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Death as a Result of Asthma in Wayne County Medical Examiner Cases, 1975–1987

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ABSTRACT: All deaths ascribed to asthma in the 5-to-40-year age group at the Wayne County Medical Examiners' Office were reviewed from 1975 to 1987 inclusive. Fifty-eight deaths were attributed solely to asthma, and the annual number increased fivefold in the 1980s to a rate of approximately 0.5 per 100 000 per year when extrapolated to the Wayne County population. Blacks were overrepresented to double their proportion in the general population. Almost all cases were known asthmatics, and many had received previous emergency care. Most fatalities occurred at night and did not demonstrate any seasonal variation. The onset of the fatal attack was apparently very rapid in most cases, with many engaged in routine activities and few surviving any length of time in hospital or having sought treatment earlier. Our data reveal a significant increase in sudden death in previously well asthmatics in Wayne County in the 1980s. Similar increases in deaths as a result of asthma have been noted previously in other countries for reasons that remain unclear.

KEYWORDS: pathology and biology, asthma, death

Despite the fact that asthma is, by definition, a reversible condition, it claims the lives of many individuals each year [1,2]. Recently, a trend of increasing mortality from asthma has appeared in the United States and other countries. The paradox of increased asthma deaths in conjunction with an increase in treatment availability has been noted in the literature [3], and the continuing deaths of young people from asthma remain perplexing [4].

The Wayne County Medical Examiners' Office (WCMEO, Michigan) serves a population that decreased from approximately 2.5 to 2.2 million from 1975 to 1987, during which time deaths attributed to asthma increased despite the decreasing population. Most of these were sudden deaths as opposed to deaths during relatively prolonged therapy as are more familiar in clinical practice. The available vital statistics report an increase in proportion of all deaths in Wayne County (WC) attributed to asthma from 0.14% in 1981 to 0.21% in 1986. The average number of asthma deaths in the approximately 10 000 cases reviewed each year by the WCMEO increased from 1.6 per year from 1975 to 1979

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to 8.3 in the period from 1985 to 1987. Most previous studies of asthma deaths have used only death certificate data. This study was undertaken to evaluate certain demographics of those cases in whom the diagnosis was supported by complete autopsy and toxicological analysis at the WCMEO from 1975 to 1987.

Methods

Deaths attributed to asthma and autopsied at WCMEO over the 13-year period from 1975 through 1987 were reviewed. Information was abstracted primarily from WCMEO files and was supplemented with hospital medical records when available (24 cases). Study cases were drawn from approximately 100 cases in which bronchial asthma or status asthmaticus was listed as a cause of death in WCMEO files. For individuals above approximately 44 years of age, other cardiovascular and respiratory diseases may complicate a primary diagnosis of asthma [5], and a decrease in accuracy of certifying asthma deaths over the age of 35 has been noted [6]. Therefore, in this study, only cases in which the victims age fell between 5 and 40 years inclusive were evaluated. To guard further against effects of coincident conditions, we excluded cases with any other diagnosis contributing to death, as we did those in which significant levels of non-therapeutic drugs were found. Cases were included only if complete autopsy, toxicologic testing, and investigation of circumstances of death revealed findings consistent with asthma and no other significant pathology.

The final selection of 58 cases were examined on the basis of age, race, sex, history and severity of asthma, medications, circumstances of death (including time of day, time of year, activity, duration of attack), and toxicological and histological findings.

Results

Some of the pertinent data available for each case are summarized in Table 1. The distribution of cases over the time course of this study is seen in Fig. 1; rates of asthma deaths by race, sex and nine-year age intervals are presented in Fig. 2.

All but 3 of the 58 cases had a known history of asthma, and asthma had been diagnosed in siblings of 1 of the 3 exceptions.

As a measure of severity of asthma, previous hospital admissions and outpatient visits were noted. Fourteen cases had documented inpatient stays, and ten other cases had known prior clinic visits, for treatment of asthma. Unfortunately, reliable information on previous medical care was unavailable for many cases.

A history of prescribed medication was obtained in 25 cases (Table 2), and 13 subjects had been treated with corticosteroids at least once. Postmortem serum theophylline concentration was determined in 14 cases, was undetectable in 6 and ranged from 5 to 24 $\mu\text{g/mL}$ in 8, with only 2 cases falling within the therapeutic range of 10 to 20 $\mu\text{g/mL}$.

This series of asthma deaths was distributed throughout the year, with no clustering in any specific month or season, although the highest monthly total did fall in early spring (Fig. 3). While the time of onset of most fatal attacks was undocumented, the majority culminated during the night (Fig. 4).

In nearly every case reviewed, the duration of the fatal asthma episode could not be determined because the exact time of onset of acute symptoms was unknown. However, almost all cases were reported to be engaged in normal activities immediately prior to sudden shortness of breath or collapse or both, and death occurred within minutes. Thirty-five cases were brought to an Emergency Room without vital signs after sudden collapse, eight cases were found unresponsive and did not respond to resuscitation attempts, and eight cases were found dead. Only one walked into an Emergency Room before collapsing, and only one case survived longer than an hour after reaching hospital.

TABLE 1—WCMEO Asthma Deaths, 1975–1987.

Case	Age, Sex, and Race ^a	Past History of Asthma and Treatment ^b	Month/Time of Death	Drug Tests ^c	Activity Before Death
1	11BM	8 H, ER previous month	5/0420	....	U after chastised by parent
2	28BF	X O	12/1225	barb.	SOB, C on way to drugstore, DOA
3	22BM	23–30 H, ER previous week, SM	11/2230	....	C walking on street, DOA
4	18BM	O previous week, TM	10/1320	....	SOB while reading, DOA
5	32WM	O previous day	5/0522	....	C at home, DOA
6	17WM	+	4/2300	....	SOB, C watching TV, DOA
7	12WM	?H, S	7/0005	....	European visitor, SOB, C, DOA
8	32BF	+, M	4/1000	....	SOB at home, DOA
9	24BF	X O, asthma since age 5	3/2115	....	SOB at home, DOA
10	14BF	X H, H previous month, STM	7/1842	....	SOB at picnic, 27 min in ER
11	39BF	+	3/0100	....	D in bed
12	27BF	+	12/0252	....	U at home, DOA
13	40WF	+	1/1617	....	C at home, DOA
14	16BM	1 H, 4 O, STM	2/0116	....	U at home with inhaler, DOA
15	15BM	+, "outgrew" childhood asthma	4/1915	....	chased by dog, C, DOA
16	17BF	+	4/1911	....	C playing soccer, DOA
17	34BM	+	5/0128	....	SOB, C, DOA
18	23BM	1 H, 5 O, ST, 3 attacks/year	6/0414	....	U at home in bathroom, DOA
19	24WM	+	7/1315	E0.10	found dead with inhaler
20	18WF	-, antihistamines	8/0200	....	found dead in bed
21	19WF	+	11/0650	....	SOB at home, C, DOA
22	23BM	3 H, 4 O, S	12/1651	....	SOB at home, C, DOA
23	30BF	+	5/1440	....	D at home
24	15BM	1 O previous 2 months, TM	7/1415	....	C running to beat curfew, DOA
25	8BM	- in victim, + in siblings	10/2020	lead	C playing with children, DOA
26	38BF	+, STM	12/2051	....	SOB at home, C, DOA
27	38WM	+, STM	12/2040	....	SOB at home, ER for 40 min
28	38BF	+, TM	1/0015	....	increased asthma meds. lately, C, DOA
29	38BF	+	5/0621	....	D on front lawn

30	29BM	O previous 2 months, STM	8/0430	...	SOB, phoned help, DOA
31	37WM	X O	9/0544	...	SOB at home, DOA
32	38WF	+ X O	9/2254	E0.17	SOB in car, DOA
33	27BF	+ , STM	10/ ?	E0.06	nurse, D at home with inhaler
34	25BM	+ , STM	10/ ?	T24.0	D at home
35	33BF	4 H, H previous 2 months, STM	3/1255	T 5.4	D at home
36	24BF	X O, O previous week, T	4/0240	T 9.4	C at home, DOA
37	31BM	+ , TM	4/2308	T.	U at home, DOA
38	11BF	+ , TM	4/1537	...	U after argument at home, DOA
39	10BM	+ , T(1.2 g in stomach)	6/1830	T.	SOB, C at home, DOA
40	24WM	+ , TM	7/0135	T 9.0	SOB, walked into ER, D in 25 min
41	39BF	+ , TM	9/0505	T.	C during phone call, DOA
42	20BM	?H, T, increased SOB previous 3 days	7/0410	T16.0	increased SOB, C at home, 130 min in ER
43	21WF	+ X H, STM	9/0313	...	C at home, DOA
44	25BF	+ X O, T	11/1853	T.	C at home, DOA
45	10BF	+ X H, STM	11/1850	T 5.0	SOB at home, DOA
46	17BF	+ X H, STM	11/1800	T12.0	C at home, coma, 1 day in H
47	8BM	+ X H, H previous month, SM	12/2005	...	C at home, DOA
48	31BM	+ , H previous day	2/0040	...	C at home, DOA
49	17BM	+ , TM	3/0236	T.	C at home, DOA
50	32WM	+ , TM	4/0023	...	C at home, DOA
51	31WF	+ , TM	4/0215	...	U at home, DOA
52	40BM	+ X H, O previous week, T	5/0017	...	SOB, C, DOA
53	25BM	+ , brother D of asthma previous year	5/1944	T 5.0	U at home, DOA
54	33BM	4 H, X O, ?meds.	7/0305	...	C at home, DOA
55	13BM	- X H, H previous week	9/0625	...	SOB at friend's, C at home, DOA
56	13BM	- X H, H previous week	9/0130	...	SOB at home, C, DOA
57	35BM	- X H, H previous week	10/1443	...	C at florist's, DOA
58	31BM	- X H, H previous week	12/1831	T.	SOB, C, DOA

^aB = black, W = white, F = female, and M = male.
^b+ = positive, - = negative, X = multiple, ? = unknown, S = corticosteroid, T = theophylline, M = sympathomimetic, O = previous office/clinic/ER visit for asthma, H = previous hospital admission for asthma, SOB = shortness of breath, and D = dead.
^cbarb. = 1.6 µg/mL of butobarbital and 1.0 µg/mL of amobarbital, lead = 0.16 µg/mL, E = ethanol (in g/dL), and T = theophylline (in µg/mL).
^dD = dead, C = collapsed, U = unresponsive, H = previous hospital admission for asthma, and DOA = dead on arrival at ER.

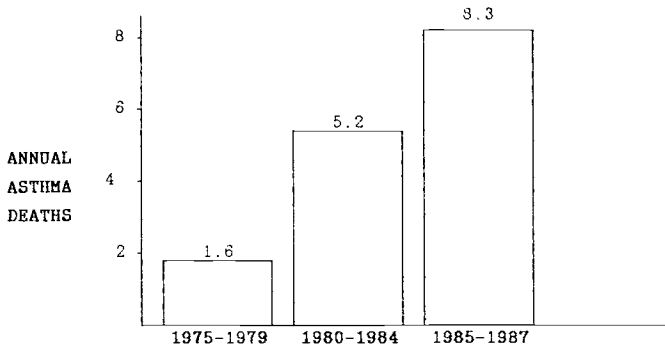


FIG. 1—Average annual number of WCMEO asthma deaths, 1975-1987.

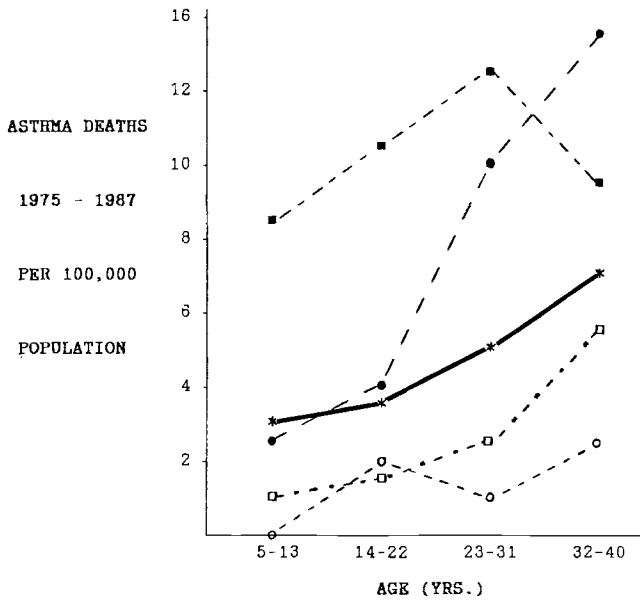


FIG. 2—WCMEO asthma deaths 1975-1987 per 100 000 of 1981 WC population by age groups (black male = ■; black female = ●; white male = □; white female = ○; total = *).

Postmortem toxicologic screening was positive for drugs other than theophylline in five cases: ethanol in three (0.06, 0.10, and 0.17 g/dL), lead in one (0.16 µg/mL), and low levels of barbiturates in one case (1.6 µg/mL of butobarbital and 1.0 µg/mL of amobarbital).

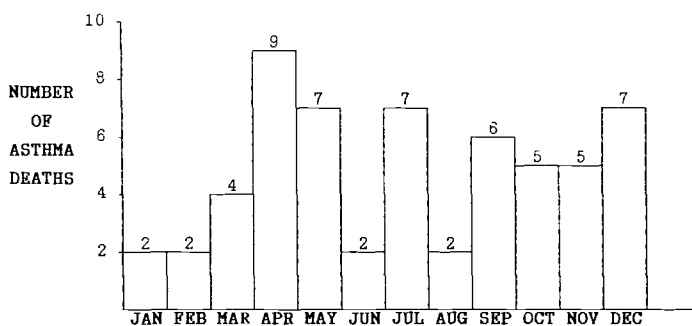
Histologic material was available for review in 31 cases, all with findings compatible with a diagnosis of asthma. These included well-developed but variable degrees of mucus plugging of small bronchi, mucous hyperplasia of bronchi, basement membrane thickening, hyperplasia of bronchiolar smooth muscle, and eosinophil infiltration.

Discussion

Our series demonstrates a significant rise in rate of death from asthma in WC in the 1980s, although the rates for the early 1980s are comparable to those recorded in the

TABLE 2—*Drugs prescribed for WCMEO asthma deaths, 1975–1987.*

Drug	No. of Cases
SINGLE DRUG:	
Theophylline	5
Sympathomimetic	1
Unspecified inhaler	1
Antihistamine	1
TOTAL	8
TWO DRUGS:	
Theophylline + sympathomimetic	5
Theophylline + corticosteroid	1
Sympathomimetic + corticosteroid	1
TOTAL	7
THREE OR MORE DRUGS:	
Theophylline + sympathomimetic + corticosteroid	3
Theophylline + 2 sympathomimetic	1
Corticosteroid + 2 sympathomimetic	1
Theophylline + 2 sympathomimetic + corticosteroid	1
Theophylline + sympathomimetic + corticosteroid + antihistamine	1
Theophylline + 2 sympathomimetic + antihistamine + antibiotic	1
Theophylline + 2 sympathomimetic + corticosteroid + antibiotic	1
TOTAL	9
Medication of unspecified type	1
Medication history unknown	33

FIG. 3—*Month of death of WCMEO asthma cases, 1975–1987.*

northwestern United States [1]. Allowing for the slight predominance of the 15 to 25 age group in the WC population, our series demonstrates a small but steady increase in asthma deaths with increasing age in the 5- to 40-year age range. The proportion of blacks in the WC population increased from 32 to 40% over the period of this study, yet more than three quarters of our series were black. This may reflect general overrepresentation of blacks in a medical examiner's case population, as suggested by Copeland [7], and the total case population of the WCMEO (68% were black in 1987).

Treatment histories were unavailable or incomplete in many cases in this series, but when known almost always included asthma medication. However, only 2 of 14 cases exhibited postmortem levels of theophylline within therapeutic limits, suggesting the common problem of poor compliance [8]. One case's use of barbiturate sedatives with their attendant respiratory depression may have influenced the fatal outcome of an asthmatic attack, as may an elevated ethanol level in Case 32.

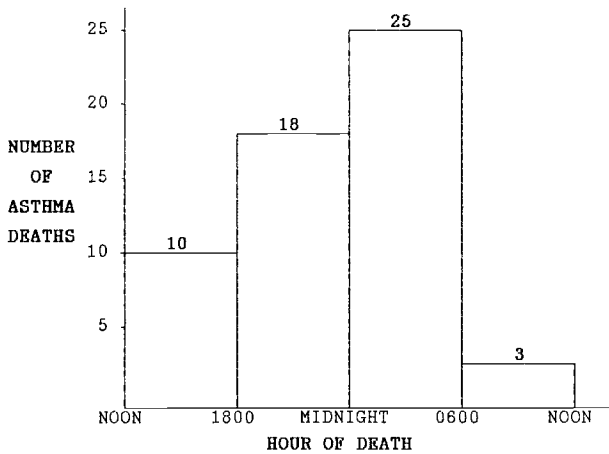


FIG. 4—Hour of death of WCMEO asthma cases, 1975–1987.

The numbers of deaths each month do not show an increase during May through July, as noted in one report [9], or July through September, as seen in another study [10]. The well-recognized predominance of nocturnal deaths from asthma [9,11] was apparent in this series, in which the majority of fatal attacks occurred during the night.

Our results are in agreement with others suggesting that 60 to 80% of fatal asthma attacks develop at home [12]. Several cases, especially those of younger ages, suffered some degree of emotional or physical stress or both just before their attacks (for example, Cases 1, 4, 5, 16, 24, and 30), supporting the view that psychosocial factors can contribute to sudden severe asthma [2,13,14]. Most striking in our cases was the apparent rapidity of death in subjects evidently engaged in routine activities only a short time before. Many cases were declared dead at home and most were without vital signs on arrival at an Emergency Room. Such cases were not being actively treated for asthma at the time of the fatal attack, and clinicians may not fully appreciate this phenomenon of sudden death in subjects who were apparently not badly compromised clinically.

The cases in this study were, by design, restricted in their age range, unlike other studies of asthma deaths. Although very sudden death from asthma may be more common at younger ages, accounting for its preponderance in these cases, this is difficult to reconcile with the observed trend of increasing asthma deaths with age. Another possible explanation is that apparently sudden death from asthma is more common in the socioeconomically disadvantaged with poorer access to health care. Such subjects appeared to be overrepresented in this series (more so than in the WC population as a whole), although it was not possible for us to undertake formal evaluations of socioeconomic status. In addition, the socioeconomically more advantaged were not dying from asthma while receiving medical care and having their deaths recorded by institutions other than the WCMEO. This is apparent from the fact that almost all WC asthma deaths recorded in the available vital statistics for the age range of this study were accounted for by WCMEO cases. They therefore do not appear to be a group that has been subject to selection bias by their place of death. It is still possible that the socioeconomically more advantaged, perhaps as a result of better long-term care and better transport, arrived at Emergency Rooms with vital functions present and were successfully resuscitated from otherwise fatal asthma episodes.

Delay in seeking medical intervention has been cited in asthma deaths [2,9,12,15–17], and this has been attributed to subjects underestimating the severity of their episode of

bronchospasm [2,9,12,15,17–21]. In this study, most cases felt well enough to engage in normal activities. For example, Case 55, a 13-year-old boy, felt well enough to sleep over at a friend's house but telephoned home at dawn saying he was unwell and would return. He collapsed on the porch of his home. Tragically, his brother had died of asthma 1 year before.

In this series, many victims appear to have been subjectively unaffected by bronchospasm until only very shortly before their deaths, while histologic examination revealed signs of chronic asthma supported by available history in many cases. It has been suggested that asthmatics may overrely on medication [22] or persist with ineffective treatment [23]. Noteworthy in this respect was one case found dead with an inhaler in hand while another was noted by family members to have been heavily self-medicating for some time before death. Case 2 was being driven to a pharmacy for asthma medications, but collapsed en route and was dead on arrival at an Emergency Room. Most cases in this study were chronic asthmatics who had previously been prescribed asthma medication, and many had histories of previous emergency treatment. They were presumably familiar with the symptoms of asthma, yet few sought medical aid for their fatal attacks until *in extremis*. While they may have been subjectively unaware of the severity of their condition, as noted by several authors [4,12,24], some were physically active without evident respiratory compromise (for example, Cases 15, 16, and 24) until the sudden onset of rapidly fatal asthma.

Sudden, unexpected death is still rare in asthmatics who should be encouraged to lead as active, normal lives as possible. Moreover, the circumstances of these cases do not negate the view of many authors [4,9,13,24,25] that asthmatics must be educated about all aspects of their condition, including its rare fatal conclusion. Despite their apparently sudden and unexpected deaths, most cases in this series had histories and autopsy findings of chronic asthma with previous severe episodes. In view of this, it would seem prudent for asthmatics and their associates to know how to monitor objectively their respiratory status and how to recognize when it is not responding to available therapy, and that they must have ready access to appropriate emergency care.

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