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The Impact of an Infectious Diseases Transition Service on the Care of Outpatients on Parenteral Antimicrobial Therapy

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Abstract

Background—Many hospitalized patients with complicated infections are discharged on outpatient parenteral antimicrobial therapy (OPAT). However, little is known about how to improve the postdischarge care of OPAT patients.

Objective—The impact of an infectious diseases transitions service (IDTS) on OPAT patient readmissions, as well as on processes of care, was evaluated.

Methods—We performed a controlled, quasi-experimental evaluation over 15 months in an academic medical center. Intervention-arm patients, before and after the introduction of an IDTS, were seen by the general infectious diseases consult teams, while control-arm patients (discharged on OPAT after hospitalization with bacteremia) were not. The IDTS prospectively tracked all OPAT patients and coordinated follow-up. The impact of the IDTS was calculated using a differences-in-differences approach where the interaction between time (before vs after the IDTS intervention) and study arm (intervention vs control arm) was the variable of interest. The control arm was used only in primary outcome analyses (readmissions and emergency department visits). Secondary outcomes included process of care measures and non-readmission clinical outcomes.

Results—Of 488 consecutive patients requiring OPAT, 362 were in the intervention arm (215 pre-intervention and 147 post-intervention) and 126 in the control arm (70 pre-intervention and 56 post-intervention). Compared to the control arm, the IDTS was not associated with changes in 60-day readmissions and/or emergency department visits (adjusted odds ratio [OR] = 0.48; 95% confidence interval [CI] = 0.13–1.79). In the intervention arm, implementation of the IDTS was associated with fewer antimicrobial therapy errors (OR = 0.062; 95% CI = 0.015–0.262), increased laboratory test receipt (OR = 27.85; 95% CI = 12.93–59.99), and improved outpatient follow-up (OR = 2.44; 95% CI = 1.50–3.97).

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Authors' Note

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Declaration of Conflicting Interests

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Conclusions—In a controlled evaluation, the IDTS did not affect readmissions despite improving process of care measures for targeted patients. Care coordination services may improve OPAT quality of care, but their relationship to readmissions is unclear.

Keywords

outpatient parenteral antimicrobial therapy; OPAT; care coordination; readmissions; antimicrobial therapy; home health

Introduction

Since the 1970s, many patients initiating long-term parenteral antimicrobials in acute care settings have completed their regimens after discharge: in skilled nursing facilities, at home with assistance from home health agencies, in hemodialysis units, and in outpatient infusion centers.^{1–3} While outpatient parenteral antimicrobial therapy (OPAT) is a low-cost alternative to acute inpatient care,⁴ up to 35% of OPAT patients experience readmissions or therapy-related adverse events.^{5–13} Guidelines recommend that mul-tidisciplinary teams closely monitor OPAT patients with clinical examination and weekly laboratory testing.^{14–16}

Transitions from inpatient to outpatient care pose challenges: discharge prescriptions frequently contain errors,^{17–21} and laboratory test results are missing in up to 63% of discharged patients.^{22–24} However, little is known about antimicrobial prescribing errors, missing laboratory results, and missed follow-up appointments in OPAT patients. Furthermore, while predischARGE multidisciplinary teams have been associated with more appropriate antimicrobial prescribing in patients discharged on OPAT,^{14,25–27} little is known about what care practices after discharge improve OPAT patient outcomes. In particular, there are limited published evaluations on the role that postdischarge multidisciplinary care coordinating services may play in clinical outcomes and on process of care measures in patients discharged on OPAT. Understanding how to improve discharge care transitions is particularly important in an era where readmissions are tied to reimbursement.²⁸

The current study evaluates the impact of a postdischarge team including infectious diseases (ID) pharmacists, physicians, and nurses on readmissions and emergency department (ED) visits, as well as on avoidable medication and monitoring errors, in an OPAT population.

Methods

Study Population

A controlled, quasi-experimental study measured the effect of a postdischarge care coordination team, the infectious diseases transitions service (IDTS), on the care of patients in an OPAT program. Data were collected on patients in an intervention arm and in a control arm. The intervention arm included those for whom the Hospital of the University of Pennsylvania inpatient ID consult services had recommended OPAT, and were discharged on OPAT between April 1, 2011, and December 11, 2011 (pre-intervention period), or between December 12, 2011, and June 30, 2012 (post-intervention period). Patients who planned to follow with a non-health system physician and those with hematologic

malignancies, HIV, or solid organ transplants (for whom other care coordination services were in place) were excluded. Control arm patients were identified through surveillance for positive blood cultures among hospitalized patients, and included those discharged on OPAT without ID consultation during these same pre-intervention and post-intervention periods. If patients required OPAT after more than 1 hospitalization, only data from the first hospital discharge were included. It was hypothesized that these patients were more accustomed to OPAT, so would be less likely to suffer an adverse event or readmission after the second hospitalization, thus creating bias.

Data Sources

All information was gathered from inpatient and outpatient medical records in the University of Pennsylvania Health System (UPHS). Data were collected during a 60-day period after the index discharge. Retrospective chart reviews were performed 60 days after discharge by an ID fellow, ID pharmacist, and medical student research assistant, all of whom were trained on use of a data collection tool. Twenty randomly selected charts assigned to each data collector were reviewed by a second data collector (60 charts overall). Interrater reliability was calculated via κ scores across the 3 raters, and ranged from .80 to 1.00.

Intervention

Prior to the intervention of the IDTS, among intervention-arm patients, the ID consult service recommended an antimicrobial course and plan of care to the inpatient primary team and to ID clinic administrative assistants (Appendix Figure 1A). The inpatient primary team then arranged placement of central venous catheters, wrote prescriptions for OPAT and laboratory monitoring, and referred the patient to a provider of OPAT supplies (skilled nursing facility, home health agency, hemodialysis facility, or outpatient infusion center). After discharge, ID clinic staff forwarded laboratory results to the ID clinic provider, if received, and scheduled follow-up appointments if the patient requested. The ID clinic did not verify receipt of the proper antimicrobial therapy, proactively assist patients in scheduling follow-up appointments, or ensure receipt of laboratory tests.

The IDTS, comprising ID specialty pharmacists, ID physicians, nurses, and a research assistant, was implemented on December 12, 2011, among intervention-arm patients. After discharge, an ID pharmacist or ID physician contacted both the provider of OPAT supplies and the patient to verify receipt of the requested antimicrobial therapy, laboratory test orders, and follow-up appointments in the ID clinic (Appendix Figure 1B). Laboratory tests were obtained weekly for each patient for the duration of OPAT. If test results were not received, IDTS members called for the results. If abnormal laboratory values were present, IDTS members discussed the results and created a management plan with the ID faculty assigned to follow the patient. The IDTS followed patients through completion of OPAT.

Variable Definitions

Primary outcome—Readmissions, ED visits, and mortality data were collected on intervention and control arm patients. Primary outcome data included readmissions and/or ED visits in UPHS within 60 days of discharge, as this would encompass the typical course

of OPAT in the vast majority of patients. The occurrence of a readmission and/or ED visit was recorded.

Secondary clinical outcomes—As secondary clinical outcomes, readmissions and/or ED visits in UPHS were recorded both within 7 days of discharge and within 30 days of discharge among all patients. Deaths within 60 days of discharge were also recorded.

Additional secondary clinical outcome measures (adverse antimicrobial events, catheter complications, infection relapse, and *Clostridium difficile* infections) were collected on intervention-arm patients only as these were unreliably documented in control-arm patients. An adverse antimicrobial event was defined as a postdischarge event thought secondary to an antimicrobial agent that resulted in a change in the antimicrobial agent (ie, rash, diarrhea, myositis, nephrotoxicity, hepatotoxicity). Catheter complications included the inadvertent removal of a catheter, a catheter-related venous thrombosis, or a catheter-related infection. Infection relapses included surgery for debridement, increase in size of an abscess or phlegmon, or recurrent positive cultures. *C difficile* infection was defined as a positive polymerase chain reaction for *C difficile* on a stool specimen in a patient with documented diarrhea.

Secondary process of care measures—Secondary data analyses were also performed on process of care measures among intervention-arm patients only. Antimicrobial prescribing errors were defined as differences between the antimicrobial agent written on the discharge summary and the ID consult service's charted management plan. Receipt of laboratory test results was defined as documentation of any requested laboratory tests being received by any member of the ID outpatient clinic in the first week after discharge. Follow-up was defined as completing a follow-up appointment with an ID provider within 60 days of discharge.

Covariates—Covariates of interest included days between ID consult signoff and patient discharge (coded as a continuous variable), primary service at discharge (coded as medical or surgical), provider of OPAT services (categorized as home health agency, skilled nursing facility, hemodialysis facility, or outpatient infusion center), gender, age (categorized a priori as a dichotomous variable at age 65, as few Medicare plans covered home-based OPAT), location of infection (coded as a categorical variable), antimicrobial agent prescribed (coded as a categorical variable), and number of antimicrobial agents prescribed (coded as a continuous variable).

Data Analysis

Chi-square and ANOVA tests, as appropriate, were used to compare differences between pre-intervention period intervention arm, post-intervention period intervention arm, pre-intervention period control arm, and post-intervention period control arm groups. For secondary analyses in the intervention group, descriptive statistics showed the prevalence of process of care measures and secondary clinical outcomes.

The primary statistical test of interest was a multivariate regression analysis investigating the effect of the interaction between study arm and timing of discharge (pre-intervention or

post-intervention) on the primary outcome (readmission and/or ED visit within 60 days of discharge) and on the secondary readmission outcomes (readmission and/or ED visit within 7 days of discharge, or within 30 days of discharge). Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) reported the effect of the IDTS by incorporating the interaction term along with the covariate for the intervention itself. Covariates considered for inclusion in the multivariate models included days between signoff and discharge, primary service at discharge, provider of OPAT services, age, gender, location of infection, antimicrobial agent prescribed, and number of antimicrobial agents. Covariates were included in the models if they were associated with a 10% change in the point estimate.

In the intervention group only, logistic regression analysis was used to determine relationships between inpatient primary service, provider of OPAT supplies, time between signoff and discharge, and the presence of the IDTS with secondary process of care measures and clinical outcomes.

Although this was a pilot study, it was estimated that to see a 15% decrease in the primary outcome, 172 patients would be needed in both the intervention arm and the control arm.

The study was approved by the University of Pennsylvania Institutional Review Board.

Results

The study included 362 patients in the intervention arm (215 pre-intervention period and 147 post-intervention period) and 126 in the control arm (70 pre-intervention period and 56 post-intervention period; see Table 1). Most received OPAT from a home health agency. Intervention-arm patients were more likely to be discharged from surgical services than control-arm patients were. Penicillins were prescribed more frequently in the intervention arm than in the control arm. However, cephalosporins were prescribed more frequently in the control arm than in the intervention arm (see Table 1).

Overall, 40.8% of patients experienced either a readmission and/or ED visit within 60 days of discharge (among the intervention arm: 38.1% during the pre-intervention period and 27.9% during the post-intervention period; among the control arm: 50.0% during the pre-intervention period and 28.6% during the post-intervention period; Table 2). During the pre-intervention period, 12.1% of intervention-arm patients had an infection relapse, and 11.6% had a catheter complication. Pre-intervention, laboratory test results were received on only 35.8% of intervention-arm patients, and 18.1% of patients experienced an antimicrobial prescribing error.

The relationships between the IDTS and readmission and/or ED visit outcomes in intervention and control arms were examined. While 60-day readmissions and/or ED visits decreased after the IDTS, these outcomes also decreased over time in the control arm (Figure 1). Adjusting for gender, age, provider of OPAT services, primary service at discharge, location of infection, antimicrobial agent prescribed, and number of antimicrobial agents, there was no relationship between the presence of the IDTS and the endpoint of readmission and/or ED visit at 60 days (see Table 3; adjusted OR = 0.48; 95% CI = 0.13–1.79). Similar results were observed for 7-day and 30-day readmissions and/or ED visits.

Table 4 displays predictors of process of care measures in the intervention arm only. Receiving OPAT from a home health provider was associated with an increased likelihood of receipt of laboratory test results (OR = 2.35; 95% CI = 1.51–3.65) and of follow-up (OR = 2.57; 95% CI = 1.56–3.89). Being discharged from a medical service was associated with a lower likelihood of follow-up (OR = 0.54; 95% CI = 0.34–0.87). For each day between ID inpatient consult team signoff and hospital discharge, there was a decreased likelihood of receipt of laboratory test results (OR = 0.93; 95% CI = 0.89–0.97) and of follow-up (OR = 0.93; 95% CI = 0.89–0.97). After adjusting for covariates (as described in Table 4), the IDTS was associated with decreased antimicrobial prescribing errors (OR = 0.062; 95% CI = 0.015–0.262), increased receipt of laboratory test results (OR = 27.85; 95% CI = 12.93–59.99), and increased follow-up (OR = 2.44; 95% CI = 1.50–3.97).

Discussion

The present study is one of the first to investigate the effect of a multidisciplinary postdischarge care coordination service, the IDTS, on readmissions and ED visits, clinical outcomes, and process of care measures among OPAT patients in an academic ID clinic. When compared with a separate, time-matched control group of patients discharged on OPAT, the IDTS was not associated with a significant decrease in the primary outcome of readmissions and/or ED visits within 60 days of discharge. Instead, both groups experienced a decline in this measure over the study period. However, the IDTS was associated with improvements in receipt of laboratory test results, patient follow-up, and antimicrobial prescribing errors. In general, during the 60-day period after hospital discharge, antimicrobial-related adverse events, catheter complications, and infection relapse were common, as were readmissions.

The IDTS was not associated with a decrease in the read-mission and/or ED visit measure. When compared with a time-matched control group, there was no measurable impact of the intervention above that of general hospital trends. These trends included an intense hospital-wide focus on preventing readmissions, through interventions such as unit-based quality improvement teams, system-wide quality improvement training sessions, and attempts to streamline the discharge process.

However, the IDTS was associated with improvements in process of care measures. Prior to the intervention, 18.1% of discharges contained an antimicrobial prescribing error. Other studies have shown that up to 33% of hospitalized patients had at least 1 chronic medication mistakenly discontinued at hospital discharge,^{17–20} and these errors are especially common in the transition from hospital to nursing home, as many study patients experienced.²⁷ Furthermore, the ID clinic received laboratory test results on only a minority of patients prior to the IDTS. Other studies have also shown that many test results pending at the time of discharge are not received by the covering physician.^{23,24} Finally, prior to the intervention, few patients followed up with the ID clinic. After the IDTS, these process of care measures improved. While we could not control for process outcomes due to the lack of documentation of these outcomes among control-group patients, the process of care improvements are more specific to the IDTS intervention and are likely related to the

intervention. Care coordination through services such as the IDTS may help with decreasing these errors.

To our knowledge, although other studies have shown that predischARGE ID teams preparing patients for OPAT have lowered costs and improved antimicrobial prescribing,^{14,25–27} this is the first study to focus on the postdischarge care coordination of OPAT patients. Postdischarge care coordination services in other patient populations have led to decreases in health services utilization and costs but have had mixed results in preventing readmissions.^{29–33} This is also one of the few studies of care coordination services among OPAT patients to involve physicians as well as nurses and ID specialty pharmacists to focus on adverse events in the real-world setting of OPAT and to describe process of care measures among OPAT patients.

The study was subject to certain limitations. The intervention focused on patients seen by the ID consult services and did not follow patients with hematologic malignancies, solid organ transplants, or HIV as these populations already had care coordination services in place. It is unclear how the intervention would have affected these groups.

Furthermore, control-arm patients may have differed from intervention-arm patients. First, not all patients discharged on OPAT received ID consultation. Those who received ID consultation (and so were included in the intervention group) could have been more complex than those who did not (and so were included in the control group). Second, as we screened for control-arm patients by surveillance for positive blood cultures, all of the control-arm patients had bacteremia, while only 13.6% of the intervention-arm patients had bacteremia. Bacteremic patients could have differed from patients receiving OPAT for other indications, by receiving shorter courses of therapy, for example. Third, at the study institution, medicine services often prescribed OPAT for bacteremic patients without ID consultation (making these patients eligible for the control group), while surgical services rarely did so. While the control arm may have differed from the intervention arm, the secular trend of decreased readmissions in the control arm was important in understanding trends in the health care environment and in making valid conclusions about readmissions.

The study contained other limitations as well. The study may have been underpowered to show the effect of the IDTS on the primary readmission/ED visit outcome. Also, after the IDTS, the general ID consult services followed OPAT patients until closer to discharge. It would be difficult to extricate the relationship between following patients until just prior to discharge from the presence of the IDTS. Data were not collected on which laboratory test results were received, as laboratory testing guidance was available only for certain indications and certain antimicrobial agents.¹⁴ Instead, laboratory tests were requested based on recommendations from the covering provider. Data were also not collected on secondary clinical outcomes among the control-arm patients as these were inconsistently documented among the control-arm patients. To have included these data would have underestimated the prevalence of non-readmission clinical outcomes among the control group. Finally, the intervention only focused on patients at one tertiary-care, academic medical center and may not be applicable to other settings.

This study is one of the first to focus on predictors of OPAT quality of care as well as the impact of an ID care coordination service on OPAT clinical outcomes and process of care measures. In the absence of structured care coordination, many laboratory test results were not received, many discharge instructions included antimicrobial prescribing errors, and many patients did not attend follow-up appointments. Although these processes of care measures improved in the targeted patient group, the intervention did not reduce readmissions and/or ED visits beyond that of baseline hospital trends. As hospital reimbursement is now tied to reducing readmissions, improving the care coordination of OPAT patients is increasingly important.

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Appendix

Figure 2. Workflow of monitoring of OPAT patients pre-intervention and post-intervention

Prior to the IDTS (Appendix Figure A), the ID clinic had no coordinated way to ensure that laboratory test results were received, that the proper antimicrobial agent was prescribed, or that the patient knew to follow-up with the ID clinic. After the IDTS (Appendix Figure B), a team of ID specialty pharmacists, ID physicians, and nurses contacted the patient, home health agency, and skilled nursing facility after discharge to ensure laboratory tests were properly ordered, that the antimicrobial agent was properly prescribed, and that follow-up had been arranged. The IDTS looked for laboratory test results weekly and contacted facilities when these results were missing. The IDTS also served as the primary contact for OPAT patients who may have experienced adverse events related to OPAT. The IDTS followed patients on OPAT through the end of therapy.

Abbreviations: OPAT, outpatient parenteral antimicrobial therapy; ID, infectious diseases; IDTS, infectious diseases transitions service.

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Figure 1.

Percentage of patients having a readmission and/or emergency department (ED) visit within 60 days of hospital discharge, in the intervention and control groups, plotted by month, as a graphical representation of the differences-in-differences approach. The infectious diseases transitions service (IDTS) intervention was implemented on December 12, 2011, as indicated by the vertical line. In the intervention group, after the IDTS intervention, the percentage of patients having a readmission and/or ED visit within 60 days of discharge decreased over time. However, after the intervention, this percentage also decreased over time in the control group.

Table 1

Characteristics of the Population, Including 362 Intervention Arm Patients and 126 Control Arm Patients.^a

Characteristic	Total (N = 488)	Intervention Arm		Control Arm		P Value
		Pre-Intervention (N = 215)	Post-Intervention (N = 147)	Pre-Intervention (N = 70)	Post-Intervention (N = 56)	
Female gender	193, 40.0%	86, 40.0%	67, 45.6%	22, 31.4%	18, 32.1%	.074
Age (mean, SD)	56.4, 16.0	55.9, 16.1	56.7, 17.3	58.1, 13.6	54.7, 14.7	.738
Provider of OPAT						
Home health agency	291, 59.7%	123, 57.2%	90, 61.2%	43, 61.4%	35, 62.5%	.638
Skilled nursing facility	179, 36.8%	86, 40.0%	53, 36.1%	24, 34.3%	16, 28.6%	.851
Other ^b	17, 3.48%	5, 2.33%	4, 2.72%	3, 4.29%	5, 8.93%	.851
Primary service						
Surgical	247, 50.6%	140, 65.1%	94, 63.9%	6, 8.57%	7, 12.5%	<.001
Medical	224, 45.9%	65, 30.2%	50, 34.0%	62, 88.6%	47, 83.9%	.001
Other ^c	17, 3.48%	10, 4.65%	3, 2.04%	2, 2.86%	2, 3.57%	.999
Days between signoff and discharge (mean, SD) ^d	4.23, 5.40	4.86, 5.61	3.30, 4.98	—	—	.0069
Number of antimicrobial agents						
1	399, 81.8%	176, 81.9%	108, 73.5%	64, 91.4%	51, 91.1%	.25
2	77, 15.8%	37, 17.2%	31, 21.1%	5, 7.14%	4, 7.14%	.25
3	12, 2.46%	2, 0.93%	8, 5.44%	1, 1.43%	1, 1.79%	.25
Indication for OPAT ^d						
Bacteremia	175, 35.9%	29, 13.5%	20, 13.6%	70, 100%	56, 100%	.974
Osteomyelitis or septic arthritis	111, 22.7%	68, 31.6%	43, 29.3%	—	—	.163
Endocarditis or vascular	82, 16.8%	54, 25.1%	28, 19.0%	—	—	.607
Neurologic infection	50, 10.2%	27, 12.6%	23, 15.6%	—	—	.403
Abdominal abscess	36, 7.38%	23, 10.7%	13, 8.84%	—	—	.563
Lung abscess or empyema	15, 3.07%	6, 3.79%	9, 6.12%	—	—	.118
Skin or soft tissue abscess or cellulitis	19, 3.89%	8, 3.72%	11, 7.48%	—	—	.062
Antimicrobial agent						

Characteristic	Intervention Arm			Control Arm		P Value
	Total (N = 488)	Pre-Intervention (N = 215)	Post-Intervention (N = 147)	Pre-Intervention (N = 70)	Post-Intervention (N = 56)	
Vancomycin	185, 37.8%	88, 40.9%	58, 39.5%	27, 38.6%	12, 21.4%	.644
Penicillins ^e	148, 30.3%	77, 35.8%	45, 30.6%	11, 15.7%	15, 26.8%	.015
Cephalosporins ^f	124, 25.4%	41, 19.1%	32, 21.8%	28, 40.0%	23, 41.1%	<.001
Carbapenems ^g	25, 5.12%	10, 4.65%	12, 8.16%	0, 0.00%	3, 5.36%	.083
Aminoglycosides ^h	23, 4.71%	12, 5.58%	8, 5.44%	2, 2.86%	1, 1.79%	.544
Daptomycin	18, 3.67%	6, 2.79%	7, 4.76%	1, 1.43%	4, 7.14%	.409
Antifungal agent ⁱ	17, 3.48%	9, 4.19%	2, 1.36%	4, 5.71%	2, 3.57%	.344
Other agent ^j	7, 1.43%	4, 1.86%	2, 1.36%	1, 1.43%	0, 0.00%	.496

Abbreviations: OPAT, outpatient parenteral antimicrobial therapy; SD, standard deviation.

^a Chi-square and ANOVA tests, as appropriate, were used to demonstrate differences between groups (pre-intervention period intervention arm, post-intervention period intervention arm, pre-intervention period control arm, and post-intervention period control arm). ANOVA was used for continuous variables, whereas χ^2 analyses were used for categorical variables.

^b Other sources of OPAT: prison, left against medical advice, outpatient infusion agency, and hemodialysis facility.

^c The inpatient service primarily caring for the patient at the time of discharge. Other primary services include gynecology or obstetrical services, dental or oral surgery services, and neurology services.

^d P value is for intervention group only.

^e Penicillins prescribed in this study included penicillin, ampicillin, ampicillin-sulbactam, nafcillin, and piperacillin/tazobactam.

^f Cephalosporins prescribed in this study included cefazolin, cefoxitin, ceftriaxone, and cefepime.

^g Carbapenems prescribed in this study include imipenem, meropenem, and ertapenem.

^h Aminoglycosides prescribed in this study included gentamicin, streptomycin, tobramycin, and amikacin.

ⁱ Antifungal agents prescribed in this study included liposomal amphotericin and caspofungin.

^j Other antimicrobial agents used in the study included aztreonam, foscarnet, and tigecycline.

Table 2

Clinical Outcomes Within 60 Days of Discharge in the Intervention Including 362 Intervention-Arm Patients and 126 Control-Arm Patients.^a

Characteristic	Total (N = 488)	Intervention Arm		Control Arm	
		Pre-Intervention (N = 215)	Post-Intervention (N = 147)	Pre-Intervention (N = 70)	Post-Intervention (N = 56)
Readmitted or ED visit, 60 days	199, 40.8%	82, 38.1%	41, 27.9%	35, 50.0%	16, 28.6%
Readmitted, 60 days	163, 33.4%	75, 34.9%	39, 26.5%	33, 47.1%	16, 28.6%
ED visit, 60 days	117, 24.0%	55, 25.6%	27, 18.4%	23, 32.9%	12, 21.4%
Readmitted or ED visit, 30 days	135, 27.7%	65, 30.2%	32, 21.8%	26, 37.1%	12, 21.4%
Readmitted, 30 days	123, 25.2%	58, 27.0%	28, 19.1%	25, 35.7%	12, 21.4%
ED visit, 30 days	92, 18.9%	44, 20.5%	23, 15.7%	15, 21.4%	10, 17.9%
Readmitted or ED visit, 7 days	44, 9.02%	23, 10.7%	9, 6.12%	8, 11.4%	4, 7.14%
Readmitted, 7 days	33, 6.76%	20, 9.30%	5, 3.40%	6, 8.57%	3, 5.36%
ED visit, 7 days	34, 6.97%	18, 8.37%	8, 5.44%	3, 4.29%	4, 7.14%
Death	37, 7.58%	9, 4.19%	8, 5.44%	12, 17.1%	8, 14.3%
Follow-up kept ^b	248, 68.5%	131, 60.9%	117, 79.6%	—	—
Week 1 laboratory results seen by ID ^c	210, 60.5%	77, 37.4%	133, 94.3%	—	—
Antimicrobial error at discharge ^d	41, 11.3%	39, 18.1%	2, 1.36%	—	—
Antimicrobial adverse event	62, 17.1%	36, 16.7%	20, 13.6%	—	—
Catheter complication	41, 11.3%	25, 11.6%	10, 6.80%	—	—
Relapse of infection	48, 13.3%	26, 12.1%	11, 7.48%	—	—
<i>Clostridium difficile</i> infection	3, 0.83%	2, 1.59%	1, 0.68%	—	—

Abbreviations: ED, emergency department; ID, infectious diseases.

^aDays are days after discharge. Outcomes are at 60 days after discharge unless otherwise indicated. Readmission and ED outcomes, as well as death, were collected in the intervention and control groups. Other analyses are in the intervention group only. Chi-square and ANOVA tests, as appropriate, were used to demonstrate differences between groups (pre-intervention period intervention arm, post-intervention period intervention arm, pre-intervention period control arm, and post-intervention period control arm). ANOVA was used for continuous variables, whereas χ^2 analyses were used for categorical variables.

^bFollow-up appointment kept with an ID provider within 60 days of discharge.

^cLaboratory test results seen by a member of the ID practice within the first week of discharge. Fifteen missing patients were readmitted or completed their OPAT courses within 1 week of discharge.

^dDifference in antimicrobial therapy agent between what was recommended by the inpatient ID team and what was written on the patient's discharge summary.

Table 3

Relationship Between the Intervention and Readmissions, Among Total N = 488.^a

	Readmission and/ or ED Visit, 60 Days	Readmission in 60 Days	Readmission and/ or ED Visit in 30 Days	Readmission in 30 Days	Readmission and/ or ED Visit in 7 Days	Readmission in 7 Days
Presence of IDTS	0.38 (0.11–1.34)	0.40 (0.11–1.45)	0.47 (0.12–1.83)	0.42 (0.11–1.67)	0.51 (0.16–1.64)	0.38 (0.032–4.37)
Presence of IDTS, adjusted	0.48 (0.13–1.79) ^b	0.45 (0.12–1.34) ^b	0.44 (0.11–1.72) ^c	0.38 (0.096–1.52) ^d	0.59 (0.066–5.26) ^e	0.38 (0.032–4.37) ^f

Abbreviations: ED, emergency department; IDTS, infectious diseases transitions service; OPAT, outpatient parenteral antimicrobial therapy.

^aReadmissions and/or ED visits are within 7, 30, or 60 days of hospital discharge. Results are reported as adjusted odds ratios and 95% confidence intervals for the interaction term between the presence of the intervention and being potentially subject to the intervention. Intervention and control groups were included in the analyses. Analyses were adjusted for gender, age, provider of OPAT services, primary service, indication for antimicrobials, type of antimicrobial, and numbers of antibiotics. Covariates were retained if they led to a 10% change in the point estimate in the model.

^bAdjusted for number of antimicrobials, primary service, age, indication for antimicrobials, gender, provider of OPAT services, and type of antimicrobial.

^cAdjusted for number of antimicrobials.

^dAdjusted for number of antimicrobials and age.

^eAdjusted for number of antimicrobials, age, gender, and primary service.

^fNo covariates passed the 10% threshold.

Predictors of Process of Care Measures and Secondary Clinical Outcome Measures in the Intervention Group Only (215 Pre-Intervention Patients and 147 Post-Intervention Patients; Total N = 362).^a

Table 4

Exposure	Antimicrobial Therapy Errors	Laboratory Results Seen	Follow-Up Appointment Kept	Antimicrobial Adverse Events	Catheter Complications	Infection Relapse
IDTS	0.062 (0.015–0.262)	27.85 (12.93–59.99)	2.44 (1.50–3.97)	2.57 (1.38–4.81)	1.44 (0.74–2.80)	0.93 (0.53–1.65)
Home health agency versus skilled nursing facility	0.99 (0.51–1.91)	2.35 (1.51–3.65)	2.57 (1.56–3.89)	0.52 (0.29–0.91)	1.13 (0.61–2.12)	0.49 (0.27–0.89)
Medical versus surgical primary service	0.77 (0.37–1.59)	0.94 (0.59–1.48)	0.54 (0.34–0.87)	0.93 (0.86–1.00 NS)	0.94 (0.86–1.02)	0.97 (0.90–1.03)
Days between ID signoff and discharge	1.02 (0.96–1.08)	0.93 (0.89–0.97)	0.93 (0.89–0.97)	1.12 (0.64–1.99)	0.68 (0.33–1.43)	0.95 (0.51–1.76)

Abbreviations: ID, infectious diseases; IDTS, infectious diseases transitions service; NS, nonsignificant.

^aOdds ratios are presented with 95% confidence intervals. Outcomes are within 60 days of discharge. Bolded values are statistically significant at $\alpha < .05$.