

Electronic Consultations in Allergy/Immunology



Neelam A. Phadke, MD^{a,b}, Anna R. Wolfson, MD^{a,b}, Christian Mancini, BS^{a,c}, Xiaoping Fu, MS^a, Susan A. Goldstein, MS^{d,e}, Jacqueline Ngo, MPH^{d,e}, Jason H. Wasfy, MD, MPhil^{b,e,f}, Aidan Long, MD^{a,b}, Aleena Banerji, MD^{a,b}, and Kimberly G. Blumenthal, MD, MSc^{a,b,c,g} Boston, Mass

What is already known about this topic? Electronic consultations (e-consults) provide rapid, focused, cost-effective care in other specialties but have not been studied in Allergy/Immunology.

What does this article add to our knowledge? E-consults comprised 10% of all new Allergy/Immunology consults, providing efficient (11-minute completion time), rapid (<24-hour turnaround time) allergist guidance, particularly for adverse drug reaction and immunodeficiency assessments.

How does this study impact current management guidelines? Many patients can be quickly helped with electronic allergist/immunologist guidance, thus reserving in-person consults for patients requiring more detailed evaluations often with specialty-specific diagnostic testing.

BACKGROUND: Allergic condition management more often requires allergist guidance than allergy testing; necessary testing may be unavailable at initial drug allergy consultations. Electronic consultations (e-consults) provide expedited, problem-focused, potentially cost-saving care in other medical specialties, but have not yet been studied in Allergy/Immunology.

OBJECTIVE: To describe e-consult use at an academic allergy/immunology practice.

METHODS: E-consult data (August 10, 2016 through July 31, 2018) and in-person consult data (August 1, 2014 through July 31, 2018) were reviewed to determine consult volume, outcomes, indications, and timing. Referral reasons and wait times were compared with chi-square tests.

RESULTS: E-consults grew from 1% to 10% of all new consults, with concurrent growth in in-person consults. Of 306 completed e-consults, 41 (13.4%) made diagnostic, therapeutic, or alternative referral recommendations, with 30 (73%) recommendations followed; 183 (59.8%) patients required an in-person Allergy/Immunology consult, and only 5 (<2%) patients saw an allergist without an e-consult recommendation to do so. E-consults were used more often than in-person consults for adverse drug reactions

(66% vs 9%; $P < .001$), especially penicillin allergy (132, 61% of all e-consults) and immunodeficiency (15% vs 2%; $P < .001$). Allergists completed e-consults in a median of 11 minutes, with a median turnaround time of 22 hours. E-consult implementation was associated with a decreased median in-person consult wait time (1.5 fewer calendar days; $P < .05$).

CONCLUSIONS: E-consults were increasingly used, particularly for historical adverse drug reactions and immunodeficiency.

Implementation of an e-consult program resulted in decreased in-person wait times despite an increase in overall consult volume, supporting this model's ability to provide expedited, problem-focused care. © 2019 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;7:2594-602)

Key words: Telehealth; E-consult; Electronic consultation; Asynchronous allergist access; Access; Adverse drug reaction; Immunodeficiency evaluation; Quality improvement

INTRODUCTION

Health care spending in the United States reached \$3.3 trillion in 2016; nearly \$665 billion was due to physician and clinical services expenditure.¹ Allergic conditions affect more

^aDivision of Rheumatology, Allergy, and Immunology, Department of Medicine, Massachusetts General Hospital, Boston, Mass

^bHarvard Medical School, Boston, Mass

^cMongan Institute, Department of Medicine, Massachusetts General Hospital, Boston, Mass

^dPerformance Analysis and Improvement Unit, Massachusetts General Hospital, Boston, Mass

^eMassachusetts General Physicians Organization, Boston, Mass

^fDivision of Cardiology, Department of Medicine, Massachusetts General Hospital, Boston, Mass

^gEdward P. Lawrence Center for Quality and Safety, Massachusetts General Hospital, Boston, Mass

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Corresponding author: Neelam A. Phadke, MD, Division of Rheumatology, Allergy and Immunology, Massachusetts General Hospital, 100 Blossom St, Cox 201, Boston, MA 02114. E-mail: nphadke@partners.org.

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Abbreviations used

ADR- Adverse drug reaction

AFR- Adverse food reaction

E-consult- Electronic consultation

EHR- Electronic health record

IQR- Interquartile range

MGH- Massachusetts General Hospital

than 50 million Americans and cost more than \$18 billion annually.² During ragweed season, patients with allergic rhinitis lose 7% of their productivity while those not on medication lose 10%; however, \$18 spent weekly on medication can manifest as a \$36 weekly gain in productivity.³ Penicillin allergy is reported by approximately 32 million Americans and results in adverse consequences for patients and costs to the health care system, but less than 0.1% of these patients see an allergist for a penicillin allergy evaluation although new multidisciplinary guidance recommends broad penicillin allergy evaluations.^{4,5} Only about half of the 9% of adults who think they are food-allergic actually are, after proper allergy testing.⁶ Despite the prevalence and impact of reported and true allergies, there are only about 5000 actively practicing allergists/immunologists in the United States.⁷ Wait times to see an allergist often exceed the 5 days reported in 2009/2010, and in-person evaluation might cost more than \$1000.^{7,8} However, some allergy consults may not be necessary; patients with nonallergic symptoms associated with drugs or foods might be referred for allergy testing that is not indicated, which can leave both the allergist and the patient dissatisfied.

Electronic consultations (e-consults, a clinician-to-clinician exchange in the electronic health record [EHR]) were developed to improve specialist access and reduce unnecessary ambulatory specialist consults.⁹⁻¹⁴ In addition to being associated with high levels of referring provider, patient, and subspecialist satisfaction, e-consults were cost-effective, with nearly \$125 saved for every traditional new patient consult replaced with an e-consult.¹²⁻¹⁷

As health care shifts to focus on value rather than volume, novel management and health care delivery strategies often require increased spending on some services to decrease costs of others.¹⁸⁻²⁰ Telehealth is a key example. Synchronous tele-allergy services have been associated with decreased patient wait time and increased patient satisfaction, particularly for food allergy, allergic rhinitis, asthma, and urticaria; other specialties have also found telehealth evaluation methods to reduce overall health care system costs.²¹⁻²⁶ Comprehensive synchronous tele-allergy services, however, require patient travel to a center equipped with necessary medical supplies for examination and/or testing in addition to remote allergist doctor-to-patient engagement.^{21,22,27} E-consults bypass these barriers but have not been implemented broadly or evaluated in Allergy/Immunology in the United States. We therefore sought to describe our institution's Allergy/Immunology e-consult program, including e-consult volume, outcomes, indications, and timing.

METHODS

E-consult description and implementation

The e-consult is an electronic, asynchronous, clinician-to-clinician (often a primary care doctor to a specialist) exchange

intended to provide specialist guidance to the requesting provider for a request that is nonurgent and problem-focused and relies on information available within the EHR. There is no direct specialist-to-patient interaction. Referring providers request an e-consult using an order in the EHR that is received in the "In Basket" of designated administrators and e-consultants. Providers can request a specific e-consultant, but most requests are sent to the assigned e-consultant, typically the attending allergist supervising inpatient consults. The e-consultant asynchronously reviews EHR data and shares diagnostic and management recommendations in a brief note recorded in the EHR. The referring provider then decides which subsequent steps to take on the basis of these recommendations. If anything remains unclear, further communication with the e-consultant can occur via repeat e-consult or subsequent formal consult. All e-consults include a disclaimer statement that recommendations are based only on the information available in the EHR and that the referring provider is responsible for ongoing management (see [Supplementary Text](#) in this article's Online Repository at www.jaci-inpractice.org).

Massachusetts General Hospital (MGH) began e-consults in 2013 in Cardiology and Dermatology with the aim to reduce unnecessary ambulatory consults to specialists and improve access for the sickest patients in our complex health care system. As of January 2019, there were 47 specialty areas of service providing e-consults within MGH at a volume of nearly 10,000 e-consults per year (2018) with more than 20,000 e-consults performed to date.^{9,11-13} E-consult program development was encouraged, supported, and advertised through the Massachusetts General Hospital Physicians Organization incentive programs in population health management and quality improvement.

Allergy/Immunology e-consults were launched in August 2016, initially as a pilot program for food and drug allergy, but because of early success, all indications were included by October 2016. In addition to the general e-consults offered, a specific e-consult initiative was started with Obstetrics in January 2018 to evaluate pregnant patients with penicillin allergy histories to optimize receipt of first-line beta-lactam antibiotic therapy when indicated.^{5,28-30} All attending MGH allergists (n = 16) participated in e-consults; the Massachusetts General Physicians Organization encouraged completion within 3 business days (service-level expectation). Given that insurance had not yet recognized e-consults for traditional reimbursement, the Massachusetts General Physicians Organization compensated allergist e-consultants internally with a per-consult fixed rate incentive payment reflective of specialist provider effort for telehealth.

Data periods and definitions

We reviewed ambulatory e-consults from August 10, 2016 through July 31, 2018, and ambulatory in-person consults (defined as a new patient, consult, or 60-minute established patient visit) from August 1, 2014 through July 31, 2018.

We identified e-consult outcomes, including diagnostic, therapeutic, and referral recommendations and how often such recommendations were followed by referring providers. Following recommendations was considered a binary outcome (yes/no) and was yes if at least 1 allergist recommendation was followed. Recommendations for in-person consult considered only those without a stipulation (eg, "refer for in-person consult if rash worsens" was excluded). When both diagnostic testing and in-person consult were recommended, in the absence of explicit instructions to send diagnostic testing before the consult, this was considered as in-person

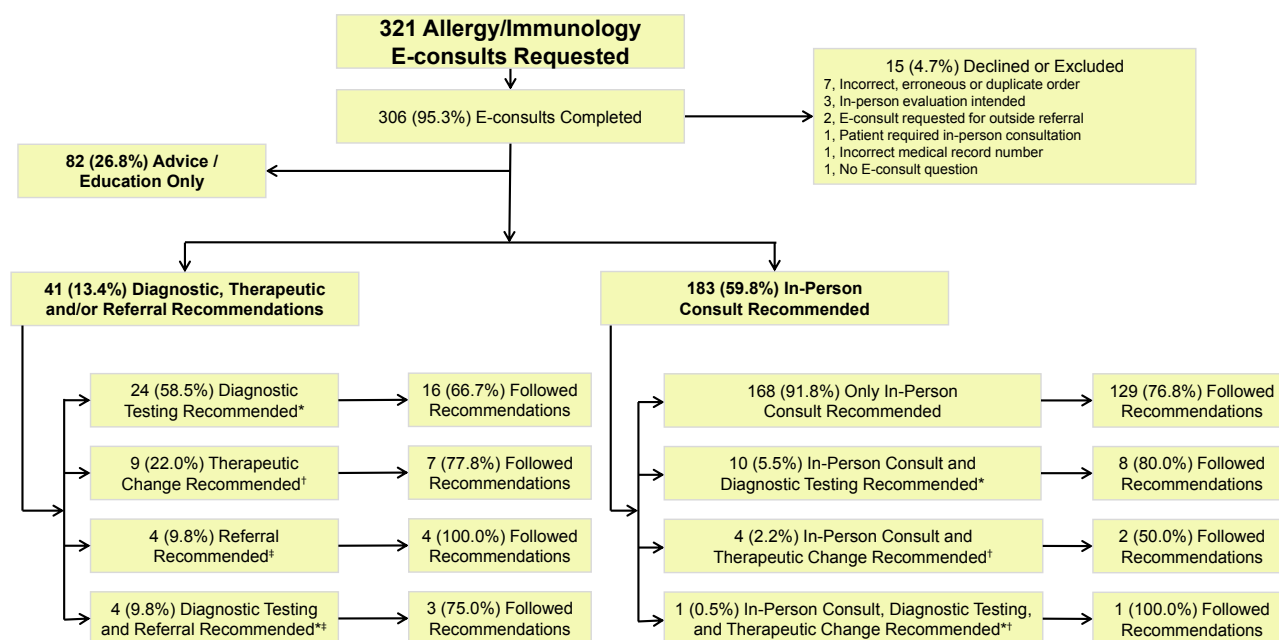


FIGURE 1. Allergy/Immunology E-consult outcomes. This flow chart describes all 321 e-consults ordered. E-consults were analyzed on the basis of need for in-person allergy/immunology consult ($n = 183$) and other diagnostic ($n = 28$), therapeutic ($n = 9$), and referral ($n = 8$) recommendations. Some e-consults made multiple recommendations. Recommendation percentages are out of 306 completed e-consults; recommendations followed percentages are of relevant recommendations made (eg, 66.7% is 16 of 24 diagnostic testing recommendations). *Recommended diagnostic testing included 35 recommendations for blood, urine, or stool laboratory testing, 2 drug challenge recommendations, 1 computed tomography scanning recommendation, and 1 spirometry recommendation. †Recommended treatments included 11 instances of recommending a new medication, 2 instances of recommending a different dose of a current medication, and 1 instance where both a new medication and a different dose of a current medication were recommended. ‡Other specialist referrals included dermatology, gastroenterology, hematology, infectious diseases, neuroimmunology, oral maxillofacial surgery, otolaryngology, and rheumatology.

consult recommended only. We additionally assessed the most common referring departments for e-consults.

We determined the number of completed e-consults, both as an absolute number and as a proportion of all allergy new patient consults.

We determined the indications for allergy e-consults and in-person consults. For e-consults, indications were based on the referring providers' descriptions, which were then grouped: adverse drug reaction (ADR), adverse food reaction (AFR), anaphylaxis, cutaneous (eg, rash, hives, itching, and dermatitis), eosinophilia, immunodeficiency, ocular allergy, respiratory (eg, cough, shortness of breath, and asthma), rhinitis, sinusitis, urticaria/angioedema, venom reaction, and other. For in-person consults, primary *International Classification of Diseases, Ninth and Tenth Revision* codes were used to group diagnoses similarly to the e-consults (see Table E1 in this article's Online Repository at www.jaci-inpractice.org).

Finally, we assessed e-consult completion time and turnaround time as well as wait times for in-person consults. Completion time, minutes between opening and closing the e-consult in the EHR, measured the time necessary for the reviewing allergist to provide clinical input on the basis of available data; turnaround time, hours between placement of the e-consult order and closing of e-consult, measured the time necessary for the ordering provider to receive allergist guidance. Patient wait times for in-person consults, defined as the number of calendar days between when an appointment was

scheduled and when a patient was seen, were calculated by month from appointment data stored on the Tableau server at MGH.

Statistical analysis

We present numbers with frequencies and medians with interquartile ranges (IQRs). We compared continuous variables (eg, completion time and wait time) using Wilcoxon rank sum test and frequencies (eg, consult indications) using chi-square tests. Comparative analyses were performed in SAS (version 9.4, SAS Institute Inc, Cary, NC).

Institutional review board

The development and assessment of this e-consult program was undertaken as a Quality Improvement Initiative, and as such was not supervised by the Partners Human Research committee per its policies.

RESULTS

E-consult outcomes

From August 10, 2016 through July 31, 2018, there were 321 e-consults ordered, with 306 (95.3%) completed (Figure 1). Ordering providers for completed e-consults were commonly obstetricians/gynecologists ($n = 133$ [43.5%]), internists/internal medicine subspecialists ($n = 130$ [42.5%]) including infectious disease specialists ($n = 12$ [3.9%]), and family practitioners ($n = 11$ [3.6%]), but also included other allergists/

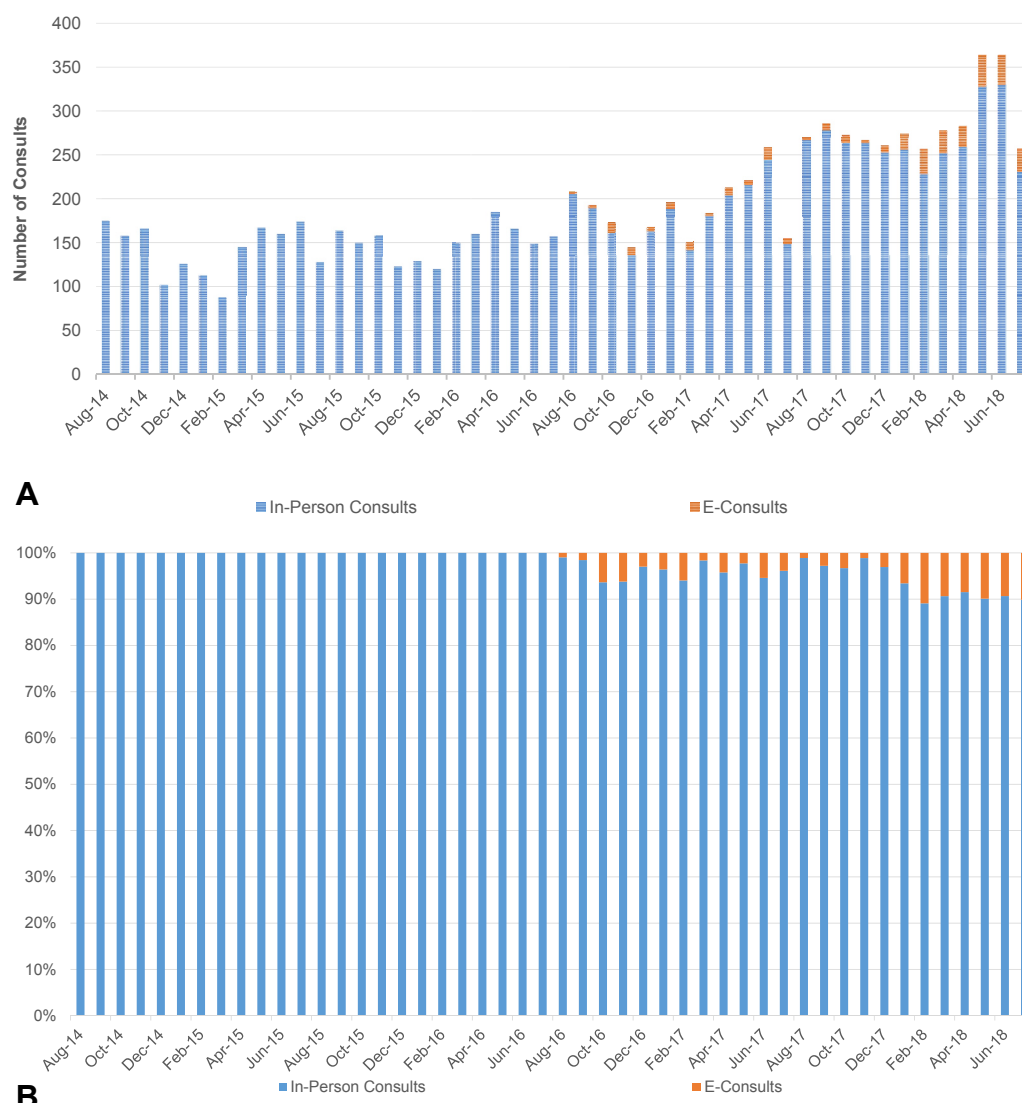


FIGURE 2. Trends in allergy e-consult and in-person consult volume. This bar graph shows the total in-person consults (blue) and e-consults (orange) from 2 years before the implementation of the e-consult program through the completion of our analysis. **A**, Number of e-consults. The number of e-consults increased from a median of 7 e-consults per month (August 2016–December 2017) to a median of 26 e-consults per month with the launch of the penicillin allergy testing program. Total consult volume (including ambulatory in-person consults and e-consults) continued to grow. **B**, E-consults as a proportion of all consults. E-consults initially comprised 0.9% of all consults; by July 2018, they comprised 10.1% of all new patient consults.

immunologists, rheumatologists, pulmonologists, cardiologists, gastroenterologists, medical geneticists, and pain medicine specialists. The consults from other allergists came from regional allergy practices regarding drug allergy testing.

Of the 306 completed e-consults, 183 (59.8%) recommended an in-person consult and 82 (26.8%) provided advice and education without further recommendations for diagnostic testing, therapeutic change, or subspecialist referral (Figure 1). Forty-one (13.4%) completed e-consults contained recommendations for diagnostic testing, therapeutic changes, and/or subspecialist referrals; 30 (73.2%) of these recommendations were followed. Allergists recommended only diagnostic testing as part of 24 (7.8%) completed e-consults; referring providers followed 16 (66.7%) of these diagnostic recommendations. Allergists

recommended only therapeutic changes in 9 (2.9%) completed e-consults; referring providers followed 7 (77.8%) of these recommendations. Allergists recommended referral to another specialist (internal medicine subspecialist or surgeon) in 4 (1.3%) completed e-consults; referring providers made this referral in all 4 (100.0%) cases. Allergists recommended both diagnostic testing and referral to another specialist in 4 (1.3%) completed e-consults; referring providers followed these recommendations in 3 (75.0%) cases.

Of allergist-recommended in-person evaluations ($n = 183$; 59.8% of all completed e-consults), 140 (76.5%) were ordered. Allergists recommended in-person consult without prior diagnostic testing or therapeutic change for 168 (54.9%) patients; these recommendations were followed in 129 (76.8%) cases. Ten

TABLE I. Indication for electronic and in-person consults*

Indication	E-consults (n = 306)	In-Person Consults (n = 8907)	P value†
ADR	201 (65.7)	770 (8.6)	<.001
Immunodeficiency	45 (14.7)	186 (2.1)	<.001
Urticaria/angioedema	16 (5.2)	1206 (13.5)	<.001
AFR	12 (3.9)	1170 (13.1)	<.001
Other	9 (2.9)	572 (6.4)	.01
Cutaneous‡	8 (2.6)	941 (10.6)	<.001
Respiratory§	5 (1.6)	654 (7.3)	<.001
Venom reaction	4 (1.3)	98 (1.1)	.58
Rhinitis	3 (1.0)	2,747 (30.8)	<.001
Eosinophilia	2 (0.7)	45 (0.5)	.67
Anaphylaxis	1 (0.3)	83 (0.9)	.53
Sinusitis	0 (0.0)	308 (3.5)	<.001
Ocular allergy	0 (0.0)	127 (1.4)	.02

*Data shown as n (%).

†P values calculated using χ^2 test.

‡For e-consults, includes issues related to atopic dermatitis, contact dermatitis, dermatitis herpetiformis, and other types of dermatitis.

§For e-consults, includes issues related to asthma, cough, and shortness of breath.

(3.3%) e-consults recommended diagnostic testing before in-person consult; this testing was ordered in 8 (80.0%) e-consults. Four (1.3%) completed e-consults recommended a therapeutic change before in-person consultation; the therapeutic change was ordered in 2 (50.0%) cases. Allergists recommended diagnostic testing, therapeutic changes, and in-person consult for 1 patient (0.3%), in whom this recommendation was followed. Only 5 (1.6%) patients had an in-person consult that was not advised by allergy e-consult. Although these referrals were primarily for patient concern or worsening symptoms (n = 3), 1 provider requested an in-person evaluation in lieu of ordering the recommended diagnostic testing. One other patient was referred for in-person allergist evaluation when dermatology referral had been recommended for a history of sulfonamide antibiotic allergy and worsening psoriasis on a nonantibiotic sulfonamide drug.

E-consult and in-person consult volume

There were 8907 in-person consults from August 1, 2014 through July 30, 2018. Even with e-consult implementation, in-person consult volume continued to rise during the study period (Figure 2, A). E-consults initially comprised 1% (n = 2) of all consults; by July 2018, e-consults comprised 10.1% (n = 26) of all consults (Figure 2, B). From August 2016 through December 2017, there was a median of 7 e-consults per month; with the launch of the obstetric penicillin allergy testing program in January 2018, monthly e-consults increased to a median of 26 e-consults per month, with 1 month having 36 e-consults.

E-consult and in-person consult indications

The most common indications for completed e-consults were ADR (n = 201 [65.7%]), immunodeficiency (n = 45 [14.7%]), and urticaria/angioedema (n = 16 [5.2%]) (Table I). ADRs were primarily to antimicrobials (n = 165 [75.7%]), with penicillin antibiotic allergy questions alone comprising 132 completed e-consults (43.1%; Table II). Other common drugs included antihypertensive (n = 9 [4.1%]) and anti-inflammatory medications (n = 8 [3.7%]) as well as vaccinations (n = 6 [2.8%]). E-consults for AFRs (n = 12) were largely to specific foods

(n = 3 [25%] for egg; n = 2 [16.7%] each for peanut and tree nut, and n = 1 [8.3%] each for alcohol and cow's milk), though some were nonspecific food allergy questions (Table II). Immunodeficiency evaluation requests (n = 45) were most commonly for frequent infections (n = 14 [31.1%]), IgM deficiency (n = 10 [22.2%]), and hypogammaglobulinemia (n = 8 [17.8%]) (Table II).

Of 183 e-consults where in-person evaluation was advised, 146 (79.8%) were for ADRs. Penicillin allergy evaluation programs with e-consult screening included 117 obstetric patients. Of obstetric e-consults, 101 (86.3%) patients had an allergy history requiring in-person evaluation for penicillin skin testing; 72 (71.3%) of these patients had been referred for the recommended consult at the time of this analysis. In-person evaluation was not indicated for 16 (13.7%) obstetric patients because of very low risk (medication advised to be administered by graded drug challenge) or high-risk allergy histories where the testing risks outweighed the benefits. If the 117 patients who had an e-consult guided by the obstetric penicillin allergy pathway were excluded, recommendation for in-person consult was made for 82 (43.4%) of the remaining 189 patients.

There were 8907 in-person consults with a primary diagnostic code. Of these, 2016 (22.6%) were coded under the *International Classification of Diseases, Ninth Revision* and 6891 (77.4%) were coded under the *International Classification of Diseases, Tenth Revision* billing codes. Of the primary codes billed, 2747 (30.8%) were for rhinitis, 1206 (13.5%) were for urticaria/angioedema, and 1170 (13.1%) were for AFR (Table I).

E-consults were used more frequently than in-person consults for ADR (65.7% vs 8.6%; $P < .001$) and immunodeficiency (14.7% vs 2.1%; $P < .001$; Table I). In-person consults were used more frequently for rhinitis (30.8% vs 1.0%; $P < .001$), urticaria/angioedema (13.5% vs 5.2%; $P < .001$), AFR (13.1% vs 3.9%; $P < .001$), and cutaneous reactions (10.6% vs 2.6%; $P < .001$).

E-consult and in-person consult timing

Allergists required a median of 11 minutes (IQR, 5-25 minutes) to complete an e-consult; venom reactions, AFR, and ADR were the most quickly reviewed e-consults, whereas those for eosinophilia, anaphylaxis (n = 1), and immunodeficiency took the longest time to complete (Figure 3, A). Median turnaround time was 21.8 hours (IQR, 5.5-69.4 hours), with fastest turnaround time for venom reactions (5.0 hours; IQR, 4.5-8.1 hours) and longest turnaround times for eosinophilia (191.3 hours; no IQR because only 2 data points), respiratory issues (44.6 hours; IQR, 26.8-55.4 hours), and immunodeficiency (39.0 hours; IQR, 18.3-96.0 hours) (Figure 3, B).

The median wait time for an in-person ambulatory consult was 22 days (IQR, 20.0-24.0 days). The median wait time decreased from 22.5 days (IQR, 20.8-24.0 days) to 21 days (IQR, 19.0-23.0 days) ($P < .05$) after implementation of e-consults.

DISCUSSION

We performed more than 300 Allergy/Immunology e-consults, a novel, asynchronous, clinician-to-clinician exchange that is nonurgent and problem-focused and relies exclusively on information available within the EHR. Although 60% of patients who received an e-consult required an in-person consult to complete diagnosis and management, all patients and referring

TABLE II. E-consult request detail

ADR* (n = 218)	
Antidepressants (2 [0.9%])	Contrast agents (3 [1.4%])
Citalopram (1 [0.5%])	Computed tomography (2 [0.9%])
Nortriptyline (1 [0.5%])	Magnetic resonance imaging (1 [0.5%])
Antihypertensives (9 [4.1%])	Diuretic agents (2 [0.9%])
ACE inhibitors (6 [2.8%])	Acetazolamide (1 [0.5%])
ARB (1, 0.5%)	Furosemide (1 [0.5%])
Beta-blockers (2, 0.9%)	Intravenous immunoglobulin (3 [1.4%])
Anti-inflammatory medications (8 [3.7%])	Local anesthetics (4 [1.8%])
Corticosteroids (2 [0.9%])	Benzocaine (1 [0.5%])
NSAIDs (6 [2.8%])	Lidocaine (1 [0.5%])
Antimicrobial (165, 75.7%)†	Marcaine (1 [0.5%])
Bacitracin (1 [0.5%])	Procaine (1 [0.5%])
Cephalosporins (7 [3.2%])	Proton pump inhibitors (3 [1.4%])
Cefazolin (2 [0.9%])	Esomeprazole (1 [0.5%])
Cefdinir (1 [0.5%])	Lansoprazole (1 [0.5%])
Cefepime (1 [0.5%])	Omeprazole (1 [0.5%])
Cephalexin (3 [1.4%])	Vaccinations (6 [2.8%])
Clofazimine (1 [0.5%])	Influenza (2 [0.9%])
Doxycycline (1 [0.5%])	Measles (1 [0.5%])‡
Fluoroquinolones (3 [1.4%])	Pneumococcal polysaccharide vaccine (2 [0.9%])
Ciprofloxacin (2 [0.9%])	Tetanus, diphtheria, acellular pertussis (1 [0.5%])
Levofloxacin (1 [0.5%])	Other (1 [0.5%] each)
Gentamicin (2 [0.9%])	Carbamazepine
Isoniazid (1 [0.5%])	Diazepam
Macrolides (4 [1.8%])	Diphenhydramine
Azithromycin (2 [0.9%])	Hydroxychloroquine
Erythromycin (2 [0.9%])	Hylan G-F 20
Penicillins (132 [60.6%])†	Insulin
Ampicillin (1 [0.5%])	Ferumoxylol
Amoxicillin (1 [0.5%])	Opioid§
Amoxicillin-clavulanate (1 [0.5%])	Palonosetron
Penicillin (128 [58.7%])†	Sulfasalazine
Piperacillin-tazobactam (1 [0.5%])	Tobramycin/dexamethasone ophthalmic
Rifampin (2 [0.9%])	Tocilizumab
Sulfonamide (10 [4.6%])	Vitamin D
Vancomycin (1 [0.5%])	Multiple drug reactions (12 [5.5%])
Immunodeficiency (n = 45)	
Frequent infections (14 [31.1%])	Other (each 1 [2.2%])
IgM deficiency (10 [22.2%])	IgA deficiency
Hypogammaglobulinemia (8 [17.8%])	Elevated IgA
IgG deficiency/IgG subclass deficiency (5 [11.1%])	Complement deficiency
Vaccination (2 [4.4%])	CHARGE syndrome
	DiGeorge syndrome

(continued)

TABLE II. (Continued)

AFR (n = 12)	
Specific food	Histamine intolerance (1 [8.3%])
Egg (3 [25%])	Specific testing question
Peanut (2 [16.7%])	IgE testing (1 [8.3%])
Tree nut (2 [16.7%])	Non-IgE testing (1 [8.3%])
Alcohol (1 [8.3%])	
Cow's milk (1 [8.3%])	
Other (n = 8, each diagnosis 1 [12.5%])	
Aeroallergen testing	Maxillary retention cyst
Fatigue	Persistently elevated IgA
Granulomatous lesions	Tuberculosis reactivation
Lower extremity edema	Vocal cord dysfunction

ACE, Angiotensin-converting enzyme; ARB, angiotensin receptor blocker; CHARGE, coloboma, heart defects, atresia choanae, growth retardation, genital abnormalities, and ear abnormalities; NSAID, nonsteroidal anti-inflammatory drug.

*Sum of 218 is greater than 201 as 12 requests were for patients with multiple ADRs.

†Drugs/drug categories accounting for at least 10% of all ADRs.

‡Patient received measles vaccine only, not measles, mumps, rubella combination vaccine.

§Ordering provider did not specify which opioid.

providers received education, and 13% of patients received exclusively electronic guidance for diagnostic, therapeutic, or referral recommendations that were followed nearly 75% of the time. Two-third of all e-consults were for ADRs, primarily to antimicrobials/penicillin. Most e-consults were completed in about 10 minutes, and referring providers received recommendations in approximately 1 day (compared with an in-person evaluation wait time of more than 20 days). The implementation of this e-consult program was associated with persistent growth in in-person consult volume and a significant reduction in wait time of 1.5 days for in-person consults.

Indications for consults differed between e-consults and in-person consults. With the implementation of e-consults, each referring provider could choose whether to order an e-consult or an in-person consult. In-person consults were primarily ordered for rhinitis and AFRs, both diagnoses frequently requiring confirmatory skin testing that is readily available in Allergy/Immunology offices. E-consults were primarily used for historical ADRs and immunodeficiency, conditions initially assessed by history alone. ADR e-consults were driven by our institution's role as a leader in drug allergy evaluations and programs to evaluate penicillin allergy histories, specifically in obstetric patients.^{28,31} Although almost all obstetric patients (86.3%) required an in-person evaluation, the e-consult replaced the initial in-person consult without testing. Because testing drugs are not readily available and mixed/diluted to the nonirritating concentrations in every Allergy/Immunology clinic, the e-consult enabled allergists to have these medications ready to perform specialized drug testing at the first in-person consult visit. Similarly, immunodeficiency evaluation patients had their first in-person Allergy/Immunology consult with relevant laboratory data already available, likely improving the productivity of the initial in-person consult and expediting the process for those who most needed more specialized immune assessments.

ADR e-consults were among the fastest for allergists to complete (10 minutes), suggesting that allergy programs that cannot address all allergic concerns via e-consult may still benefit from

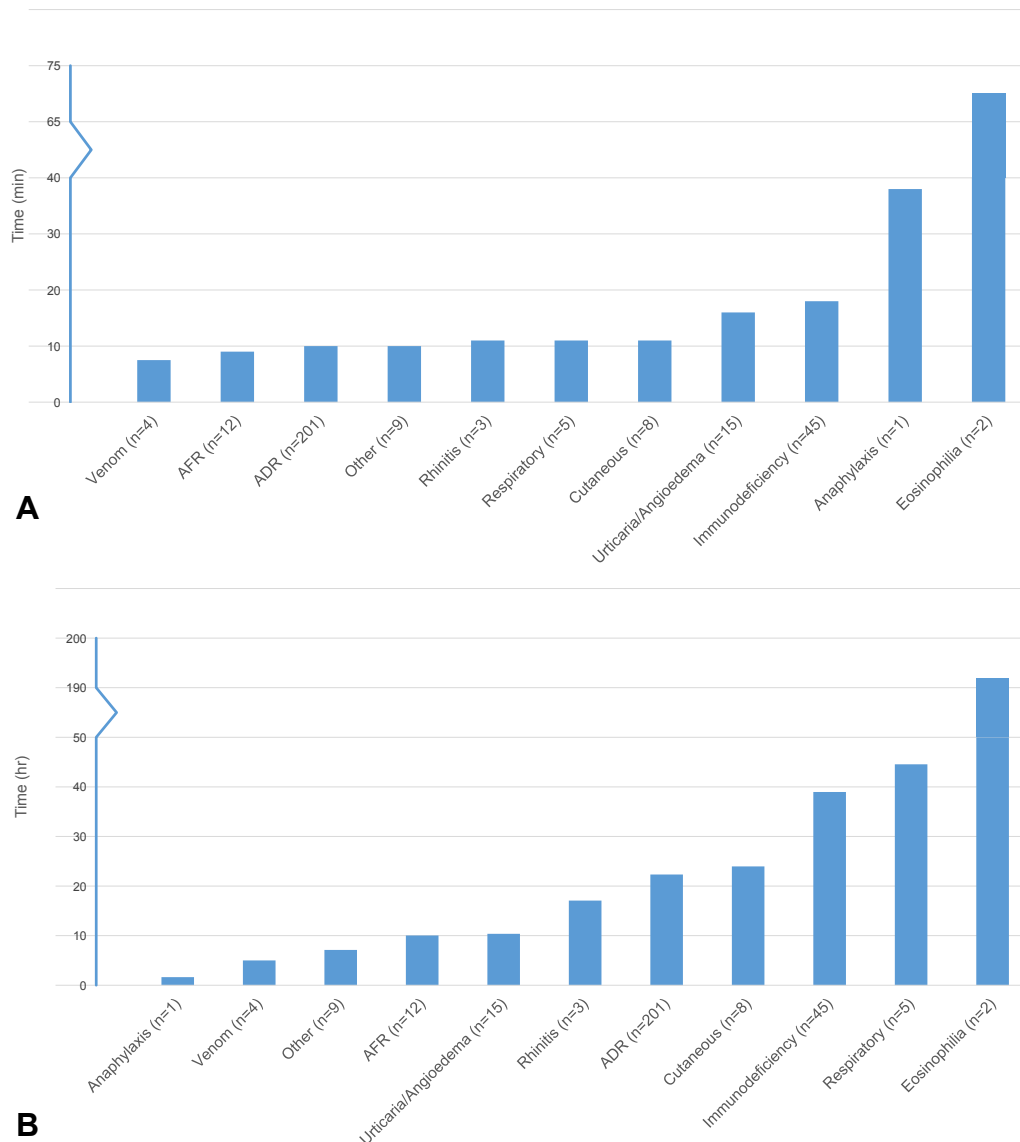


FIGURE 3. E-consult completion and turnaround time by indication. **A**, Median completion time (time from EHR encounter open to encounter close) was 11 minutes for all e-consults; e-consults for venom reactions, AFR, and ADR were the fastest to complete, whereas those for eosinophilia, anaphylaxis, and immunodeficiency took the most time. **B**, Median turnaround time (time from order entry to encounter close) was just under 1 day for all e-consults; this was shortest for venom and AFR and longest for eosinophilia, anaphylaxis, and immunodeficiency.

starting a drug allergy e-consult program, particularly for historical ADRs. Coupled with the implementation of standardized beta-lactam hypersensitivity pathways,²⁸ e-consults triage and expedite important penicillin allergy evaluations.³²⁻³⁷ Immunodeficiency evaluations may also be well suited to e-consults; immunodeficiency e-consults took only about 15 minutes to complete. In addition, given that there are few centers that specialize in drug testing or immunodeficiency, e-consult–based initial evaluations may reduce (or even eliminate) long travel times for patients who live far from such centers.

E-consult referrals came not just from generalists but also from other specialists, including outside allergists/immunologists, which suggests that all providers might benefit from

asynchronous allergist access using a formally EHR-documented and compensated method (replacing informal reviews, e-mails, and “curbsides”). Ultimately, e-consults reduced wait time for allergist guidance and had no impact on our growing total consult volume. Compared with the 3-week wait times for in-person consults, e-consults provided guidance to a clinical provider in hours to days. In addition, even at a large and busy academic institution like MGH where the attending physician who supervises inpatient consults also performs e-consults, e-consults were completed in a timely manner.

Subspecialist referrals cost up to twice as much as generalist visits and shift care responsibility to a specialist.^{38,39} Conversely, e-consults place the onus of patient care back in the hands of the

primary care provider, which increases patient satisfaction and leads to less disjointed care, but at the cost of increasing the workload of overburdened primary care providers.⁴⁰ Nonetheless, most referring providers followed specialist e-consult recommendations and rarely (<2%) referred patients for in-person consult following an e-consult without explicit recommendation to do so. Many e-consult patients were found previously to prefer receiving subspecialist advice through the familiarity of a known provider.^{12,22} There is concern that e-consults could lead to recommendations for increased testing due to inadequate available history.²⁴ However, only 9% of e-consults resulted in a recommendation for additional testing beyond what would have been done at an initial consult visit. Although there may be concern that e-consults create an extra encounter and associated charge without preventing an in-person consult, less than 2% of patients had a follow-up in-person consult without explicit recommendation to do so, and many in-person consults were likely more productive than they would have been otherwise because of the initial e-consult.

Our study was not designed to detect cost outcomes, but the impact of e-consults on costs is an important area of future investigation. Any cost analysis must consider patient time and travel costs, clinician time, and any differential downstream testing, medications, or referrals. One previous study estimated that 100 million electronic visits can result in \$5 billion in savings for the health care system.^{22,23,25} There are additional direct benefits to consider, both for specific patient populations and for all patients assessed by e-consult. E-consults are ideal for nonadherent patients and those unable to attend scheduled appointments; rather than receiving the alternative of minimal (or no) care, patients can still receive direct, focused care without the need for an additional in-person consult. All patients received specialist input more quickly than would come from waiting for an in-person consult. Referring providers also benefit from the concomitant peer-to-peer education that includes clarification and/or reassurance that a proposed plan of action is correct.¹⁰ Indeed, more than a quarter of e-consults from allergists provided education only (no diagnostic, therapeutic, or referrals suggested). Particularly in Allergy/Immunology where nonspecialist providers receive limited education and self-report major knowledge gaps,^{41,42} e-consults might improve care and reduce health care costs by preventing the ordering of large panels of unnecessary, inappropriate tests. Even for patients who ultimately require an in-person consult, the information exchanged before the consult leads to a more productive consult.¹⁰ Future assessments of the e-consult model in a prospective, randomized, controlled fashion will better facilitate outcome and cost analyses.

Although we compared indications for e-consults to indications for in-person consults, in-person consults used billing codes, and these may not be as accurate as asking the referring provider the referral question. In addition, most ADRs and AFRs are billed with the reaction as the primary diagnosis (eg, would fall under “cutaneous,” “anaphylaxis,” or “urticaria/angioedema”) and a drug or food code as the second diagnostic code. Thus, the in-person consult indications may underestimate drug and food allergy consults. Although this study comprised more than 300 e-consults and almost 9000 in-person consults, we present only an initial descriptive analysis of an e-consult program at a single academic Allergy/Immunology practice. Although our health care system acknowledges e-consult efforts with a flat physician fee per e-consult, these consults are, to date, not billable through

traditional insurance methods, which may limit their spread. Finally, although we saw a decrease in in-person consult wait times with e-consult implementation, this decrease may not have necessarily been the result of e-consult implementation.

Given the growing supply/demand mismatch between the number of practicing allergists and patients with allergy concerns, much of the burden of allergic disease diagnosis and management falls on nonallergist clinicians. In our growingly complex health care system, a model of care that places a patient’s primary care physician at the forefront of care with easy access to specialist guidance is ideal. E-consults meet this challenge, providing safe and efficient patient care in a manner that prevents unnecessary office consults and maximizes patient, referring provider, and subspecialist satisfaction. E-consults seem like an optimal form of health care delivery to consider adopting and spreading given the prevalence of large EHR networks and the minimal time effort required of providers. Promotion and proliferation of the e-consult model of care should be a priority for insurance companies, primary care providers, medical homes, patients, and allergists alike as data suggest that e-consults provide expedient, directed care, improve the quality of in-person consults, avert unnecessary in-person consults, and educate primary care doctors in a case-based relevant manner that might help curb health care spending on specialty care.

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