ORIGINAL ARTICLE

Economic evaluation of an acute paediatric hospital at home clinical trial

A Bagust, A Haycox, S A Sartain, M J Maxwell, P Todd

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See end of article for authors' affiliations

Correspondence to: Dr A Haycox, Senior Lecturer in Health Economics, University of Liverpool, Department of Pharmacology & Therapeutics, New Medical Building, Ashton Street, Liverpool L69 3GE, UK

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Aims: To compare the privately borne and NHS costs of hospital at home (HAH) and conventional inpatient care for children with selected acute conditions.
Methods: Prospective economic evaluation using cost minimisation analysis within a randomised controlled trial, in paediatric wards of a district general hospital, and private homes in the local catchment area in Wirral, Merseyside. Subjects were children who fulfilled the criteria for admission to HAH, suffering from breathing difficulties (n = 202), diarrhoea and vomiting (n = 125), or fever (n = 72).
Results: Direct costs borne by families are reduced by 41% for HAH patients (£23.31 *v* £13.76, p = 0.001). There is no evidence that HAH transfers the burden of care to parents, and there is no difference in absence rates from paid employment. Patients and their carers expressed a strong preference for HAH. Comparison of NHS costs is equivocal, depending on how HAH is implemented alongside the conventional hospital service.
Conclusion: Paediatric HAH schemes are unlikely to reduce NHS costs and do not increase privately borne costs. They will, however, significantly increase patient and carer satisfaction with care provision for sick children with appropriate conditions.

It has long been accepted that hospital admission of children should be avoided unless therapeutically necessary.[1] Although Hospital at Home (HAH) schemes have been shown to provide a cost effective alternative to hospital care (HC) in some adult patients,[2–5] there is no such evidence for paediatric HAH schemes, which may merely transfer the burden of care from publicly funded health services to private and informal carers.

We report results from a prospective economic evaluation of a paediatric HAH scheme compared to traditional hospital inpatient care, based on data collected as part of a randomised controlled trial. The economic evaluation addressed two questions:

- Does paediatric HAH care increase costs borne by parents and their families?
- Does paediatric HAH care reduce costs to the health service?

METHODS

Details of patient recruitment and randomisation are reported in the accompanying paper.[6] As the principal clinical outcome (readmission rate) did not differ significantly between the trial arms, a cost minimisation analysis was undertaken. Our principal interest was the suggestion of cost shifting from the NHS to parents and families, but we also considered differences in NHS costs.

Patients were recruited from three groups of children (breathing difficulties, diarrhoea/vomiting, and fever) requiring acute admission and meeting clinical suitability criteria for HAH care. Patients were further classified by time of randomisation: either immediately, or at first subsequent medical review (within 24 hours).

Data collection

Patient/carer costs and burden

The level of burden experienced by carers was assessed using questionnaires on private expenditure (travel, food, phone calls, and other direct costs), and absences from paid employment. A diary card captured details of parent/carer time commitment to various childcare tasks: social (playing, cuddling, talking/singing, and calming/comforting) and physical (changing nappies, feeding, bathing, taking temperature, medication, and putting to bed).

A sample of 40 families were selected for interview to assess comparative levels of satisfaction with HAH and HC. A validated interview schedule[7] and maximum variation sampling[8] were used, ensuring that views of all subpopulations were represented.

NHS care costs

The main health services resources used in the care of children were recorded: inpatient days per index admission, and subsequent readmissions for related conditions within 90 days, days of HAH care provided, home visits made, their duration, and distance travelled per visit.

The mean daily cost of inpatient care was obtained from the CIPFA database for 1999–2000.[9] At the time that this study was being planned this database was the most comprehensive database of health service costs available. However, if we were to replicate the study we would almost certainly now make use of the more recently developed NHS reference costs database. The choice of costing database, however, is unlikely to significantly alter the comparative costs of the HAH and inpatient arms of the trial. As none of the children needed surgery, and all required only routine nursing care, no weighting for dependency was appropriate. The cost of home visits was based on allocating costed staff time and non-staff running costs pro rata to the number of home visits, and estimating travel costs for each patient visit at 40p per mile.

Statistical analysis

Statistical analysis was undertaken using Microsoft Excel 2000, and SPSS for Windows, release 10.0.7. Non-responders, modes of transport, and loss of working time frequencies were compared with Pearson's χ^2 test, or Fisher's exact test as

Abbreviations: HAH, Hospital at Home; HC, hospital care

Table 1 Direct costs incurred by families

	Hospital care	Hospital at Home	p value
Mean number of journeys to hospital	5.30	3.05	<0.0001*
Mean journey distance (miles)	4.5	5.2	0.11*
Mean fares paid (users of taxis and buses only)	£10.04	£8.25	0.59†
Mean total travel cost	£21.42	£15.15	0.007*
Mean food cost	£9.23	£6.34	0.09†
Mean cost of phone calls	£0.87	£0.69	0.62†
Childcare costs	£2.24	£0.12	0.047*
Other costs	£1.17	£0.55	0.31†‡
Total direct costs	£23.31	£13.76	0.001*

*t test of means with unequal variance.
†t test of means with equal variance.
‡Excluding £130 for holiday cancellation fee for one family.

appropriate. Costs, care activity times, and working time lost were compared by independent sample *t* tests assuming equal/unequal variances as indicated by Levene's test.

RESULTS

Parents' and carers' perspective

Economic data were collected from 300 cases (75% of all patients). Respondents sometimes had difficulty recalling particular details of the episode. Parents of 127 children (32%) returned activity diaries. Comparison with non-responders showed no differences for either instrument in randomisation or its timing.

Direct costs

Travel

No differences in mode of transport to hospital were detected (mention of: ambulance, $p = 0.83$; car, $p = 0.29$; bus, $p = 0.76$; taxi, $p = 0.97$; foot, $p = 0.31$). Most reported journeys (79%) were made exclusively by car. Table 1 shows that families of HAH patients made fewer journeys ($p < 0.0001$), though mean distance travelled was similar. As the transporting of sick children is not a routine use for private cars, it is appropriate to cost variations in mileage travelled on a marginal cost basis (the additional cost solely related to the mileage travelled—largely the cost of petrol). The marginal cost of private car travel is therefore assumed to be 10p per mile, implying that the total mean cost of travel per episode is £6.27 lower for HAH patients ($p = 0.007$).

Food

Extra food costs incurred by families outside the home were slightly lower ($p = 0.09$) for HAH patients (table 1).

Telephone calls

Minimal extra telephone use was recorded.

Childcare

Only six families in HC and one in the HAH arm paid for extra childcare. Though this difference is not significant, payments made by HC families were much larger, so the mean cost per patient differed considerably (£2.24 *v* £0.12, $p = 0.047$).

Other direct costs

Only 15 families incurred additional direct costs, including a family losing £130 from holiday cancellation. This was excluded from the analysis as unrelated to the mode of care. Remaining costs did not differ significantly ($p = 0.31$).

Total direct cost

HAH families suffered lower overall direct costs (−41%, £23.31 *v* £13.76, $p = 0.001$; see table 1).

Indirect costs

Working time lost

A total of 121 families (30%) provided information on whether any family member was absent from work as a result of the child's illness. Reported absence rates were similar for HAH and HC (76% *v* 73%, $p = 0.84$). The mean number of days lost per family was also similar (2.4 *v* 2.5, $p = 0.85$). The timing of randomisation had no impact on HC families, but had important effects on HAH cases: early randomisation led to absences in fewer cases (43% *v* 90%, $p < 0.001$), and tended to involve less aggregate time off work (0.98 *v* 2.32 days, $p = 0.09$).

The method employed in costing the economic impact of days off work depends on the perspective from which the analysis is being undertaken. The majority of parents were manual workers where the wage received was directly related to their presence at work. In such circumstances a real financial loss was imposed on the family as a consequence of work absence related to childhood illness. A further question that should be addressed relates to the extent to which such absence also led to a loss of output/welfare to society as a whole. However, as there was no difference in mean work days lost (both 1.84 days per patient), this potential theoretical minefield may be disregarded.

Burden of care

Care diaries were completed for 125 cases, evenly split between trial arms ($p = 0.59$, Fisher's exact test). Despite disappointing response rate, some noteworthy patterns are evident in the data (table 2). Time spent on physical care was 27% greater in the HAH arm (215 minutes *v* 169 minutes), while social care was similar. However, a correction is required for the longer care period for HAH responders (2.37 days *v* 1.37 days). Use of time per day figures reverse these trends: parental input may be reduced for HAH, particularly in playing time (−65%, $p = 0.004$). Diary data suggest that HAH may slightly reduce the time spent carrying out physical care tasks for sick children (for example, bathing −47%, $p = 0.02$), and avoids extra social intervention from parents to distract children through play in hospital. There is no evidence that HAH transfers the burden of care to parents.

Patient/carer satisfaction

Results of the satisfaction survey are reported in full elsewhere.[10] Of 40 families participating, 90% expressed clear preference for HAH in circumstances where their child's disease could be managed at home with appropriate support. HAH was felt to empower parents to remain in control and in contact with their child, and hence avoided detrimental psychological effects associated with separation of parent and child.[11] Most parents actively welcomed the opportunity for greater participation in their child's care.[12]

Disruption to family life was much reduced in HAH cases (5% *v* 55% noted moderate disruption or worse). All families receiving HAH care reported high parental involvement compared to only 80% of HC families. Few families (5%) in either arm felt that parents bore too much responsibility. Most families felt that HAH represented a continuation of normal

Table 2 Mean time spent on care activities undertaken by families of patients

Care activities	Mean care time per patient (min)				Mean care time per patient per day (min)			
	Hospital care (n=69)	Home care (n=56)	Difference (home – hospital) (%)	p value	Hospital care	Home care	Difference (home – hospital) (%)	p value
Physical								
Changing nappies	26	42	+16 (+59%)	0.04†	21	21	+1 (+3%)	0.90*
Feeding	98	122	+24 (+25%)	0.18*	79	71	–7 (–9%)	0.58*
Bathing	27	23	–4 (–14%)	0.53*	22	12	–10 (–47%)	0.02†
Taking temperature	2	4	+2 (+79%)	0.48*	2	2	0 (–22%)	0.75*
Medication	5	14	+9 (+175%)	0.02†	4	7	+3 (+59%)	0.22*
Putting to bed	11	10	–2 (–16%)	0.70*	9	4	–5 (–54%)	0.13†
All physical care activities	169	215	+45 (+27%)	0.08†	137	117	–20 (–15%)	0.28*
Social								
Playing	85	52	–34 (–39%)	0.09*	74	26	–47 (–65%)	0.004†
Cuddling	38	75	+37 (+96%)	0.32*	35	55	+20 (+58%)	0.57*
Talking/singing	14	9	–5 (–33%)	0.46*	11	5	–6 (–55%)	0.16†
Calming/comforting	48	58	+11 (+22%)	0.65*	41	37	–4 (–10%)	0.84*
All social care activities	185	195	+9 (+5%)	0.87*	161	124	–37 (–23%)	0.48*
All care activities	355	409	+54 (+15%)	0.43*	298	241	–57 (–19%)	0.35*

*t test with equal variances.
†t test with unequal variances.

parenting, but in more familiar and less stressful surroundings than was possible in hospital.

NHS perspective

Economic analysis from an NHS perspective is complicated because during the trial, both the paediatric ward and the HAH service were operating well below full capacity. Paediatric services are frequently characterised by an apparent overcapacity for significant periods of time. Perhaps more than any other speciality, they need to have sufficient capacity to cover peaks of demand which require levels of resource that are likely to lead to over capacity during periods of lower demand. Equally, the ability to shift nursing resources in and out of paediatric wards in response to such demand fluctuations is strictly limited by the need for specific paediatric nursing qualifications. Given such service overcapacity, the results of the NHS cost analysis should be interpreted as being indicative rather than definitive. The long term cost implications to the NHS of utilising paediatric HAH as an additional service will largely depend on how efficienctly the new service is operationalised alongside a traditional paediatric hospital service (for example, rationalisation of bed capacity).

Hospital costs

A proportion of patients in both arms of the trial were not randomised immediately, but were admitted to hospital and randomised on the first subsequent medical assessment (for example, if admitted during the night). For a fair comparison between trial arms, all prerandomisation inpatient stays are included in NHS direct costs. Mean inpatient stays were 2.01 days for the hospital arm and 0.40 days for HAH, costing £741 and £147 respectively, implying a net reduction of £594 per patient for HAH patients. As eligible patients constitute only a small proportion of paediatric workload (about 10%), the effect of underoccupancy on these costs is limited.

HAH care costs

Costing of home care is more problematic. The HAH team had an establishment of 6.14 WTE nurses to ensure adequate cover to patients. However, because of slow initial take up the numbers of patients recruited to the trial and randomised to HAH was substantially below that envisaged in normal clinical practice. The HAH team leader estimates that the allocated staffing could comfortably manage 50% more cases than was supported in the trial. The main cost of HAH is salaries (£148 400 per annum), implying a cost of £707 per patient. However, with 50% greater throughput, the staffing cost of an integrated service may reduce to £470 per patient.

The other major cost incurred by home care is nurse travel to patient homes. Visits logged by nurses for study patients averaged 3.68 visits per patient, with a small number of additional unplanned visits noted. The costing basis for nurse travel to patients is different from that used to cost private travel by patients' families. As nurses' cars were used extensively for work it is appropriate to cost such visits on an average cost basis, which incorporates costs such as depreciation and maintenance. The travel reimbursement provided to nurses (40p per mile) was specifically calculated to reflect the average cost of such travel and hence was utilised in our analysis. Costing four visits per patient at the average distance per visit of 10 miles and applying the 40p standard mileage rate yields a mean travel cost per patient of £16.

Total NHS costs and sensitivity

Total NHS costs per patient appear £130 greater for HAH than HC (£870 *v* £741). The two main sources of uncertainty are the unit cost per bed day, and the throughput of the HAH service. Using national average costs (interquartile range) in place of local costs yields a net cost difference of +£165 ((+£86) – (+£279)). However, assuming 50% greater throughput alters the balance of cost considerably to –£107 with local costs, and –£72 ((–£151) – (+£42)) using national costs.

DISCUSSION

Direct costs incurred by families in the trial were generally very low, and where measurable were either similar between the two arms, or in favour of home care, because of the shorter period of involvement with the hospital. There is no evidence that home care incurs greater loss of working time, or that home care transfers the "burden of care" from health service professionals to families. There is evidence that wherever possible the initiation of HAH care should not be delayed, as this increases the likelihood of parents losing working time.

In terms of direct costs to the NHS our claims are suitably modest. There appears currently to be no significant difference in cost between HAH and traditional inpatient care with both services operating below full capacity. As the HAH service grows it is likely to experience significant "economies of scale" (largely related to closer grouping of clients) which may provide it with a cost advantage for a restricted group of clients in

What do we already know?

- Previous economic analyses of hospital at home schemes related only to specific adult populations and have focused mainly on comparative NHS costs
- Results have been equivocal: some suggesting that Hospital at Home is cheaper, and others the contrary
- In paediatric hospital at home schemes the prime concern is to improve children's experience of healthcare rather than to reduce costs

What further information does this paper provide?

- Care delivered at home does not cause any change in working time lost when children are acutely ill, and private, out of pocket costs borne by parents/carers of children are reduced
- There is no transfer of carer burden from professionals to families, and in fact the time parents need to spend in social interaction with their child is reduced at home. Most parents and children prefer to receive care at home
- NHS costs of care are not reduced by hospital at home, but may be comparable with inpatient care.

comparison to traditional hospital care. Currently, however, it is not possible to draw any firm conclusions from the trial as to whether home care in a Hospital at Home scheme is more or less costly than traditional hospital care for the defined group of patients. This will depend on the manner in which it is introduced and managed, and even on local accounting practice. However, on the basis of this analysis it appears that although HAH is unlikely to be consistently cheaper for the NHS, broadly similar costs may be achievable under normal operating conditions. The challenge facing healthcare planners is how to implement paediatric HAH schemes more widely in a clinically effective and cost effective manner.

This analysis has largely concentrated on identifying the comparative cost (in the fullest sense of the word—incorporating the privately borne burden of care) of supporting these comparatively homogeneous groups of patients in HAH and traditional inpatient care. Given this focus it was appropriate to incorporate comparative parental satisfaction (one measure of parental burden) in this paper. However, the results obtained on the cost side of the equation are best interpreted in tandem with the results obtained in our associated clinical paper. The principle message of our cost analysis is that economic factors should not dominate clinical considerations in determining the appropriate use of HAH as a complementary care provision to improve services for a defined subgroup of paediatric patients. For the types of patients included in the trial it appears that the care provided by HAH is as good as conventional hospitalisation. Evidence from the parental attitudes study indicates a very strong preference among carers to locate care in the home setting wherever possible and clinically appropriate.

It is likely that in practice HAH schemes will be able to care for patients beyond the strict criteria of the trial, leading to better use of available capacity and greater efficiency. While we await the development of a wider body of evidence for paediatric HAH, and the balance of cost advantage for the NHS is not clearly in favour of either option, decisions should be based on other criteria in the first instance, most notably the strong preferences of most families in favour of HAH.

Hospital at Home is a good deal for children and their families

An economic study of Hospital at Home care for some acutely ill children has shown that parents are better off when they care for their children at home under nurse supervision—they have fewer out of pocket expenses, do not need to take more time off work, and need to spend less time each day amusing the child.
Hospital at Home is no cheaper for the NHS than conventional care, but need not cost more, if carefully implemented. The challenge to planners is to introduce cost effective schemes, while maintaining clinical standards and user satisfaction.

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Authors' affiliations
A Bagust, Senior Research Fellow, Department of Pharmacology & Therapeutics, University of Liverpool
A Haycox, Senior Research Fellow, Department of Pharmacology & Therapeutics, University of Liverpool
S A Sartain, Researcher, Wirral Services for Child Health, Wirral Hospital NHS Trust
M J Maxwell, Head of the Clinical Practice Research Unit and Consultant in Public Health Medicine, Wirral Hospital NHS Trust
P Todd, Consultant Paediatrician, Wirral Hospital NHS Trust

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