

# Best practices, implementation and challenges of outpatient parenteral antimicrobial therapy: results of a worldwide survey among healthcare providers

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## Abstract

**Background:** Outpatient Parenteral Antimicrobial Therapy (OPAT) is considered a patient-friendly and cost-effective practice. Patients in the OPAT service can be at risk for developing adverse events. Due to extensive variations in practice, guidelines have been developed to minimize the risks.

**Objectives:** In this first worldwide survey on OPAT, we explored the current OPAT services around the world, adherence to recommendations and identified best practices and challenges from different perspectives.

**Methods:** An e-survey was conducted and consisted of questions about demographics, characteristics of the OPAT service, role of pharmacy, future developments, and respondents' views on improvements as well as best practices.

**Results:** A total of 126 responses from 28 countries were included. Seventy-eight percent (78%) of the respondents stated that their facility provides antimicrobial therapy in the outpatient setting, whereas 22% did not. Forty-two percent (42%) of the hospitals with OPAT services had a specialized OPAT service, while 14% lacked specialized services and 22% had a partially specialized team in place. In facilities with a specialized OPAT service, the number of mandatory infectious disease (ID) consultations before discharge and clinical monitoring by an ID specialist or OPAT team member, the frequency of monitoring, and the availability of an OPAT registry were higher. A multidisciplinary team's presence was commonly noted as best practices. On the other hand, respondents experienced difficulties with reimbursement and lack of standardization in the screening, follow-up and monitoring of patients.

**Conclusion:** This survey provides a better understanding of the implementation and practices of OPAT services globally and describes best practices and the challenges from different professionals.

## Plain language summary

### Best practices, implementation and challenges of outpatient parenteral antimicrobial therapy: results of a worldwide survey among healthcare providers

#### Background

- Outpatient parenteral antimicrobial therapy (OPAT) is defined as 'the administration of parenteral antimicrobial therapy in at least 2 doses on different days without intervening hospitalization'

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- National and continental studies show a great proportion of unregulated OPAT services with the implementation of a specialized OPAT team varying extensively.
- Besides the perspectives of infectious disease specialists, the perspectives of other healthcare workers involved with OPAT is under investigated.

### Method

- An electronic e-survey was conducted with questions about demographics, characteristics of OPAT service, the role of the pharmacy in OPAT, future developments and best-practices and challenges

### Results

- OPAT services have a high global adoption rate of 78%, however only 42% of healthcare facilities offer formal OPAT services
- Facilities with formal OPAT services have higher requirements for infectious disease consultation before discharge, clinical monitoring by an OPAT team member, monitoring frequency, and availability of an OPAT registry
- Best practices include a multidisciplinary OPAT team and the use of elastomer pumps
- Common challenges in OPAT involve reimbursement issues and lack of standardization in patient screening, follow-up, and monitoring.

### Conclusion

- This is the first worldwide study exploring the implementation of OPAT services and perspectives of different professionals.

**Keywords:** OPAT, Outpatient Parenteral Antimicrobial Therapy, infectious diseases, antibiotics, patient safety, survey

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### Introduction

Outpatient parenteral antimicrobial therapy (OPAT) is defined as ‘the administration of parenteral antimicrobial therapy in at least 2 doses on different days without intervening hospitalization’.<sup>1</sup> It can be provided for patients who need parenteral therapy for severe or deep-seated infections, under the condition that they are stable and healthy enough to leave the hospital.<sup>2</sup> Currently, OPAT is considered part of regular care in many countries across Europe, Asia, North America, and Oceania. It is a safe, effective, and cost-saving practice.<sup>3–9</sup> Additionally, it reduces hospital-related complications due to shorter lengths of hospitalization, allows patients to regain autonomy, and ultimately leads to a better quality of life.<sup>3,10</sup>

Even though OPAT services are usually considered safe, patients receiving antimicrobials in an outpatient setting can still be at risk for readmission, due to adverse effects, line-related complications, and treatment failures.<sup>10,11</sup> As OPAT can be performed in a variety of models, such as hospital in the home (HITH), hospital-based infusion centers, office-based infusion centers, and skilled nursing facilities, leading to variations in practice, guidelines have been developed to minimize those risks associated with OPAT.<sup>1,12,13</sup> For this, a well-functioning and specialized OPAT program should be available, with a designated and multidisciplinary team that provides input on the choice, dose, and duration of therapy.<sup>12,14</sup> By performing routine clinical and laboratory

monitoring, efficacy can be both ensured and toxicities can be assessed and prevented.<sup>1</sup>

The literature suggests that OPAT programs may deviate from the guidelines and recommendations.<sup>8,14,15–21</sup> Data from Europe and The United States of America indicate that, despite offering OPAT services, only one-third of the services have a formal OPAT program in place.<sup>15,17</sup> This aligns with a few international surveys showing that there is a great proportion of unregulated OPAT services.<sup>14,19</sup> The limitation of these studies is that they were performed from infectious disease (ID) specialists' perspectives only, thereby potentially neglecting the multidisciplinary approach of the specialized OPAT program.<sup>15–19</sup> Moreover, best practices on how to organize OPAT services have not been studied yet. Therefore, a unique worldwide survey was conducted on the implementation and characteristics of OPAT services. This is the first study that aimed to explore the extent to which and in what way OPAT services have been implemented in countries throughout the world and to share respondents' best practices, innovative ideas, and perspectives of different professions.

## Methods

A prospective e-survey (using *LimeSurvey*©) was conducted from April to September 2022. The survey consisted of six domains with a total of 34 questions (the full questionnaire is available as Supplemental file 1). Questions were asked either as open-ended or multiple-choice questions, with room for additional explanations. The six domains included demographics, characteristics of the OPAT service, the role of the pharmacy in OPAT, future developments, and questions to obtain the respondents' views on improvements and best practices. The questions were developed using literature, including international guidelines, prior surveys on OPAT, and personal experiences regarding the function of a pharmacist.<sup>1,12,14,16–22</sup> Questions were designed and refined by one investigator (M.H.) with input from other investigators (B.K., B.W.). Disagreements were resolved by recruiting another author (H.O.) to attain consensus. A proof of concept of the e-survey was distributed among all the authors to test if the questions were relevant, well-defined, and not multi-interpretable according to their own experience, leading to an additional step of refinement.

The survey was distributed by addressing national and international professional associations and organizations with OPAT as one of their areas of interest (organizations contacted were EAHP, ASHP, ESCMID, EACPT, IATDMCT, EPAR, professional groups of pharmacists, ID specialists, and microbiologists). The professional networks of the authors with the primary focus on clinical microbiologists, ID specialists, hospital pharmacists, and other physicians were also used for the distribution. They were selected because of their participation in (inter)national scientific societies with a particular focus on antimicrobial management. Contacts were encouraged to consult other colleagues in case of doubt or to forward the survey to other colleagues working in other facilities. Contacts were recruited through a personalized invitation e-mail containing a hyperlink to the electronic questionnaire. There was no specific number of recipients set.

One of the key introductory questions of the survey was whether a facility offered outpatient intravenous (IV) antimicrobial courses (regardless of the OPAT model in place). Respondents who did offer these treatments were asked detailed questions regarding their OPAT service, what respondents were least satisfied about in their OPAT services and any best practices or innovative ideas. In addition, pharmacists were asked about their role in OPAT services. On the other hand, respondents with facilities that did not offer such services were asked questions about reasons for not having an OPAT service and future directions instead.

## Data analysis

After closing the survey, data were extracted from *LimeSurvey*® (*LimeSurvey* GmbH, Hamburg). Responses were included when at least the following obligatory questions were answered: 'what is your profession?' and 'does your facility/hospital/clinic provide outpatient (intravenous) IV antimicrobial courses?' Incomplete responses were only included if the mandatory questions had been answered. Duplicate responses were excluded, except for duplicates from the same hospital but from different professions, as differences in perspectives can yield different answers. For further analysis, *SPSS* version 28.0.1.0 (IBM Corp. Armonk, NY) was used. Descriptive data analysis was conducted, whereby frequencies and

percentages were calculated for each available survey question. Both completed and partially completed questionnaires were analyzed using the number of completed responses per item as the denominator. If a question was left unanswered, it was considered a missing value and included in the analysis as 'unanswered'. The qualitative responses from the open-ended questions were used to illustrate the respondents' experiences and perspectives.

## Results

The survey yielded 126 responses originating from 103 facilities and 28 countries. The demographics of the survey respondents are shown in Table 1. The respondents were from Europe [ $n=64/126$  (51%)], followed by Asia [ $n=23/126$  (18%)], Australia [ $19/126$  (15%)], South America [ $6/126$  (5%)], North America [ $3/126$  (2%)], and Africa [ $2/126$  (2%)]. The countries represented by the respondents are displayed in Figure 1. The majority of the responding hospitals and facilities were located in urban regions [ $89/126$  (71%)] and were from universities or tertiary referral centers [ $55/126$  (44%)]. Pharmacist made up the largest part of the respondents [ $83/126$  (66%)]. 98/126 (78%) of the respondents said their facility provided outpatient IV antimicrobial courses, while 28/126 (22%) did not. Healthcare facilities with a higher number of inpatient beds tended to provide more OPAT services compared to facilities with a lower number of inpatient beds. The characteristics of the available OPAT services are displayed in Table 2, the most frequent indications for OPAT and used antimicrobials are available as Supplemental Figures 2 and 3.

For those offering OPAT services, 41/98 (42%) had a specialized and designated OPAT team in place, while 14/98 (14%) lacked specialized services, and 22/98 (22%) indicated to have a partially specialized OPAT team (see Table 2). In Australia and Europe, the majority (84% and 69% respectively) had specialized or partially specialized OPAT services in place. Facilities with a partially specialized OPAT team revealed that they approached the services differently. For example, by dividing tasks among professionals or having the transmural or the antibiotic stewardship team in charge of the OPAT service.

Facilities with a specialized OPAT service indicated the following professions as part of their OPAT staff: 33/41 (81%) pharmacists, 32/41 (78%) ID specialists, 28/41 (68%) specialized nurses, and 15/41 (37%) microbiologists. Social workers ( $n=2$ ), medical registrars ( $n=2$ ), referring physician ( $n=1$ ), coordinator of transmural care ( $n=1$ ), and anaesthesiologists ( $n=1$ ) could also be members of the OPAT team. In facilities with a specialized OPAT service with a designated OPAT team, the number of mandatory ID consultation before discharge was higher compared to overall response (see Figure 2). The same trend was visible for clinical monitoring of the patient by an ID specialist or the OPAT team (see Figure 2). In addition, daily or weekly monitoring was higher in facilities with a specialized OPAT service compared to overall response (49% versus 35%). The same trend could be seen for the availability of an OPAT registry or database (78% versus 43%).

7/28 (25%) of the facilities with no OPAT services stated that the reason of absence of an OPAT service was that it was improbable that resources would be set aside to develop this type of service, and 5/28 (18%) answered there was not enough time to discuss it. Other reasons were lack of expertise, the misuse by drug abusers, lack of reimbursement from health insurance, and laboratory monitoring. In facilities with no OPAT services, 5/28 (18%) were convinced they would not launch an OPAT service, 5/28 (18%) wanted to develop it in more than a year's time, and 13/28 (46%) were not sure about it. While 8/28 (29%) would not refer a patient for treatment if a local and effective OPAT service was available, the majority – 15/28 (54%) – would.

### *Role of professionals in OPAT services*

Pharmacists staffed the specialized OPAT team most frequently. The role of the pharmacy/pharmacist in OPAT in 36/63 (57%) of cases was advising dosages based on TDM results, followed by 29/63 (46%) drug preparation, and in 29/63 (46%) cases also the central oversight of procedures. There were several other functions appointed by the respondents. Pharmacists were involved, among others, in screening patients for OPAT, informing patients and healthcare members, and

**Table 1.** Demographics of survey respondents.

Demographics	Number of respondents (n=126) (%)
Continent	
Africa	2 (1.6)
Asia	23 (18.3)
Australia	19 (15.1)
Europe	64 (50.8)
North America	3 (2.4)
South America	6 (4.8)
Not answered	9 (7.1)
Location	
Rural	10 (7.9)
Suburban	16 (12.7)
Urban	89 (70.6)
Other*	4 (3.2)
Not answered	7 (5.6)
Type of healthcare facility	
Multispecialty clinic	4 (3.2)
Nonteaching hospital	12 (9.5)
Private practice	5 (4.0)
Teaching hospital	40 (31.7)
University or tertiary referral hospital	55 (43.7)
Other <sup>§</sup>	3 (2.4)
Not answered	7 (5.6)
Size of healthcare facility	
1–200 inpatient beds	6 (4.8)
200–500 inpatient beds	29 (23.0)
500–1000 inpatient beds	44 (34.9)
>1000 inpatient beds	36 (28.6)
No inpatient beds	4 (3.2)
Not answered	7 (5.6)

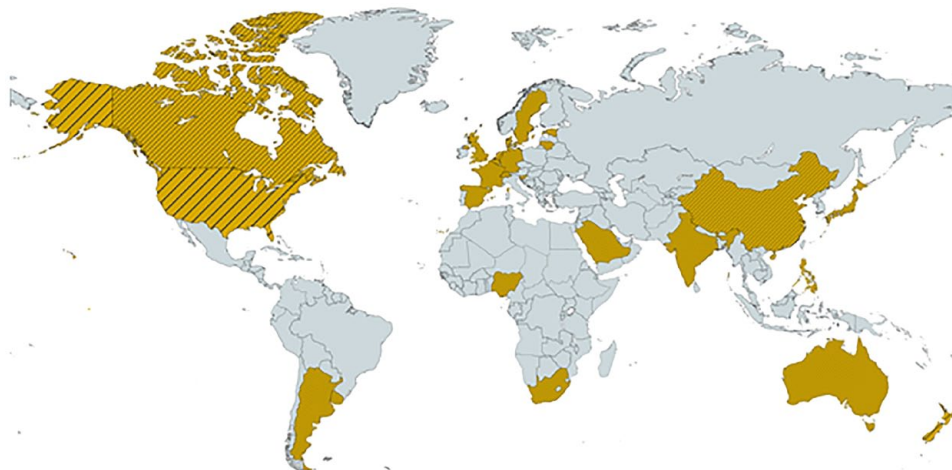
*(Continued)***Table 1.** (Continued)

Demographics	Number of respondents (n=126) (%)
Profession	
(Specialist) nurse <sup>‡</sup>	4 (3.2)
ID specialist	8 (6.3)
Microbiologist	5 (4.0)
Pharmacist	83 (65.9)
Physician <sup>§</sup>	15 (11.9)
Other <sup>  </sup>	11 (8.7)
Provide outpatient IV antimicrobial courses?	
Yes	98 (77.8)
No	28 (22.2)
*Other includes: regional (n=1), all of the above (n=1), mixed urban and rural (n=1), and no answer (n=1).	
§Other includes: secondary hospital (n=1), general hospital (n=1), and no answer (n=1).	
‡Primary disciplines of (specialist) nurse include IDs (n=3) and internal medicine (n=1).	
§Primary disciplines of physicians include internal medicine (n=3), pediatrics (n=2), nephrology (n=1), clinical pharmacology (n=2), IDs (n=3) and no answer (n=4).	
Other includes: hospital pharmacist (n=2), pharmacologist (n=3), medical technologist (n=2), hospital scientist (n=1), clinical nurse specialist (n=1), and no answer (n=2).	
IDs, infectious diseases.	

reviewing prescriptions. In addition, the pharmacist in OPAT services may have to deal with purchasing drugs and equipment and delivering them to the patient. It was further mentioned that pharmacists could also arrange funding and discuss prices with third parties.

### *Best practices and innovative ideas*

One of the most common best practices and/or innovative ideas was having a multidisciplinary team as an advisory body and/or executor of OPAT. However, the tasks and responsibilities of such a team differed. Some respondents stated that this team provided input and advice concerning OPAT, while others indicated that there was mandatory prior consent by the team to start



**Figure 1.** Countries represented by respondents: Argentina ( $n=2$ ), Aruba ( $n=1$ ), Australia ( $n=6$ ), Belgium ( $n=34$ ), Canada ( $n=2$ ), China ( $n=14$ ), Curaçao ( $n=1$ ), Denmark ( $n=1$ ), Estonia ( $n=1$ ), France ( $n=2$ ), Germany ( $n=1$ ), India ( $n=1$ ), Japan ( $n=2$ ), Lithuania ( $n=1$ ), The Netherlands ( $n=10$ ), New Zealand ( $n=13$ ), Nigeria ( $n=1$ ), Philippines ( $n=5$ ), Saudi Arabia ( $n=1$ ), Slovenia ( $n=1$ ), South Africa ( $n=1$ ), Spain ( $n=1$ ), Sweden ( $n=2$ ), Switzerland ( $n=4$ ), The United Kingdom ( $n=6$ ), Uruguay ( $n=2$ ), and The United States ( $n=1$ ).  $N=9$  were anonymous respondents.

OPAT, and some stated even a more extensive role in the follow-up and monitoring of the patients by the same team. If it was not a multi-disciplinary team, it could be an ID specialist responsible for advice and evaluation before discharge and/or overall responsibility for OPAT patients. In contrast, a specialized nurse team was also mentioned several times as a best practice, responsible for all or part of clinical evaluation, administration of the drug at home, or coordination of the OPAT services.

Another common best practice mentioned was the use of elastomeric pumps. A related suggestion was to alter the antimicrobial treatment regimen to continuous infusions to fit the HITH model and that research to further exploit this should be conducted. In addition, it was suggested that by investigating the stability of antimicrobials the number of antibiotics in OPAT can be expanded. One of the respondents mentioned that they were already carrying out stability studies.

To ensure the quality of OPAT practices, good cooperation and communication between the different stakeholders were mentioned. For example, by establishing protocols from the hospital for home nursing, or accessibility of the electronic patient dossier. The benefits of an OPAT

registry, accessible to all parties involved, were addressed.

Other practices were more patient centered. One hospital mentioned using laminated sheets with instructions to educate their patients in S-OPAT. Another hospital was developing an app for patients to allow for better communication.

#### *Challenges of OPAT*

One of the leading challenges that emerged from the survey was related to costs and reimbursement. A few hospitals mentioned that there were no additional finances to further expand the OPAT services and realize innovative ideas. Others highlighted the fact that patients had to compensate for the cost and this could lead physicians to choose the antibiotic with the lowest cost, but not necessarily the most narrow-spectrum antibiotic.

A frequently mentioned challenge was the screening and follow-up of OPAT patients. It emerged that patient selection suitable for OPAT still needed to be further developed or standardized. In some cases, it was only at the request of the treating physician. There was also no standardization of patient follow-up. A designated and/or multidisciplinary team responsible for all components of OPAT was missed by some respondents.

**Table 2.** Characteristics of OPAT services.

Characteristics	Number of respondents (n=98) (%)
Specialized OPAT service with a designated and specialized team?	
Yes	41 (41.8)
No	14 (14.3)
Partially	22 (22.4)
Not answered	21 (21.4)
OPAT population	
Adults only	40 (40.8)
Children only	3 (3.1)
Adults and children	34 (34.7)
Not answered	21 (21.4)
Length of time the facility has offered OPAT	
>5year	43 (43.9)
1–5year	23 (23.5)
Unsure	6 (6.1)
Not answered	26 (26.5)
Average number of patients with OPAT discharge (per month)	
None	1 (1.0)
1–5	27 (27.6)
6–15	14 (14.3)
16–25	8 (8.2)
26–50	9 (9.2)
>50	9 (9.2)
Unsure	9 (9.2)
Not answered	21 (21.4)
Average OPAT treatment duration	
<1 week	3 (3.1)
1–3 weeks	41 (41.8)
4–12 weeks	21 (21.4)

*(Continued)***Table 2.** (Continued)

Characteristics	Number of respondents (n=98) (%)
Unsure	12 (12.2)
Not answered	21 (21.4)
Delivery model	
Patient home	61 (62.2)
Hospital-based clinic or infusion center	13 (13.3)
Office-based infusion center	1 (1.0)
Rehabilitation facility	1 (1.0)
Other*	1 (1.0)
Not answered	21 (21.4)
Administration by	
Patient	1 (1.0)
Nurse	65 (66.3)
Physician	2 (2.0)
Unsure	2 (2.0)
Other <sup>§</sup>	7 (7.1)
Not answered	21 (21.4)
Consultation with an ID specialist required	
Yes	52 (53.1)
No	25 (25.5)
Not answered	21 (21.4)
Responsible for clinical monitoring and acting upon laboratory results <sup>#</sup>	
OPAT clinician/OPAT service team	23 (23.5)
Referring physician	48 (49.0)
ID specialist	25 (25.5)
No one	0 (0)
Unsure	6 (6.1)
Other <sup>‡</sup>	8 (8.2)
Not answered	15 (15.3)

*(Continued)*

**Table 2.** (Continued)

Characteristics	Number of respondents (n = 98) (%)
Frequency of monitoring during OPAT treatment	
Daily	7 (7.1)
Weekly	27 (27.6)
Monthly	5 (5.1)
Other <sup>§</sup>	32 (32.7)
Not answered	27 (27.6)
Frequency of TDM	
Acyclovir	
Once a week	4 (4.1)
Twice a week	2 (2.0)
More than twice a week	0 (0)
Never	25 (25.5)
No use in OPAT	35 (35.7)
Unsure	6 (6.1)
Not answered	26 (26.5)
Aminoglycosides	
Once a week	20 (20.4)
Twice a week	16 (16.3)
More than twice a week	1 (1.0)
Never	8 (8.2)
No use in OPAT	23 (23.5)
Unsure	4 (4.1)
Not answered	26 (26.5)
Amphotericin	
Once a week	3 (3.1)
Twice a week	1 (1.0)
More than twice a week	0 (0)
Never	27 (27.6)
No use in OPAT	34 (34.7)

(Continued)

**Table 2.** (Continued)

Characteristics	Number of respondents (n = 98) (%)
Unsure	6 (6.1)
Not answered	27 (27.6)
Carbapenems	
Once a week	4 (4.1)
Twice a week	1 (1.0)
More than twice a week	1 (1.0)
Never	42 (42.9)
No use in OPAT	12 (12.2)
Unsure	8 (8.2)
Not answered	30 (30.6)
Cephalosporins	
Once a week	6 (6.1)
Twice a week	2 (2.0)
More than twice a week	0 (0)
Never	50 (51.0)
No use in OPAT	5 (5.1)
Unsure	7 (7.1)
Not answered	28 (28.6)
Colistin	
Once a week	3 (3.1)
Twice a week	3 (3.1)
More than twice a week	0 (0)
Never	22 (22.4)
No use in OPAT	36 (36.7)
Unsure	6 (6.1)
Not answered	28 (28.6)
Daptomycin	
Once a week	6 (6.1)
Twice a week	1 (1.0)

(Continued)



**Table 2.** (Continued)

Characteristics	Number of respondents (n=98) (%)
More than twice a week	0 (0)
Never	32 (32.7)
No use in OPAT	28 (28.6)
Unsure	3 (3.1)
Not answered	28 (28.6)
<b>Ganciclovir</b>	
Once a week	2 (2.0)
Twice a week	1 (1.0)
More than twice a week	0 (0)
Never	22 (22.4)
No use in OPAT	41 (41.8)
Unsure	4 (4.1)
Not answered	28 (28.6)
<b>Trimethoprim/sulfamethoxazole</b>	
Once a week	2 (2.0)
Twice a week	1 (1.0)
More than twice a week	0 (0)
Never	27 (27.6)
No use in OPAT	35 (35.7)
Unsure	5 (5.1)
Not answered	28 (28.6)
<b>Vancomycin</b>	
Once a week	24 (24.5)
Twice a week	19 (19.4)
More than twice a week	3 (3.1)
Never	2 (2.0)
No use in OPAT	21 (21.4)
Unsure	3 (3.1)
Not answered	26 (26.5)

(Continued)

**Table 2.** (Continued)

Characteristics	Number of respondents (n=98) (%)
Responsible for TDM advice	
Pharmacist	43 (43.9)
Treating physician	8 (8.2)
ID specialist	14 (14.3)
Microbiologist	13 (13.3)
Other <sup>  </sup>	6 (6.1)
Not answered	14 (14.3)
OPAT patient registry or database available?	
Yes <sup>¶</sup>	42 (42.9)
No	27 (27.6)
Unsure	7 (7.1)
Not answered	22 (22.4)

\*Other includes: patient home, hospital-based clinic, and rehabilitation center (n=1).

§Other includes: self-administration if the patient is capable. If not, then a nurse (n=3) or home care (n=1). Combination of patient and nurse (n=1), parents/guardians (n=1), and home care (n=1).

‡Other includes: (clinical) pharmacist (n=2), clinical nurse specialist (n=1), community IV program pharmacist (n=1), consultant microbiologist (n=1), general practitioner (n=1), principle consultant in hospital (n=1), and occasionally nephrologist (n=1).

§Other includes: biweekly (n=6), depending on duration OPAT treatment and/or indication and/or drug (and/or TDM necessary) (n=7), depending on the individual case (n=2), depending on prescriber/team (n=3), daily by nurse team (n=2), once in treatment course (n=2), varying (n=5), only in case of issues (n=2), and do not know (n=3).

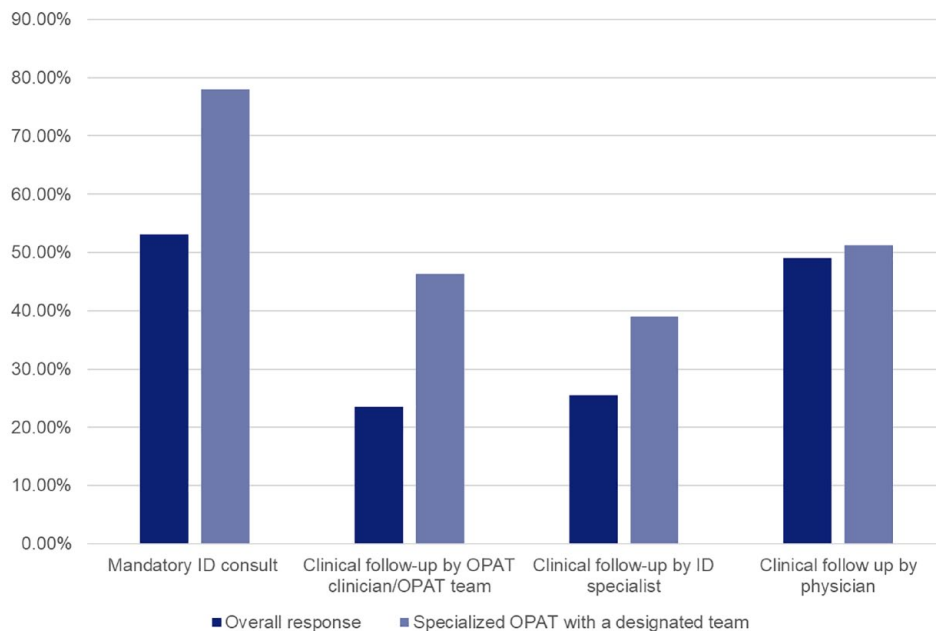
||Other includes: clinical biologist (n=1), ID registrar (n=1), no access to the lab results of outpatients, therefore ID specialist in charge (n=1), and TDM not used in OPAT (n=3).

¶OPAT registry or database was used for track service utilization (n=34), monitor patient outcomes (n=20), and benchmarking (n=13). Data entry was manual (n=28) or database was not used/unreliable (n=2).

#Multiple answers were allowed.

OPAT, outpatient antimicrobial therapy; ID, infectious disease; TDM, therapeutic drug monitoring.

The availability and logistics of TDM was mentioned several times as a challenge. It was one of the reasons, besides drug stability and dosing regimen, for the limited number of antimicrobials used in OPAT services.



**Figure 2.** Comparison of overall response and response from facilities with specialized OPAT services with a designated team.

In other cases, facilities indicated that transparency and communication between different healthcare professions could be pitfalls. In addition, it took considerable time when multiple professionals were involved to get procedures going. Following this, bureaucracy was also time-consuming. Others indicated there was a need for database support and digitalization. Furthermore, difficulties were encountered regarding the organization of OPAT. Overall, not having a standard in-house procedure, the nonavailability of round-the-clock services, lack of staff, and high workload were mentioned frequently as challenges.

### Discussion

The results of this unique global study showed a widespread adoption of OPAT worldwide (78%). This is in line with previous national or continental studies.<sup>8,16,17,20,22</sup> The implementation of a specialized OPAT team however varied extensively, with only 41/98 (42%) of the respondents providing OPAT services with a designated team. This latter finding is in line with other studies.<sup>8,15–17,20</sup> A study from Europe by Emilie *et al.* found that 6/17 (35%) nations had established OPAT services with specialized staff.<sup>17</sup> Another study in Ireland showed that 47% of the respondents did not have a designated OPAT service

available, and a study from the United States, where only one-third had a dedicated OPAT program.<sup>15,20</sup> The most common reason for the absence of an OPAT service was the lack of resources or lack of time. Other reasons were lack of expertise, the misuse by drug abusers, lack of reimbursement from health insurance, and laboratory monitoring.

The Infectious Diseases Society of America (IDSA) guideline describes that an ID specialist should address all medical decisions and have the final responsibility for patient care.<sup>1</sup> Previous studies showed that mandatory ID specialist consultations prior to discharge, follow-up appointment tracking, and laboratory tracking are significantly higher in formal OPAT programs compared to facilities with no formal OPAT programs, addressing the importance of a dedicated OPAT service.<sup>8,19</sup> This is reflected in the results of our study. We found that it is more likely that a mandatory ID specialist consultation took place prior to discharge at facilities with a designated OPAT team, as well as monitoring performed by an OPAT clinician/team member, and an expert in IDs. Taking this into account, together with a higher frequency of monitoring and higher availability of an OPAT database seen in formal OPAT program, this study shows that a formal

OPAT program in place leads to a higher adherence to the OPAT guidelines. Furthermore, having a formal OPAT program in place can tackle the frequently cited challenge of standardizing the screening and follow-up of OPAT patients.

IDSA guidelines and other guidelines recommend having a pharmacist, ID specialist, and (specialist) nurse on the OPAT team.<sup>1,9,12,13</sup> This study found that in 80% of the facilities with a designated OPAT team a pharmacist was part of the team. The ID specialist and (specialist) nurses were part of the OPAT team in 78% and 68% of the cases, respectively. In this study we found that one of the main responsibilities of a pharmacist in OPAT was giving TDM advice, followed by drug preparation, and the central oversight of procedures. A recent survey on the role of pharmacists on OPAT revealed that pharmacists gave a lot of value to selecting the initial antimicrobial regimen and reviewing patients for OPAT appropriateness.<sup>23</sup> Given the knowledge of pharmacists, it would be well to also include them in these areas of OPAT.

Frequently named best practices were having a multidisciplinary OPAT team in place or specialist nurses responsible for all or part of the OPAT care and the use of elastomeric pumps. A need for expanding the antimicrobial assortment in OPAT was mentioned several times. We hypothesize that the stability of antimicrobials due to differences in climates and temperatures may limit the implementation of antimicrobials used in OPAT. Costs and timing issues were two common OPAT challenges. These two are also crucial factors that have an impact on the decisions made in healthcare overall, and important reasons for implementing OPAT in the first place. Indeed, the absence of OPAT among the respondents was also mostly due to the lack of resources and time. These challenges are recognizable from previous research.<sup>8,14</sup> A different approach to OPAT services may be an option to initiate OPAT, as some facilities from this survey did, by, for example, dividing the tasks of OPAT among different professionals or having the ID specialist or the antibiotic stewardship team responsible for OPAT. Interestingly, 29% of the respondents would not refer a patient for treatment if a local and effective OPAT service was available, even though the reason for this was not asked in the survey. Although this was not questioned, we hypothesize that it might be due to reimbursement issues.

One of the main limitations of this study is that a large number of the responses originated from Europe, particularly Belgium. This makes it debatable if this report accurately depicts OPAT management around the globe; however, upon examination, the data from Belgium are comparable to the rest of Europe, so we expect that the overall data are not affected greatly. Even though the majority of the responses originated from Europe, we also collected data for continents with no readily available data in the literature. Furthermore, there is a possibility of nonresponse bias as a result of partially completed responses. This may be explained due to the majority of the questions in the survey not being mandatory and answer option 'unsure' was allowed. However, it may have led to a more accessible survey and an increase in the number of respondents as professionals with limited knowledge on some parts of their OPAT service could participate. By allowing free text, the quantitative data was affected. However, an attempt was made to create in-depth answers by giving respondents the opportunity to deviate from the multiple-choice options and fill in an answer themselves. Another cause for biased results can be a reduced participation of facilities that do not provide OPAT services. These facilities may have found it unnecessary to participate in the study.

To the best of our knowledge, this is the first study that examined the global implementation of OPAT services from the perspective of different professions, including pharmacists (66% of the respondents). In this way, different perspectives on best practices and challenges could be identified. Important to note is that this study made a distinction between an OPAT service that is fully specialized and one that is partially specialized. In that way, the study was able to identify cases that take a different approach and give a good reflection of real-time practices. By examining both current and long-term goals, an effort has been made to paint a complete picture of the services. The results have shown best practices and innovative ideas that highlight some of the recommendations by guidelines, for instance, having a specialized OPAT team. However, there is still a lot of room for improvement regarding the implementation of OPAT and the pursuit of national and international guidelines. The findings of this study demonstrated that OPAT implementation varied significantly. Future research can generate

more data regarding OPAT methods to standardize OPAT.

In conclusion, this study has mapped the implementation and practices of OPAT around the world and provides a unique perspective on best practices and challenges from different professionals involved in OPAT. Additionally, it can offer directions for institutions that want to launch an OPAT service or further develop their current OPAT service.

### Declarations

#### *Ethics approval and consent to participate*

According to the Medical Research involving Human Subjects Act, ethical approval was not required as no intervention was conducted and no information on the health of participants was collected. Consent for participation was implied by the completion of the survey.

#### *Consent for publication*

Not applicable.

#### *Author contributions*

**Moska Hassanzai:** Conceptualization; Formal analysis; Methodology; Project administration; Visualization; Writing – original draft; Writing – review & editing.

**Fadime Adanç:** Conceptualization; Formal analysis; Visualization; Writing – original draft; Writing – review & editing.

**Birgit Koch:** Conceptualization; Writing – review & editing.

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**Jakob van Oldenrijk:** Writing – review & editing.

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**Hein van Onzenoort:** Conceptualization; Supervision; Writing – review & editing.

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#### *Competing interests*

The authors declare that there is no conflict of interest.

#### *Availability of data and materials*

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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#### Supplemental material

Supplemental material for this article is available online.

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