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Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Safety Research and Analysis Report - B2006/0169

Final

Accidents and Incidents Involving Alcohol and Drugs in Australian Civil Aviation

1 January 1975 to 31 March 2006

Dr David G. Newman

MB, BS, DAvMed, PhD, MRAeS, FAICD, AFAIM

Consultant in Aviation Medicine

Flight Medicine Systems Pty Ltd

June 2006

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EXECUTIVE SUMMARY

Drug and alcohol use in pilots can have a detrimental impact on aviation safety. Important cognitive and psychomotor functions necessary for safe operation of an aircraft can be significantly impaired by drugs and alcohol. The purpose of this study was to determine the prevalence and nature of drug and alcohol-related accidents and incidents in Australian civil aviation. A search of the Australian Transport Safety Bureau's accident and incident database was conducted for all occurrences in which drugs or alcohol were recorded between 1 January 1975 and 31 March 2006. There were 36 drug and alcohol-related events (31 accidents and five incidents). The majority of these occurrences were related to alcohol (22 occurrences). The drugs identified included prescription drugs, over-the-counter medications and illegal drugs (including heroin and cannabis). Drug and alcohol events accounted for only 0.02 per cent of all the occurrences listed on the Australian Transport Safety Bureau's database. Drug and alcohol-related accidents accounted for 0.4 per cent of all accidents. Furthermore, 89 per cent of drug and alcohol occurrences resulted in an accident, with the proportion of these 32 occurrences that resulted in an accident quite high, at 86.5 per cent. Fatal accidents accounted for 67 per cent of all drug and alcohol occurrences. The results of this study show that the prevalence of drug and alcohol-related accidents and incidents in Australian civil aviation is very low, but that the related accident and fatality rates are high. The planned introduction of a mandatory drug and alcohol testing program into the Australian civil aviation industry will provide a more prescriptive approach to the issue of drug and alcohol use in pilots. Education and training remain important elements of an overall approach to reducing the significant impact of drug and alcohol use on flight safety.

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ABBREVIATIONS

ATSB	Australian Transport Safety Bureau
CASA	Civil Aviation Safety Authority
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
US	United States

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1 INTRODUCTION

While the use of drugs and alcohol is common in modern society, such use in the aviation industry can have a detrimental impact on overall system safety. Flying is a complex, demanding and challenging activity, requiring high levels of skill, psychomotor ability and cognitive function. The significant performance impairments associated with drug and alcohol use are well recognised. It is these impairments, especially of cognitive and psychomotor functions and abilities, which can adversely affect flight safety (see references 12, 23, 32, 42, 48, 50, 57, 59, 74, 80-82).

Most countries, including Australia, have regulations that govern the use of drugs and alcohol in aircrew. Despite this, there have been several well-publicised instances where pilots have attempted to fly or have actually done so while under the influence of various drugs or alcohol (5, 6, 16, 69). The use of alcohol and drugs by pilots has been implicated as a causal or contributory factor in aviation accidents, including some involving passenger-carrying airliners overseas (57, 67).

The purpose of this study was to determine the prevalence and nature of drug and alcohol-related accidents and incidents in Australian civil aviation, and to compare this information with other published international experience.

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2 METHODOLOGY

2.1 Data sources

A comprehensive search of the accident and incident database held and managed by the Australian Transport Safety Bureau (ATSB) was conducted. The search period was 1 January 1975 to 31 March 2006. The database was searched for accidents and incidents in which either alcohol or drugs (licit or illicit) were detected post-mortem or believed to have been significant causal or contributory factors in the occurrence.

The ATSB database records events according to occurrence type in accordance with the *Transport Safety Investigation Act 2003*. The occurrence types searched were accidents, serious incidents and incidents. The ATSB definition of an accident is "an investigable matter involving a transport vehicle where: (a) a person dies or suffers serious injury as a result of an occurrence associated with the operation of the vehicle; or (b) the vehicle is destroyed or seriously damaged as a result of an occurrence associated with the operation of the vehicle; or (c) any property is destroyed or seriously damaged as a result of an occurrence associated with the operation of the vehicle."

A serious incident is an occurrence involving circumstances indicating that an accident nearly occurred. According to International Civil Aviation Organization (ICAO), the difference between an accident and a serious incident is essentially in terms of the end result. An incident is defined as all other investigable and reportable matters where safety was potentially affected.

2.2 Method of analysis

The collected data was then tabulated in a commercially-available spreadsheet program and analysed. For each event, the following parameters were recorded: occurrence date, occurrence type, aircraft type (manufacturer and model), nature of operations, pilot licence held, pilot experience (total flying hours, command hours and hours on type), injuries sustained, occurrence outcome, and type of drug present.

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3 RESULTS

The ATSB database, for the search period 1 January 1975 to 31 March 2006, comprised an all-cause and all-classification total of 8,302 accidents, 95 serious incidents, and 151,941 incidents, giving an overall occurrence total for the study period of 160,338 events.

3.1 Drug and alcohol-related events by occurrence type

In terms of occurrences involving drugs and alcohol, there were 36 occurrences for the study period. Of these 36 events, 31 were classed as accidents, none as a serious incident and five as incidents. These figures are shown in table 1.

Table 1: Drug and alcohol-related events by occurrence type

Occurrence type	Alcohol	Drugs	Total number
Accident	17	14	31
Serious incident	0	0	0
Incident	5	0	5
Total	***22***	***14***	***36***

3.2 Drug and alcohol-related events by operation type

Table 2 shows the type of air operations being conducted for each event. The majority of these events occurred in private flying operations (61 per cent). The next most common was agricultural operations, at 11 per cent. However, most types of air operations are represented. No drug and alcohol occurrences were seen in the airline operations category.

Table 2: Drug and alcohol-related events by operation type

Operation type	Number	Percentage of total
Agriculture	4	11%
Business	1	3%
Charter	3	8%
Flying training	2	6%
Other aerial work	3	8%
Private	22	61%
Sport aviation	1	3%
Total	***36***	***100%***

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3.3 Drug and alcohol-related events by aircraft type

Table 3 shows the aircraft types involved in these events: 56 per cent involve less complex single-engine aircraft typically used for flight training and private operations. Three helicopters were involved – these were also less complex types used in training, private operations and some forms of aerial work. Twenty-four different aircraft types from 12 different aircraft manufacturers are represented in the study period.

Table 3: Aircraft types involved[1]

Manufacturer	Aircraft type	Number
Air Tractor Inc	AT-802	1
American Aircraft Corp	AA-5A	1
Beech Aircraft Corp	A23	1
Beech Aircraft Corp	A36	1
Beech Aircraft Corp	B55	1
Beech Aircraft Corp	58	1
Beech Aircraft Corp	76	1
Bell Helicopter Co	47	1
Benson	Gyroplane	1
Cessna Aircraft Company	150	1
Cessna Aircraft Company	152	2
Cessna Aircraft Company	172	8
Cessna Aircraft Company	182	1
Cessna Aircraft Company	A185	2
Cessna Aircraft Company	A188	1
Cessna Aircraft Company	210	3
De Havilland Aircraft	DH-82A	1
Gippsland Aeronautic Pty Ltd	GA-200	1
Government Aircraft Factories	N24	1
Hughes Helicopters	269	1
Partenavia Costruzioni Aeronautiche SPA	P68B	1
Piper Aircraft Corp	PA-28	1
Piper Aircraft Corp	PA-32	1
Robinson Helicopter Co	R22	2
Total		***36***

1 Beech Aircraft Company became a subsidiary of Raytheon Company in 1980. Hence, Beech Aircraft Corp may also be referred to as Raytheon.

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3.4 Highest injury outcome

Table 4 shows the breakdown of highest injury level sustained in these 36 events. In the majority of cases, the highest injury outcome was a fatality. Serious and minor injuries accounted for less than 9 per cent of the total occurrences. No injuries at all were reported in nine occurrences, all of which were related to alcohol.

Table 4: Highest injury outcome

Injury level	Number	Percentage of total
Fatal	24	66.7%
Serious	1	2.8%
Minor	2	5.5%
Nil	9	25.0%
Total	***36***	***100%***

Several of the occurrences involved pilots operating aircraft with one or more passengers involved. While there were 24 fatal occurrences, a total of 46 fatalities were recorded in these events. The following case is an example of such an event. The pilot of a privately-operated Beech Bonanza A23 and the three passengers had apparently spent the afternoon drinking alcohol at a hotel. Afterwards, they departed in the aircraft and attempted a low-level fly-past over the town. They struck a cow during this manoeuvre, and subsequently crashed. All four occupants received fatal injuries.

In some of the cases where no injuries were reported, it was only an element of luck that prevented a fatal accident. An example of this is the case of a Cessna 172 pilot who was detained by the police after landing and found to have a blood alcohol concentration of 0.285 per cent.

Table 5 shows the breakdown of occurrence pilots by the type of flight crew licence held. Fourteen pilots held commercial licences (including one with a senior commercial licence), and 14 held private pilot licences. In four cases the occurrence pilot held no licence at all. In one example of such an event, a Cessna 210 was stolen by a 16 year old who had never received any formal flying training. The aircraft crashed shortly after becoming airborne, killing the sole occupant on board, who was subsequently found to have been under the influence of alcohol.

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3.5 Highest class of licence held

Table 5: Highest class of licence held

Licence held	Number	Percentage of total
Commercial	14	38.9%
Private	14	38.9%
Student	2	5.6%
None	4	11.0%
Unknown	2	5.6%
Total	***36***	***100%***

The pilots involved in the alcohol-related accidents had an average total flight time of 578 hours, an average total command flight time of 495 hours and an average time on type of 295 hours. The pilots involved in the drug-related accidents had an average total flight time of 2,988 hours, an average total command flight time of 1,997 hours and an average time on type of 815 hours. With both groups combined, the average total flight time was 1,702 hours, the average total command flight time was 1,587 hours and the average time on type was 555 hours.

3.6 Identified drugs by class

In terms of the different drugs found in the drug-related occurrences, there was no single drug type that predominated. The drugs identified (by class) are shown in table 6.

Table 6: Identified drugs by class

Drug class	Example
Agricultural chemicals	Not specified
Analgesics	Dextropropoxyphene, Paracetamol
Antihistamines	Doxylamine
Cardiovascular drugs	Verapamil, Atenolol, Analopril
Decongestants	Pseudoephedrine
Opiates	Morphine, Heroin
Psychostimulants	Amphetamine
Recreational drugs	Cannabis
Sedatives	Diazepam
Steroids	Nandrolone, Stanozolol

This table shows that both legal and illegal drugs were identified in these occurrences. The agricultural chemicals case involved a Bell 47 helicopter engaged in crop spraying activities. The helicopter crashed as a result of a wire-strike.

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In the two accidents in which simple analgesics were found, they do not appear to have been directly contributory to the accidents. One involved a low level flight in a Cessna 210, which clipped trees and subsequently crashed. The other involved a Cessna 152, which failed to return from a training flight. It was later found crashed in bushland.

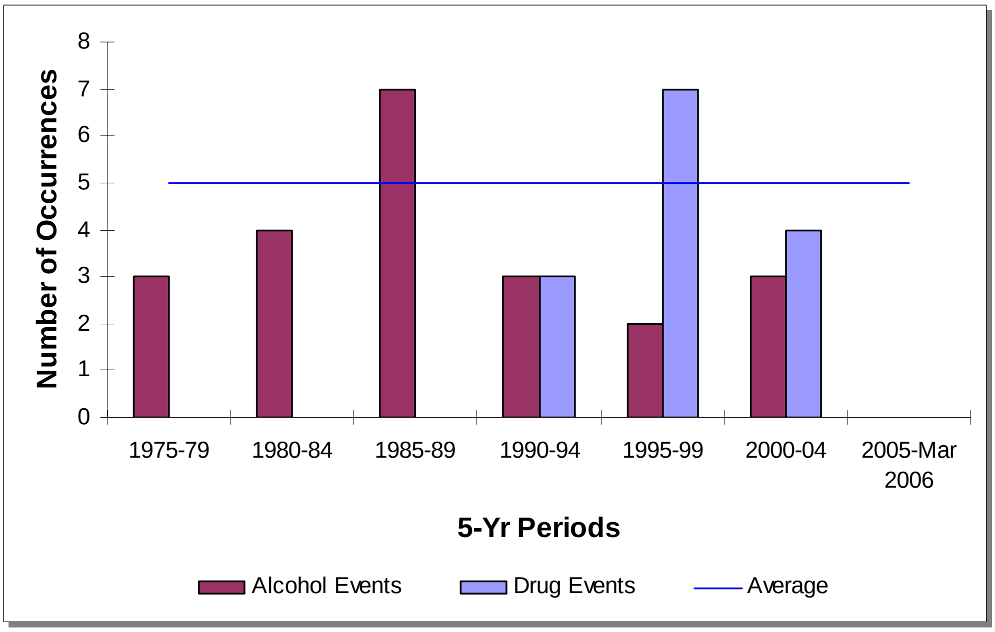
The accident pilot, in whom antihistamine was found, had been engaged in an aerobatic flight when collision with the ground occurred. No mechanical factor was found to be responsible for the accident. Similarly, the fatal accident in which a decongestant agent was found in the pilot involved a fixed-wing crop-spraying aircraft, which collided with powerlines.

The cannabis-positive case involved a Piper Cherokee Six, which crashed shortly after departing Hamilton Island, Queensland, with the resultant deaths of the pilot and all five passengers. The pilot in the case where steroids were detected was also positive for amphetamine. The pilot was flying a Partenavia P68 with one passenger on board, and collided with rising terrain while carrying out an instrument approach. Both pilot and passenger received fatal injuries.

3.7 Drug and alcohol-related events by 5-year periods

Figure 1 shows the incidence of these occurrences in 5-year epochs across the study period. The majority of the reported occurrences in the study period were in the 1995 to 1999 period. The combined average number of drug and alcohol-related occurrences per 5-year epoch is five (shown on the graph). The 2005 to 31 March 2006 epoch represents an incomplete 5-year period, but no events were recorded for either drugs or alcohol in this period. Interestingly, no drug-related events were recorded in the ATSB database until the 1990 to 1994 period. This may reflect differences in, or changes to, the manner in which reports are entered into the ATSB database during the entire study period.

Figure 1: Drug and alcohol-related events by 5-year periods and combined drug and alcohol-related average



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4 DISCUSSION

The results of this study show that the prevalence of drug and alcohol-related accidents and incidents in Australian civil aviation is very low. The database search yielded only a small number of results: 36 cases out of a total occurrence number of 160,338 (which is a rate of only 0.02 per cent). However, as a proportion of the total number of accidents for the study period, drug and alcohol occurrences accounted for 32 out of 8,302 accidents, or a prevalence of 0.4 per cent. Furthermore, the proportion of the 36 drug and alcohol occurrences that resulted in an accident is quite high, at 88.9 per cent. Thus, while the prevalence of drug and alcohol-related occurrences overall is very low, the accident and fatality rates in such occurrences are high. The results show that during the period 1 January 1975 and 31 March 2006 there was an average of five drug and alcohol events per five-year period, or about one event per year.

While a comprehensive review of the various pharmacological, physiological and psychological effects of various drugs is beyond the scope of the present study, it is worth briefly considering some of the adverse effects of alcohol and some of the more common drugs. Recent research in Australia has extensively reviewed the effects on pilot performance of alcohol and cannabis (64, 65).

Alcohol is the most widely used and abused drug in the Western world (41, 57). Alcohol has global effects on the brain and body. It can impair cognitive function, including information processing, decision-making, memory, attention, perception and reasoning, all of which can lead to increased risk-taking behaviour and inappropriate decision-making (30, 40, 49, 56, 57, 61, 64, 66, 68). Alcohol can also adversely affect balance, visual function and psychomotor performance (33, 46, 49, 62-64, 68). The performance of any demanding psychomotor task, such as flying an aircraft, is significantly impaired by the effects of alcohol (30, 63). The residual effects of alcohol can also affect performance (63, 67, 78).

Alcohol use in pilots and its consequences have been reported in many studies (25, 32, 54). The deterioration of flying skills with alcohol use has been well demonstrated in a number of studies (1, 10-12, 21-24, 26, 28, 39, 70, 74, 80, 81). Importantly, pilots are often unaware of their own performance impairment (59, 63, 64). Alcohol use and abuse in pilots is counterproductive to enhancing flight safety.

The prevalence of alcohol in aviation accidents has been the focus of much research, (2, 7, 13, 17-19, 27, 36, 47, 52, 58, 71, 76, 77, 83). The consistent finding in these studies is that 7 to 10 per cent of fatal general aviation accidents are a consequence of alcohol use by the pilot (18, 52, 64).

The prevalence of cannabis use has increased in recent years (4, 29, 50, 65). Cannabis is generally taken for its so-called “high,” a feeling of relaxation and euphoria. It can also produce severe anxiety, panic, paranoia and psychosis (4, 34, 35). Sensory perceptions, emotions and time can be altered (4, 35). Cannabis can also adversely affect the cardiovascular system, the eyes, general psychomotor performance, memory, attention and coordination (4, 8, 9, 15, 35, 37, 38, 43, 48, 65). There is also evidence that there is a residual effect of cannabis that can persist for up to 24 hours (4, 37, 48, 82). Chronic cannabis use is associated with a number of adverse health effects, including tolerance, a withdrawal syndrome, cognitive impairment, cancers and chronic respiratory problems (4, 35, 43, 45, 65).

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Cannabis use in pilots is associated with a general deterioration in flying skills and performance, while the pilot may be unaware of their level of impairment (42, 48, 55, 82,). A common finding is that the more difficult the task, the more likely that pilot performance will be impaired (65). Cannabis use in pilots therefore poses a considerable risk for flight safety.

Opiates form a group of narcotic analgesic agents, used for severe pain control (3, 15, 20, 53, 79). They include morphine, codeine and the illicit drug heroin. In addition to pain relief, opiates can cause sedation, slowed reflexes, sluggish movements, a reduced drive to breathe, cold skin, and possible vomiting. Tolerance, addiction, overdose and withdrawal can all occur. Heroin is a very strong opiate agent. In addition to the effects seen earlier, heroin can cause poor coordination, clouded mental function, impaired reasoning and reduced alertness (15, 75).

Amphetamines are psychostimulant drugs that can cause a wide spectrum of effects (15, 31). In general terms, they stimulate the release of adrenaline, which leads to cardiovascular changes, increased energy, restlessness, as well as nervousness, anxiety and irritability. Psychotic episodes following amphetamine use have been reported, and these can include symptoms such as paranoia, hallucinations, aggression and impulsive behaviour. Tolerance, addiction and fatal overdose have all been well established with amphetamine use (15, 31). Amphetamine use has been linked to a fatal aviation accident in the United Kingdom (13, 23).

Cocaine is an extremely addictive drug (15). It causes euphoria, increased energy and enhanced sensations. High doses of cocaine can produce bizarre and sometimes violent behaviour. Other effects include tremors, dizziness. Cardiovascular complications can include heart rhythm disturbances, heart attack and sudden cardiac death. Tolerance, addiction, and overdose are all associated with cocaine use.

It is useful to compare the results of the present study with the results from other investigations into the prevalence of drug and alcohol-related accidents and incidents. This would at the very least help put the Australian experience as it stands now into some international perspective. The most recent data from the United States (US) Federal Aviation Administration (FAA) involved an analysis of 3,235 fatal aviation accidents in the US (14, 44, 51). This group of studies examined the prevalence of marijuana, cocaine and methamphetamine in pilots. The researchers found an overall low prevalence of positive cases for these three drugs among the total aviation fatalities – 74 cases positive for cannabis, 24 for cocaine and 17 for methamphetamine. For each of the three drugs, the presence of the drug was a causal factor in 32 per cent of the marijuana cases, 38 per cent of the cocaine cases, and 70 per cent of the methamphetamine cases. Significantly, a large number of the positive cases also tested positive for a number of other drugs.

Morsy et al examined the results of pre-employment drug screening in Egyptian flight crews (60). The drugs screened for included cannabis, opiates, benzodiazepines (sedatives such as Diazepam) and cocaine. They found that 1.5 per cent of females and 2.5 per cent of males tested positive to either benzodiazepines (one case) or cannabis (the remainder).

Soper et al looked at female pilot fatalities and the toxicological results between 1990 and 2004 in the US (73). They found that 3 per cent of the females tested positive for alcohol, 12 per cent were positive for prescription medications and 20 per cent were positive for non-prescription medications. In overall terms, their

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results showed that female pilots were taking medications at almost twice the rate of male pilots.

Soper also examined the prevalence of a typical antihistamine agent in fatal aviation accidents (72). This drug is a commonly used, non-prescription medication for treating the symptoms of allergies or upper respiratory tract infections. Their results indicated that one commonly available type of antihistamine was present in 42 per cent of the 111 fatalities that were positive for some form of antihistamine. This equates to 2.2 per cent of all the pilot fatalities in their study population.

In a recent study, the toxicological findings of 1,587 fatal civil aviation accidents were reviewed (19). Fifty-two per cent of these accidents involved a pilot who was positive for drugs or alcohol. Alcohol was found in 6.4 per cent, and non-prescription drugs in 16.3 per cent. In terms of illegal drugs such as cannabis, cocaine and amphetamines, 6.4 per cent were positive. This is an increase over their previous two studies (17, 18). Many of the drugs found at post-mortem had the potential to impair performance. The authors concluded that the results of this and their previous studies supported the FAA's ongoing efforts to reduce the use in pilots of such performance-impairing drugs.

The presence of an agricultural chemical in a pilot's body involved in an agricultural spraying operation might not be unexpected. While the investigation of the accident in this present study found there was no evidence to indicate that the pilot's performance was degraded by physiological factors, the case highlights the potential risk to the health of aircrew handling agricultural chemicals in this setting.

In two cases, simple analgesics were found in accident pilots. This is perhaps not unexpected, given the wide use of these substances. These drugs in themselves are not incompatible with flying, but in certain circumstances the reason for taking the medication may be incompatible with the flying task. The use of antihistamines implies either hay fever, motion sickness or a cold. The particular antihistamine found in the accident pilot in this study is a sedating one, which could possibly have led to some form of pilot impairment. Decongestant use in a pilot implies the presence of symptoms of upper respiratory tract infection (the common cold). A cold is not compatible with flying, due to the increased risk of hypoxia, spatial disorientation, fatigue and the general feeling of malaise associated with it. A pilot flying with a cold may well have some performance impairment due to these factors.

The presence of drugs such as heroin, cannabis and steroids is a cause for some concern. All of these drugs have significant potential performance-impairing effects. Morphine is a strong analgesic agent, and has a number of side-effects, including sedation. Morphine use implies significant underlying pain and possibly injury, either of which might be incompatible with flight. One of the accidents in which morphine was discovered involved a Robinson R22 helicopter on a cattle-mustering operation at a remote station. The pilot lost directional control of the helicopter after a significant lateral shudder developed. Both the pilot and the passenger survived the crash, but the pilot later died as a result of the injuries sustained. It is highly probable that the presence of morphine in the blood of the pilot found at post-mortem was a result of medical treatment for his injuries, rather than prior personal use. This phenomenon has been discussed by other researchers, where the presence of narcotic analgesics was attributed to health care providers at the scene of the accident administering the drugs as part of first aid and resuscitation efforts (19).

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The use of anabolic steroids such as nandrolone and stanozolol is problematic in pilots. Steroid rage and the various cognitive impairment issues that can occur as a result of the use of these substances are incompatible with flying. In the present study, the finding of a case where heroin was detected in a pilot is a major cause for concern.

The various cardiovascular drugs found in this study are usually used to treat chest pain and high blood pressure. It is possible that the three pilots involved in these accidents were being treated for these conditions, and may have been well-controlled and their condition known to the Australian Civil Aviation Safety Authority (CASA). This information is not readily available, for the purposes of this study. Analysis of the three accidents shows that two resulted from unsuccessful attempts to recover from low-level loss of control incidents, and the other involved a collision with powerlines. In all three events the pilots were killed. It is not known whether their medical conditions played any role in the accidents, but in all three cases pilot incapacitation was not recorded as a significant factor.

It is important here to discuss some of the methodological limitations of this study. There is currently no drug and alcohol testing program in the Australian civil aviation industry. However, an extensive review by the Department of Transport and Regional Services and CASA of the safety benefits of a drug and alcohol testing program for the Australian aviation industry has been conducted and the final report was released earlier in 2006. Following on from this report, the Minister for Transport and Regional Services has announced the planned introduction of a mandatory drug and alcohol testing program for aviation safety-sensitive personnel[2].

The report made a number of recommendations as to how this process could work. However, there are a number of issues yet to be resolved before the system is put in place. Nonetheless, in the very near future Australia will no doubt adopt some form of mandatory drug and alcohol testing program.

The absence of such a program during the study period means that the data in this study probably represented an under-reporting of the prevalence of drug and alcohol use in pilots. Given the prevalence of drug and alcohol use in the general community, it is likely that a higher proportion of pilots use alcohol and drugs than is indicated by the data available from accident and incident investigations. The current reporting requirements for aviation safety occurrences means that drugs and alcohol are only examined for at post-mortem, rather than on suspicion or at random. The result of this is that a drug or alcohol-affected pilot who does not have an accident or serious incident is not likely to be tested for the presence of drugs and alcohol. Thus, to a large extent, the true prevalence of drug and alcohol use and misuse in Australian civil aviation remains largely unknown.

The US has had a drug testing program since 1989, with alcohol testing added in 1995. The overall proportion of positive drug tests in the US program is less than 1 per cent (23).

Once the mandatory drug and alcohol testing program is in place in Australia and has been operating for a period of time, it would be a very useful exercise to repeat

2 The Minister for Transport and Regional Services media release can be found at http://www.ministers.dotars.gov.au/wtr/releases/2006/May/056WT_2006.htm

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the current study and look again at the prevalence of positive tests for drugs and alcohol in Australian civil pilots. This would not only serve to examine the effectiveness of such a program, but would also give a clearer idea of the scale of the problem (particularly in the early years of its introduction). Additionally, it would provide a better basis for comparison with the results of other countries operating similar testing programs, such as the US.

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5 CONCLUSIONS

The results of this study show that the prevalence of drug and alcohol accidents and incidents is very low in Australian civil aviation. However, where alcohol and drugs are involved, there is a very high chance of an accident, especially a fatal one. The results of this study are consistent with other international experience. The planned introduction of a mandatory drug and alcohol testing program into the Australian civil aviation industry will provide a more prescriptive approach to the issue of drug and alcohol use in pilots. Education and training remain important elements of an overall approach to maximising pilot performance and reducing the significant impact of drug and alcohol use on flight safety. Such education will help ensure that pilots do not attempt to fly under the performance-impairing influence of drugs or alcohol.

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