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Prevalence of Drugs and Alcohol in Fatal Civil Aviation Accidents Between 1994 and 1998

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16. Abstract

The use of drugs and alcohol in aviation is closely monitored by the FAA Office of Aviation Medicine's (OAM's) Civil Aeromedical Institute (CAMI) through the toxicological analysis of specimens from pilots who have died in aviation accidents. This information on the use of drugs in aviation is helpful to the FAA in developing programs to reduce the usage of dangerous drugs and identify potentially incapacitating medical conditions that may cause an accident. Data collected from this research can be used to evaluate the effectiveness of the FAA drug testing program. The toxicology reports prepared by the CAMI Forensic Toxicology Research Section are used by the FAA and the National Transportation Safety Board to determine the cause of aviation accidents. Specimens (blood, urine, liver, kidney, vitreous fluid, and other bodily specimens) were collected by pathologists near the accident and placed in evidence containers provided by CAMI. These samples were refrigerated and shipped by overnight air. Upon receipt, the specimens were inventoried and accessioned for the analysis of drugs, alcohol, carbon monoxide, and cyanide. All data collected by the laboratory were entered into a computer database for future analysis. The database was searched using a Microsoft Access TM program developed by a local contractor. The database was sorted based on the class of drug, controlled dangerous substance schedules I and II, controlled dangerous substance schedules III-V, prescription drugs, over-the-counter drugs, and alcohol. The Toxicology and Accident Research Laboratory received specimens from 1683 pilots for postmortem toxicology analysis between 1994 to 1998. Controlled dangerous substances, CDS, (schedules I and II) were found in 89 of the pilots analyzed. Controlled dangerous substances (schedules III - V) were found in 49 of the pilots tested. Prescription drugs were found in 240 of the pilots analyzed. Over-the-counter drugs were found in 301 of the pilots analyzed. Alcohol at or above the legal limit of 0.04% was found in 124 pilots. The number of positive drug cases has doubled over the past 5 years. Over-the-counter medications are the most frequently found drugs in fatal aviation accidents and many of these drugs, or the medical conditions for which they are being used, could impair a pilot's ability to safely fly an aircraft. The increased number of positive cases found in this research is most likely the result of improved methods of analysis, rather than an increase in the use of drugs. The low incidence of CDS III-V drugs found in fatal aviation accidents may be a result of the difficulty in finding and identifying the new benzodiazepines commonly prescribed in this class.

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Prevalence of Drugs and Alcohol in Fatal Civil Aviation Accidents Between 1994 and 1998

INTRODUCTION

The Federal Aviation Administration's Office of Aviation Medicine is tasked with determining the fitness of pilots to fly. The use of certain drugs and specific medical conditions are strictly controlled to assure the safety of the pilot and the general public. Part of this responsibility includes enforcement of alcohol and drug use regulations (1). The Civil Aeromedical Institute (CAMI), Office of Aviation Medicine (OAM), Federal Aviation Administration (FAA), is required under Public Law 100-591[H.R.4686] (2) to help assess the role of potential medical or drug related pilot impairment in aviation accidents. The Department of Transportation (DOT) Order 8020.11 (3) requires CAMI to "conduct toxicological analyses on specimens from, and special pathologic studies on, aircraft accident fatalities" (5). This includes the identification of abused drugs such as cocaine, amphetamines, and benzodiazepines; or prescription drugs such as cardiovascular and neurological medications. This research reports the findings of these tests.

Under the cooperative efforts of the FAA and NTSB, specimens from the pilots who were fatally injured in aviation accidents were analyzed for drugs and alcohol as part of the investigation into the cause of the accidents. Analysis for the presence of drugs in body fluids and tissues of pilots in these fatal accidents was used to assist in the determination of accident causation, and whether impairment from drug use or a medical condition caused or contributed to the accident.

MATERIALS AND METHODS

Specimens (blood, urine, liver, kidney, vitreous fluid, and other body specimens) from fatal aviation accidents were collected and placed in specially designed evidence containers provided by CAMI. These samples were refrigerated and shipped by overnight air. Specimens prepared according to the instructions were maintained at approximately 4° to 6° C for 48 hours. Upon receipt at CAMI, the specimens were inventoried and accessioned for the analysis of drugs, alcohol, carbon monoxide, and cyanide. Specimens were screened for drugs of abuse by immunoassay and any positives were confirmed by gas chromatography (GC)/mass spectroscopy (MS). Specimens were screened for prescription and over-the-counter medications using a variety of analytical procedures including: immunoassay, high performance liquid chromatography (HPLC), and GC/MS. Confirmation of positives in these classes was done by GC/MS, GC/FTIR, HPLC/MS^n or by a different analytical procedure than that used in the initial screening. The total number of drugs reported in this research does not include caffeine or nicotine. Alcohol was identified and quantitated in blood, vitreous fluid, urine and tissues using headspace gas chromatography. All positive alcohols in blood, vitreous fluid, and urine at or above 20mg/dL were confirmed using fluorescence polarization immunoassay (FPIA). Only cases with ethanol at or above 0.04% were reported in this study due to the FAA regulations forbidding the operation of an aircraft by a pilot with a blood ethanol reading at or above 0.04% (40mg/dL). All data collected by the laboratory were electronically entered into a computer database for future analysis. The results of these tests can be seen in Tables 1 through 6

RESULTS AND DISCUSSION

Data from 1994 to 1998 was compared with an earlier 5-year study for the years 1989 to 1993 (4) to determine changes in the incidents of drug use in pilots. The Toxicology and Accident Research Laboratory received specimens from 1683 fatally injured pilots for postmortem toxicology analysis from 1994 to 1998 (Table 1), which is less than the 1845 (Table 2) cases reported for 1989 to 1993 (4). This is a 9% reduction in the number of fatal aviation accidents received by the laboratory between the two 5-year

Table 1. Fatal Aviation Accidents with Drugs and Alcohol

Year	C1	C1%	C3	C3%	Rx	Rx%	OT	OT%	Al	Al%	Fatal
1994	23	7.0	6	2.0	34	10.0	60	17.0	24	7.0	346
1995	16	5.0	16	5.0	53	15.0	68	19.0	14	4.0	350
1996	18	5.0	12	4.0	51	15.0	59	18.0	27	8.0	334
1997	21	7.0	10	3.0	50	15.0	64	20.0	29	9.0	323
1998	11	3.0	5	2.0	52	16.0	50	15.0	30	9.0	330
Total	89	5.0	49	3.0	240	14.0	301	18.0	124	7.0	1683

C1 = Controlled Dangerous Substance Schedules I and II
Marihuana, Cocaine, etc.
C3 = Controlled Dangerous Substance Schedules III-V
Diazepam, Phentermine, etc.
Rx = Prescription Drugs
Amitriptyline, Imipramine, etc.
OT = Over-the Counter-Medications
Pseudoephedrine, Acetaminophen, etc.
Al = Alcohol levels equal to or greater than 0.04% (40.0mg/dL)
The values included in this tabulation incorporate cases in which the source of the alcohol is both known and unknown.
Fatal = Fatal pilots only

Table 2. Fatal Aviation Accidents With Drugs and Alcohol

Year	C1	C1%	C3	C3%	Rx	Rx%	OT	OT%	Al	Al%	Fatal
1989	8	2.3	7	2.0	7	2.0	24	6.9	28	8.0	349
1990	14	3.8	5	1.4	24	6.5	32	8.7	29	7.9	367
1991	22	5.7	3	0.8	24	6.2	42	10.8	30	7.7	389
1992	17	4.3	3	0.8	24	6.0	52	13.0	29	7.3	400
1993	13	3.8	10	2.9	31	9.1	57	16.8	30	8.8	340
Total	74	4.0	28	1.5	110	6.0	207	11.2	146	7.9	1845

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periods. For 1994-1998 controlled dangerous substances (CDS, schedules I and II) were found in 89 (5%) of the pilots analyzed, which is a 25 % increase over the cases received between 1989 and 1993. The present procedure used to screen and confirm CDS I and II drugs is the same procedure used from 1989 to 1993 and this 25% increase does appear to be a real increase in the use of CDS I and II drugs. Controlled dangerous substances (schedules III - V) were found in 49 (3%) of the pilots tested, an increase of 48% over the earlier study (4). New screening methods were adopted in 1994 to detect CDS III-V drugs using HPLC/UV/FL and this could be the cause of the increased number of positive CDS III-V drugs detected. Prescription drugs were found in 240 (14%) of the pilots analyzed. This constitutes an increase of 58% for prescription drugs over the original 5-year study (4). Methods have been implemented that did not exist between 1989 and 1993 to detect prescription drugs. This could account for the increased number of prescription drugs found between 1994 and 1998. Over-the-counter (OTC) drugs were found in 301 (18%) of the pilots analyzed which constitutes an increase of 37% from the OTC drugs detected between 1989 to 1993. The methods used to screen and confirm OTC drugs have not changed over the past 10 years and the increased number of positives could be the result of an increased use of these drugs by pilots. Alcohol at or above the upper limit of 0.04% for pilots was found in 124 (7%) cases. No change was observed in the positive rate for alcohol between 1994 and 1998, compared with the positive cases found between 1989 and 1993. The reported positive alcohol increase does not differentiate between ingested and postmortem alcohol (5). In 1995 the number of positive alcohols dropped from the normal 8% positive alcohols to 4%. This low positive rate only lasted for 1 year and returned to the normal 8% in 1996. There is no clear-cut explanation for the drop in 1995. One possible explanation could be the implementation of the DUI/DWI rule, which required the FAA to check for DUI/DWI convictions of pilots and to take action to suspend medical certificates where necessary. This rule was enacted in 1991, but full implementation did not occur until about 1993.

The actual drugs identified in this study are listed in Table 3. Some drugs, such as antihistamines, included in a given category may also be available in another category. Multiple drug positives were found in several of the cases. It should be noted that drugs in Table 3 are classified based on the pure drug, and that some of these drugs may be classified differently, depending on the formulation of the drug.

Most airline transport and commercial pilots are subject to drug testing for the presence of marihuana, amphetamine/methamphetamine, morphine/codeine, cocaine, and phencyclidine (PCP). This study examined the positive drug rate based on the medical classification (Class 1, Class 2, or Class 3) of the pilot and the type of pilot certificate (A – Airline Transport, C – Commercial, O – Other). The percentage of pilots with positive CDS I-II drugs in a given medical class is within 1% of each other (Table 4). Controlled Dangerous Substances I-II were found in 9 (4%) of the 244 class 1 pilots compared with the 5% in Class 2 pilots and 6% in Class 3 pilots.

A Class 1 commercial pilot flying under CFR Part 91 (general aviation) was found to be taking cocaine; however, the 0.034 ug/mL found in urine is below the 0.150 ug/mL in urine cut off set under 49 CFR Part 40.29 (e). This pilot would have been classified as negative for cocaine under the FAA drug-testing program. The cause of the accident was reported by the NTSB to be pilot error.

Marihuana was found in 3 Class 1 commercial pilots, 1 Class 2 air transport pilot, and 10 Class 2 commercial pilots. The Class 2 airline transport pilot was flying under CFR Part 135 (air taxi and commercial) at the time of the crash. Marihuana is by far the most abused CDS drug found in commercial aviation. Morphine/Codeine was found in 1 Class 1 airline transport pilot, 3 Class 1 commercial pilots, 1 Class 2 airline transport pilot, and 3 Class 2 commercial pilots. The morphine detected in the Class 1 airline transport pilot is most likely from emergency medical treatment because other drugs, such as lidocaine, were also found that are typically used by emergency medical staff. The 0.140 ug/mL of morphine found in the urine of a Class 1 commercial pilot is below the cut-off for the FAA drug-testing program and would have been reported as negative.

Table 3. All Drugs Identified between 1994 and 1998

DRUG SCHEDULE	Drug	PILOTS CLASS 1	PILOTS CLASS 2	PILOTS CLASS 3	TOTAL PILOTS
CI and CII	Amphetamine/Methamphetamine	0	3	6	11
	Barbiturates	0	4	5	9
	Cocaine	1	3	8	13
	Codeine/Morphine	4	5	8	17
	Marihuana	4	17	21	43
	Methaqualone	0	0	0	0
	PCP	0	0	0	0
	Synthetic Opiates	0	4	6	10
CIII - CV	Benzodiazepines	3	8	18	33
	Fenfluramine	0	0	3	5
	Pentazocine	0	0	1	1
	Phendimetrazine	0	0	0	0
	Phentermine	0	0	4	7
	Propoxyphene/Norpropoxyphene	1	4	3	10
Rx	Amitriptyline/Nortriptyline	0	0	0	1
	Atenolol	1	2	9	13
	Azacyclonol	0	1	3	5
	Brompheniramine	0	2	5	7
	Carbamazepine	0	0	1	1
	Cimetidine	0	2	3	6
	Diltiazem	0	2	6	10
	Diphenhydramine	5	17	30	54
	Fluoxetine/Norfluoxetine	1	3	12	18
	Gemfibrozil	0	0	1	1
	Ibuprofen	1	4	3	9
	Imipramine/Desipramine	1	0	2	5
	Ketamine	0	0	1	1
	Lidocaine	4	10	14	32
	Metoprolol	0	3	1	5
	Minoxidil	0	1	0	1
	N-Acetylprocainamide/Procainamide	0	0	1	1
	Naproxen	0	1	4	7
	Nizatidine	0	1	1	2
	Phenytoin	1	3	4	9
	Promethazine	1	1	1	3
	Propranolol	1	0	2	3
	Sertraline/Desmethylsertraline	0	1	4	5
	Sildenafil (Viagra)/ Sildenafil Metabolite	0	1	0	1
	Theophylline	0	2	2	4
	Triamterene	0	3	4	7
	Verapamil/Norverapamil	2	5	10	18
OTC	Acetaminophen	14	31	35	81
	Chlorpheniramine/Norchlorpheniramine	5	15	24	44
	Dextromethorphan	2	8	8	18
	Dextrorphan/Nordextrorphan	3	1	4	8
	Doxylamine	2	6	7	15
	Ephedrine	4	21	21	47
	Guaiphenesin	0	1	0	1
	L-Methamphetamine	0	0	1	1
	Meclizine	0	1	0	1
	Melatonin	1	0	0	1
	Methylephedrine	0	0	1	1
	Naphazoline	1	0	0	1
	Oxymetazoline	0	1	1	2
	Phenylpropanolamine	9	35	37	82
	Pseudoephedrine	9	38	35	84
	Quinine	3	7	9	19
	Salicylates	11	42	61	114

Table 4. Fatal Aviation Accidents with Drugs and Alcohol 1994 to 1998

Class	C1	C1%	C3	C3%	Rx	Rx%	OT	OT%	Al	Al%	Fatal
1	9	4.0	4	2.0	18	7.0	36	15.0	11	5.0	244
2	31	5.0	12	2.0	69	11.0	118	19.0	43	7.0	610
3	46	6.0	25	3.0	136	18.0	144	19.0	64	8.0	762
Total	86	5.0	41	3.0	223	14.0	297	18.0	118.	7.0	1616

C1 = Controlled Dangerous Substance Schedules I and II
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Al = Alcohol levels equal to or greater than 0.04% (40.0mg/dL)
The values include in this tabulation incorporate cases in which the source of the alcohol is both known and unknown.
Fatal = Fatal pilots only

Table 5. Fatal Aviation Accidents with Drugs and Alcohol 1994 to 1998

14CFR	C1	C1%	C3	C3%	Rx	Rx%	OT	OT%	Al	Al%	Fatal
91	76	5.0	42	3.0	216	15.0	269	18.0	117	8.0	1474
135	4	5.0	1	1.0	5	6.0	8	9.0	4	5.0	87
121	0	0	0	0	0	0	0	0	0	0	6
137	6	11.0	3	6.0	6	11.0	12	22.0	1	2.0	54
133	0	0	0	0	1	14.0	1	14.0	0	0	7
Total	86	5.0	46	3.0	228	14.0	290	18.0	122	7.0	1628

C1 = Controlled Dangerous Substance Schedules I and II
Marihuana, Cocaine, etc.
C3 = Controlled Dangerous Substance Schedules III-V
Diazepam, Phentermine, etc.
Rx = Prescription Drugs
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Al = Alcohol levels equal to or greater than 0.04% (40.0mg/dL)
The values include in this tabulation incorporate cases in which the source of the alcohol is both known and unknown.
Fatal = Fatal pilots only

Table 6. Fatal Aviation Accidents Class 1 Levels A, C, P, S, and Y for 1994 to 1998

Class	A	A%	C	C%	P	P%	S	S%	Y	Y%	Total
1	131	53.9	93	38.3	15	6.2	3	1.2	1	0.4	243

A = Airline Transport Pilot
C = Commercial Pilot
P = Private Pilot
S = Student Pilot
Y = Private Pilot from Foreign Certificate
Fatal = Fatal pilots only

Amphetamine/methamphetamine was found in 2 Class 2 commercial pilots. One of the cases was a CFR Part 137 (agricultural) accident with methamphetamine and was also found to contain fluoxetine, an antidepressant. The drugs found in this case were judged an impairing factor in this accident by the NTSB. Methamphetamine and marihuana were found in another CFR Part 137 accident. The cause of this accident is still under investigation. The laboratory has never detected a positive PCP in specimens received from fatal aviation accidents. No pilot in a CFR Part 121 (Air Carrier) fatal aviation accident was found to be positive for drugs or alcohol (Table 5). It is difficult to assign any significance to this finding due to the small number of accidents (6) that occurred between 1994 and 1998. There were 87 CFR Part 135 accidents and 4 of the pilots from these accidents were found to have CDS I and II drugs. Of the 1683 pilots examined 131 pilots (8%) held a Class 1 medical and were classified as air transport and 93 (6%) were classified as Class 1 commercial pilot (Table 6). Only 1 (0.8%) of the 131 Class 1 air transport pilots was found to have CDS I-II drugs and this pilot was given morphine after the accident during emergency medical treatment. This agrees with the FAA drug testing program's findings that less than 1% of those tested under the random drug testing program are positive for abused drugs. Between 1990 and 1993 there were 4 (2.8%) out of 145 Class 1 air transport pilots found with CDS I-II drugs. One of these pilots flying Part 91 was using cocaine, 2 pilots flying CFR Part 91 were using marihuana, and 1 pilot flying CFR Part 135 was using morphine. These data indicate a drop in the use of abused drugs by Class 1 medical air transport fatal pilots over the past 10 years.

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