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Title: Telemedicine Utilization and Incorporation of Asynchronous Testing in a Pediatric Allergy Clinic During the COVID-19 Pandemic

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18 **Clinical Implications**

19 Telemedicine encounters in a pediatric allergy clinic can increase accessibility for allergy care.
20 For patients who required in-person testing, this can be successfully completed in a subsequent
21 visit, including for time-sensitive management of early food introduction in infants.

When the COVID-19 pandemic imposed the reduction of face-to-face encounters, many practices quickly adapted to use of telemedicine more broadly.^{1,2} Patient response to telemedicine has been favorable, so utilization beyond the COVID-19 pandemic continues to provide a convenient alternative for patients.³⁻⁵ However, use of telemedicine for allergy evaluation restricts the ability to perform synchronous in-clinic testing. From our institution's experience of conducting only telemedicine visits during clinic closures in Spring 2020, we report the patterns of telemedicine utilization and allergy testing at an academic pediatric allergy clinic to evaluate the viability of telemedicine and asynchronous testing for management of allergic diseases beyond a pandemic setting.

All telemedicine encounters scheduled between April 1st to 30th, 2020 at the Children's Hospital Colorado Pediatric Allergy Clinic were retrospectively reviewed in the telemedicine cohort. A similar number of in-person encounters from April 2019 were also reviewed in the in-person cohort for pre-pandemic baseline comparison. Telemedicine encounters were conducted via synchronous videoconferencing using the Vido application (Hakensack, NJ). Interpreter services were only available for Spanish during part of the study period. If testing (skin prick testing, spirometry, laboratory testing) was required, an asynchronous testing approach was employed. Patients were scheduled for a separate in-person visit for testing starting May 11, 2020. Future skin prick testing (SPT) was performed by clinic nurses and spirometry was performed by respiratory therapists via nursing-only encounters. Labs were completed in the walk-in outpatient laboratory.

Retrospective chart review data for each encounter was collected using RedCAP electronic data capture tools^{6,7} for analysis including patient demographics, type of visit, primary visit diagnosis, testing and challenges ordered and completed, and follow-up patterns. Chi-

squared test or Fischer exact test for categorical data and independent samples T-test for continuous data were employed to test statistical differences between groups.

Over the 30-day period in 2020, 365 patients were scheduled with 315 (86.3%) telemedicine encounters completed. These results were compared to 377 scheduled and 260 (69.0%) completed in-person encounters in 2019. Better show rates for telemedicine visits ($p < 0.001$) indicate that telemedicine for outpatient encounters may be more accessible for certain patients. Comparison of patient demographics and visit characteristics are shown in Table E1. Significantly fewer patients identified as Hispanic or Latino (24.4% vs. 32.4%, $p = 0.019$) and reported a primary language other than English (3.9% vs. 10.4%, $p = 0.036$) in the telemedicine cohort. With limited availability of interpreter services during the telemedicine cohort study period, there was significantly less interpreter utilization (0.6% vs. 10.4%, $p < 0.001$). This highlights the need for robust interpreter services to facilitate telemedicine for non-English speaking patients. Also, much fewer publicly insured patients were seen via telemedicine (38.1% vs. 45.9%, $p = 0.005$). These additional discrepancies indicate presence of other barriers for telemedicine among certain populations that require further exploration.

Although distribution of primary visit diagnoses were not significantly different between the two groups, there were differences in testing patterns (Table 1). In-person testing was recommended in 152 (48.3%) of telemedicine visits, which is decreased from in-person rates of 79.6% ($p < 0.001$). Less testing was required for follow-up visits and for the diagnoses of drug allergy and urticaria in both cohorts (Table 1). When stratified by primary diagnosis, there was less testing ordered in the telemedicine cohort for “food allergy or other adverse food reaction” (61.5% vs. 92.1%, $p < 0.001$), “eosinophilic gastrointestinal disease” (28.0% vs. 92.3%, $p < 0.001$) and “asthma or other respiratory disorders” (47.3% vs. 86.5%, $p < 0.001$). These

differences were more pronounced in follow-up visits (Table 1) and may be reflective of less urgent testing that was more often performed during in-person visits for ongoing monitoring of these diseases. In new patient visits for “atopic dermatitis or other rash,” there was also significantly less testing ordered (43.5% vs. 75%, $p = 0.037$). Similarly, testing for the management of dermatologic complaints may not be as urgent.

Of the recommended tests, 66.8% were completed in the telemedicine cohort and 95.6% in the in-person cohort ($p < 0.001$). There were lower rates of testing ordered and completed for SPT, spirometry and labs (Table 2). Without the convenience of synchronous testing during the same visit encounter, allergy providers may be more judicious with testing recommendations and the need for an additional encounter for patients to complete the testing would reduce rates of completion. This may be magnified due to hesitancy for in-person encounters during the COVID-19 pandemic. Although proportions of food challenges ordered were not significantly different (10.5% vs. 15.4%, $p = 0.078$), less food challenges were completed in the telemedicine cohort (63.6% vs. 87.5%, $p = 0.016$). As food challenges are scheduled as a separate visit in both cohorts, decreased completion in the telemedicine cohort is also likely primarily a consequence of the COVID-19 pandemic. In contrast, for drug challenges, where there may be less of a perceived urgency for completion even in the pre-pandemic period, orders and completion were similar in both cohorts.

Evaluation and management of possible food allergies in the infant population is often considered more time-sensitive due to the possible ramifications of delayed introduction of allergenic foods. To further evaluate possible effect of increased urgency for management on completion rates of additional testing and challenges, we specifically analyzed this subgroup of infants under 1 year of age. The telemedicine cohort consisted of more infants (11.5% vs. 6.6%,

p = 0.021). Analysis of infants less than 1 year of age had similar rates of SPT, labs and food challenges ordered and completed between the two cohorts (Table 2). These findings would suggest that within a group of patients where timely testing and challenges are emphasized, completion rates were comparable even in a pandemic setting.

With increasing demand for telemedicine, we must devise strategies to adapt to its wider use. Due to higher rates of telemedicine encounter completion, continuing to offer telemedicine encounters may improve accessibility for allergy care among certain patients. As there was notable underrepresentation among Hispanic, non-English speaking and publicly insured patients, additional barriers for access do need to be addressed, including availability of interpreter services.

About half the patients (51.7%) in the telemedicine cohort did not require any additional in-person testing, which would be the preferred group of patients to target for telemedicine management. Patients who required less testing included follow-up patients and those who presented for drug allergy or urticaria. As need for testing cannot be anticipated in all scenarios prior to the visit encounter, we sought to evaluate patterns of asynchronous testing. Although there were decreased rates of testing completion with an asynchronous model, significant differences were not seen in more time-sensitive cases of infants who may benefit from early food introduction.

A primary study limitation is the effects of the COVID-19 pandemic on testing orders and completion. There was hesitancy among allergy providers to conduct in-person testing due to concern for increased risk for virus exposure.⁸ Similar concerns were likely shared among patients. This may have reduced both testing order and completion rates, which could improve after resolution of the COVID-19 pandemic. Some testing may have also been deferred if test

results may not significantly change management. This may be seen in cases such as follow-up for longstanding IgE-mediated food allergy or well-controlled asthma, though our study was unable to identify and account for these possible scenarios. Subset analysis of infants less than 1 year of age did reveal that when the risks of delaying management may outweigh risks of increased healthcare encounters during a pandemic, testing patterns were comparable to in-person management. These results may be more reflective of practices outside of a pandemic. Additional studies will need to be completed to further evaluate asynchronous testing patterns with telemedicine after the COVID-19 pandemic.

Additionally, these results cannot be generalized to all telemedicine programs. With the resources available at our institution, patients seen via telemedicine were able to receive similar care to those seen in-person, including access to ancillary services and in-person testing and challenges. This may not be feasible at institutions that lack staffing to provide these services, particularly the availability of nursing only visits for in-person testing. Ability to return for in-person evaluation may be more difficult for patients who live further from the clinic location, so our findings cannot be readily applied to expansion of telemedicine to more remote locations. As we had focused on a pediatric population, there may also be different challenges in caring for an adult population that we did not identify. Thomas et al. 2020, described a cohort of patients seen during the COVID-19 pandemic via telemedicine in an adult allergy clinic, some of which needed an additional in-person visit for further testing.⁹ Similar to findings in this study, more than half (55%) of patients did not require additional in-person testing, but rates of test completion were not reported to determine outcomes of a similar approach in an adult clinic. Additional studies to address these scenarios are needed.

136 In conclusion, continuing to offer telemedicine in a pediatric allergy clinic can increase
137 patient accessibility. Approximately half of patients can be managed completely over
138 telemedicine, particularly follow-up patients. For patients who require testing, testing-only
139 appointments can be employed with adequate completion rates, particularly for cases that require
140 more timely management.

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Table I. Testing Orders by Primary Diagnosis

Primary Encounter Diagnosis	No. (%) of In-person Testing Ordered								
	New Patient			Follow-up			Total		
	COVID Telemedicine	Pre-COVID In-Person	p-value	COVID Telemedicine	Pre-COVID In-Person	p-value	COVID Telemedicine	Pre-COVID In-Person	p-value
Atopic Dermatitis or other rash	10 (43.5)	15 (75)	0.037	4 (50.0)	6 (46.2)	1.000	14 (45.2)	21 (63.6)	0.138
Food allergy or other adverse food reaction	49 (76.6)	46 (88.5)	0.098	15 (37.5)	35 (97.2)	<0.001	64 (61.5)	81 (92.1)	<0.001
Eosinophilic gastrointestinal disease	1 (25.0)	2 (100.0)	0.217	6 (28.6)	10 (90.9)	0.001	7 (28.0)	12 (92.3)	<0.001
Asthma or other respiratory disorders	9 (81.8)	15 (93.8)	0.549	17 (38.6)	30 (83.3)	<0.001	26 (47.3)	45 (86.5)	<0.001
Rhinitis	15 (79.0)	21 (95.5)	0.164	7 (30.4)	6 (33.3)	0.843	22 (52.4)	27 (67.5)	0.163
Drug allergy	2 (22.2)	3 (42.9)	0.596	2 (100.0)	1 (100.0)	1.000	4 (36.4)	4 (50.0)	0.658
Urticaria	7 (36.8)	10 (62.5)	0.130	2 (22.2)	1 (33.3)	1.000	9 (32.1)	11 (57.9)	0.080
Mast cell disorder/Idiopathic anaphylaxis	2 (66.6)	2 (100.0)	1.000	1 (100.0)	0 (0.0)	1.000	2 (50.0)	2 (100.0)	0.467
Concern for allergic disorder with none found	3 (25.0)	4 (80.0)	0.105	1 (100.0)	0 (0.0)	1.000	3 (23.1)	4 (80.0)	0.055
Total	98 (59.0)	118 (83.10)	<0.001	53 (35.6)	89 (75.40)	<0.001	152 (48.3)	207 (79.6)	<0.001

Table II. Testing Order and Completion Rates

	No. (%) of Testing Ordered			No. (%) of Testing Completed		
	COVID Telemedicine	Pre-COVID In- Person	p-value	COVID Telemedicine	Pre-COVID In-Person	p-value
All Patients						
Skin Prick Testing	113 (35.9)	143 (55.0)	< 0.001	87 (77.7)	143 (100.0)	< .001
Spirometry	31 (9.8)	76 (29.2)	< 0.001	13 (41.9)	73 (96.1)	< .001
Labs	40 (12.7)	76 (29.2)	< 0.001	29 (72.5)	71 (93.4)	.004
Food Challenge	33 (10.5)	40 (15.4)	0.078	21 (63.6)	35 (87.5)	.016
Drug Challenge	15 (4.8)	9 (3.5)	0.438	5 (33.3)	7 (77.8)	.089
Total	171 (54.3)	213 (81.9)	< 0.001	155 (66.8)	329 (95.6)	< 0.001
Patients < 1 year of age						
Skin Prick Testing	26 (61.9)	12 (48.0)	0.267	24 (92.3)	12 (100.0)	0.324
Labs	9 (21.4)	2 (8.0)	0.151	8 (88.9)	2 (100.0)	0.621
Food Challenge	14 (33.3)	7 (28.0)	0.649	11 (78.6)	7 (100.0)	0.186
Total	32 (78.1)	15 (79.0)	1.000	43 (87.8)	21 (100.0)	0.168

Supplemental Table

Table E1. Patient Demographics and Clinical Characteristics

	COVID Telemedicine (N=365)	Pre-COVID In-Person (N=377)	p-value
Age			
mean (SD)	7.22 (5.32)	6.90 (4.97)	0.562
Median [Min, Max]	7 [0, 21]	6 [0, 19]	
<i>Age less than 1 year</i>	42 (11.5)	25 (6.6)	0.021
Gender			
Female	139 (38.3)	146 (38.7)	0.903
Male	224 (61.7)	231 (61.3)	
Race			
American Indian/Alaska Native	4 (1.1)	3 (0.8)	0.107
Asian or Pacific Islander	8 (2.2)	8 (2.1)	
Black or African American	24 (6.6)	29 (7.7)	
White	243 (66.5)	215 (57.0)	
More than one race	28 (7.7)	43 (11.4)	
Unknown/Not reported	23 (6.3)	26 (6.9)	
Other	35 (9.6)	53 (14.1)	
Ethnicity			
Hispanic or Latino	89 (24.4)	122 (32.4)	0.019
NOT Hispanic or Latino	245 (67.1)	227 (60.2)	
Unknown/Not reported	31 (8.5)	28 (7.4)	
Primary Language			
English	351 (96.1)	338 (89.7)	0.002
Spanish	12 (3.3)	30 (8.0)	
Other	2 (0.6)	9 (2.4)	
Health Insurance			
Private	177 (48.5)	157 (41.6)	0.005
Public	139 (38.1)	173 (45.9)	
Uninsured	4 (1.1)	1 (0.3)	
Type of Visit			
New	200 (54.8)	214 (56.8)	0.589
Follow-up	165 (45.2)	163 (43.2)	
Outcome of the Visit			
Completed	315 (86.3)	260 (69.0)	<0.001
Cancelled	36 (9.9)	96 (25.5)	
No show	13 (3.8)	21 (5.6)	
Primary Visit Diagnosis			
Atopic Dermatitis or other rash	31 (9.9)	33 (12.7)	0.548
Food allergy or other adverse food reaction	104 (33.2)	88 (33.9)	
Eosinophilic gastrointestinal disease	25 (8.0)	13 (5.0)	

Asthma or other cough	55 (17.6)	52 (20.0)	
Rhinitis	42 (13.4)	40 (15.4)	
Drug allergy	11 (3.5)	8 (3.1)	
Urticaria	28 (9.0)	19 (7.3)	
Mast cell disorder/Idiopathic anaphylaxis	4 (1.3)	2 (0.8)	
Concern for allergic disorder with none found	13 (4.2)	5 (1.9)	
Interpreter Services Utilized			
Yes	2 (0.6)	27 (10.4)	<0.001
In-Person Testing			
Yes	152 (48.3)	207 (79.6)	<0.001
Deferred	14 (4.4)	0 (0.0)	
No	149 (47.3)	5 (20.38)	
Follow-up Required			
Yes	196 (62.2)	158 (60.8)	0.893
No	50 (15.9)	45 (17.3)	
Not specified	69 (21.9)	57 (21.9)	
Type of Follow-up Completed			
In-person	34 (17.3)	51 (32.3)	0.371
Telehealth	23 (11.7)	0 (0.0)	
Not completed	72 (36.7)	64 (40.5)	
Not yet required	67 (34.2)	43 (27.2)	