The delivery, setting and outcomes of paediatric outpatient parenteral antimicrobial therapy (pOPAT): a scoping review


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Abstract

Background: There has been little detailed systematic consideration of the delivery, setting and outcomes of paediatric OPAT, although individual studies report that it is a safe and effective treatment.

Objective: This scoping review examined what is known about the delivery, settings and outcomes of paediatric OPAT and to identify key knowledge deficits.

Design: A scoping review using Arksey and O’Malley’s framework was undertaken.

Data sources: Key words were identified and used to search MEDLINE and CINAHL.

Study appraisal methods: Primary research studies were included if samples comprised children and young people 21 or under, who had received OPAT at home or in a day treatment centre. The Mixed Methods Appraisal Tool (MMAT) was used to review the methodological quality of the studies

Main findings: From a preliminary pool of 157 articles, 51 papers were selected for full review. 19 studies fitted the inclusion criteria. Factors influencing delivery of OPAT were diverse and included child’s condition, home environment, child-related factors, parental compliance, training, and monitoring. There is little consensus as to what constitutes success of and adverse events in OPAT.

Conclusions: Future studies need to clearly define and use success indicators and adverse events in order to provide evidence that OPAT is safe and effective.

Implications: Consensus outcomes that include child and parent perspectives need to be developed to allow a clearer appreciation of a successful OPAT service.
Background

Children with serious bacterial infections (SBIs) have been treated using parenteral antimicrobial therapy in an outpatient setting since the mid-1970s. At this time, the intramuscular route was considered to be a clinically safe and largely successful means of treating infection. However, advances in intravenous therapy and the requirement to protect children from the pain associated with the intramuscular injections led this route to fall into disfavour.

More recently, OPAT has been defined as the parenteral administration of antimicrobials for at least two consecutive days without an intervening hospitalisation. This treatment is selectively offered to treat SBIs such as pneumonia, osteoarticular infections (OAIs) and low risk febrile neutropenia. Depending on the child’s condition at presentation, the child may be admitted to hospital and receive initial treatment and monitoring until deemed sufficiently stable to be discharged home on OPAT, or the child may be referred immediately for OPAT without ever having been admitted to hospital.

Two main approaches to OPAT delivery are used depending on the local resources available. The first is ambulatory and requires the child to return to a clinical setting (e.g., emergency department or day treatment centre) on a daily (or more frequent) basis for assessment and administration of the therapy. The second approach is home-based, with the child being assessed and the therapy administered in the child’s home either by nursing staff or by their parents who have been trained to assess and administer the antibiotics. When the service is delivered by nurses this is usually undertaken by those who are either part of a specialised OPAT team of community nurses, or those within a broader community role such as ‘hospital at home’.

A variety of patient and health care benefits are potentially associated with OPAT; most notably for health services is that OPAT is considered to be a more cost-effective option when compared to continued inpatient care. Other benefits include “parent and patient satisfaction, psychological well-being, return to school/employment, reductions in healthcare-associated infection and cost savings” (Patel et al., 2015, p361).

Given that there has been little consideration of the direct and indirect benefits, disadvantages and broader outcomes of OPAT, a scoping review was conducted to examine what is known about OPAT in terms of delivery, settings and outcomes, and to identify key areas of deficits in knowledge. Specifically, this scoping review explored primary research that examined OPAT delivered to children and young people aged 21 or under, who had received OPAT in a home or day treatment centre, of which at least 80% of treatment was intravenous.
Method

A scoping review was undertaken as the intention was to explore and map the key concepts and to identify gaps in research related to OPAT. The scoping review was conducted following Arksey & O’Malley’s (2005) framework (14), which was modified to allow more flexible and robust reporting of the results (15-17). These modifications included: 1) an iterative approach to refine our search strategy and inclusion criteria; 2) an assessment of methodological quality was undertaken using the Mixed Methods Appraisal Tool (MMAT) (18); and 3) in the absence of EQUATOR guidance on reporting we were guided by recommendations made by the Joanna Briggs Institute (19).

Inclusion Criteria and Types of Sources

The inclusion and exclusion criteria are shown in Table 1. No date restrictions were applied to the search.

Table 1: Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Primary research studies</td>
<td>1. Studies conducted in developing/low income settings</td>
</tr>
<tr>
<td>2. Articles in peer-reviewed journals</td>
<td>2. The full text of the article was unavailable</td>
</tr>
<tr>
<td>3. Published in English</td>
<td>3. Case studies, reviews, guidelines, poster, abstracts, commentaries and editorials.</td>
</tr>
<tr>
<td>4. Data is presented from children and young people aged 21 years or under (and is reported separately from adult’s data)</td>
<td></td>
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<tr>
<td>5. Children and young people who received OPAT treatment did so in their home or a day treatment centre and data from inpatients and outpatients were reported separately.</td>
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<tr>
<td>6. Children and young people received at least 80% of treatment intravenously.</td>
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<tr>
<td>7. Data from intramuscular and intravenous treatment reported separately.</td>
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The search terms were generated based upon consideration of: the population (children and young people under the age of 21 years), the “concept” under investigation (parenteral antimicrobial treatment) and the context (home-based or outpatient-based care). Key words and terms identified by the authors were used to search PubMed and CINAHL. Further key words were then identified and the new search list was used to search Google Scholar to generate a comprehensive final set of search terms (Table 2).
Table 2: Search terms (by population, concept, context).

<table>
<thead>
<tr>
<th>pOPAT OR paediatric outpatient parenteral antimicrobial therapy</th>
<th>Population (&lt;21 years)</th>
<th>Concept (Intervention)</th>
<th>Context (Setting)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Paediatric OR pediatric OR infant OR child* OR adolesce*</td>
<td>• Antibiotic OR antimicrobial AND (agent OR therapy OR prescri* OR manage*)</td>
<td>• Outpatient OR home OR ambulatory OR community</td>
</tr>
</tbody>
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Search Strategy
Major databases consulted for the indexed published literature were MEDLINE and CINAHL. Further articles not identified in the results of the above strategies were added if identified by other means (e.g. cited by a related article, identified on a World Wide Web search). The search was initially undertaken February 2017 and updated in July 2017 and was supported by an expert librarian (full electronic search strategy available upon request). A data extraction sheet was developed and iteratively refined and included the following broad categories: delivery, setting and outcomes. In line with the aims of a scoping review, all outcomes of paediatric outpatient treatment were included in the data extraction sheet.

Appraisal of study quality
The Mixed Methods Appraisal Tool (MMAT) 18 was used to review, but not score, the methodological quality of the studies. In seven of the 19 studies, it was not completely clear that the collected data adequately allowed the research question to be answered. Other key quality issues related to completeness of outcome data, appropriateness of measurements and acceptability of response rate (see Table 3).

Table 3: MMAT Synthesis Table
| question s | Do the data address the research question? | Y | Y | Y | Y | Y | UC | UC | UC | Y | Y | Y | Y | UC | UC | UC |
| 2. RCT | Is there a clear description of randomization? | Y | Y | | | | | | | | | | | | | |
| | Is there a clear description of concealment? | N | N | | | | | | | | | | | | | |
| | Are there complete outcome data? | UC | Y | | | | | | | | | | | | | |
| | Is there low withdrawal? | Y | Y | | | | | | | | | | | | | |
| 4. Quant. Descript. | Is the sampling strategy relevant? | | | | | | | | | | | | | | | |
| | Is the sample representative? | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | UC |
| | Are measurements appropriate? | UC | Y | Y | Y | UC | Y | UC | Y | Y | Y | Y | UC | Y | UC | UC |
| | Is there an acceptable response rate? | N | Y | Y | Y | UC | UC | UC | Y | Y | Y | Y | Y | UC | Y | UC |

N = No, Y = Yes, UC = Unclear

Results

Overview of the Studies
A preliminary pool of 157 articles were identified. Titles and abstracts were reviewed by two lead reviewers and where there was disagreement a third reviewer was used; 51 papers were selected for full review, from which 19 were identified as having good fit with the inclusion criteria and the objective of the review (see Figure 1: Flow diagram).
A condensed summary chart detailing the study design, sample, requirements, setting and delivery of the 19 studies included in the review is available as a supplementary file. The review of studies via the MMAT revealed the quality as fair (see Table 3).

Data were international, reporting on studies undertaken in the United States, Canada, Spain, Australia, Ireland, India, Israel and The Netherlands.

The studies included in the review had adopted a record review design with the exception of 3 cohort studies, 2 randomised control trials, an online survey and a pilot programme.
All study populations comprised children and/or young people aged 1 week to 21 years, with the exception of one study which presented data from an online survey of paediatric physicians\(^{22}\).

Sample sizes ranged from 7\(^{28}\) to 2687\(^{24}\).

**Delivery of service: target population, indications for treatment, factors influencing delivery**

The studies were mixed in terms of whether the studied cohort had a common underlying condition as well as the infective indication for receiving OPAT. Only 4 studies had a specific focus on one such condition: cancer\(^{6,21}\) and cystic fibrosis\(^{4,28}\). The remaining studies had either no specific underlying condition reported\(^{5,7-10,24-26}\) or the children had a range of underlying conditions (such as gastrointestinal diseases and HIV infection)\(^{11-13,20,22,23,27}\).

In terms of the infective indications for treatment, half of services delivered OPAT for a wide range of infection (e.g. respiratory, blood stream, urinary, and musculoskeletal)\(^{8,10-13,22,24-26}\). The remaining half were focused on a single indication for treatment, such as urinary tract infections\(^{4-7,9,20,21,23,27,28}\).

The key consideration in determining the suitability of the child for OPAT was the presence of infection. Other factors included the stability of the child’s condition\(^{7,9,11,20,23}\) and the home environment, either in generic terms\(^{22}\) or more specifically such as the need for the home environment to be ‘stable’\(^{10}\) and appropriately resourced in terms of refrigerator and/or telephone\(^{8,10,11,20,21}\). The location of the home was specifically reported as influential in determining access to pOPAT by four studies\(^{11,20,21,27}\) and, although, this was not clearly reported it is likely that this was relevant in other studies where specialist home-based teams delivered pOPAT.

Parental compliance/reliability was also reported as either an inclusion factor\(^{8,11,20,22}\) and/or the lack of these qualities as an exclusion factor\(^{9,10}\). Parents were trained to administer medication to their child in 6 studies\(^{4,6,11,23,25,27}\). In all of these studies, all children had a pre-existing condition. However, even when professionals were responsible for the administration of medication, parents received training to: assess for complications\(^{4,10,11,25,28}\) to check the child’s temperature\(^{9,20}\), deterioration\(^{27}\), inspect the IV site\(^{8}\) and troubleshoot\(^{6}\). Five studies reported that training parents required a period of time in hospital before discharge to pOPAT\(^{4,10,11,25,28}\) and one study reported that a period of hospitalisation was needed to check for drug reactions\(^{26}\).

Support for parents or carers varied across the studies depending on whether the child was receiving home-based or ambulatory care. For children in the home setting, support varied from daily phone calls and home visits as needed\(^{11}\), initial daily or twice daily visits\(^{12,21,25}\), visits about every 2.9 days\(^{27}\) and 24-hour access to professional support\(^{4-6,27}\). For children receiving ambulatory-based OPAT,
parents were advised to return to the emergency department and/or readmitted if they had concerns.\(^8,21\)

**Setting**

In most studies, the family home was the setting for the delivery of OPAT\(^4,6,10–13,21,23,25–28\). The remaining studies were set in various outpatient settings: day treatment centres\(^7,9\), a combination of hospital outpatient/local clinics\(^20\), or emergency department\(^8\). In 3 studies the location was not reported or unclear\(^5,22,24\). Little detail was provided about the outpatient settings or the actual suitability, difficulties or challenges of the home as a setting for OPAT.

**Outcomes**

No studies reported a priori criteria for success of paediatric OPAT. “Success” was therefore implied in terms of the percentage/number of children completing OPAT as home-based or outpatients\(^13\) or through reports of what percentage of episodes of treatment were completed at home\(^11\). Other studies claimed that home treatment improved the child’s condition compared to previous hospital based courses of treatment\(^28\), or implied success through noting that all ambulatory patients returned for scheduled re-evaluation within 24 hours of commencing OPAT/ initial discharge\(^8\).

Clinical complications such as line failures, rehospitalisation and adverse drug reactions were not consistently reported as adverse events although these have been identified as such in the Summary Chart.

The reporting of hospitalisation/re-admission was inconsistent. Although some studies reported the number of children who were hospitalised after commencing OPAT\(^3,7,9,10,11,12,13,20,21,25,26\), others reported the number of treatment courses that required unplanned hospitalisation\(^5,23,24\). Hospitalisation rates varied ranging from 4%\(^12\) to 22%\(^27\) of patients and between 26%\(^5\) and 29%\(^25\) of courses. Children were hospitalised as a result of being ‘unresponsive to treatment’ (22%)\(^27\); ‘inadequate clinical response’ (1%)\(^12\); ‘exacerbation of underlying condition’ (7%)\(^11\) and ‘poor evolution of infectious disease’ (3%)\(^11\), ‘deterioration’ (0.6%)\(^6\), fever\(^20,23\) and the need to ‘complete course of IVs’\(^25\). Catheter associated complications were also linked to hospitalisation\(^5,13,23,24,26\).

Other reasons for hospitalisation included ADRs and surgical management\(^5,24\), seizures and bleeding\(^20\), gastro-oesophageal reflux and positive blood culture result\(^9\). In two studies the reason for admission was less clear\(^7,10\). Unplanned medical care visits were reported in two studies with 17 out of 98 (17%) children having an unplanned visit\(^26\) and 17 (48%) having one or more unplanned visits\(^10\).

The number of other catheter related complications was reported by 5 studies\(^5,12,25–27\); only one study reported no catheter-related complications\(^6\). Extravasation, displacement and other
intravenous access issues were reported by 5 studies. Poor technique and/or technical problems were reported by 2 studies.

The definitions and reporting of adverse drug reactions (ADRs) was inconsistent between studies. In four studies reported that no ADRs occurred, and others provided generic reports of ADRs. For example, 25% of children experiencing pOPAT complications were reported as being associated with the use of highly bioavailable antibiotics. Two studies (11%) provided more detailed reports of ADRs: in one study, 70 (29%) of courses were deemed to an ADR and of these early discontinuation of antibiotics was reported in 58 courses of treatment and in the other study reported ADRs were associated with inappropriate choice of drug (6%) and inappropriate dose or duration of treatment (26%), although the authors also reported that no adverse antibiotic-related events necessitated change or cessation of antibiotic or hospital readmission.

Seven studies reported on satisfaction (parental satisfaction; children’s satisfaction), although the mechanisms of data collection were often unclear or unreported. In one study some parents (32%) were worried about taking their febrile child home and 20% were worried about taking their child home with indwelling IV access. In another study, some mothers of children aged 6-12 years were anxious about accepting the responsibility of their child's treatment and concerned about the stress that home-based care would create for the family. The 12-18 year olds in this study described liking home-based care due to the lack of disruption to home and school life, but reported missing the contact with staff and other patients that occurred when they were inpatients. In another study, children aged 10 or over completed questionnaires assessing their quality of life: Those who were treated at home had significantly better appetites and slept better compared to those who were treated in hospital.

Six studies concluded that OPAT is more cost effective than conventional inpatient treatment. Two studies notes that the cost effectiveness calculations did not account for the costs associated with complications or the direct cost to families.

**Discussion**

This scoping review has systematically examined the empirical evidence regarding the delivery, settings and outcomes of OPAT. The quality review revealed that the studies are generally fair quality. The operationalisation of specific definitions/treatments varied widely and the reporting of who gave treatment and the setting was often unclear.
The factors influencing the delivery of OPAT were diverse and included: service-related issues including staffing and monitoring; child-related factors such as age, nature of infection, clinical status; and home/parent related factors such as home environment, parental compliance, and training.

In a systematic review comparing home-based versus hospital-based treatment with intravenous antibiotics in children, the authors concluded that data about the safety of treatment was scarce. In addition to a scarcity of data, this review found that there is a lack of clarity and consensus as to what constitutes success in OPAT making comparison across studies difficult; however, individual studies report that OPAT is safe. There is also a lack of clarity and consensus in the definition and reporting of adverse events. There was little acknowledgement that although problematic, defining adverse events is necessary or acknowledging that for one type of AE – ADRs - objective criteria do exist and could be used. Conclusions about the success of OPAT have been drawn despite evidence of adverse events (which were ill defined yet occurred in most studies) and readmissions (which were reported in different ways, and likewise occurred in most studies).

In terms of key knowledge deficits within the literature we scoped for this review, most of the studies were retrospective and follow-up data examining health outcomes over time are lacking. We also know little about parents and children’s experience of OPAT. There is little reflection about the factors which may influence experience such as the child’s age, nature of infection, family circumstances and the educational level of parents. Additionally, considering the fact that infection has a higher incidence in families of lower socio-economic status, there is little detail about whether these families are excluded from OPAT or, if in receipt, how they fare in comparison to families in better circumstances. We know little of children who were not selected for OPAT or parents and children who declined this treatment and the reasons why. In agreement with the recent systematic review comparing home-based versus hospital-based treatment, we likewise conclude that although studies report patients to be safely treated at home, generalisation to all patients is difficult due to selection bias.

The evidence base for the economic benefits of OPAT is poorly and inconsistently presented and does not take account of any shift of economic burden onto the families.

**Strengths and Limitations**

This scoping review has used a robust and iterative methodological approach and included an analysis of study quality. However, the variable quality of the evidence base means that strong conclusions regarding the delivery, settings and outcomes of OPAT cannot be made. Conclusions are also complicated to draw due to the diversity in terms of the age of children receiving treatment.
children’s underlying conditions, indications for treatment and the delivery of treatment. Our focus was outpatient care therefore our findings do not reflect comparison with inpatient care.

**Implications for research**
Future studies need to clearly define success indicators and adverse events in order to substantiate claims that paediatric OPAT is safe and effective. Specifically, hospitalisation, unexpected catheter related complications, extravasation, and antibiotic complications should be reported as adverse events. To allow comparison between studies and pooling of data from different cohorts, the definitions for such AEs need to be agreed by healthcare professionals delivering adult and paediatric OPAT care.

Numerous knowledge deficits need to be addressed. There is a need for follow-up data tracking the trajectory of patient’s interactions with health care providers over time. Future research of a qualitative nature needs to be conducted with children and young people receiving OPAT, and their parents in order to explore their experiences of receiving this treatment. A thorough cost-benefit analysis needs to conducted that includes a consideration of the economic impact on the family.

**Implications for practice**
Parental and child perspectives should be sought to identify how they can best be supported. Despite the apparent professional confidence in the success and benefits of paediatric OPAT, it should not be assumed that all families will choose OPAT or that it will be the most appropriate intervention. Clear, consensus outcomes that include outcomes of importance to the children and their parents need to be developed to allow a clearer appreciation of a successful OPAT service.

**Strengths and limitations of this study**
- Identification of methodological weaknesses in studies
- Identification of gap in knowledge about parents and children’s experience of OPAT, the lack of predetermined success criteria and clarity about what constitutes an adverse event.
- Due to the variable quality of the evidence base, strong conclusions regarding the delivery, settings and outcomes of OPAT cannot be made.

**Conclusion**
Further work that includes the perspectives of children and parents and which uses clearly defined indicators will improve the evidence base for the efficacy and safety of paediatric OPAT.

**Competing interests: None declared.**
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**Contributorship Statement:** All authors (BC, EC, DP, MP, DT-R, DF-S, LB) contributed to the conception and design of the study. Article reviewing, scoring and data analysis has been performed by BC and LB with assistance from EC. All authors (BC, EC, DP, MP, DT-R, DF-S, LB) have made contributions to the drafting and revision of the article.

**Data Sharing Statement:** The summary chart has been provided as a supplementary table.

**Patient and Public Involvement:** Neither patients or the public were involved in the scoping review process.

**References**


23. Campo M, Moreno JM, Albiñana S, Valero MA, Gomis P, León-Sanz M. Outpatient intravenous


**Author, Year Country**

Banerjee et al. (2014) USA

**Design, Sample size, Age of children**

Online survey of paediatric physicians (survey open for 2 months)

558 physicians

Child’s age = NA

**Underlying condition/ Indication for treatment**

Underlying condition: Various but not reported.

Indication for treatment:
- Most commonly osteomyelitis, endovascular central nervous system infections, pneumonia

**Key requirements /influences on offering OPAT/inclusion & exclusion criteria**

Inclusion criteria:
- Patient compliance, home environment,
- Need for parental medication
- Resources for follow-up/ monitoring
- Patient age
- Presence of bacteraemia

Setting:
- Not reported

Delivery:
- Most (94%) reported that their institution had a team for peripherally inserted central catheter placement.

**Key clinical outcomes/adverse events (Note: for some papers events categorised as adverse by scoping reviewers)**

Adverse events:
- 104 (67%) respondents reported that line or drug-associated complications occurred in 10% or fewer cases.

**Other outcomes (e.g., finance, family perspectives)**

Financial:
- Revenue sources reported to support OPAT management included: outpatient visit charges (51%), inpatient consult charges (36%), support from hospital or healthcare system (18%), support from home care agency (12%), or income from infusion center (4%).
- 32% of respondents did not know the revenue source for OPAT management and 5% reported OPAT services were not financially supported.

**Author-noted limitations**

- Responses regarding OPAT programs and clinical practice, may not represent actual practice.
- Responses may be subject to recall bias.
- The generalisability of the findings to all pediatric ID practices is uncertain.
- Survey did not collect data on all of the clinical and social factors that contribute to decision making regarding OPAT use.

- OPAT use in paediatrics is uncommon.
- Most respondents significantly underestimated the risk of OPAT-related complications.
- Substantial variation in the characteristics of OPAT practices and frequency of OPAT use.
- Many pOPAT programs may lack adequate resources and infrastructure to perform appropriate follow-up of OPAT patients.
- Better evidence is needed regarding not only the benefits of pOPAT.
- Decisions to use OPAT are complex, and reasons for the variability in OPAT use by pediatric ID providers should be further explored.

**Author-noted comments/ recommendations**

- Use of OPVAT requires adequate selection criteria and patient evaluation. Patients must be medically stable, the home environment should be clean, have a telephone, etc.
- Children develop CR-BSI more frequently than adults.
- When a catheter infection occurs antibiotic parenteral therapy may be administered totally or partially at home. Cost-savings and benefits for the patient may be significant.

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**Campo et al. (2001) Spain**

**Design, Sample size, Age of children**

Retrospective review (6 years)

7 children receiving home parental nutrition (and 11 adults, whose data are not reported here)

Mean age 3.1, Range 6 months-8 year.

**Underlying condition/ Indication for treatment**

Underlying condition: Intractable diarrhoea, short bowel, motility, liver cirrhosis.

Indication for treatment:
- Cather-related infection

**Key requirements /influences on offering OPAT/inclusion & exclusion criteria**

Inclusion criteria:
- Existing CVC for infusion of HPN
- All the HPN patients/families/caregivers competent in handling CVC and avoiding and recognising complications.

Setting:
- Home

Delivery:
- Infusion performed after completion of HPN.
- If the patient’s general condition was stable, the whole therapy could be received at home. Otherwise, the patient remained in hospital until complete remission of fever occurred and sensitivities were known.

Key clinical outcomes/adverse events

Key clinical outcomes:
- No differences in the length of antibiotic treatment in CRBSI between patients admitted to the hospital or treated entirely at home.

Adverse events:
- Incidence rate of CR-BSI was 0.9 in children.
- Incidence rate of tunnel infection was none in children.
- 4 children never developed CR-BSI. Three children with episodes of CR-BSI were treated as inpatients.
- There were no adverse effects during OPVAT

**Other outcomes (e.g., finance, family perspectives)**

Financial:
- The National Health System in Spain covers all the expenses due to IV nutrition both in the inpatient and the outpatient setting, including those due to the complications of the technique.

**Author-noted limitations**

- None reported.

**Author-noted comments/ recommendations**

- Use of OPVAT requires adequate selection criteria and patient evaluation. Patients must be medically stable, the home environment should be clean, have a telephone, etc.
- Children develop CR-BSI more frequently than adults.
- When a catheter infection occurs antibiotic parenteral therapy may be administered totally or partially at home. Cost-savings and benefits for the patient may be significant.

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**Cantore (2014) Spain**

**Design, Sample size, Age of children**

Prospective descriptive.

55 children (33 males and 22 females); 35 patients (63.6%) had more than one episode – total of 163 episodes of home parental treatment

Mean age 11.1 years

**Underlying condition/ Indication for treatment**

Underlying condition:
- Cystic fibrosis, cancer, gastrointestinal diseases, HIV infection, bronchopulmonary dysplasia and hyper IgM syndrome.

Indication for treatment:
- The main sources of the treated infections were respiratory tract (76%), catheter-related bloodstream (9.2%), and urinary tract infections (5.9%).

**Key requirements /influences on offering OPAT/inclusion & exclusion criteria**

Inclusion criteria:
- Medically stable patient (assessed by interview by HHU team),
- Chronic underlying disease, non-progression infection,
- Family support, care physically & mentally able to provide treatment in the home, home address within the HHU service area, has a telephone, running water, and refrigerator,
- voluntary consent for at-home treatment, signed informed consent

Exclusion criteria:
- Infection can be treated orally or requires other inpatient treatment

Setting:
- Home

Delivery:
- Long-term patients: HHU nurses train long-term patient and the carer (in hospital) to feel to self-administer the medication and evaluate potential complications.
- Shorter treatments: HHU nursing staff perform home visits to administer the treatment (the patient and carers trained to access for complications).
- Daily phone call from HHU team while patient is home and treatment is ongoing: home visits from member of HHU team as needed.

**Key clinical outcomes/adverse events**

Key clinical outcomes:
- Most treatments (96.6%) were IV; IM route in 5 (3%) episodes.
- Peripheral access (94.5%); central access only used in 4 (2.5%) patients who had a CVC.
- 147 episodes (90.2%) of treatment at home prior to discharge.
- Mean duration of home treatment 11.05 days (SD 5.82; range 1-25 days)
- Cumulative number of treatment days was 1972

Adverse events:
- Extravasation or accidental displacement of the infusion pump (n=1, 0.6%).
- A catheter infection occurs antibiotic parenteral therapy may be administered totally or partially at home. Cost-savings and benefits for the patient may be significant.

**Financial**
- An estimated cost-analysis found that the inclusion of patients in this programme could have saved up to 95% of the cost of conventional inpatient treatment

**Author-noted limitations**

- It is a single-centre study
- The majority of referrals were CF patients.

**Author-noted comments/ recommendations**

- Essential factors for a successful OPAT programme are: appropriate infrastructure; careful selection of patients/multidisciplinary staff with experience both in at-home care delivery and in the diagnosis and treatment of infectious diseases, provision of information and training, good monitoring of the patient, guaranteed 24 h a day by hospital to address any complications that may arise.
### Doré- Bergeron et al. (2009)

**Objective:** A retrospective cohort study using record review (20-27 days).

**Setting:** Canada

**Sample Size:** 66, range: 33-85 days.

**Age of Children:** 68 months, months (range: 3-90 days).

**Underlying condition:** No other conditions reported.

**Indication for treatment:** Urinary tract infections.

**Inclusion criteria:** Children who appeared nontoxic, who had normal renal function, and who met no other exclusion criteria.

**Exclusion criteria:**
- Age of 30 days,
- Toxic appearance and dehydration,
- Abnormal renal function,
- Dubious parental compliance,
- History of urinary tract surgery,
- Abnormal cerebrospinal fluid (CSF) findings (leukocyte count of 10 cells per L or protein level of 0.40 g/L),
- Other serious medical conditions.

**Setting:**
- DTC Delivery
- All infants were initially assessed by ED pediatrics.
- The infants were monitored on a daily basis by DTC staff until symptoms improved and culture results were obtained.
- Daily visits by paediatric nurses trained in the delivery of parental antibiotic therapy on an ambulatory basis until the end of IV treatment
- Antibiotic administered via peripheral IV.
- Parents were asked to measure the child's temperature every 4 hours at home during intravenous treatment.
- More than one third of patients (36.4%) lived 20 km from the hospital.

**Key clinical outcomes:**
- Treatment with IV antibiotics at DTC lasted a mean of 2.7 days.
- 86.2% of patients with confirmed UTIs were successfully treated in DTC (defined as attendance at all visits, normalization of temperature within 48 hours, negative control urine and blood culture results, if cultures were performed, and absence of hospitalization from DTC).
- Overall success of treatment was lower for young infants, but this result was not statistically significant.

**Adverse events**
- 7 patients were hospitalized from the DTC (N=1, severe concomitant gastrointestinal reflux; N=1 right hydronephrosis). Five of 6 children with bacteremia were hospitalized because of the positive blood culture results. N=1 with bacteremia who was not hospitalized also had an uneventful course.
- Minor problems with intravenous access, including failure to establish IV access (gentamycin was administered intramuscularly) and the need to replace the IV line during the course of therapy, encountered for 5 patients (8.6%).
- Seven of the 8 "treatment failures" were considered failures because of hospital admission.

**Other outcomes:**
- Rates of parental compliance with DTC visits was 98.3%.
- Long-term results (e.g., rate and extent of renal scarring) for DTC patients not measured.
- Results might have been different in another context.

**Financial:**
- The average daily cost for hospitalization on the wards where children with UTI are usually admitted was CAN $400 (US $300) vs. daily cost for treatment at the DTC was CAN $52 (US $39); these rates did not include medication, investigation costs, and physician fees, which would be approximately the same in both settings.

**Parental Satisfaction:**
- 172 anonymous parental satisfaction questionnaires returned: 75% described the overall experience at the DTC as excellent, 20.3% as very good, and 3.3% as good. Only 2 parents (1.2%) considered their experience fair or poor. Of 43 parents whose child had been hospitalized in the past, 65.1% thought that their experience at the DTC was much better than their hospital experience, 20.9% that it was better, and 9.3% that it was similar. 32% and 20.4% expressed worry at the thought of going home with a child who was still febrile and who had indwelling IV access, respectively.

**Author's Notes:**
- None reported.

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### Gautier et al. (2004)

**Objective:** Prospective, observational (1 year).

**Setting:** Canada

**Sample Size:** 291 episodes of presumed febrile UTI were diagnosed in the ED, of which 212 (72.9%) were sent to the DTC.

**Age of Children:** 3 months to 5 years of age. Patients treated at the DTC, with a final diagnosis of UTI, had a median age of 12.0 months (range: 3-68 months).

**Underlying condition:** No other conditions reported.

**Indication for treatment:** Presumed febrile UTI.

**Exclusion criteria:**
- Toxic appearance,
- 5% dehydration,
- Dubious parental compliance,
- Parental inability to comply with the physical requirements of treatment at the DTC or parental refusal,
- Known significant uropathy,
- History of surgical intervention involving the urinary tract during the past 3 months,
- Hearing deficit,
- Abnormal serum creatinine levels,
- Other serious medical conditions.

**Setting:**
- DTC Delivery
- Evaluation performed in the ED included a complete blood count, blood culture, measurement of serum blood urea nitrogen, creatinine, and electrolyte levels, urinalysis, and urine culture.
- IV antibiotics administered via peripheral line.
- Parents were given written information about follow-up care at the DTC.

**Key clinical outcomes:**
- Duration of IV antibiotic therapy at the DTC was 1.9 days (SD: 0.9 day).
- Mean number of visits to the DTC, including appointments for renal US and voiding cystourethrography evaluations, was 3.5 (SD: 0.9).
- Parents were present at all scheduled visits in 98.9% of cases.
- Parents refused referral to the DTC or were judged unable to comply with DTC treatment by ED physicians in only 9 instances; so children hospitalized.
- Patients eligible by 24 hours in 52% of UTI episodes and by 48 hours in 82%.
- At telephone follow-up assessments 14 days after discharge, no patient had been rehospitalized because of UTI.
- Successful treatment at the DTC (defined as attendance at all visits, normalization of temperature within 96 hours, negative control urine cultures, if performed, and absence of hospitalization from the DTC) observed in 96.6% of the 178 UTI episodes.

**Adverse events**
- Minor problems with IV access occurred in 9.6% of cases.
- Four patients hospitalized from the DTC, only 1 case related to UTI treatment.
- Problems with IV access occurred in 36 instances (9.0%) (e.g., failure to establish IV access, need to reinstall IV access) during the course of therapy. No major IV complications reported.

**Financial:**
- The average daily cost for hospitalization on the wards where children with UTI are usually admitted estimated at CAN $400 (US $300) vs. daily cost for treatment at the DTC was CAN $52 (US $39); these rates did not include medication, investigation costs, and physician fees, which would be approximately the same in both settings.

**Parental Satisfaction:**
- 172 anonymous parental satisfaction questionnaires returned: 75% described the overall experience at the DTC as excellent, 20.3% as very good, and 3.3% as good. Only 2 parents (1.2%) considered their experience fair or poor. Of 43 parents whose child had been hospitalized in the past, 65.1% thought that their experience at the DTC was much better than their hospital experience, 20.9% that it was better, and 9.3% that it was similar. 32% and 20.4% expressed worry at the thought of going home with a child who was still febrile and who had indwelling IV access, respectively.

**Author's Notes:**
- None reported.
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<tr>
<th>Author, Year</th>
<th>Design, Sample size, Age of children</th>
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<th>Key requirements/Influences on offering OPAT/inclusion &amp; exclusion criteria</th>
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<td>Glackin et al (2014) Ireland</td>
<td>Retrospective record review (3 years) 32 children who received a total of 361 OPAT courses. The median age was 6.8 years (range 2.75-17.8 years). Sixteen (50%) were male.</td>
<td>Underlying condition • Cystic fibrosis (n=80), recurrent pneumonia (n=2). Indication for treatment • All children treated with OPAT had pneumonia. • Common organisms included Pseudomonas aeruginosa (mucoid and non-mucoid), Staph aureus (methicillin sensitive or methicillin resistant). Haemophilus influenza, Streptococcus pneumonia or a combination. Inclusion criteria • Usual practice stated to be individual assessment by consultant respiratory paediatrician and CF nurse oralist for suitability for home IV antibiotics</td>
<td>Setting • Home Delivery • The CF nurse specialists train parents (administration, storage of medications, hygiene, IV access care, monitoring for all potential side effects, plan of action in the event of same including names and contact numbers at the hospital. Parent training time to reach competency in OPAT administration etc. was 3-5 days, while re-training was usually &lt; 1 day. • All patients had 24hr access to medical assistance either directly or over the phone with the respiratory team or via the in-house medical registrar.</td>
<td>Key clinical outcomes • 3,688 days of intravenous antimicrobials administered at home using the OPAT programme. • On average, children had 11 courses (range 2-112) over the 3 year period, with a mean duration of 10 days therapy (range 2-42 days). • 23 (72%) of children treated with OPAT had portacaths, the remainder used long lines sited by the hospital IV team. • For children on the active lung transplant list, some courses were extended to 4.6 weeks with a change in antibiotic choice after 2.3 weeks. Adverse events • 3 (2%) portacath infections. All three were surgically removed after failure to respond to antimicrobial therapy while awaiting surgery. • One (0.6%) re-admission: a child who had a deterioration in pulmonary status and chest radiograph findings.</td>
<td>None reported</td>
<td>None reported</td>
<td>Patient benefits include reduced risk of health care associated infections and higher levels of satisfaction with OPAT (in appropriate conditions) than with inpatient hospital care. Success of OPAT is dependent on appropriate patient selection, weekly follow up of patient clinical status, blood tests, 24 hour access to medical advice and overall adherence to national practice guidelines. CF is suited to OPAT because chronicity of condition and need for repeated courses of antimicrobials parents become trained and experienced, children and families are well known to the respiratory team and many of these children have permanent indwelling IV access (portacaths) in place. In current climate of budget cuts, pressure on inpatient bed availability and risk of nosocomial Infections, OPAT is an important and effective tool</td>
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<tr>
<td>Goldman et al. (2017) USA</td>
<td>Record review of the Truven MarketScan Medicaid claims database (4 years) Paediatric Medicaid enrollees (aged 0-18 years). 4343 distinct OPAT episodes for 2687 patients.</td>
<td>Underlying condition No specific conditions reported Indication for treatment • Infections related to haematology/ oncology, gastrointestinal/ genitourinary cystic fibrosis, osteoarticular, and pulmonary, bacteremia, vascular/endocarditis, upper respiratory infection, soft tissue infection, central nervous system, urinary tract infection, other.</td>
<td>Setting Not reported Adverse events More than one third of children receiving OPAT (n = 1289; 38%) had either an ED visit or hospitalization during an OPAT episode. • Haematology/oncology diagnostic category was associated with the highest percentage of medical care encounters with 28% experiencing an ED visit and 51% having a hospitalization during an OPAT episode. • Other categories with high rates of healthcare encounters were endovascular/endocarditis (27% ED, 24% hospitalization) and GI/GU (24% ED, 30% hospitalization). • Overall, 61% of acute healthcare encounters during OPAT episodes were likely attributable to a catheter-related complication; this rate was relatively consistent across diagnostic categories • Among children who experienced an OPAT-related complication, 25% were treated with a highly bioavailable antimicrobial. • Of the 791 episodes of OPAT-related inpatient or ED use, 265 (33%) included ICD-9 code for fever, 276 (35%) included ICD-9 code for line complication, and 250 (32%) included ICD-9 codes for both fever and line complication over 20% of OPAT episodes resulted in children requiring medical care in the hospital or ED setting for an OPAT complication</td>
<td>None reported</td>
<td>None reported</td>
<td>Findings may not be generalizable to other US regions or commercially insured children. Unable to determine the population-based incidence of OPAT as database does not provide the total population of Medicaid enrolles. A conservative approach to defining OPAT may have resulted in an underestimation of the number of children prescribed OPAT. Lack of chart review may have resulted in misclassification of indication for OPAT, issues for subsequent healthcare use, and appropriateness of OPAT. An overestimation of the complication rate by including fever may be reason for high OPAT complication rate (ED visit or hospitalization)</td>
<td>OPAT is used for children with a wide spectrum of clinical diagnoses and for the administration of a wide variety of antimicrobial agents, including antibiotics and antifungals. A substantial number of OPAT episodes included highly bioavailable antimicrobials prescribed intravenously that could potentially have been administered orally. Patients receiving OPAT are at high risk for requiring additional ED and inpatient hospitalizations during their OPAT episode, and the majority of these healthcare encounters were likely related to OPAT complications. Failure to switch from OPAT to oral administration when using highly bioavailable agents can result in higher medical care cost and the potential for harm without evidence of therapeutic benefit. The high cost and potential for complications means additional studies are needed to compare the effectiveness of OPAT to oral therapy for other conditions as well as comparisons between longer and shorter durations of IV therapy. The integration of stewardship principles into clinical decision making prior to OPAT initiation is critical.</td>
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<td>Gomez et al. (2001) USA</td>
<td>Retrospective record review (4.5 years) 229 patients received 237 courses of OPAT Mean age of 8 years (median, 8 years; range, 14 days to 19 years). Majority of patients were male [127 (55%)] and Caucasian (170 (74%)].</td>
<td>Underlying condition: No specific conditions reported Indication for treatment: Many different types of infections were treated with OPAT, musculoskeletal infections remained the most commonly treated infection.</td>
<td>Not reported.</td>
<td>Setting: Home Delivery Since study was retrospective, medical &amp; social criteria used in patient evaluation for OPAT could not be reviewed. However, usual practice reported as follows: prior to discharge, family and the home situation evaluated and at least 2 family members trained (administration, caretaker management, caretaker-associated complications and adverse drug reactions). Usual practice, initial daily nurse visits, then at least once a week while OPAT was administered. And patients seen at least once every week or every other week, and weekly laboratory tests were done.</td>
<td>Key clinical outcomes: Primary IV access included central venous catheters for 125 (53%) courses, peripherally inserted central catheters for 99 (42%), peripheral IV catheters for 7 (3%) and unknown for 6 (2%) courses. The use of peripherally inserted central catheters increased from 33% in 1995 to 59% in 1998. During the review period: OPAT use increased by almost 4-fold; patients &lt;=2 years of age, showing a 7-fold increase; 42 (18%) patients &lt;=5 year of age and 1 (0.4%) &lt;=1 month of age received OPAT during the study period. Average post-OPAT follow-up period was 8 weeks (range, 1 to 67 weeks). The mean duration of therapy (31 days)</td>
<td>Adverse events: Average time to developing catheter-associated complications was 22 days. Catheter-associated complications (CAC) prompted cessation of OPAT in 17 (7%) courses. Adverse drug reactions (ADRs) developed in 70 (29%) OPAT courses and prompted early discontinuation of antibiotics in 58 (24%). Both ADRs and CACs developed in 20 (8%) OPAT courses. Average time to ADRs was 19 days (range 1 – 71 days). Rehospitalization was necessary for 62 (26%) OPAT courses. CACs and catheter changes prompted rehospitalization in 26 (42%) courses, ADRs in 17 (27%), surgery for treatment of primary disease in 18 (29%) and various other causes in 5 (8%). A few patients were rehospitalized more than once or had more than one reason for rehospitalization.</td>
<td>None reported.</td>
<td>None reported. Study was underpowered to draw conclusions about mortality (extremely low-risk/low-incidence event in this group of patients) Careful selection of patients is important: patients with controlled disease, clinically well, reliable caretakers and whose home was less than 1 hour journey from the hospital Maintaining daily telephone contact with the patient helps in monitoring patient progress when patients are unable to attend clinic daily, in times of emergency and also helps to ensure patient compliance. The risk factors significantly associated with failure in our study could help in refining criteria for pediatric LRNF and planning further studies.</td>
</tr>
<tr>
<td>Gudde et al. (2009) INDIA</td>
<td>Single institutional, randomised control trial of oncology children with low-risk febrile neutropaenia (LRFN) 88 patients (67 males, 21 females) with 123 episodes of OPAT (62 randomised to oral arm; 61 to IV arm). Median age was 8.25 years (oral) and 7.75 years (IV)</td>
<td>Underlying condition: Acute lymphoblastic leukaemia, primitive neuro-ectodermal tumour, rhabdomyosarcoma and osteosarcoma Indication for treatment: Low-risk febrile neutropenia (LRFN)</td>
<td>Inclusion criteria: Patients with age 2-15 years; absolute neutrophil count (ANC) 500/ml; nonfebrile; no clinical evidence of lower respiratory tract infection; normal chest radiograph; presence of reliable caretakers, availability of telephone contact; residence less than 1 hour from the medical centre. Exclusion criteria: Conditions normally requiring hospitalization (e.g., such as dehydration, severe mucositis, pneumonia, tephilitis); Intensive leukaemia/lymphoma treatment except maintenance therapy in acute lymphoblastic leukaemia; stem cell transplantation; refractory malignancy; renal insufficiency; severe biochemical derangements; hepatic dysfunction; neutropenia predicted to last more than 10 days after onset of fever; past History of invasive fungal infections</td>
<td>Setting: Outpatient clinic of study hospital or nearby medical clinics. Delivery: Patients were instructed to record their temperature at home 3 times daily and bring the temperature charts to the clinic every 24 to 48 hours or as often as indicated by the clinical condition where they were assessed clinically and complete blood count was checked. If unable to come at 24 hours, a phone call was made to ensure the stability of the patient.</td>
<td>Key clinical outcomes: There were 27.1% episodes in the oral arm and 24.1% episodes in the intravenous arm with no documented focus of infection. Treatment of FN was successful in 55/61 (90.16%) episodes in oral arm and 54/58 (93.10%) in IV arm. Adverse events: 3 hospitalisations (all in the oral arm; seizures, bleeding and nonresolution of fever in one patient each) and no mortality. In the 4 patients excluded from analysis there was no mortality and all underwent successful therapy of their episodes of FN. Three of the 4 excluded patients had inadvertently received cefoperazone-sulbactam instead of ceftazidime. There were 6 failures in oral and 4 failures in the intravenous arms. Subgroup analysis revealed that failure was associated with diarrhoea in the IV arm and use of oral therapy in RMS patients receiving VAC.</td>
<td>None reported. Quality of life issues during OPAT could not be addressed in this retrospective analysis</td>
<td>None reported. Further studies are needed to gain insight into the impact of OPAT on patients’ and families’ lives. Close monitoring of potential complications is needed. Medical and social criteria must apply when identifying suitable candidates. Paediatric guidelines for OPAT similar to adult guidelines need to be established.</td>
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<td>Hodgson et al. (2016)</td>
<td>Australia</td>
<td>Prospective, observational (12 months). 228 patients received OPAT in 251 episodes. Median age: 7.4 years (range 1 week to 21 years); 22 patients (10%) under 1 year.</td>
<td>• Underlying condition: Most patient referrals from intensive care (general medicine (55, 24%), haematology/oncology (18, 17%), respiratory (29, 13%) and orthopaedics (25, 10%).</td>
<td>• Setting: Home Delivery</td>
<td>• All antibiotics were administered by trained nurses, not parents. • Central venous catheter (CVC) care was consistent with hospital guidelines: no-touch sterile technique, dressings changed every seven days and inspection daily to identify insertion-site infection.</td>
<td>Financial • Reduction in cost to care for a patient at home receiving OPAT compared with the average cost of care in a hospital bed: study hospital for a medical patient is AU$590/day. As there were 384 days where OPAT replaced inpatient care, this represents an estimated cost saving of AU$1.82 million in 1 year.</td>
<td>This study did not directly compare outcomes of OPAT with inpatient antimicrobial therapy, and these groups may be different.</td>
<td>In this study population, OPAT appears to be safe (few adverse events) and cost-effective (cheaper than an equivalent inpatient bed stay). Room for improvement in documentation, drug monitoring and appropriateness and the development and implementation of an OPAT-specific guideline and increased oversight of antimicrobial use will be important. Depending on clinical response, children can still attend school or nursery, limiting educational interruptions, and parents can therefore attend work. Overall complication rate for PICC, CVC and portacaths combined was 9%, and it is not clear why this rate is so much lower. It may reflect different selection criteria for patients related to high rate of peripheral cannula use, strong hospital education from the infection Control team about CVC care or possibly under-reporting of complications.</td>
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<td>Le et al. (2010) USA</td>
<td>Retrospective record review (6 years)</td>
<td>98 patients (under age 18) who had received care from the Home Care Agency.</td>
<td>• Underlying condition: Most patient referrals from intensive care (general medicine (55, 24%), haematology/oncology (18, 17%), respiratory (29, 13%) and orthopaedics (25, 10%).</td>
<td>• Setting: Home Delivery</td>
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### Underlying condition/indication for treatment

- **USA**
  - 109 unique patients received OPAT; 13 (12%) patients received 2 or more OPAT courses.
  - The mean patient age was 8.8 years (range: 1 month–20 years), and there was an equal distribution of males (n = 63, 50%) and females (n = 63, 50%).

<table>
<thead>
<tr>
<th>Underlying condition</th>
<th>Setting</th>
<th>Key clinical outcomes</th>
<th>Other outcomes</th>
<th>Financial</th>
</tr>
</thead>
<tbody>
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<td><strong>Most common conditions</strong>: bone and joint (31%), bloodstream (15%), intra-abdominal (13%) and soft tissue (9%) infections.</td>
<td><strong>Home Delivery</strong></td>
<td><strong>Of 123 OPAT courses with follow-up, 109 (86.6%) resulted in cure, 13 (10.6%) were treatment failures and 1 (0.8%) resulted in OPAT discontinuation because the patient did not have an infection.</strong></td>
<td><strong>None reported</strong></td>
<td><strong>The complications in children receiving OPAT also raise concern about the actual cost-effectiveness and caregiver satisfaction of OPAT in children, which deserves further study.</strong></td>
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<tr>
<td>Patients’ caregivers had 24-hour access to on-call physicians in both specialties.</td>
<td><strong>None reported</strong></td>
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<td>Orme et al. (2014) Australia</td>
<td>An unblinded randomised controlled trial comparing N&lt;sup&gt;2&lt;/sup&gt;–27, 18 inpatients, 19 outpatients</td>
<td>Fever and neutropenia in children receiving chemotherapy for malignancy.</td>
<td>Inclusion criteria - Neonatal responders; - Patients within 1 hour travel time (or 30 km radius) with appropriate transport and telephone</td>
<td>Home treatment with Home and Community Care support. After discharge, PICC nurses visited twice daily to provide general review with vital signs monitoring, cephalosporin administration and blood tests.</td>
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<tr>
<td>Reid and Bonadio (2006) USA</td>
<td>Retrospective record review (5.5 years) 29 patients presenting at Emergency Department (ED) Age: ranged from 1 to 16 years.</td>
<td>Underlying condition - No associated conditions reported indication for treatment - Cellulitis (20), Lobar pneumonia (2), Fever without focus (3), pyelonephritis (2), mastoiditis (1), Group A streptococcal tonsillitis (1).</td>
<td>Key requirements /influences on offering OPAT/inclusion &amp; exclusion criteria</td>
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<td>Shemesh et al. (1998)</td>
<td>Retrospective analysis (2 years)</td>
<td>Underlying condition - Acute lymphocytic leukemia (8), Beta-</td>
<td>Key requirements /influences on offering OPAT/inclusion &amp; exclusion criteria</td>
<td>Setting - Home Delivery 29 patients were examined by their oncologist during home therapy for a mean of one visit per 2.9 days on HIAT (group total, 219 office visits).</td>
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</table>
Children's Hospital the Wilhelmina included 7 intravenous hospital 33 be a retrospective unclear (no Age of children 19 years) Median age: 8 Treated for 60 patients with haematology 30 patients with Ewing's sarcoma (2), Wilms' tumor (3), splenectomized (4), -cell lymphoma (2), exacerbation of chronic respiratory infection. Nine of these (23%) eventually led to hospitalization, for Pseudomonas infections. Four of six cases who received a combination of cefazidime and vancomycin (67%) were eventually hospitalized, two because of resistant Pseudomonas infection and two because of resistant catheter infection. Of the 10 cases who received ceftazidime alone, none required hospitalization. None of the splenectomized cases, who received cephalosporin, needed hospitalization.

Inclusion criteria
- The inclusion criteria for training sessions are that the patient should: have had at least one intravenous antibiotic course in hospital within the last year; not have any complication of the disease for which hospitalization is necessary be compliant with all other kinds of treatment (physiotherapy, good nutrition, etc.).
- Insurance companies agreed to pay for an electronic infusion pump and elastomeric bag collection pumps.
- In hospital testing of allergic reactions to drugs, the organization of home care and final instructions to patients and parents

Setting
- Home Delivery
- Two cystic fibrosis (CF) nurses were appointed to inform and instruct patients and their families about all procedures concerning antibiotic treatment.
- After a successful training contract between the patient, parents, and hospital was signed, in which the hospital agreed that home care was appropriate and guaranteed readmission in the case that home care failed or complications occurred.
- The specialized CF nurse was authorized to give intravenous injections and was responsible for the instruction of patients and parents and control at home during the treatment period.
- Prior to discharge home, patients treated with

Key clinical outcomes
- In all cases of home treatment patients improved their clinical condition, lung function and general well-being compared to former courses in hospital.
- The home-treated children all needed frequent intravenous antibiotic treatment.
- Most of the other children received only one course in a year. Four of them have been trained for home treatment and will probably have this next time.

Adverse events
- Four instances of complications during the home treatment periods for which a 24 h on-call service existed. These were: technical problems with the electronic pump, air bubbles in the cassette of the pump due to the cefazidime solution, phlebitis for which a new venous access was needed (two cases).
Van Wilke et al. (2008) USA

Retrospective record review (2 years 9 months) of 34 patients who were admitted for cystic fibrosis.

The mean age was 9.4 years (range 7 days–12 years), with 56% male and 44% female. The age distribution was relatively even between 2 weeks and 12 years of age.

Underlying condition: 2 patients had leukaemia, 2 had cystic fibrosis, no other associated conditions reported.

Indication for treatment: 30 patients had febrile neutropenia, 2 had sepsis related to bacterial meningitis, 2 had appendicitis, and 2 had meningitis.

No detail reported apart from: discharge catheter was provided by the Kaiser Orange County home health agency, which is directly affiliated with the treatment center. Between the home health care agency and the medical center, there was no standardized approach regarding this care. The care was provider dependent.

Setting: Home Delivery

Between the home health care agency and the medical center, there was no standardized approach regarding this care. The care was provider dependent.

Key clinical outcomes:
- 33 of 34 patients completed therapy as an outpatient (97%).
- 39 PICCs were placed in the 34 patients who were treated with outpatient parenteral antibiotic therapy and included in this study.

Adverse events:
- 13 of the 39 PICCs (33.3%) had a complication requiring removal of the catheter. One child was readmitted due to accidental displacement at home. 5 children were close to the end of therapy and completed it with oral antibiotics. The remaining 7 PICCs were replaced as follows: 5 with a second PICC to continue outpatient therapy, and 2 with peripheral IV catheters to complete a brief duration of outpatient therapy.
- None of the children changed to oral antibiotic therapy had treatment failure requiring need for subsequent IV antibiotics.
- There were no incidences of phlebitis or suspected or confirmed catheter infection or sepsis.
- There was a general trend toward increased odds of complications with PICCs placed midline (odds ratio 12.95; 95% CI: 0.95–175.40; P = 0.054).

Financial:
- A financial analysis was completed on the cost of home health versus the projected cost of hospitalization for the same period of time. The average daily cost for home health treatment was $115 compared with the average daily inpatient cost of $1185.
- Total cost savings on a subset of 26 patient episodes analyzed was $504,858, which was $19,418 per patient episode or $1070 per day of home health care for the 472 potential inpatient days analyzed.

Other outcomes (e.g., finance, family perspectives):
- Small sample size.
- Results may be skewed as larger centers more likely to be treating more complex patients who may be more prone to complications.
- OPAT has a significant cost savings over the alternative of inpatient treatment.
- OPAT has a positive effect on hospital utilization, which is a critical factor in smaller paediatric wards where bed availability and the difficulty of transfer to referral hospitals are issues.

Van Wilke et al. (1991) Canada

Pilot programme (research design unclear) of 13 children who were treated on more than one occasion, giving a total of 20 episodes.

Underlying condition: Cancer 

Indication for treatment: Febrile neutropenia

Inclusion criteria:
- Children who had indwelling right atrial catheters were eligible for the pilot program if they met the following criteria: (a) child eligible for at least 48 hours, after starting intravenous antibiotics in hospital; (b) child on appropriate antibiotic(s), as determined from culture results; (c) child clinically stable in the opinion of the attending hematologist; and (d) parent(s) interested, motivated, and able to administer intravenous antibiotics as assessed by the pediatric oncology nurse.

Setting: Home Delivery

Child’s parent was instructed by a pediatric oncology nurse on the process of antibiotic administration, including aseptic technique, infusion procedure, catheter care, and troubleshooting.

Parents were required to give their child’s antibiotic(s) in hospital under supervision prior to discharge, so that their proficiency at performing this task could be assessed by the pediatric oncology nurse.

The pediatric clinical pharmacist provided the parents with information on drug reconstitution, dosage, and side effects, and arranged for the supply of antibiotics.

Each family was sent home with enough antibiotics and supplies to complete a 10-14 day course of therapy as appropriate.

A follow-up appointment was made.

Key clinical outcomes:
- The children who received home therapy spent an average of 3 days in hospital followed by an average of 10 days at home. By comparison, the average length of stay for hospital treatment of febrile neutropenic episodes was 12 days during the same 6-month period.
- All episodes of fever and neutropenia were treated successfully with home IV antibiotic therapy.
- No reported adverse drug reactions, drug toxicity, or catheter complications such as occlusion, but some minor problems were encountered, such as shortages of some supplies. In every case, the shortages were discovered far enough ahead that additional supplies were obtained for the parent within 24 h.

Parental:
- Two families met the criteria for entry into the pilot program, were instructed, but decided, prior to discharge, not to proceed and the children remained in hospital for antibiotic treatment.
- The feedback from the parents who participated in this program was uniformly positive.

Financial:
- Cost analysis hampered by inability to cost inpatient treatment accurately. Average estimated daily cost of a “hospital bed” (all types) was $618; therefore, estimated cost of 12 days of inpatient therapy at $7,416 (noted to probably overestimate the true cost of such treatment).
- Using hospital acquisition costs, a somewhat clearer estimate of the cost of home therapy estimated at $2,781. These do not include the costs that are borne directly by the families of the children.

Other outcomes (e.g., finance, family perspectives):
- Home IV antibiotic therapy appears a safe and efficacious alternative to hospital management of children with malignant diseases admitted with fever and neutropenia.
- A cost analysis of the program indicates that home therapy is considerably cheaper than in-hospital treatment.
- However, costs for parents/families are expensive; especially if the parent must forego wages she/he would otherwise have earned in order to stay home with the child to administer antibiotics.
- Home IV antibiotic program for children with malignant disease was a positive experience for the children and the families involved.
to the out-patient clinic usually within 1 week of discharge.

- In addition, 24-h on-call coverage was available to all families—a service we provided already. If the child developed a fever at any time while on home therapy, the family was instructed to bring the child back to hospital for re-evaluation.