Appendix

 Table 1. The list of candidate features considered in this study.

	Table 1. The fist of candidate features considered in this study.
Feature category	Features
Features on patient	Ethnicity (Hispanic or non-Hispanic); gender; age; marital status (married, single, partnered,
demographics	divorced, widowed, or separated); race; and language.
Features related to laboratory	No. of laboratory tests; no. of laboratory tests having abnormal results; no. of days from the
tests	most recent laboratory test; whether an immunoglobulin E (IgE) test was performed; whether
tests	the greatest total serum IgE level is abnormally high; the greatest total serum IgE level; the
	largest percentage of blood eosinophils; and the largest blood eosinophil count.
Eastures related to vital signs	
Features related to vital signs	The mean diastolic blood pressure; the mean heart rate; the mean systolic blood pressure; the
	highest diastolic blood pressure; the mean temperature; the highest systolic blood pressure;
	the greatest heart rate; the mean respiratory rate; the greatest respiratory rate; the highest
	temperature; the mean peripheral capillary oxygen saturation (SpO ₂); the lowest SpO ₂ ; the
	mean peak expiratory flow; the lowest peak expiratory flow; the relative change of weight =
	(the most recently documented weight / the first documented weight - 1) × 100%; the largest
	body mass index (BMI); and the relative change of BMI = (the most recently documented BMI
	/ the first documented BMI - 1) \times 100%.
Features that are related to	No. of ICD-9 and ICD-10 diagnosis codes; no. of years from the first encounter related to
diagnoses and calculated	asthma in the data set; no. of primary or principal asthma diagnoses; no. of asthma diagnoses;
solely on ICD-9 and ICD-10	whether the most recent asthma diagnosis is a primary or principal one; the severity of the
diagnosis codes	most recent asthma diagnosis; the severity of the most severe asthma diagnosis; no. of
	diagnoses of asthma with status asthmaticus; no. of diagnoses of asthma with (acute)
	exacerbation; the exacerbation severity (uncomplicated, exacerbation, or asthmaticus) of the
	most recent asthma diagnosis; the greatest exacerbation severity of any asthma diagnosis; no.
	of days from the most recent asthma diagnosis; no. of days from the most recent diagnosis of
	asthma with (acute) exacerbation or status asthmaticus; no. of diagnoses of noncompliance
	with medication regimen; family history of asthma; chronic obstructive pulmonary disease;
	no. of years from the first encounter related to chronic obstructive pulmonary disease in the
	data set; esophagitis; allergic rhinitis; anxiety or depression; ischemic heart disease; eczema;
	gastroesophageal reflux; sleep apnea; gastrostomy tube; obesity; Alzheimer's or Parkinson's
	disease; upper respiratory tract infection; decreased tone; increased tone; cystic fibrosis;
	immunoglobulin A (IgA) deficiency; pneumonia; vocal cord dysfunction; psoriasis;
	anaphylaxis; vasculitis; cirrhosis; gastrointestinal bleeding; gastrointestinal obstruction;
	inflammatory bowel disease; mental disorder; breathing abnormality like dyspnea; pregnancy;
	vitamin D deficiency; myocardial infarction; folate deficiency; congestive heart failure;
	malignancy; peripheral vascular disease; dementia; peptic ulcer disease; cerebrovascular
	disease; substance use; rheumatic disease; diabetes with chronic complication; renal disease;
	diabetes without chronic complication; bronchopulmonary dysplasia; moderate or severe liver
	disease; mild liver disease; paraplegia or hemiplegia; acquired immunodeficiency syndrome;
	and metastatic solid tumor.
Features that are related to	Tracheostomy.
diagnoses and calculated	
jointly on ICD-9 and ICD-10	
procedure codes along with	
ICD-9 and ICD-10 diagnosis	
codes	
Features that are related to	Cataract; and sinusitis.
diagnoses and calculated	
jointly on Current Procedural	
Terminology (CPT) and	
Healthcare Common	
Procedure Coding System	
(HCPCS) procedure codes	
along with ICD-9 and ICD-10	
diagnosis codes	

Features related to the	No. of active problems; no. of active problems of wheezing; no. of active problems of asthma
problem list	with (acute) exacerbations; no. of active problems of asthma; no. of active problems of obesity;
proorem not	no. of active problems of congestive heart failure; no. of active problems of sleep apnea; no.
	of active problems of hypertension; no. of active problems of chronic obstructive pulmonary
	disease; no. of active problems of rhinitis; no. of active problems of diabetes; no. of active
	problems of anxiety/depression; no. of active problems of gastroesophageal reflux disease; no.
	of active problems about smoking; and the priority of the last active problem of asthma.
Features related to	Total no. of medications ordered; no. of medication orders; total no. of differing medications
medications	ordered; total no. of medication refills permitted; total no. of units of medications ordered;
medications	total no. of asthma medications ordered; no. of asthma medication orders; total no. of differing
	asthma medications ordered; total no. of asthma medication refills permitted; total no. of units
	of asthma medications ordered; total no. of short-acting beta-2 agonists ordered; total no. of
	refills permitted for short-acting beta-2 agonists; total no. of units of short-acting beta-2
	agonists ordered; total no. of systemic corticosteroids ordered; total no. of refills permitted for
	systemic corticosteroids; total no. of units of systemic corticosteroids ordered; no. of asthma
	reliever orders; total no. of asthma relievers ordered; total no. of refills permitted for asthma
	relievers; total no. of differing asthma relievers ordered; total no. of units of asthma relievers
	ordered; total no. of units of asthma relievers ordered that are neither short-acting beta-2
	agonists nor systemic corticosteroids; total no. of asthma relievers ordered that are neither
	short-acting beta-2 agonists nor systemic corticosteroids; no. of asthma controller orders; total
	no. of asthma controllers ordered; total no. of units of asthma controllers ordered; total no.
	of differing asthma controllers ordered; total no. of refills permitted for asthma controllers;
	total no. of inhaled corticosteroids ordered; total no. of refills permitted for inhaled
	corticosteroids; total no. of units of inhaled corticosteroids ordered; total no. of mast cell
	stabilizers ordered; total no. of refills permitted for mast cell stabilizers; total no. of units of
	mast cell stabilizers ordered; whether nebulizer was used; total no. of nebulizer medications
	ordered; no. of nebulizer medication orders; total no. of units of nebulizer medications
	ordered; total no. of differing nebulizer medications ordered; total no. of refills permitted for
	nebulizer medications; and whether spacer was used.
Features related to insurances	Whether the patient had any public insurance on the last day; whether the patient had any
	private insurance on the last day; and whether the patient was paid by oneself or a charity on
F . 1 . 1 . d	the last day.
Features related to the	No. of ED visits; no. of ED visits related to asthma; the most recent ED visit's length of stay;
patient's visit types	the mean length of stay of an ED visit; no. of visits; no. of outpatient visits to the patient's
	PCP; no. of outpatient visits; no. of outpatient visits whose primary diagnosis is asthma; no.
	of hospitalizations; the hospitalizations' total length; the mean length of a hospitalization; no.
	of hospitalizations, ED visits, and outpatient visits; no. of intensive care admissions; the most
	emergent admission type of all of the visits; the most recent visit's admission type (elective,
	urgent, emergency, or trauma); no. of major visits for asthma; and the most recent visit's type
	(ED visit, outpatient visit, or hospitalization). As in our prior paper [23], we defined a major
	visit for asthma as an ED visit having an asthma diagnosis code, a hospitalization having an
	asthma diagnosis code, or an outpatient visit having a primary diagnosis of asthma. An
	outpatient visit having only a secondary diagnosis of asthma was treated as a minor visit for
	asthma.
Features on visit status and	The day of the week when the most recent ED visit began; no. of cancelled appointments; the
appointment scheduling	most recent visit's discharge disposition location (home, left against medical advice, or other
	non-home location); no. of no shows; no. of times of leaving against medical advice; for the
	most recent visit, the time to the actual visit after making the request showing its urgency;
	across all of the visits, the shortest time to the actual visit after making the request; whether
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i	the most recent hospitalization came from the ED; no. of days from the most recent
	hospitalization; no. of visits having same day appointments; no. of days from the most recent
	hospitalization; no. of visits having same day appointments; no. of days from the most recent ED visit; no. of days from the most recent outpatient visit; no. of days from the most recent
	hospitalization; no. of visits having same day appointments; no. of days from the most recent ED visit; no. of days from the most recent outpatient visit; no. of days from the most recent ED visit on asthma; and no. of days from the most recent outpatient visit on asthma.
Features describing the	hospitalization; no. of visits having same day appointments; no. of days from the most recent ED visit; no. of days from the most recent outpatient visit; no. of days from the most recent ED visit on asthma; and no. of days from the most recent outpatient visit on asthma. No. of differing asthma medication prescribers; no. of differing EDs the patient went to; no.
Features describing the patient's care continuity degree	hospitalization; no. of visits having same day appointments; no. of days from the most recent ED visit; no. of days from the most recent outpatient visit; no. of days from the most recent ED visit on asthma; and no. of days from the most recent outpatient visit on asthma.

Features related to procedures	Mechanical ventilation reflected by ICD-10 and ICD-9 procedure codes; no. of ICD-10 and
	ICD-9 procedure codes; no. of HCPCS procedure codes of home oxygen therapy; no. of CPT
	procedure codes of the fractional exhaled nitric oxide test; no. of CPT/HCPCS procedure
	codes; no. of CPT procedure codes of pulmonary function tests; and no. of CPT/HCPCS
	procedure codes of influenza vaccination.
Allergy features	Indicator of drug or material allergy; the greatest severity of the patient's drug or material
	allergies; indicator of environmental allergy; the greatest severity of the patient's
	environmental allergies; indicator of food allergy; the greatest severity of the patient's food
	allergies; and no. of the patient's allergies.
Features related to pulmonary	The mean forced expiratory volume in 1 second (FEV1); and the lowest FEV1.
function tests	
Features related to social	No. of fluid ounces of alcohol the patient consumed every week according to the most recent
behavior history	record; whether the patient was ever documented of consuming alcohol; whether the patient
	consumed alcohol according to the most recent record; the mean no. of fluid ounces of alcohol
	the patient consumed every week across all of the records; no. of alcohol drinks the patient
	consumed every week according to the most recent record; the mean no. of alcohol drinks the
	patient consumed every week across all of the records; no. of packs of cigarettes the patient
	consumed every day according to the most recent record; whether the patient was a smoker
	according to the most recent record; the mean no. of packs of cigarettes the patient consumed
	every day across all of the records; whether the patient was a former smoker according to the
	most recent record; no. of years the patient had smoked for according to the most recent
	record; no. of times the patient took illicit drugs every week according to the most recent
	record; whether the patient took any illicit drug according to the most recent record; the mean
	no. of times the patient took illicit drugs every week across all of the records; and whether the
	patient was ever documented of taking any illicit drug.
Provider features	We defined the patient's PCP known at the most recent clinic visit as the patient's current
	PCP. We considered the following PCP features: no. of years that the PCP had practiced at
	UWM for; the PCP's age; whether the patient is of the same gender as the PCP; the PCP's
	primary specialty; whether the PCP is a resident; the PCP's type (physician, nurse, physician
	assistant, or other); the PCP's clinician title (doctor of medicine, registered nurse, physician
	assistant, or other); the percentage of the PCP's asthmatic patients in the pre-index year
	incurring asthma hospital encounters in the index year; and no. of asthmatic patients of the
	PCP.

Table 2. The features used in our final UWM predictive model and their importance values.

Rank	Feature	Importance calculated as
		the feature's apportioned
		contribution to the model
1	No. of ED visits related to asthma	0.2113
2	The mean length of stay of an ED visit	0.1088
3	No. of days from the most recent ED visit	0.1075
4	No. of primary or principal asthma diagnoses	0.0986
5	No. of days from the most recent diagnosis of asthma with (acute) exacerbation or status	0.0798
	asthmaticus	
6	Whether the patient is black	0.0423
7	No. of ED visits	0.0368
8	No. of asthma diagnoses	0.0322
9	No. of years from the first encounter related to asthma in the data set	0.0233
10	No. of nebulizer medication orders	0.0174
11	Whether the patient is white	0.0148
12	The highest systolic blood pressure	0.0128
13	No. of CPT/HCPCS procedure codes	0.0120
14	The largest BMI	0.0107
15	The most recent ED visit's length of stay	0.0104
16	Whether the patient is married	0.0102

18	17	Total no. of units of medications ordered	0.0101
19 Whether nebulizer was used 0.0081			
20			
Total no. of differing asthma medications ordered 0.0072			
The mean heart rate			
No. of diagnoses of asthma with (acute) exacerbation			
24 Whether the patient had any private insurance on the last day 0.0060 25 The mean respiratory rate 0.0058 26 No. of days from the most recent asthma diagnosis 0.0054 27 For the most recent visit, the time to the actual visit after making the request 0.0053 28 The mean systolic blood pressure 0.0064 30 Whether the patient had any public insurance on the last day 0.0046 31 Whether the patient had any public insurance on the last day 0.0042 32 The lowest SpO ₂ 0.0040 33 No. of active problems 0.0038 34 Whether the most recent visit is an ED visit 0.0038 35 The highest temperature 0.0037 40 No. of sistins 0.0034 37 No. of visits 0.0029 38 No. of visits 0.0029 39 Total no. of short-acting beta-2 agonists ordered 0.0029 40 The largest blood cosinophil count 0.0028 41 No. of sasthma reclievers ordered that are neither short-acting beta-2 agonists nor systemic corticosteroids <td></td> <td></td> <td></td>			
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For the most recent visit, the time to the actual visit after making the request 0.0054			
The mean systolic blood pressure			
Total no. of differing medications ordered 0.0046		<u> </u>	
Whether the patient has any drug or material allergy			
31 Whether the patient had any public insurance on the last day		<u> </u>	
32 The lowest SpO2 0.0040			
No. of active problems 0.0038			
34 Whether the most recent visit is an ED visit 0.0037 35 The highest temperature 0.0037 36 No. of laboratory tests 0.0034 37 No. of asthma controller orders 0.0029 38 No. of visits 0.0029 39 Total no. of short-acting beta-2 agonists ordered 0.0029 40 The largest blood eosinophil count 0.0028 41 No. of asthma medication orders 0.0027 42 Total no. of sathma relievers ordered that are neither short-acting beta-2 agonists nor systemic corticosteroids 0.0027 43 The mean temperature 0.0022 44 Total no. of inhaled corticosteroids ordered 0.0020 45 No. of days from the most recent outpatient visit on asthma 0.0020 46 The severity of the most recent asthma diagnosis 0.0020 47 Total no. of refills permitted for short-acting beta-2 agonists 0.0019 48 No. of differing providers the patient's aw in outpatient visits 0.0019 49 Age 0.0019 50 No. of outpatient visits to the patient's PCP<			
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70	Total no. of medication refills permitted	0.0005
71	The highest diastolic blood pressure	0.0005

Abbreviations:

BMI: body mass index

CPT: Current Procedural Terminology
FEV1: forced expiratory volume in 1 second
FVC: forced vital capacity
HCPCS: Healthcare Common Procedure Coding System

IgE: immunoglobulin E SpO₂: peripheral capillary oxygen saturation