Technology assessment in dentistry: a comparison of the longevity and cost-effectiveness of inlays

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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
Three different types of three-surface inlays were examined. These were conventional laboratory-fabricated ceramic inlays, chairside CAD/CAM ceramic inlays and gold inlays. The abbreviation CAD/CAM stands for computer-aided design/computer-aided manufacturing. It describes a process that enables the fabrication of ceramic restorations at the patient's chairside without a dental laboratory.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of patients requiring three-surface inlays.

Setting
The setting was secondary care. The economic study was carried out in Germany.

Dates to which data relate
The effectiveness data were derived from studies published between 1994 and 2003. Data on resource use and costs were gathered in 2003 and 2004. The price year appears to have been 2003/2004.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of completed studies.

Outcomes assessed in the review
The outcomes estimated from the literature were the combined annual survival rates for the three-surface inlays under analysis.

Study designs and other criteria for inclusion in the review
A review of the literature was undertaken to identify the primary studies. There were two basic inclusion criteria. The studies had to report annual survival probabilities and annual observations. Three further inclusion criteria were considered to make the selection stricter. First, the studies had to be randomised and controlled; observational studies were included only if the percentage of participants at the first follow-up was at least 90%, unless the study took a random sample of individuals or explained the reasons for the loss. Second, the studies had to evaluate the need for
restoration based on appropriate criteria. Third, the studies had to state or use criteria for deciding when a restoration had failed and needed to be replaced. However, such strict inclusion criteria were then relaxed as no study which met them was identified. The final studies included in the review were all case series. Details of sample sizes, follow-up and key results were provided separately for each of the included studies.

**Sources searched to identify primary studies**
MEDLINE, EMBASE, and the Cochrane Library were searched from 1966 to June 2003 using the keywords "inlays", "life tables" (or "lifetables"), and "Kaplan-Meier" (or "KaplanMeier"). A handsearch of studies included in a recently published systematic review was also performed.

**Criteria used to ensure the validity of primary studies**
The validity of primary studies was, in principle, ensured by the inclusion criteria used in the review. However, some inclusion criteria had to be relaxed because of the lack of randomised studies, and only case series were used. The internal validity of these studies appears to have been low.

**Methods used to judge relevance and validity, and for extracting data**
Not stated.

**Number of primary studies included**
Four studies were identified using the basic inclusion criteria, while 6 studies were identified through the handsearch. Thus, in total, 10 studies provided data.

**Methods of combining primary studies**
A meta-analysis was used to pool the annual survival rates from different studies. Each study was weighted by the inverse of the variance (one divided by the square of the standard error) of the effect estimate.

**Investigation of differences between primary studies**
The studies were characterised by different follow-up periods, which ranged from 3 to 20 years.

**Results of the review**
The survival rate decreased from 0.973 at year 1 to 0.909 at year 9 for laboratory-fabricated ceramic inlays, from 0.996 at year 1 to 0.891 at year 9 for chairside CAD/CAM ceramic inlays, and from 1.000 at year 1 to 0.917 at year 9 for gold inlays.

**Measure of benefits used in the economic analysis**
The summary benefit measure was inlay longevity. This was measured in terms of the number of failure-free years. An annual discount rate of 3% was applied as the benefits occurred over a long-term period.

**Direct costs**
The analysis of the costs was performed from the perspective of a German private insurer. It included dentist fees (covering the dentist's salary, material costs and computer system costs) and laboratory costs (including only the technicians' salaries). Treatment beyond initial restoration was not considered because of the difficulty of modelling the consequences of restoration failure. The costs for prior examinations and follow-up appointments were not taken into consideration because they were the same for all inlay restorations. The unit costs were not presented separately.
from the quantities of resources used. Both the costs and resource use were estimated from a random sample of all paid
dental bills from 2003 to 2004 obtained from a private German insurer. Thus, the price year appears to have been
2003/2004. Discounting was not relevant since the costs were incurred during a short timeframe.

**Statistical analysis of costs**
The costs were treated deterministically.

**Indirect Costs**
The indirect costs were not considered in the economic evaluation.

**Currency**
Euros (Euro).

**Sensitivity analysis**
A sensitivity analysis was performed to investigate how failure-free survival would change if a 4-year instead of a
9-year follow-up period was considered.

**Estimated benefits used in the economic analysis**
After 9 years, the discounted failure-free years were 7.47 (95% confidence interval, CI: 7.24 - 7.70) for laboratory-
fabricated ceramic inlays, 7.50 (95% CI: 7.42 - 7.58) for chairside CAD/CAM ceramic inlays, and 7.59 (95% CI: 7.55
- 7.63) for gold inlays.

Statistically significant differences were found in the comparison between gold and chairside CAD/CAM, (p<0.01),
and between chairside CAD/CAM and laboratory-fabricated ceramic inlays, (p<0.05). However, the difference
between gold and laboratory-fabricated ceramic inlays was not statistically significant, (p<0.10), because of the lack of
statistical power.

Using a 4-year follow-up, period the number of undiscounted failure-free years was 3.86 (95% CI: 3.80 - 3.93) for
laboratory-fabricated ceramic inlays, 3.95 (95% CI: 3.94 - 3.96) for chairside CAD/CAM ceramic inlays, and 3.99
(95% CI: 3.98 - 4.01) for gold inlays.

**Cost results**
After 9 years, the costs were Euro 520 (95% CI: 494 - 545) for laboratory-fabricated ceramic inlays, Euro 433 (95%
CI: 419 - 447) for chairside CAD/CAM ceramic inlays, and Euro 478 (95% CI: 450 - 505) for gold inlays. All these
differences were statistically significant, (p<0.02).

**Synthesis of costs and benefits**
An incremental cost-effectiveness ratio (i.e. the cost per discounted failure-free year gained) was calculated to
combine the costs and benefits of the alternative inlays.

The incremental analysis revealed that laboratory-fabricated ceramic inlays were dominated by chairside CAD/CAM
ceramic inlays (the reference strategy). The incremental cost per discounted failure-free year gained with gold inlays
over chairside CAD/CAM ceramic inlays was Euro 487 (95% CI: 456 - 518).

The sensitivity analysis (4-year follow-up) showed that the incremental cost-effectiveness ratio of gold versus
chairside CAD/CAM ceramic inlays was Euro 1,082 per failure-free year gained (95 CI: 287 - 2,254).
Authors' conclusions
Laboratory-fabricated ceramic inlays were less effective and more costly than chairside CAD/CAM ceramic inlays, while gold inlays were more costly and led to higher survival rates than chairside CAD/CAM ceramic inlays. However, if the survival difference between gold and chairside CAD/CAM ceramic inlays was assumed to be clinically irrelevant, chairside CAD/CAM ceramic inlays would also become more cost-effective than gold inlays in Germany.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparators was clear since the available three-surface inlays were considered in the analysis. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came from a synthesis of published studies that had been identified from a review of the literature. Extensive information on the conduct and method of the review was provided, and the criteria used to include primary studies were reported. When strict criteria were used to identify high-quality primary studies, no publications were retrieved. Thus, less stringent criteria were applied, and only case series were included in the review. Hence, the internal validity of the selected studies might have been quite low. Most details of the primary studies, such as setting, number of observations and length of follow-up, were reported. A statistical approach was used to pool the primary estimates. The issue of uncertainty associated with the length of the observation period was investigated in the sensitivity analysis.

Validity of estimate of measure of benefit
The benefit measure used in the analysis was specific to the interventions considered in the study. It will not be comparable with the benefits of other health technologies. Discounting of inlay survival was performed since the long-term benefits were assessed. Undiscounted results were also reported. The authors stated that the use of the so-called quality-adjusted tooth-years would have allowed longevity to be combined with quality of life issues such as side-effects and aesthetics of inlays. However, these were not used given the lack of data.

Validity of estimate of costs
The cost analysis was consistent with the perspective adopted in the study. The source of the costs reflected the charges relevant to a private insurer. The unit costs were not presented separately from the quantities of resource use, and macro-categories of costs were reported. Thus, it may be difficult to replicate the analysis in other settings. Also no sensitivity analysis of the costs was performed and the external validity of the cost analysis appears to have been low. However, statistical analyses of the costs were performed using standard tests and the price year was reported, which will facilitate reflation exercises in other timeframes.

Other issues
The authors did not compare their findings with those from other studies, stating that limited evidence on the cost-effectiveness of three-surface inlays had been published. The issue of the generalisability of the study results to other settings was not addressed and limited sensitivity analyses were performed. This reduces the external validity of the study.

The authors noted several limitations of their analysis. First, the results of the literature review did not lead to robust clinical estimates, especially given the problems of insufficient reporting in the primary studies. Second, the clinical data were derived from non-randomised studies without a control group, and these are usually associated with a weak internal validity. Third, there were few studies with long-term follow-up and all of them focused on gold inlays. Fourth, other dimensions of the health outcomes, such as post-operative hypersensitivity or aesthetic appearance, were not measured because of the lack of data. Fifth, the impact of a reimbursement policy change was not assessed. Finally, the adoption of a societal perspective would have been more appropriate but it was beyond the scope of the study.
Implications of the study
The study results supported the use of chairside CAD/CAM ceramic inlays. However, the authors noted that caution is required when interpreting the results of the study given the limitations of the analysis. The authors stressed the deficits in the quality of studies reporting longevity of three-surface inlays.

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Other publications of related interest


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