A cost-effectiveness modelling study of strategies to reduce risk of infection following primary hip replacement based on a systematic review

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Scientific summary

Reducing infection risk following primary hip replacement

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Scientific summary

Background

Total hip arthroplasty (THA) is common in the UK, and demand is rising as the population ages. There are risks with THA, and deep infection of the surgical site is reported in 0.7% of all cases. This uses up scarce health-care resources and impacts on the patients' quality of life. Deep infections often lead to revision surgery, which is invasive, painful and costly. A range of strategies is employed in NHS hospitals to reduce the risk of deep infection following THA. However, no economic analysis has been undertaken to compare the value for money of competing prevention strategies. This information will enable policy-makers to identify a cost-effective approach to managing the risks of infection among patients who have a primary THA in NHS hospitals.

Objectives

To compare the costs and health benefits of strategies to reduce the risk of deep infection following THA in NHS hospitals. To make recommendations to decision-makers about the cost-effectiveness of the alternatives.

Methods

An evidence synthesis exercise was completed and an economic decision-analytic model used to assess the cost-effectiveness of nine different treatment strategies to reduce the risk of surgical site infection (SSI) following THA carried out in NHS hospitals. Only deep infections were included. Superficial infections were excluded because they are relatively easy to treat and are not associated with severe or long-term effects for the patient.

Data sources and extraction

Literature searches using MEDLINE, EMBASE, Cumulative Index to Nursing and Allied Health Literature and the Cochrane Central Register of Controlled Trials, were undertaken to identify infection prevention strategies in the period 1966–2012. Relevant journals, conference proceedings and bibliographies of retrieved papers were hand-searched. Orthopaedic surgeons and infection prevention experts were also consulted. The search was limited to English-language papers. The selection of evidence was conducted by two independent reviewers and discrepancies were resolved. The patient, intervention, comparison and outcome framework revealed the population consisted of patients undergoing total hip replacement (THR); the intervention was infection control strategies to prevent THR-related SSI; the comparison was infection control strategies compared with other control strategies in the mixed-treatment comparison network; and the outcome was the number of THR-related SSIs. Studies were included if they were interventions that reported THA-related deep SSI as an outcome. Antibiotic prophylaxis, antibiotic-impregnated cement and ventilation systems used in the operating theatre were indicated. The key outcome variables evaluated were total number of THRs performed and the total number of deep SSIs diagnosed following the THR procedures.

Data synthesis

A mixed-treatment comparison was used to synthesise evidence of effectiveness of nine different treatment strategies, treatments (Ts) 1–9. The statistical method allowed estimates of the relative effectiveness of each treatment in a network to be compared. Judgements based on existing evidence were made regarding the size of the treatment effect. T1 was the reference for comparison and included no antibiotic prophylaxis, plain cement and conventional ventilation without laminar airflow system. This was trialled against eight other treatments.

Economic modelling

We used a Markov model with health states to describe the treatment paths a patient could follow if they developed a deep SSI after THA. These were debridement, antibiotics and implant retention, a one-stage revision, the two stages of a two-stage revision and permanent resection. Also included were states for no infection, deep infection and successful treatment. All states in the model were mutually exclusive and had 'cost' and 'quality-of-life' tariffs attributed to them. The probability of patients transitioning between states over time was assigned. Costs and quality-adjusted life-years (QALYs) for each cycle were calculated for each competing treatment strategy. The model was run for 5 years until all patients had transitioned through the model. Total cost and QALYs across all cycles were summed for each treatment. Data to inform model parameters were taken from relevant NHS databases that were linked together. It would not be possible to run a prospective clinical trial to address the same research question.

Results

Twelve studies, of which six were randomised controlled trials and six were observational studies, involving 123,788 THRs and nine infection control strategies, were identified. The quality of the evidence was judged against four categories developed by the National Institute for Health and Care Excellence's *Methods for Development of NICE Public Health Guidance* (http://publications.nice.org.uk/methods-for-the-development-of-nice-public-health-guidance-third-edition-pmg4). All evidence was found to fit the two highest categories of 1 and 2.

A cohort of 77,321 patients who had a primary THR in 2012 was simulated for conditions relevant to T1 (no systemic antibiotics, plain cement and conventional ventilation). All other treatment strategies reduced risk and resulted in fewer cases of deep infection with T6 (systemic antibiotics, antibiotic-impregnated cement and conventional ventilation) the most effective. T6 prevented a further 1481 cases of deep infection and led to the largest annual cost savings of –£8,325,277 (95% uncertainty interval –£17,981,040 to £5,765,832). The mean gains to health benefits measured by QALYs were greatest at 147 QALYs gained (95% uncertainty interval 585 to 1157 QALYs gained). Based on this analysis, T6 is the optimal decision, with the highest probability of being cost-effective, at 32%. Other treatments that include laminar airflow (T7) and the additional use of body exhaust suit (T9) are common among NHS trusts, yet lead to both high costs and lower health outcomes (£5,053,528 higher costs and 23 fewer QALYS for T7 vs. T6; and £9,106,352 higher costs and 84 fewer QALYS for T9 vs. T6).

Conclusions

The modelling results indicate that the combination of systemic antibiotics, antibiotic-impregnated cement and conventional operating theatre ventilation (T6) is the most effective strategy for reducing the risk of SSI following THA. It was associated with the greatest prevention of cases of SSI, the largest cost saving and gains to QALYs. Other strategies that are commonly used among NHS hospitals lead to higher cost and worse QALY outcomes. There are opportunities to save resources and improve health outcomes.

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