

# Outpatient Parenteral Antimicrobial Therapy Practice in United Kingdom: A Single-center Experience

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## ABSTRACT

**Objectives:** This study sought to analyze the outpatient parenteral antimicrobial therapy (OPAT) services provided by a tertiary hospital, in terms of types and duration of antimicrobials administered, and assess whether these services were in line with current good practice recommendations. **Methods:** The electronic healthcare records of all stable patients with infectious diseases, aged  $\geq 18$  years, who received OPAT services between January 2019 and March 2021, were analyzed. For statistical analysis, the patients were divided into younger ( $< 65$  years) and older ( $\geq 65$  years) adults and the difference between them, in terms of healthcare resources utilization, was assessed. **Results:** Over 27 months, 199 patients received OPAT services, resulting in saving of 7514 bed-days. Bone and joint infections (38.7%) were the predominant diagnoses. The median actual OPAT duration was significantly greater than the planned duration for the total study population, younger adults, and older adults ( $p < 0.050$ ). Of 28 (14.1%) patients with adverse events, 25 were related to antimicrobials while the remaining three were associated with catheters. There were no significant differences between younger and older adults in the characteristics evaluated, except for the higher incidence of *Staphylococcus aureus* ( $p < 0.001$ ) and *Escherichia coli*, *Staphylococcal* spp., *Streptococcal* spp., and *Pseudomonas* spp. ( $p = 0.003$ ) infection in older adults. **Conclusions:** The actual median duration of OPAT therapy was significantly longer than planned, with suboptimal adherence to the principles of antimicrobial stewardship. OPAT has been shown to be safe for both younger and older adults.

Outpatient parenteral antimicrobial therapy (OPAT) was first described in 1974 in the US and since then has grown in popularity in many countries.<sup>1,2</sup> Compared to traditional inpatient care, OPAT brings benefits such as better-quality care and shortened hospital stays resulting in greater savings, shorter waiting lists, greater availability of hospital beds, and greater patient comfort in maintaining daily activities, resulting in patient satisfaction.<sup>3</sup>

OPAT involves administering intravenous (IV) antimicrobials to patients with infectious diseases in outpatient care (hospital OPAT) or at home, by a

nurse (homecare OPAT), or by themselves/relatives.<sup>4</sup> These services are usually used in indications such as cystic fibrosis, infectious endocarditis, complicated urinary tract infections, bone and joint infections (BJIs), and skin and soft tissue infections (SSTIs).<sup>5</sup> Early OPAT services focused on the timely dismissal of hospitalized infection patients who were stable in care, requiring only extensive parenteral antimicrobial therapy. Over the past two decades, the services have made concerted efforts to avoid hospitalization of many acutely infected patients.<sup>6-10</sup>

Following the original consensus statement issued in 1998, the recommendations for OPAT in

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the UK were regularly updated and the most recent recommendations were published in 2019 to keep pace with the changing scenario.<sup>11,12</sup> Despite the late start and slower initial introduction, OPAT services have expanded significantly in the UK.<sup>13</sup> Recently, the link between OPAT and antimicrobial stewardship (AMS) has been recognized. Thus, OPAT is diligently disseminated as part of the UK government's AMS programme.<sup>14</sup>

However, the expansion of these services has resulted in significant differences in OPAT practices, supply models, and governance rules. In addition, compliance with the national OPAT practice recommendations is weak.<sup>13</sup> Therefore, we conducted this study to review the model and duration of OPAT services provided by our hospital, and to understand the demographic and clinical profiles of the patients. We also assessed whether our OPAT services were in line with the recommendations for current good practice in the treatment of infections and have made recommendations to minimize shortcomings.

## METHODS

This retrospective study was performed in a 550-bed tertiary hospital in the UK providing care in all major specialties. The electronic healthcare records of all the patients who received OPAT services between January 2019 and March 2021 were analyzed. The stable patients with infectious diseases, belonging to either-sex, aged  $\geq 18$  years, and receiving outpatient IV antimicrobials were included in the study. Those receiving antimicrobials through oral and other parenteral routes than IV were excluded.

Inhouse OPAT services at our hospital began on 1 October 2020, before which these services used to be outsourced. The organizational aspects of our multidisciplinary OPAT team were based on the UK OPAT good practice recommendations and their subsequent updates.<sup>11,12</sup> The team, comprising a clinical microbiologist, a physician, clinical pharmacists, and specialist nurses, catered to patients with infectious diseases who were referred by physicians from the inpatient hospital wards and outpatient clinics. A weekly multidisciplinary team meeting was held for review of symptoms, treatment, as well as inspection and care of patient equipment such as the catheters. Follow-up laboratory and radiological investigations were performed, if required.

The patients received antimicrobials through peripheral catheters or peripherally inserted central catheters (PICC lines), the latter being inserted by specialist radiologists. The choice of the catheter was dependent on the duration of therapy (short vs. long term) and the type of therapy (intermittent vs. continuous administration). The PICC lines were used if the therapy was required for more than seven days and continuous administration was advised by the treating physician.

We used one of the two models of antimicrobial administration: clinic and homecare OPAT, where the nurses administered the therapy at the infusion site and home, respectively. The former model was mainly used for mobile patients requiring short-term antimicrobials (less than four days), while the latter model was used for those with limited mobility.

Data related to demographics (age and sex), diagnosis, presence of comorbidities such as diabetes mellitus (DM), rheumatoid arthritis and immunosuppression, the status of microbiological examination (prior to and during OPAT), antimicrobials used, duration of therapy (planned and actually administered), antimicrobials changed after microbiological examination, radiological examinations including computed tomography and magnetic resonance imaging, and outcomes of infection were recorded. Adverse events (AEs) related to antibiotics requiring discontinuation of therapy, vascular access complications, and death were also noted.

The data was analyzed with IBM SPSS Statistics (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). The normality of the continuous variables was tested with Shapiro-Wilk's test and non-normality distributed data was represented as median interquartile range (IQR). The categorical variables were represented as frequencies (percentages). For the purpose of analysis, the patients were distributed into two groups: younger adults ( $< 65$  years) and older adults ( $\geq 65$  years). Comparison between continuous and categorical variables was done with Mann-Whitney U and chi-square test, respectively. A two-tailed  $p < 0.050$  was considered statistically significant.

## RESULTS

Over 27 months, a total of 199 patients received OPAT services. They were predominantly male

**Table 1:** Characteristics of patients receiving OPAT (N = 199).

Characteristics	n	%
Age, year (median (IQR))	74 (62–84)	-
Male	121	60.8
<b>Comorbidities</b>		
Diabetes mellitus	70	35.2
Rheumatoid arthritis	9	4.5
Immunocompromised host	62	31.2
<b>Catheter type</b>		
Peripheral catheter	96	48.2
PICC lines	103	51.8
<b>Referred from</b>		
Inpatient wards	126	63.3
Outpatient clinics	73	36.7
<b>Model of antimicrobial administration</b>		
Hospital OPAT	101	50.8
Home OPAT	98	49.2
<b>Indications for OPAT</b>		
Bones and joints infection	77	38.7
Pulmonary infection	24	12.1
Infected prosthesis	24	12.1
Skin and soft tissue infection	20	10.1
Sepsis	19	9.5
Renal and urinary infections	8	4.0
Others	27	13.6
<b>Investigations</b>		
Radiological	101	50.8
Microbiological	188	94.5
<b>Timing of microbiological examination, n = 188</b>		
Prior to initiation of antimicrobials	142	75.5
Within two weeks of antimicrobials initiation	35	18.6
Two weeks after antimicrobials initiation	8	4.3
Both prior to and two weeks after antimicrobials initiation	3	1.6

OPAT: outpatient parenteral antimicrobial therapy; IQR: Interquartile range; PICC: peripherally inserted central catheters.

(60.8%) with a median age of 74 (IQR = 62–84) years. The majority had been referred from inpatient wards (126; 63.3%). Half of the patients received hospital OPAT (101; 50.8%) through PICC lines (103; 51.8%). Among various indications requiring IV antimicrobial therapy, the most commonly observed were BJI (77; 38.7%), pulmonary infection (24; 12.1%), infected prosthesis (24; 12.1%), and SSTI (20; 10.1%). Microbiological and radiological examinations were performed in 188 (94.5%) and 101 (50.8%) patients, respectively. DM (70; 35.2%)

**Table 2:** Microbiological findings, antimicrobials used, and complications of OPAT (N = 199).

Characteristics	n	%
<b>Microorganisms identified, n = 188</b>		
No growth	58	30.9
<i>Staphylococcus aureus</i>	38	20.2
<i>Escherichia coli</i>	18	9.6
<i>Staphylococcal</i> spp.	6	3.2
<i>Streptococcal</i> spp.	16	8.5
<i>Pseudomonas</i> spp.	12	6.4
Others	40	21.3
<b>Antimicrobials used</b>		
Any flucloxacillin combination	67	33.7
Any teicoplanin combination	49	24.6
Any amoxicillin combination	18	9.0
Any ertapenem combination	10	5.0
Any ceftriaxone combination	9	4.5
Piperacillin/tazobactam	19	9.5
Others	27	13.6
Antimicrobials changed after microbiological examination, n = 188	31	16.5
<b>Duration of antimicrobials prescribed</b>		
Planned, median (IQR)	42 (14–42)	-
Actual, median (IQR)	37 (15–51)	-
<b>Duration of OPAT</b>		
Longer than planned	135	67.8
As planned	34	17.1
Shorter than planned	30	15.1
<b>Complications</b>	28	14.1
Gastrointestinal	13	46.4
Hematological	4	14.3
Others	11	39.3
<b>Mortality after completion of OPAT</b>		
At 30 days	2	1.0
At one year	18	9.0

OPAT: outpatient parenteral antimicrobial therapy; IQR: interquartile range.

was the most common comorbidity. Among those in which microbiological examination was performed, 142 (75.5%) patients had it prior to initiation of antimicrobials. While 35 (18.6%) and eight (4.3%) patients underwent microbiological examination within and after two weeks of the initiation of antimicrobials, respectively. However, only three (1.6%) patients underwent microbiological examination both prior to and after the initiation of antimicrobials [Table 1].

Among patients who underwent microbiological examination, 58 (30.9%) had no growth of microorganisms. Among those with the growth of

**Table 3:** Comparison of characteristics of patients receiving OPAT.

Characteristics	Younger adults (< 65 years) n = 54 n (%)	Older adults (≥ 65 years) n = 145 n (%)	p-value
Age, year (median (IQR))	55 (50–60)	80 (72–85)	< 0.001
Male	33 (61.1)	88 (60.7)	0.957*
<b>Comorbidities</b>			
Diabetes mellitus	22 (40.7)	48 (33.1)	0.316*
Rheumatoid arthritis	4 (7.4)	5 (3.4)	0.232*
Immunocompromised host	12 (22.2)	50 (34.5)	0.097*
<b>Catheter type</b>			
Peripheral catheter	26 (48.1)	70 (48.3)	0.987*
PICC lines	28 (51.9)	75 (51.7)	
<b>Referred from</b>			
Inpatient wards	36 (66.7)	90 (62.1)	0.550*
Outpatient clinics	18 (33.3)	55 (37.9)	
<b>Model of antimicrobial administration</b>			
Hospital OPAT	29 (53.7)	72 (49.7)	0.611*
Home OPAT	25 (46.3)	73 (50.3)	
<b>Indications for OPAT</b>			
Bones and joints infection	21 (38.9)	56 (38.6)	0.798*
Pulmonary infection	5 (9.3)	19 (13.1)	0.259*
Skin and soft tissue infection	4 (7.4)	16 (11.0)	
Infected prosthesis	7 (13.0)	17 (11.7)	0.811*
Sepsis	4 (7.4)	15 (10.3)	0.879*
Renal and urinary infections	3 (5.6)	5 (3.4)	
Others	10 (18.5)	17 (11.7)	0.213*
<b>Investigations</b>			
Radiological	31 (57.4)	70 (48.3)	0.252*
Microbiological	51 (94.4)	137 (94.5)	0.992*
<b>Timing of microbiological examination</b>			
Prior to initiation of OPAT	41 (80.4)	101 (73.7)	0.140*
Within two weeks of OPAT initiation	9 (17.6)	26 (19.0)	0.344*
Two weeks after antimicrobials initiation	1 (2.0)	7 (5.1)	
Both prior to and two weeks after OPAT initiation	0 (0.0)	3 (2.2)	

OPAT: outpatient parenteral antimicrobial therapy; IQR: interquartile range; PICC: peripherally inserted central catheters.

\*Chi-square test.

microorganisms, *Staphylococcus aureus* (38; 20.2%) was most commonly isolated. The majority of the patients received a single antimicrobial (147; 73.9%). Flucloxacillin (49; 24.6%), teicoplanin (32; 16.1%), and piperacillin-tazobactam (19; 9.5%) were the most common single antimicrobial agents used. Of all the antimicrobials, any flucloxacillin combination (67; 33.7%) followed by any teicoplanin combination (49; 24.6%) were the most common. Though 188 (94.5%) patients underwent microbiological examination, only in 31 (16.5%) of those cases were antimicrobials changed after receiving the culture reports. The planned durations

for the administration of the antimicrobials ranged 3–90 days, while the actual durations ranged 3–187 days. Two-thirds of patients (135; 67.8%) received OPAT for longer periods than planned. Five (2.5%) patients received antimicrobials for 100 days or more, and one for 187 days. A minority (34; 17.1%) received antimicrobials as per the planned durations, while 30 (15.1%) received OPAT for shorter periods than planned. Re-treatment was required for 30 (15.1%) patients. Twenty-eight (14.1%) patients developed AEs, of which those involving the gastrointestinal system 13 (46.4%) pre dominated [Table 2].

**Table 4:** Comparison of microbiological findings, antimicrobials used, and complications of OPAT.

Characteristics	Younger adults (< 65 years) n = 54 n (%)	Older adults (≥ 65 years) n = 145 n (%)	p-value
<b>Microorganisms identified</b>			
No growth	14 (27.5)	44 (32.1)	0.538*
<i>Staphylococcus aureus</i>	20 (39.2)	18 (13.1)	< 0.001*
<i>Escherichia coli</i>	1 (2.0)	17 (12.4)	0.003*
<i>Staphylococcal</i> spp.	1 (2.0)	5 (3.6)	-
<i>Streptococcal</i> spp.	3 (5.9)	13 (9.5)	-
<i>Pseudomonas</i> spp.	1 (2.0)	11 (8.0)	-
Others	11 (21.6)	29 (21.2)	0.952*
<b>Antimicrobials used</b>			
Any flucloxacillin combination	23 (42.6)	44 (30.3)	0.104*
Any teicoplanin combination	10 (18.5)	39 (26.9)	0.223*
Any amoxicillin combination	4 (7.4)	14 (9.7)	0.987*
Any ertapenem combination	3 (5.6)	7 (4.8)	-
Any ceftriaxone combination	3 (5.6)	6 (4.1)	-
Piperacillin/tazobactam	5 (9.3)	14 (9.7)	0.933*
Others	6 (11.1)	21 (14.5)	0.537*
Antimicrobials changed after microbiological examination	7 (12.9)	24 (16.6)	0.535*
<b>Duration of antimicrobials prescribed</b>			
Planned, median (IQR)	42 (14–42)	42 (14–42)	0.771 <sup>s</sup>
Actual, median (IQR)	41 (15–51)	36 (14–51)	0.569 <sup>s</sup>
Antimicrobials for duration more than planned	29 (53.7)	77 (53.1)	0.940*
<b>Complications</b>			
Gastrointestinal	5 (9.3)	8 (5.5)	0.342*
Hematological	1 (1.9)	3 (2.1)	0.575*
Others	4 (7.4)	7 (4.8)	-
<b>Mortality after completion of OPAT</b>			
At 30 days	0 (0.0)	2 (1.4)	0.069*
At one year	2 (3.7)	16 (11.0)	

OPAT: outpatient parenteral antimicrobial therapy; IQR: interquartile range.

\*Chi-square test; <sup>s</sup>Mann-Whitney U.

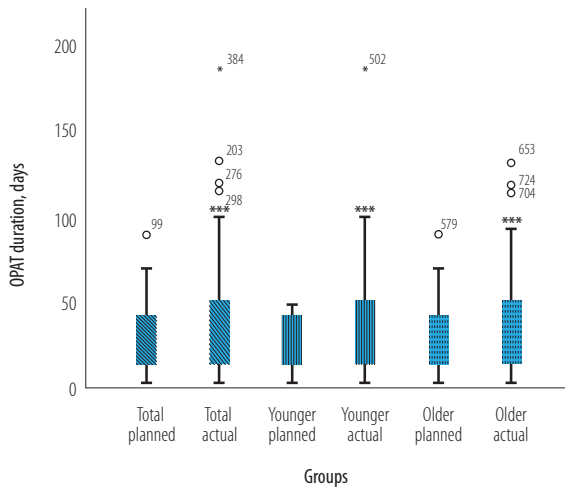
Of the 28 cases of AE, 25 were antimicrobials-related, while the remaining three were catheter-associated. Among the patients with AEs, six had diarrhea, three had vomiting, two each had nausea and lethargy, and one each had acute kidney injury, anemia, neutropenia, hyperkalemia, chest pain, raised alkaline phosphatase levels, insomnia, relapse of infection, septic infection, sepsis secondary to chest drains, septic emboli, and death. Catheter-associated AEs were related to line blockage, swelling of skin adjacent to the catheter, and thrombophlebitis in one patient each. Two patients died after 30 days of completing OPAT, and after one year, this number rose to 18. The deaths were related to relapse of pulmonary infection in eight

patients, malignancy in five, and sepsis in five patients [Table 2].

Between the younger and older groups, there were no significant differences in characteristics such as sex, comorbidities, catheter type, referral status, model of antimicrobial administration, indications for OPAT, or types of investigations conducted ( $p > 0.050$ ) [Table 3].

Significantly more older adults had an infection due to *S. aureus* ( $p < 0.001$ ), and *Escherichia coli*, *Staphylococcal* spp., *Streptococcal* spp., and *Pseudomonas* spp. ( $p = 0.003$ ). However, there was no significant difference between younger and older adults in terms of other isolated microorganisms, antimicrobials used, duration of antimicrobials





\*\*\*Statistically significant difference between the planned and actual duration of OPAT services ( $p < 0.050$ ).

**Figure 1:** Association between planned and actual duration of outpatient parenteral antimicrobial therapy (OPAT) in the total study population, younger adults, and older adults.

prescribed, and OPAT AEs ( $p > 0.050$ ). Though more older adults had mortality both after 30 days and one year, this did not reach a statistically significant level ( $p = 0.069$ ) [Table 4].

The median actual OPAT duration was significantly greater than the median planned OPAT duration for the total study population ( $p < 0.001$ ), younger adults ( $p = 0.031$ ) and older adults ( $p = 0.002$ ) [Figure 1].

No statistically significant association was found between cases of death and variables of sex, comorbidities (DM, rheumatoid arthritis, and immunosuppression), microbiological examination prior to antimicrobials, continuation

of antimicrobial therapy longer than planned, AEs, PICC lines, referral from inpatient wards, or using hospital OPAT service (all  $p > 0.050$ ) [Table 5].

## DISCUSSION

While antimicrobial agents are indispensable in treating severe and potentially fatal infections,<sup>15</sup> their injudicious use can lead to negative outcomes. Some antimicrobials (aminoglycosides) used in combinations with other antimicrobials (amphotericin) or other classes of drugs produce toxic AEs. Indiscriminate use of broad-spectrum antimicrobials disrupts the normal body flora, thereby permitting proliferation of resistant and opportunistic microorganisms which can lead to secondary infections.<sup>16</sup> Thus, ideally, the pathogen should be identified and its virulence estimated before initiating the antimicrobial therapy and planning its duration.

The OPAT has become common in Canada and the UK. It is also practiced in various forms in some countries in South America, Europe, and the Asia Pacific.<sup>1,17–20</sup> Several health care centers across Australia and New Zealand also provide OPAT services.<sup>21–24</sup> In Asia, the rising popularity of OPAT is marred by lax regulations. One comprehensive survey found that 97/171 (57%) healthcare facilities across 17 Asian countries were not following the recommended OPAT practices.<sup>25</sup>

Our hospital in Surrey, England, follows the UK national recommendations which require OPAT services to be run by a multidisciplinary team with

**Table 5:** Association between death and characteristics of patients who died one year after cessation of OPAT.

Characteristics	Death		Total	* <i>p</i> -value
	Yes, n = 18 n (%)	No, n = 181 n (%)		
Male	11 (61.1)	110 (60.8)	121	0.978
Diabetes mellitus	10 (55.6)	60 (33.1)	70	0.058
Rheumatoid arthritis	1 (5.6)	8 (4.4)	9	0.825
Immunosuppression	9 (50.0)	53 (29.3)	62	0.070
Microbiological examination prior to OPAT	12 (66.7)	130 (71.8)	142	0.266
Antimicrobials further than planned	8 (44.4)	98 (54.1)	106	0.432
Adverse events	0 (0.0)	28 (15.5)	28	NA
PICC lines	7 (38.9)	96 (53.0)	103	0.252
Referral from inpatient wards	9 (50.0)	117 (64.6)	126	0.219
Hospital OPAT	8 (44.4)	93 (51.4)	101	0.575

OPAT: outpatient parenteral antimicrobial therapy; PICC: peripherally inserted central catheters.

\*Chi-square test.

at least one physician, an infectious disease specialist, a specialist nurse, and a clinical antimicrobial pharmacist.<sup>12</sup> In this study, we have analyzed our OPAT services provided between January 2019 and March 2021.

Over the course of 27 months, 199 patients were treated with OPAT. This saved 7514 bed-days, benefiting both patients and healthcare. The majority of these patients were referred from inpatient wards which reflects the actual needs of inpatient centers for beds. Our results are consistent with those reported in other studies.<sup>26,27</sup> Therefore, extended OPAT services lead to shorter hospital stays, particularly beneficial for hospitals with high bed occupancy. In addition, these services improve patient satisfaction.<sup>28,29</sup>

BJI together with infected prosthesis were the dominant indications that required antimicrobial therapy. Other studies also have reported a high prevalence of these infections.<sup>27,30</sup> BJI and SSTI lead to significant numbers of hospital admissions with longer hospital stays.<sup>31</sup> Prosthetic joint infections, although infrequent, carry 2–3 times higher risk of revision surgery. With the growing population of older people, the proportion of joint prostheses is expected to increase exponentially, along with cases of prosthetic joint infection.<sup>32</sup> Thus, the number of elderly patients requiring OPAT services is expected to increase.

Our OPAT team treated patients who were predominantly infected with *S. aureus* and *E. coli*. Among the other isolated microorganisms, one patient each had infection with *Clostridium difficile* and methicillin-resistant *S. aureus*. The infection-prone factors in the patient population were advanced age, most patients being aged  $\geq 65$  years, and mostly affected by immunosuppression due to comorbidities such as DM, steroid use, and cancers. Antimicrobial resistance is a growing international health problem,<sup>33,34</sup> further increasing the demand for parenteral antimicrobials. OPAT services need to develop more flexibility and readiness to address difficult-to-treat infections and new scenarios arising from resistant gram-negative bacterial infections.

We observed that flucloxacillin, teicoplanin, and their combinations with other antimicrobials were most often used. Similar results have been reported by other studies.<sup>35,36</sup> Although hospital OPAT was the dominant model, we observed greater acceptance

of home OPAT model in the last year. However, none of the patients felt comfortable with the self-treating OPAT model. This was basically due to the relatively new OPAT set-up in our hospital, and as a confidence-building measure, the OPAT group actively supported the home model instead of the self-rationing model, which requires training and supervision.

In case of infections with rapid clinical improvement, traditional long-acting IV antimicrobials may not always be necessary and an early transition from IV to oral treatment is possible. Long-term antimicrobial therapy is associated with a higher risk of resistance.<sup>37</sup> AMS is essential to prevent the risk of routine continuance OPAT for far longer than originally envisaged.<sup>38,39</sup> Indeed, we observed that many patients—both younger and older adults—were receiving OPAT significantly longer than planned. This is supported by reports elsewhere that patients treated partially or entirely at home may receive longer-term therapy than those treated entirely in hospital.<sup>38</sup>

Only three-quarters of our OPAT patients underwent microbiological tests before antimicrobials were administered. It is worth noting that only a fraction of patients had their antimicrobials changed after receiving the culture report. Although multidisciplinary team meetings were held weekly after the initiation of OPAT inpatient care to review patients' symptoms and treatment, retrospective analysis and internal discussion records showed that only 29% of patients were treated as per standard OPAT recommendations on appropriate testing, antibiotic selection, and treatment duration. These were primarily attributed to temporary staffing and inadequate sharing of documentation among the OPAT multidisciplinary team. Another factor was that OPAT services were being outsourced before October 2020 with an attendant lack of monitoring of services. In addition, the contribution of the 2019 coronavirus outbreak to the functioning of OPAT team and attitudes of patients toward prolonged antimicrobial therapy could not be ignored, as it resulted in many patients missing clinic appointments or follow-ups, leading to prolonged antimicrobial therapy.

A few other studies have compared the OPAT characteristics and results in younger and older adults. We did not notice any significant differences between them except for the significantly greater median age

and infections with *S. aureus*, *E. coli*, *Staphylococcal* spp., *Streptococcal* spp., and *Pseudomonas* spp. in older adults. Other studies reported similar results.<sup>30,40</sup> Brzozowski et al,<sup>30</sup> showed no difference between the younger and older patients in terms of AEs or access to health care within 30 days of OPAT cessation. Mujal et al,<sup>40</sup> reported that the rates of antibiotic treatment and re-hospitalization in younger and older patients were the same due to poor control of underlying infection, however, older adults had a higher rate of rehospitalization resulting from the exacerbation of the underlying diseases. In addition, AEs and catheter-related complications were identical across the age groups.

No statistically significant association was found between mortality and the different characteristics studied. Salles et al,<sup>41</sup> also reported lack of significant association between mortality and factors such as age group, sex, type of infection, OPAT model, type of catheter, or microbiological test used to guide treatment. Mortality, however, was significantly associated with palliative care and post-enrolment physician visit. Shrestha et al,<sup>42</sup> who studied nonagenarians receiving OPAT services, found a significant association between mortality and age, as well as *Clostridioides difficile* infection, higher white blood cell count, and lower platelet count at hospital admission. These parameters were not part of our study, so we could not assess such association.

Our study has limitations. First, being a retrospective study dependent on past healthcare records, it was not possible to randomize patients by age group. Second, we could not find accurate records of sensitivity reports, source data for various microbiological samples, or decisions taken to extend OPAT. Third, no data was available on other comorbidities that might have influenced mortality or AEs. The lack of data on immunomodulatory drugs meant that no drug-drug interactions leading to failure of antimicrobial therapy could be identified. Fourth, the retrospective nature of the study meant that we were unable to assess patient satisfaction, while the lack of data on treatment costs prevented cost analysis. Fifth, being a single-center study, the results cannot be generalized. Finally, no microorganisms were isolated from 30.9% of patient samples. Thus, there is a high probability that infection was not the cause of these patients' presentation.

The results of this study suggest that much more needs to be done to achieve the recommended

level of OPAT functioning. We make the following recommendations: First, the antibiotic registry should be easily accessible and available in the form of a single digital registry that includes antimicrobials prescribed in both inpatient and outpatient settings. These records should include patient details including diagnosis, comorbidities, specialties treating the patient, name of prescriber and administrator, antimicrobials prescribed with their rationale, dose, route, frequency and AEs, microbiological tests and their results, planned duration of treatment, and actual duration of treatment (start and end dates). Second, active surveillance should be carried out at regular intervals. Monitoring should focus on the following: (1) microbiological, hematological, and radiological examinations; (2) notification of the examination results to the referring or responsible physician; and (3) the maintenance and follow-up of a digital record containing the physician's comments on the results of the examinations and the estimated duration of any additional antimicrobial treatment. Third, an integrated outpatient system should be established in hospitals offering OPAT services. This system should alert all collaborating physicians when a patient arrives at the hospital, either in the emergency department or in the outpatient department, especially if the patient is receiving IV antimicrobials. Cooperation should be enhanced between physicians responsible for administering antimicrobials and physicians monitoring the patient for other conditions, the OPAT team, and general practitioners.

## CONCLUSION

The need and relevance of OPAT services are increasing with the growing public acceptance of the home model. This study suggests that the actual duration of OPAT services was significantly longer than planned and that the principles of AMS were less adhered to. In terms of different parameters, there was no significant difference between younger and older adults, except for older adults having a higher incidence of *S. aureus*, *E. coli*, *Staphylococcus* spp., *Streptococcus* spp., and *Pseudomonas* spp. infections. OPAT was found to be safe for both younger and older adults, with no significant association between mortality and patient characteristics.



### Disclosure

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