

# Perspectives of United States–Based Infectious Diseases Physicians on Outpatient Parenteral Antimicrobial Therapy Practice

Yasir Hamad,<sup>1</sup> Michael A. Lane,<sup>1,2</sup> Susan E. Beekmann,<sup>3</sup> Philip M. Polgreen,<sup>3</sup> and Sara C. Keller<sup>4,5</sup>

<sup>1</sup>Department of Internal Medicine, Washington University in St. Louis School of Medicine, St. Louis, Missouri; <sup>2</sup>Center for Clinical Excellence, BJC HealthCare, St. Louis, Missouri; <sup>3</sup>Department of Internal Medicine, Carver College of Medicine, University of Iowa, Iowa City, Iowa; <sup>4</sup>Department of Medicine and <sup>5</sup>Armstrong Institute of Patient Safety and Quality, Johns Hopkins University School of Medicine, Baltimore, Maryland

**Background.** Although outpatient parenteral antimicrobial therapy (OPAT) is generally considered safe, patients are at risk for complications and thus require close monitoring. The purpose of this study is to determine how OPAT programs are structured and how United States–based infectious diseases (ID) physicians perceive barriers to safe OPAT care.

**Methods.** We queried members of the Emerging Infections Network (EIN) between November and December 2018 about practice patterns and barriers to providing OPAT.

**Results.** A total of 672 members of the EIN (50%) responded to the survey. Seventy-five percent of respondents were actively involved in OPAT, although only 37% of respondents reported that ID consultation was mandatory for OPAT. The most common location for OPAT care was at home with home health support, followed by post–acute care facilities. Outpatient and inpatient ID physicians were identified as being responsible for monitoring laboratory results (73% and 54% of respondents, respectively), but only 36% had a formal OPAT program. The majority of respondents reported a lack of support in data analysis (80%), information technology (66%), financial assistance (65%), and administrative assistance (60%). The perceived amount of support did not differ significantly across employment models. Inability to access laboratory results in a timely manner, lack of leadership awareness of OPAT value, and failure to communicate with other providers administering OPAT were reported as the most challenging aspects of OPAT care.

**Conclusions.** ID providers were highly involved in OPAT, but only one-third of respondents had a dedicated OPAT program. Lack of financial and institutional support were perceived as significant barriers to providing safe OPAT care.

**Keywords.** antimicrobial use; care delivery; OPAT; practice management; patient safety.

Outpatient parenteral antimicrobial therapy (OPAT) is a convenient approach for delivering parenteral antibiotics outside the hospital setting [1, 2]. OPAT shortens hospital stays, decreases health care expenditures, and increases patient satisfaction [3–5]. OPAT is effective and generally considered safe [6] but requires close monitoring for therapy-related complications and treatment failure [7, 8]. The standard of care for monitoring patients receiving OPAT includes clinical follow-up and at least weekly monitoring of clinical laboratory results [9]. OPAT monitoring programs designed to ensure safe and effective care are labor-intensive [10]. A 2013 survey of infectious diseases (ID) physicians queried through Centers for Disease

Control and Prevention (CDC)–sponsored Emerging Infections Network (EIN) reported that only one-quarter of respondents had a dedicated OPAT program. Those ID physicians reported that the lack of a dedicated OPAT team, the large number of locations in which patients received OPAT, insufficient communication between health care workers, and a large volume of laboratory results were the most common barriers to the safe delivery of OPAT [10]. In another national survey of ID physicians administering OPAT, systemic laboratory test result tracking, communication between inpatient and outpatient providers, and adherence to clinic visits were more likely to occur in practices with a formal OPAT program [11]. In an era where OPAT may be rapidly expanding due to increasing pressure to decrease length of stay and decrease costs, we surveyed ID physicians in the EIN to better clarify how OPAT patients are managed and to identify barriers to the safe care of OPAT patients.

## METHODS

### Instrument

We developed a survey instrument in collaboration with ID physicians and EIN staff, with technical assistance from the

Received 24 May 2019; editorial decision 1 August 2019; accepted 5 August 2019.

Correspondence: S. C. Keller, MD, 550 N Broadway St Suite 405, Johns Hopkins University School of Medicine, Baltimore, MD 21287 (skeller9@jhmi.edu).

### Open Forum Infectious Diseases®

© The Author(s) 2019. Published by Oxford University Press on behalf of Infectious Diseases Society of America. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial re-use, please contact journals.permissions@oup.com DOI: 10.1093/ofid/ofz363

CDC. The instrument contained 10 multiple choice or Likert-style items and 1 free-text item allowing respondents to provide additional comments. The survey was piloted with a group of content experts, and questions were modified based on their feedback. The survey focused on the respondents' role with OPAT, location where OPAT is received, providers responsible for managing OPAT, time devoted to OPAT, institutional support given to OPAT, and barriers to safe OPAT care ([Appendix Table 1](#)).

### Study Population and Distribution

The EIN is a CDC-supported volunteer-based group of practicing ID physician members of the Infectious Diseases Society of America (IDSA). Approximately 20% of ID physicians in clinical practice in the United States are members of the EIN [12]. The EIN was established as a provider-based emerging infections surveillance network that communicates regularly about emerging infectious diseases and related phenomena. EIN members also volunteer to complete surveys. Baseline geographic and practice characteristics for EIN members are maintained in a database and updated regularly.

EIN members were sent the confidential survey by email link or by facsimile and could complete the survey between November 14, 2018, and December 17, 2018. Nonresponders were given 2 reminders after the initial request to complete the survey. Similar to previous EIN surveys, the response rate was calculated from EIN members who had ever responded to a survey [12].

Participants who reported having a role with OPAT were eligible to answer the survey. Participants were asked to comment on OPAT as it occurs at the primary hospital where they work.

### Data Analysis

Categorical data were presented using frequencies. For categorical variables, the chi-square test or analysis of variance (ANOVA) was performed as applicable. We were interested in what resources might be available to ID physicians with different employment structures (ie, working in a military or Veterans Administration facility, employed by a hospital or clinic, working in a private or group practice, or working in an academic medical center). Differences were considered statistically significant if  $P < .05$ .

To assess for the possibility of nonresponse bias, we compared geographic and practice characteristics between respondents and nonrespondents.

All quantitative analyses were performed using SAS 9.4 software (Cary, NC).

We also analyzed qualitative data. Participants were asked to respond to the item "additional comments about OPAT and related safety issues" with free-text responses. Two authors (Y.H., S.K.) systematically read the responses and derived codes. They reached agreement on classification of the responses.

Percentages of respondents answering the item and illustrative quotes are presented.

## RESULTS

Of 1353 active EIN physician members with an adult ID practice, 672 (50%) responded to the survey. Respondents were more likely than nonrespondents to have >25 years of experience (30% vs 22%;  $P < .01$ ). Respondents were more likely than nonrespondents to be employed at a Veterans Affairs facility and less likely to be employed at a medical school (6.1% vs 4.4% and 32.6% vs 35.1%, respectively;  $P = .03$ ). No significant differences were identified in regional distribution, primary hospital type, hospital size, or percentage of respondents who were fellows-in-training ([Supplementary Table 1](#)). One hundred sixty-five members (25%) did not have any role in managing OPAT patients and were excluded, leaving 507 respondents to answer the survey questions.

Two hundred eighteen (43%) respondents had recommended OPAT as an inpatient consultant, whereas 410 (81%) had seen OPAT patients in clinic after hospital discharge ([Table 1](#)). Only 37% of respondents ( $n = 186$ ) reported that ID consultation was mandated in their hospital before discharging patients on OPAT. However, the majority of respondents ( $n = 344$ , 68%) reported that >75% of patients discharged on intravenous antibiotics were managed by ID as outpatients. Outpatient and inpatient ID physicians were most frequently identified as being responsible for monitoring laboratory results (73% and 54% of respondents, respectively). A minority of respondents ( $n = 182$ , 36%) used a dedicated OPAT program or service to monitor patients. The majority of respondents felt that the rate of complications did not change ( $n = 191$ , 37%) or decreased ( $n = 165$ , 33%) over the past 5 years.

Receipt of OPAT at home with assistance of home health or home infusion agencies was the most common OPAT delivery method, followed by receipt of OPAT at post-acute care facilities (skilled nursing facilities, subacute or acute rehabilitation facilities, and long-term acute care facilities) ([Figure 1](#)). Interestingly, 32% of respondents rated an infusion center as the most or second most common OPAT delivery method in their practice ( $n = 147$ ), and 30% of respondents rated home without assistance from home infusion or home health as the most or second most common OPAT delivery method in their practice ( $n = 127$ ). Most respondents ( $n = 314$ , 62%) indicated that ID physicians spent at least 4 hours per week on OPAT ([Figure 2](#)). Many respondents also noted that nurses spent at least 4 hours per week on OPAT ( $n = 220$ , 51%).

Respondents described the adequacy of support for OPAT. Most respondents ( $n = 283$ , 64.6%) felt that OPAT services are not well supported financially. Most participants felt that administrative support levels ( $n = 263$ , 59.8%), information technology support levels ( $n = 284$ , 66.2%), and data support levels ( $n = 330$ , 80.2%) were not adequate for the care of OPAT

**Table 1. Employment and OPAT Structures as Reported by 507 Infectious Diseases Physicians in the Emerging Infections Network Who Were Involved in OPAT**

Characteristics	No. (%)
<b>Employment</b>	
Hospital or clinic	185 (36.45)
Private or group practice	146 (28.8)
University or medical school	145 (28.6)
Veterans Affairs, military, or federal facility	31 (6.1)
<b>Role in OPAT<sup>a</sup></b>	
Recommend OPAT as an inpatient consultant	218 (43.0)
Responsible for placing OPAT orders as an inpatient consultant	338 (66.7)
See patients receiving OPAT in clinic after hospital discharge	410 (80.9)
Manage OPAT program or clinic, or primary person responsible for managing OPAT	167 (32.9)
Initiate OPAT in outpatients	6 (1.2)
Remotely monitor OPAT	8 (1.6)
<b>Percentage of OPAT patients managed by infectious diseases (answered by 449)</b>	
<26	41 (8.1)
26–50	15 (3.0)
51–75	49 (9.7)
76–100	344 (67.9)
<b>Labs followed by<sup>a</sup>:</b>	
Discharging physician	32 (6.3)
Primary care provider	53 (10.5)
Skilled nursing facility provider	118 (23.3)
Home infusion pharmacist	146 (28.8)
Inpatient infectious diseases physician	267 (52.7)
OPAT service	182 (35.9)
Outpatient infectious diseases physician	369 (72.8)
Infectious diseases nurse	4 (0.8)
Another team (such as surgery, hospitalist, etc.)	2 (0.4)
No one	4 (0.8)
<b>Change in frequency of OPAT-related complications over the last 5 y (answered by 447)</b>	
Much more frequent	18 (4.0)
Somewhat more frequent	73 (16.3)
No change	191 (42.7)
Somewhat less frequent	131 (29.3)
Much less frequent	34 (7.6)

Abbreviations: OPAT, outpatient parenteral antimicrobial therapy.

<sup>a</sup>Respondents were able to select all responses that applied; numbers add to more than 100%.

patients. These perceptions did not vary across employment structures (data not shown).

Barriers to safe OPAT care reported as challenging or very challenging by over half of respondents included laboratory results not returning in a timely fashion ( $n = 292$ , 58.5%), leadership not valuing OPAT ( $n = 293$ , 58.4%), and struggles communicating with OPAT providers (eg, post-acute care facilities and infusion centers;  $n = 273$ , 54.4%) (Table 2). In addition, many respondents noted that barriers including failure to follow up with infectious diseases ( $n = 241$ , 47.9%), volume of laboratory results to review ( $n = 241$ , 47.8%), lack of clinicians

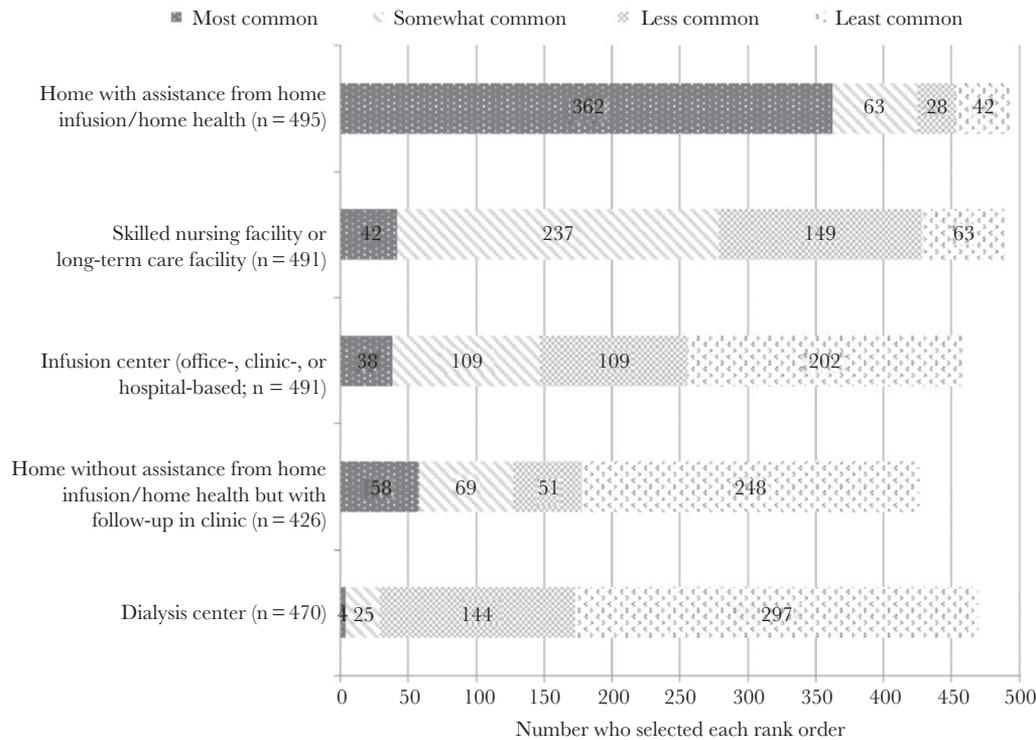
reviewing laboratory test results ( $n = 228$ , 45.2%), and difficulty using the electronic medical record system ( $n = 219$ , 43.5%) were challenging or very challenging. There were no statistically significant differences among perceptions of barriers when respondents were compared among different employment settings (data not shown).

Free-text comments were received from 85 participants (Table 3). Common themes included poor communication between outpatient ID providers and those delivering OPAT (eg, post-acute care facilities, hemodialysis centers, etc.) and poor communication between inpatient and outpatient OPAT providers at the time of hospital discharge ( $n = 32$ , 37.6%), lack of financial support ( $n = 20$ , 23.5%), inadequate care coordination especially regarding obtaining laboratory test results ( $n = 18$ , 21.2%), and poor patient selection ( $n = 18$ , 21.2%). As one respondent explained, “The value of a formal OPAT service is to an insurer mix, not to the hospital, so it has been a non-starter to ask for the hospital to pay to support a team of OPAT pharmacists that in essence reduces costs to a [third] party.” Some discussed the high-risk nature of OPAT and the need for ID involvement in management; one respondent stated, “The further the process gets from my office, the more dangerous it feels.” However, many still believed OPAT was a necessary part of ID clinical care; one respondent stated, “All ID doc[tors] should have OPAT in the out[patient] practice.”

## DISCUSSION

We found that ID physician involvement in OPAT was high, but that ID physicians caring for OPAT patients perceived multiple barriers to safe care. Although ID physicians provided care for the majority of OPAT patients and had primary responsibility for laboratory monitoring, only one-third of respondents used a dedicated OPAT program. Receipt of OPAT at home with assistance from home health nursing remains the most common model for OPAT delivery [10]. The most common barriers to delivering high-quality and safe care for OPAT patients were lack of leadership support for OPAT, lack of timely receipt of laboratory results, and difficulties in communication with post-acute care providers.

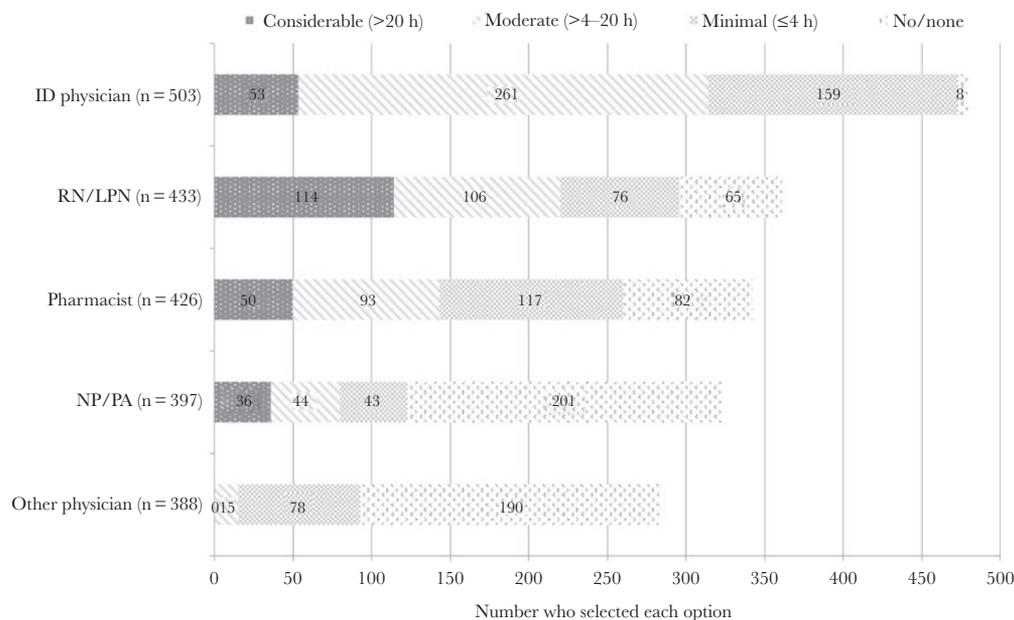
As it was first used among children with cystic fibrosis for management of pulmonary infections 4 decades ago [13], OPAT has been used in multiple settings to treat long-term infections and save the hospitals, payers, and the health care system money [14, 15]. However, the ID physicians who manage these patients perceive that the effort and time spent in OPAT oversight are not well-reimbursed [16]. This heavy burden of uncompensated care shouldered by ID physicians may contribute to the specialty being among the lowest-compensated medical specialties [17]. In our study, managing these patients, tracking and reviewing laboratory test results, managing adverse drug events, monitoring and preventing venous catheter complications, and monitoring the underlying infection took ID physicians



**Figure 1.** Respondents ranked outpatient parenteral antimicrobial therapy delivery sites from the most to least common.

a significant amount of time on a weekly basis: 62% stated that they spent at least 4 hours a week on OPAT. Beyond follow-up clinic visits, obtaining compensation for this time from insurers is difficult in the absence of a hospital-based OPAT

program. Possibly as a result, most ID physicians in our survey felt that inadequate financial support for OPAT was a challenge. Respondents also noted poor administrative, data analysis, and information technology support. Significantly, more than half



**Figure 2.** Respondents rated the amount of time spent in a usual week managing outpatient parenteral antimicrobial therapy patients by each of the health care workers listed. The numbers are the total number of participants who responded in each category. Abbreviations: ID, infectious diseases; LPN, license practical nurse; NP, nurse practitioner; RN, registered nurse; PA, physician's assistant.

**Table 2. Perceptions of Barriers to Safe OPAT Care Among 507 Infectious Diseases Physicians in the Emerging Infections Network Who Had a Role Caring for Patients on Outpatient Parenteral Antimicrobial Therapy; Proportion of Respondents Who Rated the Barriers as Challenging or Very Challenging Recorded**

Barrier	Perceived as Challenging or Very Challenging, No. (%)
Laboratory results do not return in a timely fashion (missing = 8)	292 (58.5)
Leadership does not value OPAT (missing = 5)	293 (58.4)
Failure to communicate with other OPAT providers (eg, post-acute care facility, infusion center, etc.; missing = 5)	273 (54.4)
Failure to follow up with infectious diseases (missing = 4)	241 (47.9)
Too many laboratory results on OPAT patients to review (missing = 3)	241 (47.8)
No one is reviewing laboratory results on OPAT patients (missing = 3)	228 (45.2)
Difficulty using the electronic medical record system (missing = 4)	219 (43.5)
Cannot get prescribed agents for OPAT after discharge (missing = 5)	129 (25.7)
Unclear who has ownership over patient cases (missing = 3)	121 (24.0)
Patients referred for OPAT who are inappropriate for OPAT (missing = 4)	100 (19.9)
Cannot identify patients appropriate for OPAT (missing = 8)	78 (15.6)

Abbreviation: OPAT, outpatient parenteral antimicrobial therapy.

of respondents stated that a barrier to safe OPAT provision was a lack of hospital leadership awareness of the value of OPAT. This lack of leadership awareness may contribute to a perceived lack of support. These barriers were similar no matter the type of hospital the ID physician worked in or the type of employment structure.

Meanwhile, the lack of hospital leadership awareness of the value of OPAT may explain why only 36% of respondents had dedicated OPAT programs. This is an increase over the 26% of EIN survey respondents who reported having a dedicated OPAT team in 2013 but is still only a minority of respondents [10]. The presence of a formal OPAT program has been associated with implementation of safer OPAT practices such as systematic laboratory test result tracking and ensuring patient adherence to clinic visits [11]. A structured OPAT program and formal OPAT care team have recently been reported as among the most important quality indicators in OPAT care [18]. Recognition of the value of OPAT by hospital leadership may aid further dissemination of dedicated OPAT programs and result in improvements in the quality of OPAT care.

More than one-third (37%) of respondents reported mandatory ID consultation before OPAT. Although this is somewhat higher than the 22% of respondents who reported mandatory ID consultation before OPAT in a 2013 survey [10], this is still a minority of respondents. Researchers have shown that mandatory ID consultation before OPAT prescription promotes antimicrobial stewardship by identifying patients who can be narrowed or switched to oral agents [19]. In fact, ID-led OPAT improves outcomes compared with OPAT not led by ID physicians, with decreased rates of emergency department visits and hospitalizations and decreased health care expenditures [20]. Where possible, more hospitals may consider requiring ID consultation before OPAT prescription. In addition, it is possible that some hospitals lack ID capacity to staff all OPAT patients before discharge. In the absence of adequate ID capacity for

mandatory in-person consultation, formal remote ID evaluation via telemedicine, brief case review, or other innovations could improve antimicrobial stewardship and quality of care. However, despite the low proportion of respondents who described mandatory ID consultation for OPAT patients, our ID respondents still reported caring for the vast majority of patients on OPAT.

In this survey, a newer form of OPAT delivery, self-OPAT (where the patient or family member would perform all OPAT care at home in the absence of home health assistance but with close follow-up in clinic) was used by some respondents [9]. Self-OPAT, a novel form of OPAT delivery, has been associated with similar or better outcomes (readmission or mortality within 30 days of hospital discharge) when compared with other OPAT models [21].

Respondents identified challenges related to communicating with other OPAT providers to be a significant barrier to safe care. Specifically, respondents in our survey described difficulty communicating with health care workers at the post-acute care facilities and unclear ownership of patients. Receiving OPAT at post-acute care facilities has been associated with higher readmission rates and higher risk of venous catheter complications [22, 23]. Implementation of robust OPAT services could serve as an important point of continuity as patients transition across sites of care.

The strengths of this study include the large number of respondents and high response rate (close to 50%). Respondents included 1 in 10 ID physicians in the United States and were representative of ID physicians in the United States, including different regions of the country and different health systems and employment models. However, our study has limitations. Although EIN is representative of US-based ID physicians, it is possible that ID physicians outside the network have different practice patterns. Respondents were more likely to be more experienced physicians, though the difference, while statistically significant, was relatively small. We did not capture experiences of OPAT from non-ID physician perspectives (eg, OPAT that

**Table 3. Free-Response Concerns Raised About Safe Provision of OPAT; Number and Percentage of 85 Who Responded to Items Shown**

Concern Raised	Frequency of Respondents Raising Concern, No. (%)	Illustrative Quote
Poor communication	32 (37.6)	"[Our] biggest problems are in patients who go to [skilled nursing facilities]—they don't do the labs, don't send patient for [follow-up] appointment[s], etc."
		"Communication about [intravenous] antibiotics being continued after discharge at outside hemodialysis centers, nursing homes, and skilled nursing facilities is almost nonexistent. I can only assume that the orders are being carried out, appropriate labs are being monitored."
		"At times, I feel there is no involvement from other care providers in hospital [which leads to] dumping patients out in the community on [intravenous] antibiotics, and it's often impossible to get them to re-evaluate these same patients."
Financial reimbursement	20 (23.5)	"[I wonder] why physicians sometimes benefit financially from OPAT. [I am] curious how prevalent this is."
		"Poor Medicare coverage for elderly patients also complicates [my] ability to choose safe medications for home infusion."
		"The value of a formal OPAT service is to an insurer mix, not to the hospital, so it has been a non-starter to ask for the hospital to pay to support a team of OPAT pharmacists that in essence reduces costs to a [third] party."
Inadequate care coordination	18 (21.2)	"[There is a] significant delay in getting labs from home health. Our facility employs a [registered nurse] to oversee labs and track them down, but prior to this it was extremely challenging. [We] often did not get labs at all and many [of our] patients [were] lost to follow-up."
		"We have a very strong OPAT program send about 100–150 people home each month on [intravenous] treatment. [We have a] rare safety issue where a patient may go to a facility that is far out of our 'jurisdiction' and it is not easy to get information or labs, but that is rare."
		"I pay a [nurse practitioner/physician's assistant] to help follow OPAT pts and help me make sure that balls are not dropped."
Poor patient selection	18 (21.2)	"In the urban...area where I practice over 50% of the patients who get OPAT could be better managed with oral antimicrobials."
		"I follow[ed] all my [intravenous antibiotic patients] in the past, [but] less so now with [intravenous] heroin [users who develop] endocarditis as it's a big time investment with lots of noncompliance and little ethical or financial reward."
Poor follow-up	14 (16.5)	"[For example, an] ID progress note suggested weekly CPK monitoring for patient on daptomycin. The suggestion was mistakenly transcribed as CRP [The] patient returned to [the] hospital three weeks later with severe myalgias, cough, and [a] CPK of 20 000."
		"The hardest is when a person is being discharged from another facility and their provider wants to follow the patient—yet my name goes on the orders."
Medicolegal liability	4 (4.7)	"[The] cost and liability are being shifted from the hospital (and administration) to the ID practitioner, without concurrent clerical and technical support."
		"The further the process gets from my office, the more dangerous it feels."

Abbreviations: CPK, creatinine phosphokinase; CRP, C-reactive protein; ID, infectious diseases; OPAT, outpatient parenteral antimicrobial therapy.

may be prescribed by oncologists or the perspectives of advanced practitioners). In addition, we asked respondents about their experiences with OPAT, which may have been subject to recall bias. However, we feel that our study did capture ID physicians' experiences with providing OPAT.

Our study highlighted the high rate of involvement of ID providers in managing OPAT patients both before and after hospital discharge. Lack of support was common across practice settings. Efforts are needed to improve awareness of OPAT value among health care systems leaders and policy makers in order to establish OPAT programs that can help improve patient safety.

### Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

### Acknowledgments

**Financial support.** This publication was supported by the Cooperative Agreement Number, 1 U50 CK000477, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services. This work was also supported by the Agency for Healthcare Research and Quality (1K08HS025782-01 to S.C.K.).

**Potential conflicts of interest.** All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

### References

- Petrak RM, Skorodin NC, Fliegelman RM, et al. Value and clinical impact of an infectious disease-supervised outpatient parenteral antibiotic therapy program. *Open Forum Infect Dis* 2016; 3(X):XXX–XX.
- Cox AM, Malani PN, Wiseman SW, Kauffman CA. Home intravenous antimicrobial infusion therapy: a viable option in older adults. *J Am Geriatr Soc* 2007; 55:645–50.

- Nguyen HH. Hospitalist to home: outpatient parenteral antimicrobial therapy at an academic center. *Clin Infect Dis* **2010**; 51(Suppl 2):S220–3.
- Yan M, Elligsen M, Simor AE, Daneman N. Patient characteristics and outcomes of outpatient parenteral antimicrobial therapy: a retrospective study. *Can J Infect Dis Med Microbiol* **2016**; 2016:8435257.
- Wai AO, Frighetto L, Marra CA, et al. Cost analysis of an adult outpatient parenteral antibiotic therapy (OPAT) programme. A Canadian teaching hospital and Ministry of Health perspective. *Pharmacoeconomics* **2000**; 18:451–7.
- Ruh CA, Parameswaran GI, Wojciechowski AL, Mergenhausen KA. Outcomes and pharmacoeconomic analysis of a home intravenous antibiotic infusion program in veterans. *Clin Ther* **2015**; 37:2527–35.
- Hale CM, Steele JM, Seabury RW, Miller CD. Characterization of drug-related problems occurring in patients receiving outpatient antimicrobial therapy. *J Pharm Pract* **2017**; 30:600–5.
- Lee B, Tam I, Weigel B 4th, et al. Comparative outcomes of  $\beta$ -lactam antibiotics in outpatient parenteral antibiotic therapy: treatment success, readmissions and antibiotic switches. *J Antimicrob Chemother* **2015**; 70:2389–96.
- Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis* **2019**; 68:e1–35.
- Lane MA, Marschall J, Beekmann SE, et al. Outpatient parenteral antimicrobial therapy practices among adult infectious disease physicians. *Infect Control Hosp Epidemiol* **2014**; 35:839–44.
- Muldoon EG, Switkowski K, Tice A, et al. A national survey of infectious disease practitioners on their use of outpatient parenteral antimicrobial therapy (OPAT). *Infect Dis* **2015**; 47:39–45.
- Pillai SK, Beekmann SE, Santibanez S, Polgreen PM. The Infectious Diseases Society of America Emerging Infections Network: bridging the gap between clinical infectious diseases and public health. *Clin Infect Dis* **2014**; 58:991–6.
- Rucker RW, Harrison GM. Outpatient intravenous medications in the management of cystic fibrosis. *Pediatrics* **1974**; 54:358–60.
- Paladino JA, Poretz D. Outpatient parenteral antimicrobial therapy today. *Clin Infect Dis* **2010**; 51(Suppl 2):S198–208.
- Tice AD. Pharmacoeconomic considerations in the ambulatory use of parenteral cephalosporins. *Drugs* **2000**; 59(Suppl 3):29–35; discussion 47–9.
- Nolet BR. Update and overview of outpatient parenteral antimicrobial therapy regulations and reimbursement. *Clin Infect Dis* **2010**; 51(Suppl 2):S216–9.
- Jena AB, Olenksi AR, Blumenthal DM. Sex differences in physician salary in US public medical schools. *JAMA Intern Med* **2016**; 176:1294–304.
- Berrevoets MA, Ten Oever J, Oerlemans AJ, Kullberg BJ, Hulscher ME, Schouten JA. Quality indicators for appropriate outpatient parenteral antimicrobial therapy (OPAT) in adults: a systematic review and RAND-modified Delphi procedure. *Clin Infect Dis*. **In press**.
- Shrestha NK, Bhaskaran A, Scalera NM, et al. Contribution of infectious disease consultation toward the care of inpatients being considered for community-based parenteral anti-infective therapy. *J Hosp Med* **2012**; 7:365–9.
- Shah A, Petrak R, Fliegelman R, et al. Infectious diseases specialty intervention is associated with better outcomes among privately insured individuals receiving outpatient parenteral antimicrobial therapy. *Clin Infect Dis* **2019**; 68:1160–5.
- Bhavan KP, Brown LS, Haley RW. Self-administered outpatient antimicrobial infusion by uninsured patients discharged from a safety-net hospital: a propensity-score-balanced retrospective cohort study. *PLoS Med* **2015**; 12(12):e1001922.
- Schmidt M, Hearn B, Gabriel M, et al. Predictors of unplanned hospitalization in patients receiving outpatient parenteral antimicrobial therapy across a large integrated healthcare network. *Open Forum Infect Dis* **2017**; 4:XXX–XX.
- Townsend J, Keller S, Tibuakuu M, et al. Outpatient parenteral therapy for complicated *Staphylococcus aureus* infections: a snapshot of processes and outcomes in the real world. *Open Forum Infect Dis* **2018**; 5:XXX–XX.

**Appendix Table 1. Differences Between Respondents and Nonrespondents**

Characteristics	Respondents (n = 672), No. (%)	Nonrespondents (n = 681), No. (%)	PValue
Region of practice			.76
South	199 (29.6)	199 (29.2)	
West	157 (23.4)	159 (23.3)	
Midwest	167 (24.9)	159 (23.3)	
Northeast	145 (21.6)	156 (22.9)	
Puerto Rico or Canada	4 (0.6)	8 (1.2)	
Years of experience			.008
<5	115 (17.1)	120 (17.6)	
5–14	238 (35.4)	278 (40.8)	
15–24	116 (17.3)	132 (19.4)	
>25	203 (30.2)	151 (22.2)	
Primary respondent employment			.03
Hospital/clinic	235 (35.0)	234 (34.4)	
Private/group practice	177 (26.3)	178 (26.1)	
University/medical school	219 (32.6)	239 (35.1)	
VA and military	41 (6.1)	30 (4.4)	
Primary respondent hospital			.21
Community hospital	178 (26.5)	207 (30.4)	
Nonuniversity teaching hospital	175 (26)	154 (22.6)	
University hospital	238 (35.4)	245 (36)	
VA or military hospital	46 (6.8)	34 (5)	
City/country hospital	35 (5.2)	41 (6)	
Hospital bed size			.34
<200 beds	75 (11.2)	65 (9.5)	
200–350 beds	157 (23.4)	153 (22.5)	
351–450 beds	101 (15.0)	129 (18.9)	
451–600 beds	1365 (20.2)	127 (18.6)	
>600 beds	203 (30.2)	207 (30.4)	
Current fellow-in-training	40 (5.9)	26 (3.8)	.068