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CLINICAL PHARMACY RESEARCH REPORT

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Impact analysis of virtual ambulatory transplant pharmacists during COVID-19

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Abstract

Introduction: During the coronavirus disease 2019 (COVID-19) pandemic, transplant centers were challenged to meet the demand for new telemedicine strategies. The ability of lung transplant providers (LTP) to conduct face-to-face clinic visits for high-risk immunocompromised patients, such as lung transplant recipients (LTR), was limited. Through the implementation of comprehensive medication management visits, pharmacists were able to assist LTP in the transition to telemedicine.

Methods: A retrospective chart review of telephone encounters from cardiothoracic (CT) transplant pharmacists at our center from March to September 2020 was completed. LTR scheduled for clinic visits with LTP were called prior to the visit by CT transplant pharmacists who conducted medication list reviews, adherence assessments, and medication access assistance. Clinical recommendations were communicated directly to the LTP and documented in patient electronic medical records. The primary outcome was the number of pharmacist-driven clinical interventions. Secondary endpoints included the clinical severity and value of service of each intervention, percentage of accepted recommendations, patient cost savings interventions, prevention of adverse events, and avoidance of inappropriate doses.

Results: From March to September 2020, the CT transplant pharmacists conducted 385 virtual visits on 157 LTR with a median of 20 minutes spent per visit. There were 891 total interventions made by CT transplant pharmacists, including 778 medication discrepancies identified. Over 60% of encounters demonstrated some form of medication error and over 55% of encounters exhibited value of pharmacy services.

Conclusion: Implementation of CT transplant pharmacist telehealth visits has potential for increased patient access to pharmacy care and improved accuracy of medication lists. When focusing on the severity of errors and value of services, most demonstrated a level of significance. Further investigation is needed to analyze the impact of this service on patient outcomes as well as cost-effectiveness.

KEYWORDS
collaborative practice, comprehensive medication management, medication optimization, patient communication, telemedicine, transplant

Lindsay Park and Ju Hee Kim contributed equally to this study.

1 | INTRODUCTION

During the coronavirus disease 2019 (COVID-19) pandemic, the ability of pharmacists and healthcare providers to conduct face-to-face ambulatory care visits has been significantly limited. High-risk immunocompromised patients, such as lung transplant recipients (LTR), were immediately placed on strict restrictions as we learned more about the virus. With the initial surge of COVID-19 cases during March of 2020, means for virtual visits were explored due to the increasing limitations of in-person clinic visits despite the increasing need for follow-up visits with these high-risk LTR.

The first adaptation included the implementation of pharmacist-driven telephone-based clinics. The American Telemedicine Association defines telemedicine as "the use of medical information exchanged from one site to another via electronic communications to improve a patient's health status".[1] The substantial benefit of combining telemedicine and pharmacist interventions in this patient population has been described in literature. One study demonstrated improved quality and safety with the medication discharge process when pharmacists were involved in a telehealth transitional care management for high medication risk patients.[2] As transplant recipients require case management and chronic medication monitoring after discharge, another study revealed the positive impact of interventions by clinical pharmacists in a high-risk patient population of kidney transplant patients.[3] Virtual visits allowed patients to receive high-quality care regardless of physical contact limitations. Other studies describing telemedicine in transplant illustrate the impact of increasing patients' perceptions of skin cancer risk through mobile medical applications as well as improving adherence levels with laboratory testing through text messaging.[4,5]

Though LTR are considered an inherently complex thoracic allograft population, most transplant literature focuses on the intricacies of the abdominal transplant population. Currently, there is a lack of literature describing the role and impact of transplant pharmacists in telehealth for the LTR population. As the lung transplant providers (LTP) transitioned to a telemedicine approach for clinic visits, the CT transplant pharmacists' expertise were requested to help the LTP acclimate to telemedicine. CT transplant pharmacists called patients prior to their scheduled telemedicine visit to complete a medication list review of their complex posttransplant regimens as well as an adherence assessment. This patient conversation helped to refine clinical recommendations made to the LTP and further define the CT transplant pharmacist's role in the telehealth environment. This study describes the creation of a CT transplant pharmacist role in a LTR virtual clinic and describes the clinical interventions and medication errors identified by the pharmacists during COVID-19.

2 | METHODS

A retrospective chart review was completed of telephone encounters conducted primarily by two CT transplant pharmacists at our center from March to September 2020. Each CT transplant pharmacist had 2 years of residency training, including a specialty year in solid organ transplant. In addition, they work with the CT transplant population daily, rotating through inpatient and ambulatory care services. Telephone visits were conducted 1 to 3 days prior to scheduled patient telehealth or clinic visits with advanced practice providers or attending pulmonologists, referred to as LTP for the purposes of this paper. Calls were not conducted if patients were contacted within the past 30 days. In collaboration with the LTP, CT transplant pharmacists focused calls on high-priority patients, including but not limited to, outcomes based on evaluation of adherence rates and new clinical findings. Though patients were not scheduled at exact times for these virtual visits, they were told by schedulers and during inpatient stays to anticipate a phone call by the pharmacist prior to their clinic visit. This method ensured flexibility for pharmacists and patients due to the virtual nature of the visits. During the visit, the pharmacists utilized a standardized template to conduct lab evaluations, medication list reviews, adherence assessments, in addition to an assessment of patient tolerability of medications, cost limitations, and medication access (see Appendix A). Cost savings interventions were defined as interventions resulting in a lower cost alternative agent, use of lower tier agents per insurance formularies, enrollment in patient assistance programs, or discontinuation of high-cost agents. Adherence assessments were defined using criteria outlined in Appendix B. Prior to these clinic visits, CT transplant pharmacists reviewed individual patient's electronic medical record (EMR), including but not limited to, relevant labs, microbiology, pulmonary function tests, and consult notes. Using this objective data, CT transplant pharmacists made interventions to the team after gaining additional context from conversations with the patients and reviewing the patient medication list. CT transplant pharmacists called patients utilizing institution network phones; however, Doximity or Google Voice was utilized when requiring remote access. Virtual appointments were often conducted in conjunction with caregivers. Clinical assessments and recommendations were communicated directly to the LTP in a concise email prior to each clinic visit and subsequently documented in the patient's EMR. At the following clinic visit, LTP utilized the pharmacist assessments and recommendations to implement interventions and further optimize patient care.

Baseline characteristics and interventional data from each virtual visit were manually extracted from the EMR and corresponding emails between providers and pharmacists. Data collection was conducted by two individuals to ensure consistent results. Endpoints were analyzed using both summative and descriptive statistics. A subanalysis was conducted comparing acute vs chronic virtual visits. Patient virtual visits ≤1 year from transplant were categorized as acute or chronic if ≥1 year from transplant. Subanalysis continuous and categorical data were analyzed utilizing the *t* test and Fisher's exact test, respectively. Analysis was performed using GraphPad QuickCalcs (GraphPad Software, San Diego, California). The impact of CT transplant pharmacy interventions was then graded according to the validated instrument proposed by Overhage and Lukes to assess severity of error and value of service.[6] Severity of error was defined by an assessment of therapy appropriateness per practice standards and

categorized into (A) potentially lethal, (B) serious, (C) significant, (D) minor, and (E) no error. Value of service was defined by assessment of potential impact of the intervention on patient care and categorized into (1) extremely significant, (2) very significant, (3) significant, (4) somewhat significant, and (5) no significance (see Appendix C).

The primary outcome was number of pharmacist-driven clinical interventions made during COVID-19 virtual lung transplant visits. Secondary endpoints included clinical severity and value of service of each intervention, percentage of accepted recommendations, patient cost-savings interventions, prevention of adverse events, and avoidance of inappropriate doses.

This paper describes a Quality Assurance and Performance Improvement initiative and did not require an Institutional Review Board approval.

3 | RESULTS

From March to September 2020, 157 LTR participated in the pharmacist-initiated telemedicine service. The CT transplant pharmacists spent a median of 20 (0-90) minutes per visit. There was a median of 2 (1-10) virtual visits conducted per patient. For each visit, patients were reached after an average of 1 attempt. A total of 69 voicemails were recorded for patients who were unable to be reached.

3.1 | Baseline characteristics

The baseline demographics and clinical characteristics of the study population are summarized in Table 1. Over half of the study population had between 5 and 10 comorbid conditions (68.8%), while nearly one third had interstitial lung disease (39.5%) as their indication for transplant. The most common comorbid conditions were hypertension, coronary artery disease, gastroesophageal reflux disease, and pancreatic insufficiency. The study population presented with a median of 22 (12-40) medications on their list at each virtual visit. Participants were reported to have excellent (n = 154, 50.3%), good (n = 144, 47.1%), or poor (n = 8, 2.6%) adherence to their medications (see Appendix B).

3.2 | Pharmacist-driven clinical interventions

Though there was no established comprehensive drug therapy management (CDTM) agreement with LTP, pharmacist-driven interventions were based on a combination of institutional protocol as well as professional clinical judgment. Table 2 lists the total number of interventions and identified discrepancies by the CT transplant pharmacists. Clinical interventions were made at most telehealth visits (74.8%). Most telehealth visits had interventions acted upon by CT transplant pharmacists (62.3%) and some visits had interventions acted upon by the providers (18.4%). A median of 3 (range 0-9) interventions were sent to LTP per visit, of which a median of 1 (range 0-7) were acted upon by pharmacists and 0 to 3 interventions were acted upon by providers. Due to the absence of a CDTM and certain

TABLE 1 Baseline characteristics of transplant patients (N = 157)

Age, year (median, range)	**60 (26-79)**
Race/ethnicity, n (%)	
White	144 (91.8)
Hispanic	10 (6.3)
Black	3 (1.9)
Time from transplant, years (median, range)	3 (0-28)
Years from transplant, n (%)	
<1	10 (6.4)
1–5	100 (63.7)
>5	47 (29.9)
Indication for transplant, n (%)	
COPD	45 (28.7)
Interstitial lung disease	62 (39.5)
Cystic fibrosis	43 (27.4)
Pulmonary hypertension	7 (4.4)
Number of comorbid conditions, (median, range)	8 (2–19)
Comorbid conditions, n (%)	
<5	15 (9.5)
5–10	108 (68.8)
>10	34 (21.7)
Number of medications per patient, (median, range)	22 (12–40)
Medications per visit, n (%)	
≤15	21 (6.9)
16-24	192 (62.7)
≥25	93 (30.4)
Use of pill box at time of visit, n (%)	
Yes	271 (91.8)

TABLE 2 Results from phone visits

Total calls completed, n	385
Calls with interventions sent, n (%)	288 (74.8)
Calls with actionable interventions, n (%)	240 (62.3)
Calls with interventions acted upon, n (%)	71 (18.4)
Medication discrepancies per call (median, range)	2 (0–10)
Total medication discrepancies, n	778
Other, n (%)	135 (20)
Incorrect doses, n (%)	156 (20)
Medication added, n (%)	188 (24.2)
Discontinued medication, n (%)	299 (38.4)
Total interventions, n	891

TABLE 3 Types of pharmacist interventions[a], n (%)

Types of interventions	
Medication education	311 (20.8)
Updated team with adherence level	305 (20.4)
Adherence counseling	291 (19.5)
Social distancing/COVID-19 precautions	255 (17.1)
Report changes in clinical status	70 (4.7)
Adverse event reporting	69 (4.6)
Recommended change to pharmacologic therapy	65 (4.4)
Non-pharmacologic therapy recommendation	38 (2.5)
Renal dosing	30 (2.0)
Recommended immunosuppressant adjustment	26 (1.7)
Cost-savings intervention	23 (1.6)
Avoidance of drug-drug interaction	9 (0.6)
Referral to in-person pharmacy visit	2 (0.1)

[a]An intervention can be considered more than one type.

TABLE 4 Characterizing impact of CT transplant pharmacists' interventions by severity of error and value of services, n (%)

Severity of medication errors	
A. Potentially lethal	7 (0.8)
B. Serious	19 (2.1)
C. Significant	155 (7.4)
D. Minor	367 (41.2)
E. No error	343 (38.5)
Value of pharmacy services	
1. Extremely significant	1 (0.1)
2. Very significant	34 (3.8)
3. Significant	163 (18.3)
4. Somewhat significant	327 (36.7)
5. Adverse significance	366 (41.1)

legal restrictions regarding scope of practice, most CT transplant pharmacists' clinical interventions required provider implementation. Interventions acted upon by CT transplant pharmacists included the following: medication education, patient assistance program enrollment, adherence improvement interventions, medication access interventions, and safe over-the-counter supplementation for issues related to hair loss or insomnia (see Table 3). Interventions focused on posttransplant immunosuppressive complications included but were not limited to infectious disease (opportunistic infections prophylaxis), neurotoxicity, nephrotoxicity, cardiovascular health, diabetes, anticoagulation, and gastric dysmotility. Of the 891 total interventions, 204 (22.9%) were specific to transplant medications and 687 (77.1%) interventions were nontransplant medications. A subanalysis comparing acute and chronic patient visits demonstrated no significant difference between the two groups in the impact of this service, though there was a trend toward more medication discrepancies identified for chronic patients ($P = .0013$). Inversely, acute patient visits showed trends of having longer time spent on call ($P = .0142$) and more actionable interventions per call ($P = .0189$) (see Appendix D[6]).

3.3 | Severity of error and value of service

The results from grading the interventions are shown in Table 4. Utilizing the validated tool, pharmacists identified some form of medication error in over 60% of encounters and value of pharmacy services in over 55% of encounters.

4 | DISCUSSION

Prior to the COVID-19 pandemic, in-person visits were standard practice by CT transplant pharmacists, though they were limited to 5-minute medication list updates as part of in-person clinic visits. Due to time and space constraints, further recommendations were not feasible. However, when the pandemic forced a pivot to virtual visits, an opportunity for further pharmacist involvement arose. What started as assisting with simple medication list updates transitioned into a comprehensive virtual visit with significant intervention for adherence counseling and critical updates to maintain accurate medication lists. The pharmacist's role in clinic evolved from maintaining accurate medication lists to leading comprehensive virtual visits with significant clinical and educational interventions.

Through this practice expansion, the study was able to reach over 80% of our LTR patients. These calls were initiated during the peak of the pandemic in March 2020, at the time of the COVID-19 shelter-in-place order. This may have contributed to ability to contact LTR on the first attempt in most cases, an advantage for telehealth that is likely to change as quarantine restrictions lift across the country. As noted in commentary from Wright and colleagues, there is currently no literature evaluating outcomes of implementing virtual visits in LTP warranted by the pandemic.[7] In this analysis of virtual ambulatory care visits with LTR, the study results showed that per visit, there was a median of 3 (range 0-9) medication discrepancies and 1 (range 0-7) actionable intervention made by the CT transplant pharmacists. The results demonstrated that per visit there was a low rate of provider interventions acted upon. Provider intervention in this study was recorded based on written changes in the EMR immediately following the CT transplant pharmacist call. Meanwhile, actionable interventions by the CT transplant pharmacists centered on issues such as medication education, patient assistance program enrollment, adherence interventions, over-the-counter supplement counseling, and medication access clarifications. All other actions, such as renal dose adjustment of medications and immunosuppressant dose changes, required LTP intervention from an ordering perspective. Thus, the low number of interventions acted upon by LTP may be reflective of the educational nature of several interventions that did not require follow-up. The inability for in-person dialogue to clarify interventions may have also contributed to the low rate of action on interventions. Email

communication between CT transplant pharmacists and LTP promoted greater efficiency and pursuit of the goal to enhance this new service together. Another consideration for the low provider acceptance rate could be that some minor interventions confounded results; a few recommendations were accepted much later after further discussion, and/or not specifically documented, resulting in an inaccurate depiction of the true acceptance rate. If CT transplant pharmacists had a CDTM protocol in place, immediate interventions could have been made and documented. In a trial analyzing the impact of pharmaceutical care at transplant clinics, Wang and colleagues organized pharmacist recommendations into six scales, evaluating rates of physician acceptance and improved treatment outcomes. With a total of 55 pharmacotherapy recommendations, 18.2% were defined as "slightly significant." Furthermore, mean physician acceptance rates for pharmacotherapeutic interventions were evaluated based on type of recommendations and drug class recommendations, which were 96% and 97%, respectively. In this study, pharmacists' interventions helped physicians with medication selection and detection of adverse reactions. Utilizing Wang and colleagues' tool, the authors found a positive potential impact of clinical pharmacists' involvement in transplant clinic on patient outcomes. Had the study classified clinical interventions based on a similar manner, this type of standardized approach could have altered the low acceptance rate. [8]

Overhage and Lukes' scale was found to be an applicable and reliable tool to characterize CT transplant pharmacists' clinical activities. [6] The use of two different scales avoided issues that may arise when utilizing a single instrument to measure two separate elements, "since services can be identified as high value even when there are no prescribing errors." [6]

A handful of patient errors and pharmacist intervention were quite notable. One "potentially lethal" patient error consisted of taking an incorrect 50% dose reduction of azathioprine for 3 weeks, which led to a "very significant" impact of preventing a possible case of organ rejection. Another "potentially lethal" error consisted of a patient's confusion of dose changes between tacrolimus and warfarin, resulting in the patient unknowingly increasing the dose of tacrolimus instead of adjusting warfarin. The CT transplant pharmacist successfully intervened and spent an extensive amount of time with the patient during multiple visits, focusing on patient education and adjustment in the immunosuppressant regimen. This value of service was considered "extremely significant" since any further delay in identification of this error could have resulted in a potential hospitalization or fatal situation (see Table 4).

The specific errors and interventions mentioned above resulted in more frequent follow-up with a total of five visits each, which was at least double the number of visits in comparison with other patients with less severe errors. From this analysis, categorizing the range of severity of errors could result in development of quality-improvement processes. Our efforts focused on outlining types of discrepancies that were discovered and resolved by the CT transplant pharmacists, highlighting the close monitoring and interventions made. Strategies could be employed to alert greater attention to these more serious errors rather than less serious errors. In addition, though the subanalysis showed that there were no significant differences in the impact of services between acute and chronic patient visits, the trends found may act as a guide for more meaningful follow-up. Based on these results, acute LTR may benefit more from a full telehealth visit, while chronic LTR may benefit more from medication list reviews. Ranking the severity and value of service helped to assess the value of CT transplant pharmacists in a telehealth ambulatory care setting, though challenges remain in establishing the value of service reimbursement.

Given the complex medication regimens, the most frequent interventions included CT transplant pharmacists conducting medication education and adherence counseling. Existing literature supports the impact of the transplant pharmacists on long-term success of organ transplantation and adherence levels. Klein and colleagues found that pharmaceutical care of liver transplant patients led to a significant increase in compliance with immunosuppressive therapy and improved attainment of target immunosuppression blood levels.[9] In addition, a randomized prospective trial revealed the complexity of posttransplant care involving management of polypharmacy and routine laboratory testing, demonstrating that 90-day readmission rates were significantly lower in the telemedicine-based home management program group than that in the standard-of-care group.[10] Though this study did not explore readmission rates, future studies should further explore the impact of telemedicine on readmissions.

Though sparse, current literature on telehealth services further support the findings of this study, highlighting the benefit of and barriers to establishing these services. In a retrospective review assessing outcomes of chronic lung allograft dysfunction progression and mortality in the Greater Toronto Area, following select patients long term with telehealth was associated with increased access to care as well as reduced time and financial burdens for patients residing in longer distances from the hospital. Interestingly, their clinic workflow consisted of scheduling annual visits once LTR reached the 2-year posttransplant mark, utilizing at-home video conferencing software. "Interval visits were scheduled if clinically indicated."[11] Conversely, this study's clinic patient population consists of both acute and chronic patients, demonstrating the potential benefit of virtual visits with the pharmacist immediately posttransplant and throughout the LTR's long-term course. In addition, a recent 6-week follow-up survey analyzed the impact of COVID-19 on practices and policies in the United States; it found challenges implementing telemedicine, which consisted of training staff (61%), providing equipment to staff (30%), and providing software to staff (41%) while patient-related challenges involved patient access to and ability to utilize the technology (81% and 86%).[12] As this study's telehealth method was via telephone, there were no technology-associated difficulties. As the future of telemedicine in transplant heads toward a favorable path, it will be essential to be aware of potential barriers such as lack of digital literacy, disparities in technology access, use by patient age, race/ethnicity, and socioeconomic status. To overcome these barriers, lasting telehealth services must be validated from a financial and regulatory perspective.[13]

This study should be interpreted by considering several limitations. First, the small sample size within a single institution could pose lack of patient heterogeneity, race, and even socioeconomic status. Another limitation is possible misinterpretation of patient cost-savings

interventions. Cost-savings interventions were assessed utilizing the same severity of error and value of service scale rather than quantification of cost-savings. This method was used due to variability of intervention types and number of outpatient pharmacies at which lung transplant patients fill their prescriptions. Due to the outpatient nature of this clinic, direct cost-savings to the hospital could not be assessed. In addition, there were limitations regarding the lack of a comparable control group and inability to depict statistical significance. The CT transplant pharmacists utilized Overhage and Lukes' tool to analyze the interventions, which may incorporate reviewer bias. Due to data analysis of the severity of error and value of service completed by separate reviewers, there was a slight discrepancy in the total number of interventions. Lastly, the mode of pharmacist-to-provider communication via email correspondence and progress notes could have led to inconsistencies in data collection. Because analyses of interventions acted upon by providers were completed via chart review, lack of documentation may have impacted the true rate of intervention acceptance.

The lung transplant clinic could serve as an effective space to facilitate initiation of a CDTM agreement, to improve patient-pharmacist access and clinical collaboration on complex patients. The expansion of pharmacist-run telehealth services would offer the benefits of reduced travel needs and increased visit scheduling flexibility.

There were key factors that contributed to the success of this telehealth program. First, the expectation was established with patients that a CT transplant pharmacist would be calling prior to their clinic visit. This allowed patients to be available and prepared to receive calls from the pharmacist. Second, the times for telemedicine visits were kept flexible to account for the competing demands of a CT transplant pharmacist. Lastly, a standardized visit template was constructed for consistent documentation and guided visits. This standardization could allow pharmacy learners to assist with these calls, facilitating an independent outpatient experience. These are all best practices that institutions should look to establish when implementing a pharmacist-initiated telehealth service for LTR.

5 | CONCLUSION

In conclusion, this retrospective chart review highlighted a positive impact on patient care through the implementation of CT transplant pharmacist-initiated telehealth visits for LTR. Analysis of the clinically impactful interventions has shown potential to increase patient access to pharmacy care and improve accuracy of medication lists. In addition, when focusing on the severity of errors and value of service, most interventions demonstrated a level of significance (see Table 4).

Future investigators are encouraged to conduct studies to further analyze the impact of pharmacist telehealth on patient outcomes as well as cost-effectiveness. More specifically, a reduction in hospital readmissions could be utilized to support continued implementation of these services. Currently, our practice model was developed to be conducted primarily by two CT transplant pharmacists responsible for both inpatient and outpatient care of heart and LTR. Given the potential benefits of this program, continued practices may warrant expansion, dedicated training, specialized ambulatory care roles, and increased funding. Moreover, with the rapid development of virtual platforms, clinical pharmacy practices should explore ways to incorporate video capability to capture more of the nature of in-person meetings. Establishing virtual transplant clinics will enhance the pharmacist's role in providing advantageous services for the lung transplant population even after the COVID-19 pandemic.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Lindsay Park contributed to the conception and design, participated in analyzing and interpreting data, participated in writing of the paper, participated in the approval of the final version to be published. Ju Hee Kim participated in analyzing and interpreting data, participated in writing of the paper, participated in analyzing and interpreting data, participated in the approval of the final version to be published. Georgina Waldman contributed to the conception and design, participated in analyzing and interpreting data, participated in critical revision of the paper, participated in the approval of the final version to be published. Christin Rogers Marks contributed to the conception and design, participated in critical revision of the paper, participated in the approval of the final version to be published. Jacqueline E. Clark contributed to the conception and design, participated in analyzing and interpreting data, participated in critical revision of the paper, participated in approving the final version to be published.

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APPENDIX A: SOAP NOTE

Transplant pharmacy telephone visit

@NAME is a **@AGE @SEX** s/p lung transplant on **@TXPDATE**. The patient was called by the pharmacist to review home medications in preparation for their upcoming lung transplant clinic visit. The patient's current medication list was reviewed and updated in Epic.

@NAME reviewed the following items during the telephone encounter: {filled pill box, empty pill box, medication bottles, transplant medication card, medication list, vitals log, blood sugar log}.

Current medications

@CURRENT MEDS.

Current immunosuppressive regimen

Tacrolimus ***mg BID.

Mycophenolate mofetil/sodium ***mg BID.

Prednisone ***mg daily.

During our visit the patient reported the following adverse effects potentially related to their immunosuppression: [none, headache, tremor, neuropathy, seizure, renal dysfunction, hyperkalemia, hair loss, hypomagnesemia, hypophosphatemia, nausea, vomiting, diarrhea, heartburn, neutropenia, anemia, thrombocytopenia, new onset diabetes, difficulty controlling blood sugar, difficult to control hypertension, increased appetite, weight gain, difficulty sleeping, difficulty concentrating, agitation, altered mental status, hair growth, gingival hyperplasia, elevated cholesterol, elevated triglycerides, rash, mouth ulcers, edema].

Contraception

{Not applicable—patient is postmenopausal, not applicable—patient had a hysterectomy, patient has an IUD in place, patient had a tubal ligation, patient's partner has vasectomy, patient is using single hormonal contraception, patient is using hormonal contraception with a barrier, patient is using dual barrier method contraception, patient is not currently using contraception and is of child bearing potential}.

Posttransplant medication adherence and access assessment

Patient reviewed from their medication card: {YES/NO}.

Patient was knowledgeable of current medication names: {YES/NO}.

Patient was knowledgeable of current medication doses: {YES/NO}.

Patient was knowledgeable of current medication indications: {YES/NO}.

Who is responsible for managing medications: {***, self, self with assistance from partner, patients' partner, visiting nurse, nursing facility, other support ***}.

Primary medication management strategy: {fills a weekly pill box, takes medications from bottles as prescribed by MD, medications provided in blister packs, ***}.

Who is responsible for filling pill box: {***, self, self with assistance from partner, patients' partner, visiting nurse, nursing facility, other support ***}.

The patient's medication list {WAS/WAS NOT} correct.

- Medications added to the home medication list:***
- Medications stopped on the home medication list:***
- Medications edited on the Epic medication list:***

The patient uses the following tools as reminders to take medications: {***, alarms on phone, reminder app on phone ***, follows consistent routine}.

The patient takes their medications regularly at ***am/***pm.

@NAME {HAS/HAS NOT} missed any doses of their medications.

Patient is having difficulty affording medications: {YES/NO}.

Confirmed that patient has an adequate supply of all medications at this time and does not have difficulty affording their current regimen.

Spent approximately *** minutes reviewing medications and providing medication education via telephone counseling.

All questions/concerns were addressed to the patient's satisfaction.

Summary of pharmacist activities

During this visit, the following activities were completed: [medication reconciliation, adherence assessment and counseling, posttransplant medication counseling, HCV medication counseling, blood pressure log review, blood sugar log review, medication access counseling].

Pharmacist assessment and recommendations

1. Immunosuppression:
2. Opportunistic Infections:

a. Viral: ***
b. PCP: ***
c. Fungal: ***

3. ID:

a. Vaccines: Patient has *** received their high dose flu shot for 2021on ***

4. CLAD prevention: Patient is taking azithromycin *** and ***statin per protocol for CLAD prevention
5. Hypertension:
6. Blood sugar management:
7. GI:
8. Renal: SCr at last lab draw ***, CrCl ***. Medications adjusted: ***.
9. Anticoagulation: ***
10. Bone health:
11. Medication adherence—Patient endorses *** adherence to the current regimen and has *** missed ***doses of their medications.

APPENDIX B: MEDICATION ADHERENCE RATES

Excellent	100% medication adherence No indication for future pharmacist follow-up
Good	<100% medication adherence Requires follow-up
Poor	<100% medication adherence + lack of medication awareness Requires immediate clinical intervention Requires more frequent follow-up

APPENDIX C: INSTRUMENT FOR CHARACTERIZING PHARMACISTS' CLINICAL ACTIVITIES

Severity of error in medication order

Assess the inappropriateness of the order or its deviation from the standard of practice.

A. *Potentially lethal*	• High potential for life-threatening adverse reactions • Potentially lifesaving drug at a dosage too low for the disease being treated • High dosage (>10 times normal) of drug with low therapeutic index
B. - *Serious*	• Route of administration could lead to severe toxicity low dosage of drug for serious disease in patient with acute distress • High dosage (4-10 times normal) of drug with low therapeutic index • Dosage resulted in serum drug concentration in potentially toxic range • Drug could exacerbate the patient's condition (related to warnings or contraindications) • Misspelling or mix-up in medication order could lead to dispensing of wrong drug • Documented allergy to drug • High dosage (10 times normal) of drug without low therapeutic index • Omission of pretest for drug hypersensitivity
C. *Significant*	• High dosage (1.5-4 times normal) of drug with low therapeutic index • Drug dosage too low for patient's condition • High dosage (1.5-10 times normal) of drug without low therapeutic index Errant dual-drug therapy for single condition • Inappropriate dosage interval omission from medication order
D. *Minor*	• Incomplete information in medication order • Unavailable or inappropriate dosage form • Nonformulary drug Noncompliance with standard formulations and hospital policies Illegible, ambiguous, or nonstandard abbreviation
E. *No error*	• Information or clarification requested by physician or other health care professional from pharmacist • Cost savings only

Value of Service

Assess the potential impact of the pharmacists' recommendations on patient care.

1. *Extremely significant*	• Recommendation qualified by extremely serious consequences or potential life-and-death situation
2. *Very significant*	• Recommendation qualified by extremely serious consequences or potential life-and-death situation • Avoidance of serious adverse drug interaction or contraindication to use
3. *Significant*	• Recommendation would bring patient care to a more acceptable, appropriate level (ie, standard of practice), including quality-of-life issues with evidence from the patient or documentation elsewhere, as well as issues of cost and convenience. (Standard of practice is defined by institutional guidelines and protocols and supported by acceptable references to the literature.)
4. *Somewhat significant*	• Patient's benefit from the recommendation could be neutral depending on professional interpretation (to distinguish this rank from rank 3, where a standard of practice would support the recommendation) • More information or a clarification must be obtained by the pharmacist from the physician, nurse, or other appropriate health care professional before an order can be processed
5. *No significance*	• No significance information only • Recommendation not patient specific
6. *Adverse significance*	• Adverse significance recommendation inappropriate; its implementation may lead to adverse outcomes

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APPENDIX D: ACUTE VS CHRONIC PATIENT SUBANALYSIS

Subanalysis	Acute [a] (N = 118)	Chronic [b] (N = 267)	*P* value
Time to visit, months (median, range)	6 (0–12)	47 (13-595)	<0.0001
Time on call, minutes (mean ± SD)	25.8 ± 15.9	22.4 ± 7.6	0.0142
Total discrepancies, n	1 (0-7)	3 (0-10)	0.0013
Interventions, n (median, range)			
Interventions sent per call	3 (0–7)	3 (0-9)	0.3085
Actionable interventions per call	2 (0–6)	1 (0–7)	0.0189
Interventions acted upon per call	0 (0–3)	0 (0–3)	0.0437
Severity of error, n (%)			0.8838
A	3 (1.0)	4 (0.7)	
B	3 (1.0)	16 (2.6)	
C	57 (19.1)	98 (16.2)	
D	117(40.8)	250 (41.4)	
E	107 (37.3)	236 (39.1)	
Value of service, n (%)		0 (0.0)	0.9836
1	1 (0.3)		
2	9 (3.1)	25 (4.1)	
3	52 (18.1)	111 (18.4)	
4	110 (38.3)	217 (35.9)	
5	115 (40.1)	251 (41.6)	

[a] Acute: <12 months posttransplant.
[b] Chronic: > 12 months posttransplant.