conscious, voluntary actions (control processes).

**Alcohol** Alcohol is the most common, and most widely abused, CNS depressant. With some notable exceptions, most CNS depressants have effects similar to alcohol.

**Benzodiazepines** Benzodiazepines are generally designed to be taken orally; however many illicit users may break tablets down for injection purposes.

**Gamma-hydroxybutyrate (GHB)** GHB is most often available as an odorless and colorless liquid with a salty taste.

**Possible effects of CNS depressants** CNS depressants have general effects similar to alcohol, namely reduced social inhibition, slowed reflexes, impaired judgment and concentration and coordination.

Speech may be slurred, mumbled, and incoherent. Paradoxical behavior may occur, such as euphoria, depression, laughing, or crying for no apparent reason.

**Onset and duration of CNS depressants** CNS depressants subject to misuse are short-, medium-, or long-acting. Onset and duration are as follows:

*Short-acting* Effects are apparent in 10–15 min, and dissipate in around 4 h.

*Intermediate-acting* Effects are apparent in 30 min, and last 6–8 h.

*Long-acting* Effects are seen after an hour and last for between 8 and 14 h.

**Central nervous system depressants – expected roadside observations**

- normal pupil size (but may be dilated)
- watery eyes – droopy eyelids (ptosis)
- drowsiness
- thick, slurred, slow speech
- uncoordinated
- slow, sluggish reactions.

### Hallucinogens

Hallucinogens can be defined as drugs that cause hallucinations. A hallucination can be defined as: "a sensory experience of something that does not exist outside of the mind." It may involve hearing, seeing, smelling, tasting, or feeling something that isn't really there, or it may involve distorted sensory perceptions.

**Ketamine** Ketamine is a dissociative anesthetic and also a CNS depressant, but may produce hallucinations. It is used as a veterinary anesthetic, and is frequently abused. It is found as capsules, powder, crystals, or tablets.

**Phenyl cyclohexl piperidine (PCP)** Commonly contracted to phencyclidine (PCP or angel dust) is found as a white crystalline powder. Depending on dose, it can act as an anesthetic, depressant, stimulant, or hallucinogen. It was formerly used as a veterinary anesthetic.

**Lysergic acid diethylamide** Lysergic acid diethylamide (LSD) is a synthetically prepared hallucinogen and has no medical use. In its pure form it is a white, odorless crystalline powder. In the UK, however, it is most commonly found converted into its liquid form and applied to blotting-paper squares or "tabs." It is the most common form of hallucinogen and probably the best known.

**Magic mushrooms (psilocybin)** Psilocybin is a naturally occurring hallucinogenic drug that can be found in various species of wild-growing mushrooms, in the UK notably the liberty cap. These mushrooms can be eaten fresh or allowed to dry and eaten later.

These mushrooms contain two related compounds:

1. psilocin (4-hydroxy-*N*,*N*-dimethyltryptamine)
2. psilocybin (4-phosphoryloxy-*N*,*N* dimethyltryptamine).

**Possible effects of hallucinogens** Hallucinogens allow the human senses to experience stimuli at a much greater intensity than normal. As a result, many people take great care to take hallucinogens in a controlled environment as bad stimuli and good stimuli are magnified. Flashbacks may occur; this is the reemergence of some aspect of the hallucinogen experience in the absence of the drug.

One common type of hallucination produced by these drugs is synthesthesia, which is a transposing of sensory modes. For example, seeing a particular sight may cause the user to perceive sound.

**Onset and duration of effects** LSD will take effect within 20–30 min of use while it will take longer with magic mushrooms, between 60–90 min, before there is any noticeable effect. The effects from magic mushrooms will generally wear off after 3 h. LSD is relatively long-lasting and the effects could remain visible for anything up to 10 or 12 h.

**Hallucinogens – expected roadside observations**

- pupils possibly dilated
- dazed appearance – uncoordinated
- poor balance
- distorted time and distance perception
- sweating, goosebumps (piloerection)
- paranoia
- nausea
- hallucinations/synthesthesia.

### Inhalants

Inhalants are breathable chemicals that produce mind-altering effects. The most common types of inhalants encountered in the UK are volatile solvents and aerosols.

Volatile solvents comprise a large number of readily available substances such as glue, paints, nail varnish remover, thinners, and lacquers. They are described as volatile because the solvent evaporates in the air. The commonest active ingredient in solvents is toluene.

Aerosols are chemicals that are discharged from a pressurized container. Intoxicating effects are more often caused by the propellant as opposed to the chemical for which the product was sold. Commonly abused aerosols include hairsprays, deodorants, and insecticides. Abused aerosols contain various hydrocarbon gases, principally butane and propane, that produce drug-like effects.

Some inhalant users prefer to put the volatile solvent in a plastic bag or crisp packet; others soak rags or socks and then sniff the fumes.

**Possible effects of inhalants** Inhalants generally produce acute intoxication similar to alcohol. Nausea, vomiting, sneezing, and coughing may occur. There may also be giddiness, tachycardia, sedation, poor coordination, and slurred speech.

**Onset of effects and duration of effects** Inhalants are all ingested orally by inhaling the vapors and the effects are felt almost immediately.

The duration of the effects ranges from a few seconds up to 2 h, depending on the substance used. Glue, paint, petrol, and other commonly abused inhalants could last up to 8 h.

**Inhalants – expected roadside observations**

- pupils possibly dilated
- dizzy/light-headed/nausea
- smell
- residue around face
- bloodshot, watery eyes
- disorientation and confusion
- distorted time and distance perception
- flushed, sweaty appearance
- intense headache
- noncommunicative/slurred speech.

## See Also

**Road Traffic, Determination of Fitness To Drive:** General; Driving Offense; **Road Traffic, Global Overview of Drug and Alcohol Statistics**

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# General

**C H Wecht and S A Koehler**, Allegheny County Coroner, Pittsburgh, PA, USA



## Introduction

This article will review medical conditions and medications that may impair the driver's performance. The role of the physician in assessing driver's fitness, and methods of assessing and screening in the USA and other countries are also reviewed. This article will also provide an overview of the US population aged 65 and over, the causes of mortality among the elderly, and an analysis of elderly drivers.

## Determination of Driver Fitness

### Driver's Family and Caregiver's Insight into Their Deficits

Drivers, especially those with cognitive disorders such as dementia and Parkinson disease (PD), tend to overestimate their driving performance abilities and are

less likely to report driving problems to their physicians. These drivers seldom stop driving on their own. More commonly, they have stopped after intervention by family (24%), family and patient jointly (13%), the family doctor (18%), or memory clinic (11%). Almost half the patients found to be demented while undergoing first-time evaluations in a geriatric clinic were still driving; younger and male demented drivers were less likely to stop driving despite significant cognitive impairment. A high percentage of individuals with Alzheimer disease (AD) who failed a road test for driving competency considered themselves to be safe drivers. Family and other caregivers also provided an unreliable assessment of the perceptions of the driving ability of impaired drivers. Studies have found long periods between the caregiver's perception that the patient should stop driving and actual cessation – up to 4 years in some cases. Therefore, it is the role of the physician to determine the medical fitness of the driver.

### Role of the Medical Community in Assessing Driving Fitness

Physicians play a key role in determining if their patients should continue their driving privileges. Therefore, they require knowledge of driving reporting laws, skill in identifying risky drivers, and in counseling patient and family on strategies for driving cessation. In addition, they should know how to refer marginal drivers for driving training. When physicians are assessing the fitness of one of their patients, the physical examination should be directed toward the identification of any existing conditions and the degree of functional compromise. Medical or surgical control of the condition, duration of satisfactory control, and patient reliability are important considerations. However, it has been shown that the knowledge of doctors in reporting laws is weak. It has also been shown that 28% of all geriatricians do not know how to report patients with dementia who are potentially dangerous drivers.

In 1999, the American Medical Association adopted a new ethical guideline stating that it is "desirable and ethical" for physicians to notify a state licencing authority about patients who, because of a medical condition, may be unsafe to drive. Physicians need knowledge of driving reporting laws and skills in identifying risky drivers and counseling patient and family on strategies for driving cessation. They should know how to refer marginal drivers for driving training. State-by-state criteria for the medical conditions that physicians are required to report, where to obtain the forms, and where to mail are available on the American Medical Association website entitled "Physician's Guide to Assessing and Counseling Older Drivers" at www.ama-assn.org/go/olderdrivers.

Below are some medical conditions that physicians should be aware of that may impair a driver's ability to operate a motor vehicle safely and the degree of restriction these conditions entail.

## Cardiovascular Medical Conditions That May Impair the Driver

### Atrial Flutter/Fibrillation (Bradycardia or Rapid Ventricular Response)

Once the heart rate and symptoms have been treated, there should be no restrictions on driving privileges.

### Cardiac Conditions That Cause Sudden, Unpredictable Loss of Consciousness

The main consideration in determining medical fitness to drive for individuals with cardiac conditions is the risk of presyncope or syncope due to brady- or tachyarrhythmia. Where individuals have a known arrhythmia, the physician should identify and treat the underlying cause, if possible, and recommend temporary driving cessation until control of symptoms has been achieved.

### Cardiac Disease from Structural or Functional Abnormality

Two major considerations in determining medical fitness to drive are the risk of presyncope or syncope due to low cardiac output and the presence of cognitive deficits due to chronic cerebral ischemia. Drivers who experience presyncope, syncope, extreme fatigue, or dyspnea at rest or at the wheel should cease driving. Physicians should refer patients with clinically significant cognitive changes for a cognitive testing and to a driving rehabilitation specialist (DRS) for evaluation.

**Cardiac surgery involving median sternotomy** Drivers may resume driving 4 weeks after coronary artery bypass grafting (CABG) and/or valve replacement surgery, and within 8 weeks of heart transplant, depending on resolution of cardiac symptoms and the patient's course of recovery. In the absence of surgical and postsurgical complications, the main limitation to driving is the risk of sternal disruption following median sternotomy. If clinically significant cognitive changes persist following the patient's physical recovery, cognitive testing and fitness evaluated by a DRS are recommended before the patient is permitted to resume driving.

### Congestive Heart Failure

Physicians should reassess a driver's fitness with congestive heart failure (CHF) every 6 months or as needed depending on the clinical course and control of symptoms. Individuals with functional class III CHF (marked limitation of activity but no symptoms at rest, working capacity 2–4 METs (metabolic equivalents)) should be reassessed at least every 6 months.

### High-Grade Atrioventricular (AV) Block

Individuals with symptomatic AV block corrected without a pacemaker may only resume driving after they have been asymptomatic for 4 weeks and electrocardiogram (ECG) documentation shows resolution of the block.

### Hypertrophic Obstructive Cardiomyopathy

Drivers who experience syncope or presyncope should stop driving until they have been treated.

### Pacemaker

An individual may resume driving 1 week after pacemaker insertion if no longer experiencing presyncope or syncope; ECG shows normal sensing and capture; and pacemaker performs within the manufacturer's specifications.

### Paroxysmal Supraventricular Tachycardia or Wolff–Parkinson–White Syndrome

Individuals with a history of symptomatic tachycardia may resume driving after being asymptomatic for 6 months and on antiarrhythmic therapy. Drivers who undergo radiofrequency ablation may resume driving after 6 months if there is no recurrence of symptoms, or sooner if no preexcitation or arrhythmias are detected on repeated electrophysiology testing. No restrictions apply if the individual is asymptomatic during documented episodes.

### Percutaneous Transluminal Coronary Angioplasty (PTCA)

A driver may resume driving 48 h to a week after successful PTCA and/or stenting procedures, depending on the patient's baseline conditions and course of recovery from the procedure and underlying coronary artery disease.

### Prolonged, Nonsustained Ventricular Tachycardia (VT)

Individuals with symptomatic VT may resume driving after 3 months if they are on antiarrhythmic therapy – with or without an internal cardioverter defibrillator (ICD) – guided by invasive electrophysiologic (EP) testing, and the VT is noninducible at repeated EP testing. Drivers may resume driving after 6 months without arrhythmic events if they are on empiric antiarrhythmic therapy (with or without an ICD), or have an ICD alone without additional antiarrhythmic therapy. No restrictions apply if the individual is asymptomatic during documented episodes.

### Sick Sinus Syndrome, Sinus Bradycardial Sinus Exit Block, Sinus Arrest

Individuals with symptomatic disease can be managed with pacemaker implantation. Physicians should be alert to clinically significant cognitive deficits due to chronic cerebral ischemia. Those with significant cognitive changes should be referred to a driver rehabilitation specialist for a driver evaluation. No restrictions apply if the individual is asymptomatic during documented episodes. Regular medical follow-up is recommended to monitor cardiac rhythm and cognitive abilities.

### Sustained Ventricular Tachycardia

Individuals with VT may resume driving after 3 months if they are on antiarrhythmic therapy (with or without an ICD), guided by invasive EP testing, and VT is noninducible at repeated EP testing. Drivers may resume driving after 6 months without arrhythmic events if they are on empiric antiarrhythmic therapy (with and without an ICD), or have an ICD alone without additional antiarrythmic therapy.

### Time-Limited Restrictions

The length of time of the driving restriction following cardiac procedures is based on the patient's recovery from the procedure itself and from the underlying disease for which the procedure was performed.

### Unstable Coronary Syndrome (Unstable Angina or Myocardial Infarction)

Individuals with unstable coronary syndrome should not drive if they experience symptoms at rest or at the wheel. Drivers may resume driving when they have been stable and asymptomatic for 1–4 weeks, as determined by a cardiologist following treatment of the underlying coronary disease. Drivers may resume within 1 week of successful revascularization by PTCA and 4 weeks after CABG.

### Valvular Disease

Drivers who experience syncope or presyncope should stop driving until the underlying disease has been corrected.

## Neurological Conditions That May Impair the Driver

Neurological conditions that can affect one's driving performance range from conditions that progress with time such as those caused by dementia, multiple sclerosis, and PD, and those that occur rapidly, caused by stroke and cerebrovascular accident. Insults to the cerebral vascular system may cause a wide variety of symptoms, including sensory deficits, motor deficits, and cognitive impairment. These symptoms range from mild to severe and may resolve almost immediately or persist for years. During evaluations the physician must take into account the individual's unique constellation of symptoms, severity of symptoms, course of recovery, and baseline functions when making recommendations concerning driving privileges. Among drivers, individuals with dementia are more likely to continue to drive even when it is highly unsafe for them to operate a vehicle.

### Brain Tumors

Recommendations to continue driving should be based on the type of tumor, location, rate of growth, type of treatment, presence of seizure, and presence of cognitive or perceptual impairment. Due to the progressive nature of certain types of tumors, the evaluation of fitness to drive needs to be done serially.

### Dementia

Individuals with dementia are often undetected and undiagnosed until late in the course of the disease. Initially, family and physicians may assume that the individual's decline in cognitive function is part of the normal aging process. Physicians are encouraged to be alert to the signs and symptoms of dementia and to pursue an early diagnosis. Early diagnosis is the first step in promoting driving safety for a dementia patent. The second step is intervention, which includes medication to slow the course of the disease, and counseling to prepare the individual for eventual driving cessation. When the assessment shows that the driver poses a significant safety risk, driving must cease. With early planning among the patient, family, and driver, the transition between driving and nondriving can be less traumatic.

The Alzheimer's Association position statement on driving states:

> A diagnosis of dementia is not, on its own, a sufficient reason to withdraw driving privileges. A significant number of drivers with dementia are found to be competent to drive in the early stages of the illness. Therefore, the determining factor in withdrawing driving privileges should be based on the individual's driving ability. When the individual poses a serious risk to self or others, driving privileges must be withheld. Physicians with patients that have a history of dementia are recommended to perform a focused medical assessment that includes history of driving difficulty from family members or caregiver and an evaluation of cognitive abilities, including memory, attention, judgment, and visuospatial abilities. Physicians should be aware that patients with progressive dementia require serial assessment, including a formal assessment of driving skills consisting of an on-road driving assessment performed by a DRS.

**Dementia of the Alzheimer type (DAT)** Individuals with DAT have revealed an increased driving accident rate even with questionable or mild severity. Accident statistics show an increased risk for those with very mild and mild DAT. A number of studies have shown that individuals with even very mild or mild DAT are 2–3 times more likely to be in a crash compared to healthy age-matched controls, and that a high percentage of these individuals stopped driving only after having an accident. Among persons with AD, the increase in crash risk develops toward the end of the third year and more than doubles in the fourth year. Patients who have had AD for more than 2 years should have their driving ability closely monitored if they are to continue driving as the overall risk to society increases over time.

Optimum timing and type of screening for the cognitively impaired driver are still uncertain. Most recommend retesting every 6 months, although a clear-cut policy intended chiefly for primary care physicians is still lacking. In 1996, the California Department of Motor Vehicles revised its policy to revoke the driver's license automatically only of persons with moderate or advanced dementia, and to enable those with very mild dementia to demonstrate the capacity to drive through a reexamination process.

### Migraine and Recurrent Headache Syndrome

Individuals with recurrent headaches should be cautioned against driving when experiencing neurologic manifestations (visual disturbances or dizziness), when distracted by pain, and while on any barbiturate, narcotic, or narcotic-like analgesic.

### Multiple Sclerosis

Driving recommendations should be based on the types of symptoms and level of symptom involvement. Physicians should be alert to deficits that are subtle but have a strong potential to impair driving performance, such as muscle weakness, sensory loss, fatigue, cognitive or perceptual deficits, and symptoms of optic neuritis. Driver's evaluation should include an on-road driving assessment performed by

a DRS and serial evaluation as the patient's symptoms evolve and progress.

### Parkinson Disease

Individuals with advanced PD may be at increased risk of motor vehicle crashes due to both motor and cognitive dysfunction. Drivers typically complained particularly of difficulty managing pedals and assessing distances properly. Persons with mild PD experience problems with diminished visual contrast sensitivity, slower verbal learning, and slower set-shifting and executive tasks, all of which theoretically might affect driving. In moderately advanced disease, once patients begin to suffer motor freezing, they also perform poorly on dual tasks; when quizzed while walking, both their stride length and verbal fluency decline, reflecting frontal lobe compromise.

Driving recommendations should be based on the level of motor and cognitive syndrome involvement, patient's response to treatment, and presence and extent of any medication side-effects. Serial physical and cognitive evaluations are recommended every 6–12 months due to the progressive nature of the disease. The driver assessment should consist of an on-road driving assessment performed by a DRS. The United Parkinson Disease Rating Scale (UPDRS) and the Trial Making B test results both correlated well with driving performance.

### Peripheral Neuropathy

Lower-extremity deficits in sensation and proprioception may be exceedingly dangerous for driving, as the driver may be unable to control the foot pedals or may confuse the accelerator with the brake pedal. If deficits in sensation and proprioception are identified, referral to a DRS is recommended.

### Seizure Disorder

Epidemiological studies have determined that the riskiest drivers with epilepsy were those who were the most noncompliant with their prescribed medications and were the most likely to drive illegally without a license. Studies found that over 50% of persons with epilepsy drove illegally without completing a sufficiently long seizure-free interval or did not report breakthrough seizures to their physicians in states with mandatory doctor-reporting requirements. Those persons with epilepsy who abuse alcohol are clearly at much higher risk.

According to the Consensus Statements on Driving Licencing in Epilepsy, from the American Academy of Neurology, American Epilepsy Society, and the Epilepsy Foundation of America, individuals with seizure disorder should not drive until they have been seizure-free for 3 months. The 3 month interval may be lengthened or shortened based on the presence of favorable or unfavorable modifiers. The following modifiers would increase the interval: noncompliance with medications, alcohol and/or drug abuse in the past 3 months, an increased number of seizures in the past 12 months, previous bad driving record, structure brain lesions, noncorrectable brain function or metabolic condition, frequent seizures after seizure-free interval, and previous crashes due to seizures in the past 5 years. The optimal minimal seizure-free interval to minimize seizure-related crashes is still unknown. In the USA, the seizure-free interval mandated by regulatory authorities varies from 2 years to as little as 3 months. Currently, six states in the USA and five provinces in Canada mandate that the physician report to the state anyone with epilepsy.

**Patient with seizure and the law** Health providers must counsel their patients about the imperativeness and advantages of reporting the seizure disorder to the appropriate licencing authority. Patients should understand that this process not only improves public safety but also shields the driver from litigation should he/she have a seizure while driving, provided that individuals have not been otherwise negligent. If patients do not report their disorder and recurrent seizures, and do not obtain the physician's statement, they may face civil liability and criminal prosecution in the event of an accident related to a seizure. In addition, if the physician believes that the patient has not self-reported and is endangering the public by driving, the physician should have the right to report the patient (with immunity). Moreover, the epileptic driver's insurance company may deny coverage for the accident, particularly when the facts show that the individual failed to take the prescribed antiepileptic medication appropriately.

For those patients who have controlled their seizures successfully, the physician may offer a statement to the licencing authority, usually on specified forms, confirming that the individual's seizures are controlled. With this statement, the physician asserts the opinion that, if licenced to drive, the person will not present an unreasonable risk to public safety. Generally, state medical review boards then review the driving application and physician statement and render a decision on whether to grant the license. State laws protect the physician from liability for violating patient confidentiality for statements about driving risk presented to the state, provided the statement is made in good faith and with reasonable belief of its accuracy. However, filling out the forms for the state authority is not enough. Providers may ask

patients to sign in the medical record that they have received and understood counseling about driving risks and their obligations to report their disorder. Providers have an obligation to use reasonable care to protect potential victims and prevent harm to the public. Physicians who fail to counsel patients about driving risks from uncontrolled seizures, or who fail to document such counseling, may face future direct liability exposure, even to other individuals and third parties injured in seizure-related accidents.

#### Stroke

Individuals with a history of stroke are at an increased driving-related risk due to decreased cognitive and psychomotor abilities. Individuals with acute motor, sensory, or cognitive deficits should not drive. Depending on the severity of residual symptoms and the degree of recovery, the driving restrictions may be permanent or temporary. All drivers with moderate to severe residual hemiparesis should be prohibited from driving before undergoing driving assessment. Even if symptoms improve to the extent that they are mild or completely resolved, the individual should undergo a driver assessment test such as the Washington University Road Test, as reaction time may continue to be affected. Perceptual tests such as the Motor-free Visual Perception Test (MVPT) and Trail Making B Test have also been shown to be predictive of on-road performance.

#### Subarachnoid Hemorrhage

Individuals with subarachnoid hemorrhage should not drive until symptoms have stabilized or resolved, and following a medical assessment performed by a DRS.

#### Syncope

Syncope may result from various cardiovascular and noncardiovascular causes; it is recurrent in up to 33% of cases. The most common cause of syncope is cardiac arrhythmias. Driving restrictions for neurally mediated syncope should be based on the severity of the presenting event. No driving restrictions are necessary for infrequent syncope that occurs with warning and with clear precipitating causes. Individuals with severe syncope may resume driving after adequate control of the arrhythmia has been documented and/or pacemaker implantation. Driving cessation is recommended for individuals who continue to experience unpredictable symptoms after treatment with medications and pacemaker insertion.

#### Transient Ischemic Attacks

Individuals who experience a single or recurrent transient ischemic attacks should refrain from driving until they have undergone medical assessment and appropriate treatment.

### Traumatic Brain Injury That May Impair the Driver

Individuals with traumatic brain injury should not drive until symptoms have stabilized or resolved. Traditionally, most driving rehabilitation programs have focused on the operational level, with emphasis on handling the vehicle and use of controls and mirrors, rather than tactical and strategic skills, where the deficits may lie for drivers with traumatic brain injury.

#### Vascular Malformation

Following the detection of a brain aneurysm or arteriovenous malformation, the individual should cease driving until assessed by a neurosurgeon. The individual may resume driving if the risk of a bleed is small, an embolization procedure has been successfully completed, and/or the patient is free of medical contraindications to driving, such as uncontrolled seizures or significant perceptual or cognitive impairment.

### Metabolic Conditions That May Impair the Driver

Individuals in the acute phase of metabolic disorders (diabetes, Cushing disease, Addison disease, hyperfunction of the adrenal medulla, and thyroid disorder) may experience signs and symptoms that are incompatible with safe driving.

#### Insulin-Dependent Diabetes Mellitus

In individuals demonstrating satisfactory control of the diabetes, able to recognize the warning symptoms of hypoglycemia, and meeting visual standards, there are no restrictions for operating a motor vehicle. Drivers should not drive during acute hypoglycemic and hyperglycemic episodes. Individuals who experience recurrent hypoglycemic or hyperglycemic attacks should not drive until they have been free of significant hypoglycemic or hyperglycemic attacks for 3 months.

#### Noninsulin-Dependent Diabetes Mellitus

If the driver's condition is managed by lifestyle changes and/or oral medication, there are no restrictions to driving privileges.

#### Hypothyroidism

If the hypothyroidism condition is not treated satisfactorily, the following symptoms may compromise

safe driving: cognitive impairment, drowsiness, and fatigue. If residual cognitive deficits continue despite treatment, the individual may consider on-road assessment performed by a DRS.

## Respiratory Conditions That May Impair the Driver

### Chronic Obstructive Pulmonary Disease (COPD)

Individuals with COPD should not drive if they suffer dyspnea at rest or at the wheel (even with supplemental oxygen), excessive fatigue, or have significant cognitive impairment. If individuals require supplemental oxygen to maintain a hemoglobin saturation of 90% or greater, they should use oxygen at all times while driving. Due to the often tenuous oxygenation status of these individuals, they should be counseled to avoid driving when they have other respiratory symptoms that may indicate concomitant illness or exacerbation of COPD (new cough, increased sputum production, change in sputum color or fever). Because COPD is a progressive disease, periodic reevaluations for symptoms and oxygenation status are required. Driver assessment should consist of an on-road driving assessment performed by a DRS with the driver's oxygen saturation measured during the on-road assessment.

## Renal Condition That May Impair the Driver

### Chronic Renal Disease

Drivers with chronic renal disease have no restrictions unless they experience symptoms such as cognitive impairment, impaired psychomotor function, seizures, or extreme fatigue from anemia. Individuals who require hemodialysis can drive without restriction if they comply with nutrition and fluid restriction. Certain medications used to treat the side-effects of hemodialysis may cause impairment to ones driving ability. In addition, the dialysis itself may result in hypotension, confusion, or agitation in many patients. These effects may require avoiding driving during the immediate postdialysis period. If the physician is concerned, the patient should take an on-road driving assessment performed by a DRS.

## Sleeping Disorders That May Impair the Driver

Individuals with sleeping disorders such as narcolepsy and sleep apnea should cease driving upon diagnosis but resume driving upon treatment. Only six US states – California, Maryland, North Carolina, Oregon, Texas, and Utah – have guidelines for narcolepsy. Physicians may consider using scoring tools such as the Epworth Sleepiness Scale to assess the patient's level of daytime drowsiness. In 1991, the US Federal Highway Administration recommended that drivers with suspected or untreated sleep apnea "not be medically qualified for commercial motor vehicle operation until the diagnosis has been eliminated or adequately treated." Two states, California and Texas, currently have guidelines addressing sleep apnea. Currently, the impact of these regulations on crash rates or on the practice of sleep medicine has not been assessed.

## Sensory Conditions That May Impair the Driver

### Visual Acuity

The NHTSA (National Highway Traffic Safety Administration) has established guidelines for unrestricted driver's license and states that a driver must have 20/25 static near visual acuity in each eye (with correction less than 10 D), monocular visual fields of 120° in each eye, and binocular visual fields of 70° to the right and to the left in the horizontal meridian. Many common eye conditions require special consideration but lack set standards, including impairments of color vision and dark adaptation; heterophoria; stereopsis; monocular vision; refractive states; and telescopic lenses. Both dynamic visual acuity and static acuity decline with age, however, with dynamic acuity, the ability to resolve details of moving objects deteriorates more rapidly.

### Visual Attention

Older drivers with 40% or greater impairment in their useful field of view (UFOV) – which stems from decline in visual sensory function, visual processing speed, and/or visual attention skills – appear to be at an increased crash risk. Older adults who failed the UFOV task have been shown to have 3–4 times more accidents overall and 15 times more intersection accidents than older adults who passed the UFOV task. The NHSTA recommends that the UFOV protocol be incorporated as a diagnostic test of cognitive deficits, to predict driving impairments for license renewal applicants. The formal testing of UFOV can be performed at the physician's office.

### Cataracts

Individuals with moderately advanced cataracts (20/40 to 20/60) suffer more at-fault car crashes than individuals without cataracts. Fortunately, visual impairment from cataracts is correctable with

surgery to 20/40 acuity or better in most cases. An eye specialist should counsel patients regarding the dangers associated with driving with cataracts and suggest driving restrictions (e.g., at night/dusk, in reduced-visibility conditions such as rain, fog) until surgery has been performed.

#### Hearing Loss

Relatively few studies have examined the relationship between hearing impairment and the risk of motor vehicle crashes. Of these studies, none has demonstrated a significant relationship between hearing impairment and the risk of crash; therefore, there are currently no restrictions.

#### Vertigo

Drivers with acute vertigo should cease driving until symptoms have fully resolved. Individuals with chronic vertiginous disorder are strongly recommended to undergo driver assessment consisting of an on-road driving assessment performed by a DRS before resuming driving. The medications commonly used to treat these conditions have a significant potential to impair driving skills.

## Deficits of the Extremities That May Impair the Driver

Deformities of the feet (toenail irregularities, calluses, bunions, hammer toes), impairment of gait and balance, and drivers who indicate that their feet or legs feel cold have all been shown to increase car collisions. Older drivers with poor flexibility of arms, legs, and neck are at increased crash risk. Epidemiological studies have reported that older women who could not extend their arms above shoulder height were more than twice as likely to crash their vehicles. In another study, limited neck range of motion was independently associated with adverse driving events.

## Medications and Their Effects on Drivers' Fitness

Many commonly used prescriptions and over-the-counter medications can impair driving performance. In general, any drug with prominent central nervous system effects has the potential to impair an individual's ability to operate a motor vehicle. The level of impairment varies between medications within the same therapeutic class, and in combination with other medications or alcohol. Side-effects that may affect driving performance range from drowsiness, blurred vision, and slow reaction time, to extrapyramidal side-effects. Physicians should make every effort to prescribe nonimpairing medications. However, if prescriptions that can impair driving need to be prescribed, physicians should counsel the patient regarding the side-effects. Therefore, physicians should counsel their patients of the specific symptoms and side-effects associated with the prescribed medication and inform them to alert the physician if these symptoms occur. When prescribing new medications, the physician should consider the present regimen of prescriptions, nonprescription medications, and seasonally prescribed medications. The combinations of drugs may affect drug metabolism and excretion, producing additive or synergistic interactions. A physician may consider formal psychomotor testing consisting of an on-road driving assessment performed by a DRS while off and on the medication to determine the extent of impairment.

Below is a partial list of medications, their effects on the driver, and recommendations regarding driving a motor vehicle.

#### Anticholinergics

The anticholinergic effects that can impair driving performance include blurred vision, sedation, confusion, ataxia, tremulousness, and myoclonic jerking. Individuals should be advised that psychomotor and cognitive impairment may be present even in the absence of subjective symptoms. Subtle deficits in attention, memory, and reasoning may occur with therapeutic dosage of anticholinergic drugs without signs of frank toxicity. These deficits have often been mistaken for symptoms of early dementia in elderly patients.

#### Anticonvulsants

Individuals should temporarily cease driving during the time of medication initiation, withdrawal, or dosage change due to the risk of recurrent seizure and potential medication side-effects that may impair driving performance. If there is a significant risk of recurrent seizure during medication withdrawal or change, the individual should immediately cease driving for at least 3 months. If an individual experiences a seizure after medication withdrawal or change, he/she should not drive for 1 month after resuming a previously effective medication regimen.

#### Antidepressants

Driving impairment varies among the different classes of antidepressants, and even within certain classes of antidepressants. In general, antidepressants that possess antagonistic activity at cholinergic, alpha$_1$-adrenergic, and histaminergic receptors are the most impairing. Individuals should be advised not to

drive during the initial phase of antidepressant dosage adjustment(s) if they experience drowsiness, lightheadedness, or other side-effects that may impair driving performance.

**Bupropion** The side-effects of bupropion (Wellbutrin® or Zyban®) include anxiety, restlessness, and insomnia. Patients should be counseled about these side-effects and their potential to impair driving performance. Bupropion may cause seizure at high doses. It should not be prescribed to individuals with a history of epilepsy, brain injury, or eating disorder.

**Monoamine oxidase inhibitors** The side-effects of monoamine oxidase inhibitors that may impair driving performance include blurred vision, overstimulation, insomnia, orthostatic hypotension (with transient cognitive deficits), and hypertensive crisis.

**Tricyclic antidepressants** Tricyclic antidepressants have been shown to impair psychomotor function, motor coordination, and open-road driving. Common side-effects of tricyclic antidepressants that may impair driving performance include sedation, blurred vision, orthostatic hypotension, tremor, excitement, and heart palpitation. Studies have indicated an increase in the risk of drivers involved in motor vehicle crashes who take tricyclic antidepressants. Tricyclic antidepressants should be avoided in individuals who wish to continue driving. If nonimpairing alternatives are not available, the physician should advise patients of the potential side-effects and recommend temporary driving cessation during the initial phase of medication initiation/dosage adjustment.

### Antiemetics

Numerous classes of drugs, including antihistamines, antipsychotics, cannabinoids, benzodiazepines, 5-hydroxytryptamine antagonists, and glucocorticoids are used for their antiemetic effects. Side-effects of antiemetics that may impair driving performance include sedation, blurred vision, headache, confusion, and dystonias. Significant driving impairment may be present even in the absence of subjective symptoms.

**Antihistamines** The older antihistamines such as diphenhydramine and chlorpheniramine have pronounced central nervous system effects. Sedating antihistamines have been shown to impair psychomotor performance, simulated driving, and open-road driving. Individuals may experience impairment even in the absence of subjective symptoms of impairment. Therefore, individuals taking sedating antihistamines should be advised not to drive while on medication. In contrast, nonsedating antihistamines do not produce this type of impairment if taken at the recommended dosage. However, higher-than-recommended doses may impair driving performance.

**Antihypertensives** The common side-effects of antihypertensives, such as lightheadedness, dizziness, and fatigue, coupled with the properties of hypotensives, may impair driving performance. In addition, antihypertensives with a prominent central nervous system effect, including beta-blockers and sympatholytic drugs such as clonidine, guanfacine, and methyldopa, may cause sedation, confusion, insomnia, and nervousness. Individuals taking antihypertensives should be advised that they may cause electrolyte imbalance and affect driving.

**Antiparkinsonians** There are several classes of medication to treat PD, including levodopa, antimuscarinics, amantadine, and dopamine agonists. Common side-effects of these drugs that may impair driving include excessive daytime sleeping, lightheadedness, dizziness, blurred vision, and confusion. Sudden irresistible attacks of sleep have been shown as a side-effect with the dopamine agonist drugs pramipexole and ropinirole. Based on the extent of the disease, the physician may order the patient to undergo formal psychomotor testing or driving evaluation performed by a DRS. Although levodopa improves memory and verbal fluency, it worsens simultaneous visual and auditory reaction times. Trihexyphenidyl, another popular medication for PD, impairs attention, learning, and free recall.

**Antipsychotics** Most, if not all, antipsychotic medications have a strong potential to impair driving performance through various central nervous system effects. The "classic" antipsychotics are heavily sedating, and all produce extrapyramidal side-effects. Modern drugs have a lower tendency to cause extrapyramidal side-effects; they too are sedating. Patients should be counseled about these side-effects and advised not to drive if they experience side-effects that are severe enough to impair driving performance. The individual may consider formal psychomotor testing consisting of an on-road driving assessment performed by a DRS.

### Benzodiazepines (Sedatives/Anxiolytics)

Benzodiazepine use has demonstrated impairment to vision, attention, motor coordination, and driving

performance. Evening dosage of long-acting benzodiazepines has been shown markedly to impair psychomotor function the following day. Benzodiazepine-like hypnotics such as zolpidem and zaleplon have a rapid rate of elimination; therefore psychomotor functions and skills to safely operate a motor vehicle have been shown 5 hours after taking zalepon and 9 hours after taking zolpidem. Individuals taking long-acting drugs or those during the daytime should be advised of the potential for impairment, even in the absence of subjective symptoms. Individuals should also be advised to avoid driving, particularly during the initial phase of dosage adjustment.

#### Muscle Relaxants

Most skeletal muscle relaxants (carisoprodol and cyclobenzaprine) have significant central nervous system effects. Drivers should be advised regarding the side-effects and recommended not to drive during the initial phase of dosage adjustment.

#### Stimulants

The common side-effects of stimulants (amphetamines and methylphenidates) that may affect driving performance include euphoria, overconfidence, nervousness, irritability, anxiety, insomnia, headache, and rebound effects as the stimulants wear off. Drivers should be advised regarding the side-effects and recommended not to drive during the initial phase of dosage adjustment.

## Standardized Tests for Driving Performance

There are a number of methods to test driving performance. These range from cognitive testing to real-life on-road driving assessments. Cognitive measures such as the Clinical Dementia Rating (CDR) scale, Sternberg memory search test, visual tracking and the UFOV examination, the Boston test, and the MMSE (Mini Mental State Examination) test can all be used to assess cognitive function and level of driving impairment. The American Academy of Neurology recommended using the CDR to assess individuals with DAT. The MMSE was found to be a significant predictor of final on-road driving performance results, but not of crashes and traffic violations. The Boston naming test has also been shown to be a predictor of driving ability.

Physicians who have concerns that their patients may be unsafe to drive should refer these individuals to a DRS. A standardized road test may be the only appropriate means of determining driving competence in people diagnosed with neurological and physical impairment. The DRS conducts closed-course, off-road, and on-road performance testing. Closed-course testing allows assessment of a person's ability to track, steer, and brake a car, but yields limited information on actual driving behavior. Testing in stationary training cars is not adequate for persons with central neurological disorders. It is useful in drivers recovering from a stroke or traumatic brain injury, as a prelude to formal on-road examinations. A popular standardized on-road measure is the Washington University Road Test (WURT) of driving performance, that is commonly used in driving research in the elderly and a wide range of cognitively impaired population. The WURT is a 45-min in-traffic road test along a predetermined route. The open-course test is conducted in traffic and assesses several typical driving skills such as maintaining speed, obeying traffic signs, signaling, turning, changing lanes, and negotiating intersections. The road test provides an accurate and reliable functional assessment of driving ability and the test–retest reliability is high.

The methods developed and employed in the USA for testing drivers' performance and the presence of illicit drugs have been adapted by countries in Europe and Australia. In the UK two drug recognition systems are used, Drug Recognition Training (DRT) and Field Impairment Testing (FIT). The DRT combined with the FIT system is used to identify the signs and symptoms associated with the effects of drugs and the assessment of the driver's drug impairment. A version of the American field sobriety test of drivers, FIT was introduced with minor differences in Scotland, England, and Wales in 2000. The main difference between the US and UK and European field sobriety tests is that horizontal and vertical gaze nystagmus is replaced by an examination of the pupils.

#### Government Regulation

The US federal government and individual states play the central role in licencing drivers. The driver's licencing regulation is specific for each state. The ultimate decision to remove driving privileges rests in the hands of the local driver's licencing authority. In 1991, 46 states had restrictions regarding individuals with seizures; 26 states limited drivers who have episodic loss of consciousness from other medical causes; and eight states had laws regarding individuals with known cardiac arrhythmias. Therefore, the physician's role is simply advisory.

## The Role of the Postmortem Examination

The legislation and medical guidelines are based primarily on empirical and statistical data. The information generated from postmortem examinations and a

review of the driver's past medical history are critical for the refinement and future generations of sound medical guidelines. The postmortem examination of a driver involved in a fatal motor vehicle crash is the final assessment of the performance of the driver and his/her physician. Throughout the USA all fatal motor vehicle crashes require a postmortem examination. The forensic pathologist is able to review the driver's medical records and the results of the postmortem examination of the internal organs and the results of toxicological analysis.

## Americans: Age 65 and Over

### Population

In 1980, the US population of individuals aged 65 and over represented 26.5 million (11.3%) of the total US population. Ten years later this population increased to 30.9 million, 12.5% of the total population. Based on projections, by the year 2025 more than 18% of the US population will be 65 and older, and by 2040 the elderly will represent 20% (68 million) of the US population. The percentage of individuals aged 85 and older is increasing at a faster rate than ever before.

### Mortality

The two leading causes of natural death among individuals aged 65 and over are cancer and heart disease. Among unintentional injuries resulting in death, the two leading causes in the 65–74-year-old group are motor vehicle accidents and falls. The Insurance Institute for Highway Safety estimates that, by the year 2030, 25% of all fatal traffic crashes will involve drivers 65 and older.

### Number of Licenced Drivers

Currently, older drivers represent only a fraction of the total driving public. However, they represent the fastest-growing segment of the driving population. In 1980, there were 13.3 million licenced older drivers, representing 9.3% of all drivers in the USA. By 1991, there were 21.8 million, representing 13%, with 6.6 million (4%) drivers over 85 years old. The Federal Highway Administration reported that in 1996 there were 15 648 000 licenced drivers aged 65–74 years, and 9 522 000, aged 75 and over. It has been estimated that, by the year 2020, more than 15% of drivers will be older than 65 years. The National Institute on Aging estimates that, by 2030, there will be an estimated 40 million licenced drivers, with 25% of all drivers aged 65 and over, and about 9 million of these aged 85 and over.

### Motor Vehicle Crashes

Accidents were the fourth leading cause of death in the USA in 1999; motor vehicle accidents accounted for over half of these deaths. Automobile crashes in the USA in 1999 claimed the lives of 40 000 individuals and disabled 2.2 million. The pattern of motor vehicle crashes and fatal motor vehicle accidents in the USA is U-shaped. The number of fatal motor vehicle accidents is high among drivers aged 16–24 years old; it then steadily decreases until the age of 45–55. After the age of 55, it starts to increase, with the greatest increase occurring after the age of 60. The accident rates for drivers aged 16–19 is 28 per million miles driven, whereas in adults older than 85 years the rate jumps to 85 accidents per million miles driven.

### Profile of Elderly Drivers

Driving is an economic, social, and recreational necessity for most Americans and plays a central role in the lives of adults, especially older adults, who rely on the private automobile for 88% of their transportation needs. Individuals with preexisting medical conditions and/or those who develop conditions that can affect their driving performance will result in a conflict between reasonable transportation opportunities, the role of physicians, and society's need to protect public safety.

Most seniors are as capable of driving safely as their younger counterparts, and when they become aware that they have a problem, they typically act responsibly by limiting or modifying their driving habits. Older drivers in general drive less, drive less at night, avoid heavy traffic times and complicated roadways, and limit their geographic area. Ever-growing traffic volumes, congestion, and novel highway features and vehicle technologies demand greater attention by drivers. They incur accidents in situations that require astute perception, problem-solving ability, immediate reactions, and agile decision-making. However, older drivers are overrepresented when fatalities or crashes are adjusted for vehicle miles traveled. They commit more driving errors, such as failure to yield right-of-way, incorrect lane changes, and improper turning, particularly left-hand turns, and turning from the wrong lane. When they crash, elderly drivers are more likely to incur injury and death. As a group, people older than 65 years nonetheless have fewer accidents than any other age group, largely because they drive fewer kilometers. Those older than 75 years are twice as likely as the average driver, per mile driven, to crash their cars, while those older than 85 are 2.5 times more likely, even without adjustment for miles driven. Men

are 2–4 times more likely to crash than women, even when adjusted for the increased time men spend driving, though this difference begins to disappear later in life.

## See Also

**Road Traffic, Determination of Fitness To Drive:** Sobriety Tests and Drug Recognition; Driving Offense; **Road Traffic, Global Overview of Drug and Alcohol Statistics**

## Future Reading


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# Driving Offense

**C H Wecht and S A Koehler**, Allegheny County Coroner, Pittsburgh, PA, USA



## Introduction

This article will provide an overview of driving offenses created by the intake of drugs, including alcohol, and unsafe driving behavior. In addition, antemortem and postmortem forensic evaluation of driver behavior and level of impairment will be reviewed.

## Postmortem Forensic Toxicology

Individuals involved in a fatal motor vehicle accident undergo from a postmortem examination, complete with toxicological analysis, to simply an analysis of blood drawn from the heart, to no blood for analysis in some areas. Postmortem forensic toxicology analysis is conducted to ascertain what role alcohol or other drugs may have played in the driver's ability to operate a vehicle safely. Specimens are obtained during the postmortem examination for this purpose.

Blood is the most important specimen obtained during postmortem examination for forensic toxicology analysis. The sample of blood should be obtained from the heart and from a peripheral site such as the femoral or jugular veins. In addition to blood, vitreous humor from the eye, urine from the bladder, and bile from the gallbladder are also collected during the postmortem examination. After these fluids have been collected they undergo toxicological analysis. Techniques used for this identification include spectrophotometry, chromatography, and immunoassay.

## Human Performance Toxicology

The branch of forensic toxicology that focuses on the relationship between the presence of a drug and the associated behavioral changes or human performance is termed behavioral toxicology. The field of behavioral toxicology combines the disciplines of psychology, toxicology, and pharmacology. Behavioral toxicology focuses on both licit and illicit drugs and evaluates the effects of therapeutic drugs when administered in the prescribed manner for their normal medical application, as well as when they are incorrectly administered or abused.

### The Effects of Alcohol

Alcohol produces a wide range of behavioral effects such as decreased visual acuity and peripheral vision, and these effects increase significantly as the blood alcohol concentration (BAC) rises above $0.07\,g\,dl^{-1}$. At a BAC of $0.08\,g\,dl^{-1}$, sensitivity to pain decreases. Reaction time is impaired at $0.05\,g\,dl^{-1}$. Those who consume alcohol irresponsibly face a much higher risk of driving accidents. Three drinks in 60 min for an average man or in 90 min for an average woman will raise the blood alcohol level to 0.05% ($0.01\,mmol\,l^{-1}$), a level at which the risk for crash doubles. In the USA, the vast majority of states specify 0.10% as the legal definition of impairment, and a few have lowered the legal limit to 0.08%. Generally, two 45-ml (1.5-oz) drinks of spirits result in a blood level of 0.05%.

The behavior changes associated with alcohol and its effect on driving performance have been well established. Epidemiological studies have shown that 40–60% of all fatally injured drivers had a BAC of $0.10\,g\,dl^{-1}$ or greater, and 30–40% of those had a BAC $> 0.15\,g\,dl^{-1}$. The cost of drink-related accidents has been estimated at $45 billion a year, with $70 billion lost in quality of life. In 1997, in the USA, just over 16 000 people were killed in crashes involving alcohol, nearly two-fifths of all traffic deaths. Mothers Against Drunk Driving (MADD) estimates that about 800 000 Americans are injured in alcohol-related crashes every year, and that three of every 10 Americans will be involved in an alcohol-related traffic crash at some time in their lives.

Comparison of the impacts of alcohol and epilepsy, the medical condition most commonly reported to driving-licencing authorities, reveals that, of every 10 000 individuals killed in motor vehicle accidents, 4000 deaths are due to excess alcohol, six to natural causes, and only one to epilepsy. It is strange that all 50 states in the USA carefully advise physicians to report to licencing authorities any driver with uncontrolled epilepsy, but none mandate reporting of drivers with alcoholism. Not surprisingly, very few physicians in practice ever do.

Certain other behaviors inflate accident rates as well. A history of a previous serious accident, especially when the driver was at fault, presents an increased risk (and insurance premiums). The relative risk of a crash while driving a sports car is 1.3 and while talking on a cellular phone it is estimated to be 4.3. As automakers bring more satellite-based telecommunications to drivers – e-mail, traffic reports, navigational systems – the temptation to "multitask" increases, further distracting motorists.

#### Driving under the influence of alcohol (DUIA) and driving under the influence of drugs (DUID)

*Driving under the influence (DUI)* The first legislation making DUI an offense in the USA was passed in 1939. A joint meeting of the Committee to Study Problems of Motor Vehicle Accidents (a special committee of the American Medical Association) and the Committee on Alcohol and Other Drugs established the offense levels of DUI based on BAC levels. Later, the committee name was changed to the Committee on Alcohol and Drugs. The committee also formulated the basis of the Chemical Test Section of the Uniform Vehicle Code. In 1960, the Committee on Alcohol and Drugs released the recommendations that DUI laws use the level of $0.10\,g\,dl^{-1}$ BAC as presumptive evidence of guilt. The Uniform Vehicle Code was amended to reflect this recommendation in 1962. The relative probability of having an accident by BAC is shown in Table 1. In 1971, the Committee stated that alcohol, regardless of previous experience with this compound, impaired driving performance at a BAC of $0.08\,g\,dl^{-1}$ or greater. The standardized field sobriety tests were developed in the late 1970s.

**The sobriety tests** When a police officer encounters a possibly impaired driver, he/she initiates a three-phase evaluation process called the DUI arrest decision process. Phase 1 involves the initial observation

**Table 1** The relative probability of having an accident by blood alcohol concentration (BAC) level

| *BAC level ($g\,dl^{-1}$)* | *Probability of having an accident* |
|---|---|
| 0.04 | Drivers were as likely to have an accident as a sober driver |
| 0.06 | Drivers were twice as likely as sober drivers to cause an accident |
| 0.10 | Drivers were six times as likely as sober drivers to cause an accident |
| 0.15 | Drivers were 25 times as likely as sober drivers to cause an accident |

of the motion of the vehicle, such as weaving, signaling, speed, and the driver's response to the officer's commands. Phase 2 is the officer's direct contact with the driver. During the interview with the driver the officer evaluates the physical appearance, dexterity, breath odor, condition of the eyes, color of the face, and speech patterns. Phase 3 involves the administration of several psychomotor tests and the breath test. The three tests that constitute the standardized field sobriety test are the one-leg stand (OLS), the walk and turn (WAT), and the horizontal gaze nystagmus (HGN). The HGN is the most sensitive test to determine the impairing effects of alcohol. The specimen for DUI cases is the breath. Law enforcement prefers the breath test because collection and analysis are performed together. Blood specimens must be drawn by a trained healthcare professional, and urine must be collected under controlled and observed conditions. After the three phases the officer should be able to ascertain whether arrest or release of the driver is indicated.

**Sample collection among individuals of DUIA and DUID** Specimens among living subjects should be collected from individuals suspected of being impaired by alcohol or other drugs. Blood samples are collected using the venepuncture technique. The disinfectant used to clean the arm should not contain ethanol, isopropanol, or any other volatile compound. Povidone iodine solutions are recommended. Samples used for alcohol determinations should contain blood collected in two 10-ml gray-top tubes of blood (e.g., Vacutainer® Tubes), while urine should be collected in a plastic container. Samples used for alcohol and drug screens should contain at least two 10-ml gray-top tubes of blood, two 10-ml green-top tubes of blood, and one plastic container of urine. The urine specimens should be collected in a plastic container designed to prevent leakage during transport. The specimens should be collected while the subject is being observed. It is critical that a blood sample is submitted for all DUIA and DUID cases. A urine specimen by itself will only indicate recent ingestion. All specimens should be labeled, and put in a closed, sealed, and tamper-resistant package with: the name of defendant, specimen type, and the date and time specimen was obtained. The sample should be refrigerated and submitted as soon as possible after collection. Each specimen should contain a brief history, indicating any pertinent information or observations regarding the history, such as: medication taken that day, medical conditions, time of last drink, last meal, and drug history (such as history of drug abuse). In addition, document how much time has elapsed between the time when the drug (or drugs) might have been taken and the time of sample collection.

In postmortem cases of suspected cases of DUIA or DUID, the following biological samples should be collected. Blood should be collected from the heart blood, 60 ml in culture tube and 10 ml in a gray-top tube; femoral blood in two 10-ml gray-top tubes; and antemortem blood if available. Urine (30–60 ml in culture tube), bile (30 ml in culture tube), and all vitreous fluid should also be collected. Samples of liver (60 g) and lung (10 g) and all contents of the stomach should be collected. In cases of suspected overdoses, package intact tablets separately and identify them as being found in the stomach contents. In suspected cases of inhalant, solvent abuse, or methane deaths submit lung samples (10 g) in an airtight and half-full container (use 40-ml volatile organic compound vials with a Teflon seal). All specimens must be labeled with autopsy number, name of deceased, date, and type of specimen. Each blood specimen must be labeled as to the anatomic site of origin (i.e., heart blood, chest blood). Antemortem blood samples must be labeled with the autopsy name, number, and the date and time of collection. Refrigerate samples prior to submission.

## Drugs and Driving

The role of drugs of abuse other than alcohol has been recognized in an analysis of impaired driving performance. This insight led to the formation of the Drug Evaluation and Classification (DEC) program in the USA. Following several field validity studies by the NHTSA and the NIDA, the standards for training police officers as drug recognition experts (DREs) were established. The DRE drug evaluation has 12 components: (1) breath alcohol test; (2) interview of the arresting officer; (3) preliminary examination of the suspect; (4) examination of the eyes; (5) divided-attention psychophysical tests; (6) vital signs examination; (7) dark room examination; (8) examination of muscle tone; (9) examination for injection sites; (10) suspect's statements and other observation; (11) opinion of the evaluator; and (12) toxicology examination.

If it is the opinion of the DRE officer that the driver's impairment is caused by drugs, toxicological analyses are performed. In general, blood is the best specimen for analysis. Urine specimen is suitable for toxicology screen; however, no direct relationship can be ascertained between the urine concentration of a drug and impairment. Therefore, positive identification of a drug is only an indicator of

**Table 2** Physiological features of various drugs used by the drug recognition evaluation (DRE)[a]

| *Drug recognition evaluation* | *CNS depressant* | *CNS stimulants* | *Hallucinogens* | *PCP* | *Narcotic* | *Inhalants* | *Cannnabis* |
|---|---|---|---|---|---|---|---|
| Pupil size | Normal | Dilated | Dilated | Normal | Constricted | Normal | Normal/ slightly dilated |
| Reaction to light | Slow | Slow | Normal | Normal | Normal | Slow | Normal |
| Horizontal gaze | Nystagmus present | Nystagmus not present | Nystagmus not present | Nystagmus present | Nystagmus not present | Nystagmus present | Nystagmus not present |
| Vertical gaze | Nystagmus present | Nystagmus not present | Nystagmus not present | Nystagmus present | Nystagmus not present | Nystagmus may be present | Nystagmus not present |
| Smooth convergence | Lacking | Present | Present | Lacking | Present | Lacking | Lacking |
| Pulse rate | Elevated or depressed | Elevated | Elevated | Elevated | Depressed | Elevated | Elevated |
| Blood pressure | Lowered | Elevated | Elevated | Elevated | Lowered | Lowered | Elevated |
| Body temperature | Lowered | Elevated | Elevated | Elevated | Lowered | Lowered or elevated | Normal |
| Muscle tone | Normal | Rigid | Rigid | Rigid | Normal to flaccid | Normal | Normal |
| Injection site | Not present | Present | Not present | Not present | Present | Not present | Not present |

CNS, central nervous system; PCP, phencyclidine.
[a]It should be noted that in many circumstances a mixed picture of drug and alcohol use has taken place rendering this information unsound.

exposure. It should also be noted that there is no well-established correlation between blood concentration and performance impairment for any drug other than alcohol. Table 2 shows physiological features of various drugs used by the DRE.

Drivers under the influence of drugs are a significant problem outside the USA. The number of drivers under the influence has been increasing in the UK. This increase has resulted in the establishment of DEC programs in these countries. In the UK the Drug Recognition Training (DRT) and Field Impairment Testing (FIT) were developed. The DRT is used to identify the signs and symptoms associated with the effects of drugs. The effectiveness and interpretation of these testing methods is still widely debated as mis- or over-interpretation may occur. The FIT system was derived from the US sobriety testing that has been in use for over 20 years. The FIT used in non-US countries is very similar to the ones used in the US.

### The Effects of Various Drugs on the Human Body

**Central nervous system (CNS) depressants** This class includes alcohol, the most common CNS depressant. Other drugs include barbiturates, benzodiazepines, antidepressants, and antipsychotic drugs. Drugs in this category result in a dose-related slowing of reflexes, loss of social inhibitions, impaired divided attention and judgment, increased risk-taking behavior, and emotional instability.

**CNS stimulants** This class includes cocaine, and members of the amphetamine class such as methamphetamine. Acute use of the drugs in this category results in improved mood and a feeling of pleasure. Chronic use leads to paranoid behavior, psychosis, and violence.

**Hallucinogens** This class includes lysergic acid diethylamide (LSD), 3,4-methylenedioxyamphetamine (MDA), and methylenedioxymethamphetamine (MDMA). Drugs in this category cause an altered or distorted perception of reality. Performance usually involves difficulty in remaining motivated and attending to a particular task.

**Phencyclidine (PCP)** This class includes PCP and its structural analogs. PCP has anesthetic properties, hallucinogenic effects, and may act as either a CNS depressant or stimulant. Drivers under PCP experience disorientation, slurred speech, agitation, excitement, and altered perception of self, and typically have a fixed, blank stare.

**Narcotic analgesics** This class includes natural opiates (heroin, morphine, and codeine), and synthetic opiates (hydromorphone, hydrocodone, fentanyl, methadone). The initial effects include a feeling of intense pleasure followed by dysphoria, nausea, and vomiting. Chronic use does not appear to interfere with intellectual or physical ability.

**Inhalants** This class comprises the volatile organic solvents (e.g., toluene, gasoline), hydrocarbon gases (butane, freon, propane), anesthetic gases (halothane, nitrous oxide), and nitrites (isobutyl, amyl, and butyl nitrites). Inhalation of the fumes results in a feeling of euphoria, and CNS depression similar to the effects of alcohol. Abusers experience disorientation and confusion.

**Cannabis** This class includes marijuana, hashish, hash oil, and $\triangle^9$-tetrahydrocannabinol (TCH) from the *Cannabis sativa* plant. At low doses these drugs cause a pleasurable high. Performance deficits from these drugs are primarily caused by a lack of motivation and an inability to attend to a task. Following use of marijuana performance on a standard field sobriety test is significantly impaired.

### Drug Evidence with a Vehicle

The vehicle involved in a fatal injury is routinely searched for evidence of drug use. The most typical finds are cans of beer. On occasion drug paraphernalia is also located within the vehicle. Once drug evidence has been located, it should be collected and submitted for analysis. If vegetable-type matter is located or if the material appears to be freshly harvested marijuana it should be dried and packaged in a sealed suitable paper container prior to submission. Do not seal freshly cut suspected marijuana in plastic bags since such packaging promotes the growth of mold and the deterioration of the evidence. If moldy vegetable matter is encountered, the sample must be sealed in an airtight container.

Evidence must be submitted in sealed packages. Use evidence tape or clear shipping tape to seal packages. Regular Scotch tape is not acceptable. All sealed packages must be initialed by the person who sealed the package and by the submitter. With small items, the sealed evidence package should be no larger than $13 \times 18$ cm ($5 \times 7$ in.). For very large samples, such as suitcases, travel bags, or large plants, a sealed corrugated cardboard box is preferable to other types of paper. Evidence from different actors in the same case must be packaged in separate sealed containers and clearly marked with the actor's name.

## Unsafe Driving Behavior: Not Drug-Related

### The Drowsy Driver

The NHTSA estimates that 1–3% of US highway crashes and 4% of fatal motor vehicle crashes are caused by driver sleepiness. Few attempts have been made to assess the total costs of drowsy driving, although a recent report from the NHTSA estimated them at $12.4 billion a year. Reports have shown that, when impairments in performance caused by alcohol and sleep deprivation were compared directly, sustained wakefulness for 17 h decreased performance about as much as a BAC of 0.05%.

Fatigue is the leading cause of long-haul truck crashes. Rates of drowsy-driving crashes are highest among young people (especially men), shift workers, and people with untreated sleep conditions. NHTSA data show that males are five times more likely than females to be involved in drowsy-driving crashes. It has also been shown that male youths with the greatest extracurricular time commitments were most likely to report falling asleep at the wheel. The subgroup at greatest risk comprised the brightest, most energetic, and hardest-working teens.

Experimental evidence has shown that sleeping less than 4 consolidated hours per night impairs performance of vigilance tasks. Individuals working rotating shifts lose 2–4 h with each shift. People who are restricted to 4–5 h sleep per night for 1 week need two full nights of sleep to recover vigilance, performance, and normal mood, according to one study. Although the relative risk for fall-asleep crashes has not been established, individuals who exhibit a sleep latency of less than 15 min on the maintenance of wakefulness test, a routine sleep lab study, are categorically too sleepy to drive a motor vehicle. Sleepiness and alcohol interact, with sleep restriction exacerbating the sedating effects of alcohol.

A 1996 random survey of licenced drivers in New York state conducted by McCartt in order to determine the prevalence and circumstances of drowsy driving discovered that 54.6% of drivers had driven while drowsy within the past year; 22.6% had even fallen asleep at the wheel without having a crash; 2.8% had crashed when they fell asleep; and 1.9% had crashed when driving while drowsy. Of the reported crashes due to driving while drowsy or falling asleep at the wheel, 82.5% involved the driver alone in the vehicle, 60.0% occurred between 11:00 P.M. and 7:00 A.M.; 47.5% were drive-off-the-road crashes; and 40.0% occurred on a highway or expressway. Multiple regression analysis suggested that the following driver variables are predictive of

an increased frequency of driving drowsy: demographic characteristics (younger drivers, more education, and men); sleep patterns (fewer hours of sleep at night and greater frequency of trouble staying awake during the day); work patterns (greater frequency of driving for job and working rotating shifts); and driving patterns (greater distance driven annually and fewer number of hours a person can drive before becoming drowsy). Knowledge of specific risk factors for sleep-related crashes is an important first step in reducing the thousands of deaths and injuries each year in the USA attributed to drowsy driving.

### Sleep-Related Deaths

Obstructive sleep apnea has been shown to be associated with an increased risk of road traffic accidents. Sleep apnea, as measured by the apnea–hypopnea index, has been associated with traffic accidents. As compared to those without sleep apnea, patients with an apnea–hypopnea index of 10 or higher had an odds ratio of 6.3 of having a traffic accident. In 1991 an expert panel of the Federal Highway Administration recommended that drivers with suspected or untreated sleep apnea "not be medically qualified for commercial motor vehicle operation until the diagnosis has been eliminated or adequately treated."

A 2003 population-based case-control study was carried out by Stutts to examine driver risk factors for sleep-related motor vehicle crashes. Cases included 312 drivers involved in recent North Carolina crashes and identified on police reports as being asleep at the time of the crash; 155 drivers were identified as fatigued. Controls were 529 drivers also involved in recent crashes but not identified as asleep or fatigued, and 407 drivers not involved in recent crashes. All drivers were contacted for brief telephone interviews. Results showed that drivers in sleep-related crashes were more likely to work multiple jobs, night shifts, or other unusual work schedules. They averaged fewer hours' sleep per night, reported poorer-quality sleep, were less likely to feel they got enough sleep, were sleepier during the day, drove more often late at night, and had more previous instances of drowsy driving. Compared to drivers in nonsleep-related crashes, they had been driving for longer times, been awake more hours, slept fewer hours the night before, and were more likely to have used soporific medications.

### Cell Phone Use and Driving

The popularity and increased use of cell phones, especially while driving, has raised the concern that this behavior is a cause of many road crashes. Epidemiological studies based on data obtained from insurance claims, police-reported collisions, cell phone companies, and violations have examined the risk of cell phone use and crashes. Drivers using cell phones had a higher risk of an at-fault crash than did nonusers. Cell phone users also had a higher proportion of rear-end collisions. The violation pattern of cell phone users suggests that they are, in general, riskier drivers. A study by Nabeau in 2003 showed the relative risk of all accidents and of accidents with injuries is higher for users of cell phones than for nonusers. The relative risk for injury from a collision was 38% higher among men than women cell phone users. However, this risk diminishes to 1.1 for men and 1.2 for women after controlling for other variables, such as the kilometers driven and driving habits. The most significant finding regarding cell phone use was the association of a dose–response relationship between the frequency of cell phone use and crash risks. The adjusted relative risk for heavy users is at least twice that of those making minimal use of cell phones; the latter show similar collision rates as do the nonusers.

## See Also

**Road Traffic, Determination of Fitness To Drive:** Sobriety Tests and Drug Recognition; General; **Road Traffic, Global Overview of Drug and Alcohol Statistics**

## Further Reading

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