ABSTRACT

We attempted to address deficiencies in administrative health service data during a study of cardiorespiratory emergency department visits. From 1994-1996, we obtained data on 9,264 visits and conducted 1,772 follow-up interviews. The median interval between symptoms and visit ranged from 0.8 days (95% CI 0-1.7) for cardiac conditions to 4.0 days for chronic obstructive pulmonary disease (COPD) (95% CI 2.7-5.3) and respiratory infections (95% CI 3.5-4.5). Infection was the most common trigger of respiratory visits. Although most had improved at follow-up, symptoms persisted following the visit for a mean of 4.5 days (95% CI 3.8-5.4) for cardiac conditions to 8.4 days (95% CI 7.2-9.5) for COPD. Among adults aged <70, the mean number of reduced activity days per episode ranged from 4.7 (95% CI 3.9-5.4) for asthma to 6.6 (95% CI 5.9-7.4) for respiratory infections. Our data assist in interpreting epidemiological studies based on administrative data, and illustrate the broad impacts of cardiorespiratory disease episodes.

ABRÉGÉ

Nous avons tenté de compenser le manque de données administratives sur l'utilisation des services de santé au cours d'une étude sur les visites à l'urgence pour des problèmes cardiorespiratoires. De 1994 à 1996, nous avons recueilli des données sur 9 264 visites et procédé à 1 772 entrevues de suivi. L'intervalle médian entre l'apparition des symptômes et la visite s'étendait de 0,8 jour pour les problèmes cardiaques (IC de 95 %, de 0 à 1,7) à 4,0 jours pour les cas de bronchopneumopathie chronique obstructive (BCO) (IC de 95 %, de 2,7 à 5,3) et les infections respiratoires (IC de 95 %, de 3,5 à 4,5). L'infection est apparue comme le facteur le plus commun à l'origine d'une visite pour problème respiratoire. Même si lors du contrôle de suivi, la plupart des cas s'étaient améliorés, les symptômes persistaient en moyenne de 4,5 jours après la visite pour les problèmes cardiaques (IC de 95 %, de 3,8 à 5,4) à 8,4 jours (IC de 95 %, de 7,2 à 9,5) pour les cas de BCO. Chez les adultes de moins de 70 ans, le nombre moyen de jours d'activités réduites par épisode variait de 4,7 (IC de 95 %, de 3,9 à 5,4) pour l'asthme à 6,6 (IC de 95 %, de 5,9 à 7,4) pour les infections respiratoires. Nos données aident à interpréter les études épidémiologiques fondées sur des données administratives, et illustrent le vaste impact des épisodes de maladies cardiorespiratoires.

Beyond Administrative Data: Characterizing Cardiorespiratory Disease Episodes Among Patients Visiting the Emergency Department

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Numerous factors contribute to morbidity from cardiorespiratory disease by causing acute episodes superimposed on the underlying chronic condition. Administrative data on health service utilization have been used extensively to examine morbidity and mortality from asthma¹ and other cardiorespiratory diseases. As a case in point, the current epidemiologic literature linking air pollution to effects such as death and admission to hospital relies almost exclusively on administrative data originally collected for other purposes. Interpretation of this literature is limited by the incomplete picture of disease episodes provided by these data. We attempted to address these information gaps using data collected during a study of air pollution and emergency department visits for cardiorespiratory conditions. In this paper, we present a descriptive analysis of the characteristics of patients who visited the emergency department during the study, as well as the nature and outcome of their disease episodes.

METHODS

The rationale and overall design of the study are described in detail elsewhere.² Data presented here were collected prospectively in two hospital emergency departments (EDs) in Saint John, New Brunswick, between July 5, 1994 and March 31, 1996, for visits assigned a diagnosis of asthma, chronic obstructive pulmonary disease (COPD), respiratory infection, or cardiac condition. These conditions were selected based on previous studies linking them with air pollution.^{3,4} Data were obtained from the clinical record and directly from patients during or after their visit. A 60% random sample was drawn from those who agreed to follow-up, with the exception of those with asthma, for whom an attempt was made to follow-up all willing ED visitors. Follow-up was conducted two weeks after the ED visit using a structured telephone interview.

Personal characteristics and usual triggers were examined using patients as the unit of analysis, based on the first visit for each patient during the study period, while all other variables were examined using visits as the unit of analysis. Validity and reliability of data were determined by examining internal consistency of responses.

This project was approved by the ethics review committee of Saint John Regional Hospital.

RESULTS

During the study period, 9,264 visits by 6,820 individuals were captured. Unless otherwise indicated, valid data were avail-

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able for over 90% of observations for a given variable. The most frequent reasons for non-response among records classified by the interviewer as incomplete were inability to contact the patient after leaving the ED (49.0%), patient unable or too ill (24.6%) and patient refused (20.2%).

Table I summarizes patient demographic characteristics, past medical history, asthma severity rating based on past history (criteria described in table), and smoking. Strong ($p \leq 0.001$, chi-square test unless otherwise indicated) and clinically significant associations were observed between severity rating and variables reflecting components of the rating, including previous use of inhaled steroids (93.6% vs. 68.0% for severe vs. mild asthma), previous use of oral steroids (77.4% vs. 36.3%), previous admission to hospital (90.3% vs. 44.3%), previous admission to ICU (29.0% vs. 12.6%), previous intubation (19.4% vs. 1.2%, Fisher's exact test), as well as admission to hospital for the current visit (29.0% vs. 4.8%). Associations were also observed between severity rating and quality of life as measured in the follow-up interview, including nightly nocturnal awakening (46.7% vs. 9.9%, Fisher's exact test, $p=0.012$) and spending 1 or more days in bed (35.7% vs. 17.9%, $p=0.06$).

Data on the time interval between onset of symptoms and ED visit are summarized in Figures 1A-D.

Of those who identified triggers of the symptoms prompting their current visit, the most commonly identified for asthma and COPD visits was infection (58.8% and 42.0% respectively), while for cardiac conditions, minimal activity (i.e., patient not exerting him/herself when symptoms began – 34.3%) and physical exertion (29.0%) were the most commonly identified. Asthma and COPD patients who had been previously diagnosed were also asked about usual triggers. Of those who identified usual triggers, those most commonly identified for asthma were infection (33.3%), allergies/ pollens/ animals (20.5%), and weather (19.3%), while for COPD they were weather (34.2%), infection (16.1%) and other environmental factors (11.9%). Tobacco smoke was identified as a usual trigger by 7.8% of asthma and 8.3% of COPD patients. Air pollution

TABLE I
Personal Characteristics of ED Visitors by Diagnostic Category

	Asthma	COPD	Respiratory Infection*	Cardiac Condition†
Number of visits (% of all visits)	2334 (25.2)	946 (10.2)	3761 (40.6)	2223 (24.0)
Number of patients	1586	599	3354	1721
Maximum visits per patient	19	20	6	10
Percent male	48.7	52.3	50.0	53.2
Age (mean, range)	22 (<1 - 92)	67 (29 - 97)	32 (<1 - 101)	68 (1 - 98)
Main Activity, age ≥ 16 (%)				
Working at a job	51.1	11.0	42.4	21.0
Attending school	17.9	0.7	6.6	0.5
Keeping house	11.6	10.3	13.0	6.5
Retired	6.9	66.3	28.0	64.0
Unable to work for health reasons	4.3	9.8	4.5	4.8
Other	8.3	1.9	5.4	3.2
(completeness of data (%))	(78.6)	(70.1)	(67.6)	(67.5)
Previously diagnosed (%)	74.1	70.1	28.0	34.3
(completeness of data (%))	(80.1)	(68.1)	(84.3)	(86.3)
Severity (%)‡		NA	NA	NA
Mild	77.6			
Moderate	17.8			
Severe	4.6			
(completeness of data (%))	(71.1)			
Daily cigarette smoking (%)				
(patients ≥ 12 years of age)	36.4	44.8	41.7	25.6
(completeness of data (%))	(80.4)	(76.1)	(74.3)	(67.3)
Regular smoker in household (%)	55.1	51.2	52.2	35.2
(completeness of data (%))	(83.2)	(69.8)	(74.7)	(62.9)

* includes pneumonia (48.2%), bronchitis (33.7%), croup (13.3%), bronchiolitis (4.8%)

† includes angina (37.4%), congestive heart failure (28.2%), conduction disturbance/dysrhythmia (18.7%), myocardial infarction (13.4%), sudden cardiac death (2.4%)

‡ classified as mild if low dose inhaled steroid or intermittent use of prn β -agonist (< 1 puffer every 3-6 months); moderate if well controlled on inhaled steroid, occasional β -agonist use (1-2 puffers every 3 months), occasional ED visit; and severe if multiple hospitalizations, lost time from work or school 2 or more times per year, daily or frequent β -agonist use (2 or more canisters per month), 1500 μ g or more per day of inhaled steroid, or steroid dependent.

TABLE II
Outdoor Activity Patterns Prior to Visit and in General, by Diagnostic Category

	Asthma	COPD	Respiratory Infections	Cardiac Conditions
Mean hours per period during week preceding ED visit				
Midnight - 6 am	0.1	0.0	0.0	0.0
6 am - noon	0.9	0.6	0.8	0.9
Noon - 6 pm	1.6	0.8	1.2	1.2
6 pm - midnight	0.8	0.3	0.5	0.5
TOTAL (95% CI)	3.3 (3.1-3.5)	1.7 (1.5-1.9)	2.4 (2.3-2.5)	2.6 (2.4-2.8)
Mean hours per day (95% CI) reported during follow-up interview				
April - Sept. weekday	4.8 (4.5-5.0)	4.6 (3.9-5.3)	4.8 (4.5-5.0)	5.0 (4.5-5.4)
April - Sept. weekend day	6.6 (6.3-6.9)	5.0 (4.3-5.7)	6.3 (6.0-6.6)	5.8 (5.3-6.2)
Oct. - March weekday	1.9 (1.7-2.0)	1.7 (1.3-2.2)	1.9 (1.8-2.1)	2.0 (1.8-2.3)
Oct. - March weekend day	2.5 (2.3-2.6)	2.0 (1.4-2.6)	2.4 (2.2-2.5)	2.1 (1.9-2.4)
WEIGHTED AVERAGE (all months, days of week)	3.7	3.3	3.6	3.6

was identified as a trigger of the current episode for 1.9% of asthma visits and 2.4% of COPD visits, while it was identified as a usual trigger by 2.8% of asthma patients and 8.3% of COPD patients.

Data on outdoor activity patterns were available for 64.1% of asthma visits, 63.2% of COPD visits, 58.7% of respiratory infection visits, 57.9% of visits for

cardiac conditions, and 88% or more of follow-up interviews in the various diagnostic categories (Table II). A moderate correlation was observed between the average number of hours spent outdoors per day during the week preceding the ED visit, and a weighted average of the average number of hours spent outdoors per day on weekdays and weekends, as measured

during the follow-up interview. For visits occurring in April through September the Pearson R was 0.37 ($p < 0.0001$), while for visits occurring in October through March the Pearson R was 0.38 ($p < 0.0001$).

Data on medication use at the time of the ED visit as well as disposition of the current visit are summarized in Tables III and IV respectively.

Between September 1, 1994 and August 31, 1995, follow-up interviews were completed for 733 asthma visits, 82 COPD visits, 687 respiratory infection visits, and 270 visits for cardiac conditions, which

represent response rates of 84.3%, 49.9%, 87.6% and 66.9% respectively.

Those who completed follow-up interviews were younger than those who did not, for respiratory infection visits (mean age 24.1 versus 32.8, $p < 0.0001$, t-test) and cardiac visits (mean age 63.4 versus 68.9, $p < 0.0001$). For respiratory infection visits, those who completed interviews were less likely to be retired (15.4% versus 31.2%, $p = 0.001$, chi-square test). They were also more likely to be female for COPD visits (58.0% versus 45.5%, $p = 0.031$) and respiratory infection visits (54.9% versus

TABLE III
Medication Use at Time of Visit,
by Diagnostic Category

Medication Type	Diagnosis Group	
	Asthma	COPD
β-agonist (%)	66.5	62.4
Inhaled steroids (%)	41.3	44.6
Anticholinergics (%)	7.9	40.9
Cromoglycate/ketotifen (%)	6.6	1.4
Methylxanthines (%)	2.9	14.8
Nedocromil (%)	2.7	4.2
Oral steroids (%)	2.1	11.5
Cardiac Conditions		
Platelet inhibitors (including ASA) (%)	65.1	
Diuretics (%)	32.4	
Nitrates (%)	30.9	
Calcium channel blockers (%)	30.5	
β-blockers (%)	20.9	
ACE inhibitors (%)	19.1	
Digoxin (%)	14.7	
Other cardiovascular (anti-arrhythmics, vasodilators, α-blockers, other antihypertensives) (%)	4.0	

48.7%, $p = 0.004$). For asthma visits, the severity rating was more likely to be moderate or severe for those who completed follow-up interviews versus those who did not (38.8% versus 25.7%, $p = 0.001$). For visits for respiratory infections, those who completed follow-up interviews were less likely to have been admitted (13.6% versus 18.4%, $p = 0.003$).

Most visitors in all diagnostic categories indicated that their condition had improved at the time of follow-up (asthma – 90.9%, COPD – 86.6%, respiratory infections – 91.6%, and cardiac conditions – 91.1%). The mean number of days (95% CI) that symptoms continued following the ED visit for asthma, COPD, respiratory infections and cardiac conditions were respectively: 7.1 (6.7-7.5), 8.4 (7.2-9.5), 7.8 (7.5-8.2), and 4.5 (3.8-5.2). A majority of asthma visitors (63.7%) reported nocturnal awakenings at least occasionally in the interval between their visit and the follow-up interview, while 24.7% experienced awakenings frequently or nightly.

Several other outcomes were also commonly reported in the interval between onset of earliest symptoms and the follow-up interview (Table V). Figures 2 and 3 present the average number of occurrences/days of selected outcomes during this interval.

Internal consistency of data on quality-of-life impacts from the follow-up ques-

tionnaire was examined by stratifying the sample into those who did and did not report being admitted to hospital. Those who reported being admitted also reported a significantly greater number of days of various quality of life effects than those who did not. This included bed days (means of 3.1 vs. 1.1 respectively, $p < 0.0001$, t-test), reduced activity days (6.1 vs. 4.4, $p < 0.0001$), missed work (2.3 vs. 1.3 days, $p = 0.0004$), missed social or leisure activities (2.4 vs. 1.9 days, $p = 0.0047$), parental missed work (1.1 vs. 0.3 days, $p < 0.0001$), parental missed leisure activities (1.7 vs. 0.8 days, $p = 0.0022$), other caregiver missed work (0.6 vs. 0.1 days, $p < 0.0001$), and other caregiver missed leisure activities (0.8 vs. 0.4 days, $p < 0.0001$). We also found that 96.7% of hospital admissions recorded in our ED data were also reported by patients at follow-up. Conversely, 92.9% of hospital admissions reported at follow-up could be confirmed in our ED data.

DISCUSSION

In addition to their general relevance to the descriptive epidemiology of cardiorespiratory disease, our findings have implications for the interpretation of air pollution epidemiology literature as highlighted below.

A majority of patients with respiratory infections and cardiac conditions had not been previously diagnosed, and of previously diagnosed asthmatics, the majority were characterized as having mild asthma. Five percent or less of asthma, respiratory infection and cardiac visitors and ten percent of COPD visitors reported an inability to work for health reasons. Thus, a minority would be considered particularly fragile in terms of their health status.

We observed an unexpectedly high proportion of ED visitors for respiratory conditions who were either daily smokers or who reported a regular smoker in the household, relative to results reported elsewhere for asthma,⁵⁻¹⁰ although similar rates of exposure to environmental tobacco smoke were reported by Ducharme.¹¹ This could be accounted for by a generally higher prevalence of smoking in Saint John relative to elsewhere in Canada.¹² Exposure to

TABLE IV
Disposition of Visits by Diagnostic Category

	Asthma	COPD	Respiratory Infections	Cardiac Conditions
Repeat visit (% of initial visits*)				
Within 1 day	2.6	0.8	2.1	2.0
Within 3 days	3.9	2.7	3.4	3.4
Within 14 days	6.2	6.4	4.0	3.4
Hospital admission (%)				
Ward or not specified	9.3	40.3	15.9	43.0
ICU	2.7	2.4	1.5	2.7
CCU	0.0	0.0	0.1	28.4
Death (%)	0.0	0.5	0.4	5.2

* % repeat visits within 1 and 3 days excludes initial visits which resulted in admission; % repeat visits within 14 days includes initial visits which resulted in admission.

TABLE V
Percentage of Respondents Reporting Selected Outcomes Between Onset of Symptoms and Follow-up Interview, by Diagnostic Category

Outcome	Asthma	COPD	Respiratory Infections	Cardiac Conditions
Additional medication use	87.8	75.6	85.7	71.8
Stayed in bed all or most of day	20.6	35.4	38.3	51.1
Reduced activity days (other than bed days)	63.9	75.0	70.5	66.2
Missed school (age 5-15)	62.6	NA	71.3	NA
Missed work (age 16-69)	31.6	10.5	36.7	26.2
Lost social/leisure time	39.5	33.3	43.6	37.8
Parental lost work time	17.6	NA	18.3	NA
Parental lost social/leisure time	27.7	NA	25.5	NA
Other caregiver lost work time	9.4	2.4	9.2	8.3
Other caregiver lost social/leisure time	9.4	8.5	11.5	16.6
Physician office visit	58.7	50.0	54.3	50.0
Hospital admission	14.2	46.3	16.1	80.0
ICU/CCU admission	5.3	1.2	3.5	52.7
In-hospital procedure	0.4	2.4	1.0	50.6
Outpatient services	0.8	4.9	1.3	5.3
Equipment purchase/rental	20.5	9.8	8.7	1.9
Out-of-pocket expenses	68.7	53.7	68.9	55.1

Figure 2. Health care utilization per disease episode, by diagnosis group (point estimate and 95% CI)

Figure 3. Number of days of quality-of-life impacts per disease episode, by diagnosis group and age (point estimate and 95% CI)

tobacco smoke could increase susceptibility to air pollution.

It appeared that the most common primary trigger of respiratory disease episodes was viral upper respiratory tract infection. This is consistent with other published data on asthma,^{5,6,11,13-15} although viral infections may be a more important trigger of asthma for children than adults.¹⁶

Our findings on timing of symptoms were generally comparable to results reported elsewhere,¹⁷⁻¹⁹ although observations have been variable for asthma ED visits.^{13,14,20-22} These findings, together with evidence from studies which find the strongest association between air pollution and hospital admissions with a lag of 0-2 days prior to the visit,^{3,4} suggest that in many cases air pollution acts as an exacer-

bator of a condition which has often already been precipitated by some other factor.

The number of hours spent outdoors per day as reported by ED visitors during the week preceding their ED visit was lower than that reported at the time of the follow-up interview, which suggests that illness could result in reduced time spent outdoors. However, outdoor activity during the week preceding the ED visit was higher than that reported by the general population,²³ and by a subgroup of older adults from the current study who participated in a personal exposure study.²⁴ This may reflect overestimation of outdoor activity when subjects are simply asked to recall a number of hours, rather than completing an hour-by-hour diary. Nonetheless, the

patterns of outdoor activity by diagnostic category, season, and weekday versus weekend conformed to our expectations.

Regarding use of medications by asthmatics prior to their visit, compared to most earlier reports, use of β -agonists, methylxanthines and oral steroids was less frequent in our study, while use of inhaled steroids and anticholinergics was similar or more frequent.^{5-7,9,14,20-22} We found greater use of oral steroids (17.8%), anticholinergics (24.7%), and methylxanthines (9.6%) among those whose past asthma history was rated as severe. While inhaled steroid use was also more prevalent in this group (60.3%), current treatment guidelines suggest that it should be higher.²⁵ This may indicate under-treatment which is a potentially important susceptibility factor with

respect to exacerbation of symptoms by air pollution. No comparable data were available in the literature with respect to medication use by those visiting the ED with COPD or cardiac conditions.

With respect to disposition, asthma relapse rates in our study were considerably lower than comparably defined rates reported in clinical trials: 12% within 48 hours,²⁶ 26% within 7 days,²⁶ and 38% within 21 days.²⁷ Similarly, the relapse rate we observed for COPD was lower than reported elsewhere.²⁸ No data were available from the literature on relapse rates for other conditions. Although relapse rates were relatively low in our study, where they are higher they could contribute to serial correlation in daily time series studies. The proportion of asthma visits resulting in admission was lower than that reported in most other studies,^{5,9,14,20,22} while the proportion of COPD visits resulting in admission was slightly higher in our study than in a previous study.²⁹ We were not able to identify studies reporting admission rates for the other diagnostic groups. If lower relapse and admission rates for asthma reflect more appropriate management than in previous studies, susceptibility to air pollution as a trigger could be reduced in this population.

The primary limitation of our data is the lack of completeness of information for certain variables, principally for the data collected in the ED. This was more of a problem for visits for COPD and cardiac conditions than for other visits, and thus probably reflects an inability to obtain information from patients whose condition was more severe. This would tend to reduce the generalizability of our findings to more severe episodes of these conditions. For asthma visits, those who completed follow-up interviews were more likely to have severe asthma, which could upwardly bias our estimates of associated quality-of-life impacts. Conversely, for visits for respiratory infections and cardiac conditions, those who completed follow-up interviews may have experienced fewer quality-of-life impacts, since they were younger, and for visits for respiratory infections, less likely to be admitted to hospital.

Despite its limitations, this study has permitted us to more accurately characterize patients who present to the ED with cardiorespiratory disease and to gain a more thorough understanding of the nature and outcome of their disease episodes. We estimated the health care costs associated with these episodes in a companion paper.³⁰

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