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Major article

Surgical site infection prevention following total hip arthroplasty in Australia: A cost-effectiveness analysis

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Background: Surgical site infection (SSI) is associated with substantial costs for health services, reduced quality of life, and functional outcomes. The aim of this study was to evaluate the cost-effectiveness of strategies claiming to reduce the risk of SSI in hip arthroplasty in Australia.
Methods: Baseline use of antibiotic prophylaxis (AP) was compared with no antibiotic prophylaxis (no AP), antibiotic-impregnated cement (AP + ABC), and laminar air operating rooms (AP + LOR). A Markov model was used to simulate long-term health and cost outcomes of a hypothetical cohort of 30,000 total hip arthroplasty patients from a health services perspective. Model parameters were informed by the best available evidence. Uncertainty was explored in probabilistic sensitivity and scenario analyses.
Results: Stopping the routine use of AP resulted in over Australian dollars (AUD) $1.5 million extra costs and a loss of 163 quality-adjusted life years (QALYs). Using antibiotic cement in addition to AP (AP + ABC) generated an extra 32 QALYs while saving over AUD $123,000. The use of laminar air operating rooms combined with routine AP (AP + LOR) resulted in an AUD $4.59 million cost increase and 127 QALYs lost compared with the baseline comparator.
Conclusion: Preventing deep SSI with antibiotic prophylaxis and antibiotic-impregnated cement has shown to improve health outcomes among hospitalized patients, save lives, and enhance resource allocation. Based on this evidence, the use of laminar air operating rooms is not recommended.

Total hip arthroplasty (THA) is a commonly performed procedure, and numbers are increasing with ageing populations.[1] One of the most serious complications in THA is surgical site infection (SSI) caused by pathogens entering the wound during the procedure. Treatment options depend on a number of different factors besides infection type and onset of symptoms, such as condition of the implant and soft tissue; health condition of the patient; and also the preferred treatment by the head surgeon, hospital facilities, and patient preferences.[2] Superficial infections do not have a big impact on quality of life and are simply treated with inexpensive oral antibiotics. Deep/organ infections on the other hand can have catastrophic consequences for the patient and typically require revision surgery or in very severe cases permanent removal of the prosthesis. Consequently, SSIs are associated with a substantial economic burden for health services, increased mortality, and reduced functional outcomes in patients.[3-8]

Health care facilities face pressures of providing best care at the lowest cost. Numerous strategies exist to prevent SSI, but there is no gold standard, and clinical practice varies widely. Systemic antibiotic prophylaxis is already part of standard praxis in primary THA in Australia, yet other measures such as the use of antibiotic-impregnated cement and ultraclean air systems are not well established and are controversial. Systematic reviews of some of these measures have assessed the effectiveness of individual strategies, but it is unclear which strategies or combination of strategies is not only the most effective but furthermore is cost-effective.[9-21]

To use scarce resources efficiently, it is important to establish a cost-effective approach to preventing deep SSI in total hip

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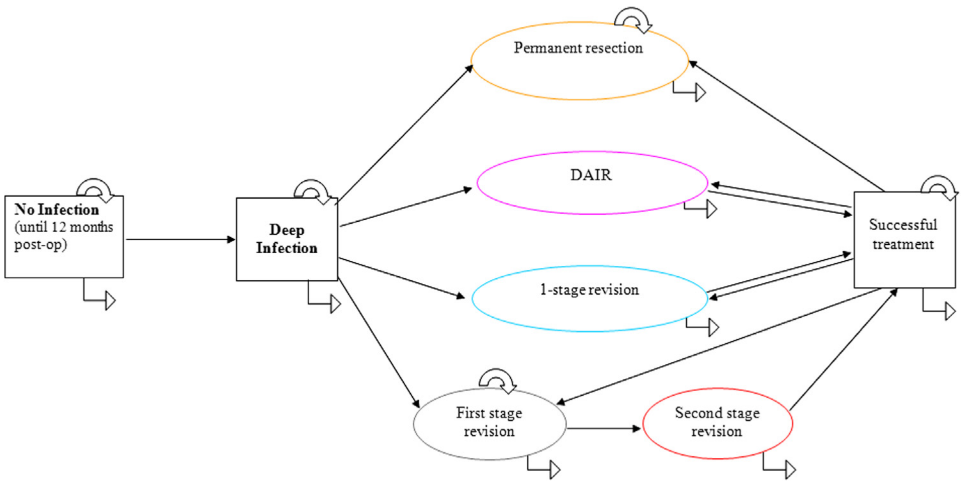

Fig 1. Economic decision model illustrating possible transitions between health states. = Probability of remaining in health state. = Mortality associated with health state. = Probability of transitioning between health states.

arthroplasty. By preventing these infections, not only costs but also unnecessary patient suffering can be reduced. The aim of this project was to evaluate the cost-effectiveness of strategies claiming to decrease the risk of deep SSI following THA in Australia.

METHODS

There are several steps preceding the actual cost-effectiveness analysis: choosing infection prevention strategies for evaluation (comparators), designing the decision model, and identifying parameters to inform model health states. The cost-effectiveness analysis consists of a baseline analysis using point estimates of parameter values, followed by analysis considering uncertainty surrounding model parameters, as well as scenario analyses.

Comparators

For the cost-effectiveness evaluation, potential prevention measures were established based on the review of clinical guidelines[22-25] and through structured interviews with local orthopedic surgeons, infection control professionals, and infectious diseases physicians. Strategies were rated for importance in SSI prevention post-THA in an online survey by N = 19 experts from the same discipline areas. Selected strategies were recommended by at least one of the guidelines and classed as highly important by the majority of experts.[26]

The baseline comparator is the routine use of preoperative antibiotic prophylaxis (AP). The 3 alternatives evaluated in the decision model are as follows: no use of antibiotic prophylaxis (No AP), additional use of antibiotic-impregnated cement (AP + ABC), and additional use of laminar air operating rooms (AP + LOR). The latter refer to operating rooms with high-efficiency particulate air (HEPA)-filtered laminar airflow ventilation using (vertical) laminar airflow supply air diffusers, as opposed to conventional operating rooms with HEPA-filtered air with turbulent ventilation.[27]

Decision model

Decision models are a valuable tool for simplifying complex processes, in particular when clinical data are vague, to simulate long-term outcomes with existing data, to synthesize evidence, and to compare intervention alternatives.[28] They show how a hypothetical cohort of patients moves through defined health states relevant to a decision problem.

A Markov state-transition model was developed for the Australian context (see Fig 1) and subsequently validated by orthopedic surgeons and infectious disease specialists at a steering group meeting. The model was designed to capture key events related to deep SSI occurring within the first 12 months following primary THA (details on model development and assumptions are available from the authors on request). In each model cycle, patients can move between health states (Fig 1, as indicated by arrows). Each health state is associated with certain health outcomes (mortality/morbidity) and costs.

Initially, all patients are assumed to be in the "no infection" health state. Patients diagnosed with deep infection within 12 months move to the "deep infection" health state in the relevant model cycle. Treatment options include "debridement, antibiotics, and implant retention" (DAIR), "1-stage revision" (exchange of prosthesis in one operation), and 2-stage revision. The latter is divided into "first-stage revision" in which the prosthesis is removed, and, once the infection is under control, a "second-stage revision" in which the new prosthesis is inserted. A less common treatment option is "permanent resection," which describes permanent removal of the prosthesis, used for severe cases. After the initial treatment for infection, patients move to the "successful treatment" state where they remain unless further treatment is required because of recurring or persisting symptoms of infection. In this case, patients can undergo any of the 4 treatment options multiple times until the treatment is successful or until they are absorbed by death or permanent resection.

Model parameters

All parameters used to inform the decision model are detailed in Table 1. These were clinical effect sizes of infection prevention measures, health, and cost outcomes associated with each health state as well as probabilities of transitioning between health states.

Health outcomes were measured as quality-adjusted life years (QALYs), incorporating both morbidity (quality of life) and mortality (length of life). QALYs are expressed by utility values ranging from 0 (death) to 1 (perfect health). Mortality because of revision surgery and underlying mortality were based on Australian data.[29,30] The best available evidence for utility, mortality because of deep infection, and clinical effect size parameters were harvested from the medical literature using reproducible methods (details available from authors on request).