

Evaluation of Asthma Status Classification Consistency in Electronic Health Records by Asthma Specialist Review versus Rules-Based Algorithms

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Introduction

- Electronic Health Record (EHR) data provides extensive, cost-effective information that can be used to identify individuals for research studies¹
- Previous studies have identified asthma patients using rules-based algorithms and machine learning techniques in the EHR using manual chart review as the reference standard²⁻⁴
- Here, we determined if select rules-based algorithms were consistent with asthma classifications made by asthma specialists

Methods

- We randomly selected 600 patients at PennMedicine from January 2017 – August 2023 who had an International Classification of Diseases, Tenth Revision (ICD-10) code for asthma (i.e., J45*) with one of the following medication criteria:
 - no short-acting beta agonist (SABA) or inhaled corticosteroid (ICS) (n=200); a SABA and no ICS (n=200); or an ICS and no SABA (n=200)
- Asthma specialists (1 pulmonologist, 3 allergists/immunologists) created an asthma classification guide with definitions for *Definite/Highly Probable*, *Probable*, *Probably Not/No*, and *Unknown* classifications
 - each patient record was independently reviewed and labelled by two specialists
- Asthma classifications via manual chart review was compared to select rules-based algorithms

Results

- Patients with J45* ICD-10 and an ICS with no SABA had different demographic characteristics than the other two cohorts (Table 1)

Table 1. Patient characteristics stratified by selection criteria.				
Demographic characteristic	Selection Criteria			
	ICD-10 N = 200 ¹	ICD-10/SABA N = 200 ¹	ICD-10/ICS N = 200 ¹	Overall N = 600 ¹
Age				
18-34	77 (39%)	63 (32%)	36 (18%)	176 (29%)
35-54	60 (30%)	73 (37%)	54 (27%)	187 (31%)
55-74	55 (28%)	52 (26%)	81 (41%)	188 (31%)
75+	8 (4.0%)	12 (6.0%)	29 (15%)	49 (8.2%)
Sex				
Female	131 (66%)	146 (73%)	112 (56%)	389 (65%)
Male	69 (35%)	54 (27%)	88 (44%)	211 (35%)
Unknown/Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Race				
AIAN	0 (0%)	1 (0.5%)	1 (0.5%)	2 (0.3%)
Asian	6 (3.0%)	7 (3.5%)	6 (3.0%)	19 (3.2%)
Black	48 (24%)	59 (30%)	24 (12%)	131 (22%)
NHPI	0 (0%)	1 (0.5%)	0 (0%)	1 (0.2%)
White	116 (58%)	104 (52%)	146 (73%)	366 (61%)
Unknown/Other	30 (15%)	28 (14%)	23 (12%)	81 (14%)
¹ n (%)				

- After initial chart review, 465 of 600 records had consistent classifications (weighted κ-coefficient=0.74). Remaining disagreements were resolved until complete agreement was met
- Of the three criteria used to select our cohort, those with J45* ICD-10, a SABA, no ICS had the highest asthma outcome of 91% when *Definite/Highly Probable* and *Probable* classifications were combined (Table 2)

Table 2. Consistency of asthma specialist versus rules-based algorithm classifications of asthma. Shown are the counts for each asthma specialist classification against selected rules-based algorithms, along with the corresponding percentage.					
Rules-based Algorithm (Number with asthma according to rule)	Asthma Specialist Classification				Dichotomous*
	Definite/Highly Probable	Probable	Probably Not/No	Unknown	Has Asthma
J45* ICD-10, no SABA or ICS (N=200)	80 (40%)	71 (36%)	20 (10%)	29 (15%)	151 (76%)
J45* ICD-10 and SABA, no ICS (N=200)	136 (68%)	45 (23%)	8 (4%)	11 (6%)	181 (91%)
J45* ICD-10 and ICS, no SABA (N=200)	89 (45%)	55 (28%)	13 (7%)	43 (22%)	144 (72%)
≥ 2 J45* ICD-10 and SABA (N=136)	96 (71%)	30 (22%)	3 (2%)	7 (5%)	126 (93%)
Active J45* ICD-10 in Problem List and SABA (N=136)	101 (74%)	28 (21%)	1 (1%)	6 (4%)	129 (95%)
Primary J45* ICD-10 and SABA (N=127)	92 (72%)	27 (21%)	3 (2%)	5 (4%)	119 (94%)
*The dichotomous classification is based on the summation of <i>Definite/Highly Probable</i> and <i>Probable</i> labels via manual chart review					

- We assessed 12 rules-based algorithms with variations of the presence of ICD-10 codes and medications within the EHR in which 3 algorithms had >90% *Definite/Highly Probable* or *Probable* classifications by manual chart review (Table 2)

Discussion

- The initial chart review round showed moderate agreement amongst asthma specialists, suggesting variations in asthma diagnosis in clinical practice.
- The selection criteria for the three groups of people suggest somewhat strict rules for identifying asthma patients. However, we determined several rules that can be used to identify asthma patients with high classification consistency when using manual chart review as the reference.

Future Directions

- Increase cohort to include selection criteria of individuals with a SABA and ICS medication
- Predict who is in each asthma classifier based on available information from the EHR

References

- Kim E, Rubinstein SM, Nead KT, Wojcieszynski AP, Gabriel PE, Warner JL. The Evolving Use of Electronic Health Records (EHR) for Research. *Semin Radiat Oncol.* 2019 Oct;29(4):354–61.
- Xi N, Wallace R, Agarwal G, Chan D, Gershon A, Gupta S. Identifying patients with asthma in primary care electronic medical record systems. *Can Fam Physician.* 2015 Oct;61(10):e474–83.
- Nissen F, Quint J, Wilkinson S, Müllerova H, Smeeth L, Douglas IJ. Validation of asthma recording in electronic health records: a systematic review. *Clin Epidemiol.* 2017 Dec;Volume 9:643–56.
- Al Sallakh MA, Vasileiou E, Rodgers SE, Lyons RA, Sheikh A, Davies GA. Defining asthma and assessing asthma outcomes using electronic health record data: a systematic scoping review. *Eur Respir J.* 2017 Jun;49(6):1700204.

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