

Inpatient allergy/immunology consultations in a tertiary care setting

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ABSTRACT

Few studies have examined inpatient referral patterns for fellowship training programs and none for allergy/immunology (AI) since 2003. The primary end point was the reason for consultation, and secondary end points included the AI diagnosis made and outcomes. We retrospectively reviewed all inpatient AI consultations from July 1, 2001 through June 30, 2007. These 6 years of data were combined with 14 years of data examining the reason for consult from a previous study. The data were analyzed for trends and changes over the entire 20-year period. A total of 254 AI inpatient consults were reviewed over the 6 years studied. Thirty-six percent (92/254) of inpatient consults were for evaluation of adverse drug reactions (ADRs), 22% (55/254) miscellaneous reasons, 17% (43/254) urticaria/angioedema, 13% (32/254) for possible immunodeficiency, 9% (23/254) for anaphylaxis, and 3% (8/254) for asthma. AI inpatient consults show a significant decline over the recent 6-year period ($p = 0.0023$) despite stable total hospital admissions since 1998. Over the last 20 years, an 85% decrease ($p < 0.00001$) in inpatient asthma consults and increases ($p < 0.05$) in immunodeficiency, rash, and urticaria/angioedema evaluations have been observed. Not following AI recommendations resulted in a 16.6 odds ratio (95% CI, 5.55–49.93) that a patient's clinical status would be worse or unchanged. Inpatient AI consults have declined with associated reduction in asthma inpatient consults. Although ADRs and anaphylaxis consults have been stable, evaluations for immunodeficiency, rash, and urticaria/angioedema have increased. Following inpatient AI recommendations is associated with improved patient outcomes.

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Key words: Adverse drug reactions, allergy immunology, anaphylaxis, angioedema, asthma, immunodeficiency, inpatient consult, outcomes, rash, urticaria

The specialty of allergy/immunology (AI) is a challenging and varied discipline that has seen substantial scholarly and clinical advances in the last 10 years. Allergic disease affects >50 million people and is the fifth leading cause of chronic disease in the United States. Nearly 465,000 hospital admissions for asthma-related disorders occur each year. Not counting adverse drug reactions (ADRs), 190 people die from anaphylaxis annually.¹ In the past 10 years, over 100 immune defects have been identified though many (45%) may never be referred for subspecialty evaluation.² Understanding how hospital referrals for these important diseases occurs is important for the practicing allergist and for the educational planning of AI fellowships.

Medline search (keywords: inpatient consults, inpatient allergy, and inpatient allergy consults) finds that several epidemiological studies have examined aspects of allergic diseases, such as anaphylaxis in the emergency room, drug allergy, asthma, primary immunodeficiency (ID), and angioedema admissions.^{2–6} Several other specialties have evaluated the indications for their departmental inpatient consults and have been published in their respective subspecialty journals.^{7–12} Only two published studies have looked at all inpatient consultations for AI.^{13,14} England *et al.* from 1987 to 2001 analyzed reasons for consultation and helped provide guidance for AI fellowship training as well as internal medicine and pediatric residency education.¹³ However, since 2003, no further AI inpatient studies have been published but much has changed.

Wilford Hall Medical Center (WHMC) is the largest medical center in the U.S. Air Force. WHMC is a regional referral hospital and a level 1 trauma center. It has 218 staffed beds, serves as a major teaching hospital for two medical schools, trains residents and fellows from 32 specialties and subspecialties, and provides training to a variety of other health care professionals. Information on recent inpatient AI consultations will help guide efforts in graduate medical education training for AI fellows, internal medicine, pediatric residencies, and medical students. Information in this study may assist in

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allocation of resources and aid in inpatient physician utilization.

Our primary objective was to evaluate the reason for inpatient AI consultation over the last 6 years with secondary objectives to evaluate the diagnosis made and outcomes achieved. With this 6-year study, added to our previous 14 years of data, we extended the ability to examine trends on AI inpatient consultation to a total of 20 years.

METHODS

This retrospective, single-blinded, descriptive research protocol was approved by the WHMC Institutional Review Board. We reviewed our intradepartmental inpatient clinical database for details on consultations between July 1, 2001 and June 30, 2007. Additional information was collected, such as admitting specialty, reason for consult, and primary through tertiary AI diagnosis. Outpatient medical records were reviewed for information regarding any change in clinical condition as determined by review of the treating provider's assessment at the next outpatient appointment or inpatient encounter. Outcomes were determined by review of their outpatient encounter and recorded by a single observer as better, unchanged, or worse. Hospital statistics and demographics were obtained from hospital shared records.

All inpatient consults received by AI between July 1, 2001 and June 30, 2007 were included. Reasons for referral were categorized and relative frequencies were calculated by simple percentages of total.

Statistical Analyses

Paired *t*-tests were used to compare consult data from two different time periods. The *p* values were two tailed and 95% CIs of differences were calculated. Fisher's exact tests with two-tailed *p* values were used to evaluate clinical outcomes data and comparisons between reasons for consults in the different time periods. The value of *p* < 0.05 was considered statistically significant. Odds ratios were calculated for clinical outcomes. Statistical analyses were calculated using an online software program (Graphpad, La Jolla, CA and DJR Hutchon, Darlington, England).

RESULTS

Reason for Consults

A total of 254 AI inpatient consults were reviewed from the academic years of July 1, 2001 to June 30, 2007; 121 (48%) were male patients. Analysis of inpatient consults shows that 25% (63/254) were in the pediatric age group (0–18 years old) and 75% (191/254) were adults (52% [133/254] young adult [19–65 years old]; 23% [58/254] geriatric [>65 years old]; Table 1). The median age was 39.5 years.

Table 1 Demographic information

Gender	Percentage (No.) of All 254 Consults
Female	52% (133)
Male	48% (121)
Consults by age ranges	
Pediatrics	25% (63)
0–5 yr old	13% (32)
6–18 yr old	12% (31)
Adult	75% (191)
19–65 yr old	52% (133)
>66 yr old	23% (58)

Consults to AI were requested by internal medicine (49% [125/254 patients]), pediatrics (20% [50/254 patients]), pulmonary/critical care (7% [17/254]), cardiology (5% [13/254]), general surgery (4% [11/254]), and all other specialties (15% [38/254]).

The most common reasons for AI consultation were ADRs (37% [93/254], Fig. 1), urticaria with or without angioedema (17% [43/254]), ID (13% [32/254]), rash (11% [28/254]), other (11% [27/254]), anaphylaxis (9% [23/254]), and asthma (3% [8/254]). Antibiotics as a whole accounted for 68% (63/93) of all ADRs. Of the 63 antibiotic ADRs, penicillin (PCN) was the most common at 45% (42/93).

Possible ID was the third most common consult (13% [32/254]).

Twenty-seven consults were received for miscellaneous reasons. These included six consults for suspected food allergy, three consults each for allergic bronchopulmonary aspergillosis, eosinophilic disorders, and venom allergy. Two consults for latex, shortness of breath, eczema, and other not otherwise specified were requested. Only one consult was requested for contact dermatitis, chronic sinusitis, drug reaction, and hypersensitivity pneumonitis.

The most common reason for consulting AI varied by age group; ID was the most common reason in the pediatric age group (32% [20/63]; see Fig. 5, B–C) and ADR consults were the most common reason in the adult age group (42% [80/191]; see Fig. 5, C–D). Subgroup analysis shows that possible ID was the most common reason for consults in our 0- to 5-year-old age group (44% [14/32]; see Fig. 5 B). Food allergy contributed to a higher percentage of anaphylaxis in the pediatric and young adult age groups compared with the geriatric group. Conversely, medications contributed to a higher proportion of anaphylaxis in the adult group compared with the pediatric group.

AI Diagnoses

Analysis of the six most common AI diagnoses shows relative changes in diagnosis as the population

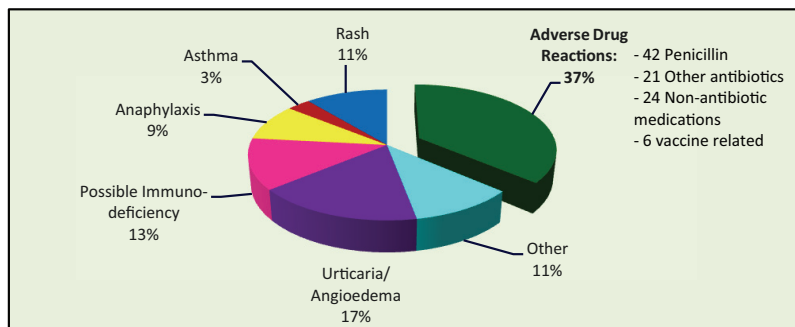


Figure 1. Frequency of reasons for primary allergy/immunology consultation for study period 2001–2007.

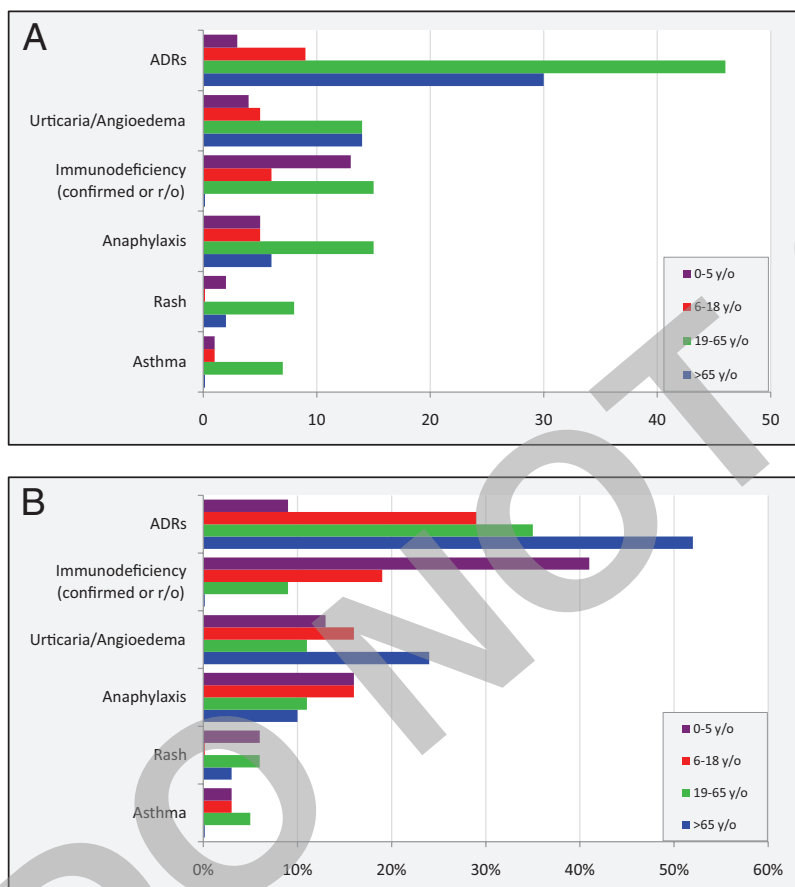


Figure 2. (A) Six most common diagnoses (most common on top to less common on bottom) by absolute numbers of each diagnosis, subgrouped by age. (B) Six most common diagnoses (most common on top to less common on bottom) by percentage of respective age groups.

ages, evident by both absolute numbers of diagnoses made and relative frequencies of each diagnosis by age group (Fig. 2, A and B, respectively). Although possible ID was the third most common reason for consult overall, these data show that ID, either confirmed or ruled out, was the most common diagnosis in 0- to 5-year-old patients (41% [13/32]) in this age range followed distantly by food allergy at 9%. ID diagnoses remain notable in the 6- to 18-year age range although ID does show a relative decrease as the pediatric group gets older. In contrast, other diagnoses such as the ADRs, urticaria/angioedema, and anaphylaxis start to become more common as the population ages. ID diagnoses are still seen in the 19- to 65-year-old patients but represent a smaller proportion of the total diag-

noses. ADRs make up >50% of top 10 diagnoses in the adult age groups but only 22% of diagnosis in the pediatric groups.

AI Clinical Outcomes

Outpatient follow-up clinical information was available for 49% (125/254) of consults. Clinical outcomes varied substantially whether AI recommendations were followed or not, as determined by outpatient record review. When AI recommendations were followed (107 known cases), 94% (101 cases) improved, 6% (6 cases) were unchanged, and none were worse (Fig. 3). When AI recommendations were not followed (15 known cases), 7% (1 case) improved, 53% (8 cases)



Figure 3. Clinical outcomes (better, worse, or unchanged) based on if AI recommendations were followed or not followed. ‡Fisher's exact test, denotes statistical significant difference of $p < 0.0001$.

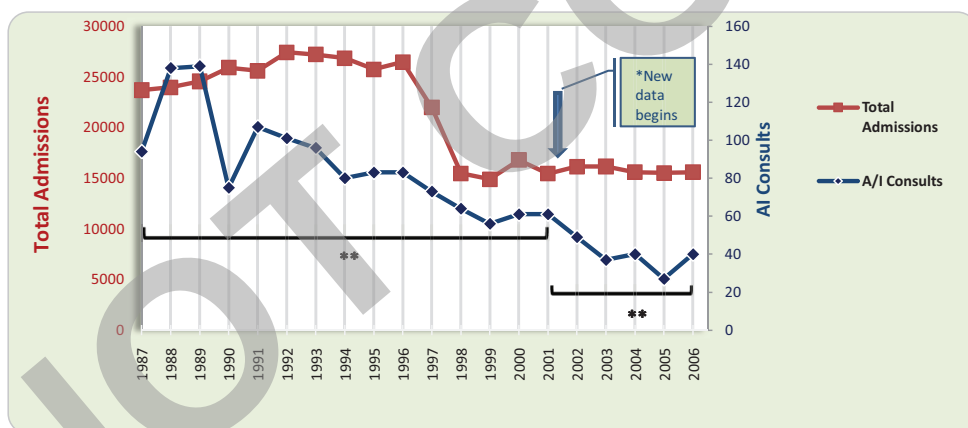


Figure 4. Total admission versus A/I consults by fiscal year (FY). Data combined from all years with available data: 1987–2006. (*Data adapted with permission from Ref. 13) **Paired t-test: previous consults per year to recent consult per year period ($p = 0.0023$; 95% CI, 36.64–96.69).

were unchanged, and 40% (6 cases) were worse. The odds ratio that a patient's clinical status would be unchanged or worse if AI recommendations were not followed is increased 16.6-fold (95% CI, 5.55–49.93). In summary, 94% of patients improved if AI recommendations were followed versus 93% of patients stayed the same or became worse if AI recommendations were not followed ($p < 0.0001$).

Twenty-Year Data Analysis

AI inpatient consults showed a continued decline over the 6 years studied despite a relative leveling off of total hospital admissions since 1998 (Fig. 4). Over the study period, the number of inpatient consults decreased from 61 in the 2001–2002 academic years to 40 patients in 2006–2007, averaging 42 consults per year over the 6-year study period. The difference in number of annual inpatient AI consults between time periods studied was significant ($p = 0.0023$; 95% CI, 36.64–96.69).

Analysis of reasons for consultations as a whole and within age groups between this study period (6 years) and the previous data set by England *et al.* (14 years) were available to allow compilation of 20 years of inpatient AI consults (Fig. 5, A–D).¹³ Differences in AI

diagnoses and clinical outcomes were not collected in previous studies and thus are not available for comparison. A few key comparisons from this large data set are notable between ADRs, asthma, and ID consults. ADRs were the most common reason for consultation as a whole in both periods studied. Both study periods show similar relative frequencies in all age ranges except the geriatric group and a relative increase in ADRs as the population ages, peaking between 48 and 67% in the geriatric population.

ID consult frequency increased in all but the geriatric group but only statistically significantly when all ages are included ($p = 0.043$; Fig. 5 A) and in the 6- to 18-year-old subgroup ($p = 0.015$; Fig. 5 C). Neither study period received a single inpatient consult for ID evaluation in the geriatric age group in the last 20 years.

Taken together, urticaria and/or angioedema accounted for 17% of all consults to AI. Urticaria/angioedema consults saw a 59% increase between time periods overall and within age groups. The increase was significant in the study as a whole ($p < 0.0001$; Fig. 5 A) as well as the pediatric ($p = 0.011$, Fig. 5 B; $p = 0.044$, Fig. 5 C) and geriatric groups ($p = 0.0005$, Fig. 5 E). Clinical outcomes data from this study period show

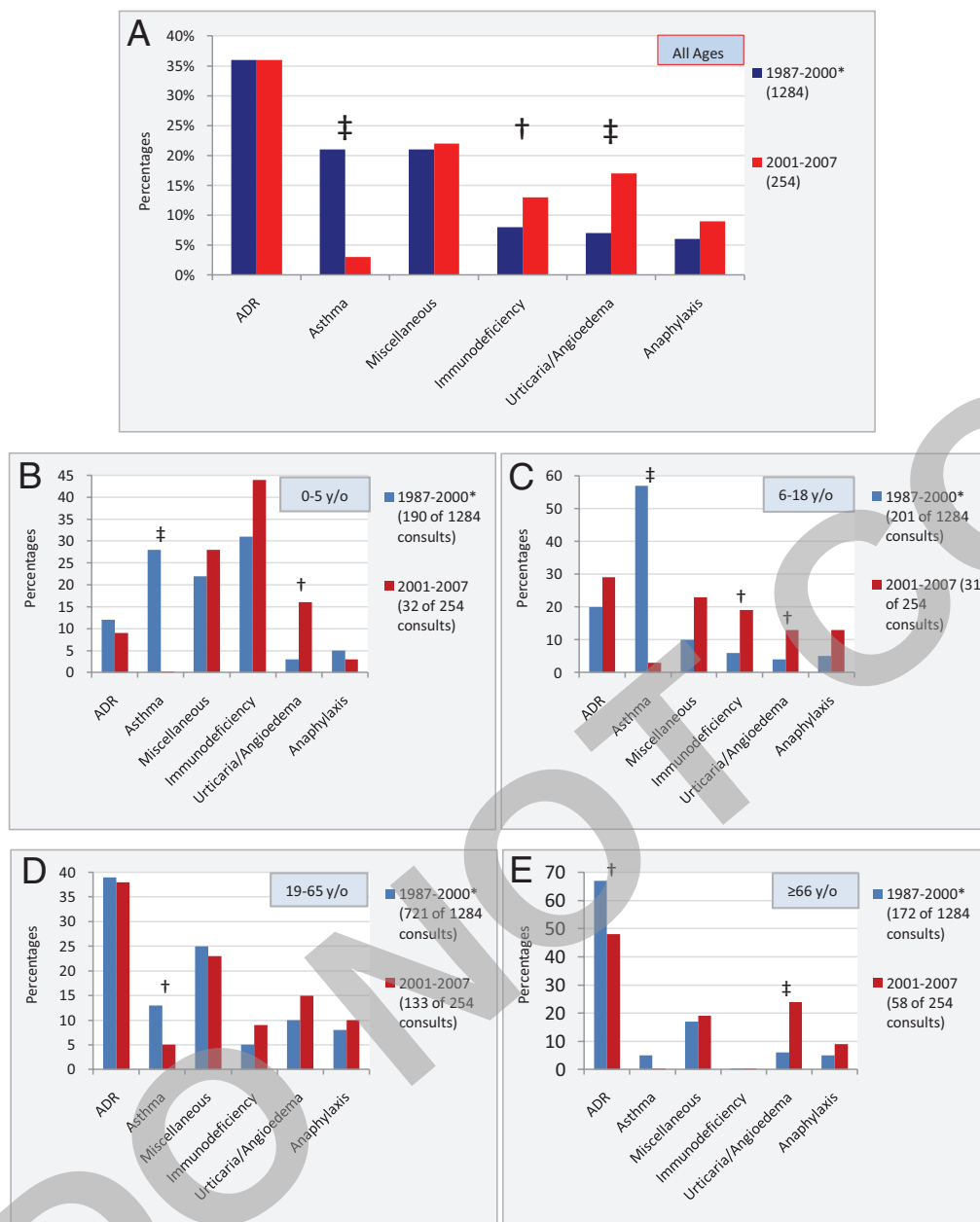


Figure 5. (A–E) Reason for consult as percentage of total consults by age group. Current data period compared with previous data. (A) All ages; (B) 0–5 years old; (C) 6–18 years old; (D) 19–65 years old; (E) ≥66 years old. (*Data adapted with permission from Ref. 13) †Fisher's exact test, denotes statistical significant difference of $p < 0.05$. ‡Fisher's exact test, denotes statistical significant difference of $p < 0.005$.

that AI's recommendations result in an improvement in most (72% [31/43]) of these patients' symptoms.

An 86% decrease in inpatient asthma consultations was noted between study periods (21% of all consults in England *et al.*¹³ to 3% over our study period; $p < 0.0001$; Fig. 5 A). This reduction is apparent between studies across all age ranges but is statistically significant across the pediatric age groups ($p < 0.0001$; Fig. 5, B–C) and the young adult group ($p = 0.008$; Fig. 5 D).

We performed a review of shared hospital records for any asthma-related admission (ICD 493.XXX) to either pediatrics or internal medicine general wards or intensive care units. Overlapping data were only available from fiscal years 2003 to 2006. During these years, between 231 and 313 patients were admitted for an asthma-related

diagnosis (fiscal years 2003–2006: 313, 255, 231 and 282, respectively). Stated another way, of 1081 asthma-related admissions in the last 4 years of our study, AI was consulted once for an inpatient consult.

Anaphylaxis was a common reason for consult in this study period (9% [23/254]; Fig. 1). Overall, the frequency of consults showed an increased trend overall and varied within age groups (Fig. 5, A–E) but did not reach significance. The evaluation of rash has seen a significant increase (82% from 2 to 11%; $p = 0.0336$; 95% CI, 0.35–5.65) between time periods.

DISCUSSION

The practice of medicine, in general, and AI, in particular, continues to be a dynamic pursuit. By analyz-

ing inpatient consults from the patient's admission through AI's consultation to the outpatient follow-up, we can analyze most aspects affecting our patients. Our outcomes data show that we can have a pivotal role in the inpatient care of patients with AI problems. Our specialty understands AI disease processes and should reduce unnecessary evaluations, improve patient outcomes, and, as such, may reduce the length of inpatient stays.

Improved understanding of the problems and age groups we are consulted for and the diseases we later diagnose should allow us to tailor our inpatient consult services. This may include admission screening (*i.e.*, multiple community acquired infections and high-risk infections) as suggested by experts in ID disorders,^{2,15} resident education of primary ID red flags, and guide in-hospital marketing of our services to those most likely to need them. In our study, the increase in inpatient consults for ID overall and in the 6- to 18-year-old age ranges already show some success in awareness, possibly because of growing Accreditation Council for Graduate Medical Education curriculum emphasis as well as our local educational efforts. Our data can be used to further guide us toward the age range where our efforts would have higher yield and away from age ranges that would be lower yield. ID consult frequency increased in all but the geriatric group but only statistically significantly when all ages are included ($p = 0.043$) and in the 6- to 18-year-old subgroup ($p = 0.015$). In the last 20 years, not a single inpatient consult for ID evaluation in the geriatric age group was received at our institution. Efforts for education, admission screening, and marketing of services to adult specialties can be tailored toward those issues that impact them more frequently, such as ADRs and urticaria/angioedema, and focus primary ID education on consideration of common variable immunodeficiency in the adult populations.

Specialists caring for all age groups would be served by understanding our role in the evaluation of anaphylaxis and rash. The evaluation of rash has seen a significant increase (82% from 2 to 11%; $p = 0.0336$; 95% CI, 0.35–5.65) between study periods. AI education has already experienced an increased emphasis on the evaluation and differential diagnosis of rash at our institution and these data support the importance of this change and our continued emphasis.

Asthma is the most common chronic disease in childhood but it appears that the role of AI in inpatient management has diminished in recent years. A solitary consult for asthma in the last 4 years of this study when there were 1081 asthma-related admissions speaks loudly on many fronts. The reduction in asthma consults is likely multifactorial. One contributing factor may be the positive effects of a research study for asthma disease management in 1995 that resulted in every asthma admission getting an automatic asthma

consult by AI.¹⁶ Additionally, this likely represents, in part, success in outpatient and emergency management and education about asthma over the last several years and we should all be pleased with the progress that this may represent. There has also been a general shift of asthma care to the outpatient setting that may have contributed to this reduction in asthma inpatient consults. Indeed, Dietrich and colleagues reported on outpatient consultation patterns between 2006 and 2007 at our institution and found that asthma was the second most common reason (20% [288/1412]) for outpatient AI consultation.¹⁷ However, 1 consult for asthma of 1081 (0.09%) admissions likely represents many missed opportunities as well as threatens our specialty's inpatient asthma currency and reduces opportunities for continued outpatient management as well as impacts our beneficiaries outcomes. AI has a unique role in the possible modulation of and progression of their disease by early intervention with immunotherapy, an opportunity that is missed if we are never involved in the care of these 1081 patients.

This is the first published AI study to evaluate the effect of AI recommendations on patient's clinical outcomes and is clinically and statistically significant. Our data support not only the importance of AI to inpatient medical services and our understanding of varied unique medical conditions but also the relevance of AI to inpatient's clinical outcomes as well. By evaluating and understanding our outcomes data, the specialty of AI can better advocate for our clinical relevance in a practice environment with shrinking local and federal reimbursements and reductions in AI specialty educational funding. This is especially relevant to the ongoing debate of reimbursements being linked to outcomes measures and clinical performance.

Strengths of this study are that it is the most complete allergy inpatient consult study to date with 20 years of reason for consult data as well as 6 years of allergy diagnosis and outcomes data. It is the only study to establish statistically significant changes over time between reasons for consults as well clinically and statistically significant outcomes data (Table 2).

Weaknesses of this study include the retrospective nature of the data collection, which is dependent on the data collection and maintenance of paper and the electronic clinical database. Reason for consultation data was often clear as to what clinical question the consulting team wanted answered, but at the time of initial consultation the diagnosis may have been less defined. For instance, a consult may be received for urticaria and the diagnosis was PCN anaphylaxis. We addressed these issues by selecting the most specific diagnosis as the primary diagnosis (*i.e.*, PCN) and the less specific (anaphylaxis) as secondary. Additionally, the data was classified by a single observer before any analysis resulting in internally consistent data with

Table 2 Strengths of this study when compared with previous literature

Previous Studies	Years Studied	Consult No.	Ages Included (yr)	Subgroup Analysis	Consult Reason	Hospital Data Comparison	Diagnosis	Clinical Outcomes	Statistical Significance
Quinn ¹⁴	4	165	0-18		×	×			
England ¹³	14	1284	0-99	×	×	×			
Otto (this study)	20	1538	0-99	×	×	×	×	×	×
	6	254	0-99	×	×				

minimal bias. The clinical status was determined by review of the outpatient record written by a physician, recorded by the single observer. The clinical status was as such determined by the follow-up physician, not the study observer.

Future research considerations could include making changes to specific AI education and marketing of available services targeted to relevant age-based specialties as discussed previously. Additionally, we could apply appropriate screening parameters as mentioned previously to proactively offer our services when certain admission diagnoses are met. We could prospectively measure these interventions in regard to outpatient outcomes and average hospital stays against this study's set of data.

CONCLUSIONS

This research is the most detailed AI inpatient consult study to date and is presented with a compilation of 20 years of AI inpatient consults at a single institution. Although inpatient AI consults appear to be declining, our specialty remains helpful and relevant to large medical centers, especially in the evaluation of ADRs, ID, anaphylaxis of any cause, rash, and urticaria/angioedema. We may be missing many opportunities in the management of inpatient asthma. We offer an in-depth understanding of allergic and immunologic disease, education to Accreditation Council for Graduate Medical Education programs, unique and specialized testing, desensitization protocols, and improved clinical outcomes.

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