A cost and outcomes comparison of a novel integrated pediatric air and ground transportation system

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Two alternative systems of transporting critically ill children, by air and by a mixed air-ground system, were compared. The air transport system was 100% hypothetical. The mixed air-ground system was based on the present “hub and spoke” system used in the institution. This system consisted of three helicopters plus five ambulances. The helicopters were rotated such that two were available for service while the third underwent maintenance. The five ambulances also rotated such that four were in operation at all times. Three of the five ambulances were pre-positioned at community hospitals located 42, 62 and 122 miles from Duke University Medical Center. The fourth was based at the medical center and moved throughout the system, depending on service needs.

Type of intervention
Other: Transportation.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised critically ill paediatric patients less than 18 years old, who were transferred to the tertiary hospital.

Setting
The setting was tertiary care. The economic study was carried out in Durham (NC), USA.

Dates to which data relate
The effectiveness data were derived from transfers that took place between June and December 1997. The resources used appear to have been collected at the same time. The price year used was not stated.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was carried out retrospectively on the same study sample as that used in the initial effectiveness study.

Study sample
The authors conducted a review of the institution's database for details of all paediatric transfers between June and December 1997. During this time a mixed system was in operation. Of those identified, 45% were surgical and 55%
were medical admissions. In total, 96 children were transported from the surrounding referral community hospitals and were included in the study. Of these, 46 (48%) were transported by means of ground and 50 (52%) by air.

**Study design**
The study question involved comparing air with an ambulance-air mix. However, the authors undertook a retrospective cohort study in a single centre. This compared two cohorts of patients from the existing mixed ambulance-air transport system to each other (i.e. air versus ground). The rationale for this seems to have been that, if the effects of both means of transport are the same whether in a mixed or single transportation system, then the study question boils down to which means of transport is the most effective. This question can be best analysed in the retrospective cohort analysis undertaken. It must be pointed out, however, that the inferred assumption is highly questionable. In the initial analysis each patient's length of follow-up varied depending on his or her length of stay at the medical centre.

**Analysis of effectiveness**
The authors compared the effectiveness results of the air and ground components of the mixed air-ground transportation system. The two cohorts within the mixed system were comparable to the study population. The authors used hospital stay to evaluate the outcomes, hypothesizing that longer lengths of stay represented worse outcomes, and 24-hour mortality. They also compared the predicted and actual mortality of the two separate cohorts of the mixed system. The authors did not assess the combined effectiveness of air and ground. They used the separate effectiveness measures as a proxy for the effectiveness of the mixed system, as explained in the 'Study Design' section.

**Effectiveness results**
There were no significant differences in the length of hospital stay or the 24-hour and predicted mortality rates between the air and ground cohorts.

Total mortality was 6% for the air group and 0% for the ground group. The difference was statistically significant, (p<0.05).

There were significant differences between the two cohorts in paediatric risk of mortality score and discharge, (p<0.05).

The total transport time was 131.8 (+/- 44.9) minutes for the air cohort and 158.0 (+/- 70.2) minutes for the ground cohort, (p<0.05).

**Clinical conclusions**
The authors concluded that their study demonstrated that the hub and spoke (mixed) transportation system was a timely and safe method for the transport of critically ill children.

**Methods used to derive estimates of effectiveness**
The authors made assumptions in order to derive estimates of effectiveness.

**Estimates of effectiveness and key assumptions**
The authors assumed that the effectiveness of the air component in the mixed system was equal to that of air transportation alone. They also assumed that the two separate effectiveness measures for the mixed system could be used as a proxy for the actual effectiveness of the mixed system.

**Measure of benefits used in the economic analysis**
No summary measure of benefit was used in the economic analysis. Thus, a cost-consequences analysis was conducted.
Direct costs
The direct costs were derived using the total costs generated by the initial comparative analysis, air versus ground transportation. The quantities and the costs were not reported separately. The costs were obtained from the totalled variable, fixed and overhead components of the overall transport costs. The variable costs changed in proportion to the changes in the activity level of the transport system. The fixed costs included leases, nurse and crew salaries, secretarial fees and rent. The overhead costs included hospital administration, utilities, maintenance and rent for the institution.

The quantity/cost boundary adopted was that of the health service provider. The quantities and costs were estimated from actual data. Discounting was not carried out since the costs were incurred in less than one year. The quantities were obtained from the medical records department, while the cost data came from the hospital cost accounting system used by the medical centre. The quantities were measured between June and December 1997, but the price year was not stated. The hypothetical air system costs were derived using the mixed system costs. In addition, the number of transports was calculated using the average number of transfers per year over the last five years in the study institution; no other details were reported.

Statistical analysis of costs
No statistical tests were carried out in the cost analysis.

Indirect Costs
No indirect costs were included.

Currency
US dollars ($).

Sensitivity analysis
A sensitivity analysis was not conducted.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
Air transport cost $4,326 while ground transport cost $1,566.

The total cost of air transportation was $792,132 per year, based on the cost of the mixed system. The cost of mixed air-ground transportation was $551,832.

The savings were estimated to be $240,000 per year.

Synthesis of costs and benefits
No synthesis of the costs and benefits was conducted.

Authors' conclusions
The study demonstrated that the hub and spoke (mixed) transport method was timely and safe for the transportation of critically ill children. The authors also concluded that a mixed air-ground transport system produces a significant amount of savings. The study indicated that air and ground transportation act synergistically and the integrated system will provide a similar benefit at a lower cost.
CRD COMMENTARY - Selection of comparators
The reason for the choice of the comparator was clear. The comparator, air only, was chosen as it was considered to be the best method of transporting critically ill children. You should decide if this is a widely used technology in your own setting.

Validity of estimate of measure of effectiveness
The initial study was a retrospective cohort study. The study sample was derived from a review of the transportation records of the institution. During the 6 months that were reviewed, the mixed transportation system was in operation. The effectiveness results from the air and ground components of the mixed system were used to assess both the individual and joint effects of the different transport methods. The authors' analysis therefore assumed that the effectiveness of air and ground transport was equal whether they were in a single or mixed transportation system. This assumption is questionable and raises doubts over the validity of the study design. The authors did not deal with the issue of how the transport was allocated in the mixed system, but they did acknowledge that the use of helicopters was reserved for time-dependent emergencies and urgent transports. This makes the assumption that the effectiveness of air alone when no allocation is being made, is equal to air when an allocation decision has been made, highly questionable. The initial study sample appears to have been representative of the study population. In addition, the two initial cohorts were shown to be comparable. However, it is difficult to ascertain what effect the use of the proxy effectiveness measures has had on the results obtained.

Validity of estimate of measure of benefit
No summary measure of benefit was used in the economic analysis. The study was therefore classed as a cost-consequences study.

Validity of estimate of costs
All the cost categories relevant to the hospital perspective appear to have been included in the analysis. The costs and the quantities were not reported separately. Although some analysis was conducted when comparing the air and ground systems, it is not possible to know if extrapolating these results has caused bias. No statistical analysis of the prices and costs was conducted. Consequently the generalisability of the findings will be limited, especially since the costs were taken from the authors' setting. Further, the total costs of the hypothetical air transport were based on an estimate derived by the authors. The total cost per year for paediatric transports was estimated from the average number of air transfers for the previous five years. The date to which the prices relate was not reported.

Other issues
The authors made appropriate comparisons of their effectiveness findings with those from other studies, but the issue of generalisability was not addressed. The authors do not appear to have presented their findings selectively, although the validity of the results rests on an assumption. The conclusions reflected the scope of the analysis. The authors reported that a limitation to their study was the means by which they accrued the adverse effects in transit. They also indicated that they did not carry out a detailed analysis of the allocation decision, as the purpose of their study was to assess the clinical outcomes of an integrated air-ground transport system.

Implications of the study
The authors did not make any recommendations. It could be of value to repeat the study using actual effectiveness data collected retrospectively from a period when the air-only system was in use, and a combined effectiveness measure from the mixed system. This would allow for a less biased comparison of the two systems.

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