Intravenous ceftriaxone at home versus intravenous flucloxacillin in hospital for children with cellulitis: a cost-effectiveness analysis

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Summary

Background Outpatient parenteral antibiotic therapy after hospital admission is increasingly popular, but its use to avoid admission to hospital altogether by treating patients wholly as outpatients remains uncommon in children. One reason for the low use of treatment at home is the scarcity of evidence of its cost-effectiveness. In this planned follow-up analysis of the Cellulitis at Home or Inpatient in Children from the Emergency Department (CHOICE) trial, we aimed to assess the cost-effectiveness of an admission avoidance pathway, in which children were treated at home, compared with standard hospital care for the intravenous treatment of moderate or severe cellulitis.

Methods We did a cost-effectiveness analysis to compare home treatment with intravenous ceftriaxone versus hospital treatment with intravenous flucloxacillin in children aged 6 months to 18 years who had presented to the emergency department at The Royal Children's Hospital, Melbourne, VIC, Australia, with moderate or severe uncomplicated cellulitis. We included costs from two sources: institutional costs at a patient level and expenses incurred by families. We measured effectiveness with quality-adjusted life years (QALYs), which we derived from the Child Health Utility 9D questionnaire, and a clinical outcome of treatment failure, which was the primary outcome of the CHOICE trial. We planned to calculate the incremental cost-effectiveness ratio, defined as the difference between groups in total cost divided by the difference between groups in effectiveness. The CHOICE trial is registered at ClinicalTrials.gov, number NCT02334124.

Findings We included 180 children who comprised the per-protocol population in the CHOICE trial: 89 children in the home group and 91 children in the hospital group. The institutional cost per patient per episode was significantly lower in the home group than in the hospital group (AUS$1965 *vs* $3775; p<0·0001). The mean cost incurred per family was $182 for the home group and $593 for the hospital group (p<0·0001). Both measures of effectiveness were significantly better in the home group than in the hospital group: QALYs were 0·005 for the home group versus 0·004 for the hospital group (p<0·0001), and treatment failure occurred in one (1%) patient in the home group versus seven (8%) patients in the hospital group (risk difference –6·5%, 95% CI –12·4 to –0·7; p=0·029). Calculating the incremental cost-effectiveness ratio was thus deemed redundant.

Interpretation Treatment at home was less costly and more effective than standard hospital care for children with moderate or severe cellulitis. These findings support development of this admission avoidance pathway in hospitals.

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Introduction

Outpatient parenteral antibiotic therapy (OPAT) after hospital admission has become a widely endorsed model of care worldwide in the past decade.[1–3] Its use reduces hospital-acquired infections, negative psychosocial effects, and the inconvenience of hospital admission.[4,5] There is increasing interest in the use of OPAT to avoid hospital admission altogether by administering these antibiotics directly from the emergency department, instead of within a hospital ward, but this approach has yet to gain acceptance in paediatric departments. One reason that this approach is not used is a frequently cited concern by clinicians of the rapid onset of infections in children and the potential for rapid deterioration. Consequently, although OPAT has been shown to be less expensive than inpatient treatment in non-randomised studies,[6] the inadequate evidence for its effectiveness in children and concern about re-admissions has resulted in hospital admission remaining the default pathway.[7,8] Additionally, widespread implementation has been restricted by studies that have preselected patients for success. These studies have also not incorporated cost-effectiveness analyses of an admission avoidance pathway in patients who have been randomised, either in adults or in children.

The ideal cost-effectiveness analysis considers a societal perspective by use of patient-level data, considering both institutional costs and expenses incurred by patients and families. Additionally, for results to have an effect, the economic analysis needs to incorporate intervention outcomes that are meaningful to patients and clinicians

Research in context

Evidence before this study

We searched for studies in MEDLINE published from Jan 1, 1946, to Nov 30, 2018, and in Embase published from Jan 1, 1974, to Nov 30, 2018, with the search terms "cost-effectiveness" and "outpatient". We restricted searches to "all child (0–18 years)", with no language restrictions. We found no cost-effectiveness analyses in randomised studies that compared outpatient versus hospital antibiotic therapy, or in which patients completely avoided hospital admission. Non-randomised outpatient versus hospital studies have used secondary or retrospective data or hypothetical cohorts to evaluate cost-effectiveness, and these studies have suggested that outpatient treatment is less costly. Additionally, a systematic review of the literature on the economic evaluation of outpatient parenteral antimicrobial therapy (OPAT) in adults did not identify any cost-effectiveness analyses in randomised cohorts.

Added value of this study

To our knowledge, this is the first cost-effectiveness study to compare OPAT with hospital treatment in a randomised cohort of children who require intravenous antibiotics. Our study considered costs from the societal perspective—ie, from the perspective of patients, families, and health-care providers. We have shown that families incur a burden of cost that is three times greater when their child is treated in hospital than when they are treated at home, which is a factor that is often overlooked by clinicians. Our study measures the cost-effectiveness of home versus hospital care by use of a clinical effectiveness outcome that is specific to cellulitis and in terms of quality-adjusted life years, a standard measure in economic evaluation.

Implications of all the available evidence

Our economic analysis, together with the findings of clinical efficacy, safety, and patient preference of receiving intravenous antibiotics at home, provides strong evidence for avoiding hospital treatment altogether with a home or ambulatory pathway for children with moderate or severe cellulitis. Our study provides the evidence for policy makers and stakeholders to resource outpatient or ambulatory pathways that are immediately responsive to children attending emergency departments. Our study design and outcomes also act as a platform for the evaluation of outpatient pathways for other acute infections.

and comparable for health-care institutions. Effectiveness in economic evaluations is commonly measured with quality-adjusted life years (QALYs), to allow comparison across disease areas to facilitate allocation of resources.[9] QALYs are calculated with utility scores over a specified time, namely the time horizon. Despite being the most widely used quality-of-life (QOL) measure in economic evaluation, QALY was absent from the few studies[10,11] to date on admission avoidance, which have relied on disaggregated measures of cost and effectiveness.

One of the most common acute infections treated with OPAT is cellulitis,[2,12] a skin infection with an incidence of 20 per 1000 person-years in children.[13] A few observational studies[14,15] in children have shown that moderate or severe cellulitis requiring intravenous antibiotics can be effectively and safely treated at home following discharge directly from the emergency department (instead of admitting and treating individuals as inpatients), although none have evaluated the cost-effectiveness of treatment at home. To our knowledge, the Cellulitis at Home or Inpatient in Children from the Emergency Department (CHOICE) study[16] was the first randomised controlled trial (RCT) to compare the efficacy and safety of OPAT versus hospital treatment in children for the management of moderate or severe cellulitis following admission to the emergency department. Here we report the planned economic evaluation for this trial, with the aim to evaluate the cost-effectiveness of admission avoidance versus hospital treatment for moderate or severe cellulitis in children that required intravenous antibiotics.

Methods

Study design, participants, and outcomes

The CHOICE trial was a single-centre, open-label, randomised controlled, non-inferiority trial that was based at The Royal Children's Hospital (Melbourne, VIC, Australia). For the trial, we recruited children aged 6 months to 18 years who presented to the emergency department with moderate or severe uncomplicated cellulitis, and we excluded those with complicated cellulitis, immunosuppression, toxicity, or serious comorbidities. Eligible children whose parent or guardian provided written informed consent were randomly assigned (1:1) to receive either standard care in hospital (comprising 50 mg/kg intravenous flucloxacillin every 6 h) or care at home under the Hospital-in-the-Home programme (comprising 50 mg/kg intravenous ceftriaxone once daily), which was an alternative treatment pathway provided by the same hospital. The primary outcome of the trial was treatment failure, which was defined as no clinical improvement or occurrence of an adverse event that resulted in a change of initial antibiotics within 48 h of the first antibiotic dose in the emergency department. The full trial protocol[17] and findings[16] have been published previously. The trial and cost-effectiveness analysis were approved by the institutional ethics committee.

The cost-effectiveness analysis was done from a societal perspective, which included costs to the health-care institution and to patients and families. We compared cost-effectiveness between the groups from initial presentation to the emergency department until discharge from medical care. We included all children in the per-protocol

population in the cost-effectiveness analysis instead of the intention-to-treat population because some patients did not receive their allocated treatment, which would lead to a mismatch between resources used and outcomes achieved.

Estimation of costs

The costs of home and hospital care for individual patients were obtained from the hospital administrative costing unit, which included direct and indirect costs of medical care, including medications, staff time, and overheads, as is standard for tertiary hospitals in Australia.[18] The total cost for each individual patient comprises the sum of cost groupings, such as medical, nursing, allied health, imaging, pathology, pharmacy, theatre, emergency department, and allied health.[19] Costs to patients and families were collected with self-reported questionnaires that were completed by parents or carers (appendix p 5). The questionnaire asked about costs incurred for food, transport, parking, medication, or other expenses during treatment, as well as the number of days absent from paid or unpaid work, from the time of presentation to the emergency department until the end of treatment. Paid work was costed by use of average weekly earnings from the Australian Bureau of Statistics. Unpaid work was costed at a third of average earnings, in line with the friction-cost approach.[20] Costs incurred before 2017 were inflated to the 2017 price by use of the Consumer Price Index from the Australian Bureau of Statistics. All costs were recorded in Australian dollars (AUS$). Costs were also presented in 2017 UK pounds sterling (£) by use of the 2017 Purchasing Power Parity from the Organisation for Economic Co-operation and Development Statistics (equating AUS$1 to £0·48).

Effectiveness analyses

Effectiveness was measured in two ways: the clinical primary outcome of treatment failure and QALYs derived from utility scores. Utility scores—ie, the ability to perform activities of daily living—were obtained by use of the Child Health Utility 9D (CHU9D) questionnaire, a widely used and validated QOL assessment measure for children.[21,22] CHU9D questionnaire responses were collected within 24–48 h of admission to the emergency department to reflect QOL during treatment. For children aged 6 years and younger, parents answered the CHU9D questionnaire; children older than 6 years, answered the questionnaire themselves. A second CHU9D questionnaire was administered 14 days after treatment completion to assess QOL after resolution of the infection. To obtain QALYs, utility scores reported during treatment were multiplied by 2 days (multiplied by 0·0056—ie, 2/365—to obtain a number per year), which was the mean duration that participants received the intervention (both at home and in hospital). For QALYs after resolution of infection, utility scores were multiplied by 14 days (multiplied by 0·04—ie,14/365—to obtain a number per year).

Missing data

For patients with missing costs to the family or utility score data, we used random datapoints from the distributions of mean cost or effectiveness from the relevant treatment group. This approach is likely to result in wider confidence intervals for costs and utility scores than would be obtained with predictive mean matching methods, and it is thus considered more conservative.

Statistical analysis

Cost differences were calculated per patient episode first, which included the total duration of their medical care, and per day second, which is the total cost of their medical care divided by the number of days of medical care. The incremental cost-effectiveness ratio, defined as cost per treatment failure avoided was calculated as the mean cost difference to the hospital per patient episode divided by the difference in treatment failure. The incremental cost-effectiveness ratio per QALY was calculated as the mean cost difference to hospital per patient episode divided by the difference in QALYs between home and hospital. A χ^2 test (for dichotomous outcomes) and Student's *t* test (two-sided; for continuous outcomes) were used to compare outcomes between groups. Analyses were done with Stata/IC version 15.1.

See **Online** for appendix

To account for sampling and parameter uncertainty, we did sensitivity analyses. We employed probabilistic sensitivity analyses, using a bootstrapping method with 1000 replications from cost and effectiveness datapoints at the patient level. Results are depicted on cost-effectiveness planes. We did several one-way and two-way sensitivity analyses, in which we varied the costs and the effectiveness for four different scenarios. In the first, we doubled the distance of the actual catchment area from 50 to 100 km from the hospital. In the second, we doubled the incidence of re-admissions by use of utility data from a previous study[23] that found increased cost and decreased utility in the home treatment group. In the third, we increased doctors' salaries by 50% to reflect applicability to places where doctors are paid more. Finally, we doubled the nursing visits to a frequency of twice daily. Drug costs were based on those of the institutional pharmacy, and costs of distance travelled were obtained from the Australian Taxation Office, using figures for car expenses.

For the **Australian Consumer Price Index Inflation Calculator** see www.abs.gov.au/websitedbs/d3310114.nsf/home/consumer+price+index+inflation+calculator

The economic evaluation follows the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) guideline for trial-based cost-effectiveness analysis,[24] and we have reported this evaluation with the ISPOR consolidated health economic evaluation reporting standards guideline.[25] The CHOICE trial is registered at ClinicalTrials.gov, number NCT02334124.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The first author and corresponding author

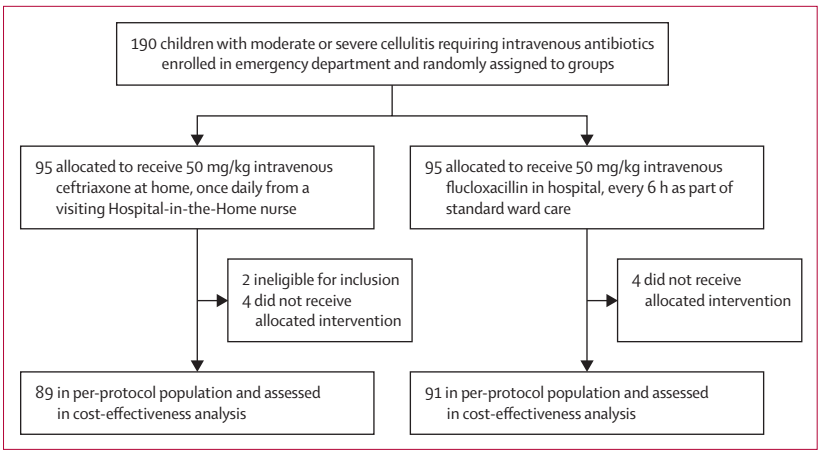

Figure 1: **Trial profile**

	Home (n=89)	Hospital (n=91)
Mean age (SD), years	7·0 (5·0)	7·2 (4·2)
Sex		
Female	36 (40%)	48 (53%)
Male	53 (60%)	43 (47%)
Presence of co-morbidity	11 (12%)	12 (13%)
Presence of periorbital cellulitis	25 (28%)	25 (27%)
Systemic features	36 (40%)	40 (44%)

Data are n (%) unless otherwise indicated.

Table 1: **Baseline characteristics of patients in the per-protocol population**

had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

In our analyses, we included effectiveness data collected for treatment between Jan 9, 2015, and June 15, 2017. 180 children in the per-protocol population in the CHOICE trial, including 89 children who were randomly assigned to receive intravenous ceftriaxone at home and 91 children who were randomly assigned to receive intravenous flucloxacillin in hospital, were included in our cost-effectiveness analysis (figure 1). We found no differences in baseline demographic characteristics or clinical features at randomisation (ie, at presentation to the emergency department) between the two groups (table 1).[16] The mean duration of medical care was 2·5 days (SD 1·5) in the home group and 2·0 days (1·1) in the hospital group.

The cost to the institution associated with each individual was available for every patient in the trial; a breakdown of these costs is shown in table 2. Questionnaires about costs to families were completed for 68 (76%) of 89 children in the home group and for 69 (76%) of 91 children in the hospital group. There were no differences in demographics, clinical features, or outcomes between those who did and did not return the questionnaires (appendix p 2).

The mean cost to our institution of treating a patient with moderate or severe cellulitis at home was $1965 (£963) per patient episode versus $3775 (£1850) in hospital (table 3). The highest cost incurred was in medical and nursing salaries (table 2). The mean cost to the emergency department for a patient treated at home was $623 (£305) versus $850 (£417) for those treated in hospital (difference –227, 95% CI –106 to –347; p=0·0003). Drainage of an abscess in five (6%) patients in the home group and five (5%) patients in the hospital group, and foreign body removal in one (1%) patient in the hospital group were the only complications from the infection that occurred in the per-protocol population during the study. Patients who required an additional procedure to drain their abscess had an increased institutional cost, which is included in the stated costs ($623 and $850). Six (55%) of these 11 patients had their abscess drained or foreign body removed in the emergency department, with the costs to the emergency department already included in the stated costs. For those whose abscess was drained in the operating theatre (one patient in the home group, four patients in the hospital group), this procedure added a cost of $755 (£370) for the patient in the home group and a mean cost of $560 (SD 156; £274 [76]) for the patients in the hospital group. There were no other complications and all patients recovered.

The mean total cost to families who had a child treated at home was $182 (£104) per episode, versus $593 (£338) per episode for a child to be treated in hospital (table 3). The highest cost incurred by families was attributed to absence from paid work, for a mean duration of 0·7 days (SD 1·0) in the home group versus 2·0 days (1·9) for parents of children in hospital (p<0·0001). The mean total cost to families for absence from both paid and unpaid work was significantly less for children in the home group ($171 *vs* $542; p<0·0001).

The total cost saving to our hospital for the 89 patients who were treated at home during the 29 months of the study was $161001. If all 252 patients who were eligible for treatment during that time period[16] had been treated via the home pathway, the potential cost savings would have been $455868 ($188136 per year; 95% CI 137696–238680). The families of the 89 children in the home treatment group saved $36490. If every eligible child had been treated via the home pathway, the potential cost savings for families would have been $103320 ($42640 per year; 32448–52832). These findings represent potential cost savings to the hospital and to families of $230776 per year (170144–291512).

Of the patients in the home group, one (1%) patient had treatment failure versus seven (8%) patients in the hospital group (risk difference –6·5%, 95% CI –12·4 to –0·7; p=0·029). The home patient with treatment failure was admitted to hospital for 3 days.

The mean utility score—ie, the ability to perform activities of daily living—was higher in the home group than in the hospital group (table 3). When converted to

	Home (n=89)	Hospital (n=91)
Cost to health-care institution		
Outpatient parenteral antibiotics and Hospital-in-the-Home or ward doctor salaries	174 (43)	410 (181)
Outpatient parenteral antibiotics and Hospital-in-the-Home or ward nursing salaries	240 (59)	67 (117)
Admission process from the emergency department to hospital ward*	0	570 (171)
Emergency department costs (including emergency department medical or nursing salaries)	623 (298)	850 (492)
Pathology	77 (91)	121 (136)
Pharmacy	13 (5)	22 (18)
Antibiotic (1 g vial)	0·61	0·95
Antibiotic cost for a 30 kg child at a dose of 50 mg/kg per day	1·22	7·60
Other institutional costs†	126 (31)	331 (159)
Transport costs per km	0·68	0
Total costs (including emergency department costs)	970 (374)	2388 (1378)
Cost to families		
Absence from paid work	62 (57)	232 (267)
Absence from unpaid work	7 (12)	38 (12)
Expenses during treatment	28 (11)	66 (13)
Total cost to family	73 (12)	297 (27)

Data are mean cost per patient per day (SD), expressed as AUS$. *Including administrator, doctor, and nurse salaries to process the admission and transfer the patient from the emergency department to the ward. †Including administrative functions, imaging, nursing or medical supplies, allied health, and overheads, including travel time.

Table 2: **Comparison of institutional costs and costs to families**

	Home (n=89)	Hospital (n=91)	Difference (95% CI)	p value
Cost outcomes, AUS$				
Cost to hospital per patient episode	1965 (964)	3775 (2116)	−1809 (−1324 to −2295)	<0·0001
Cost to hospital per patient per day	970 (374)	2388 (1378)	−1419 (−1120 to −1717)	<0·0001
Cost to family per patient episode	182 (261)	593 (501)	−410 (−312 to −508)	<0·0001
Cost to family per patient per day	73 (12)	297 (27)	−222 (−210 to −235)	<0·0001
Effectiveness outcomes				
Treatment failure*	0·01	0·08	−0·07 (−0·12 to −0·07)	0·0029
Utility score during intervention	0·86 (0·13)	0·75 (0·14)	0·11 (0·07 to 0·14)	<0·0001
Quality-adjusted life years	0·005 (0·001)	0·004 (0·001)	0·0006 (0·0004 to 0·0008)	<0·0001

Data are mean (SD), unless otherwise indicated. The incremental cost-effectiveness ratio was not calculated because the results of the individual cost and effectiveness analyses indicated that the home treatment strategy was dominant. *Expressed as n (%), these data are 1 (1%) and 7 (8%).

Table 3: **Cost and effectiveness outcomes**

QALYs, the QALY for the home group was higher than that for the hospital group. After resolution of cellulitis, the mean utility score did not differ between the home (0·95 [SD 0·01]) and the hospital groups (0·93 [0·01]; difference −0·02, 95% CI −0·04 to 0·00; p=0·0646).

Calculating the incremental cost-effectiveness ratio was redundant because there was no extra cost for home compared with hospital treatment to achieve the incremental effectiveness (and thus a calculation would result in a negative ratio, which would be uninterpretable). The cost-effectiveness planes show that treatment at home is cost-effective (based on the proportion of datapoints in the bottom-right quadrant) using either effectiveness outcome with a high level of certainty (figure 2A). In the QALY assessment, all points were in quadrants where treatment at home is less costly, and 98·3% were in the bottom-right quadrant where treatment at home is more effective (1·7% datapoints were in the bottom-left quadrant; figure 2B).

In the sensitivity analyses, despite varying different key cost components of care to determine the effects of making the travel or staff costs more expensive or the treatment failure rate worse, the home intervention remained the dominant strategy (appendix p 3).

Discussion

In this cost-effectiveness analysis, intravenous treatment of moderate or severe cellulitis in children was less costly (for the institution and families) and more effective (using either the clinical outcome or QALY) when given at home than in hospital. Our findings are consistent with previous studies. In our economic evaluation of home versus hospital treatment for any condition in children, treatment for cellulitis at home was a convincingly dominant strategy.

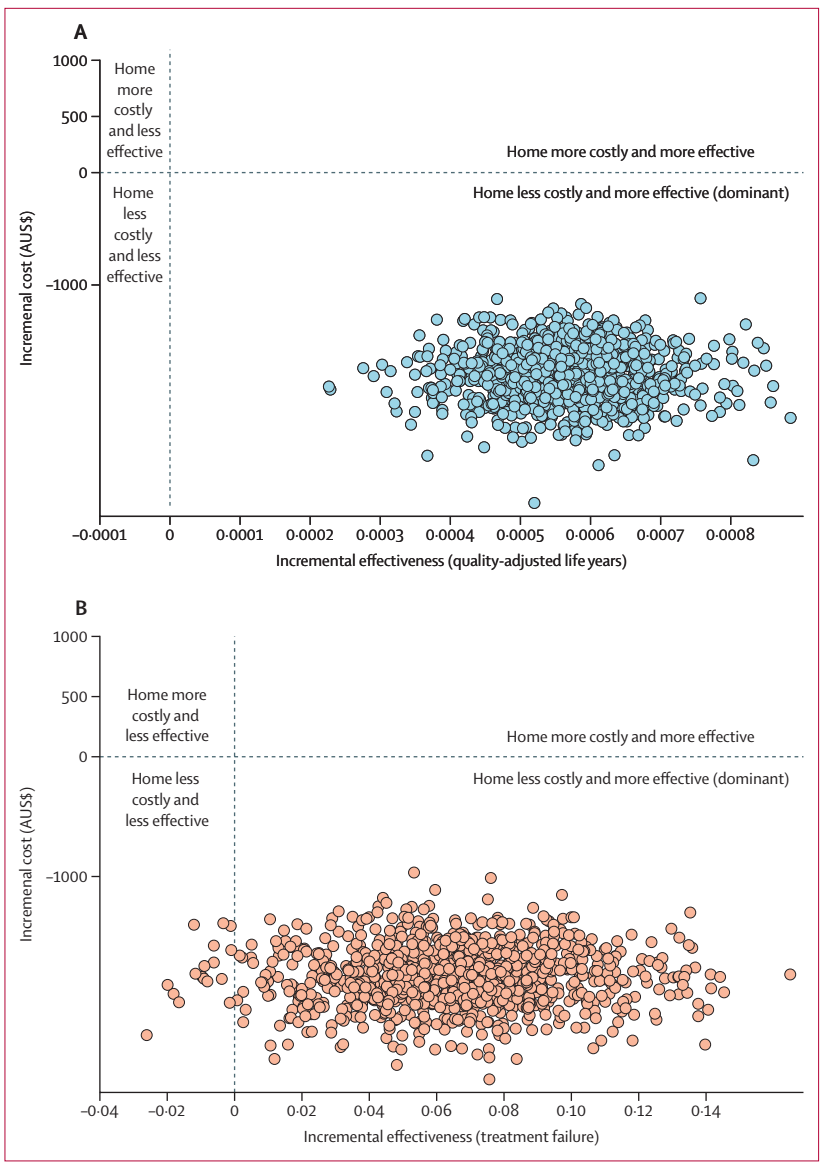

Figure 2: **Quality-adjusted life years (A) and treatment failure (B) on cost-effectiveness planes**
Data are incremental costs and effects of home versus hospital treatment, shown as a distribution. Each point represents 1 bootstrap iteration. The quadrants represent combinations of possible outcomes.

Patients treated at home who were admitted to hospital with complications did not incur extra costs compared with patients treated in hospital. Previous studies[12,15,16,26] have provided evidence that home treatment is safe and efficacious for children with moderate or severe cellulitis. These results contrast with the findings of the only other RCT in children treated at home to do a cost comparison.[27] In that trial, which compared nurse observation of children with various acute conditions in hospital versus at home after a short hospital stay, costs to the health-care provider (the UK National Health Service) did not significantly differ between groups (£870 per patient at home *vs* £741 per patient treated in hospital). This finding is explained by patients in the home group being initially treated in hospital, incurring a hospital cost in addition to the home cost, and by under-recruitment in the home treatment group, resulting in a higher ratio of nurses to patients, and thus higher costs per patient.

To our knowledge, this study is the first to use a validated child health utility score to compare OPAT with hospital care. In previous studies[4,28] that have assessed QOL beyond parental satisfaction, the authors have designed the surveys themselves. During the acute infection the utility score that we obtained was lower than that 2 weeks later, when the score at resolution of infection was close to 1·0 (perfect health). Use of a validated, standardised score in this study and showing that it works enables comparisons between studies and policies (eg, to determine whether QOL is better for all types of infections or just skin infections), and it allows the same measure to be used with confidence in future research of OPAT through our finding of a difference between utility scores between home and hospital.

To ensure applicability beyond the trial setting, we did sensitivity analyses with different hypothetical scenarios to capture other potential real-life situations. Considering the generalisability of the cost-effectiveness findings under different care pathways and resource contexts, the findings of the sensitivity analyses were supportive of our key conclusions. In these analyses, we incorporated factors that would adversely affect costs of home treatment (catchment distance, number of visits), costs and effectiveness of home treatment (incidence of re-admissions from home during treatment), or costs of both treatment locations (medical staff costs). An increase in catchment area (increasing nursing time and travel resources) is relevant to services in rural areas that are further from the hospital. Doubling the incidence of readmissions during treatment at home did not affect the outcome and indicates that, even if a patient must return to hospital, there are benefits to initiating a home treatment pathway. Finally, although increasing doctors' salaries was a somewhat cynical adjustment, we found that the cost-effectiveness benefits remained even in differently resourced situations.

Although all analyses were specific to management of cellulitis, they should be broadly applicable to comparisons of home versus hospital treatment for other medical conditions. The finding that home-based treatment was more cost-effective than hospital-based treatment in this study is similar to a cost-effectiveness analysis of OPAT in children with febrile neutropenia,[23] thus supporting the generalisability of our results. The sensitivity analysis in which home visits were increased to two per day was done to consider conditions requiring more intense home needs, such as newly diagnosed diabetes, for which glucose monitoring might be required more frequently than once a day. The benefits of treating infections at home in children with underlying chronic conditions that necessitate frequent admissions,

such as cystic fibrosis or cancer, could have even greater benefits in terms of QALY.

Although the antibiotic cost was less than $2 per patient in both groups in this study, and it was not the primary driver of cost, in areas where MRSA prevalence is higher, antibiotic costs would be greater because of the higher cost of once-daily antibiotics such as teicoplanin, linezolid, or daptomycin. There are also economic implications of having complications more frequently, as reported with MRSA, such as abscesses requiring drainage. Australia, like many regions worldwide, has a low prevalence of MRSA in children and, as such, antibiotics used for empiric therapy do not need to be effective against MRSA.

Our findings should inform clinicians of the costs that families and society incur when children are admitted to hospital for cellulitis: $593 per family for an admission lasting 2 days, which is a substantial cost. This finding compares unfavourably with the $182 for home treatment for the same condition. Most clinicians would likely not consider this cost when admitting a child to hospital. Most of this cost incurred is from the parents' absence from work, which was significantly higher in the hospital group than in the home group. Two previous studies[27,29] found that parents or carers of children treated with OPAT were less likely to be absent from work than those of children treated in hospital. This finding could be attributed to parents being more likely to stay with their child when they are in hospital, whereas other carers or extended family members can care for a child treated at home. Additionally, one parent might stay with a child in hospital while the other cares for siblings at home, whereas for a child treated at home, one parent can be responsible for all childcare. This consideration would be especially important for single-parent families.

The economic implications of replacing standard hospital treatment with home treatment across the whole of Australia are unrealised. In 2016–17, there were 85 991 attendances to the emergency department at our hospital, and approximately 1 997 606 attendances to emergency departments by children aged 18 years and younger across Australia.[30] During the 29 months of the CHOICE trial,[16] 252 children at our hospital were eligible for inclusion (ie, 104 children per year). With a conservative estimate that a similar proportion of paediatric attendances are due to moderate or severe cellulitis across Australia (although attendance for this reason is likely to be higher in tropical regions), this estimate equates to 2415 children attending emergency departments with this infection every year who would be eligible for ambulatory intravenous treatment. Assuming 2415 children who would be eligible for ambulatory intravenous treatment attend the emergency department with this infection every year, the total potential societal cost saving would be $5 358 885 (3 950 940–6 769 245). Although this value does not seem large, this finding is for a 2-day admission for the severe end of a single infection. If this finding could be replicated in several infections that require antibiotics, such as urinary tract infections,[31] febrile neutropenia,[4] and viral infections that require nurse observations,[32] savings would rapidly accrue.

The strengths of our study include that children were randomly assigned to groups, reducing the bias of self-selection or a highly selected patient group; use of patient-level cost data from real-life outcomes; use of a validated child utility score to compare home care with hospital care; and the comprehensive cost-effectiveness analysis. However, our study has several limitations. First, the study was done in a single tertiary centre with the largest paediatric home care team in Australia.[3] This team has strong medical oversight and skilled nurses, which contributed to the low frequencies of complications and re-admissions in the study, but these factors add to the costs of the service. However, when the incidence of re-admission was hypothetically increased, the home treatment pathway remained the dominant strategy. Second, the questionnaires completed by families were anonymous (to obtain candid answers from families), preventing us from ascribing the burden of costs incurred by families to specific patient outcomes. The utility data and costs incurred by families were provided by only 75% of families, although there were no differences in baseline characteristics or clinical outcomes between those who did and did not provide data.

In conclusion, for children with moderate or severe cellulitis, intravenous antibiotic treatment at home, decided upon presentation to the emergency department, is cost-effective compared with admission to a hospital ward. These findings, in addition to our RCT[16] showing the clinical efficacy and safety of home treatment versus hospital treatment, as well as increased patient or parent satisfaction, provide strong evidence to stakeholders and policy makers to support a treatment pathway from the emergency department to home for this condition. Our study highlights the value of a comprehensive cost-effectiveness analysis in the allocation of resources for developing new models of care, although each condition should be analysed independently as there could be unrecognised differences.

Contributors

LFI conceptualised and coordinated the study, did the initial and subsequent data analyses, drafted the initial manuscript, and revised subsequent drafts. LFI, LH, SMH, FEB, and PAB designed the study. LH guided the statistical analysis. SMH, FEB, and PAB provided input into data analysis. KD designed the family questionnaire part of the study. LH, SMH, KD, FEB, and PAB reviewed and revised the manuscript and approved the final draft. All authors approved the final manuscript.

Declaration of interests

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