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ECONOMICS

Frequency of health service use in the year prior to asthma death

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Abstract

Objective: High frequency health service use (HSU) is associated with poorly controlled asthma, and is a recognized risk factor for near-fatal or fatal asthma. The objective of this study was to describe the frequency of HSU in the year prior to asthma death. *Methods*: Individuals aged 0–99 years who died from asthma from April 1996 to December 2011 in Ontario, Canada were identified as cases. Cases were matched to 4–5 live asthma controls by age, sex, rural/urban residence, socioeconomic status, duration of asthma and a co-diagnosis of COPD. HSU records in the year prior to death [hospitalization, emergency department (ED) and outpatient visits] were assembled. The association of prior HSU and asthma death was measured by conditional logistic regression models. *Results*: From 1996 to 2011, 1503 individuals died from asthma. While the majority of cases did not have increased HSU as defined in the study, compared to matched live asthma controls, the cases were 8-fold more likely to have been hospitalized two or more times (OR = 7.60; 95% CI: 4.90, 11.77), 13-fold more likely to have had three or more ED visits (OR = 13.28; 95% CI: 7.55, 23.34) and 4-fold more likely to have had five or more physician visits for asthma (OR = 4.41; 95% CI: 3.58, 5.42). *Conclusions*: Frequency of HSU in the year prior was substantially higher in those died from asthma. Specifically, more than one asthma hospital admission, three ED visits or five physician visits increased the asthma mortality risk substantially and exponentially.

Keywords

Asthma, health service use, hospitalization, morbidity, mortality

History

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Introduction

In the past two decades, the rate of asthma mortality in developed countries has declined substantially [1,2]. This decline may be attributable to the increased use of inhaled corticosteroids (ICS) and advances in asthma education, awareness and management [1,3]. Despite the decline in overall asthma mortality, there has been less of an improvement in asthma morbidity and health service use (HSU), and a number of unnecessary asthma fatalities still occur each year. High frequency of HSU – including a history of hospital and/or Intensive Care Unit (ICU) admission and mechanical ventilation due to asthma – is associated with poorly controlled asthma, and is a recognized risk factor for near-fatal or fatal asthma [4–9]. A systematic review of 27 studies on near-fatal and fatal asthma reported that a history of hospital and/or ICU admissions and mechanical ventilation due to asthma were reliable predictors of asthma mortality [4]. In Australia, Jalaludin et al. found that, compared to age and sex matched controls, those who died from asthma were more likely to have visited the emergency department (ED) in the past 2 years [8]. While these studies provide insight on the relationship between asthma mortality and HSU, it would be informative to quantify HSU with closer proximity (i.e. in the year prior) to death.

Thus, the objective of this study was to use population-based data to quantify and describe HSU in the year prior to death and compare this HSU between those who died from asthma and matched controls.

Methods

A retrospective cohort was created using 15 years of population-based data from Ontario, Canada, which has a population of 13.5 million residents and a universal, single-payer healthcare system covering all physician and hospital services. Data were obtained from six health administrative databases (detailed in E1 of online supplement), which include information on: HSU (i.e. hospital admissions, ED visits, physician office visits); primary and contributing causes of death; date of death; demographic characteristics, including residence postal code; and – for those 65 years and over – prescriptions dispensed in the year prior to death. Acute HSU records for asthma, asthma-related and other

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conditions in the year prior to death were assembled for all cases and controls.

Cases and controls were obtained from the *Ontario Asthma Surveillance Information System* (OASIS), a population-based longitudinal surveillance system that identifies and tracks individuals living with asthma [10]. OASIS defines individuals with asthma as those with at least two asthma outpatient claims in two consecutive years or at least one hospitalization for asthma [10]. This administrative data definition for asthma has been validated and shown to have 89% sensitivity and 72% specificity in children (under 18 years of age) and 83.8% sensitivity and 76.5% specificity in adults [10,11]. Cases were all individuals with asthma aged 0–99 years in OASIS who died of asthma as an underlying cause between April 1996 and December 2011. Cause of death was defined according to International Classification of Diseases codes (ICD-9 or ICD-10, depending on year of death). ICD-9 and ICD-10 codes were also used to define HSU. ICD-9 and ICD-10 codes were the clinical modification codes and are listed in E2. Depending on the year, 10–25 diagnostic codes were listed for each type of healthcare encounter, but for the purpose of this paper, only the most responsible diagnosis was counted. Controls were individuals with asthma in the OASIS database who were alive at the time of death of cases and were matched by: age (±2 years), sex, residence (rural: population <10 000; urban: population ≥10 000) [12], socioeconomic status proxy-measured by neighbourhood income quintiles, duration (±1 year) of asthma and presence/absence of chronic obstructive pulmonary disease (COPD). Most cases (98.6%) were matched with five controls. Those who were selected as cases were removed from the control population. Thus, cases were never used as controls prior to the year in which they became a case. HSU was observed in the same fiscal year for each case and matched controls.

The association of asthma mortality and prior HSU was measured using a conditional logistic regression model, with asthma mortality as the dependent variable. Potential confounders not used in matching were included in this model as covariates, including: years of COPD, region of residence, major chronic comorbidities (detailed ICD-codes in E2 of online supplement), prior admission to ICU for asthma or asthma-related conditions, mechanical ventilation received. For those 7 years and older, results were also adjusted for the use of pulmonary function tests in the year prior to death. Results were presented as odds ratios (OR) with 95% confidence intervals (CI). All analyses were carried out using SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

Matching was successful on all criteria used (Table 1). The pattern of asthma health service used differed greatly between the two groups, as well as the type of physicians seen in the last 12 months (Table 1). Although the majority of cases did not have increased HSU as defined by the study, cases had more frequent HSU for asthma in the year prior to death compared to their matched controls (Table 1; see Table E3 of online supplement for HSU for asthma-related and other conditions and Table E4 for HSU stratified by <60 years of age and ≥60 years of age). Compared to controls, cases were more likely to have any ambulatory visits (i.e. see a general practitioner, non-respiratory specialist or respiratory specialist) than to have no visits (Table 1). Among those 65 years and older, for whom we have prescription medication data, cases had higher asthma medication use for both ICS and short acting beta-2 agonists (Table 1). Cases and controls that did not see a physician in the year prior had less ICS use. Cases seen by a respiratory specialist had higher beta-2 agonist use (Table 2).

The odds of dying from asthma were 8-times greater among those who were hospitalized three or more times for asthma in the year prior, 13-times greater for those who had three or more ED visits for asthma in the year prior and 4-times greater for those who had five or more physician visits for asthma in the year prior (Table 3; see Table E5 of online supplement for OR by covariates). Adjusting for medication prescription in the last 12 months (data only available for patients ≥65 years of age), the odds of dying from asthma were 5-times higher in those who were hospitalized two or more times, 4-times higher in those who had three or more ED visits, and 2-times higher in those with five or more physician visits for asthma (Table 3).

Discussion

This matched case–control study using population-based asthma surveillance data showed that in the year prior to death, those who died of asthma were more likely to visit the ED for asthma and were more likely to be hospitalized than those who did not die. Those who died from asthma had substantially higher odds of asthma HSU in the year prior. Even after adjusting for medication prescription in those ≥65 years of age, the odds of dying from asthma remained higher in those who had two or more hospitalizations, three or more ED visits, or five or more physician visits for asthma.

A greater proportion of those who died saw a general practitioner, non-respiratory specialist and respiratory specialist in the year prior to death. This is not surprising given that these individuals also had higher HSU. It is likely that they were referred to a physician or specialist after being admitted to the hospital or ED. It is interesting that nearly half of the cases saw a non-respiratory specialist in the year prior to death. This may signify that these individuals had other, non-respiratory health conditions that they were seeking care for.

Similar to findings reported in a systematic review of risk factors associated with near-fatal and fatal asthma [4], the current study found that hospitalization was one of the strongest predictors of asthma mortality. The results also indicated that more than one asthma hospital admission, more than three ED visits, or more than five physician visits increases the asthma mortality risk substantially and exponentially. Recognizing frequent HSU as a potential warning sign for asthma mortality may be helpful given that previous studies have shown that patients do not always recognize the severity of their asthma symptoms [13–15]. In 2013, Fletcher and Hiles conducted a questionnaire-based online survey of UK adult patients with self-reported asthma [16]. Nearly 80% of the 1083 participants described their asthma control as ‘‘good’’ or ‘‘very good’’ despite two-thirds

Table 1. Study population characteristics, pattern of HSU and asthma medication use for asthma among cases and controls in the year prior to index date.

	Cases ($n = 1503$)		Matched controls ($n = 7446$)		
	Number	%	Number	%	p Value
Demographics					
Age at time of case death					0.896
0–19	48	3.2	270	3.6	
20–39	120	8.0	581	7.8	
40–59	244	16.2	1221	16.4	
60–79	459	30.5	2376	31.9	
≥80	632	42.0	2998	40.3	
Mean ± SD	69.41 ± 21.28		68.82 ± 21.13		0.326
Median (IQR)	76 (56–85)		76 (56–85)		0.173
Sex					0.873
Female	998	66.4	4960	66.6	
Male	505	33.6	2486	33.4	
COPD present	1109	73.8	5498	73.8	0.966
Income quintile					0.932
1 (lowest)	405	27.1	2018	27.2	
2	356	23.8	1761	23.7	
3	258	17.3	1281	17.3	
4	242	16.2	1198	16.1	
5 (highest)	234	15.7	1163	15.7	
Rural or urban residence[a]					0.539
Urban	1303	86.8	6478	87.0	
Rural	198	13.2	964	13.0	
Years of asthma					
Mean ± SD	8.34 ± 5.10		8.33 ± 5.05		0.951
Median (IQR)	7 (5–12)		7 (5–12)		0.914
Pattern of asthma health services use					
Health service use[b]					
≥2 Hospitalizations	97	6.5	40	0.5	<0.0001
≥3 ED visits	72	4.8	21	0.3	<0.0001
≥5 Physician office visits	245	16.3	287	3.9	<0.0001
≥2 Hospitalizations OR ≥3 ED visits	140	9.3	57	0.8	<0.0001
≥2 Hospitalizations OR ≥3 ED visits OR ≥5 physician office visits	335	22.3	334	4.5	<0.0001
Physician group seen in the last 12 months[c]					<0.001
None (no physician visits)	32	2.1	4078	54.8	
General practitioners	435	28.9	790	10.6	
Non-respiratory specialists	716	47.6	2087	28.0	
Respiratory specialists	320	21.3	491	6.6	
Asthma medication use (only includes individuals aged ≥65 years)					
ICS use (in year prior to index date)	828	82.1	2913	59.2	<0.001
Beta-2 agonist (in year prior to index date)					<0.001
None	147	14.6	2128	43.2	
1–4 canisters	222	22.0	1245	25.3	
5–12 canisters	305	30.3	977	19.8	
13–20 canisters	155	15.4	366	7.4	
>20 canisters	179	17.7	208	4.2	

Respiratory specialist is a physician specialized in respirology, clinical immunology, paediatric respirology and paediatric clinical immunology; non-respiratory specialists are specialists except respiratory specialist, as defined above and general practitioners are physicians with specialty in paediatrics and general or family practitioners. ED, emergency department; OHIP, Ontario Health Insurance Plan; ICS, inhaled corticosteriod; SD, standard deviation; IQR, interquartile range. All percentages adjusted for missing data.

[a]Rural community defined as one with fewer than 10 000 residents.

[b]Counts are not mutually exclusive. Percentages represent percent of all cases or controls.

[c]These categories are mutually exclusive and consist of all possible physician groups.

having experienced ''frequent'' day-time symptoms and more than a third having ''frequent'' night-time symptoms in the previous 2 years. It may be possible to use frequent HSU to identify patients with uncontrolled asthma who are not aware of their asthma symptom severity. However, it should be noted that the majority of cases did not have high HSU as defined in this study. Thus, it is clear that these HSU cut-points are limited in their ability to predict asthma mortality in the majority of individuals who died from asthma. More sensitive HSU cut-points would be beneficial to identify those with higher odds of asthma mortality. Once identified, healthcare providers could focus on these individuals to ensure they know their asthma triggers, understand what it means to ''control'' asthma and recognize when asthma is ''not controlled'' before it leads to an undesirable or fatal outcome.

Table 2. Percent distribution of asthma medication use among cases and controls by physician group seen in the year prior to index date.

	Total		None (no physician visits)		General practitioners		Non-respiratory specialists		Respiratory specialists	
Asthma medication use	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls
ICS use[a]	82.1	59.2	33.3	50.6	74.2	56.0	83.1	62.6	92.3	84.2
Beta-2 agonist[a]										
None	14.6	43.2	41.7	57.7	17.7	40.8	15.5	35.3	7.2	23.4
1–4 canisters	22.0	25.3	8.3	24.6	21.4	24.1	23.5	26.5	20.3	24.8
5–12 canisters	30.3	19.8	25.0	13.7	29.9	20.7	30.2	23.1	31.1	28.8
13–20 canisters	15.4	7.4	8.3	2.9	15.1	8.9	14.1	9.8	18.9	13.2
>20 canisters	17.8	4.2	16.7	1.1	15.9	5.6	16.7	5.3	22.5	9.8

ICS, inhaled corticosteroid.
[a]In year prior to index date.

Table 3. Adjusted OR of asthma mortality from conditional logistic regression models.

	≥2 asthma hospitalizations		≥3 asthma ED visits		≥5 outpatient physician visits		≥3 Asthma ED visits OR ≥2 asthma hospitalizations		≥3 Asthma ED visits OR ≥2 asthma hospitalizations OR ≥5 outpatient physician visits	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Total study population	7.60	[4.90, 11.77]	13.28	[7.55, 23.34]	4.41	[3.58, 5.42]	5.44	[4.48, 6.60]	4.41	3.58 5.42
In patients ≥65 years old only										
Unadjusted for asthma medication prescriptions	5.78	[3.44, 9.69]	6.27	[2.66, 14.77]	3.10	[2.40, 4.01]	5.62	[3.52, 8.98]	3.67	[2.89, 4.65]
Adjusted for the following asthma medication prescriptions in last 12 months:	4.73	[2.74, 8.19]	3.67	[1.51, 8.94]	2.35	[1.79, 3.08]	4.34	[2.65, 7.12]	2.77	[2.15, 3.56]
Inhaled corticosteroids	0.60	[0.48, 0.75]	0.61	[0.49, 0.75]	0.62	[0.50, 0.77]	0.60	[0.48, 0.75]	0.62	[0.50, 0.77]
Short acting β2-agonist										
≤4 canisters	2.07	[1.61, 2.66]	2.11	[1.65, 2.71]	2.07	[1.61, 2.66]	2.07	[1.62, 2.66]	2.04	[1.59, 2.63]
5–12 canisters	3.75	[2.90, 4.86]	3.76	[2.91, 4.87]	3.63	[2.80, 4.71]	3.76	[2.91, 4.87]	3.61	[2.79, 4.68]
13–20 canisters	5.68	[4.18, 7.74]	5.68	[4.18, 7.73]	5.62	[4.13, 7.66]	5.58	[4.10, 7.60]	5.47	[4.01, 7.46]
>20 canisters	10.59	[7.67, 14.62]	10.96	[7.95, 15.10]	10.54	[7.64, 14.54]	10.58	[7.66, 14.61]	10.19	[7.37, 14.10]

OR, odds ratio; CI, confidence intervals; PFT, pulmonary function tests. All models were adjusted for comorbidity (prevalence of chronic diseases), ICU admissions, mechanical ventilation, use of pulmonary function testings, regions of residence and the duration of COPD.

This matched case–control population-based study had a number of strengths, including a large sample size with 15 years of data, and complete information on patient demographics, accounting for all deaths in the population. A few limitations should be noted. The health administrative data definition of asthma may be subject to potential misclassification when compared to clinical evaluation by a physician, compounded by the fact that physicians do not always accurately diagnose asthma. Some previous studies have shown asthma to be overdiagnosed, while others have shown it to be underdiagnosed by physicians; it is therefore not clear how misdiagnosis may have influenced the results [17–19]. However, the asthma case definition used in this study has been previously validated with chart abstraction studies [10,11].

Future research could assess HSU in cases longitudinally. This would help determine if HSU increased only during the year prior to death, or if cases had increased frequency of HSU for longer periods of time. A detailed analysis of medication use in the year prior to death would also be very informative to assess severity of asthma prior to death, and if asthma severity is the underlying reason for high HSU.

In conclusion, individuals who died from asthma had substantially higher frequency of HSU, included ED admissions, hospitalizations and physician visits. Future research would do well to examine the possibility of using increased frequency as a warning sign of asthma mortality in an attempt to prevent mortality.

Declaration of interest

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Supplementary material available online