
Subspecialty evaluation of chronically ill hospitalized patients with suspected immune defects

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Background: The diagnosis of primary immunodeficiency is suggested by recurrent or unusual infections and inflammatory and autoimmune conditions. Because the diversity of immune defects and clinical presentations poses a diagnostic challenge in hospital populations, a computer algorithm was devised to help identify patients.

Objective: To assess use of pertinent subspecialty clinics by patients with clinical features of immunodeficiency.

Methods: Using a validated algorithm based on *International Classification of Diseases, Ninth Revision (ICD-9)*, codes applied to The Mount Sinai Hospital billing records, we investigated hospitalized patients, 60 years or younger, who had been diagnosed as having conditions associated with immunodeficiency, excluding those with confounding medical conditions. Immunodeficiency-related disease codes were given a weighted score based on relative severity and expressed as a sum for admissions between January 1, 1999, and December 31, 2003. Demographic features, subspecialty care, and clinic attendance were determined.

Results: The 296 computer-identified patients with illnesses characteristic of immunodeficiency were 35.8% Hispanic, 27.0% African American, and 21.6% white; their median age was 13.3 years. Patients were hospitalized 1,261 times, or a median of 4.2 times each (range, 1–42 times), and had 5,700 diagnoses. Of the patients, 75.0% received primary care at The Mount Sinai Hospital. Although the most common diagnosis was pneumonia ($n = 243$), 45% of patients never received allergy/immunology or pulmonary subspecialty care.

Conclusion: Despite receiving primary medical care at the same hospital, many frequently hospitalized subjects with features of immunodeficiency do not receive medical care in appropriate subspecialty clinics.

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INTRODUCTION

Primary immune deficiency diseases arise because of defects of the adaptive or innate immune system. In the past decade, more than 100 immune defects have been identified, resulting in an estimated overall prevalence of 1:10,000 persons; yet, the genetic causes for the most common defects remain unknown.^{1–3} The clinical manifestations of immunodeficiency encompass a constellation of symptoms, including recurrent or severe sinopulmonary and gastrointestinal infections and, often, autoimmune or inflammatory conditions. Additional complications include cancers, particularly lymphoma, and constitutional symptoms, such as fever or failure to thrive.^{4–9} Despite the numbers and relative incidences of

these immunodeficiency syndromes, delay in diagnosis is common.^{8,10–12} The underlying racial and ethnic distribution of primary immune diseases in general has not been clarified; in addition, some of the most common defects have not been identified in patients of African American or Hispanic (predominantly Latin American or Mexican American) descent as commonly as in white patients. These observations suggest there may be a lack of recognition of these syndromes in nonwhite populations.^{6,8,12–14}

In a previous study,¹⁵ a computer algorithm was devised to identify potentially undiagnosed patients in a general hospital population containing many African American and Hispanic patients. Based on the medical discharge billing codes in the *International Classification of Diseases, Ninth Revision (ICD-9)*,¹⁶ the computer algorithm selected hospitalized patients who had been given a diagnosis of 2 or more ICD-9 codes relating to medical conditions characteristic of immunodeficiency, such as pneumonia, bronchiectasis, septicemia, meningitis, selected autoimmune conditions, and opportunistic infections (Table 1). With informed consent, 59 of 82 patients approached when they returned for readmission or a clinic visit were tested; 17 of these 59 patients (29%) had primary immunodeficiency and 13 (22%) had secondary immune defects. Thus, the computer algorithm helped identify individuals with immune defects in our general hospital pop-

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Table 1. Condensed List of ICD-9 Codes and Their Weight

ICD-9 code	Diagnosis	Weight of code
38.1–38.4	Bacterial septicemias	3
36.9, 47.9, and 47.8	Meningococcal meningitis, aseptic meningitis, and viral meningitis	3
320.3 and 320.9	Bacterial meningitis	3
289.59	Spleen abscess	3
481, 482, 482.2, 482.9, 485, and 486	Bacterial pneumonias	3
510.9	Empyema	3
513	Abscess of lung	3
566	Rectal abscess	3
572	Abscess of liver	3
730.0–730.9	Osteomyelitis	3
07.1	Giardiasis	2
283.9	Autoimmune hemolytic anemia ^a	2
287.3	Primary thrombocytopenia and ITP ^a	2
288 and 288.8	Neutropenia and lymphocytopenia	2
494	Bronchiectasis ^a	2
682, 682.1, and 682.2	Cellulitis of the face	2
683	Lymphadenitis	2
789.2	Splenomegaly ^a	2
787.91	Chronic diarrhea ^a	1
112, 112.3, and 117.9	Thrush, cutaneous candidiasis, and mycoses ^a	1
382.4 and 382.9	Chronic/suppurative otitis media ^a	1
383.1	Chronic mastoiditis ^a	1
461 and 473	Acute or chronic sinusitis	1
466 and 491.9	Acute or chronic bronchitis	1
579.9	Malabsorption ^a	1
780.6	Fever, unknown origin	1
783.2 and 783.4	Abnormal loss of weight ^a and failure to thrive	1
785.6	Enlargement of lymph nodes	1

Abbreviations: ICD-9, *International Classification of Diseases, Ninth Revision (ICD-9)*; ITP, idiopathic thrombocytopenic purpura.

^a To avoid overcounting, these codes were only counted once in a 30-day period.

ulation. Of the newly identified immunodeficient patients, 86% were Hispanic or African American.¹⁵ Because the scoring system used an arbitrarily set threshold for suggesting that an immunodeficiency might be present, we subsequently tested and verified the method in a large group of physician-referred patients later proved to have an immune defect.¹⁷ Because, in the previous study, the most prevalent diagnosis of computer-selected inpatients was pneumonia and many of the admissions were complicated by other significant infections, we undertook the present study to determine where such a group of hospitalized patients actually received their clinical care and if appropriate subspecialty care was being used.

METHODS

Hospital and Demographics

The Mount Sinai Medical Center is a tertiary referral center in New York City that also serves the inner-city communities of Harlem. Hospitalized patients are 42% white, 22% Hispanic, and 16% non-Hispanic African American. The main insurance payers for subjects younger than 60 years are health maintenance organizations (HMOs) (39%), Medicaid (in-

cluding Health First and various other managed Medicaid programs) (30%), commercial insurance carriers (22%), and Medicare (5%).

Diagnosis Codes and Scoring

A list of diagnoses and conditions suggestive of immunodeficiency was compiled as previously described using standard immunologic references and reviews of primary immunodeficiency. This list contains 174 separate and expanded ICD-9 diagnosis codes (immune deficiency related [IDR] codes).¹⁵ A score of 1, 2, or 3, numerically reflecting the severity (with 3 being most severe) of the illness, was assigned for each of these diagnoses. (Table 1 gives a condensed version of these codes.) The discharge diagnosis codes of all patients admitted to The Mount Sinai Hospital during the 5-year interval from January 1, 1999, to December 30, 2003, were surveyed, using record/billing data stored in a database (Oracle; Oracle Corporation, Redwood Shores, California) and medical system (Eagle 2000; Eagle Systems Technology, Germantown, Tennessee), scored and totaled. For each admission, the primary diagnosis and up to 7 secondary diagnoses were reviewed. The final diagnosis of pneumonia for any admission was

made based on radiographic evidence, continuing and confirming daily clinical notes, and the conclusions of the physician of record in the discharge summary. As in the previous study, a chosen minimum IDR score of 6 or greater was used to select patients of interest. Patients older than 60 years and those with any of the 1,800 ICD-9-coded diseases that could result in illnesses similar to immunodeficiency, including human immunodeficiency virus, alcoholism, cystic fibrosis, quadriplegia, cancer, and stem cell or organ transplantation, were excluded. The demographic information on sex, age, race, and ethnic group; home ZIP code; insurance primary payer; and all hospital consultation, clinic, and outpatient attendance records were extracted from the database.

Inpatient Consultations and Outpatient Clinic Visits

A total of 490 clinics are available at The Mount Sinai Medical Center, including the adult and pediatric emergency departments, walk-in clinics, and all general and subspecialty clinics of medicine and pediatrics. All inpatient and outpatient billing records from January 1, 1999, to December 30, 2003, were examined to determine whether a patient of interest had visited the primary care sites, defined herein as the general medical, general pediatric, medical-pediatric, and emergency department visits. Patients who had attended (≥ 1) adult allergy/immunology, adult chest, pediatric allergy/immunology, or pediatric chest outpatient clinics in this period were designated as patients who had received "A/I/P" subspecialty evaluation. Using attending billing records and compiled inpatient consultation records, a patient was also considered to have had a subspecialty evaluation if there was a record of 1 or more allergy/immunology, pulmonary, or pulmonary/critical care (A/I/P) inpatient evaluations.

Data and Statistical Analysis

SAS statistical software (SAS Institute Inc, Cary, North Carolina) and another system (Oracle) were used to extract and analyze the data from a database (Eagle 2000). χ^2 Tests were used to test for differences between patient groups for nominal variables. The Mantel-Haenszel χ^2 test for trend was used for ordinal factors. All tests used a significance level of .05. Using SAS statistical software, logistic regression also was applied to explore independent predictors of a patient's being evaluated by a subspecialist in A/I/P. Computer software (Excel; Microsoft Corporation, Redmond, Washington) was used to analyze data. This retrospective study was performed under an institutional review board-granted waiver of informed consent.

RESULTS

Comparing Computer-Selected Hospitalized Patients With the General Hospital Patient Population

The billing records recorded 227,571 admissions to The Mount Sinai Hospital for 138,461 patients, who had 1,180,962 discharge diagnoses. The overall inpatient population, excluding all patients older than 60 years and our computer-selected patients, was a median age of 31.3 years

(interquartile range, 1.7–44.7 years), and there was a median of 1 admission per patient (range, 1–97 admissions). Of these inpatients, 95.0% had 5 or fewer admissions. The primary insurance payers were HMO and Medicaid (Table 2). Using the computer algorithm to search discharge diagnoses, we identified 296 patients who had an immune deficiency score total of 6 or greater. These patients were hospitalized 1,261 times, or a median of 4.2 times each (range, 1–42 times). Nearly one third of these patients had more than 5 admissions to the hospital within the study period. This group of patients was younger than other (non-computer-selected) inpatients younger than 60 years ($P < .001$), with a median age of 13.3 years (interquartile range, 3.8–44.4 years). In contrast to other hospitalized subjects, most computer-selected patients were Hispanic, African American, or white ($P < .001$) (Table 2). Most of this patient group was insured by Medicaid compared with other hospitalized subjects ($P < .001$). More of these computer-selected patients lived in the same or contiguous zip codes around The Mount Sinai Medical Center than the other hospitalized subjects (Table 2). Although the actual mortality of these patients is not known, 18 were known to have died at The Mount Sinai Hospital during the period of study.

IDR Scores, Diagnoses, and Demographics of Subjects Evaluated by Subspecialty Physicians

The 296 computer-selected patients had been given 5,700 primary and secondary diagnoses, or a mean of 19.3 diagnoses each, compared with the overall hospitalized patient group younger than 60 years, who had a mean of 8.5 diagnoses per person in this same period ($P = .001$). The IDR scores of these subjects ranged from 6 to 40 (mean, 7.8). Of the diagnoses that were specifically targeted by the computer screening, the most frequent was pneumonia, affecting 243 patients (82.1%), who had 490 episodes of pneumonia (unspecified, bacterial, viral, or fungal), followed by bacterial sepsis, empyema, and bronchiectasis (Table 3). The most common other non-immune deficiency-related diagnoses among these patients included asthma (with or without exacerbation [119 patients]), hypertension, and diabetes mellitus.

Considering that all forms of pneumonia or asthma were the 2 most common diagnoses, we investigated the potential overlap between these conditions. For the computer-selected group, there were 490 admissions for pneumonia. Of the 296 patients, 120 (40.5%) had pneumonia and asthma on the same admission. For 55 (45.8%) of these patients, pneumonia was the primary diagnosis and asthma a secondary diagnosis.

Reviewing all outpatient clinic visits showed that the 296 patients made 5,573 clinic visits, or an average of 18.8 visits per person, during the 5 years, indicating a high use of The Mount Sinai Medical Center medical services. However, of the 296 subjects, only 163 (55.1%) had A/I/P consultation, A/I/P outpatient subspecialty care, or both during the 5-year period. Furthermore, these patients had only 366 A/I/P encounters, an average of only 2.2 encounters per person.

Table 2. Demographic Characteristics of the 296 Computer-Selected Patients and the Remaining Inpatients: 1999–2003

Characteristic	Computer-selected patients (n = 296) ^a	Other inpatients <60 y (n = 102,893) ^{a,b}	P value
Sex			
Female	163 (55.1)	62,819 (61.1)	<.05 ^c
Male	133 (44.9)	40,047 (38.9)	
Ethnicity/race			
Hispanic	106 (35.8)	22,382 (24.5)	<.001 ^c
African American	80 (27.0)	16,544 (18.1)	
White	64 (21.6)	43,178 (47.2)	
Other	46 (15.5)	9,421 (10.3)	
Age, y			
0–<1	58 (19.6)	26,045 (25.3)	<.001 ^d
1–10	90 (30.4)	5,275 (5.1)	
11–20	19 (6.4)	6,734 (6.5)	
21–30	21 (7.1)	14,001 (13.6)	
31–40	31 (10.5)	20,490 (19.9)	
41–50	32 (10.8)	15,556 (15.1)	
51–60	45 (15.2)	14,792 (14.4)	
Zip code			
In area (10029 and 10035)	77 (26.0)	12,527 (12.2)	<.001 ^c
Other zip codes	219 (74.0)	90,366 (87.8)	
Primary payer			
Medicaid	156 (52.7)	30,667 (30.2)	<.001 ^c
Medicare	16 (5.4)	5,518 (5.4)	
Commercial	49 (16.6)	22,526 (22.2)	
HMO	71 (24.0)	40,181 (39.6)	
Self-pay	4 (1.4)	2,550 (2.5)	
Hospital admissions			
1–5	193 (65.2)	98,169 (95.4)	<.001 ^c
>5	103 (34.8)	4,724 (4.6)	

Abbreviation: HMO, health maintenance organization.

^a Data are given as number (percentage) of each group. Percentages are based on the total for each characteristic and may not total 100 because of rounding.

^b Numbers in subgroups do not always add up to the total because of missing data.

^c χ^2 Test.

^d Mantel-Haenszel χ^2 test.

Compared with the 133 patients who had not received subspecialty care, the 163 who did receive A/I/P consultation or subspecialty care were younger, had Medicaid as the primary payer, and were more likely to be Hispanic or African American and living in the same ZIP code as The Mount Sinai Medical Center (Table 4). The 133 patients who did not receive an A/I/P subspecialty evaluation had a more equal distribution with respect to ethnicity and race; 50.3% were adult, most lived outside the 2 local ZIP codes, and most had either HMO or Medicaid coverage.

To further understand the differences between the 163 A/I/P subspecialty–evaluated patients and the remaining 133 patients who never received this care at The Mount Sinai Medical Center, we examined discharge diagnoses, number of hospitalizations, and overall IDR total scores. The subjects who had documented subspecialty care had significantly more diagnoses overall (4,422 vs 1,278 for those with no subspecialty care), more hospitalizations (825 vs 436), more episodes of pneumonia and asthma, and higher IDR scores

(Table 5). All differences were statistically significant ($P < .001$). Nearly half of the subspecialty-evaluated patients (48.4%) had more than 5 admissions, compared with only 18.7% of the non–subspecialty-evaluated group ($P < .001$).

To determine what specific features were most likely to be associated with a patient being seen by A/I/P physicians, a logistic regression determined for a P value of .05 demonstrated that pneumonia was an independent variable, predictive of subspecialty evaluation. Patients diagnosed as having pneumonia were 1.3 times more likely to receive subspecialty care (confidence interval, 1.06–1.76). When the P value was liberalized to .10, Hispanic race, Medicaid as a payer, total number of diagnoses, IDR score, number of hospitalizations, and the diagnosis of asthma were also independent variables predictive of A/I/P subspecialty care. In addition to all these factors, patients who received primary care at The Mount Sinai Medical Center were also more likely to obtain A/I/P subspecialty care ($P = .04$). Of the 296 patients, 222 (75.0%) had received *primary care* at The Mount Sinai Medical

Table 3. Most Common Diagnoses for Computer-Selected Subjects^a

Diagnosis	No. of subjects affected
Immune related	
Pneumonia not specified	402
Bacterial, viral, or fungal pneumonia	88
Sepsis (all bacteria)	82
Empyema with or without fistula	46
Bronchiectasis with or without an acute exacerbation	44
Osteomyelitis (all locations)	41
Cellulitis	38
Urinary tract infection	32
Primary thrombocytopenia	33
Bacterial or viral meningitis	19
Other	
Asthma, unspecified	252
Asthma, with an acute exacerbation	186
Hypertension	144
Diabetes mellitus	77
Congestive heart failure	69
Sickle cell anemia disease with crisis	66
Anemia not specified	55
Hypovolemia	53
Decubitus ulcer	50
Systemic lupus erythematosus	48

^a Based on the 5,700 primary and secondary diagnoses for 296 patients.

Center (defined as visits in the general medical, pediatric, or medical-pediatric practices or the emergency department). Of these 222 patients, 130 (58.6%) received A/I/P subspecialty care. For the 74 subjects who had not visited primary care sites at The Mount Sinai Medical Center, only 33 (44.6%) obtained A/I/P subspecialty care.

DISCUSSION

In a prior study,¹⁵ patients with medical characteristics of either primary or secondary immune deficiency were not, for the most part, referred for immunologic evaluation or medical care in this specialty. In the present study, we investigated the clinical care patterns of a group of 296 such subjects gathered from the inpatient population for more than 5 years to determine the demographics of this group, where medical care was being rendered, and if we could identify any differences between the group of subjects who were referred for appropriate subspecialty care and those who were not.

As shown for a different cohort of admitted subjects,¹⁵ and compared with all the other general patients admitted to The Mount Sinai Hospital, the 296 patients in this study who were selected by the computer scoring algorithm as potentially immune deficient were younger, had a higher frequency of admissions, and were more likely to be Hispanic or African American, insured by Medicaid, and live in the zip codes contiguous to The Mount Sinai Hospital than other subjects not selected by computer screening.

Although 243 of these patients (82.1%) had 490 episodes of pneumonia, and 40% had been diagnosed as having asthma on the same or different admissions, only 55.1% (163/296) of these subjects had had either a documented consultation or care by any A/I/P service in the 5-year period of review. Although most (75.0%) of the computer-selected patients did receive at least some primary care at The Mount Sinai Hospital, and this was associated with an increased likelihood of A/I/P subspecialty care, this group of patients had a mean of only 2.2 subspecialty contacts over 5 years, in all likelihood an insufficient number of encounters to render appropriate care.

The patients who had A/I/P subspecialty evaluation or care were younger, because 57.0% of the 163 patients in this group were younger than 10 years. Whether pediatricians or medicine-pediatric practitioners are more likely to enlist the participation of these subspecialists^{18,19} or if parents are more likely to take their children to follow-up clinic referrals is not known. Furthermore, the older or non-Medicaid patients in this cohort may have identified alternative locations for medical care and, thus, were not captured by our billing records. However, previous studies done elsewhere have shown that Medicaid-enrolled subjects with chronic conditions are unlikely to receive care in any relevant subspecialty arena. In 1 study of 57,328 children or adolescents with 1 of 11 chronic conditions, most of the subjects had no identifiable relevant subspecialty visit in the study year.^{18,20} In that same study, for 16,302 of these patients with asthma, only 24% had seen a subspecialist (also defined as allergy/immunology and pulmonary subspecialties). Although that previous study concentrated on outpatient care, in the present study, we gathered data on patients who had been multiply hospitalized over 5 years, suggesting that even for sicker subjects, appropriate consultation and outpatient follow-up does not always occur. The reasons for this poor pattern of clinical care are unclear. Although 80% of emergency department patients are referred for follow-up care, patients who have a general care physician are usually referred back to this person for follow-up and not to a subspecialist.²¹ Another issue is the difficulty of obtaining a timely appointment in an appropriate setting, especially for subjects with Medicaid.^{21,22}

There are intrinsic problems with the use of the billing record in the analysis of medical care, the foremost being the application of inaccurate or incomplete ICD-9 codes. Nevertheless, ICD-9 codes as applied to large populations have been useful in the analysis of lower respiratory tract infections,^{23,24} the use of pneumococcal vaccination on prevention of pneumonia,^{24,25} and the use of leukotriene inhibitors on asthma.²⁵ In our study, we were not able to determine if an appropriate subspecialty referral had been made but not carried out; if "curbside," but nondocumented, consultations had been obtained; or if medical encounters had occurred, but had not been submitted for billing.

In previous studies, episodes of recurrent pneumonia were associated with immune deficiency in 10% to 16% of cases^{26,27}; not surprisingly, this diagnosis was predictive of re-

Table 4. Demographic Characteristics of Computer-Selected Patients Who Did and Did Not Undergo Subspecialty Evaluation

Characteristic	Patients who underwent subspecialty evaluation (n = 163) ^a	Patients who did not undergo subspecialty evaluation (n = 133) ^a	P value
Sex			
Female	86 (52.8)	75 (56.4)	.53 ^b
Male	77 (47.2)	58 (43.6)	
Ethnicity/race			
Hispanic	71 (43.6)	35 (26.3)	<.008 ^b
African American	40 (24.5)	40 (30.1)	
White	34 (20.9)	30 (22.6)	
Other	18 (11.0)	28 (21.1)	
Age, y			
0–<1	33 (20.2)	25 (18.8)	.005 ^c
1–10	60 (36.8)	30 (22.6)	
11–20	14 (8.6)	5 (3.8)	
21–30	7 (4.3)	14 (10.5)	
31–40	14 (8.6)	17 (12.8)	
41–50	17 (10.4)	15 (11.3)	
51–60	18 (11.0)	27 (20.3)	
ZIP code			
In area (10029 and 10035)	48 (29.4)	29 (21.8)	.01 ^b
Other ZIP codes	115 (70.6)	104 (78.2)	
Primary payer			
Medicaid	97 (59.5)	23 (17.3)	<.002 ^b
Medicare	10 (6.1)	42 (31.6)	
Commercial	29 (17.8)	59 (44.4)	
HMO	26 (16.0)	6 (4.5)	
Self-pay	1 (0.6)	3 (2.3)	
Hospital admissions			
1–5	85 (52.1)	108 (81.2)	<.001 ^b
>5	78 (47.9)	25 (18.8)	

Abbreviation: HMO, health maintenance organization.

^a Data are given as number (percentage) of each group. Percentages may not total 100 because of rounding.^b χ^2 Test.^c Mantel-Haenszel χ^2 test.Table 5. Differences in Subjects Who Underwent and Did Not Undergo Subspecialty Evaluation^a

Variable	Subjects Who Underwent Subspecialty Evaluation (n = 163)	Subjects Who Did Not Undergo Subspecialty Evaluation (n = 133)
No. of diagnoses of pneumonia	2.3 (0–42)	0.7 (0–12)
No. of diagnoses of asthma	1.6 (0–7)	1.0 (0–4)
No. of hospitalizations	5.1 (1–42)	3.3 (1–20)
Immune-related score	8.5 (6–40)	6.9 (6–18)

^a Data are given as mean (range). $P < .001$ for all differences between the 2 groups.

ferral for subspecialty evaluation as determined by logistic regression. Asthma was also common and was another independent predictor for subspecialty referral. Exploring the overlap between all kinds of pneumonia and asthma, 120 patients (40.5%) had been diagnosed as having both conditions on 1 or more admissions; for more than half of these patients, the primary diagnosis was pneumonia. Because asthma may be associated with areas of atelectasis, confirming the diagnosis of pneumonia (especially ICD-9 code

486.0) can present difficulties and so pneumonia may have been overdiagnosed. However, the diagnosis or presence of asthma does not exclude immune deficiency; in a national survey of common variable immune deficiency, 10% of patients had been told that they had asthma (data on file, USIDnet.org; available at: <http://www.usidnet.org>). In addition, culture evidence in children has shown that for most, asthma exacerbations are often associated with viral infections,^{28,29} suggesting that even for this group of patients, immune defects may be present.

This study shows that 44.9% of patients hospitalized with pneumonia, or with other significant bacterial infections leading to sepsis, empyema, or bronchiectasis, with or without a diagnosis of asthma, do not obtain A/I/P subspecialty care. The data presented herein are similar to previously published information on a large cohort of chronically ill children, in which most of the children followed up had no identified relevant subspecialty care in a study year.^{18,20} Outcomes of pneumonia have been shown to improve when treated under specific guidelines in contrast to general care by primary physicians.^{30,31} Significant literature^{32–34} also suggests that generalists do not adequately manage asthma and that appropriate subspecialty care reduces illness and hospitalizations. Relevant to the present patient population, which is predominantly minority, the lack of appropriate subspecialty care is likely to contribute to the observed treatment disparities and increased mortality rates noted in these populations.^{35,36}

Remedies for the lack of referral of frequently ill patients to appropriate subspecialties are not readily available. At The Mount Sinai Medical Center, in an effort to do this for our patient cohort, the hospital information system sends an e-mail alerting our investigators of a newly registered patient who has previously qualified for further evaluation. Although we acknowledge that this would not generally be applicable to each medical center, newly emerging opportunities to integrate information technology into patient care are increasingly being introduced into medical care and research. These methods, based on accumulated clinical and/or laboratory data, are likely to provide opportunities to identify selected patients who require additional investigation.

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