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Outpatient Parenteral Antimicrobial Therapy in a Safety Net Hospital: Opportunities for Improvement

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Background. Outpatient parenteral antimicrobial therapy (OPAT) is a safe and cost-effective transitional care approach administered via different delivery models. No standards exist for appropriate OPAT program staffing. We examined outcomes of patients receiving OPAT via different care models to identify strategies to improve safety while reducing health care overuse.

Methods. Retrospective demographic, clinical, and outcome data of patients discharged with OPAT were reviewed in 2 periods (April–June 2021 and January–March 2022; ie, when staffing changed) and stratified by care model: self-administered OPAT, health care OPAT, and skilled nursing facility OPAT.

Results. Of 342 patients, 186 (54%) received OPAT in 2021 and 156 (46%) in 2022. Hospital length of stay rose from 12.4 days to 14.3 in 2022. In a Cox proportional hazards regression model, visits to the emergency department (ED) within 30 days of OPAT initiation (hazard ratio, 1.76; 95% CI, 1.13–2.73; $P = .01$) and readmissions (hazard ratio, 2.34; 95% CI, 1.22–4.49; $P = .01$) increased in 2022 vs 2021, corresponding to decreases in OPAT team staffing. Higher readmissions in the 2022 cohort were for reasons unrelated to OPAT ($P = .01$) while readmissions related to OPAT did not increase ($P = .08$).

Conclusions. In a well-established OPAT program, greater health care utilization—length of stay, ED visits, and readmissions—were seen during periods of higher staff turnover and attrition. Rather than blunt metrics such as ED visits and readmissions, which are influenced by multiple factors besides OPAT, our findings suggest the need to develop OPAT-specific outcome measures as a quality assessment tool and to establish optimal OPAT program staffing ratios.

Keywords. ED visits; outpatient parenteral antimicrobial therapy; readmissions; staffing ratio; OPAT care models.

Outpatient parenteral antimicrobial therapy (OPAT) is a safe and cost-effective transitional care treatment model. Its numerous benefits include improved patient quality of life over inpatient care and hospital cost savings [1]. OPAT programs decrease health care utilization by lowering the number of inpatient days, emergency department (ED) visits, and hospital readmissions [2, 3]. Increases in ED visits and hospital readmissions further strain ED and hospital resources, which can be financially burdensome to the health care system [1]. Despite the known benefits, determining the best OPAT implementation model and appropriate staffing ratios for these care models is challenging and not well studied. Complicating the equation in the United States, OPAT is frequently available as a treatment option only for insured patients.

In 2009, Parkland Health (PH) developed a unique self-administration OPAT (S-OPAT) model for uninsured patients, whereby patients and families were trained to self-administer intravenous (IV) antibiotics at home with weekly outpatient follow-up for nursing, safety monitoring, and pharmacy needs. Importantly, the 30-day readmission rate among patients receiving S-OPAT was 47% lower when compared with patients discharged with traditional models of OPAT that utilized home health or skilled nursing facility services [4]. As the PH-OPAT program has evolved, the S-OPAT team has increasingly cared for insured patients who receive OPAT via a home infusion pharmacy and a home health nursing agency, at hemodialysis centers, or in skilled nursing facilities.

There were many disruptions to the OPAT program during the COVID-19 pandemic, including greater use of telehealth, frequent turnover in nursing and care coordination teams, reassignment of physician and pharmacist responsibilities, and limitations in transitioning patients to post–acute care settings. Additionally Parkland hospital experienced surges in ED visits and hospital occupancy, which are known to adversely affect efficiency, patient outcomes, and mortality [5, 6]. While the

Received 01 February 2024; editorial decision 27 March 2024; accepted 02 April 2024; published online 3 April 2024

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https://doi.org/10.1093/ofid/ofae190

PH-OPAT program adapted to the many changes, in 2022 significant attrition occurred across the OPAT team. We sought to examine reasons for ED visits among patients receiving OPAT and the impact of personnel changes on health care utilization, with a goal of identifying strategies to improve the safety and experience of patients receiving OPAT.

METHODS

Setting

PH is a 900-bed, publicly funded, safety net, and tertiary care hospital and health system serving 2.5 million Dallas County residents. In fiscal year 2022, PH discharged 56 920 adult patients and treated 220 323 patients in the ED and 1 213 316 in the outpatient setting. Approximately 42% of patients who receive care at PH are uninsured [7].

PH-OPAT Program

The OPAT program was developed in 2009, and at its peak in 2017, it was responsible for 1200 patient discharges. The number of patients receiving OPAT has decreased in recent years, due to an increase in the number of patients discharged on either oral antibiotics or long-acting agents. Approximately, 70% of patients evaluated by the inpatient OPAT team are eventually discharged with OPAT.

The OPAT team consists of an infectious diseases (ID) pharmacist and an inpatient care coordinator who interview patients for OPAT eligibility and set up OPAT services, as well as 6 registered nurses who teach patients or their family members how to self-administer IV antibiotics prior to discharge from the hospital. They also provide general and vascular access device (VAD) care in the outpatient ID clinic. An ambulatory care nurse navigator coordinates care with patients and external partners, such as home health agencies, infusion pharmacies, skilled nursing facilities, and other clinics. Regularly scheduled follow-up care with an ID physician or advanced practice provider is provided in the ID clinic. In 2022, the team experienced significant turnover: 4 of 6 RNs, a care coordinator, and a nurse navigator left their positions in a 12-month period. Staff turnover occurred for a variety of reasons, such as burnout, changing or increased family responsibilities, and offers elsewhere that provided improved compensation or career growth. Furthermore, the ID pharmacist, physicians, and advanced practice providers all acquired additional organizational responsibilities related to COVID-19 treatment, therapeutics (monoclonal antibodies), and vaccine distribution, further disrupting the OPAT care processes.

OPAT Care Models

Three care models are provided by the Parkland OPAT program: S-OPAT, health care OPAT (H-OPAT), and skilled nursing facility OPAT (SNF-OPAT).

S-OPAT is the Parkland-developed model in which patients are taught to self-administer IV antibiotics by a trained registered nurse, inpatient medications are provided by the Parkland pharmacy, and patients are seen weekly by an registered nurse in clinic for VAD care and phlebotomy for laboratory monitoring. Patients receiving S-OPAT are typically seen by an ID physician or advanced practice provider every other week or at the end of therapy, whichever is sooner.

H-OPAT is the practice whereby many tasks of OPAT (eg, VAD care and phlebotomy) are performed by a home health nursing agency/home infusion pharmacy or the hemodialysis center. H-OPAT consists of patients receiving care from home health/home infusion agencies and those receiving OPAT at hemodialysis centers, as these 2 groups are primarily cared for by providers outside of the Parkland ID clinic.

SNF-OPAT is composed of patients discharged to an SNF that provides all nursing care and administers prescribed IV antibiotics. H-OPAT and SNF-OPAT patients are typically seen by a provider in the ID clinic 2 to 3 weeks after discharge and before therapy ends, whichever is first.

Patients and Characteristics

All PH patients aged >18 years who were discharged with OPAT between 1 April and 30 June 2021 (cohort 2021) and 1 January and 30 March 2022 (cohort 2022) were included. The study periods reflect 2 time frames during the COVID-19 pandemic: when the OPAT team staffing was relatively stable (cohort 2021) and a period with maximal turnover (cohort 2022). Patients were identified from a telephone log that includes all patients who receive OPAT and is maintained by the OPAT pharmacist and nurses. If a patient had multiple OPAT treatment courses during the designated period, only the first OPAT course was included during the observed time frame. If a patient receiving OPAT was readmitted to the hospital and discharged with OPAT, this was considered a single OPAT course, including when the antimicrobial course was extended from the initially planned end date of therapy.

Data Collection

The electronic health record (Epic) was reviewed retrospectively to collect demographic, medical, and health care utilization information via a standardized instrument (Research Electronic Data Capture). Admissions to other facilities were captured if information was shared through the electronic health record. Data were collected by multiple reviewers (M. A., J. K. P., R. B.) and adjudicated by an ID faculty physician (L. M. C., T. M. P., M. A. L.). The study was approved by the University of Texas Southwestern Medical Center institutional review board and the Parkland research review committee, which granted a waiver of patient consent.

Statistical Analysis

The primary outcome was ED visits within 30 days of being discharged with OPAT, with secondary outcomes of readmissions

and VAD-related complications during OPAT. Demographic and other characteristics were analyzed and stratified by OPAT group and year (2021 vs 2022). Continuous variables (eg, age, hospital length of stay) were compared by analysis of variance and categorical variables (eg, gender, primary language) by the chi-square test or, where appropriate, Fisher exact test [8]. To determine independent risk factors for health care utilization between the 2021 and 2022 cohorts, a multivariable Cox proportional hazard model was employed. We used a 2-sided significance level ($\alpha = .05$) to detect any difference among the OPAT groups. Only statistically significant variables ($P < .05$) were added to the model. Statistical analyses were performed with R (R Foundation for Statistical Computing) and SPSS version 21 (IBM Corp). *P* values were 2-tailed, and $P \leq .05$ was considered statistically significant.

RESULTS

Of the 342 patients (Table 1), 186 (54%) received OPAT between 1 April and 30 June 2021 and 156 (46%) between 1 January and 31 March 2022. In 2021, 43.4% of patients received S-OPAT, 31.5% H-OPAT, and 25% SNF-OPAT, with similar numbers in 2022.

Baseline Characteristics of Patients

Overall the mean age was 54 years (SD, 14) and 111 patients (33%) were female (Table 1). The program serves a diverse population with 169 (51%) patients self-identifying as ethnically Hispanic. English was the most common language, spoken by 209 (62%) patients, with 36% having Spanish as their primary language. In 2021, 70% of patients evaluated by the OPAT team were discharged with OPAT, as compared with 62% in the 2022 cohort. Significantly more patients in the 2021 cohort had diabetes (58% vs 44%) and peripheral vascular disease (13% vs 6%) vs the 2022 cohort. Most patients were treated for a primary musculoskeletal infection (42%), followed by endovascular infection (39%).

When compared by OPAT model of care (Table 2), 51% of patients in SNF-OPAT carried a diagnosis of substance use disorder, as opposed to 7% in S-OPAT and 5% in H-OPAT ($P < .001$). There was a higher percentage of hemodialysis (37%, $P < .001$) in H-OPAT as compared with SNF-OPAT (2%) and S-OPAT (0%). Coronary artery disease (11%) and hypertension (34%) were more common among patients in the H-OPAT group. The S-OPAT group had more patients with genitourinary infection than the H-OPAT and SNF-OPAT groups ($P < .001$).

Health Care Utilization

The overall hospital length of stay was 13.2 days (SD, 11.5), which was 12.3 days in 2021 and rose to 14.3 days in 2022 (Table 3). The increase was primarily driven by a longer length of stay for patients receiving H-OPAT (10.9 days in 2021 vs 13.4 in 2022) and SNF-OPAT (16.9 days in 2021 vs 21.8 in 2022; Table 2).

Table 1. Patient Characteristics and Health Care Utilization

Characteristic	Total	2021	2022	*P* Value
Patients	342 (100)	186 (54.4)	156 (45.6)	
Age, y, mean (SD)	53.4 (13.9)	52.8 (13.8)	54 (14.0)	.428
Female	111 (32.5)	58 (31.2)	53 (34)	.575
Race				.267
White	228 (66.7)	129 (69.4)	99 (63.5)	
Black or African American	100 (29.2)	52 (28.0)	48 (30.8)	
Other	14 (4.1)	5 (2.7)	9 (5.8)	
Ethnicity: Hispanic or Latino	174 (51)	102 (54.8)	72 (46.5)	.12
Primary language				.234
English	210 (61.4)	109 (58.6)	101 (64.7)	
Spanish	122 (35.7)	73 (39.2)	49 (31.4)	
Other	10 (2.9)	4 (2.2)	6 (3.8)	
Comorbidities				
Diabetes mellitus	176 (51.5)	107 (57.5)	69 (44.2)	.014
Substance use disorder	61 (17.8)	32 (17.2)	29 (18.6)	.739
Chronic kidney disease	49 (14.3)	23 (12.4)	26 (16.7)	.258
End-stage renal disease on dialysis	44 (12.9)	22 (11.8)	22 (14.1)	.531
Peripheral vascular disease	35 (10.2)	25 (13.4)	10 (6.4)	.03
Current cancer	40 (11.7)	23 (12.4)	17 (10.9)	.674
Hypertension	181 (52.9)	106 (57)	75 (48.1)	>.99
Coronary artery disease	35 (10.2)	21 (11.3)	14 (9.0)	.482
HIV/AIDS	12 (3.5)	4 (2.2)	8 (5.1)	.152
Autoimmune disease	14 (4.1)	10 (5.4)	4 (2.6)	.274
OPAT diagnosis[a]				
Bone and joint infection	145 (42.4)	84 (45.2)	61 (39.1)	.259
Endovascular infection	131 (38.3)	77 (41.4)	54 (34.6)	.199
Skin and soft tissue infection	28 (8.2)	17 (9.1)	11 (7.1)	.483
Central nervous system infection	38 (11.1)	15 (18.1)	23 (14.7)	.05
Intra-abdominal infection	20 (5.8)	11 (5.9)	9 (5.8)	.955
Genitourinary infection	61 (17.8)	40 (21.5)	21 (13.5)	.053
Pulmonary infection	6 (1.8)	4 (2.2)	2 (1.3)	.692
Other	2 (0.6)	1 (0.5)	1 (0.6)	>.99

Data are presented as No. (%) unless noted otherwise.

Abbreviation: OPAT, outpatient parenteral antimicrobial therapy.

[a]Patients could have >1 diagnosis.

During the 2021 study period, 41 patients (22%) sought care in the ED while undergoing OPAT (Table 3), for a total of 63 visits with a range of 1 to 4 visits per patient. Of these, 19 (46%) were OPAT-related ED visits, and 22 (54%) were not related to OPAT issues. Thirty-eight patients (92%) visited the ED within 30 days of discharge, with no significant difference in the time to the first ED visit between cohorts (12.9 days in 2021 vs 13.2 in 2022, $P = .93$). In 2022, ED visits increased significantly ($P = .001$): 60 patients (38%) had 79 ED visits, of which 53 visits (88%) occurred within 30 days of discharge. Among these visits, 26 (43%) were related to OPAT and 34 (57%) were not related to OPAT. ED visits that were related to VADs (eg, dressing changes and dislodgement) accounted

Table 2. Patients' Characteristics and Outcomes Stratified by OPAT Groups

Characteristic	Total	SNF-OPAT	H-OPAT	S-OPAT	*P* Value
Patients	342 (100)	84 (24.6)	117 (34.2)	141 (41.2)	
Age, y, mean (SD)	53.4 (13.9)	54.8 (13.5)	55.3 (14.5)	50.9 (13.3)	.021
Female	111 (32.5)	20 (23.8)	37 (31.6)	54 (38.3)	.094
Race					<.001
White	228 (66.7)	43 (51.2)	72 (61.5)	113 (80.1)	
Black/African American	100 (29.2)	40 (47.6)	39 (33.3)	21 (14.9)	
Other	14 (4.1)	1 (1.2)	6 (5.1)	7 (5.0)	
Hispanic/Latino	174 (51)	22 (26.2)	48 (41.0)	104 (73.8)	<.001
Primary language					<.001
English	210 (61.4)	73 (87.0)	83 (70.9)	54 (38.3)	
Spanish	122 (35.7)	11 (13.1)	29 (24.8)	82 (58.2)	
Other	10 (2.9)	0 (0)	5 (4.3)	5 (3.5)	
Year					.679
2021	186 (54.4)	46 (54.8)	60 (51.3)	80 (56.7)	
2022	156 (45.6)	38 (45.2)	57 (48.7)	61 (43.3)	
Comorbidities					
Diabetes mellitus	176 (51.8)	39 (46.4)	63 (54.8)	74 (52.4)	.555
Substance use	58 (17.1)	43 (51.2)	5 (4.3)	10 (7.1)	<.001
Chronic kidney disease	49 (14.4)	11 (13.1)	25 (21.7)	13 (9.2)	.020
End-stage renal disease on dialysis	44 (12.9)	2 (2.4)	42 (36.5)	0 (0)	<.001
Peripheral vascular disease	35 (10.3)	7 (8.3)	15 (13.0)	13 (9.2)	.512
Current cancer	40 (11.8)	5 (6.0)	13 (11.3)	33 (23.4)	.090
Hypertension	181 (52.9)	46 (25.4)	73 (40.3)	62 (34.3)	.012
Coronary artery disease	35 (0.1)	14 (40)	17 (48.6)	4 (11.4)	.001
HIV/AIDS	12 (0.04)	5 (41.7)	5 (41.7)	2 (16.7)	.173
Autoimmune disease	14 (0.04)	2 (14.3)	6 (42.9)	6 (42.9)	.620
Infectious diseases diagnosis for OPAT[a]					
Bone and joint infection	144 (42.4)	41 (48.8)	47 (40.9)	56 (39.7)	.383
Endovascular infection	131 (38.5)	33 (39.3)	47 (40.9)	51 (36.2)	.787
Skin and soft tissue infection	28 (8.2)	8 (9.5)	13 (11.3)	7 (5.0)	.176
Central nervous system infection	37 (10.9)	14 (16.7)	11 (9.6)	12 (8.5)	.159
Intra-abdominal infection	20 (5.9)	3 (3.6)	4 (3.5)	13 (9.2)	.084
Genitourinary infection	61 (17.9)	6 (7.1)	16 (13.9)	39 (27.7)	<.001
Pulmonary infection	6 (1.8)	1 (1.2)	1 (0.9)	3 (2.1)	.435
Other	3 (0.9)	1 (1.2)	1 (0.9)	1 (0.7)	.145
2021					
Days, mean (SD)					
Hospital length of stay	12.3 (8.2)	16.9 (9.5)	10.9 (5.2)	10.7 (8.3)	<.001
Time to the first ED visit	12.9 (10)	14.2 (11.5)	9.8 (9)	15.4 (10.1)	.27
No. of patients	186 (100)	46 (25)	60 (31.5)	80 (43.5)	
ID consult prior to discharge	161 (87.5)	44 (95.6)	49 (84.4)	68 (85)	.155
Had ED visit	41 (22)	8 (17.4)	16 (26.7)	17 (21.3)	.437
Visited ED within 30 d	38 (20.7)	9 (15.2)	19 (25.9)	17 (20)	.429
Readmitted while undergoing OPAT	16 (8.7)	2 (4.3)	8 (13.8)	6 (7.5)	.494
ED visit/100 OPAT person-days					
Overall	1.41	0.22	0.56	0.63	.388
OPAT related	0.63	0.11	0.22	0.27	.240
2022					
Days, mean (SD)					
Hospital length of stay	14.3 (14.5)	21.8 (23.4)	13.4 (10.6)	10.4 (6.8)	.001
Time to the first ED visit	13.3 (12.8)	12.1 (6.8)	10.9 (14.7)	16.2 (12.8)	.383
No. of patients	156 (100)	38 (24.4)	57 (36.5)	61 (39.1)	
ID consult prior to discharge	142 (91)	34 (89.5)	54 (94.7)	54 (88.5)	.463
Had ED visit	60 (38.5)	16 (42.1)	19 (33.3)	25 (41)	.62
Visited ED within 30 d	53 (32.1)	16 (42.1)	16 (31.6)	25 (26.2)	.268
Readmitted while undergoing OPAT	28 (47.5)	9 (56.3)	7 (38.9)	12 (48)	.642

Table 2. Continued

Characteristic	Total	SNF-OPAT	H-OPAT	S-OPAT	*P* Value
ED visit/100 OPAT person-days					
Overall	2.11	0.51	0.79	0.81	.226
OPAT related	0.76	0.22	0.27	0.27	.617

Data are presented as No. (%) unless noted otherwise.

Abbreviations: ED, emergency department; H-OPAT, healthcare OPAT; ID, infectious diseases; OPAT, outpatient parenteral antimicrobial therapy; S-OPAT, self-administered OPAT; SNF-OPAT, skilled nursing facility OPAT.

[a]Patients could have >1 diagnosis.

Table 3. Health Care Utilization During OPAT

Type of Utilization	2021	2022	*P* Value
Days, mean (SD)			
Hospital length of stay	12.4 (8.2)	14.3 (14.5)	.138
Time to the first ED visit	12.9 (10.1)	13.2 (12.6)	.93
No. of patients	186	156	
ID consult before discharge	163 (87.6)	142 (91)	.315
ED visit	41 (22)	60 (38.5)	.001
Within 30 d	38 (20.4)	53 (34)	.01
OPAT related	19 (10.2)	26 (16.7)	.079
Non–OPAT related	22 (11.8)	34 (21.8)	.013
Readmitted with OPAT	16 (8.6)	28 (17.9)	.01
ED visit/100 OPAT person-days			
Overall	1.41	2.11	.460
OPAT related	0.63	0.76	.684

Data are presented as No. (%) unless noted otherwise.

Abbreviations: ED, emergency department; ID, infectious diseases; OPAT, outpatient parenteral antimicrobial therapy.

for 11 (58%) and 12 (46%) visits classified as OPAT related during the 2021 and 2022 time frames, respectively. Most notable was the significant increase in ED visits not deemed related to OPAT in 2022 ($P = .01$), a trend not witnessed among the ED visits related to OPAT ($P = .08$).

Hospital readmissions also rose significantly between the 2 years: from 8.6% in 2021 to 17.9% in 2022 ($P = .01$; Table 3), with the largest increases in the SNF-OPAT group (4.3% in 2021 vs 23.7% in 2022) and S-OPAT group (7.5% in 2021 vs 19.7% in 2022; Table 2).

Risk Factors

Risk factors for ED visits within 30 days, VAD-related complication, and readmissions were analyzed (Figure 1).

ED Visits Within 30 Days of Discharge With OPAT. Overall 89 patients visited the ED within 30 days of OPAT initiation. Patients with a history of an ED visit within the preceding 12 months had a significantly higher likelihood of visiting the ED within the 30-day time frame (hazard ratio [HR], 1.13; 95% CI, 1.01–1.25; $P = .03$) even when considering other patient demographics.

VAD-Related Complications. There were 39 VAD-related complications during the periods studied, with older patients being much more likely to experience a complication (HR, 1.04; 95% CI, 1.01–1.07; $P = .014$). Paradoxically, patients discharged on a higher number of medications were less likely to experience line-related complications (HR, 0.91; 95% CI, .84–.98; $P = .014$; Table 4).

Readmissions. A total of 44 patients were readmitted while undergoing OPAT. A significantly higher risk of readmission was noted among patients who had visited the ED within the preceding 12 months (HR, 1.18; 95% CI, 1.03–1.35; $P = .017$) and those who were receiving OPAT in 2022 (HR, 2.34; 95% CI, 1.22–4.49; $P = .01$; Table 4).

DISCUSSION

In our well-established OPAT program at PH, health care utilization—specifically length of stay, ED utilization, and readmissions—rose among patients receiving OPAT, for reasons not related to OPAT. This increase was presumably due to higher staff turnover and attrition among the OPAT team. Our findings are important because of the lack of well-defined standards for the optimal patient-to-personnel ratios for OPAT programs, which are critical mechanisms to transition care. In health care, decreases in staffing have been associated with increased safety failures and higher mortality, some of which were well documented during the COVID-19 pandemic [9, 10].

When compared with 2021, the number of ED visits and readmissions rose significantly during 2022, driven primarily by the number of non–OPAT-related ED visits and readmissions. Our findings are not unique, and other OPAT programs have described this phenomenon [11], though the specific reasons for the increases are not clearly captured. Pragmatically, OPAT personnel help patients navigate the health care system, ensuring timely follow-up care with other services and providers (diabetes, surgery, interventional radiology, etc) [12]. In our case, higher staff turnover decreased some of the hidden but critical coordinating care not related to OPAT but frequently done in context with OPAT care. This "value added" activity is particularly crucial in the safety net setting, where patients experience multiple barriers to health care because of poor health literacy, language barriers, financial insecurity, lack of transportation, among other reasons.

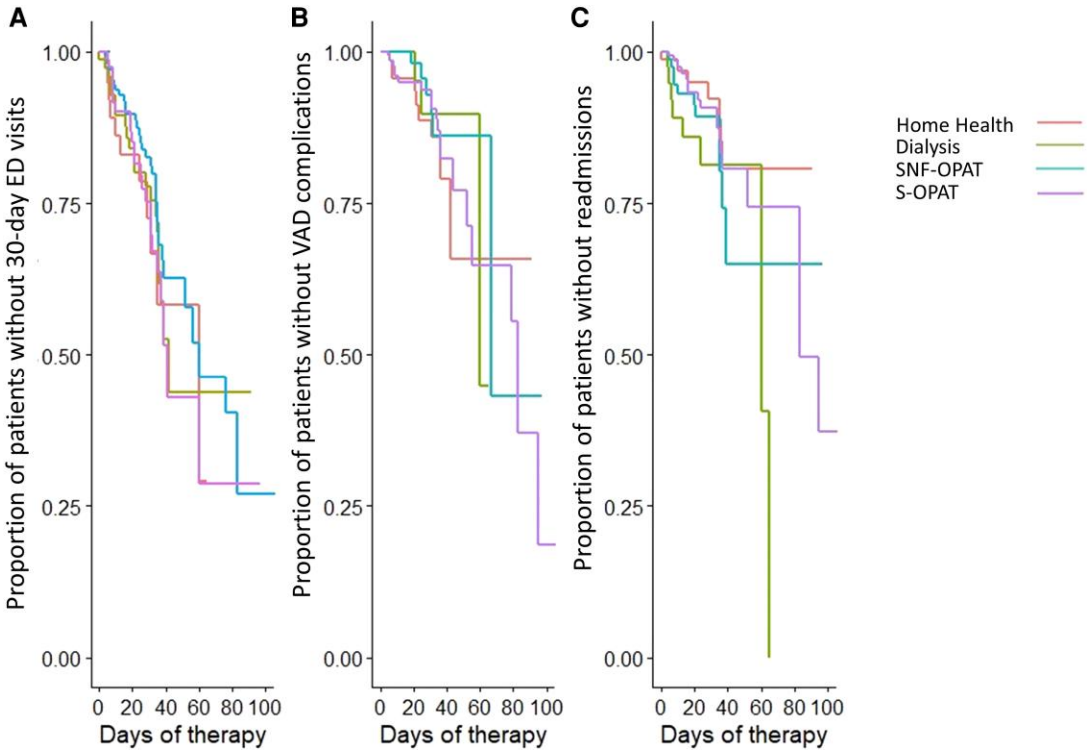

Figure 1. Survival curves demonstrate OPAT outcomes over time via a Cox proportional hazards model. The lines reflect where OPAT was delivered: self-administered (S-OPAT); skilled nursing facility (SNF-OPAT); hemodialysis OPAT; and home health administered OPAT. *A*, Proportion of patients free of ED visits within 30 days of OPAT. *B*, Proportion of patients free of VAD-related complications. *C*, Proportion of patients free of readmissions while undergoing OPAT. ED, emergency department; OPAT, outpatient parenteral antimicrobial therapy; VAD, vascular access device.

Staffing issues and the impact on patient care include more than nursing. Similar to nurses in the hospital setting, a staffing ratio for ID pharmacists in OPAT has been proposed [13]. Furthermore, in OPAT settings the ideal staffing for nursing, care coordination, and physicians or provider support has not been determined. While attrition of nursing personnel would directly affect our S-OPAT patients, presumably the effect of shortages in nursing staff at home health agencies [14, 15] and skilled nursing facilities [16] would have repercussions for patients receiving OPAT in other settings, including the H-OPAT and SNF-OPAT models of care. We did not examine patient experiences, but poorer patient outcomes were described during the COVID-19 pandemic—ones thought to be related to changes in patient-staff ratios, staff education, and staff familiarity with settings in even well-resourced hospitals [17].

Finally, ID consultation and early ID follow-up have been shown to decrease rates of readmission among OPAT patients [18–20] and have been proposed as an ID-driven quality metric. In our program, >87% of patients receiving OPAT had an ID consultation, with no significant difference between the cohorts in 2021 and 2022.

Among OPAT-related reasons for ED visits, 46% to 58% were related to VAD issues, which has led us to reexamine the services that our patients can access in the ambulatory setting, including the availability of an outpatient vascular access team. These data are supportive of a qualitative study that found that OPAT is anxiety provoking to patients and that having staff take the time to educate and support them would alleviate these feelings [21]. Beyond patient care, services including the number of patients evaluated for OPAT and eventually discharged with OPAT decreased from 70% in 2021 to 62% in 2022, which likely relates to decreased staffing of the OPAT team. For example, several patients eligible for OPAT were not discharged, due to a reduction in the number of nurses to teach patients how to self-administer IV antibiotics or to a lack of care coordinators to set up OPAT. The care coordination team faced challenges placing patients, due to difficulty in securing SNF beds or home health agencies that could accept patients during this period. For all these reasons, enhancing staffing, outreach, and educational efforts for patients is critical, and our focus is to improve transition to the ambulatory setting.

On a theoretical level, it is important to develop OPAT-specific measures that reflect the care provided by an OPAT team. These measures should reflect the size of an OPAT program beyond the number of patients discharged with OPAT annually or weekly. To reflect the burden of this care and to

Table 4. Risk Factors Associated With ED Visits Within 30 Days, VAD-Related Complications, and Readmissions for Patients Receiving OPAT

	Hazard Ratio	95% CI	*P* Value
ED visit within 30 d			
Primary language			.870
English	1 [Reference]		
Spanish	0.810	.488–1.345	.415
Other	1.332	.393–4.515	.645
Age	1.010	.993–1.027	.259
Total medications upon discharge	0.993	.952–1.035	.732
Year			
2021	1 [Reference]		
2022	1.756	1.130–2.728	.012
No of hospitalizations within 12 mo prior to OPAT	1.127	1.014–1.252	.027
VAD-related complications			
Primary language			.699
English	1 [Reference]		
Spanish	0.778	.362–1.673	.521
Other	1.583	.191–13.131	.671
Age	1.036	1.007–1.066	.014
Total medications upon discharge	0.906	.838–.980	.014
Year			
2021	1 [Reference]		
2022	1.885	.943–3.768	.073
No. of hospitalizations within 12 mo prior to OPAT	1.152	.942–1.409	.168
Readmission			
Primary language			.545
English	1 [Reference]		
Spanish	1.250	.689–3.426	.539
Other	2.243	.669–16.818	.306
Age	1.007	.982–1.033	.566
Total medications upon discharge	0.974	.893–1.026	.407
Year			
2021	1 [Reference]		
2022	2.340	1.219–4.493	.011
No. of hospitalizations within 12 mo prior to OPAT	1.180	1.030–1.352	.017

Abbreviations: ED, emergency department; OPAT, outpatient antimicrobial therapy; VAD, venous access device.

The types of antibiotics prescribed to the patients were also included in the model, but they were not significant for all outcome variables: ED visits within 30 days ($P = .302$), VAD-related complications ($P = .303$), and readmission ($P = .484$).

ensure the value-added elements of care that do affect safety, other aspects of care need to be considered. For example, the duration of OPAT can influence outcomes for a program [22]. To try to capture additional aspects of OPAT care and standardize this in a measure, we looked at the number of ED visits and readmissions per 100 days of OPAT therapy. Although both measures rose during 2022, the increase was not statistically significant, likely reflecting our sample size. Nevertheless, this provided us with an adjustment that may prove important moving forward.

Our study has limitations in that it was an observational study with a limited sample size and did not include direct measures of severity of illness or comorbidities. We attempted to address some of these limitations by including the total number of medications prescribed at discharge as a surrogate for the number and intensity of comorbidities [23, 24]. While there were differences in comorbidities between the care models—such as greater substance use disorder among patients in SNF, increased hemodialysis among H-OPAT, and more genitourinary infections among S-OPAT patients—these differences are explained by pragmatic considerations: the inability to discharge patients with substance use disorder to a less supervised setting at home, convenient dosing of IV antibiotics after hemodialysis, and the need for IV antibiotics to treat antimicrobial-resistant organisms in patients with pyelonephritis. Importantly, we found no statistically significant differences in comorbidities when examined by year of discharge, except for an increase in diabetes mellitus and peripheral vascular disease in the 2021 cohort, when the program was fully staffed and hence unlikely to explain our results. Additionally, we were unable to include standard measures of social determinants of health that are important considerations when examining increased health care utilization [25]. That said, the patients served by our hospital have similar social and economic circumstances, and we do not think that these social determinants of health changed over the 2 periods studied. While the relatively large OPAT program is a strength of the study, we sampled a subset of patients in the 2 years studied, which may have limited our ability to directly compare outcomes in multiple care models. Furthermore, we used data from the electronic health record rather than from insurance claims, and we may have missed health care utilization (ED visits and hospitalizations) that occurred outside our system despite reviewing our records for non-PH encounters.

As health care continues to move toward more cost-conscious, value-based care, our experience supports the need for appropriate infrastructure and resources to achieve these goals. OPAT can reduce length of stay, readmissions, and ED visits [2, 3, 12], although recent data demonstrate the need for appropriate infrastructure and an expert multidisciplinary team to best support state-of-the-art practice [26]. Furthermore, OPAT may be a model for fee-for-value compensation, especially with care moving into ambulatory and nontraditional settings [27, 28]. Our experience shows that the benefits of OPAT can be adversely affected by disruptions or decreased staffing of these multidisciplinary teams, which could also lead to greater health care utilization. There are currently few metrics that reflect the quality of care provided by an individual ID practitioner [29]. While OPAT-related outcomes could have potential as ID-specific quality metrics, the impact of care delivery processes potentially outside the direct control of the ID practitioner should be considered when developing these metrics.

We found a higher-than-expected increase in health care utilization (length of stay, number of ED visits, and hospital readmissions) in a well-established OPAT program. Our data suggest that disruptions in staffing may have contributed to these trends in services needed. We also identified opportunities to enhance ambulatory services that may alleviate the need for an ED visit by an OPAT patient. Importantly the increases in readmissions that were not related to OPAT may point to the role that OPAT plays in engaging patients in other needed care. While these findings are interesting, further research is needed to better define how to measure OPAT "work" and specific quality metrics, what staffing is critical, and what the consequences are of less robust staffing.

Notes

Acknowledgments. We thank the dedicated PH-OPAT staff and ID pharmacists who have thanklessly supported these patients over the years.

Patient consent statement. The design of this work was approved by the University of Texas Southwestern Medical Center institutional review board and the Parkland research review committee, which granted a waiver of patient consent.

Potential conflict of interest. All authors: No reported conflicts.

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