DOT/FAA/AM-05/20
Office of Aerospace Medicine
Washington, DC 20591

Epidemiology of Toxicological Factors in Civil Aviation Accident Pilot Fatalities, 1999-2003

Arvind K. Chaturvedi
Kristi J. Craft
Dennis V. Canfield
James E. Whinnery
Civil Aerospace Medical Institute
Federal Aviation Administration
Oklahoma City, OK 73125

November 2005

Final Report

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-05/20		

4. Title and Subtitle	5. Report Date
Epidemiology of Toxicological Factors in Civil Aviation Accident Pilot Fatalities, 1999-2003	November 2005
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Chaturvedi AK, Craft KJ, Canfield DV, and Whinnery, JE	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
FAA Civil Aerospace Medical Institute P.O. Box 25082 Oklahoma City, OK 73125	11. Contract or Grant No.

12. Sponsoring Agency name and Address	13. Type of Report and Period Covered
Office of Aerospace Medicine Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591	14. Sponsoring Agency Code

15. Supplemental Notes

This work was accomplished under the approved task AM-B-05-TOX-202.

16. Abstract

Prevalence of drug and ethanol use in aviation is monitored by the Federal Aviation Administration (FAA). Under such monitoring, epidemiological studies for the 1989–1993 and 1994–1998 periods indicated lower percentages of the presence of illegal (abused) drugs than that of prescription and nonprescription drugs in aviation accident pilot fatalities. In continuation of these studies, an epidemiological assessment was made for an additional period of 5 years. Postmortem samples from aviation accident pilot fatalities submitted to the FAA Civil Aerospace Medical Institute (CAMI) are toxicologically analyzed, and those analytical findings are stored in a database. This CAMI database was examined for the period of 1999–2003 for the presence of controlled substances of Schedules I–V, prescription and nonprescription drugs, and ethanol in the pilot fatalities. Out of 1629 fatal aviation accidents from which CAMI received biosamples, there were 1587 accidents wherein pilots were fatally injured. Drugs and/or ethanol were found in 830 of the 1587 fatalities. Controlled substances of Schedules I and II and Schedules III–V were detected in 113 and 42 pilots, respectively. Prescription drugs were present in 315 pilots, nonprescription drugs in 259 pilots, and ethanol in 101 pilots. Controlled substances of Schedules I and II were detected in only 5 of the 122 First-Class medical certificate-holding airline transport pilots. In addition to the controlled substances, many of the prescription and nonprescription drugs found in the fatalities have the potential for impairing performance, thereby adversely affecting the ability of an individual to optimally pilot an aircraft. Findings from this study were consistent with those of the 2 previous epidemiological studies and support the FAA's programs, including the FAA's drug-testing program, aimed at identifying potentially incapacitating medical conditions and reducing the usage of performance-impairing drugs or ethanol.

17. Key Words	18. Distribution Statement
Epidemiology, Toxicological Factors, Pilot Fatalities, Civil Aviation Accident Investigation	Document is available to the public through the Defense Technical Information Center, Ft. Belvior, VA 22060; and the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	17	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Epidemiology of Toxicological Factors in Civil Aviation Accident Pilot Fatalities, 1999-2003

INTRODUCTION

The Federal Aviation Administration's (FAA's) Office of Aerospace Medicine is tasked with determining the fitness of pilots to fly aircraft and enforcing related drug and alcohol use regulations (1,2). Under this task, specific medical conditions and the use of certain drugs and ethanol are strictly controlled to ensure the safety of the pilots and the general public. The 1988 Aviation Safety Research Act (1) and the U.S. Department of Transportation Order 8020.11B (3) require that the Office of Aerospace Medicine's Civil Aeromedical Institute (CAMI)[1] assist in assessing the role of potential medical condition- or drug/ethanol-related performance impairment of pilots in aviation accidents. In this regard, CAMI is also required to conduct special pathological studies and perform toxicological analyses on specimens from aircraft accident fatalities.

Such toxicological analyses of postmortem samples from aviation accident pilot fatalities are useful in determining whether performance impairment from medical condition(s) and/or drug and ethanol usage was a contributory factor in a particular accident. This analytical process includes identification of controlled substances of Schedules I and II, such as amphetamines, cocaine, and marihuana; controlled substances of Schedules III, IV, and V, such as benzodiazepines, phentermine, and propoxyphene; prescription drugs, such as antidepressants, antihypertensives, and anticonvulsants; nonprescription drugs, such as antihistaminics, antipyretics, and decongestants; and ethanol in the postmortem samples (4,5).

Including controlled substances and ethanol, several prescription and nonprescription medications are known to affect the central nervous system (5–7). For example, first-generation antihistaminics—brompheniramine, chlorpheniramine, diphenhydramine, and doxylamine—cause drowsiness and sedation (8), leading to performance impairment. Negative influences of chlorpheniramine and diphenhydramine have been evaluated on a wide range of task performance and mood measures (9,10). Studies such as the presence of methamphetamine in toxic concentration in a civil aviation accident pilot fatality (11) and the prevalence of first-generation antihistaminics (12,13) and of selective serotonin reuptake inhibitors (SSRIs; 14) have been reported. Antihistamines were found in approximately 5% of pilot fatalities (12,13), while SSRIs in only 1.5% of the fatalities (14). Previous epidemiological studies have indicated relatively low percentages of pilot fatalities wherein abused drugs were found, in comparison to prescription and nonprescription drugs during the time periods of 1989–1993 (15) and 1994–1998 (16). In the present study, the epidemiological assessment of the presence of drugs and ethanol was evaluated in the civil aviation accident pilot fatalities for an additional 5-year period of 1999–2003.

MATERIALS AND METHODS

Postmortem Biological Specimens

During the investigation of aircraft accidents occurring within the jurisdiction of the United States, autopsied biological samples (blood, urine, liver, kidney, vitreous fluid, and other body specimens) collected from pilot fatalities of civil aircraft accidents are submitted to CAMI for toxicological analyses (1). These aviation accidents encompass accidents involving registered as well as unregistered aircraft. Not all of the pilots involved in these accidents may necessarily have been certified pilots or may necessarily have been medically certified to fly an aircraft. Biological sample submissions are coordinated through the FAA's Office of Accident Investigation by the National Transportation Safety Board (NTSB), which is responsible for investigating all U.S. civilian aircraft accidents. The collected samples are submitted to CAMI in the FAA's TOX-BOX evidence containers described elsewhere (17).

Analytical Toxicology

The biological specimens from pilot fatalities are routinely analyzed for the presence of combustion gases (carbon monoxide and hydrogen cyanide), a wide range of illicit, prescription, and nonprescription drugs, and alcohol/volatiles (17). This process entails screening (preliminary) and confirmatory/quantitative analyses. All of these exogenous substances (analytes) in the specimens are analyzed according to established standard procedures

[1]In 2001, the Civil Aeromedical Institute's name was changed to Civil Aerospace Medical Institute (CAMI). The Institute is located in Oklahoma City, Oklahoma, and is an organizational element of the Office of Aerospace Medicine.

of the CAMI Laboratory, utilizing ultraviolet/visible spectrophotometry, fluorescence polarization immunoassay, radioimmunoassay, gas chromatography/mass spectrometry (GC/MS), high- performance liquid chromatography (HPLC), and HPLC/MS. Alcohol/volatile analysis is performed by headspace gas chromatography and radiative energy attenuation method. The analyses are dependent upon the nature of analytes, the sensitivity and specificity of analytical methods used, and the availability of sample types and amounts. Analytes found in a fatality might not have necessarily been detected, or even analyzed, in each of the sample types submitted from that particular accident pilot fatality.

Database

The toxicological findings of civil aircraft accident fatalities are electronically stored in a database maintained at CAMI. This CAMI Toxicology Database was examined for the presence of controlled substances (scheduled drugs), prescription and nonprescription drugs, and ethanol in the pilot fatalities from whom postmortem samples were submitted to CAMI during a 5-year period, 1999–2003. For this period, the database search also entailed the numbers of all aviation accidents and pilot fatalities, including the airman flying and medical certificates of those pilots and the flight categories of the associated accidents. Pilots that did not have airman flying and/or medical certificates were also part of the study. In the present study, fatalities consist of only pilots—copilots are not included.

Since caffeine and nicotine are not considered drugs, these compounds are not incorporated in the list of drugs found in the pilot fatalities. Ethanol is reported in only those cases wherein ethanol concentrations were ≥ 0.04% (w/v), as the FAA regulations (2) forbid the operation of an aircraft by a pilot with a blood ethanol reading ≥ 0.04% (40 $mg \cdot dL^{-1}$).

Drug Classification (or Grouping) and Pilot Fatality Numbers

Although efforts were made to group controlled substances (scheduled drugs) as classified by the U.S. Drug Enforcement Administration (4), it was sometimes necessary to combine the same types of several substances into 1 group to minimize the cumbersomeness of tables incorporated in this study. For example, the group barbiturates consisted of butalbital, pentobarbital, and phenobarbital; the group synthetic opiates included hydrocodone, hydromorphone, meperidine, oxycodone, and their metabolites; and the group benzodiazepines entailed α–hydroxyalprazolam, alprazolam, diazepam, midazolam, nordiazepam, oxazepam, and temazepam. Some of the barbiturates included in Schedule II could also be classified in Schedule III or IV. Pharmaceutical preparations containing opiates, up to certain concentrations, are classified under Schedule III, but they fall in the category of Schedule II at higher concentrations, or if they are seized during a drug law enforcement action in any solid or other dosage form. Drugs could be classified as prescription drugs instead of nonprescription drugs, depending upon the amounts and formulations of those drugs. It is common in the pharmaceutical industry to categorize a drug in prescription or in nonprescription category based upon the nature of pharmaceutical formulation and preparation wherein the drug is present.

Therefore, in the present study, drugs found in the fatalities were classified based upon their mere presence, even though some of the drugs could be classified differently. In fatalities wherein multiple drugs and ethanol were found, such fatalities were counted more than once—that is, for each drug under its respective category and for ethanol.

RESULTS

Pilot Fatalities, Flight Categories, and Airman Flying and Medical Certificates

During 1999–2003 with respect to airman flying certificates, 1367 (90%) of the total 1524 pilot fatalities were associated with general aviation [Title 14 Code of Federal Regulations (CFR), Part 91] accidents (Fig. 1). In these accidents, the highest number of pilots (693) were rated as private pilots and the second highest number of pilots (413) were rated as commercial pilots. Also, there were 201 pilots rated as airline transport pilots.

In relation to airman medical certificate categories (Fig. 2), the highest number of pilot fatalities (1350; 90%) of the total 1508 pilot fatalities were associated with general aviation accidents. Of these 1350 fatal accidents, 183 pilots held First-Class medical certificates, 437 Second-Class medical certificates, and 730 Third-Class medical certificates. The total of 1508 pilot fatalities does not include medically uncertified pilots.

As exhibited in Figure 3, there were 122 airline transport pilots of the 222 pilots holding First-Class medical certificates. In this medical certificate category, there were 78 commercial pilots, 18 private pilots (1 private pilot with the flying certificate of a foreign country), and 4 student pilots. Of the 548 Second-Class medical certificate holders, 108 pilots were rated as airline transport pilots, 348 commercial pilots, 86 private pilots, and 6 student pilots. In the category of the Third-Class medical certificate holders, 15 pilots were rated as airline transport pilots, 82 commercial pilots, 590 private pilots (5 private pilots with the certificate of a foreign country), and 48 student pilots, totaling 735 pilots.

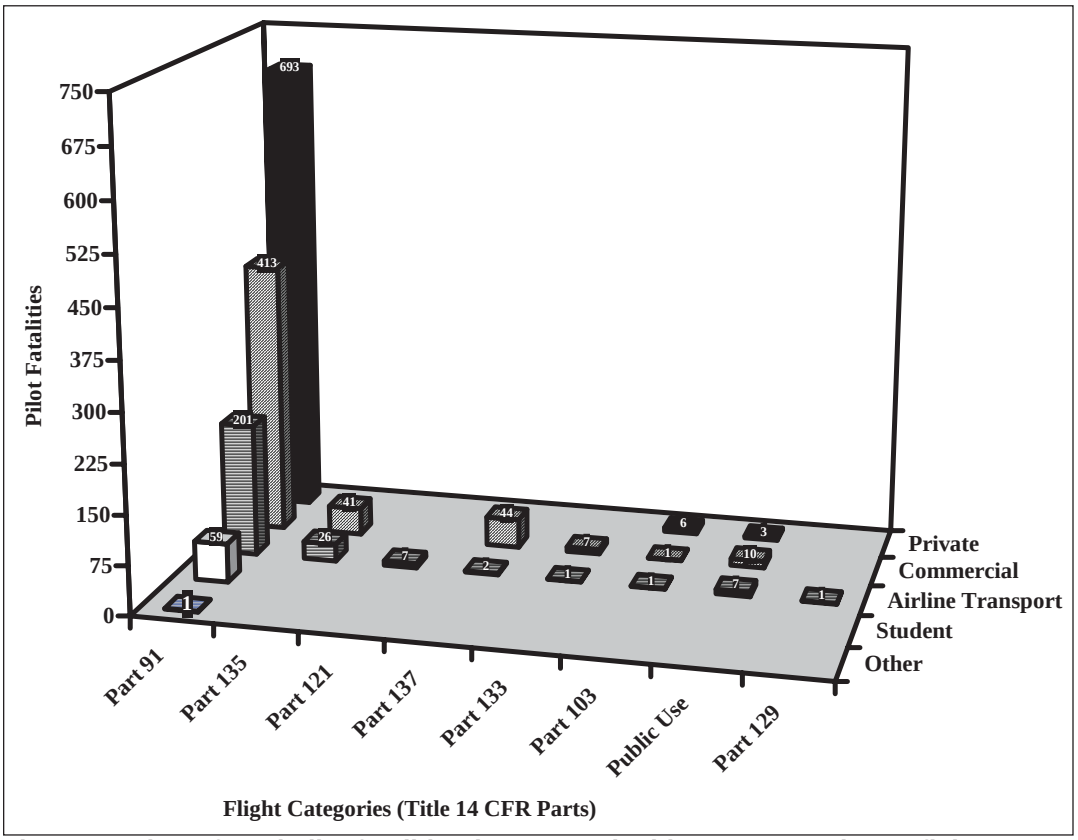

Fig. 1. Number of total pilot fatalities (1999–2003) with respect to airman flying certificate categories and flight categories (Title 14 CFR Parts) of the aircraft involved in the fatal accidents. For the description of flight categories under Title 14 CFR Parts, refer to the first column of Table IV.

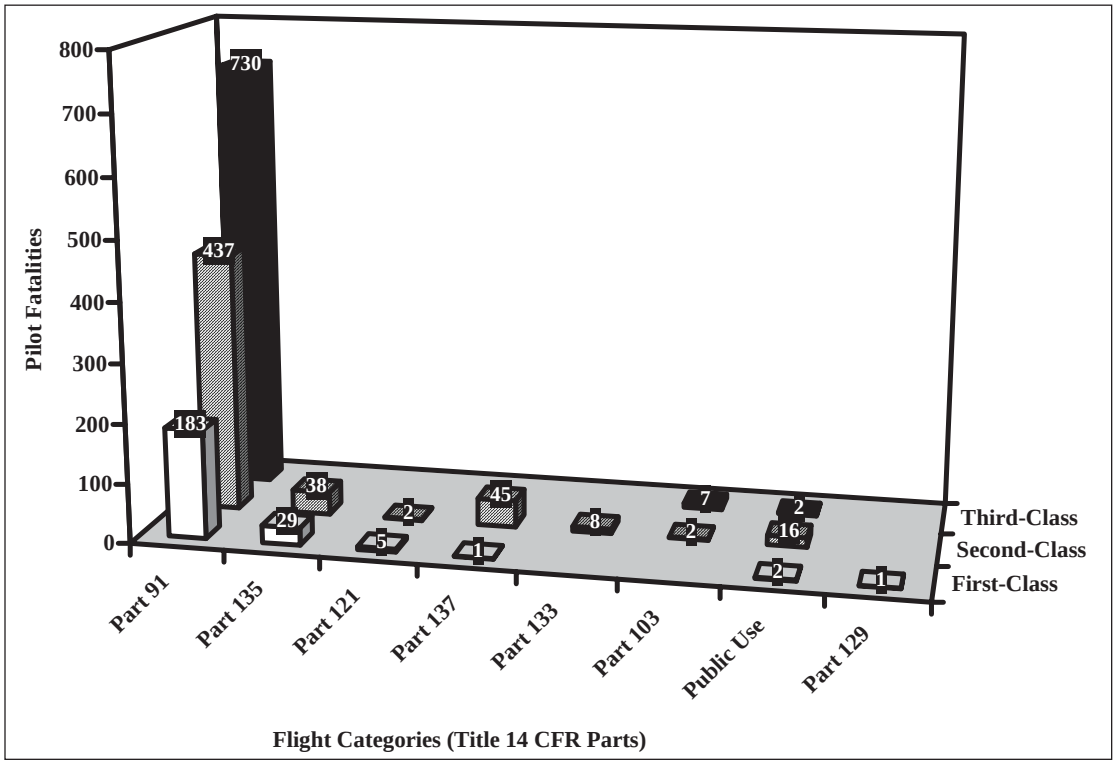

Fig. 2. Number of total pilot fatalities (1999–2003) with respect to airman medical certificate categories and flight categories (Title 14 CFR Parts) of the aircraft involved in the fatal accidents. For the description of flight categories under Title 14 CFR Parts, refer to the first column of Table IV.

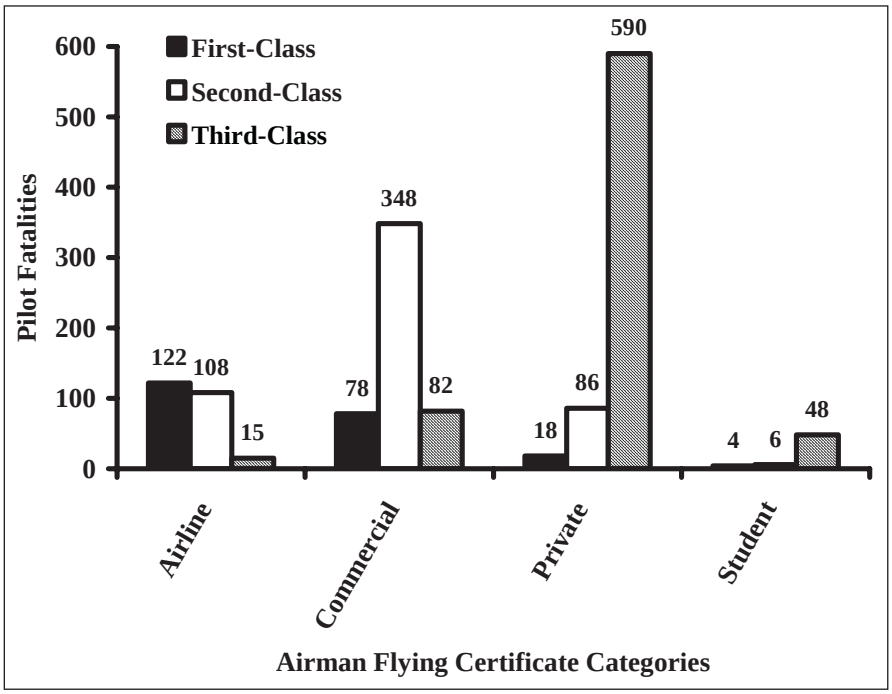

Fig. 3. Airman flying certificate and airman medical certificate categories of pilots (1999–2003) who were involved in fatal aviation accidents. One of the 18 First-Class private pilots held a foreign flying certificate, and 5 of the 590 Third-Class private pilots held a foreign flying certificate.

Pilot Fatalities With Drugs and Ethanol, by Year

Out of 1629 fatal aviation accidents from which CAMI received biosamples, there were 1587 accidents wherein pilots were fatally injured. Postmortem biosamples were received from these 1587 pilot fatalities, ranging from 305 to 334 fatalities each year during the 5-year period of 1999–2003 (Table I). The number of fatalities wherein drugs and/or ethanol were detected was 830, which was 52% of the 1587 fatalities. Of the 830 fatalities, prescription and nonprescription drugs were detected in 574 (69%) fatalities, whereas controlled substances (Schedules I–V drugs) were found in 155 (19%) fatalities and ethanol in 101 (12%) fatalities. The percentages of fatalities in which Schedules I and II drugs, Schedules III–V drugs, and ethanol were detected ranged from 6–9, 2–3, and 5–9%, respectively. The fatality percentage, based upon the presence of drug(s) and/or drug metabolite(s), was approximately 38% of all pilot fatalities.

Pilot Fatalities With Drugs and Ethanol by Medical Certificate Classes

Based on the category of pilot medical certificate held, there were 1519 fatalities, of which 222 pilots had First-Class certificates, 551 Second-Class certificates, and 746 Third-Class certificates (Table II). Of the 1519 fatalities, there were 783 fatalities in which drugs and/or ethanol were found. In the 783 pilots, the First-Class certificate was held by 79 (10%), the Second-Class certificate by 270 (34%), and the Third-Class certificate by 434 (55%). Scheduled drugs and/or ethanol were detected in 241 and prescription and nonprescription drugs in 542. Schedules I–V drugs were found in 15, 53, and 78 pilots holding First-Class, Second-Class, and Third-Class medical certificates, respectively.

Pilot Fatalities With Drugs and Ethanol by Medical Certificates and Flying Ratings

Drugs and/or ethanol were found in 79 of the 221 pilots with First-Class medical certificates, in 270 of the 548 pilots with Second-Class medical certificates, and in 424 of the 730 pilots with Third-Class medical certificates (Table III). Schedules I–V drugs were detected in 7 of the 122 First-Class, in 10 of the 108 Second-Class, and in 1 of the 15 Third-Class medical certificate-holding airline transport pilots. Of the 585 private pilots with the Third-Class medical certificates, there were 346 (59%) pilots wherein drugs and/or ethanol were detected, and Schedules I–V drugs were present in 62 (11%) of the pilots. None of the Schedules I–V drugs were found in the 4 student pilots holding First-Class medical certificates. Among Second-Class medical certificate-holding pilots, there were 2 of the 6 student pilots wherein Schedules I–V drugs were detected. Of the 48 Third-Class medical certificate-holding student pilots, Schedules I–V drugs were present in 8.

Table I. Drugs and Ethanol Found in Aviation Accident Pilot Fatalities, 1999–2003

Year	Pilot Fatalities*						All Pilot Fatalities by Year
	Schedules I and II Drugs†	Schedules III, IV, and V Drugs†	Prescription Drugs	Nonprescription Drugs	Ethanol	Total with Drugs and Ethanol	
1999	19 (6)	8 (3)	55 (18)	47 (15)	26 (9)	155 (51)	305
2000	22 (7)	9 (3)	47 (14)	57 (17)	22 (7)	157 (47)	334
2001	26 (9)	8 (3)	61 (20)	47 (15)	22 (7)	164 (54)	305
2002	20 (6)	9 (3)	74 (24)	52 (17)	16 (5)	171 (55)	312
2003	26 (8)	8 (2)	78 (24)	56 (17)	15 (5)	183 (55)	331
Total	113 (7)	42 (3)	315 (20)	259 (16)	101 (6)	830 (52)	1587

*Numbers in parenthesis indicate percent fatality based on the corresponding numbers in the last column (All Pilot Fatalities by Year). More than 1 drug and ethanol were present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug under its respective category and for ethanol. Pilots flying unregistered aircraft were also included.

†Controlled substances (Schedules I–V drugs) as classified by the U.S. Drug Enforcement Administration (4).

Table II. Medical Certificate Categories With Drugs and Alcohol Found in Aviation Accident Pilot Fatalities, 1999–2003

Medical Certificate Category	Pilot Fatalities*						All Pilot Fatalities by Medical Certificate Category
	Schedules I and II Drugs†	Schedules III, IV, and V Drugs†	Prescription Drugs	Nonprescription Drugs	Ethanol	Total with Drugs and Ethanol	
First-Class	12 (5)	3 (1)	25 (11)	30 (14)	9 (4)	79 (36)	222
Second-Class	41 (7)	12 (2)	95 (17)	84 (15)	38 (7)	270 (49)	551
Third-Class	55 (7)	23 (3)	170 (23)	138 (18)	48 (6)	434 (58)	746
Total	108 (7)	38 (3)	290 (19)	252 (17)	95 (6)	783 (52)	1519

*Numbers in parenthesis indicate percent fatality based on the corresponding numbers in the last column (All Pilot Fatalities by Medical Certificate Category). More than 1 drug and ethanol were present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug under its respective category and for ethanol. For the names of drugs found under the airman medical certificate categories, refer to Tables V, VI, and VII. Pilots flying unregistered aircraft were also included.

†Controlled substances (Schedules I–V drugs) as classified by the U.S. Drug Enforcement Administration (4).

Table III. Flying Ratings and Medical Certificates With Drugs and Ethanol Found in Aviation Accident Pilot Fatalities (1999–2003)

Airman Flying Rating	Pilot Fatalities*						All Pilot Fatalities by Flying Rating
	Schedules I and II Drugs†	Schedules III, IV, and V Drugs†	Prescription Drugs	Nonprescription Drugs	Ethanol	Total with Drugs and Ethanol	
			First-Class Medical Certificate-Holding Pilots				
Airline Transport	5 (4)	2 (2)	17 (14)	23 (19)	4 (3)	51 (42)	122
Commercial	3 (4)	0 (0)	5 (6)	7 (9)	2 (3)	17 (22)	78
Private	4 (24)	1 (6)	2 (12)	0 (0)	3 (18)	10 (59)	17
Student	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)	1 (25)	4
Total	**12 (5)**	**3 (1)**	**25 (11)**	**30 (14)**	**9 (4)**	**79 (36)**	**221**
			Second-Class Medical Certificate-Holding Pilots				
Airline Transport	8 (7)	2 (2)	24 (22)	10 (9)	5 (5)	49 (45)	108
Commercial	23 (7)	9 (3)	60 (17)	56 (16)	28 (8)	176 (51)	348
Private	8 (9)	1 (1)	9 (10)	16 (19)	5 (6)	39 (45)	86
Student	2 (33)	0 (0)	2 (33)	2 (33)	0 (0)	6 (100)	6
Total	**41 (7)**	**12 (2)**	**95 (17)**	**84 (15)**	**38 (7)**	**270 (49)**	**548**
			Third-Class Medical Certificate-Holding Pilots				
Airline Transport	1 (7)	0 (0)	8 (53)	2 (13)	0 (0)	11 (73)	15
Commercial	4 (5)	1 (1)	20 (24)	16 (20)	4 (5)	45 (55)	82
Private	44 (8)	18 (3)	130 (22)	114 (19)	40 (7)	346 (59)	585
Student	4 (8)	4 (8)	9 (19)	4 (8)	1 (2)	22 (46)	48
Total	**53 (7)**	**23 (3)**	**167 (23)**	**136 (19)**	**45 (6)**	**424 (58)**	**730**

*Numbers in parenthesis indicate percent fatality based on the corresponding numbers in the last column (All Pilot Fatalities by Flying Rating). More than 1 drug and ethanol were present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug under its respective category and for ethanol. For the names of drugs found under the airman medical certificate categories, refer to Tables V, VI, and VII. Pilots flying unregistered aircraft were also included.

†Controlled substances (Schedules I–V drugs) as classified by the U.S. Drug Enforcement Administration (4).

Flight Categories and Pilot Fatalities With Drugs and Ethanol

With respect to the flight categories of aviation accidents, there were a total of 1570 pilot fatalities (Table IV). Of these fatalities, there were 821 (52%) fatalities in which drugs and/or ethanol were present. There were 152, 568, and 101 fatalities wherein Schedules I–V drugs (controlled substances), prescription and nonprescription drugs, and ethanol were, respectively, found. Associated with general aviation (Title 14 CFR, Part 91) accidents, there were a total of 1409 pilot fatalities, of which 757 (54%) fatalities were found to contain drugs and/or ethanol. Schedules I–V drugs were detected in 140 of the 757 fatalities. There were no fatalities in which Schedules I–V drugs were found in the flight category of air carrier (Title 14 CFR, Part 121), rotorcraft external load (Title 14 CFR, Part 133), or public use (flights used for the governmental agencies). Of these 3 categories, ethanol was detected in only 1 of the total 7 pilots of the CFR Part 121 related accidents and in 2 of the total 20 pilots of the public use related accidents. The percentage of the fatalities with scheduled drugs (controlled substances) was high in the accidents associated with ultralight aircraft (Title 14 CFR, Part 103). There was only 1 foreign air carrier (Title 14 CFR, Part 129) involving pilot fatality. In this fatality, no drug or ethanol was detected.

Medical Certificate Categories With Scheduled Drugs Found in Pilot Fatalities

In general, the number of First-Class medical certificate-holding pilots wherein Schedules I–V drugs and/or their metabolites were found was lower than the number of Second-Class and Third-Class medical certificate-holding pilots (Table V). The number of pilots wherein scheduled drugs were present and who were holding Second-Class medical certificates was relatively higher than the number of First-Class medical certificate-holding pilots, but was less than the number of Third-Class medical certificate-holding pilots. Marihuana (tetrahydrocannabinol and/or tetrahydrocannabinol carboxylic acid) was detected in the highest number of 21 pilots with Third-Class medical certificates. Codeine and/or morphine were present in 31 pilots. Of these pilots, 4 held First-Class, 13 Second-Class, and 13 Third-Class medical certificates, while 1 pilot was medically uncertified. Benzodiazepines were also found in 13 pilots holding Third-Class medical certificates. Synthetic opiates were detected in the fatalities—the fatality number was 2 in the First-Class medical certificate category, and the numbers were 9 and 8 in the Second-Class and Third-Class medical certificate categories, respectively. Including marihuana and benzodiazepines, other drugs were also detected in medically uncertified pilots. Phencyclidine was not detected in any pilot fatality.

Medical Certificate Categories With Prescription Drugs Found in Pilot Fatalities

The presence of prescription drugs and/or their metabolites was relatively more prevalent in the pilots holding Third-Class medical certificates than in pilots holding First-Class or Second-Class medical certificates (Table VI). Diphenhydramine was found in the maximum number of 83 pilot fatalities. The number of fatalities wherein lidocaine and atropine were detected ranked numbers 2 and 3, respectively. The presence of antihypertensives and SSRIs also dominated in the fatalities.

Medical Certificate Categories With Nonprescription Drugs Found in Pilot Fatalities

Nonprescription drugs and/or their metabolites were most prevalent in the pilots who held Third-Class medical certificates (Table VII). Pseudoephedrine ranked as the number-1 drug, as this was present in 91 fatalities, followed by acetaminophen in 84, phenylpropanolamine in 76, and ephedrine in 74. Salicylate was found in 41 pilots, whereas chlorpheniramine was present in 31.

DISCUSSION

Biological samples from pilot fatalities of circa 80% of the total U.S. civil aviation accidents investigated by the NTSB are submitted to CAMI for toxicological evaluation (17). During 1999–2003, samples from a total of 1587 pilot fatalities were received, translating into the equivalent number of fatal aircraft accidents. This number entails registered as well as unregistered aircraft, such as ultralight vehicles. The pilots of such aircraft could also be noncertified to fly aircraft and may or may not hold medical certificates. The highest number of all pilot fatalities observed with the general aviation (Title 14 CFR, Part 91) accidents in comparison to the other flight categories of Title 14 CFR Parts—Part 135, Part 121, Part 137, Part 133, and Part 103—is consistent with the previous observations made during the first-generation H_1 antihistaminics (13) and SSRIs (14) studies.

Comparison of the epidemiological toxicology findings of the 1999–2003 period with those of the 1994–1998 period (16) suggested that the incidents of drug and ethanol use in pilots did not increase considerably during the 1999–2003 period. The total pilot fatalities with drugs and/or ethanol were 830 (52%) of the 1587 pilot fatalities during this period, while such fatalities were 803 (48%) of the 1683 pilot fatalities for the 1994–1998 period (16). However, both 52% and 48%

Table IV. Aviation Accident Flight Categories With Drugs and Ethanol Found in Pilot Fatalities (1999–2003)

Flight Category[*]	Pilot Fatalities[†]						All Pilot Fatalities by Flight Category
	Schedules I and II Drugs[‡]	Schedules III, IV, and V Drugs[‡]	Prescription Drugs	Nonprescription Drugs	Ethanol	Total with Drugs and Ethanol	
General Aviation (14 CFR, Part 91)	101 (7)	39 (3)	291 (21)	234 (17)	92 (7)	757 (54)	1409
Air Taxi and Commuter (14 CFR, Part 135)	5 (7)	1 (1)	7 (10)	5 (7)	2 (3)	20 (30)	67
Air Carrier (14 CFR, Part 121)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	1 (14)	7
Agricultural (14 CFR, Part 137)	2 (4)	1 (2)	6 (13)	12 (26)	3 (7)	24 (52)	46
Rotorcraft External Load (14 CFR, Part 133)	0 (0)	0 (0)	1 (13)	3 (38)	0 (0)	4 (50)	8
Ultralight (14 CFR, Part 103)	2 (17)	1 (8)	4 (33)	1 (8)	1 (8)	9 (75)	12
Public Use[§]	0 (0)	0 (0)	1 (5)	3 (15)	2 (10)	6 (30)	20
Foreign Air Carriers (14 CFR, Part 129)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
Total	110 (7)	42 (3)	310 (20)	258 (16)	101 (6)	821 (52)	1570

[*]Code of Federal Regulations (CFR), Title 14—Aeronautics and space, Chapter I (1-1-04 Edition)—Federal Aviation Administration, Department of Transportation, U.S. Government Printing Office (2004), Washington, DC.

[†]Numbers in parenthesis indicate percent fatality based on the corresponding numbers in the last column (All Pilot Fatalities by Flight Category). More than 1 drug and ethanol were present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug under its respective category and for ethanol. Pilots flying unregistered aircraft were also included.

[‡]Controlled substances (Schedules I–V drugs) as classified by the U.S. Drug Enforcement Administration (4).

[§]Flights used for the federal, state, and local government agencies.

Table V. Airman Medical Certificate Categories With Controlled Substances (Scheduled Drugs) Found in Pilot Fatalities[*] (1999–2003)

Drugs/Drug Groups	First-Class Medical Certificate-Holding Pilots	Second-Class Medical Certificate-Holding Pilots	Third-Class Medical Certificate-Holding Pilots	All Pilot Fatalities[†]
		Schedules I and II Drugs[‡]		
Amphetamine/ Methamphetamine	1	5	5	11
Barbiturates[§]	0	2	8	10
Cocaine/Metabolite(s)	3	4	8	16
Codeine/Morphine	4	13	13	31
Marihuana[¶]	3	11	21	39
MDMA[**]	0	1	0	1
Synthetic Opiates[††]	2	9	8	20
		Schedules III, IV, and V Drugs[‡]		
Benzodiazepines[‡‡]	2	6	13	24
Phentermine	1	1	2	5
Propoxyphene/ Norpropoxyphene	0	5	6	12
Zolpidem	0	0	2	2

[*]More than 1 drug was present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug. Pilots flying unregistered aircraft were also included.

[†]Also includes medically uncertified pilots.

[‡]Controlled substances (Schedules I–V drugs) as classified by the U.S. Drug Enforcement Administration (4).

[§]Butalbital, pentobarbital, and/or phenobarbital, though some of these barbiturates could also be classified in other schedules.

[¶]Tetrahydrocannabinol and/or tetrahydrocannabinol carboxylic acid.

[**]3,4-Methylenedixoymethamphetamine.

[††]Hydrocodone, hydromorphone, meperidine, oxycodone, and/or their metabolites.

[‡‡]α–Hydroxyalprazolam, alprazolam, diazepam, midazolam, nordiazepam, oxazepam, and/or temazepam.

Table VI. Airman Medical Certificate Categories With Prescription Drugs Found in Pilot Fatalities[*] (1999–2003)

Drug/Drug Metabolite(s)	First-Class Medical Certificate-Holding Pilots	Second-Class Medical Certificate-Holding Pilots	Third-Class Medical Certificate-Holding Pilots	All Pilot Fatalities[†]
Amitriptyline/Nortriptyline	0	1	5	7
Amlodipine	0	1	5	6
Atenolol	1	2	10	14
Atropine	1	6	15	24
Azacyclonol	3	0	2	5
Benzocaine	0	1	0	1
Bisoprolol	1	0	1	2
Brompheniramine	0	2	0	2
Bupropion/Metabolite	1	4	3	9
Carbamazepine	0	1	0	1
Cetirizine	0	0	3	3
Chloroquine	0	3	0	3
Cimetidine	0	5	4	9
Citalopram/Metabolite(s)	2	1	8	11
Cyclobenzaprine	0	0	1	1
Diltiazem	0	3	6	10
Diphenhydramine	7	24	46	83
Doxazosin	0	1	0	1
Doxepin/Nordoxepin	0	1	0	1
Etomidate	1	0	0	1
Fluconazole	1	0	2	3
Fluoxetine/Norfluoxetine	1	5	9	21
Hydrochlorothiazide	0	1	2	3
Hydroxyzine	0	0	1	1
Imipramine/Desipramine	0	2	1	4
Labetalol	0	0	1	1
Lidocaine	3	8	17	30
Metoclopramide	1	0	0	1
Metoprolol	0	4	10	17
Mirtazapine	0	0	1	2
Moricizine	0	0	0	1
Nadolol	1	0	0	1
Naproxen	0	1	2	3
Nizatidine	0	0	1	1
Pantoprazole	0	1	0	1
Paroxetine	1	2	12	16
Phenyltoloxamine	0	1	0	1
Procainamide/*N*–Acetylprocainamide	0	2	0	2

(continued)

Table VI. Airman Medical Certificate Categories With Prescription Drugs Found in Pilot Fatalities[*] (1999–2003) (Continued)

Drug/Drug Metabolite(s)	First-Class Medical Certificate-Holding Pilots	Second-Class Medical Certificate-Holding Pilots	Third-Class Medical Certificate-Holding Pilots	All Pilot Fatalities[†]
Propranolol	0	1	3	5
Quinidine	0	0	1	1
Ranitidine	2	3	9	17
Sertraline/Desmethylsertraline	0	6	11	19
Sildenafil/Metabolite(s)	0	1	3	4
Theophylline	1	3	2	6
Tramadol	0	1	11	12
Trazodone	0	1	2	4
Triamterene	1	5	2	8
Trimethoprim	1	0	4	5
Venlafaxine/Desmethylvenlafaxine	1	3	2	6
Verapamil/Norverapamil	0	3	6	11

[*]More than 1 drug was present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug. Pilots flying unregistered aircraft were also included.

[†]Also includes medically uncertified pilots.

Table VII. Airman Medical Certificate Categories With Nonprescription Drugs Found in Pilot Fatalities[*] (1999 – 2003)

Drug/Drug Metabolite(s)	First-Class Medical Certificate-Holding Pilots	Second-Class Medical Certificate-Holding Pilots	Third-Class Medical Certificate-Holding Pilots	All Pilot Fatalities[†]
Acetaminophen	11	34	36	84
Chlorpheniramine	1	11	18	31
Dextromethorphan/Metabolite(s)	1	7	9	20
Doxylamine	0	8	11	19
Ephedrine	9	24	41	74
Meclizine	0	0	1	1
(–)-Methamphetamine	1	4	3	8
Oxymetazoline	0	1	0	1
Phenylpropanolamine	10	27	38	76
Pseudoephedrine	11	33	46	91
Quinine	3	13	20	37
Salicylate	8	13	18	41
Triprolidine	0	1	1	2

[*]More than 1 drug was present in some fatalities. Therefore, those fatalities were counted more than once—that is, for each drug. Pilots flying unregistered aircraft were also included.

[†]Also includes medically uncertified pilots.

values were higher than that of the 31% value (565 out of 1845 fatalities) for the 1989–1993 period (15). The presence of Schedules I and II drugs increased from 74 fatalities during 1989–1993 and from 89 fatalities during 1994–1998 to 113 fatalities during 1999–2003; an increase was also noted with the prescription drugs in the 1999–2003 study. The presence of Schedules III–V drugs increased from 28 fatalities during 1989–1993 and decreased from 49 fatalities 1994–1998 to 42 fatalities during 1999–2003. An increase-and-decrease pattern in the number of fatalities was also observed with the nonprescription drugs. The number of fatalities with ethanol decreased from 146 (15) and 124 (16) to 101 in the current study. The pilot fatality percentage, based upon the presence of drug(s) and/or drug metabolite(s), was higher (38%) during 1999–2003 than the percentages observed during the periods of 1989–1993 (27%) and 1994–1998 (32%).

Airline transport-rated pilots holding First-Class medical certificates qualify to fly aircraft for transporting passengers and for other purposes, but Second-Class and Third-Class medical certificate-holding airline transport pilots do not qualify to transport passengers. Since most of the airline transport and commercial pilots are subjected to random drug testing for the presence of amphetamines, cocaine, marihuana, opiates, phencyclidine, and/or their metabolites (18), the present study examined the positive drug rate based on the airman medical, as well as airman flying certificate classifications. It was found that the percentage of pilots with Schedules I and II drugs in a given medical class (First-Class, Second-Class, and Third-Class) was approximately within 1% of each other. With respect to airman medical certificate categories, the percentage of fatalities wherein Schedules I–V drugs and ethanol were detected was approximately the same (241 out of 1519 fatalities; 16%) in the present study than that was observed (245 out of 1616 fatalities; 15%) in the 1994–1998 study (16). However, prescription and nonprescription drugs during 1999–2003 were found in a higher number of fatalities (542; 36%) relative to the fatalities (520; 32%) reported in the 1994–1998 study. With respect to flight categories, it is clearly evident that scheduled and prescription drug use dominated in fatalities associated with general aviation and ultralight flights.

Although the prevalence of scheduled drugs in the fatalities was, in general, consistent with the findings of the previous studies (15,16), the increase in their prevalence, if any, could be attributed to the possibilities of (i) scientific and technical advances in the sensitivity of analytical detectability, (ii) genuine authorized medical use of such drugs, and/or (iii) their real abuse. The analytical sensitivity enhanced the detection of not only the parent drugs but also their metabolite(s), even if they were present in low concentrations. Narcotic analgesics found in pilot fatalities could have been administered by emergency health care providers at accident scenes, or at hospitals for pain reduction and/or surgical procedures. However, the presence of abused drugs—for example, amphetamine, methamphetamine, 3,4-methylenedioxymethamphetamine, cocaine, and marihuana—could have been attributed to their unauthorized use. Prescription drugs, such as atropine and lidocaine, might have been administered by health care providers for resuscitation. The presence of prescription drugs found in the fatalities reflected the current trends in the popularly dispensed groups of medications—antihypertensives and antidepressants—in the U.S. (19–24). The use of nonprescription drugs was primarily associated with drug preparations and formulations used to alleviate allergy and cold symptoms.

The percentages of fatalities with ethanol during 1999–2003 on yearly and medical certificate category bases ranged from 4–9%, which were similar to the numbers reported in the 2 previous studies (15,16). Since the method used for ethanol analysis does not differentiate ingested ethanol from postmortem ethanol (25), the presence of ethanol in those pilots may not necessarily suggest the consumption of ethanol. In reducing the use of ethanol in pilots, the Driving Under the Influence (DUI)/Driving While Intoxicated (DWI) rule (26) plays a crucial role under which the FAA monitors DUI/DWI convictions of pilots and takes action to suspend medical certificates where necessary.

Although no pilot fatality in an air carrier (Title 14 CFR, Part 121) related aviation accident was found to be positive for scheduled drugs, it is difficult to assign any significance to this finding due to the small number of CFR Part 121 accidents that occurred between 1993 and 2003. This observation agrees with the FAA drug-testing program's conclusion that less than 1% of those pilots tested under the drug-testing program are positive for abused drugs (18,27). Overall, findings from the present study were consistent with those of the 2 previous epidemiological studies (15,16) and support the FAA's programs, including the FAA's drug-testing program, aimed at identifying potentially incapacitating medical conditions and reducing the use of performance-impairing drugs or ethanol (18,27). In addition to scheduled drugs (controlled substances), many of the prescription and nonprescription drugs found in the fatalities have the potential for impairing performance, thereby adversely affecting a pilot's ability to safely fly an aircraft.

REFERENCES

1. Aviation Safety Research Act of 1988: Public Law 100-591 [H.R. 4686]. 100th U.S. Cong., 2nd Sess., 102 Stat. 3011 (Nov. 3, 1988).
2. Code of Federal Regulations (CFR). Title 14—Aeronautics and space, Chapter I (1-1-04 Edition)—Federal Aviation Administration, Department of Transportation, Subchapter F—Air traffic and general operating rules, Part 91—General operating and flight rules, Subpart A—General: 91.17, alcohol or drugs. Washington, DC: U.S. Government Printing Office, 2004.
3. Aircraft accident and incident notification, investigation, and reporting. U.S. Department of Transportation, Federal Aviation Administration, Order No. 8020.11B, Chapter 4—Aircraft accident investigation responsibilities, Section 3—Office of Aviation Medicine, Paragraph 137—Civil Aeromedical Institute responsibilities, Washington, DC (Aug. 16, 2000).
4. Code of Federal Regulations (CFR). Title 21—Food and drugs, Chapter II—Drug Enforcement Administration, Department of Justice, Part 1308—Schedules of controlled substances. Washington, DC: U.S. Government Printing Office, 2002.
5. Physicians' desk reference. 57th ed. Montvale, NJ: Thomas PDR, 2003.
6. Physicians' desk reference for nonprescription drugs and dietary supplements. 24th ed. Montvale, NJ: Thomas PDR, 2003.
7. Hardman JG, Limbird LE, Gilman AG, eds. Goodman & Gilman's The pharmacological basis of therapeutics, 10th ed. New York, NY: McGraw-Hill; 2001.
8. Brown NJ, Roberts, LJ, II. Histamine, bradykinin, and their antagonists. In: Hardman JG, Limbird LE, Gilman AG, eds. Goodman & Gilman's The pharmacological basis of therapeutics, 10th ed. New York, NY: McGraw-Hill; 2001:645–67.
9. Gilliland K, Schlegel RE, Nesthus TE. Workshift and antihistamine effects on task performance. Washington, DC: U.S. Department of Transportation, Federal Aviation Administration; Dec. 1997 Report No: DOT/FAA/AM-97/25.[2]
10. Weiler JM, Bloomfield JR, Woodworth GG, et al. Effects of fexofenadine, diphenhydramine, and alcohol on driving performance. A randomized, placebo-controlled trial in the Iowa driving simulator. *Ann Intern Med* 2000; 132:354–63.
11. Chaturvedi AK, Cardona PS, Soper JW, Canfield DV. Distribution and optical purity of methamphetamine found in toxic concentration in a civil aviation accident pilot fatality. *J Forensic Sci* 2004; 49:832–6.
12. Soper JW, Chaturvedi AK, Canfield DV. Prevalence of chlorpheniramine in aviation accident pilot fatalities, 1991–1996. *Aviat Space Environ Med* 2000; 71:1206–9.
13. Chaturvedi AK, Craft KJ, Akin A, et al. First-generation H_1 antihistaminics found in pilot fatalities of 1990–2002 civil aviation accidents [abstract]. *Aviat Space Environ Med* 2004; 75(4; Section II): B49.
14. Akin A, Chaturvedi AK. Selective serotonin reuptake inhibitors in pilot fatalities of civil aviation accidents, 1990–2001. *Aviat Space Environ Med* 2003; 74:1169–76.
15. Canfield D, Flemig J, Hordinsky J, Birky M. Drugs and alcohol found in fatal civil aviation accidents between 1989 and 1993. Washington, DC: U.S. Department of Transportation, Federal Aviation Administration; Nov. 1995 Report No: DOT/FAA/AM-95/28.[2]
16. Canfield DV, Hordinsky J, Millett DP, et al. Prevalence of drugs and alcohol in fatal civil aviation accidents between 1994 and 1998. *Aviat Space Environ Med* 2001; 72:120–4.
17. Chaturvedi AK, Smith DR, Soper JW, et al. Characteristics and toxicological processing of postmortem pilot specimens from fatal civil aviation accidents. *Aviat Space Environ Med* 2003; 74:252–9.
18. Code of Federal Regulations (CFR). Title 14—Aeronautics and Space, Chapter I (1-1-04 Edition)—Federal Aviation Administration, Department of Transportation, Subchapter G—Air carriers and operators for compensation or hire: certification and operations, Part 121—Operating requirements: domestic, flag, and supplemental operations, Appendix I—Drug testing program. Washington, DC: U.S. Government Printing Office, 2004.

[2]This publication and all Office of Aerospace Medicine technical reports are available in full-text from the Civil Aerospace Medical Institute's publications Web site: www.faa.gov/library/reports/medical/oamtechreports/index.cfm

19. Latner AW. The top 200 drugs of 1999: The more things change, the more they stay the same. *Pharm Times* 2000 Apr; 66(4):16-32.

20. Latner AW. The top 200 of 2000: drugs of the new millennium. *Pharm Times* 2001 Apr; 67(4):14-29.

21. Top 10 drugs of 2001 [editorial]. *Pharm Times* 2002 Apr; 68(4):10-5.

22. Vaczek D. Top 200 drugs of 2002. Retrieved 30 November 2004, from: http://www.pharmacy-times.com/article.cfm?ID=338.

23. Vaczek D. The top 200 prescription drugs of 2003. *Pharm Times* 2004 Jul; 70(7):46,50,52, and 54.

24. The top 200 prescriptions for 2003 by number of US prescriptions dispensed. Retrieved Nov. 29, 2004, from: http://www.rxlist.com/top200.htm.

25. Canfield DV, Kupiec T, Huffine E. Postmortem alcohol production in fatal aircraft accidents. *J Forensic Sci* 1993; 38:914–7.

26. Code of Federal Regulations (CFR). Title 14—Aeronautics and Space, Chapter I (1-1-04 Edition)—Federal Aviation Administration, Department of Transportation, Subchapter D—Airmen, Part 61—Certification: pilots, flight instructors, and ground instructors, Subpart A—General: 61.15, offenses involving alcohol or drugs. Washington, DC: U.S. Government Printing Office, 2004.

27. Department of Transportation, Federal Aviation Administration, Antidrug and alcohol misuse prevention programs for personnel engaged in specified aviation activities. *Federal Register* 1999 Dec; 64(232):67965–6.