

EMERGENCY MEDICINE AND CARE

Use of emergency departments and primary care visits for asthma related conditions in the 3 years following an asthma education program

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Abstract

Background: This study examines changes in Primary Care Visits (PCVs) and Emergency Department Visits (EDVs) among 1918 patients with asthma who attended either two visits, one visit or were no-show referrals at the Dr. Patrick Gill Asthma Education Center (AEC) in Charlottetown Prince Edward Island (PEI) between January 1, 2003 and March 31, 2008 compared to 2799 controls selected from a list of PEI asthma patients developed for the Canadian Chronic Disease Surveillance System (CCDSS). **Methods:** Hurdle regression was used to model counts of PCVs and negative binomial models were used to model counts of EDVs at 12 months prior to AEC contact and 0–1, >1 to 2 and >2 to 3 years after AEC contact. The PEI Research Board approved the project. **Results:** No-show referrals had a significant increase in pediatric EDVs and PCVs in the first year after referral. The higher rates of PCVs and EDVs prior to contact with the AEC in patients referred to the AEC were reduced after contact with the AEC, although they remained significantly higher than the CCDSS controls. **Conclusions:** Compared to patients who attended the AEC, referred patients who did not attend the AEC did not achieve similar reductions in pediatric EDVs and PCVs in the first year after referral.

Keywords

Asthma education, emergency department, healthcare utilization, hurdle models, office visit, primary care, Prince Edward Island

History

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Introduction

Self-reported asthma affects 8.6% of the population of Canada and 10.6% of the population of Prince Edward Island (PEI) [1]. Asthma requires active management to minimize exacerbations, achieve and maintain symptom control and maintain normal activity levels with normal pulmonary function [2]. Asthma education is identified as an essential component of asthma management by the Canadian Asthma Consensus Guidelines, particularly for patients with high asthma-related morbidity and frequent acute care use [3]. Working with a Certified Respiratory Educator is identified by the Public Health Agency of Canada as a means of learning about asthma control [4]. Randomized controlled trials of asthma education in adult and pediatric patients have been repeatedly shown to be effective in reducing absences from school and work and decreasing Health Care Utilization (HCU) [5–9].

Few published evaluations of programs are available once the program is established as part of the regular healthcare system, despite Canadian guidelines recommending structured evaluations [3,10]. Published studies have also experienced difficulties with limited long-term follow-up of outcomes [5,9]. Record linkage studies involving asthma have focused on asthma prevalence and HCU as outcomes, without considering the impact of asthma education [11–16].

We sought to establish the effect of asthma education provided at the Dr. Patrick Gill Asthma Education Center (AEC) in Charlottetown, Prince Edward Island (PEI) on HCU using record linkage and a retrospective cohort study design. The aim of this study was to measure the association between attendance at the AEC and changes in HCU among asthma patients.

Methods**Study design and data sources**

Asthma patients are referred to the AEC through family physicians, emergency department (ED) and walk-in clinic physicians, and by specialists (pediatricians and

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respirologists). Although the pediatricians and respirologists all made multiple referrals, the majority of cases were referred by general practitioners who typically referred 1–3 patients to the AEC per year. The AEC provides access to a tailored, structured intervention in self-management asthma education for adult and pediatric patients by a registered nurse and a respiratory therapist, both Certified Asthma Educators. The first and subsequent sessions as necessary consist of a review of the disease, triggers, medications, proper medication technique, the development of a primarily symptom-based written action plan and pre-/post-bronchodilator spirometry. A 6-month follow-up session is tailored to client needs and provides reinforcement for the action plan and pre/post bronchodilator spirometry. A standardized survey is conducted at each visit.

We started with a numerically identified list of all patients who received referrals to the AEC between January 1, 2003 and March 31, 2008. We divided the patients into three exposure groups based on the number of visits they had attended at the AEC: two visits, one visit and no-show referrals. No-show referrals are those patients referred to AEC and never presented. The date of the first appointment was used as the contact date for patients who attended the AEC. For no-show referral patients, we added 6 weeks to their referral date to account for the average wait time between referral and appointment time at the AEC and used this date as their hypothetical contact date.

We developed a fourth exposure group as a baseline from a list of asthma patients identified from administrative data using validated Canadian Chronic Disease Surveillance System (CCDSS) methodology [17]. Baseline controls were selected from 17 845 asthma patients in PEI by assigning a random number and a random hypothetical date of contact with the AEC between January 1, 2003 and September 30, 2008 to all patients who met the CCDSS definition of asthma and who were not seen or referred to the AEC. The CCDSS asthma registry definition included all patients with either two visits to a physician for a most responsible diagnosis of asthma in a 2-year period or a hospitalization with asthma listed under any diagnosis field [17]. All patients whose assigned random contact date was before the date of inclusion on the CCDSS asthma registry or who were under 1 year of age at the random contact date were removed from the list of possible controls. Three controls with the same year of birth and sex were selected for each AEC case, except in the case of controls aged 1–4.9 years of age. In this age group, several factors contributed to the reduced availability of controls, including referrals of possible controls to the AEC, being less than 1 year of age at the assigned contact date and an assigned contact date that was before the date of inclusion on the CCDSS registry. Controls without any contact with the healthcare system in the 4-year study period were removed from the list of controls. The resulting controls have approximately the same age and sex distribution as the AEC patients but are not matched to each individual AEC case.

Demographic information, including age at first contact with the AEC, sex and urban or rural residence, was obtained from the common client registry of provincial health numbers. Urban residence was defined based on Canada Post's postal code designations where 0 is defined as rural and 1 is defined as

urban [18]. Three urban and three rural postal codes were recoded as their population base was a better fit for the opposite definition. Based on the date of first visit to the AEC, season of contact was defined as winter (December 21–March 20), spring (March 21–June 20), summer (June 21–September 20) and fall (September 21–December 20).

The frequency of HCU, defined as Primary Care Visits (PCVs) and Emergency Department Visits (EDVs), for asthma-related International Classification of Diseases Version 9 (ICD-9) codes, using the combined adult and pediatric codes defined by To et al. [11], were our outcome measurements (Appendix 1 - Table A1). We used “asthma-related” ICD-9 codes to highlight healthcare utilization of asthma patients that was asthma related but extended beyond routine HCU and HCU for other conditions. Frequencies were obtained by searching for the ICD-9 codes in the PEI physician claims processing database. We combined office and walk-in clinic visits into PCVs for analysis due to small rates of walk-in visits and to account for patients without a family doctor using walk-in clinics as a source of primary care. The PEI Research Board provided ethical approval for the project.

Statistical analysis

The incidence rate of EDVs and PCVs was calculated for each time period based on the date or hypothetical date of contact with the AEC. These time periods were defined as 12 months prior to AEC contact, 0 to 1 year, >1 to 2 years and >2 to 3 years after AEC contact.

To test the difference in EDVs and PCVs for the exposure groups compared to the CCDSS controls at each time period, count regression models were used. We applied the process used by Hidayat et al. [19] to select the appropriate count model. PCVs in both pediatric and adult groups achieved the best fit using hurdle models. Hurdle models use logistic regression to determine if there are differences in the rate of patients *with or without* PCVs in each year by their AEC visit status and a zero-truncated negative binomial (ZTNB) regression to model rates for patients that had *at least one* PCV in each year. EDVs achieved the best-fit using negative binomial (NB) regression models. All covariates, including EDVs or PCVs 12 months prior to AEC contact, sex, age, urban–rural residence, season and year of contact with the AEC were included in the initial model using backwards-stepwise regression to identify and retain significant covariates ($p < 0.05$). In cases where significant covariates differed between models for the same outcome but different time periods, we included all significant covariates in each model. All models were adjusted for the person-years contributed by each observation when observations were censored during the year. Comparisons between models of different time periods were made because the models used the same covariates and any change in the number of observations included was the result of random elimination based on follow-up information only being available until March 31, 2009. The odds and rate ratios of AEC groups within each model were compared using margins calculated from the model predictions [20].

We completed regression diagnostics using a generalized linear model with a log link and negative binomial family to

approximate the results of NB and ZTNB regression and to calculate Cook's distance and deviance residuals. We examined extreme values of Cook's distance and deviance residuals for patterns. For logistic models, we examined standardized Pearson's residuals and leverage for patterns in the extreme values [21,22].

Results

There were a total of 836 patients (213 adult and 623 pediatric) with two-visits, 239 patients (64 adult and 175 pediatric) with one visit, 88 patients (40 adult and 48 pediatric) who were no show referrals and 2799 (881 adult and 1918 pediatric) CCDSS controls for a total of 13 612.3 person years of follow-up time (4105.9 adult and 9506.4 pediatric). There was a 36.6% reduction in the number of person-years of follow-up from 12 months prior to AEC contact to >2 to 3 years after contact resulting from the data being truncated at the end of the study period. Patients who attended the AEC were more likely to be children and least commonly presented in the summer. No-show referral patients had a slightly different pattern in demographics in which there were more females, more young adults (20–34 years), and no particular seasonal pattern compared to those who attended the AEC. The distribution of the CCDSS controls reflects the overall sex and age distribution of the cases, and the random assignment of hypothetical contact date.

Table 1 describes adult and pediatric EDV and PCV incidence rates. In general, the rate of visits for the one and two visit groups decreased for all time periods after contact with AEC compared to the period prior to AEC contact. This is true for all adult and pediatric AEC patient groups except

Table 1. Asthma related primary care and emergency department visits by asthma education centre (AEC) visit status.

Incidence rate				
	12 months prior to AEC contact	0 to 1 year after AEC contact	>1 to 2 years after AEC contact	>2 to 3 years after AEC contact
AEC visits				
Adult primary care visits				
Two visits	3.14	2.52	1.88	1.55
One visit	2.25	2.01	1.08	1.12
No-show referral	1.12	1.82	1.18	1.64
CCDSS controls	0.78	0.72	0.69	0.76
Adult emergency department visits				
Two visits	0.62	0.30	0.31	0.36
One visit	0.58	0.28	0.23	0.66
No-show referral	0.40	0.38	0.12	0.15
CCDSS controls	0.14	0.16	0.18	0.16
Pediatric primary care visits				
Two visits	2.56	1.66	1.17	1.00
One visit	2.16	1.27	0.99	0.60
No-show referral	1.15	1.34	0.66	0.67
CCDSS controls	0.51	0.41	0.34	0.34
Pediatric emergency department visits				
Two visits	0.48	0.27	0.23	0.19 ^a
One visit	0.46	0.27	0.28	0.16
No-show referral	0.31	0.65	0.23	0.10
CCDSS controls	0.17	0.13	0.11	0.10

^aOne person dropped due to follow-up time of 0.01 years and one emergency department visit. CCDSS, Canadian Chronic Disease Surveillance System.

for the one visit adult EDV rate which had an increase in the third year post-AEC contact compared to the rate prior to contact. The pattern is different in the no-show group which ranged from relatively stable (in the adult EDV) to more than doubling (in the pediatric EDV) in the first period after hypothetical contact. The visit rates for the CCDSS controls were always lower than the AEC referred patients and remained relatively stable in the adults and decreased somewhat in the pediatric rates throughout the time period.

Tables 2–4 describe both odds ratios, the odds of making no PCVs in the AEC group divided by the odds of making no PCVs in the CCDSS control group, and rate ratios, the rate of PCVs or EDVs in the AEC group divided by the rate of PCVs or EDVs in the CCDSS controls.

The effect of AEC visits on adult PCVs after adjustment for significant covariates is described in Table 2. The logistic regression showed that all AEC groups were significantly more likely to have a PCV visit than the CCDSS controls ($p < 0.01$), except for the one visit group at >2 to 3 years after AEC contact ($p = 0.10$). The ZTNB regression shows that the no-show referral group had a large increase in the rate of visits compared to the CCDSS controls at 0–1 years after contact with the AEC ($p < 0.01$). At 12 months prior to contact, the two-visit group had a significantly higher ($p < 0.01$) PCV rate compared to all other groups. By >2 to 3 years after contact with the AEC, there are no significant differences between any groups.

The effect of AEC visits on pediatric PCVs after adjustment for age, sex and season and year of contact is described in Table 3. The logistic regression showed that all AEC groups were significantly more likely to have a PCV visit ($p < 0.01$). The ZTNB regression shows that the two-visit group continues to have PCVs at a significantly higher rate ($p < 0.01$) until >2 to 3 years after AEC contact.

The effect of AEC visits on adult and pediatric EDVs after adjustment for significant confounders is described in Table 4. There was a significant increase in pediatric EDVs ($p = 0.01$) and decrease in adult EDVs ($p = 0.02$) in the 0–1 year after referral to the AEC in the no-show referral group. Overall the rate of pediatric and adult EDVs in the one- and two-visit groups decreased compared to 12 months prior to AEC contact but not to a level significantly different than the CCDSS controls.

Discussion

The regression analyses, except for adult EDVs, indicate an increasing trend of asthma-related HCU in the first year after referral for those patients who refused AEC services. This is in contrast to patients who attended the AEC who, for the most part, had decreasing HCU rates after the referral but not down to the level of the CCDSS controls.

The study design provides a measure of the effectiveness of asthma education in practice, without the highly structured confines of a randomized clinical trial. The use of record linkage information to identify AEC patients and suitable controls from the CCDSS allows for this type of applied evaluation.

The use of asthma-related ICD-9 codes, the 3-year follow-up period and the large sample size are important strengths of

Table 2. Adult primary care visits (PCVs) by asthma education centre (AEC) visit group.

Part 1: Logistic regression ^b for Prob(PCVs = 0) Odds ratio Prob(AEC Visits = 0) (95% CI)				
AEC visits	12 months prior to AEC contact (n = 1198)	0 to 1 year after AEC contact (n = 1198)	>1 to 2 years after AEC contact (n = 1099)	>2 to 3 years after AEC contact (n = 860)
Two visits	0.09 (0.06–0.14) ^a	0.12 (0.09–0.18) ^a	0.22 (0.16–0.32) ^a	0.26 (0.18–0.38) ^a
One visit	0.18 (0.10–0.31) ^a	0.17 (0.10–0.30) ^a	0.24 (0.13–0.44) ^a	0.53 (0.25–1.13)
No-show referral	0.38 (0.20–0.74) ^a	0.33 (0.17–0.64) ^a	0.37 (0.19–0.74) ^a	0.38 (0.18–0.83) ^a
CCDSS Controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)
Part 2: Zero-truncated negative binomial regression ^b for mean (non-zero PCVs) Rate ratio (95% CI)				
AEC visits	12 months prior to AEC contact (n = 492)	0 to 1 year after AEC contact (n = 481)	>1 to 2 years after AEC contact (n = 384)	>2 to 3 years after AEC contact (n = 284)
Two visits	1.62 (1.30–2.02) ^a	1.54 (1.24–1.92) ^a	1.27 (1.00–1.61) ^a	0.91 (0.66–1.26)
One visit	1.36 (0.93–1.99)	1.21 (0.84–1.75)	0.60 (0.35–1.04)	1.09 (0.53–2.24)
No-show referral	0.93 (0.52–1.68)	2.13 (1.32–3.44) ^a	1.13 (0.65–1.96)	1.51 (0.78–2.92)
CCDSS controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)

^a $p < 0.05$.^bAdjusted for sex, age, season and year of contact with the AEC. CI, Confidence Interval; CCDSS, Canadian Chronic Disease Surveillance System.

Table 3. Pediatric primary care visits (PCVs) by asthma education centre (AEC) visit group.

Part 1: Logistic regression ^b for Prob(PCVs = 0) Odds ratio (95% CI)				
AEC visits	12 months prior to AEC contact	0 to 1 year after AEC contact	>1 to 2 years after AEC contact	>2 to 3 years after AEC contact
Two visits	0.09 (0.07–0.12) ^a	0.15 (0.12–0.18) ^a	0.22 (0.18–0.28) ^a	0.24 (0.19–0.30) ^a
One visit	0.15 (0.10–0.21) ^a	0.22 (0.16–0.31) ^a	0.29 (0.20–0.42) ^a	0.45 (0.29–0.70) ^a
No-show referral	0.27 (0.15–0.49) ^a	0.21 (0.12–0.39) ^a	0.31 (0.16–0.61) ^a	0.32 (0.16–0.65) ^a
CCDSS controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)
Part 2: Zero-truncated negative binomial regression ^b for mean (non-zero PCVs) Rate ratio (95% CI)				
AEC visits	12 months prior to AEC contact	0 to 1 year after AEC contact	>1 to 2 years after AEC contact	>2 to 3 years after AEC contact
Two visits	1.64 (1.45–1.87) ^a	1.37 (1.13–1.66) ^a	1.48 (1.17–1.88) ^a	1.05 (0.77–1.43)
One visit	1.54 (1.27–1.87) ^a	1.09 (0.80–1.49)	1.39 (0.94–2.06)	1.09 (0.57–2.08)
No-show referral	0.98 (0.63–1.52)	1.30 (0.76–2.23)	0.79 (0.35–1.79)	0.49 (0.16–1.45)
CCDSS controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)

^a $p < 0.05$.^bAdjusted for age, sex, and season and year of contact with the AEC. CI, confidence interval; CCDSS, Canadian chronic disease surveillance system.

the study, compared to previous studies. Three years provides a measure of the long-term effect of the education received and an opportunity to assess the duration of the effect of AEC education on HCU [5,23,24].

Selection bias was reduced in this study by including all patients who were referred to the AEC within the study time period. The selection process for the CCDSS controls utilized random numbers and a large database of asthma patients ($n = 17\,845$) who met the CCDSS criteria for asthma to select a control group with a similar age and sex profile to the AEC patients. There is some self-selection of patients to AEC visit groups, whereby the patients with the highest HCU at 12 months prior to contact with AEC, attended two visits at the AEC. The no-show referrals had the lowest HCU of any AEC group prior to referral, but also showed evidence that they could have benefitted from attending the AEC because of their increased HCU at 0–1 year (except adult EDVs) after referral to the AEC. This represents a potentially inappropriate use of health care that could have been reduced with AEC

attendance and may have increased both overall population wait times for PCVs and EDVs and costs to provincially funded healthcare. The AEC program is well attended and the referral only group contains few people resulting in higher variability. It is possible that the act of being referred to the AEC was a catalyst for change even in those patients who did not attend and some of the increase in HCU of these patients might be the result of the referral to the AEC.

Some of the higher HCU in patients who attended the AEC may be the result of increased patient awareness and understanding of asthma and may represent preventative care, something emphasized by asthma care guidelines [3]. In addition, although no measures of asthma severity were available, patients with more severe asthma may have been more likely to be referred to the AEC and these patients would likely have more HCU and be on more medications than the average patient meeting the CCDSS definition of asthma. We calculated that, for patients that attended the AEC, the sensitivity of the CCDSS definition for the

Table 4. Emergency department visits (EDVs) by asthma education centre (AEC) visit group.

AEC visits	Adult regression ^b Rate ratio (95% confidence interval)			
	12 months prior to AEC contact (n = 1196)	0 to 1 year after AEC contact (n = 1196)	>1 to 2 years after AEC contact (n = 1097)	>2 to 3 years after AEC contact (n = 858)
Two visits	4.77 (3.20–7.10) ^a	1.96 (1.26–3.03) ^a	1.80 (1.09–2.98) ^a	2.74 (1.53–4.88) ^a
One visit	4.69 (2.46–8.91) ^a	1.88 (0.90–3.92)	1.30 (0.49–3.48)	3.66 (1.30–10.32) ^a
No-show referral	3.57 (1.51–8.46) ^a	2.77 (1.17–6.59) ^a	0.99 (0.26–3.71)	1.37 (0.33–5.74)
CCDSS controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)
AEC visits	Pediatric regression ^c Rate ratio (95% confidence interval)			
	12 months prior to AEC contact (n = 2764)	0 to 1 year after AEC contact (n = 2764)	>1 to 2 years after AEC contact (n = 2512)	>2 to 3 years after AEC contact (n = 2024)
Two visits	2.55 (2.05–3.17) ^a	1.80 (1.39–2.34) ^a	1.93 (1.43–2.62) ^a	1.77 (1.24–2.51) ^{ad}
One visit	2.75 (1.94–3.89) ^a	1.95 (1.28–2.99) ^a	2.26 (1.37–3.75) ^a	1.50 (0.78–2.89)
No-show referral	2.05 (1.01–4.15) ^a	5.21 (2.66–10.20) ^a	2.30 (0.88–6.03)	1.08 (0.28–4.17)
CCDSS controls	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)	1.00 (baseline)

^a $p < 0.05$.^bAdjusted for age and urban–rural residence.^cAdjusted for age, urban–rural residence and year and season of contact with the AEC.^dOne person dropped due to follow-up time of 0.01 years and one EDV. *n*, number of individual patients in model; CI, Confidence Interval; CCDSS, Canadian Chronic Disease Surveillance System.

diagnosis of asthma was 84.2% overall (Adults = 87.1% and Pediatric = 83.1%).

The outcome in this study is HCU information collected from provincial physician billing and hospital discharge abstract databases and any errors are likely to occur randomly. There exists the possibility of misclassification of patients by using ICD-9 codes as outcome measurements; however, some of this may be attenuated by using a broader “asthma-related” definition for HCU rather than a narrow asthma-only one. A chart audit could have helped address the specificity and sensitivity of the ICD-9 codes in this study.

Physicians may have different thresholds for referral to the AEC, but because of the large number of physicians making referrals to the AEC, there exists the potential for a referral bias for specific physicians. Since the AEC appears to reduce EDVs, it would be beneficial for standardized AEC referral criteria to be developed to encourage patient referral.

Asthma education is only one important component of the wider picture of HCU among asthma patients and any interpretation of the effect of the AEC needs to consider the cultural context of health care usage patterns. In addition, the goal of asthma education is to reduce the impact of asthma on quality of life, therefore some of the outcomes cannot be measured directly via changes in HCU. For example, a patient who has received asthma education may actually make more PCVs to achieve better asthma control. The effect of asthma education on healthcare utilization can be viewed as a proxy for other measures of asthma management and control. A previous report of the impact of education received at the AEC on quality of life demonstrated significant reductions in episodes of chest tightness, cough, wheezing and shortness of breath and a significant decrease in the proportion of patients with sleep interrupted by asthma symptoms. There were also significant improvements in the number of days missed from work and school, resulting in improved productivity [25].

Conclusion

Asthma prevalence remains high in PEI and Canada as a whole and requires a significant amount of health care resources to manage. This study offers a comprehensive evaluation of the effect of the AEC on HCU and has two broad conclusions. First, the group of patients who were referred to the AEC and failed to attend any asthma education consistently showed an increase in their healthcare utilization in the time period immediately following their referral, except for adult EDVs. Second, the HCU of AEC patients remain significantly higher than the HCU of the CCDSS control after asthma education. These results provide further evidence of the importance of continuing asthma education programs for managing and controlling asthma and the continued evaluation of established programs to ensure proper health care utilization.

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Declaration of interest

The authors JC and JH are employees of the Dr. Patrick Gill Asthma Education Centre and MZ is the Consultant Pediatrician and Medical Director of the Dr. Patrick A. Gill Asthma Centre. KG is an epidemiologist working with the Epidemiology Unit, Chief Public Health Office, PEI Department of Health and Wellness. CM, CS and CC are employees of the Epidemiology Unit, Chief Public Health Office, PEI Department of Health and Wellness. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Appendix 1

Table A1. ICD-9 diagnosis codes for asthma-related conditions [11].

ICD-9	Description
307	Habit spasms, tics, stuttering, tension headaches
462	Acute pharyngitis
460	Acute nasopharyngitis, common cold
461	Acute sinusitis
464	Acute laryngitis, tracheitis, croup, epiglottitis
465	Acute upper respiratory tract infection
466	Acute bronchitis
473	Chronic sinusitis
477	Allergic rhinitis, hay fever
480–486	Pneumonia (all types)
487	Influenza
490	Bronchitis, not otherwise specified
493	Asthma
494	Bronchiectasis
519	Other disease of the respiratory system
530	Esophagitis, cardiospasm, ulcer of esophagus, stricture
536	Hyperchlorhydria, hypochlorhydria, dyspepsia, indigestion
786	NYD epistaxis, hemoptysis, cough, dyspnea, masses
787	NYD anorexia, nausea and vomiting, heartburn, dysphagia
786.09	Wheezing