

A comparison of asthma deaths and near-fatal asthma attacks in South Australia

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ABSTRACT: Studies seeking to identify factors predictive of asthma mortality have relied on information obtained from relatives, other close acquaintances, and doctors who cared for the deceased. We wanted to determine whether asthmatics who have suffered a near-fatal asthma attack (NFA) are similar to asthmatics who have died of asthma with respect to important features, because studies of NFA asthmatics may provide a better insight into causes of asthma death. Such studies would avoid the difficulties associated with seeking information secondhand from proxy informants.

Two groups were studied: asthmatics who had suffered a near-fatal asthma attack resulting in a visit to the accident and emergency departments of teaching hospitals (n=154), and asthmatics certified as dying of asthma who, following panel review, were confirmed to have died from this disease (n=80). For each case in the two groups, an interview questionnaire was administered to a close acquaintance (household or family member) and to the general practitioner.

Both groups shared many important characteristics. Similarities related to: frequency of symptoms; frequency of hospital and intensive care unit admissions for asthma; use of asthma crisis plans; compliance with prescribed medications; quality of personal asthma management; and asthma severity. The two groups also showed similar psychiatric profiles, and similar use of asthma medications on a regular basis and with increased symptoms. However, NFA cases tended to be younger, were more likely to be male, and less likely to have concurrent medical conditions. Where the final episode was considered definitely or probably preventable, NFA cases were less likely to have experienced delay in actually receiving medical care, and were found to have had more ready access to acute medical care.

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Certified asthma death rates increased markedly in Australia in the 10 yrs to 1988 [1]. Meanwhile, a number of studies have identified high levels of potentially preventable or avoidable factors associated with asthma mortality [2–5], including deficiencies in professional and self-management characteristics. YELLOWLEES and RUFFIN [6] also found high levels of psychiatric disorders, including denial and anxiety, among individuals experiencing near-fatal attacks of asthma. REA *et al.* [5] indicated the importance of a history of a previous near-fatal asthma attack as a risk factor for subsequent death due to asthma. This observation raises the question of whether asthmatics who suffer near-fatal attacks (NFAs) are similar in many respects to those who die of asthma.

If it can be shown that NFA cases are similar to asthma death cases with regard to asthma severity, quality of personal, self-management and psychosocial characteristics, and other features, then broader descriptive studies of NFA cases may yield a better characterization of

asthmatic subjects at risk of fatal asthma, and reveal opportunities for preventive intervention. Such studies would not encounter the difficulties found in death studies, where detailed information cannot be obtained directly from subjects.

A principal objective of the present study was to test whether patients dying of asthma and asthmatics experiencing NFAs were similar with regard to: their personal and psychiatric characteristics; the history and severity of their asthma; features of medical and personal management; circumstances surrounding the fatal or near-fatal episode; and whether the episode could have been prevented.

Methods

The State of South Australia has a population of over 1.4 million people, of whom more than one million reside in the capital city, Adelaide. The study period was from

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May, 1988 to June, 1991. Persons dying in South Australia during this period were enrolled in the study if "asthma", "asthmatic" or "status asthmaticus" was recorded in Part I or II of the death certificate. The death certificates were reviewed by a panel comprising six respiratory physicians, a general practitioner and a research assistant (a registered nurse). If, following this review, the panel considered that the death may have been due to asthma, the certifying doctor was interviewed concerning the circumstances surrounding the death. This applied for 89% of cases. Except where certifying doctors provided clear and compelling evidence that asthma was not the cause of death, interviews were held with the subjects' general practitioners, allied health professionals and household or other close acquaintances. This normally occurred within three months of the death. Close acquaintances were not available for interview in three instances, and declined to participate on five other occasions. Of the 165 deceased cases where interviews of close acquaintances and medical practitioners were possible (95%), the panel concluded that 80 were "definite" asthma deaths, and the remainder were either not due to asthma or the role of asthma was uncertain. Only data for the 80 "definite" asthma deaths are presented here.

During the same period, NFA cases visiting the accident and emergency departments of Adelaide teaching hospitals were recruited. To be eligible for entry into the study, cases had to have experienced asthma resulting in either respiratory arrest, or an arterial carbon dioxide tension (P_{aCO_2}) above 50 mmHg (6.7 kPa), and/or an altered conscious state or inability to speak on presentation to hospital [6]. Of the 158 eligible cases identified during the study period, 154 (97%) agreed to participate. To obtain comparable data for both the deceased and NFA cases, and to avoid measurement bias in the comparisons, interviews of an identical format to those for death cases were held with household or other close acquaintances and general medical practitioners, as a prelude to case review by the assessment panel. The reliability of data obtained directly from household and other close acquaintances, when compared with data obtained from cases suffering near-fatal asthma attacks, has been described previously [7].

The interview questionnaire used in previous surveys of asthma mortality in New Zealand and Victoria was used [2, 3]. The questionnaire contained sections on personal details, previous asthma symptoms and management, and circumstances surrounding the final event. Additional items concerning psychiatric characteristics were added. These included history of personal and family psychiatric treatment, the denial scale of the Illness Behaviour Questionnaire [8], and the General Health Questionnaire (GHQ)-28 [9], which measures psychiatric caseness.

A diagnosis of asthma was accepted if the subject's general practitioner reported that he/she had asthma, and one of the following conditions was present: 1) subjective evidence of variable wheeze and/or breathlessness and a response to asthma treatment; 2) objective evidence of 20% reversibility in peak expiratory flow recordings, or forced expiratory volume in one second (FEV_1) by

spirometry (with 200 ml incremental improvement following bronchodilator administration); and 3) autopsy evidence of asthma, including epithelial shedding, eosinophil infiltration in the walls of small airways and thickening of the basement membrane.

All reported information was reviewed by the assessment panel, which made collective judgements based on the professional backgrounds of members. The presence of psychosocial features which may have contributed to the asthma episode was assessed from reported evidence of psychiatric illness, drug abuse, social isolation, intellectual handicap or denial of asthma severity. Judgements concerning the severity of the asthma, and the likelihood that asthma caused the final episode, were made according to criteria established prior to study commencement. Asthma severity in the 12 months prior to the fatal or near-fatal episode was classified as mild, moderate or severe, based on reported symptoms, exercise capacity, medication requirements and frequency of attacks, and utilization of medical services for asthma episodes, as described by ROBERTSON *et al.* [2]. Assessments were made concerning the quality of self-management and the appropriateness of, and compliance with, prior therapy; and whether the subject had been provided with an action plan specifying the actions to be taken in the event of deteriorating asthma control. Finally, an assessment was made concerning the preventability of the episode and whether end-stage asthma was present.

It was recognized from the outset that panel assessments of many items would be highly subjective. Attempts were made to reduce the potential for bias by undertaking panel assessments of death and NFA cases in haphazard order, and by using a highly structured assessment process. Because respondents were often insufficiently well-informed to respond, the numbers of responses (n) varied for individual items. These numbers are specified with the results.

Analysis

Univariate comparisons of death and NFA data were undertaken using the Mann-Whitney U-test for ordinal variables, and the conventional Chi-squared test for polychotomous nominal and dichotomous variables [10]. Fisher's exact test was substituted when 2×2 tables yielded expected values of less than five [11]. Because death and NFA cases were found to vary by age and sex, unconditional logistic regression was undertaken when univariate tests produced p values towards the lower end of the scale ($p < 0.25$) [12, 13]. The purpose was to test whether individuals' features were predictive of membership of the death or NFA group after adjusting for age and sex. To improve model fit, age was treated as three dummy variables, *i.e.* 20–39, 40–59 and ≥ 60 yrs, respectively, with 0–19 year olds as the reference category. All models were examined for goodness of fit and collinearity among predictors, and were found to fit the data well, with little evidence of ill-conditioning [14]. Throughout the results section, it should be noted that reference to regression analysis pertains to logistic regression, where age and sex were entered together with the feature of specific interest.

Results

Personal characteristics

For age and sex. Death cases (n=80) were older than the NFA cases (n=154), the mean (\pm SEM) ages being 52 (\pm 2.4) and 36 (\pm 1.8) yrs, respectively. There was also a difference by sex ($\chi^2_{(1)}=6.4$; $p=0.011$), with males comprising 39% of deaths and 57% of NFA cases. Age and sex were found to be independent predictors in the logistic regression ($p<0.001$ and $p=0.010$, respectively).

Searching for psychosocial factors. There was no significant difference between the 22% of death cases (n=63) and 17% of NFA cases (n=121) who had a history of psychiatric consultation ($p=0.457$), or between the 21% (n=58) and 14% (n=119), respectively, where a past psychiatric history was obtained for a first-degree family member ($p=0.388$).

Mean denial scores for subjects aged 15 yrs or more were 3.1 for death cases (n=58) and 3.4 for NFA cases (n=96), with high scores of three or more being more common among NFA cases (74%) than death cases (55%) ($\chi^2_{(1)}=4.9$; $p=0.026$). Regression analysis showed this latter difference to be significant after age-sex adjustment ($p=0.041$).

As for denial, assessments of psychiatric caseness (using the GHQ-28 questionnaire) were limited to subjects aged 15 yrs or more; the mean scores being 5.3 for death cases and 5.7 for NFA cases (Mann-Whitney; $p=0.846$).

Based on all of the available evidence, the panel concluded that 86% of the death cases (n=77) and 88% of NFA cases (n=153) had psychosocial features which could have contributed to their asthma episode ($p=0.739$).

For tobacco use. The histories of death cases (n=71) and NFA cases (n=127) were similar, with 45 and 52%, respectively, being smokers or ex-smokers ($p=0.434$), and 14 and 19%, respectively, being current smokers ($p=0.506$).

Asthma features

No significant intergroup differences were found for asthma severity ratings or effects on work or school attendance (table 1). Whilst objective evidence of fixed airflow obstruction tended to be more common for death cases, this was not significant ($p=0.115$), nor was it in the regression analysis after age-sex adjustment ($p=0.741$). Symptom histories suggested that more death cases than NFA cases had experienced frequent symptoms in the three months prior to the last episode, but this was not a significant predictor in the regression analysis ($p=0.311$). Whilst death cases were found to have suffered from asthma for a longer duration than NFA cases, this was a function of their older age and was not significant when adjusting for age and sex in the logistic regression ($p=0.649$).

Significant intergroup differences were evident for other features, however. Fewer death cases showed objective evidence of reversibility, as indicated by spirometry or peak-flow monitoring, and this was confirmed in the regression analysis ($p=0.053$). Regression analysis also confirmed that after age-sex adjustment, death cases were more likely to have other significant medical conditions ($p=0.019$). By comparison, NFA cases were reported to have shown a greater tendency towards unstable and deteriorating asthma symptoms during the past 12 months,

Table 1. – Features of asthma conditions of 80 cases dying of asthma and 154 having near-fatal attacks, as assessed from reports of near acquaintances and medical practitioners: South Australia, 1988–1991

Feature	Death cases %	Near-fatal attack cases %	p value
Asthma severity			
Mild	5	7	
Moderate	22 (n=73)	28 (n=148)	0.260*
Severe	73	65	
Objective evidence of:			
Reversibility	37 (n=79)	51 (n=148)	0.061†
Fixed airflow obstruction	24 (n=78)	15 (n=142)	0.115†
Symptom history			
None for 3 yrs	1	1	
None for 3 months	1 (n=74)	3 (n=126)	0.085*
In last 3 months less than weekly at least weekly	11 87	20 76	
Symptom progression in last 12 months			
Improving	3	2	
Stable	52 (n=64)	33 (n=95)	0.014*
Unstable/deteriorating	45	65	
Mean duration since age of onset yrs	25.1 (n=67)	21.2 (n=149)	0.158*
Asthma causing >1 week absence from work/school/usual daily activities (12 month period)	57 (n=63)	62 (n=123)	0.650†
Presence of other significant medical conditions	63 (n=70)	33 (n=131)	<0.001†

*: Mann-Whitney U-test; †: conventional Chi-squared test (one degree of freedom). n: number of cases where valid responses were obtained for each feature.

which was also confirmed in the regression analysis ($p=0.023$).

Responses to prior acute episodes

Death and NFA cases had similar histories for: visits to hospital accident and emergency departments; hospital admissions; admissions to intensive care units; and episodes requiring assisted ventilation (table 2).

Routine asthma management

Choice of primary health care provider was similar, with 74% of death cases and 71% of NFA cases using general medical practitioners (table 3). However, death cases reportedly had made more visits to their doctors for asthma in the prior 12 months, and this was confirmed to be so after age-sex adjustment in the regression analysis ($p=0.013$).

When all aspects of clinical care were considered by the panel, a similar proportion of death (28%) and NFA cases (23%) was found to have received care of optimum quality. Whilst more death than NFA cases had been given a crisis plan, this was not found to be significant in the regression analysis ($p=0.448$). However, more death cases (92%) than NFA cases (80%) were reported to have been shown how to use an inhaler, and this was significant in the regression analysis ($p=0.014$).

Whilst death cases were found in the univariate analysis to have had better self-management, this feature was age-related and the difference was not significant after adjusting for age and sex in the regression analysis ($p=0.471$). Similarly, whilst death cases reportedly showed better compliance with prescribed medications, this was not significant in the regression analysis ($p=0.944$). Moreover, the use of peak-flow meters at home in the last three months appeared to be similar in the two groups (table 3).

Use of medications

Regular use. A higher proportion of death cases (92%) ($n=76$) used some type of asthma medication regularly, when compared with NFA cases (79%) ($n=151$) ($\chi^2_{(1)} p=0.019$). The difference was confirmed after age-sex adjustment in the regression analysis ($p=0.003$).

More death cases than NFA cases reportedly used beta-agonists. After adjusting for age and sex in the regression analysis, the following were found to be more common among the death group: 1) use of any beta-agonist ($p=0.046$); 2) use of nebulized beta-agonists (any) ($p=0.016$); and 3) use of beta-agonist plus theophylline ($p=0.049$) (table 4).

There was also a tendency for more death than NFA cases to use a bronchodilator (beta-agonist or theophylline), together with an inhaled corticosteroids or cromoglycate, plus oral corticosteroids (table 4), but these differences were not significant in the regression analysis ($p>0.200$).

Symptomatic use. More death cases (92%) ($n=77$) were found to increase their use of some type of asthma medication with increased symptoms, when compared with NFA cases (84%) ($n=152$) ($\chi^2_{(1)} p=0.109$). This was confirmed after age-sex adjustment in the regression analysis ($p=0.017$). However, differences were not found by type of medication (table 5).

Purchasing. There was no significant difference between the proportions of death cases ($n=61$) and NFA cases ($n=123$) who were reported to have purchased beta-agonists directly from a pharmacy rather than on prescription, 16 and 24%, respectively, ($p=0.352$). Whilst fewer death cases (24%) than NFA cases (42%) were found to have made repeat purchases of prescribed items without further medical consultation ($\chi^2_{(1)}=4.7$; $p=0.030$), this was not significant after age-sex adjustment in the logistic regression ($p=0.215$).

Table 2. – Responses to past acute asthma episodes by 80 cases dying of asthma and 154 having near-fatal attacks, as assessed from reports of near acquaintances: South Australia, 1988–1991

Responses	Death cases	Near-fatal attack cases	p value
Mean number of visits to hospital accident and emergency department per subject			
Last 12 months	0.4 ($n=71$)	0.5 ($n=125$)	0.291*
Last month	0.1 ($n=77$)	0.1 ($n=151$)	0.537*
Visiting hospital accident and emergency department %			
Last 12 months	15 ($n=71$)	22 ($n=125$)	0.394†
Last month	4 ($n=77$)	6 ($n=151$)	0.755§
Hospital admission %			
Ever	80 ($n=74$)	81 ($n=131$)	0.982†
Last 12 months	39 ($n=71$)	45 ($n=125$)	0.562†
Last month	15 ($n=71$)	11 ($n=125$)	0.520†
Admission to an intensive care unit (ever) %	24 ($n=67$)	25 ($n=122$)	0.955†
Requirement for assisted ventilation %	17 ($n=64$)	17 ($n=125$)	0.890†

*: Mann-Whitney U-test; †: conventional Chi-squared test (one degree of freedom); §: Fisher's Exact Test. n: number of cases where valid responses were obtained for each item.

Table 3. – Features of routine asthma management of 80 cases dying of asthma and 154 having near-fatal attacks, as assessed from reports of near acquaintances and medical practitioners: South Australia, 1988–1991

Features	Death cases	Near-fatal attack cases	p value
Primary care provider %			
General medical practitioner	74	71	
Specialist physician	11	18	
Hospital clinic staff	4 (n=74)	1 (n=130)	0.363 [#]
Community health centre staff	4	3	
Other	7	8	
Mean number of visits to doctor per subject			
Last 12 months	17.9 (n=58)	10.2 (n=126)	0.004*
Last month	1.4 (n=61)	1.1 (n=123)	0.254*
Visiting a doctor %			
Last 12 months	97 (n=58)	95 (n=126)	1.000 ^{\$}
Last month	69 (n=61)	57 (n=123)	0.161 [†]
Appropriate crisis plan provided %	63 (n=72)	51 (n=150)	0.130 [†]
Used a peak-flow meter at home %	31 (n=64)	38 (n=124)	0.458 [†]
Had a lung-function test (from general practitioner) %	35 (n=69)	41 (n=98)	0.530 [†]
Had a lung-function test (general or specialist practitioner) %	72 (n=74)	79 (n=139)	0.288 [†]
Generally took medication as prescribed %	69 (n=62)	58 (n=126)	0.176 [†]
Clinical care regarded as optimum %	28 (n=78)	23 (n=151)	0.501 [†]
Self-management %			
good	38	22	
adequate	9 (n=74)	11 (n=150)	0.022*
poor	53	67	

*: Mann-Whitney U-test; †: conventional Chi-squared test (one degree of freedom); \$: Fisher's Exact Test; #: conventional Chi-squared test (four degrees of freedom). n: number of cases where valid responses were obtained for each feature.

Table 4. – Medications used regularly during the past 12 months by 80 cases dying of asthma and 154 having near-fatal attacks, as assessed from reports of near acquaintances: South Australia, 1988–1991

Medications	Death cases %	Near-fatal attack cases %	p value
Beta-agonists (any)	86 (n=80)	77 (n=154)	0.116 [†]
Nebulized beta-agonists (any)	39 (n=80)	22 (n=154)	0.011 [†]
Beta-agonists without accompanying corticosteroids	53 (n=80)	45 (n=154)	0.327 [†]
Theophylline	49 (n=80)	49 (n=154)	0.896 [†]
Theophylline without corticosteroids or cromoglycate	38 (n=80)	37 (n=154)	0.945 [†]
Inhaled disodium cromoglycate	6 (n=80)	8 (n=154)	0.735 [†]
Inhaled corticosteroids	44 (n=80)	38 (n=154)	0.506 [†]
Oral corticosteroids	26 (n=80)	16 (n=154)	0.098 [†]
Beta-agonists plus theophylline	86 (n=80)	77 (n=154)	0.143 [†]
Bronchodilator (beta-agonists or theophylline) plus inhaled corticosteroid or cromoglycate	48 (n=80)	44 (n=154)	0.657 [†]
Bronchodilator (beta-agonist or theophylline) plus inhaled corticosteroid or cromoglycate plus an oral corticosteroid	18 (n=80)	10 (n=154)	0.134 [†]
Bronchodilator (beta-agonist or theophylline) plus an oral corticosteroid but no inhaled corticosteroid or cromoglycate	9 (n=80)	6 (n=154)	0.715 [†]

†: conventional Chi-squared test (one degree of freedom); n: number of cases where valid responses were obtained.

Table 5. – Medications used with increased symptoms during the past 12 months by 80 cases dying of asthma and 154 having near-fatal attacks, as assessed from reports of near acquaintances: South Australia, 1988–1991

Medications	Death cases %	Near-fatal attack cases %	p value
Beta-agonists (any)	88 (n=80)	82 (n=154)	0.417 [†]
Nebulizer beta-agonists (any)	48 (n=80)	39 (n=154)	0.264 [†]
Theophylline	6 (n=80)	8 (n=154)	0.735 [†]
Inhaled corticosteroids	6 (n=80)	7 (n=154)	0.987 [†]
Oral corticosteroids	21 (n=80)	20 (n=154)	0.976 [†]

Final episodes

Of the death cases (n=79), 49% were found to have experienced acute progressive respiratory distress, 32% a sudden collapse, and 5% to have died whilst receiving palliative care, whereas 14% were found dead. The ratio of acute progressive respiratory distress to sudden collapse of 4.0:1 for NFA cases (n=154) was much higher than the corresponding ratio of 1.6:1 for death cases (n=64), and the difference was significant in the regression analysis after age-sex adjustment (p=0.005).

Ready access to acute and general medical care applied to over 90% of subjects, but 56% of death cases (n=64) and 58% of NFA cases (n=154) were found to have delayed seeking medical care. Undue delay in receiving this care was found for 28% of death cases (n=65) and 10% of NFA cases (n=153), and this was significant after age-sex adjustment in the regression analysis (p=0.003).

More of the death cases (n=70) than NFA cases (n=153) were considered to have experienced appropriate help-seeking from close acquaintances, the respective percentages being 71 and 50% ($\chi^2_{(1)}=8.4$; p=0.004), but this feature was strongly age-related and the difference was not statistically significant in the logistic regression (p=0.114).

Preventability

Panel assessments of this aspect varied ($\chi^2_{(3)}=26.4$; p<0.001), the respective percentages for death cases (n=79) and NFA cases (n=153) being: 1) definitely preventable 22 and 8%; 2) probably preventable 41 and

75%; 3) probably not preventable 28 and 11%; and 4) definitely not preventable 10 and 6%. Notably, 62% of deaths were considered definitely or probably preventable, compared with 83% of NFA cases. More death cases (n=75) than NFA cases (n=151) were considered to be end-stage (17 and 3%, respectively), and this difference was significant in the regression analysis after age-sex adjustment (p=0.034).

Table 6 indicates that there was little difference between preventable (definitely or probably) death cases and NFA cases with regard to the proportion who delayed seeking medical care at the time of the final episode. Similarly, there was little difference observed in the quality of their prior clinical care or self-management. Whilst family and self help-seeking actions at the time of the final episode tended to be more appropriate amongst the death cases, the difference was not statistically significant after age-sex adjustment in the regression analysis (p=0.148). However, death cases were more likely to have experienced a delay in actually receiving medical care during the final episode, and this difference was confirmed after age-sex adjustment (p<0.001). Also, the regression analysis indicated that, after age-sex adjustment, death cases had less ready access to acute medical care (p=0.032).

Discussion

This study shows that asthmatics dying from asthma share many important similarities with those asthmatics who survive a near-fatal attack. This applies to: the severity of their asthma; the frequency of asthma symptoms;

Table 6. – Features of 49 cases dying of asthma, and 127 having near-fatal attacks, where these outcomes were assessed from reports of near acquaintances and medical practitioners to be definitely or probably preventable: South Australia, 1988–1991

Feature	Death cases %	Near-fatal attack cases %	p value
Delay receiving medical care	39 (n=44)	13 (n=127)	<0.001 [†]
Delay seeking medical care	73 (n=45)	64 (n=127)	0.326 [†]
Medical care not readily available	20 (n=49)	11 (n=127)	0.167 [†]
Routine self-management not adequate	63 (n=49)	72 (n=127)	0.314 [†]
Appropriate crisis plan not available	43 (n=49)	54 (n=127)	0.270 [†]
Routine clinical care not regarded as optimum	86 (n=49)	83 (n=127)	0.795 [†]

[†]: conventional Chi-squared test (one degree of freedom). n: number of cases where valid responses were obtained for each feature.

the impact of asthma on school or work attendance; history of asthma episodes leading to visits to hospital accident and emergency departments, general hospital admissions and admission to intensive care units; the type of primary health care provider; history of lung-function testing; use of crisis plans; compliance with prescribed medications; and quality of medical management. Help-seeking behaviour during the fatal or near-fatal episode appeared to be similar, and history of previous psychiatric consultation and levels of psychiatric caseness were also similar.

The asthma death and NFA cases included in the present study were not similar in all respects, however. NFA cases tended to be younger, to include more males, to be less likely to have concurrent medical conditions, to be more likely to have high levels of denial, to have made fewer doctor visits for asthma in the 12 months prior to the attack, and to have made less use of asthma medications in general.

The levels of asthma severity found in this study were similar to those found in previous studies; 73% of asthma death cases and 65% of NFA cases were classified as having severe asthma, compared with 65% who were assessed as having severe asthma in the Victorian asthma mortality study [2]. In the present study, 39% of asthma death cases and 45% of NFA cases were reported as having been admitted to hospital in the preceding 12 months, compared with 39% of cases reported to have been admitted in the preceding 12 month period in both the New Zealand and Victorian asthma mortality studies [2, 3]. CRANE *et al.* [15] report that a history of admission for asthma in the preceding 12 months is the strongest single indicator of risk for subsequent death from asthma, and is also an indicator of subsequent risk for readmission.

TOWN *et al.* [16] identified the utility of an asthma management plan which incorporates peak expiratory flow monitoring. The Victorian asthma mortality study reported that 65% of cases (n=193) had been provided with an appropriate asthma management plan [2], compared with 37% of asthma death cases and 49% of NFA cases in the present study. Only 31% of asthma death cases and 38% of NFA cases were reported as having used a peak flow meter at home, which is not significantly different from the proportion (31%) previously reported amongst asthmatics attending accident and emergency departments in 1992 [17]. Only 13 of 163 cases were reported to have had a peak expiratory flow meter in the Victorian asthma mortality study performed in 1986 [2].

Prior medical management was assessed as optimal in only 25% of asthma death and NFA cases combined, with no significant difference between the two groups, on the basis of a consensus opinion of a reviewing committee. However, the perception of the quality of the medical management was extremely difficult to distinguish, from the quality of personal asthma management. Individual self-management was assessed as poor for 53% of asthma death cases and 67% of NFA cases. However, when the analysis was restricted to subjects aged less than 60 yrs, similar levels of poor self-management were seen for both groups. Reported compliance with prescribed medication from general practitioner reports was similar

for the two groups (69 and 58%, respectively). Similar levels of poor self-management were reported from the first case-control study of asthma death from New Zealand [5]. The British Thoracic Association investigation into asthma deaths assessed compliance as having been adequate in 69% of 90 cases, and that deterioration in asthma control had not been appreciated by managing doctors for 63% of cases, with supervision being classified as satisfactory for only two of 90 cases [4].

In the present study, 39% of asthma death cases and 22% of NFA cases used regular nebulized beta-agonist therapy, compared with 28% of cases in the New Zealand asthma mortality study [3]. It is unclear whether a possible relationship between regular use of beta-agonists and increased morbidity is a class effect relevant to the use of all beta-agonists [18], a function of the potency of the preparation [19], or a function of the particular type of beta-agonist used [20]. That 53% of asthma death cases and 45% of NFA cases in the present study were regularly using beta-agonists without concomitant preventive medication gives cause for concern. The corresponding figure for the Victorian asthma mortality study was 41% [2]. Regular use of oral corticosteroids was reported for 26% of the asthma death and 16% of the NFA cases, with a figure of 16% also applying in the Victorian asthma mortality study [2], compared with 42% in the New Zealand study from the early 1980s, and 69% in the British study from the late 1970s [3, 4].

Reportedly, 16% of asthma death cases and 24% of NFA cases had purchased medications (inhaled beta-agonists) directly from the pharmacist without a doctor's prescription. Asthmatics who purchase beta-agonists directly from the pharmacist have been shown to be less likely to consult with family doctors and also less likely to use prescription-only medication [21]. The high rate of repeat purchase of asthma medication on prescription without further medical consultation, as observed for asthma death (24%) and NFA cases (42%), suggests that an opportunity for regular review and education regarding appropriate asthma treatment is not being utilized for asthmatics who have clearly experienced high levels of prior morbidity due to asthma.

Delay in seeking medical care was a feature of the final event for 56% of asthma deaths and 58% of NFA cases. Delay receiving medical care was more common in the asthma death group than the NFA group. Amongst those cases where the final event was considered either definitely or probably preventable, delay in actually receiving medical care and less ready access to acute medical care distinguished death cases from NFA cases. Asthma education will need to provide asthmatics with skills to recognize deteriorating control of asthma, and with appropriate strategies to manage the deterioration. At present, many asthmatics appear to just increase the use of inhaled beta-agonist therapy, adopting a "wait and see" approach and hoping the situation will improve. It is of concern that in response to increased asthma symptoms only 20% of asthma death and NFA cases were reported to have increased use of oral corticosteroid medication in the prior 12 months, whilst over 80% of cases in both groups had increased the use of beta-agonists.

Overall, 22% of asthma deaths in the present study were assessed as definitely having preventable factors associated; and 8% of the NFA cases were so assessed, compared with 37% of 126 asthma death cases which were assessed as definitely preventable in the Victorian study [2]. Almost two-thirds (62%) of asthma death cases in the present study were considered definitely or probably preventable, compared with 61% of 271 cases in the New Zealand asthma mortality study [3], and 86% of 90 cases in the British study [4]. A higher proportion of NFA cases (83%) was assessed as having preventable factors definitely or probably present, possibly reflecting the lower incidence of end-stage asthma in this younger group. This study identifies high levels of denial and prior psychiatric morbidity both in asthmatics dying of asthma and suffering a near-fatal attack of asthma, together with poor quality of personal and medical management of asthma. These are factors which should be addressed in future intervention studies, to reduce the risk of adverse outcomes from asthma in this high risk group who already have high levels of contact with the medical care system.

Although NFA and death cases appear not to be synonymous groups, it is clear that they are similar in many respects. Indeed, it is possible that some of the "significant" differences found between these groups could have occurred by chance in response to multiple testing. We conclude that more emphasis should be placed on studies of near-fatal asthma cases in the future. Through case "self-reporting", more accurate and detailed information should be obtainable to indicate how both near-fatal and fatal asthma episodes might be prevented.

We conclude that asthmatics who survive a near-fatal asthma episode share many important features with asthmatics who die of asthma, and should be subjected to more intensive research to indicate how asthma morbidity and mortality may be prevented.

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