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ORIGINAL ARTICLE

Sociodemographic and clinical factors associated with acceptance of outpatient parenteral antibiotic therapy in a Singapore tertiary hospital from 2014 to 2017

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Abstract

Outpatient parenteral antibiotic therapy (OPAT) can facilitate early discharge; however, not all offered OPAT can accept. We assessed factors associated with acceptance of OPAT in a large Asian tertiary hospital cohort. From 2014 to 2017, we reviewed all referrals to Singapore General Hospital's (SGH) Outpatient Parenteral Antibiotic Therapy (OPAT) service. We compared differences in sociodemographic and clinical factors between patients who opted for OPAT and those who declined, using chi-square test for univariate analysis and logistic regression for multivariate analysis. From 2014 to 2017, a total of 1406 OPAT referrals were made. Of these, 95.9% (1349/1406) were deemed suitable for OPAT. Amongst those suitable, 90.0% (1213/1349) accepted OPAT treatment. On multivariate analysis, being independently ambulant (aOR = 3.46, 95%CI = 2.21–5.37) was independently associated with higher odds of acceptance for OPAT; whereas, patients with peripheral vascular disease had lower odds of accepting OPAT (aOR = 0.32, 95%CI = 0.16–0.62). Lower socioeconomic status (SES) was closely associated with rejection of OPAT, with markers of both individual-level SES (subsidized ward class) and area-level SES (staying in a public rental flat) being independently associated with lower odds of OPAT preference. Distance and travel time were not associated with OPAT acceptance. The top reasons for rejecting OPAT were lack of caregiver ($n = 35$), mobility issues ($n = 24$), financial issues ($n = 24$), and difficulty caring for the line ($n = 21$). Comorbidities, mobility, and financial issues are important factors to consider when determining suitability for OPAT. More can be done to improve accessibility of OPAT amongst lower-income patients and those staying in lower-SES areas.

Keywords Outpatient parenteral antibiotic therapy · Socioeconomic · Acceptability

Introduction

Outpatient parental antibiotic therapy (OPAT) consists of providing antimicrobial therapy by parenteral infusion in the outpatient setting, without the need for hospitalization. Studies consistently demonstrate the cost-effectiveness of OPAT [1], with good outcomes and clinical efficacy [2]. Patient safety and clinical effectiveness are commonly considered in evaluation of OPAT services, but patient and practitioner acceptability are less frequently studied [3]. Additionally, there is less focus on reasons why prospective OPAT candidates may actually reject OPAT [4, 5]; however, such information is useful in analyzing how OPAT services can be improved and modified to be made more accessible to a wider prospective patient population. While OPAT is delivered as an organized service in many Western countries, norms for OPAT in Asian countries are relatively different [6], with greater fragmentation of care [7]. More research is needed on how OPAT services can be optimized in the context of Asian societies to improve accessibility and utilization.

Singapore is one such example of a rapidly urbanizing Asian society. OPAT has been established in Singapore since 2002 and is now available at most major public

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hospitals [8, 9]. Its cost-effectiveness has been demonstrated in the local setting [10], with low rates of complications and re-admissions [8, 9]. While differences exist in how OPAT services are structured in various tertiary hospitals, all do utilize a coordinator to screen potential OPAT referrals for appropriateness and suitability [9]. OPAT has been utilized in the treatment of a variety of infections, including skin and soft tissue infections (SSTIs) [8] and urinary tract infections [11]. Given Singapore's high urban density, OPAT services were initially established using an infusion center model (hospital-based OPAT, or H-OPAT), in which patients had to make daily visits to the outpatient OPAT clinic [9, 12]. However, from 2006 onwards, most centers now offer self-administered OPAT (S-OPAT) as an alternative option, where patients or their caregivers are trained to self-administer antibiotics at home via elastomeric devices [12]. In more recent years, a small minority received OPAT in their own homes via trained outreach staff (homecare OPAT); however, the bulk of patients still receive either H-OPAT or S-OPAT, with H-OPAT accounting for the majority of episodes [13]. This setup is different from OPAT services in Western countries, which rely more on homecare OPAT compared to S-OPAT and H-OPAT [3, 14], though studies have shown no difference in safety and outcomes [14]. In Singapore, healthcare expenses are funded via a mix of private savings and government subsidies [15]. Individuals are mandated to save for their own healthcare expenditures in forced savings accounts (Medisave); funds in Medisave accounts can be used to pay for inpatient expenses, with the balance being paid out-of-pocket [16]. Patients also receive means-tested subsidies to their healthcare bills. However, outpatient expenses are usually covered out-of-pocket, with caps on how much can be covered using Medisave funds. OPAT is considered an outpatient expense, with Medisave withdrawals for OPAT coverage capped at S$600 (USD $435) per weekly cycle, with a maximum of S$2400 (USD $1750) a year [17]. In general, OPAT does result in lower daily costs of treatment, compared to inpatient treatment [10]. However, since inception, financial disincentives to OPAT utilization have existed for subsidized patients [9]. Some patients are required to be admitted inpatient prior to OPAT so that some of the OPAT charges can be covered in the inpatient Medisave cost. While this may serve as a financial disincentive, the extent to which it potentially impacts OPAT acceptability is unknown. Accessibility to OPAT is an important issue, given that the bulk of OPAT patients (75% in 2005) actually comes from subsidized classes [9]. Given the cost-effectiveness of OPAT, we were interested in investigating what factors might be associated with OPAT acceptance in our local context, and potential barriers that might hinder broader OPAT acceptance in our local community.

Methodology

Study setting

We conducted a cross-sectional study of all patients referred to the OPAT service at Singapore General Hospital, a tertiary public hospital in Singapore, from January 2014 to December 2017. During this time period, our institution offered both H-OPAT and S-OPAT services. Generally, prospective patients for OPAT are first referred to an infectious diseases specialist and subsequently reviewed by a dedicated OPAT team (comprising doctors and nurses) to assess suitability for OPAT treatment. Referrals of prospective candidates for OPAT are usually seen by the OPAT team within 24 h (during working hours). As part of this assessment, the dedicated OPAT team assess suitability to OPAT based on patients' medical and social situations. Based on this, patients are deemed either suitable or unsuitable for OPAT. The OPAT team also provides OPAT orientation and counseling, including financial counseling on the treatment fee to the patient and prospective careers). Patients then choose whether to accept or decline OPAT.

Study population

At baseline, we prospectively collected the following information: sociodemographic characteristics (gender, age, resident status, subsidy class, type of housing (public or private), and whether they stayed in a public rental flat neighborhood (which is a marker of low area socioeconomic status in Singapore) [18]); clinical characteristics (comorbidity burden, based on the Charlson Comorbidity Index, CCMI; mobility status—whether the patient was independently ambulant, or wheelchair/bed-bound); and referral characteristics (year of referral, referring department, and if the patient had OPAT previously). In Singapore, hospital patients can opt for different ward classes (with differing levels of amenities), which in turn are linked to differing levels of subsidy that are subject to means testing. Patients opting for private ward classes (class A/B1) have minimal subsidies, whereas for patients in subsidized ward classes (class B2/C) enjoy 50–80% subsidies, depending on their monthly income [19]. Patients' ward classes are hence a reflection of their socioeconomic status [15]. We also calculated the average travel time (based on driving time) and geographical distance (based on straight-line distances) between the patient's residential address (postal code) and the OPAT clinic at SGH. The average driving time between patients' residential address and SGH was 18.9 min (SD = 6.78), while the mean straight-line geographical distance between patients' residential address and SGH was 15.43 km (SD = 8.06). We dichotomized average driving time and geographical straight-line distances using the mean value as the cutoff. Data on average travel times and geographical distance were obtained from the OneMap API [20], which is developed

by the Singapore Land Authority. Based on the documentation provided by the OPAT team, we classified the reason cited as reasons for rejection from OPAT. We classified these reasons into patient-related factors as well as discharge-related factors.

Ethics approval

This study involved human participants and was approved by the Singhealth Institutional Review Board (IRB) (approval number: CIRB 2014/151/F). Approval for retrospective analysis of patient data was obtained from the Singhealth IRB.

Statistical analysis

We compared differences in sociodemographic and clinical factors between patients who accepted OPAT and those who declined, using chi-square test for univariate analysis and logistic regression for multivariate analysis. All statistical analysis was performed using STATA (Version 22.0, USA) and statistical significance was set at $p < 0.05$.

Results

From January 2014 to December 2017, a total of 1406 referrals were made to our institution's OPAT service. Of these, 95.9% (1349/1406) were deemed suitable for OPAT. The top reasons for unsuitability were availability of oral options (40.0%, 23/57) and being deemed medically unsuitable by the OPAT team (75.4%, 43/57). The main reasons for medical unsuitability centered around concerns with regard to the patient's overall clinical condition (32.6%, 14/43) and concerns with the status of the patient's infection (30.2%, 13/43).

Amongst those who were deemed suitable for OPAT, 90.0% (1213/1349) eventually chose OPAT treatment.

The factors associated with patients' acceptance of OPAT on univariate analysis are listed in Table 1. Being aged < 60 years, having minimal comorbidities (CCMI score of 0), and being independently ambulant were associated on univariate analysis with preference for OPAT treatment. Clinically, patients referred for orthopedic-related infections (e.g., osteomyelitis) and patients having underlying medical conditions of ischemic heart disease, peripheral vascular disease, previous stroke, and chronic kidney disease had lower odds of acceptance of OPAT on univariate analysis. On the social aspects, socioeconomic factors were a key factor associated with OPAT acceptance in the univariate analysis. Subsidized patients (B2/C class) and those staying in public rental flats were less likely to accept OPAT treatment (all $p < 0.05$). Referrals in subsequent years (from 2015 onwards) and referrals of patients warded under the Department of Infectious Diseases (as opposed to a patient being cared for primarily by another subspecialty) were also associated with higher odds of being accepted for OPAT treatment, on univariate analysis. Acceptance rates for OPAT were 84.4% in 2014, compared to acceptance rates of 90.8–92.2% from 2015 to 2017; hence, we bifurcated referrals into those received in 2014, and those received from 2015 to 2017. There was no difference in acceptance rates by proximity to OPAT (whether measured by driving time or straight-line distances).

The factors independently associated with acceptance of OPAT on multivariate analysis are listed in Table 2.

On multivariate analysis, being independently ambulant (aOR = 3.46, 95%CI = 2.21–5.37) was independently associated with higher likelihood of acceptance for OPAT; whereas patients with peripheral vascular disease were less likely to accept OPAT (aOR = 0.32, 95%CI = 0.16–0.62). Socioeconomic status (SES) was closely associated with OPAT acceptance, with markers of both individual-level SES (subsidized ward class) and area-level SES (staying in a public rental flat) being independently associated with lower odds of OPAT acceptance. Referrals in subsequent years and referrals of inpatients under the Department of Infectious Diseases were also independently associated with higher likelihood of being accepted for OPAT treatment. We further analyzed the reasons for rejection of OPAT (Table 3). The top three reasons for rejection of OPAT were as follows: lack of caregiver ($n = 35$), mobility issues ($n = 24$), financial issues ($n = 24$), and difficulty caring for the line ($n = 21$). The top reasons for rejection of OPAT were mainly patient-related. These issues centered around concerns with administration (e.g., issues with caring for line, lack of manual dexterity, and visual impairment); logistical issues (lack of caregiver or limited mobility making it difficult to return for outpatient visits); and financial issues. In a minority of cases, factors related to patient's discharge precluded OPAT; this included having to remain inpatient for other reasons (e.g., continuation of other medical treatments, chemotherapy, or rehabilitation); transfer of care to other settings (e.g., discharge to home country); and short remaining duration of parenteral antibiotic therapy, or alternative locations for outpatient antibiotic administration (e.g., hemodialysis centers, outpatient chemotherapy units).

Discussion

In our study, about 5% of referrals to OPAT were deemed unsuitable, with medical suitability or availability of alternative oral options being the main reasons. Identifying and checking patient suitability for OPAT is a key component of managing risks associated with OPAT services [21], and physician judgment is important [22]. In this study of OPAT acceptance in a high-income country with a hybrid healthcare financing system, about 10% of patients deemed suitable for OPAT rejected OPAT; this was comparable with similar rates of about 10–12% in other studies [4, 5, 23]. The factors independently associated with acceptance of OPAT can be divided into referral

Table 1 Sociodemographic and clinical factors associated with acceptance of outpatient parenteral antibiotic therapy from 2014 to 2017, amongst those eligible for OPAT ($N = 1352$)

	Did not accept OPAT, *n*%	Accepted OPAT, *n*%	OR (95% CI)	*p* value
Demographic factors				
Gender				
Female	62 (12.2)	448 (87.8)	1.00	0.080
Male	77 (9.1)	765 (90.9)	1.59 (1.17–2.16)	
Age				
Age < 60 years	62 (8.3)	683 (91.7)	1.00	0.009
Age ≥ 60 years	77 (12.7)	530 (87.3)	0.63 (0.44–0.89)	
Resident				
No	5 (7.1)	65 (92.9)	1.00	0.542
Yes	134 (10.5)	1148 (89.5)	0.66 (0.26–1.67)	
Socioeconomic factors				
Subsidized class				
No (A/B1 class)	17 (6.0)	265 (94.0)	1.00	0.008
Yes (B2/C class)	122 (11.4)	948 (88.6)	0.50 (0.30–0.84)	
Housing type				
Public housing	118 (11.0)	958 (89.0)	1.00	0.011
Private housing	11 (5.3)	197 (94.7)	2.20 (1.17–4.17)	
Area socioeconomic status				
Owner-occupied	112 (9.2)	1099 (90.8)	1.00	0.001
Staying in public rental housing	17 (23.3)	56 (76.7)	0.34 (0.19–0.60)	
Geographical factors				
Driving time				
Staying ≤ 19 mins away from OPAT	59 (9.7)	550 (90.3)	1.00	0.779
Staying > 19 mins away from OPAT	68 (10.2)	598 (89.8)	0.94 (0.65–1.36)	
Geographical distance				
Staying ≤ 15 km away from OPAT	58 (10.2)	509 (89.8)	1.00	0.926
Staying ≤ 15 km away from OPAT	71 (10.0)	642 (90.0)	1.03 (0.72–1.49)	
Clinical factors				
Mobility status				
Non-ambulant (wheelchair or bedbound)	43 (26.1)	122 (73.9)	1.00	< 0.001
Ambulant independently	96 (8.1)	1091 (91.9)	4.00 (2.67–6.00)	
Charlson Comorbidity Index (CCMI)				
CCMI = 0	32 (7.5)	395 (92.5)	1.00	0.021
CCMI ≥ 1	107 (11.6)	818 (88.4)	0.62 (0.41–0.94)	
Has ischemic heart disease				
No	110 (9.4)	1056 (90.6)	1.00	0.013
Yes	29 (15.6)	157 (84.4)	0.56 (0.36–0.88)	
Has peripheral vascular disease				
No	122 (9.4)	1177 (90.6)	1.00	< 0.001
Yes	17 (32.1)	36 (67.9)	0.22 (0.12–0.40)	
Has stroke				
No	130 (9.9)	1179 (90.1)	1.00	0.035
Yes	9 (20.9)	34 (79.1)	0.42 (0.20–0.89)	
Has chronic kidney disease				
No	113 (9.6)	1065 (90.4)	1.00	0.044
Yes	26 (14.9)	148 (85.1)	0.60 (0.38–0.96)	
Has cancer				
No	113 (10.6)	955 (89.4)	1.00	0.512
Yes	26 (9.2)	258 (90.8)	1.17 (0.75–1.84)	
Disease characteristics				
Orthopedic-related disease				
No	85 (8.7)	887 (91.3)	1.00	0.004
Yes	54 (14.2)	326 (85.8)	0.58 (0.40–0.83)	

Table 1 (continued)

	Did not accept OPAT, *n*%	Accepted OPAT, *n*%	OR (95% CI)	*p* value
Prosthetic infection				
No	131 (10.5)	1112 (89.5)	1.00	0.409
Yes	8 (7.3)	101 (92.7)	1.49 (0.71–3.12)	
Osteomyelitis				
No	111 (9.4)	1066 (90.6)	1.00	0.011
Yes	28 (16.0)	147 (84.0)	0.55 (0.35–0.86)	
Intra-abdominal abscess				
No	111 (10.5)	943 (89.5)	1.00	0.666
Yes	28 (9.4)	270 (90.6)	1.4 (0.73–1.76)	
Organism characteristics				
Staphylococcal infections				
No	107 (9.8)	982 (90.2)	1.00	0.259
Yes	32 (12.2)	231 (87.8)	0.79 (0.52–1.20)	
Unknown organism				
No	121 (10.9)	987 (89.1)	1.00	0.104
Yes	18 (7.4)	226 (93.6)	1.54 (0.92–2.58)	
Treatment characteristics				
Using > 1 antibiotic in OPAT				
No	130 (10.5)	1112 (89.5)	1.00	0.516
Yes	9 (8.2)	101 (91.8)	1.31 (0.65–2.67)	
Mode of OPAT				
Infusion center model (H-OPAT)	79 (9.2)	780 (90.8)	1.00	0.094
Self-administration via elastomeric pump (S-OPAT)	60 (12.2)	433 (87.8)	0.73 (0.51–1.04)	
Referral characteristics				
Referral discipline				
Not referred from infectious diseases department	120 (11.4)	933 (88.6)	1.00	0.010
Referred from infectious diseases department	19 (6.4)	280 (93.6)	1.90 (1.15–3.13)	
Not referred from medical department	65 (12.1)	474 (87.9)	1.00	0.083
Referred from medical department	74 (9.1)	739 (90.9)	1.37 (0.96–1.95)	
Year of referral				
2014	48 (15.6)	260 (84.4)	1.00	0.001
2015–2017	91 (8.7)	953 (91.3)	1.93 (1.33–2.82)	
Had OPAT before				
No	129 (10.6)	1089 (89.4)	1.00	0.296
Yes	10 (7.5)	24 (92.5)	1.47 (0.75–2.87)	

Table 2 Sociodemographic and clinical factors independently associated with acceptance of outpatient parenteral antibiotic therapy from 2014 to 2017 ($N = 1352$)

Sociodemographic/clinical factors	Adjusted odds ratio (aOR), 95% confidence interval (95% CI)	*p* value
Demographic factors		
Male gender (vs. female gender)	1.42 (0.96–2.91)	0.080
Independently ambulant (vs. bedbound/wheelchair bound)	3.46 (2.21–5.37)	< 0.001
Clinical factors		
Has peripheral vascular disease (vs. no peripheral vascular disease)	0.32 (0.16–0.62)	0.001
Socioeconomic factors		
Subsidized patient (B2/C class) vs. private patient (B1/A class)	0.38 (0.19–0.75)	0.005
Staying in a public rental flat vs. staying in owner-occupied housing	0.43 (0.23–0.81)	0.009
Referral characteristics		
Referred after 2014 (vs. referrals in 2014)	1.90 (1.26–2.87)	0.002
Referred from ID department (vs. referrals from other departments)	1.74 (1.01–2.98)	0.045

Table 3 Reasons for rejection of outpatient parenteral antibiotic therapy ($N = 139$)

Reasons for rejection of outpatient parenteral antibiotic therapy	Number of patients (n)
Patient factors	
Difficult venous access	1
Visual impairment	3
Lack of manual dexterity	2
Poor compliance	2
Difficulty caring for line	21[3]
Lack of caregiver	35[1]
Mobility issues	24[2]
Financial issues	24[2]
Patient choice	16
Discharge factors	
Prolonged inpatient stay; antibiotics completed inpatient	12
Discharged to community hospital as required rehabilitation	12
Concurrently undergoing chemotherapy	3
Going back to home country	4
Discharge against medical advice	7
Antibiotics given in alternative outpatient setting (e.g., ATU, HD center)	7

Numbers in superscript represent the most common reasons cited. More than one reason could be cited for each individual patient

characteristics and patient characteristics. Referrals of inpatients cared for by infectious disease (ID) physicians had higher odds of accepting OPAT, perhaps because of greater propensity for right-siting of patients at the onset. In our institution, all potential OPAT referrals are referred, initially, to an ID physician; if the primary ID physician concurs with the referral, then the OPAT team sees and provides counseling/training for the prospective OPAT candidate. As self-administered OPAT (S-OPAT) formed almost a third of our center's cases (36.5%), the OPAT orientation and counseling for S-OPAT can be fairly lengthy (~ 45–60 min) as compared to that for H-OPAT (~15 mins), as patients need to learn how to self-connect and store elastomeric pumps and be counseled on the additional cost (on top of the standard education on line care and location of the OPAT clinic). Thus, adding an extra triage step in the form of ID referral helps to allocate OPAT resources more efficiently. Other institutions that use S-OPAT also report significant time spent on patient/career training (1–2 h), with patients requiring a day or two to become proficient with self-administration of antibiotics [5, 24].

Low functional status (impaired mobility) and presence of peripheral vascular disease were significantly associated with OPAT acceptance. In our center, during the time period of this study, we offered both H-OPAT and S-OPAT, with around two-thirds of patients using H-OPAT (needing to attend OPAT clinic daily for antibiotics infusion that last for up to 60 min) and one-third of patients using S-OPAT (needing to attend OPAT clinic one–two times a week for clinical assessment and refill of medication). Lack of a caregiver and mobility issues were oft-cited reasons for rejection of OPAT. In densely built-up urban Singapore, actual physical distance or driving time to OPAT was not associated with OPAT acceptance. Rather, independent mobility and availability of a career were the key factors, suggesting that the key issue for OPAT candidates was getting out of the house, rather than the total time or distance that they had to travel. Greater adoption of homecare OPAT in hospital-at-home models may be a potential solution to this problem. In Western societies, utilizing the concept of hospital-at-home units, home intravenous antimicrobial treatment is targeted to more complex patients, with greater intervention from both nursing staff and physicians (e.g., ~ 5 physician visits and ~ 10 nursing visits per episode) [25]. While home OPAT forms a part of the evolving OPAT landscape in Singapore [12], OPAT is still predominantly delivered in the form of H-OPAT, perhaps due to concerns regarding the risks of clinical deterioration [13]. In most Asian countries, H-OPAT is the predominant service offered, with a small number of institutions (Singapore, Malaysia, Japan) offering S-OPAT; [6] homecare OPAT is much less common. In our center, the expansion of transitional homecare programs [26] has led to the opportunity to expand homecare OPAT; however, as transitional homecare programs are limited to geographic areas within the designated catchment of the hospital [27], this poses a limitation when patients requiring OPAT services fall outside of the zones.

Socioeconomic status at the individual level and at the area level was significantly associated with OPAT acceptance. Those staying in public rental flats had lower odds of acceptance for OPAT Home ownership rates are high in Singapore (87.2%) [28]. For the needy (< 5% of population) who cannot afford their own home, heavily subsidized public rental housing is available [29]. Staying in a public rental flat in Singapore has been correlated with lower utilization of other health services, such as preventive services and health screening [30, 31]. The association between socioeconomic status (ward class) and OPAT acceptance noted in our study is likely a function of major cost disincentives that patients appropriate for OPAT experience in our local context. In 2002, the Ministry of Health approved the usage of Medisave for OPAT, but with a withdrawal limit of S$600 (USD $435) per week, subject to an annual limit of S$2400 (USD $1750) [32]. These caps have remained in place since 2002 [17], even as healthcare costs continue to rise [33]. If subsidized patients remain inpatient for intravenous antibiotics, they can utilize up to S$450 (USD $350) per day from Medisave for daily hospital charges [34]. If they choose to receive OPAT, though the mean cost of OPAT is lower than that of inpatient care (mean cost of OPAT in a 2010 study averaged USD $278 per day, compared with USD $457 for inpatient care) [10], patients likely have to pay a significant portion of OPAT costs out-of-pocket, given the withdrawal

limit of S$600 (USD $435) per week [32]. This is a significant disincentive, especially since the majority (79.0%) of potential OPAT enrollees in our study came from the subsidized class. The uptick in OPAT acceptance post-2015 could also potentially be attributable to changes to healthcare financing. In 2015, the usage of Medisave was expanded to cover the cost of outpatient scans (up to S$300); those aged ≥ 65 years could use an additional S$200 a year for outpatient treatment [35]. Previously, OPAT enrollees had to pay for outpatient services, such as consultation fees, laboratory tests (e.g., for therapeutic drug monitoring) and radiology (e.g., for follow-up scans after completing a course of OPAT) with out-of-pocket payment, as Medisave withdrawals cannot be used to pay for these outpatient services; as opposed to the inpatient setting where these services are included in the consolidated inpatient bill and can be paid for by Medisave. Financial barriers to accepting OPAT exist in other countries with different healthcare models [36]; in a study of Canadian patients, lower-income patients preferred remaining in hospital for antibiotic administration, as opposed to OPAT; perhaps because of similar reimbursement issues [37]. However, solutions for these barriers need to take into account features of healthcare financing that are specific to each country. In Singapore, a possible solution would be to raise OPAT-specific withdrawal limits to reduce out-of-pocket payment. In the long run, perhaps a shift towards a bundled payments system for common infectious diseases conditions [38] could shift the burden away from the individual (out-of-pocket payments) towards institutional support for OPAT, given its lower cost than inpatient care [10]. OPAT's role in easing the transition from inpatient to outpatient care [39] needs to be reflected in funding structures, in order to improve accessibility.

The limitations of our study were as follows. As this was a single-site study, the findings may not be fully representative of all prospective OPAT enrollees in Singapore. However, significant similarities exist in the structure of various OPAT programs in Singaporean tertiary hospitals [9]. Additionally, patients referred on for evaluation by the dedicated OPAT team had usually been assessed by an infectious diseases physician in the ward; without the role of the infectious disease physician in triaging referrals, the rate of inappropriate referrals may potentially be much higher. Findings about financial barriers to accepting OPAT also have limited generalizability to other countries, as Singapore has its own unique model of healthcare funding.

In conclusion, comorbidities, mobility, and financial issues are all important factors to consider when determining suitability for OPAT. Socioeconomic status (SES) was closely associated with OPAT acceptance, with markers of both individual-level SES (subsidized ward class) and area-level SES (staying in a public rental flat) being independently associated with lower odds of OPAT acceptance. More can be done to improve accessibility of OPAT amongst lower-income patients in the Singaporean context, in particular by removing financial disincentives.

Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

Ethical approval This study involved human participants and was approved by the Singhealth Institutional Review Board (IRB) (approval number: CIRB 2014/151/F). Approval for retrospective analysis of patient data was obtained from the Singhealth IRB.

Informed consent Waiver of informed consent for retrospective analysis of patient data was obtained from the Singhealth IRB.

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