Cost-effectiveness of head computed tomography in infants with possible inflicted traumatic brain injury

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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
The study examined the use of computed tomography of the head (head CT) for the diagnosis of inflicted traumatic brain injury (iTBI) in selected infants. Head CT was compared with a policy of no CT.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis

Study population
The study population comprised a hypothetical population of 5-week-old infants without a history of recent trauma and with normal neurologic examinations. Two cohorts were considered: infants presenting to an ED with an apparently life-threatening event (ALTE), and infants with unexplained scalp bruising on ED examination.

Setting
The setting was an ED. The economic study was carried out in the USA.

Dates to which data relate
Clinical data used in the study and most information on resource use were derived from studies published between 1990 and 2006. The price year was 2005.

Modelling
A Markov model was constructed. This followed infants from first ED visit presentation at 5 weeks through 52 weeks of age under the two diagnostic strategies. Weekly cycles were considered. The structure of the model was presented. Under a CT policy, children had imaging during the ED visit; under a no CT strategy, infants were discharged without CT. Subsequent clinical and economic outcomes depended on the assumed probabilities of events, which were described graphically. The health states, which were described, were based on the severity of iTBI (initial, mild, severe, fatal). The impact of undiagnosed iTBI was the key step of the model, together with the accuracy of head CT.

Study designs and other criteria for inclusion in the review
The clinical and epidemiological data used in the decision model were:

the prevalence of iTBI in infants presenting to an ED with a history of ALTE and infants with unexplained scalp bruising on ED examination;

rates of false-negatives and false-positives with initial head CT reading;

the risk of fatal iTBI in infants with undiagnosed iTBI;

the rate of protective placement after a report of any iTBI;

the rate of subsequent iTBI without protective placement (over 47 weeks and weekly rate);
the accuracy of subsequent iTBI diagnosis;

the fatality rate and disability from subsequent iTBI; and

the rate of foster placement after a report of any iTBI.

Sources searched to identify primary studies
The clinical data were derived from several published studies. Some national health databases were used to describe iTBI outcomes. Some characteristics of the primary source (i.e. number of patients involved and setting) were provided for a few studies, but the designs of these studies were not clear.

Methods used to derive estimates of effectiveness
The authors stated that some clinical estimates were identified through a systematic review of the literature. However, no information on the methods or conduct of this review was provided. It was stated that there was limited paediatric-specific information in the literature, leading to high uncertainty around model estimates.

Measure of benefits used in the economic analysis
The summary benefit measure used was the number of severe or fatal iTBI cases averted. This benefit measure was estimated using the modelling framework. No discounting was necessary.

Direct costs
The analysis of the direct costs was carried out from the viewpoint of a third-party payer. The cost categories included were unsedated non-contrast head CT, ED visit, and medical services associated with both acute care of iTBI (including hospital stay in ward and intensive care unit) and chronic medical services for survivors of iTBI. Most of the costs were derived from Medicare and Medicaid payment schedules. Hospital charge data were obtained from the Children's Hospital of Pittsburgh from 1995 to 1999. Charges were adjusted by using a generic cost-to-charge ratio. The frequency of events requiring medical care was derived from published data. However, a breakdown of the unit costs and quantities of resources used was not provided. Discounting was not relevant as all the costs were incurred within 1 year. All costs were inflated to 2005 values using the Consumer Price Index.

Statistical analysis of costs
The costs were treated deterministically in the base-case analysis.

Indirect Costs
The societal costs associated with child protective services, police investigation and legal actions, as well as chronic societal costs associated with in-home or out-of-home placements for iTBI survivors, were included in the analysis. These costs were derived from published sources. As in the analysis of the direct costs, the price year was 2005 and discounting was not required.

Currency
US dollars ($).

Sensitivity analysis
Extensive sensitivity analyses were carried out to assess the robustness of the cost-effectiveness results to variations in model inputs. Wide variations were used, which was appropriate given the uncertainty surrounding both the clinical and economic estimates. A deterministic sensitivity analysis was carried out by varying all model parameters in one- and two-way analyses. A probabilistic sensitivity analysis (Monte Carlo simulation) was also undertaken to deal with the simultaneous variation of model inputs. Triangular distributions were assigned to each model parameter.

Estimated benefits used in the economic analysis
The benefits were not reported.

Cost results
The total costs were not reported.
**Synthesis of costs and benefits**

Incremental cost-effectiveness ratios (ICERs; i.e. the incremental cost per severe or fatal iTBI case averted) were calculated in order to combine the costs and benefits of the two alternative strategies.

In the population of infants presenting with unexplained scalp bruising, head CT was both more effective and less expensive than no head CT from the perspective of the third-party payer. The ICER was $132,701 from a societal perspective.

In the population of infants presenting with ALTE, the ICER of head CT in comparison with no CT was $72,744 from the perspective of the third-party payer and $209,328 from a societal perspective.

The sensitivity analysis carried out from the perspective of the third-party payer suggested that the dominance of head CT in the bruising scenario was sensitive to assumptions about the acute medical costs of iTBI, cost of CT and probability of repeat iTBI. Specifically, CT remained dominant when imaging cost less than $368 ($236 in the base-case), the probability of repeat iTBI was less than 34%, or the costs of acute medical care for initial iTBI were lower than 35% of the costs associated with mild iTBI. The results were less robust in the ALTE scenario, with the acute medical costs of iTBI being the most influential model input. From the societal perspective, the costs of foster care had the strongest impact on the results of the analysis.

The probabilistic sensitivity analysis showed that, from the perspective of the third-party payer, head CT was dominant for 96% of simulations in the bruising scenario. In the ALTE scenario, the ICER fell below the threshold of $100,000 in 98% of simulations. From a societal perspective, 89% and 60% of all simulations were below the threshold of $200,000 in bruising and ALTE scenarios, respectively.

**Authors' conclusions**

The authors concluded that computed tomography (CT) diagnosis of inflicted traumatic brain injury (iTBI) was a cost-saving and cost-effective strategy from the perspective of the third-party payer over a short-term horizon. However, when societal costs were considered, early diagnosis of iTBI was more expensive because of the high cost of child protection for abused children.

**CRD COMMENTARY - Selection of comparators**

The choice of the comparator (i.e. no head CT) was appropriate since it reflected the current alternative option in the authors' context. The use of magnetic resonance was not considered as this device is often not available in the context of a hospital ED. You should decide whether this is a valid comparator in your own setting.

**Validity of estimate of measure of effectiveness**

Clinical estimates are likely to have been identified through a review of the literature, although the authors did not report the methodology used to identify and select primary studies. Furthermore, little information on the design and other characteristics of the primary studies was provided, which limits the possibility of assessing the validity of the clinical data. Aware of this limitation, the authors undertook extensive sensitivity analyses using wide ranges of values to address the issue of uncertainty surrounding the clinical inputs.

**Validity of estimate of measure of benefit**

The summary benefit measure was specific to the disease under examination and would be difficult to compare with the benefits of other health care interventions. However, cases averted represents a commonly used benefit measure for diagnostic interventions. The authors stated that it was not possible to calculate long-term benefit measures such as quality-adjusted survival, owing to the relative lack of published data.

**Validity of estimate of costs**

The cost analysis took account of two possible points of view. Thus, the economic study was carried out with the inclusion of all relevant categories of costs, given the specific perspective. The costs were presented as macro-categories, which is consistent with the use of Medicare/Medicaid databases to derive cost data. However, no breakdown of the cost items was provided and no information on the quantities of resources used or unit costs was given. This could limit the possibility of replicating the analysis in health care settings other than the USA. Statistical
analyses of the costs were not performed in the base-case analysis, but probabilistic distributions were attributed to economic inputs in the sensitivity analysis. The price year was reported, which will facilitate reflation exercises in other time periods. The authors stated that the assumptions made in the estimation of acute medical costs represented a limitation of the analysis.

Other issues
The authors did not compare their findings with those from other studies because of the lack of published studies on the use of CT for the diagnosis of iTBI. The issue of the generalisability of the study results to other settings was implicitly addressed in the sensitivity analysis, in which a wide range of alternative values was tested. The authors discussed the potential implications of adopting a longer time horizon, which could make the early diagnosis of iTBI more cost-effective from a societal perspective.

Implications of the study
The study results suggest that head CT for the early diagnosis of iTBI might be a cost-effective strategy. Future studies should investigate the long-term costs and benefits of such a policy.

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