

Original article

A population-based epidemiologic analysis of deaths from anaphylaxis in Florida

Background: Previous US population-based epidemiologic studies of anaphylactic deaths have been limited by small populations and/or few deaths. The objective of this study was to determine the 10-year incidence of death from anaphylaxis in Florida and its descriptive epidemiology.

Methods: Patients who died from anaphylaxis from 1996 to 2005 were identified from ICD-9 and ICD-10 codes on death certificates statewide. Age, race and gender-specific anaphylactic death rates were calculated.

Results: There were 89 deaths among Florida residents. The individuals with autopsy confirmed diagnoses, and those with clinical diagnoses only, did not differ with regard to race, anaphylactic triggers or the clinical variables of lung and heart disease. Annual death rate for anaphylaxis in Florida was 5.02/10 000 000. The relative risk of death from anaphylaxis was 14.09 for individuals ≥ 65 years old ($P = 0.0000002$) and 6.38 for individuals 35–64 years old ($P = 0.0019$) compared with those who were 5–14 years of age. Deaths among Florida residents that occurred in emergency rooms or outpatient settings were 2.11 times as likely to be anaphylactic deaths than deaths that occurred in inpatient settings ($P = 0.0026$). The ratios of anaphylactic deaths to total deaths in March and April and in July and August were greater than the ratios for the other bimonthly periods ($P = 0.02$).

Conclusion: Death from anaphylaxis in Florida was more likely to occur in older individuals, in an emergency department, and in the months of March and April and July and August.

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Anaphylaxis is a potentially life-threatening syndrome which occurs as a result of mast cell and basophil mediator release. This cellular activation usually occurs following exposure to an antigen to which an individual has been sensitized and produced antigen-specific IgE but may also result from exposure to a nonspecific mast cell activator (1). Two US population-based studies of anaphylaxis have previously been reported. One based on a medical record review in Olmsted County, MN, reported one death during a 5-year period (2). The other study of 229 422 children and adolescents enrolled in a health maintenance organization reported no deaths during a 5-year period (3). A recent population-based study of hospitalization for anaphylaxis in Florida in 2001 found two deaths among hospitalized patients that year (4). Population-based European studies have reported one death (UK) (1994–1999) (5) and 24 deaths

(Switzerland) (1996–1998) (6). One study of the entire UK population reported 214 deaths over a 10-year period (1992–2001) (7). The previous US studies analyzed only limited populations. We conducted a descriptive study and detailed analysis of a case series to determine the epidemiology of death from anaphylaxis in Florida. Our goals were to evaluate the incidence during a 10-year period of death from anaphylaxis, place of death, anaphylactic triggers, age, sex and clinical characteristics of the victims using information contained on their death certificates. This use of statewide death certificate data represents a novel approach in the study of death from anaphylaxis in the United States.

Materials and methods

Source population and inclusion criteria

Death certificates were obtained from the Florida Department of Health, Office of Vital Statistics, for the years 1996 through 2005 inclusive. SPSS programs were written by Florida Department of Health staff to search for death certificates which listed anaphylaxis

Abbreviations: CI, Confidence interval; ICD-9, International Classification of Diseases, Ninth Revision; ICD-10, International Classification of Diseases, Tenth Revision; RR, relative risk; FL, Florida; ACME, Automated Classification of Medical Entities.

as one of the causes of death. The *International Classification of Diseases, Ninth Revision* (ICD-9) was used for 1996–1998. The program for the 1996–1998 records searched through the 20 multiple Cause-of-Death fields (Automated Classification of Medical Entities [ACME] 1–20) for the list of codes: ICD 9, codes 995.0 (Anaphylactic shock) and 999.4 (Anaphylactic shock because of serum).

The *International Classification of Diseases, Tenth Revision* (ICD 10) coding was used to search the 1999–2005 death records. The program looked through the 20 multiple Cause-of-Death fields (ACME1–ACME20) for the list of codes: T50.9 (overdose or wrong substance given), T63.2 (scorpion sting), T63.4 (insect sting), T63.6 (marine animal sting), T63.9 (sting), T78.0 (food), T78.2 (anaphylactic shock), T80.5 (serum) and T88.6 (correct substance properly administered). Each death certificate was reviewed by one of the authors (MRS) to verify that anaphylaxis was listed as one of the causes of death.

Ninety-six records were provided. Review of the death certificates revealed that one death was because of asthma, one was because of hereditary angioedema, one because of septic shock, one because of anoxic encephalopathy and one because of lung cancer. These five were excluded. There were seven individuals who were residents of other states who died in Florida. These were also excluded. However, the Florida Department of Health was aware of five residents of Florida who died of anaphylaxis in other states during this period but had no other information regarding those individuals. These five were included for the calculation of the overall 10 year average annual incidence of anaphylactic death but were excluded from all other calculations such as age group, gender-specific incidence, etc.

A total of 84 were Florida residents and died in the State of Florida. Age and gender-specific anaphylactic death rates for Florida residents were calculated by dividing the appropriate number of deaths that occurred from 1996 to 2005 by the stratum-specific Florida population estimates for those years (8). The Florida Department of Health, Office of Vital Statistics provides data in 10 year groups for ages 5 years and older, e.g. ages 5–14 years, 15–24 years, etc. Clinically, relevant age groups were defined so that they could be compared with equivalent age groups for which population data were available from the Florida Department of Health as just described. The age groups consisted of school-aged children (ages 5–14 yr), adolescents and young adults (ages 15–34 years), middle aged adults (ages 35–64 years) and older adults (ages 65 years or older).

An average annual Florida anaphylaxis mortality rate was calculated by summing the number of deaths as a result of anaphylaxis

in Florida residents during the years 1996–2005 and dividing this figure by the sum of the annual Florida population estimates spanning 1996–2005 (8). We report the rates such that there is at least one significant figure to the left of the decimal point as is usual in descriptive epidemiology. This study was considered to be a random sample in time of a 10-year period, and therefore the 10-year anaphylaxis mortality rate was treated as a statistic (rather than a parameter) even though all of the reported anaphylaxis deaths were captured (9, 10). Statistics have standard errors; consequently, a 95% confidence interval was calculated for the population death rate. The large denominator (> 177 million) precluded the calculation of exact limits for a binomial distribution. Instead Wilson's method was utilized (11). This technique results in confidence limits that are close to the exact binomial confidence limits.

Chi-squared tests and, when indicated, Fisher's exact tests were used to determine the significance between proportions. In the comparison of the group with an autopsy confirmed diagnosis and the group with a clinical diagnosis, the null hypothesis is that the method of diagnosis (autopsy diagnosis vs clinical diagnosis) is independent of each of the demographic and clinical variables analyzed in Table 1. EPI INFO software for Windows (Version 3.3.2; Centers for Disease Control and Prevention, Atlanta, GA, USA) was utilized to perform a chi-squared test for linear trend in proportions to evaluate the increase in anaphylaxis mortality by age. Relative risks (RR) of anaphylaxis mortality and Mantel-Haenszel age-adjusted RRs were calculated using OpenEpi (12). The proportion of all deaths that were anaphylactic deaths was calculated for the period 1996–2005 by bimonthly intervals. To account for potential confounding by age, age-adjusted proportions by bimonthly intervals were calculated using the direct method of adjustment and 18 age groups (13). The total number of deaths because of any cause that occurred in January and February during the 1996–2005 period served as the standard population.

Crude and age-adjusted proportional mortality ratios and accompanying 95% confidence intervals were calculated using OpenEpi (12). The Mantel-Haenszel method was used to age-adjust the proportional mortality ratios (12). Proportional mortality ratios were calculated to assess the association between the location of death and the cause of death (anaphylactic vs all other causes of death). The proportion of all inpatient deaths that occurred throughout Florida among Florida residents as a result of anaphylaxis served as the denominator for the calculation of the proportional mortality ratios.

The nonparametric Wilcoxon rank sum test was used to assess whether decedants with asthma as a group were different in age

Table 1. Characteristics of autopsy confirmed anaphylaxis diagnosis vs clinical diagnosis

Variable	Autopsy confirmed diagnosis (n = 34)	Clinical diagnosis (n = 50)	P-value
Male	22 (65%)	20 (40%)	0.045*
Age	51.7 (range: 13–86 years)	65.2 (range: 14–92 years)	0.0011**
White	29 (85%)	42 (88%)	1
Triggers			
Food	4 (12%)	3 (6%)	0.43*
Hymenoptera	3 (9%)	6 (12%)	0.55*
Radiocontrast medium	3 (9%)	3 (6%)	0.65*
Medication	8 (24%)	14 (28%)	0.38*
Clinical variables			
Lung disease (asthma, COPD)	3 (9%)	8 (16%)	0.37*
Heart disease	4 (12%)	12 (24%)	0.20*

The null hypothesis is that the method of diagnosis (autopsy diagnosis vs clinical diagnosis) is independent of each of these demographic and clinical variables.

*Fisher's exact test; **Student's *t*-test.

from decedents without asthma. The average annual incidence rates for anaphylactic death in other locations were calculated from previously published information so that those rates could be compared with the average annual incidence rate for Florida. The 10 year population estimate for Great Britain for 1992–2001 was determined by obtaining the mid-year population estimate for 1997 (14) and multiplying by 10. The 3 year population estimate for Switzerland for 1996–1998 was determined by obtaining the mid-year population estimate for 1997 (15) and multiplying by three. The 5 year population estimate for Olmsted County, Minnesota for 1983–1987 was determined by taking the mean of the US census population estimates for 1980 and 1990 and multiplying by five (16). The report which used the U.K General Practice Research Database (5) determined the number of people who were actively enrolled each year (personal communication, K. Wilcox Hagberg, MPH, Boston Collaborative Drug Surveillance Program).

The study protocol was approved by the El Paso Institutional Review Board for the Protection of Human Subjects at the Texas Tech University Health Sciences Center, El Paso, Texas.

Results

Descriptive epidemiology (Table 1)

Florida's population rose from 14 477 888 in 1996 to 18 018 497 in 2005 with a 10 year total of 177 163 075 (8). A total of 89 cases were included to determine the average annual incidence of death from anaphylaxis which was 5.02 per 10 000 000 population [95% confidence interval (CI) = 4.08–6.18/10 000 000 population]. Detailed information was available for the 84 individuals who were Florida residents and died in the state of Florida. Autopsies were performed in 41 of these cases. The autopsy findings were used to complete the cause of death on the death certificate in 34 instances. The individuals with autopsy confirmed diagnoses were younger and more likely to be men than those with clinical

diagnoses only (Table 1). However, these two groups did not differ with regard to race, anaphylactic triggers or the clinical variables of lung disease [asthma and chronic obstructive pulmonary disease (COPD)] and heart disease. The median age was 61 years with a range of 13–92 years. The group was 50% male and 85% White. Among those with lung disease, eight had asthma and three had COPD. There were 16 with heart disease.

The 84 cases for which the death certificates were available were included in the determination of age-specific death rates from anaphylaxis (Table 2). Total population for ages 5–14 for all 10 years = 20 898 504. There were two deaths among this age group. $2/2.09 = 0.96$ deaths/10 million. Total population for ages 15–34 for all 10 years = 41 271 449. There were seven deaths among this age group. $7/4.127 = 1.70$ deaths/10 million. The 10 year Florida population for subjects 35–64 years old = 62 256 014. There were 38 anaphylactic deaths among this age group. $38/6.23 = 6.10$ deaths/10 million. The 10 year FL population for subjects ≥ 65 years old = 27 432 884. There were 37 deaths among this age group. $37/2.74 = 13.49$ deaths/10 million. The RR of death from anaphylaxis was 14.09 for individuals ≥ 65 years old ($P = 0.0000002$) and 6.38 ($P = 0.0019$) for individuals 35–64 years old in comparison with those who were 5–14 years of age. The likelihood of death from anaphylaxis increased with increasing age, P for trend < 0.0000001 (Fig. 1). Neither the crude nor the age-adjusted RRs for sex and race were statistically significant (Table 2).

Fifty percent of the population was male. The annual incidence of anaphylaxis among men is 5.34 deaths/10 million which is not different from that among women which is 5.08 deaths/10 million (Table 2). There were 71

Table 2. Average annual anaphylaxis mortality rate and relative risk of anaphylaxis mortality in Florida, 1995–2006

Risk group	Number of deaths	Anaphylaxis mortality rate per 10 million population	Relative risk (95% confidence interval)	Fisher's exact P -value*	Age-adjusted relative risk† (95% confidence interval)	Fisher's exact P -value* (age-adjusted result)
Overall mortality rate	89‡	5.02 (4.08–6.18)§	–	–	–	–
Age (years)						
≥65	37	13.49	14.09 (3.40–58.47)	0.0000002	–	–
35–64	38	6.10	6.38 (1.54–26.43)	0.0019	–	–
15–34	7	1.70	1.77 (0.37–8.53)	0.74	–	–
5–14	2	0.96	1 (Referent)	–	–	–
Sex						
Male	42	5.34	1.06 (0.69–1.62)	0.78	1.16 (0.75–1.78)	0.51
Female	42	5.08	1 (Referent)	–	1 (Referent)	–
Race						
Non-white	13	4.46	0.81 (0.45–1.45)	0.75	0.81 (0.44–1.45)	0.56
White	71	5.37	1 (Referent)	–	1 (Referent)	–

*Two-tailed.

†Mantel–Haenszel relative risk.

‡There were 89 anaphylactic deaths among Florida residents. Five of those occurred outside of Florida and information other than the cause of death was not available. There were 84 death certificates available for analysis.

§95% Wilson's confidence interval.

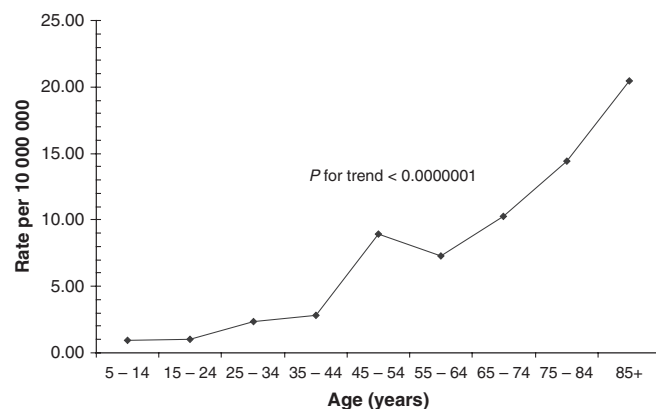


Figure 1. Anaphylactic death rates by age, Florida, 1996–2005.

Whites (85%) among those who died with anaphylaxis. The annual incidence of anaphylactic death is 5.37 deaths/10 million among Whites which was not different from that among non-Whites which is 4.64 deaths/10 million (Table 2).

Heart disease was present in 16 (19%) who died with anaphylaxis. Asthma was present in eight individuals (10%) and COPD in three (4%). The median age of the asthmatic individuals was 33.5 years (range 13–64 years). They were younger than the nonasthmatics whose median age was 63 years (range 24–92 years) ($P = 0.0019$, two-sided Wilcoxon rank sum test).

A total of 51 of the 84 deaths (63%) occurred in a hospital (Table 3). 24 deaths (28%) occurred in an Emergency Department or other outpatient care setting. Five deaths (6%) occurred at home and one death (1%) occurred in a nursing home. Three deaths occurred in other undetermined settings. Proportional mortality ratios are also shown in Table 3. Deaths in the emergency department and outpatient settings were more likely to be anaphylactic deaths than deaths that occurred among inpatients (age adjusted proportional mortality ratio = 2.11, $P = 0.0026$). Deaths in the nursing home

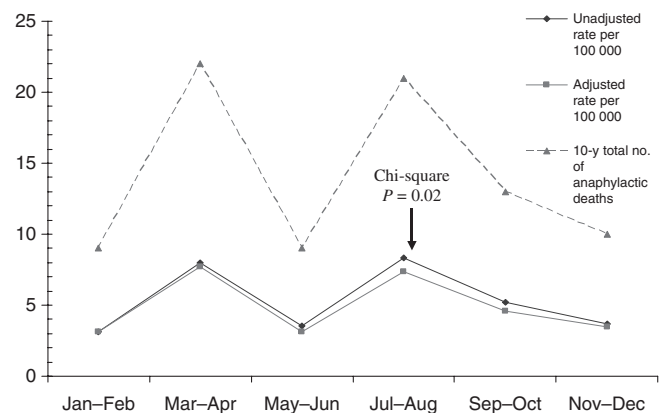


Figure 2. Temporal trend in the number of anaphylactic deaths (indicated with a broken line and triangle markers) and proportion of all deaths that were anaphylactic deaths per 100 000 total deaths [Unadjusted (diamond with solid line) and age-adjusted (square with solid line)].

were less likely to be anaphylactic deaths than deaths in the hospital (age adjusted proportional mortality ratio = 0.08, $P = 0.0005$) (Table 3).

Anaphylactic deaths occurred preferentially in the months of March (14 deaths, 17%) and April (10 deaths, 12%) and July (11 deaths, 13%) and August (10 deaths, 12%). The remaining 39 deaths (46%) were distributed among the remaining 8 months of the year. This is in contrast with all deaths which occurred relatively evenly throughout the year. Age adjusted proportions were calculated. There was no confounding of consequence by age. The ratios of anaphylactic deaths to total deaths in March and April and in July and August were significantly greater than the ratios for the other bimonthly periods ($P = 0.02$, 6×2 chi-squared test for independence) (Fig. 2).

The distribution of principal anaphylactic triggers is presented in Table 4. The anaphylactic trigger was specified on 44 of the 84 death certificates. There were 22 (50% of those specified) deaths as a result of

Table 3. Association between place of death and cause of death (anaphylactic death compared with deaths from other causes), Florida, 1996–2005

Place of death	Number of anaphylactic deaths	Number of deaths because of other causes	Unadjusted proportional mortality ratio*	95% confidence interval	P-value†	Age-adjusted proportional mortality ratio*	95% confidence interval	P-value‡
Hospital: ER/outpatient	24	106 309	2.78	1.71–4.51	0.0002	2.11	1.28–3.48	0.0026
Nursing home	1	288 123	0.04	0.01–0.29	<0.0001	0.08	0.01–0.52	0.0005
Decedent's home	5	401 070	0.15	0.06–0.38	<0.0001	0.14	0.06–0.35	<0.0001
Other (Other specified and Unknown)	3	140 274	0.26	0.08–0.84	0.01	0.18	0.05–0.67	0.004
Hospital: inpatient	51	627 369	1	(Referent)	–	1	(Referent)	–

*Proportion of Florida residents who died of anaphylaxis in a particular location compared with the proportion of Florida residents who died of anaphylaxis in the hospital as an inpatient.

†Two-tailed Fisher's exact

‡Two-tailed Mantel–Haenszel summary chi-square.

Table 4. Triggers for anaphylaxis ($n = 84$)

Description of diagnosis	Number (% of those with triggers indicated on death certificate) (ages in years)
Anaphylactic shock	84
Trigger not specified on death certificate	40
Anaphylactic shock because of food	7 (16%)
Peanuts	4 (ages 25, 36, 37, 64)
Crustaceans	1 (age 45)
Fruits (mango)	1 (age 50)
Food additives	1 (age 87)
Anaphylactic shock because of Hymenoptera	9 (20%)
Bees	2 (ages 24, 54)
Wasp	2 (ages 62, 62)
Ant	4 (ages 53, 61, 77, 90)
Uncertain	1 (age 34)
Anaphylactic shock because of radiocontrast medium	6 (14%) (ages 42, 46, 58, 68, 72, 77)
Anaphylactic shock because of medications	22 (50%)
Unspecified	4 (ages 71, 73, 78, 82)
Heparin	2 (ages 54, 68)
Protamine	4 (ages 64, 70, 71, 83)
Beta lactams	3 (ages 46, 46, 58)
Sulfamethoxazole/trimethoprim	1 (age 70)
Vancomycin	1 (age 91)
Quinupristin/dalfopristin (Synercid)(streptogramin)	1 (age 58)
Intravenous immunoglobulin	1 (age 76)
Indocyanine green	1 (age 78)
Local anesthetic	2 (ages 40, 86)
Acetaminophen and propoxyphene (Darvocet)	1 (age 76)
Oxcarbazepine	1 (age 48)

medications. The specific medications are listed in Table 4. Seven were men and 15 were women. Women were more likely than men to die from medication-induced anaphylaxis ($P = 0.048$, chi-square). There were nine deaths (20%) because of Hymenoptera stings (five) or ant bites (four). Men were more likely than women to have died from Hymenoptera anaphylaxis than from anaphylaxis from all other causes ($P = 0.03$, Fisher's

exact test). The deaths of 16% of the case series were caused by foods and 14% by radiocontrast media (Table 4).

Discussion

We report the average annual incidence of death from anaphylaxis in Florida to be 5.02 per 10 000 000 population from 1996 to 2005. This compares with one death from anaphylaxis in Olmsted County, MN (approximate population of 99 238 people in 1985) (16) over the 1983–1987 5-year interval (2) in which the average annual incidence of anaphylactic death was 20.15 per 10 000 000 population. However, because only one death occurred in Olmsted County, it is possible that the higher average annual incidence recorded there is a chance occurrence and does not represent the true incidence of anaphylactic death. Another possible explanation of this difference is that anaphylactic death is not diagnosed in 75% of cases in Florida. Underdiagnosis of anaphylaxis has been documented in other settings (17). However, the average annual incidence of anaphylactic death in Olmsted County was not different from that in Florida by chi-squared testing (Table 5) ($P = 0.45$). It is also believed that underdiagnosis of anaphylactic death as a result of food allergy may occur because these deaths may be coded as asthma deaths (18). A Canadian study revealed that 30 of 32 who died from anaphylaxis died with a respiratory condition listed as the cause of death (19). However, a Swedish study (20) did not find anaphylactic deaths to have been misdiagnosed as asthma deaths (T. Foucard, personal communication). A review of the epidemiology of anaphylaxis in the US estimated that there are approximately 1500 deaths annually with a fatality rate for anaphylaxis of 55/10 000 000 people (21). Our data suggest that this latter estimate may be inaccurately high.

Another comparison for the average annual incidence of death from anaphylaxis in Florida is the average annual incidence of death from anaphylaxis in the United Kingdom, 3.73/10 000 000 (7, 22) and 1.25/10 000 000 (5), and Switzerland, 11.06/10 000 000 (6). Table 5 shows the comparison of the average annual incidence of

Table 5. Comparison of the average annual incidence of death from anaphylaxis in Florida 1996–2005 with other published population-based anaphylactic mortality rates

Region years evaluated (reference)	Number of cases	Total cumulative population for years indicated	Anaphylactic deaths/10 million population (95% CI)*	P (Fisher's exact test)†
Florida 1996–2005	89	177 163 075	5.02 [4.08–6.18]	
Olmsted Co., Minn, 1983–1987 (2)	1	496 190	20.15 [3.56–114]	0.45
UK 1992–2001 (7)	214	573 337 000	3.73 [3.26–4.27]	0.24
UK 1994–1999 (5)	1	8 000 000	1.25 [0.21–7.08]	0.19
Switzerland 1996–1998 (6)	24	21,721,389	11.06 [7.41–16.44]	0.002

*Wilson's confidence interval.

†Two-tailed Fisher's exact test sequentially comparing Florida 1996–2005 with each of the other published population-based anaphylactic mortality rates.

anaphylactic death in the previous studies with the average annual incidence in Florida. The average annual incidence in Switzerland (11.06/10 000 000) was significantly greater than that in Florida by the Fisher's exact test ($P = 0.002$). The UK incidence rate reported using the U.K. General Practice Research Database (5) (1.25/10 000 000) should be considered an estimate of the incidence proportion (personal communication, K. Wilcox Hagberg, MPH, Boston Collaborative Drug Surveillance Program). This finding and the other UK study were not different by the Fisher's exact test (Table 5) ($P = 0.19$ and 0.24 , respectively) from that found in Florida.

We report that the likelihood of death from anaphylaxis increases with increasing age. This is consistent with our earlier finding that the likelihood of hospitalization from anaphylaxis similarly increases with increasing age (4). The present study is the only study to report age-group specific anaphylactic death rates. The previous British study (7) did not report age-specific mortality rates.

We found no difference in the likelihood of death from anaphylaxis between men and women, and between White and non-White individuals. This finding is consistent with previous estimates of anaphylactic death. However, those reports did not account for the total population of each race and each sex. (7). This study is also the only one to report anaphylactic proportional mortality (see Methods) by location of death (i.e. hospital inpatient, emergency department/clinic, home, etc) (Table 3).

The information on the death certificates on anaphylactic triggers was available on only 42 of the 84 death certificates (50%). In the cases in which the anaphylactic trigger was specified, we found that 50% were because of medications, 20% because of Hymenoptera stings, and 16% and 14% because of foods and radiocontrast media, respectively. The British population-based study (7) found that 37% were because of medications, 22% because of Hymenoptera stings, 27% because of foods and 5% because of radiocontrast media reactions. Our findings approximate the British data. The proportion of food-related anaphylaxis that we observed was similar to that found in Sweden (20).

Men were more likely than women to have died from Hymenoptera anaphylaxis than from anaphylaxis from all other causes. This finding is consistent with our previous finding that men were more likely than women to have been hospitalized for Hymenoptera anaphylaxis (4).

We found that anaphylactic death in Florida was more likely to occur in the months of March and April and again in July and August. The increase in deaths in the summer months was consistent with our previous report that hospitalization for anaphylaxis in Florida in 2001 was increased in the third quarter of that year (23). That increase in hospitalizations was accounted for by Hymenoptera sting anaphylaxis (23). We are not able to make a

similar association of a seasonal change in Hymenoptera sting anaphylaxis with the seasonal change in anaphylactic death. The Olmsted County study (2) found that the incidence of anaphylaxis was greatest in July, August and September in Minnesota. This was attributed by the authors to insect sting anaphylaxis (2).

This report has several strengths. The use of a series of statewide death certificates is a novel approach to study anaphylactic mortality. It is the first to study the epidemiology of anaphylactic death in the United States for a population of more than 16 000 000 people. A search of the PubMed/MEDLINE database did not reveal any similar large population-based studies in the United States. This study is also the first to report age-specific anaphylactic death rates. In addition, this is the first study to report anaphylactic deaths per population for gender and race. It is also the first to report anaphylactic proportional mortality by location and by month of death.

Our analysis was limited by our inability to confirm the accuracy of the complete death certificate record using another database. Underdiagnosis of anaphylaxis is believed to be common (17). To further evaluate the possibility of underdiagnosis, Florida in-hospital deaths from anaphylaxis in 2001 as determined from death certificates in the present study were compared with a review of all 10 diagnosis fields (as opposed to using only the principle diagnosis) of the hospital discharge database of the Florida Agency for Health Care Administration [see reference (4) for methods]. Four deaths were captured by both sources. Five in hospital deaths that were likely to be due to anaphylaxis were not so reported on the death certificates and three in hospital anaphylactic deaths as reported on the death certificates were not coded as anaphylaxis in the hospital discharge database. This limited assessment of the completeness of the death certificate data suggests that the actual number of anaphylactic deaths in Florida is higher than it is possible to determine on the basis of an analysis of only a single database.

The diagnosis of anaphylaxis was confirmed by autopsy in 40% of our cases. There was no difference in race, anaphylactic triggers or the clinical variables of lung disease (asthma and COPD) and heart disease between those with an autopsy confirmed diagnosis and those with a clinical diagnosis. However, those with an autopsy confirmed diagnosis were younger and more likely to be men than those with a clinical diagnosis. Nevertheless, we report a significantly higher death rate with increasing age. This suggests that underdiagnosis as a result of ascertainment bias (i.e. there were more anaphylactic deaths with increasing age although there were fewer autopsy confirmed diagnoses with increasing age) was not a significant factor in our analysis. We were unable to verify any of the diagnoses because of the retrospective nature of the study and because the deaths occurred throughout the state of Florida.

In conclusion, this large retrospective investigation of deaths from anaphylaxis in the State of Florida found an average annual incidence of 5.02 deaths per 10 000 000 people. People who were ≥ 65 years old and who were 35–64 years old, were 14.09 times and 6.38 times, respectively, as likely to die of anaphylaxis than those who were 5–14 years of age. Death from anaphylaxis was more likely to occur in an emergency department or clinic than in the hospital and was more likely to occur in March and April and in July and August than death from other causes.

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