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Review

Barriers and facilitators for the implementation and expansion of outpatient parenteral antimicrobial therapy: a systematic review

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SUMMARY

Outpatient parenteral antimicrobial therapy (OPAT) has been expanding in recent years and serves as a viable solution in reducing the shortage of hospital beds. However, the wider implementation of OPAT faces numerous challenges. This review aimed to assess implementation barriers and facilitators of OPAT services. Studies describing barriers and facilitators of the OPAT service were retrieved from PubMed, Scopus, MEDLINE, EMBASE, CINAHL, Cochrane Library, Web of Science Proceedings, International Pharmaceutical Abstracts and PsycINFO. All types of study designs published in the English language were included. Studies that did not mention any barrier or facilitator, did not differentiate OPAT and inpatient, focused on specific antimicrobials or diseases, and made no distinction between parenteral and other treatments were excluded. Qualitative analysis was performed using the 'best-fit' framework approach and the Consolidated Framework for Implementation Research (CFIR). The review was PROSPERO registered (CRD42023441083). A total of 8761 studies were screened for eligibility and 147 studies were included. Problems in patient selection, lack of awareness, poor communication and co-ordination, lack of support, lack of structured service and inappropriate prescriptions were identified. OPAT provides safe, effective and efficient treatment while maintaining patients' privacy and comfort, resulting in less daily life disruption, and reducing the risk of infection. Satisfaction and preference for OPAT were very high. Initiatives in strengthening OPAT such as antimicrobial stewardship and telemedicine are beneficial. Challenges to and facilitators of OPAT were identified among patients, health professionals, OPAT service providers and healthcare administrators. Understanding them is crucial to designing targeted initiatives for successful OPAT service implementation.

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Introduction

Healthcare systems are facing pressures from worldwide population growth [1]. This translates into higher demand for acute inpatient care, often surpassing the capacity of healthcare facilities in terms of both hospital beds and the necessary workforce for managing hospital admission, particularly in low- to middle-income countries [2]. Even in high-income countries, the healthcare system has been shown to be vulnerable during the recent coronavirus pandemic, whereby thousands of patients were not able to access essential hospital care for life-threatening conditions [3]. In the wake of the pandemic, the delivery of patient care outside the hospital setting for conditions that would otherwise require traditional hospital beds, known as the Hospital-in-the-Home (HITH) programme, has emerged as a critical tool for health systems to tackle challenges associated with the shortage of hospital beds [4]. The scope of HITH programmes is broad and includes the treatment of various infections that require parenteral antimicrobial therapy [5].

Outpatient parenteral antimicrobial therapy (OPAT), often delivered via HITH services, is the management of infections outside the hospital setting in the community or at home by administration of more than one dose of parenteral antimicrobials on different days [6]. The first documented OPAT practice was in 1974, for the treatment of chronic bronchopulmonary infection in a paediatric population [7]. A year later, it expanded into the adult population including self-administration of parenteral antimicrobials [8]. In recent years, OPAT has seen considerable growth in middle-to high-income countries [9] due to the significant benefit it offers both to the healthcare system and patients [10]. It reduces length of hospital stay or avoids hospitalization thereby freeing hospital beds, improves cost-effectiveness and increases patient satisfaction [11].

Despite the benefits, the continuing growth of OPAT, however, is not without challenges. Many barriers, particularly in the structural and governance aspect of the service including compensation schemes and the integration with health insurance systems, hinder a healthy expansion of an OPAT programme [12]. The service modalities are progressively becoming more complex and there is opportunity for improvement in the efficiency and quality of the service [13]. Without careful planning and thorough understanding of the enablers and barriers for a healthy progression of the programme, implementing an efficient service that avoids unintended consequences is likely to be a significant challenge for healthcare systems [14].

Understanding the barriers and facilitators of current practice is essential for progressive implementation of a safe, effective and efficient OPAT [4]. This systematic review aimed to assimilate data from the literature and synthesize the barriers and facilitators reported by patients, their carers and healthcare professionals.

Methods

This systematic review was conducted following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA-P) 2020 guideline [15] (Supplementary data). The protocol was registered in PROSPERO (CRD42023441083).

Data sources and search strategy

The systematic literature search was undertaken in PubMed, Scopus, MEDLINE (Ovid), EMBASE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, Web of Science Proceedings, International Pharmaceutical Abstracts and PsycINFO. Potentially relevant studies were also identified by a manual search from the reference lists of retrieved studies. The research team iteratively developed a comprehensive search strategy. The search terms were based on the consideration of the population (all types of patients, caregivers and practitioners), intervention (OPAT) and relevant outcome (barriers and facilitators). The search was limited to the English language, and all searches were carried out from the inception of each database until 5th/6th June 2023. Details of the search strategy are presented in the Supplementary data and PRISMA figure.

Eligibility criteria

Studies were included if: (1) the participants of the study were patients, their care providers, or healthcare practitioners; (2) they described intravenous (IV) antimicrobial administration in an outpatient setting; (3) they assessed any facilitating factors for OPAT; and/or (4) they described any barriers in OPAT service delivery. There was no restriction to study design and time. Abstracts, letters, grey literature (publications outside of commercial publishing) and studies that did not mention any barrier or facilitator were excluded. Studies were excluded if: (i) the findings were based on secondary data; (ii) data regarding barriers and facilitators were not extractable; (iii) they did not differentiate between OPAT and inpatient treatment; (iv) they did not evaluate the OPAT programme, focussing instead on the evaluation of suitability of specific antimicrobials for OPAT or characteristics of a particular diseases treated under OPAT programme; and (v) they did not make a clear distinction between IV antimicrobials and other treatments.

Study selection

The study selection, which involved title and abstract screening and full-text review, was carried out by two independent reviewers (S.A.M. and G.M.A.) using the eligibility criteria. Any discrepancies between the two reviewers were resolved through discussion, with the involvement of a third reviewer (F.S.) when necessary. Inter-rater reliability was reported in terms of Cohen's kappa value. Article screening was managed by Covidence software (Veritas Health Innovation, Melbourne, Australia).

Data extraction

Data was extracted by one reviewer (S.A.M.), while another reviewer (G.M.A.) extracted a sample of studies to validate the collected data. A standardized data abstraction format was used to extract characteristics of studies (name of authors, publication year, study design, study area, study period, study population, clinical characteristics, type of OPAT models) and data on barriers and facilitators to OPAT service.

Risk of bias assessment

Risk assessment was conducted by one reviewer (S.A.M.) using previously reported evaluation tools. The Newcastle–Ottawa scale for cohort and case–control studies [16] and the Cochrane risk-of-bias assessment tool for experimental studies [17] were used for quality appraisal. Studies in Newcastle–Ottawa scale are rated in three categories (selection, comparability, and exposure) on a 0 to 9 scale: 6–9 good, 3–5 fair and 0–2 poor quality [16]. Many studies included in this review simply evaluated OPAT service and used methodologies that were not suitable for these scoring systems. Hence, the quality assessment tool initially developed by Mitchell and colleagues [18] and modified for OPAT [19] was used for other observational studies. The tool used three evaluation criteria (population, methodology and analysis) and categorized into four: strong+ (score strong in all), strong- (strong in two and moderate in one area), moderate (strong in one and moderate in two, or moderate in all areas) and insufficient (insufficient in one area or insufficient data for grading) [19]. As the aim of the review was to identify barriers and facilitators for OPAT service, all studies were included, regardless of the risk of bias score.

Data synthesis and summary measure

The proportion and/or the odds ratio of barriers or contributing factors was recorded if reported. However, the heterogeneity of included studies and the qualitative nature of the outcome meant that meta-analysis was not applicable. Therefore, data on barriers and contributors to OPAT service were identified, organized and structured to perform qualitative analysis in accordance with the Consolidated Framework for Implementation Research (CFIR) theoretical framework. The CFIR provides a comprehensive taxonomy of influential factors across multiple levels, which are organized into five domains, each further subdivided into various constructs. The domains of CFIR include innovation, the inner setting, the outer setting, the characteristics of the individual, and the implementation process [20]. The review team (S.A.M. and G.M.A.) thoroughly investigated the patterns of meaning within the data and coded directly to the established constructs of the CFIR [20] through best-fit framework synthesis [21]. A new construct was introduced to accommodate codes that did not align with any of the existing CFIR domains. In this review, the following definitions were applied to the domains of CFIR: 'innovation' refers to OPAT, 'inner setting' pertains to the patient's home or healthcare institution offering OPAT services (e.g., hospital, infusion centre) and 'individuals' encompasses patients, their caregivers, or healthcare professionals who deliver the innovation. Considering the diverse characteristics of the included studies, both quantitative and qualitative data were collectively analysed and presented descriptively through narration.

Results

A total of 8754 studies were searched in all electronic databases. An additional 24 potentially relevant studies were obtained from a manual search of previous studies. After the removal of duplicates, eligibility screening excluded 3577 abstracts (Figure 1). The Kappa value indicated substantial inter-rater reliability [22] for screening (0.67) and eligibility (0.79). A total of 514 studies were eligible for full-text review. Of these, a total of 147 [9,11,12,19,23–165] studies involving more than 130,000 treatment episodes met eligibility criteria and were included for final thematic analysis.

Characteristics of included studies

Many of the studies were conducted in North America ($N = 65$, 44.2%) followed by Europe ($N = 47$, 32%). One study was conducted on both continents [117]. More than one-third ($N = 54$, 36.7%) of studies were from the USA. One study in Europe [57] and three studies in North America [28,43,99] involved multiple countries. Studies were undertaken from 1983 [123] to 2023 [23,130]. More than two-thirds ($N = 100$, 68%) of studies were carried out within the last 10 years. The sample size of the studies ranged from six [58] to 17,841 [57] and could not be determined in three studies [88,126,132]. Musculoskeletal infections ($N = 95$, 90.5%) constituted most of the OPAT services followed by urinary tract infections ($N = 77$, 73.3%) (Supplementary data).

Only 14 (9.5%) of the included studies had comparator(s). Most of the studies ($N = 104$, 70.7%) evaluated multiple outcomes. The most commonly used OPAT model was self, or carer-administered OPAT at patient's home (S-OPAT) ($N = 96$, 65.3%), followed by physician or nurse-administered OPAT at patient home (H-OPAT) ($N = 83$, 56.5%) and clinic or infusion centre administration (C-OPAT) ($N = 52$, 35.4%). The type of OPAT delivery model was unclear in three studies which only reported as "home infusion" while 22 (15%) of studies failed to report the model of care. Less than one-third (28.6%) of the studies reported a single delivery model (S-OPAT 16.3%, C-OPAT 5.4%, H-OPAT 6.8%). Few studies reported other sites such as prisons [68,109], dialysis centres [68,106], acute-care facilities [77,143], rehabilitation centres [81,109,111,115,119,130], long-term care facilities [81,130] and sociosanitary centres [111] (Supplementary data).

Almost half (51.7%) of the studies utilized observational design of which 52 (68.4%) were retrospective. Only one study (0.7%) was a randomized clinical trial (RCT) (Table I). Data sources for the majority (70.7%) of studies were medical records and/or OPAT databases. Other methods of data collection included an interview (telephone or face to face) (10.6%), focused group discussion (4.4%), questionnaire (16.2%), observation (1.7%) and contextual inquiries (2.5%). More than one method of data collection was utilized in 10.2% of studies.

Risk of bias assessment

There was one RCT with a low risk of bias [38]. All the cohort studies were of good quality (range 6–9, median 8). Two case–control studies had fair quality (score 5), although an adequate description of cases was not provided [49,64]. All pre-post quasi-experimental studies had a low risk of bias (Supplementary data). Based on Minton and colleagues' scoring system [19], 122 observational studies' quality was evaluated. Of which, 46 (37.7%), 62 (50.8%) and 14 (11.5%) scored strong+, strong- and insufficient, respectively.

CFIR conceptual domains

The summary, outlining the identified barriers and facilitators thematized from the included studies in accordance with the CFIR structure, is provided in Table II.

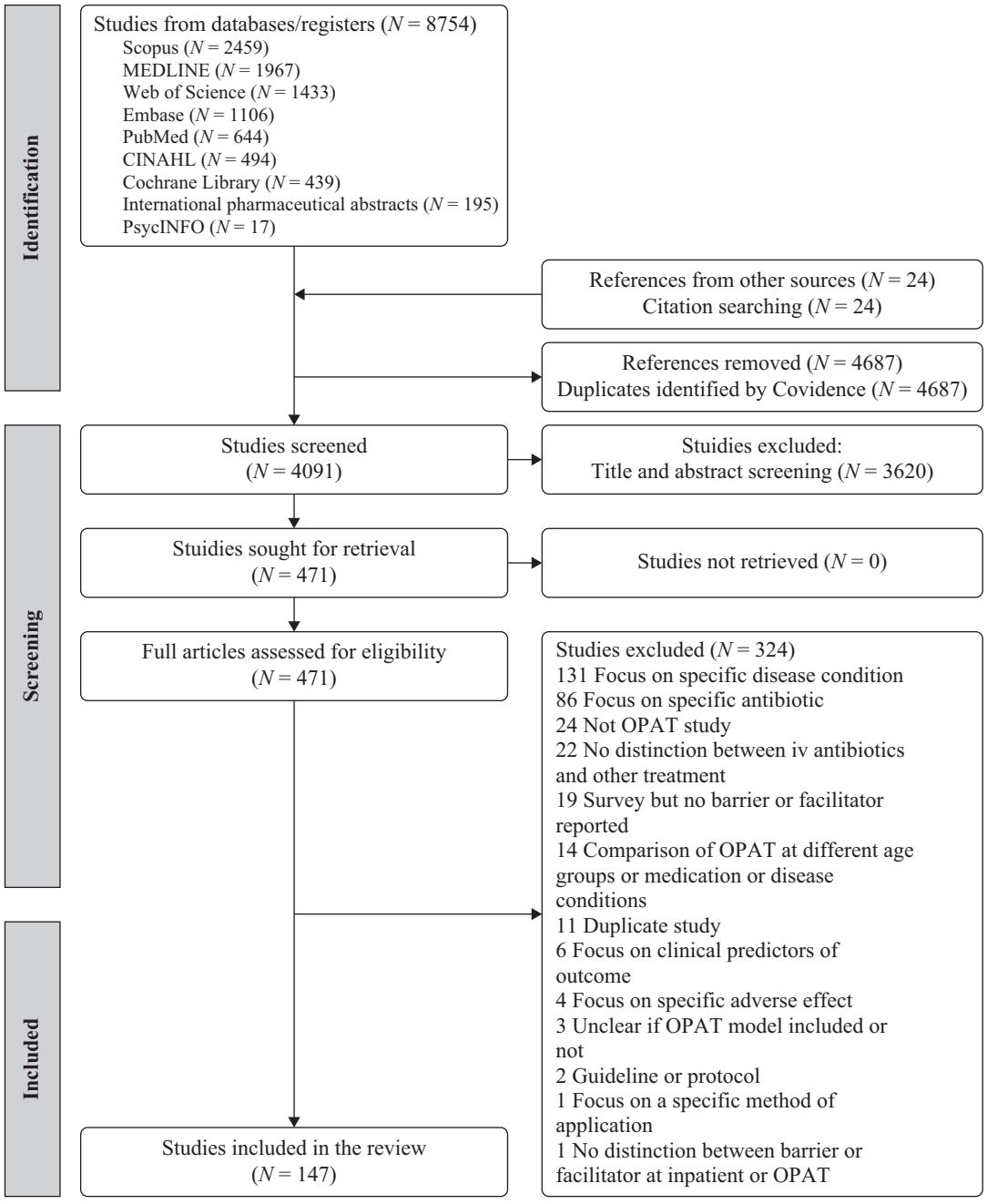

Figure 1. PRISMA flow chart for screening articles and selection of included studies. OPAT, outpatient parenteral antimicrobial therapy.

Domain 1: Innovation

This domain assessed factors including the presence of evidence supporting clinical effectiveness, cost-effectiveness and relative advantage of OPAT compared with traditional inpatient antimicrobial treatment.

Efficacy

Of the 56 studies evaluating the clinical effectiveness of OPAT, only three observational studies [108,142,164] and one RCT [38] included an inpatient comparator. The rate of clinical outcome, either clinical cure or improvement ranged from 28.6% [68] to 100% [12,69,73]. The reported rate of treatment failure and mortality ranged from 0% [145] up to 36% [32] and 0% [45,128,145,165] to 1.9% [38], respectively. No significant outcome difference between home and inpatient treatment was reported in two of the three observational studies that compared OPAT versus inpatient treatment [108,164]. In one of these three observational studies, the risk of death within 90 days was significantly lower for OPAT patients than inpatients (2.0% vs 8.8%, P=0.001) [142]. In all of the remaining observational studies that did not directly compare OPAT and inpatient therapy but assessed treatment outcomes, OPAT was recommended as an effective

Table I
The number/proportion of included studies by study design

Study design	Number	Percentage	Number of participants
Case–control	2	1.4	108
Case series	2	1.4	145
Prospective cohort	8	5.4	5912
Retrospective cohort	12	8.2	12,459
Cross-sectional	83	56.5	64,576
Non-randomized study	4	2.7	1393
Randomized clinical trial	1	0.7	100
Qualitative	14	9.5	312
Survey	21	14.3	3697

treatment programme (Supplementary data) that significantly improved the patient's quality of life [61,91,124,134].

Safety

Seventy-eight studies assessed the safety of OPAT, with only one cohort study [142] and RCT [38] incorporating inpatient treatment as a comparator [38,142]. These studies examined three safety outcomes: the incidence of antimicrobial-related adverse effects, catheter-related complications and the occurrence of OPAT-related hospital readmissions. In the RCT, no significant difference in the number of adverse events was reported ($P>0.05$), and a low incidence of complications was observed among patients treated at home ($P<0.005$) [38]. The reported incidence of antimicrobial-related adverse effects in observational studies ranged from 0.04% [53,123] to 29.03% [120]. However, the risk of adverse events during OPAT (35.6%) versus inpatient treatment (39.0%) ($P=0.732$) was comparable [142]. Catheter-related complications were found in up to 33% of OPAT patients [157], with no evidence indicating a higher association of device-related complications in S-OPAT [30]. The maximum reported incidence of OPAT-related hospital readmissions was 26% [60]. Furthermore, OPAT patients experienced more hospital readmissions when compared with discharged inpatients (30.5% vs 23.0%) [142]. However, in a study, almost all patients (97.1%) said they believe OPAT is safe [37]. Although very few studies made direct comparison, many observational studies concluded OPAT as a safe alternative to inpatient treatment (Supplementary data).

Cost effectiveness

The impact of OPAT on healthcare costs was evaluated in 44 studies. All of these studies showed that the implementation of OPAT programme reduced healthcare costs. Cost saving of the OPAT programme was mainly related to shortening length of hospital stay. In addition, OPAT reduced the risk of acquiring nosocomial infections which contributed to overall cost savings [29]. General practitioners [121] and infectious disease (ID) physicians [134] stated that OPAT programmes freed up hospital beds by avoiding prolonged hospital stay. Four studies directly compared the cost of OPAT with inpatient treatment and demonstrated the cost effectiveness of an OPAT programme [108,124,142,164]. Compared with the national average treatment cost for inpatient care, the cost of OPAT amounted to 47% [11], 39% [45] and 73.5% [124] of these costs.

Being at home

In OPAT, treatment at home was reported to be more comforting and less frustrating than hospital attendance [19]. Most patients within an OPAT programme were perceived to have freedom, happiness, comfort, less life disruption to them and their families, and a quick recovery [34,37,39,108,113,133]. Hospital treatment was perceived to pose challenges for OPAT patients with dependents at home [72]. Moreover, patients and their carers were anxious about the limited access to and costs associated with hospital parking [151,154]. Patients were also concerned about the increased risk of hospital-acquired infections [72,154]. There was a perception that OPAT made patients feel more autonomous, enabling self-administration of parenteral antimicrobials [101] and allowing them to return to their normal routine [125,154,159].

Domain 2: Outer setting

The outer setting in the CFIR assessed external factors impacting OPAT implementation. This included the availability of economic, political and technological support for OPAT delivery.

Financial insecurity

It was reported that patients may have rejected OPAT services due to a direct financial impact on them [160]. That is, patients enrolled in OPAT without health insurance coverage faced high out-of-pocket payments for consultation and laboratory tests [164]. Even for those patients who were covered, inconsistency and delay in reimbursement approval for parenteral antimicrobials was perceived as a negative [117,26].

Integration of telemedicine with OPAT

The use of audio-visual-based telemedicine in OPAT was perceived as feasible and had the possibility of ensuring satisfactory clinical outcomes [49]. In one study, the readmission rates between patients treated in OPAT versus those treated in video telemedicine-based OPAT were not significantly different [64]. In another study, patients treated using call-based telemedicine demonstrated a reduced risk of readmission compared with those without telemedicine ($P=0.003$) [78]. Video-based telemedicine saved costs and time associated with travel [146], and patients residing in geographically isolated locations were successfully treated while maintaining the standard of care [64].

Domain 3: Inner setting

The inner setting represented the physical and organizational context where OPAT was put into practice. This domain encompassed internal factors affecting OPAT implementation, including the availability of infrastructure, training, supplies and equipment, organization of tasks and responsibilities, relationships, and communication dynamics among patients and healthcare professionals.

Limited support and infrastructure

Despite the increasing demand for outpatient treatment, there was a lack of sufficient commitment to the OPAT programme [66,117]. This was evident in the limited administrative [19,66,115] and financial support provided to OPAT, as well as inadequate infrastructure, including outpatient treatment centres and information technologies [66,143]. In a survey conducted in 2019, over half of European countries lacked the necessary infrastructure for OPAT [9]. Moreover, another survey conducted in 2012 reported limitations in

Table II
Summary of barriers and facilitators

Domain (construct)	Contributors	Construct	Barriers
Innovation			
Innovation evidence-base	Safety Efficacy Clinical effectiveness Better quality of life		
Innovation cost	Cost-effective Saving hospital beds Reduced healthcare-associated infections		
Innovation relative advantage	Being at home Less disruption to daily life Comfort Greater autonomy Better freedom Perception of recuperating Inaccessibility and mounting hospital parking fees Less concern about infections		
Outer setting			
Local conditions	Telemedicine-supported OPAT	Financing	Financial insecurity Lack of financial incentive Inconsistency and delay in reimbursement approval
Inner setting			
Culture	Relationship between patients and OPAT team Patient faith, trust and confidence Compassionate, respectful and caring service OPAT team availability Friendliness of OPAT team	Structural characteristics	Limited support and infrastructure Nonavailability or limited capacity of existing service Lack of administrative, information technology, and financial support Poor commitment to the OPAT programme Nurse liability
Mission alignment	Implementation of antimicrobial stewardship	Relational connections	Lack of co-ordination Lack of responsible health professionals for care transition Role ambiguity Lack of clear communication channels Lack of planning Clinical apathy
		Communications	Communication between patients and health professionals Lack of patients' involvement in decision making Patients' low health literacy Lack of clarity Use of medical terms Provision of contradictory or wrong information Poor communication skill Rushed instruction Language barrier
		Available resources	Medication-related Poor availability of medicine Multiple daily dosing Drug instability Use of infusion than bolus injection
		Work infrastructure	Healthcare professional's workload Belief that OPAT increases the workload Lack of time to organize OPAT Belief that OPAT is time-consuming
		Work infrastructure	Lack of structured OPAT service Lack of formal OPAT team

Table II (*continued*)

Domain (construct)	Contributors	Construct	Barriers
			Lack of dedicated OPAT team Lack of specific OPAT legal framework and guideline Lack of international OPAT guideline
Access to knowledge and information	Knowledge and awareness[b] Training		Knowledge and awareness[b] Patients lack knowledge Patients lack awareness of OPAT options Belief that hospital is safe Belief that medication administration is not role of patient Lack of OPAT training and trained staff Health practitioners' knowledge gap Patient monitoring Poor laboratory result availability and review Poor patients follow-up Lack of tracking system for laboratory results and patient follow-ups
Individuals			
Implementation facilitators	Expertise of individuals in OPAT programme		Selection of patients[a] Inappropriate patient selection Geographic location Inappropriateness of prescription[a] Choosing inappropriate antimicrobial Incorrect indication, dose, duration, route of administration Use of broad-spectrum antimicrobials
Capability	Medication administration and patient convenience[b] User-friendly elastomeric pumps Device comfort		Medication administration and patient convenience[b] Concerned about line failure Loss of confidence in their skills Believe that OPAT is associated with increased workload
Motivation	Adherence to treatment[b] Compliance with treatment		Adherence to treatment[b] Skipping administration steps Storing supplies out of recommended temperature Lack of transport Forgetting appointment Feeling sick
Implementation process			
Assessing needs	Acceptance of OPAT treatment Better preference High patient and health professional satisfaction		

OPAT, outpatient parenteral antimicrobial therapy.
[a] Constructs added to capture salient theme not included in the CFIR.
[b] Theme incorporates both barrier and facilitator categories.

outpatient infrastructure as perceived by ID physicians [28]. Furthermore, in studies conducted in 2016 [153] and 2018 [66], the number of clinicians working within the existing OPAT infrastructure was perceived as insufficient. Even for health professionals offering OPAT services in the community, the measures for preventing risks associated with OPAT remained unclear [66,117].

Lack of co-ordination

In a survey conducted in 2018, more than half of ID physicians reported poor co-ordination between inpatient care and OPAT providers [66]. This lack of co-ordination was perceived as challenges in effectively transitioning patients between the hospital and the community [134]. The inadequate co-ordination across inpatient and outpatient health systems may have been attributed to various factors, including the absence of responsible health professionals for care transition [34,35], role ambiguity [65,83,117], a lack of clear communication channels [88], insufficient planning [19,132] and clinical apathy [134].

Communication between patients and health professionals

In a 2022 survey, poor communication was observed in some hospitals practicing OPAT [143]. The common barriers to

communication included lack of patient involvement in decision making [34], low health literacy of patients, use of medical jargon [83,88], poor communication skills [74,87,99,106], rushed instructions [84,88], language barriers [58], lack of clarity [34,35,58,154], contradictory information [34,84], or wrong information [58,84]. There were documented cases where patients missed doses due to miscommunication with OPAT practitioners [125].

Relationship between patients and OPAT team

Seven studies explored the relationship between patients and their healthcare providers. Health professionals were available when patients sought help [133] and provided due attention to patients' needs [19]. Patients admired healthcare professionals' hearty friendliness [113]. Healthcare practitioners were perceived to be compassionate, respectful, and to provide a caring service which helped patients develop trust, faith and confidence [39,40,151]. However, in one study, a few patients complained about inconsistencies in care between service providers [97] and felt either ignored or not treated in a professional manner [106].

Antimicrobial stewardship initiative

The implementation of an antimicrobial stewardship (AMS) programme in OPAT promoted the appropriate use of antimicrobials. In one study, a high level of appropriate antimicrobial prescribing was observed following AMS implementation in paediatric OPAT (P=0.04) [79]. The stewardship programme resulted in a reduction of parenteral antimicrobial prescription, hospital admission rates and inpatient bed days [147].

Antimicrobial availability, dose and stability

The availability and stability of antimicrobial agents affects the implementation of existing OPAT services. In studies conducted in 2018 and 2016, shortages of antimicrobial medications [66] and administration devices [153], respectively, may have forced a shift in treatment to inpatient care [58,126]. Additionally, a study in 2021 revealed instances where few patients experienced antimicrobial stock shortages during outpatient treatment [132]. The capacity to maintain antimicrobials within specified storage conditions during administration was perceived as a challenge [85]. Antimicrobial agents that do not possess adequate stability can lead to a diminished shelf life and, consequently, less effective treatment for patients receiving care at home [85].

Physicians commonly cited the frequency of antimicrobial administration and the necessity of infusions rather than bolus injections as reasons for denying OPAT referrals [40,117]. Patients reported experiencing notable limitations in their daily activities when receiving antimicrobial treatment through continuous infusions, as compared with single daily therapy [34]. Additionally, they expressed dissatisfaction with the considerable amount of time required for administering antimicrobials due to the frequent administration schedule [65,88].

Knowledge and awareness

Patients often had limited awareness of the available OPAT options [117,151] and lacked knowledge regarding the administration devices involved [47,126]. Some patients held the belief that hospitals are inherently safer than receiving treatment at home, and they perceived medication administration as solely the responsibility of healthcare professionals [151]. Within a paediatric OPAT setting, many parents struggled to recall potential adverse events associated with the administered antimicrobial therapy [39].

In a 2022 study, knowledge gaps were identified among healthcare practitioners in almost all hospitals where OPAT was practiced [143]. Both hospital practitioners and family physicians reported a lack of adequate training specifically related to the use of administration devices in 2016 [153]. Additionally, ID physicians highlighted the absence of a sufficient number of trained staff members for OPAT practice in 2018 [66]. In Europe, trained OPAT teams were only available in six countries, accounting for 35.3% of surveyed countries in 2019 [9].

Workload to healthcare professionals

According to ID physicians, OPAT increased the workload for health practitioners [134]. Physicians [121] and private nurses cited excessive workload as a limiting factor for OPAT services [153]. Some clinicians identified referral [40] and training of patients as time-consuming [87]. They reported struggling to organize OPAT [134] and review laboratory results due to lack of time [66]. In 2022, several hospitals reported experiencing time pressures on their staff when organizing OPAT services [143].

Lack of structured OPAT service

The availability of a dedicated OPAT team was found to be limited in 2012 [99,114], with some health institutions lacking a structured [9,99,129], team-based OPAT service [143]. This lack of a structured OPAT team led to wide variation in team composition and practices [46]. For instance, ID physicians may not have been involved in reviewing OPAT orders [43] and consultations may not have been requested for most patients during OPAT initiation [28,66,99,158]. This variation in structure and practices has been attributed to the absence of specific OPAT legal framework [9,134] and an international OPAT guideline [117].

Patient monitoring

Poor patient follow-ups and lack of laboratory monitoring were documented barriers to OPAT services [40,132]. A study in 2011 reported that several OPAT episodes may not have had laboratory test results [77]. In a 2018 survey, almost half of the ID physicians reported a lack of patient follow-up and laboratory monitoring in their practice [66]. Additionally, some ID physicians reported never monitoring laboratory results in studies conducted in 2004 [43] and 2012 [114]. The absence of a structured system for tracking laboratory results and patient follow-up presented a challenge for clinicians [115].

Domain 4: Individual

This domain comprised the roles and characteristics of individuals engaged in OPAT implementation. Key elements included the presence of expert professionals supporting implementation, patient commitment, and the possession of knowledge and skills required for administering parenteral antimicrobial treatment.

Expertise of individuals in OPAT programme

The implementation of an OPAT programme, supervised by an ID physician and led by an OPAT nurse, reduced hospital readmissions (P=0.003) and improved clinical outcomes (P<0.001) [23]. A team led by ID physicians or regular consultations with ID

physicians was reported as being critical in optimizing antimicrobial therapy [44,136,137] and facilitating AMS activities including parenteral to oral switch and stopping unnecessary antimicrobials [136,137,162]. OPAT with ID consultation has a lower frequency of treatment adjustment recommendations including potentially avoidable courses compared with no ID consultation ($P<0.001$) [139]. Moreover, where possible, consultation with an expert team rather than individual ID physicians resulted in a better outcome for antimicrobial optimization ($P=0.06$) [162]. Inclusion of a pharmacist in the OPAT team was deemed important and demonstrated an increase in the appropriate use of medicines, compliance with monitoring guidelines, and a reduction in treatment failure ($P<0.001$) [148].

Medication administration and patient convenience

Despite the technical complexity of IV therapy [101], patients rated portable infusion pumps as user-friendly for the administration of parenteral antimicrobials [133]. Although a few patients faced difficulties due to a loss of confidence in their skills [65,151,154,160], many patients were happy with infusing medications and going about their daily business including bathing with an IV catheter [85,87]. However, some patients experienced difficulties in showering, walking and sleeping during continuous IV drug administration and were concerned about IV line failure [34]. Some patients reported limitations in social activities [65] and some parents refused to send their children to school with a drug administration line [39]. Older patients were often not happy with the 'computer age', and faced difficulty in using programmable infusion pumps [100]. Few patient families believed that OPAT was associated with an increased workload [37]. OPAT was perceived to have not caused any major disruption to family life compared with hospital admission [40].

Adherence to treatment

Among nine studies that reported on adherence, most of the studies found good adherence to treatment (Supplementary data). Some patients failed to take medications as prescribed due to lacking transport, forgetting appointments, falling sick [65], skipping administration steps, and storing medicines out of the recommended temperature ranges [84,85]. A significantly higher number of patients treated in skilled nursing facilities missed doses compared with those managed at home by healthcare companies ($P=0.05$) [106].

Domain 5: Implementation process

The implementation process included activities and strategies employed for establishing an OPAT. One such strategy involves assessing the needs and preferences of patients regarding parenteral antimicrobial treatment.

Patients' acceptance of OPAT

Preference for OPAT treatment was assessed in 15 studies. Almost all studies reported preference for OPAT over inpatient treatment. Both patients [37,48,63,93,108,113,160,161] and carers [116] preferred OPAT over inpatient treatment. Most carers and patients would also choose OPAT treatment again if the service was needed [11,40,45,149] and recommend it to others [35]. However, patients who did not have household support or a carer, had problems in mobility, low income, or difficulty in using medication administration devices were likely to prefer inpatient care [160].

Patients' satisfaction with OPAT service was very high (Supplementary data). The majority of patients treated by home healthcare companies had more satisfaction than patients treated by skilled nursing facilities ($P<0.001$) [106]. Almost all patients' service expectations were met [45], while most patients rated OPAT services as excellent [11]. Carers were highly satisfied with in-home treatment ($P<0.001$) [38], while physician satisfaction with OPAT treatment was also very high [130].

Themes not within CFIR domains and constructs

Inappropriateness of prescription. Though the magnitude of inappropriate antimicrobial prescriptions varied, studies that evaluated the appropriateness of parenteral antimicrobial prescriptions in an OPAT setting identified some irrational prescribing practices [54,110]. Inappropriate antimicrobial selection [24,75,105], incorrect dose [24,75], prolonged duration [24,75,105] and continuation of an IV antimicrobial where an oral alternative exists were identified as inappropriate practices [70,94,105].

Patient selection

Poor selection of candidate patients for OPAT enrolment was not uncommon [87,88]. ID physicians acknowledged the improper selection of some patients in contemporary OPAT programmes [66]. In some practices, OPAT was incorrectly indicated for a significant proportion of treatment episodes [70,94,105]. Some practices lacked a system for re-evaluation of patients after enrolment or monitoring mechanisms that could check unnecessary OPAT indications or the need to make adjustment [132].

In the selection of suitable patients, geographic location may have been a concern for healthcare practitioners [134]. These practitioners also reported the location of [153] and diversity among patients as common barriers to OPAT services [99]. In 2019, five European countries (31.3%) reported geographical constraints as a challenge to providing OPAT services [9].

Discussion

This systematic review has identified both barriers and facilitators influencing the implementation and expansion of the OPAT programme using CFIR. OPAT is notable for its safety, efficacy and effectiveness. It has higher patient satisfaction and preference compared with traditional inpatient care, primarily attributed to enhanced privacy, comfort, reduced disruption to daily life and a lower risk of infection. AMS initiatives and integration of telemedicine strengthen the programme. However, certain barriers exist within OPAT implementation. These encompass challenges such as inappropriate patient selection, lack of awareness, nonadherence to established guidelines, deficiencies in communication and co-ordination, limited infrastructure, the absence of a structured service, and inappropriate prescribing practices.

OPAT is a safe and effective treatment choice for patients needing parenteral antimicrobial therapy. The clinical use and efficacy of OPAT across numerous countries over the past several years are supported by an expanding body of evidence [10]. Notably, no studies have presented evidence supporting the inferiority of home-based treatment when compared with the conventional inpatient approach [166]. The overall evidence from the literature suggests non-inferiority of OPAT to

inpatient treatment. However, to maximize its benefit, it is crucial to carefully customize existing OPAT services to align with local needs, and thereby facilitate its expansion to include infections that are not currently treated in outpatient settings.

To maintain the safety and effectiveness of OPAT, careful patient selection remains essential. The allocation of outpatient treatment should be precise, relying on well-considered selection criteria. Healthcare professionals should adhere to available guidelines tailored to aid them in choosing appropriate candidates for OPAT [10,168], ensuring that best practices are followed. Rigorous risk identification, assessment and quality assurance should align closely with established practice guidelines and recommendations to mitigate risks and enhance the quality of care [5,6].

OPAT enables a substantial cost reduction associated with hospitalization, such as room charges, nursing care, and other hospital-related expenses. According to two systematic reviews, cost savings range from 30% to 75% [166] and 57.19% [169]. This cost reduction is primarily attributed to the avoidance of prolonged hospital stays, which frees up hospital beds, and reduces the strain on healthcare facilities [170]. Moreover, OPAT contributes to cost savings by reducing the need for additional healthcare professionals and healthcare visits. Home-based treatment also reduces the risk of nosocomial infections, subsequently lowering treatment costs for both patients and healthcare institutions [171].

The OPAT service is marked by high acceptability and satisfaction [166,167], owing to its inherent flexibility, which empowers patients to exert greater control over and adapt their lives around their treatment regimen. None the less, it is imperative for patients and their caregivers to be well informed about the available OPAT options and their responsibilities in the treatment process. Adequate training and proficiency should be essential prerequisites [172]. Furthermore, measures must be in effect to address any potential miscommunication between patients and healthcare providers. These can be realized by placing patients at the centre of their care experience [173] and fostering a collaborative team approach rooted in shared values and principles [174].

Despite the limited integration of telemedicine into OPAT [5], it has demonstrated its potential in providing safe and cost-effective treatments, consistently resulting in high patient satisfaction [175]. Telemedicine enhances healthcare accessibility for patients unable to attend in-person, effectively overcoming geographical and other obstacles to receiving antimicrobial therapy [176]. The incorporation of telemedicine for patient monitoring and consultations allows for prompt interventions. OPAT teams can maintain regular reviews and discussions regarding treatment progress with the patient, underscoring telemedicine's significance in the care continuum. Therefore, the judicious inclusion of telemedicine into conventional OPAT programmes should be acknowledged and implemented with due diligence.

Inappropriate antimicrobial use in OPAT presents a concern due to its potential to fuel antimicrobial resistance and increase the likelihood of hospitalization [110]. However, OPAT stands as a valuable strategy in the battle against inappropriate antimicrobial use by promoting targeted therapy, shortening hospital stays and potentially decreasing selection pressure [5]. Consultations with ID physicians play a crucial role in reducing the extent of inappropriate antimicrobial use [139,177]. Moreover, OPAT facilitates patient compliance with prescribed treatment regimens, thereby mitigating the risk of incomplete treatment courses. Thoughtful consideration of strategically selected broad-spectrum antimicrobials offers an effective means to reduce dosing frequency and enhance ease of administration [178]. Furthermore, the incorporation of quality indicators serves as a valuable tool for assessing and guiding the judicious and appropriate use of antimicrobials in OPAT [179].

AMS initiatives have been expanding in OPAT to promote judicious antimicrobial utilization. These multi-faceted interventions include switching IV to oral therapy, selecting narrow-spectrum parenteral antimicrobials, reducing treatment duration, optimizing antimicrobial susceptibility testing, and implementing routine laboratory and safety monitoring [178]. These initiatives are crucial in limiting the unnecessary use of OPAT, thus minimizing associated costs and potential patient burden [180]. Tailoring AMS efforts to local healthcare contexts and individual patient circumstances is important in improving outcomes. Recognizing the dynamic nature of healthcare, the initiatives should be sustainable over time by incorporating robust quality improvement processes that encompass comprehensive audits and actionable feedback [181].

There exists a disparity in the structure and execution of OPAT services across different countries [182]. Consequently, variations have been observed in the composition of OPAT teams. Furthermore, OPAT teams often exhibit suboptimal adherence to monitoring guidelines, including laboratory assessments and follow-up protocols. To strengthen both existing and emerging OPAT services, it is imperative to establish a formal and dedicated OPAT team. Guidelines strongly recommend the formation of a dedicated OPAT team, comprising an ID physician, a clinical microbiologist, an OPAT nurse, a clinical pharmacist and a community nurse [10]. Such a team would be helpful in structuring patient assessments, selecting appropriate antimicrobial therapies, closely monitoring patients and effectively managing any adverse events that may arise [10]. Moreover, fostering continuous care co-ordination between inpatient and outpatient OPAT teams is essential for achieving improved patient outcomes [68,183].

The stability of antimicrobials is a crucial factor in the success of OPAT. Irrespective of the environmental temperature during the infusion process, medications in OPAT must demonstrate stability. However, the stability of antimicrobial agents within refrigerators and administration devices emerges as a critical concern [184]. For some antimicrobials, this concern is heightened by the limited availability of comprehensive stability data, specifically at room and warmer temperatures [185] which presents a significant obstacle to service delivery [186]. The potential consequences of inadequate stability are multifaceted and include a risk of underdosing, which could compromise therapeutic efficacy and impact patient outcomes.

Limited support and infrastructure pose significant challenges to the implementation and success of OPAT programmes. Access to care becomes a critical concern when there is a shortage of healthcare facilities equipped for safe parenteral medication administration. A dedicated infrastructure is important to alleviate the strain on inpatient facilities and to ensure equitable access to OPAT services. Poor accessibility of service not only jeopardizes timely treatment but also forces patients to make extensive travel and incur additional expenses [187]. Implementation of telemedicine [175] and collaboration with community organizations can help address these issues.

However, in settings where resources are limited, significant challenges arise in the use of information technology and the availability of a trained healthcare workforce.

This systematic review may be susceptible to publication bias because it included peer-reviewed journals, potentially favouring the inclusion of studies more likely to be accepted for publication. By excluding grey literature, it might not fully capture all barriers and facilitators related to OPAT services. Furthermore, while the thematic analysis method used is well established, it is important to acknowledge its inherent limitations. It remains unclear whether the thematic analysis reflects the frequency of reported themes or the analytical weighting towards a theme with a high level of explanatory value [188]. In addition, most of the included studies were conducted in North America and Europe, in a relatively similar cultural settings, and therefore the generalizability of findings to other settings may be limited given the impact of cultural influences on OPAT and prescribing practice. Furthermore, limiting the review to English-language-only studies might introduce language bias. The inclusion of various study designs, a comprehensive review of multiple studies, and the involvement of multiple reviewers enhanced the inclusivity of the results. Moreover, this review employed an implementation framework (i.e., CFIR), enabling the formulation of strategies that aim to enhance the acceptance, execution and long-term sustainability of evidence-based interventions.

In conclusion, OPAT provides a safe, effective and cost-efficient alternative to inpatient treatment. It not only maintains patients' privacy, comfort and daily routines, but also lowers the risk of nosocomial infections associated with prolonged hospital stays. The implementation of AMS interventions and integration of telemedicine can significantly enhance the effectiveness of the OPAT programme. However, there are wide variations in the organization and delivery of OPAT programmes, as well as adherence to monitoring guidelines. Challenges such as inappropriate prescriptions, insufficient communication, co-ordination gaps, service structure deficits, and limited awareness are associated with the current OPAT practice. It is important to note that the specific barriers and facilitators may vary across healthcare institutions, depending on the unique nature and scope of the issues they face. A comprehensive understanding of these obstacles is essential to design targeted initiatives for the successful delivery of OPAT services.

Author contributions

S.A.M.: conceptualization, methodology, investigation, formal analysis, data curation, writing — original draft. M.O.T.: supervision, writing — review and editing. G.M.A.: investigation. D.E.: supervision, writing — review and editing; F.S., conceptualization, methodology, supervision, writing — review and editing.

Conflict of interest statements

The authors declare no potential conflicts of interest.

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Appendix A. Supplementary data

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