Guest editorial

Prosthetic joint infections – a need for health economy studies

The incidence of prosthetic joint infection (PJI) after primary hip and knee joint replacement surgery in the Scandinavian countries has declined since the 1970s, from approximately 10% to about 1% today (Lidgren 2001). There has, however, been a slight increase in all the Scandinavian countries during the last few years (Dale et al. 2012), and today PJI is still a common reason for early revision after a primary joint replacement. There is great variation in adherence to well-proven preventive measures, and even more in how PJIs are managed. Prosthetic joint infections cause great suffering in those affected, and they have a real impact on the economy of our healthcare systems.

A crucial point in health economic evaluations is to analyze how medical interventions can create maximum benefit and output with a limited budget. Cost-effectiveness is a central concept in health economics. In the cost-effective use of limited resources, a reasonable relationship between costs and health gains is desirable. This means that with different choices between medical interventions, the alternative that requires the least resources related to defined goals will be chosen—or a more expensive alternative with a better outcome might be chosen if the costs for the alternative with the best outcome are affordable. In some situations the decisions are rather simple, e.g. when the costs of two equally good treatments can be compared. In other cases, the decision making is more complicated and then formal health economic analyses are required. During the past two decades, the methods of health economic evaluations have undergone extensive development and become more uniform.

There are three main types of health economic analyses (Table). Cost analysis (cost-of-illness studies) is the simplest way to make an economic evaluation. Only costs are involved in comparisons of different treatments, and no outcome measures are required because they are considered to be equally good. In these analyses, however, the work of identifying the dominant cost items is crucial.

In the cost-effectiveness analysis, both costs and effects are used. Often the effects are measured in terms of physical units such as rate of revision due to infection, rate of patients going-back to work, or more disease-specific measures such as rate of postoperative complications or deep infection. Because disease-specific measures are often used in the cost-effectiveness analysis, this kind of evaluation is suitable for interventions with a small number of outcome measures and comparisons are performed on the same kinds of disease.

The outstanding and most frequently used method is a cost-effectiveness analysis where the outcomes for the treatment alternatives being compared are measured in QALYs (quality-adjusted life years) and the cost-effectiveness is expressed in dollars per quality-adjusted life year gained. In many coun-

Types of health economic studies

Example	Medical intervention	Costs	Outcome
Cost Analysis			
Bengtson et al. 1989	No infection vs PJI	Hospital costs	Costs of systemic antibiotics in knee replacement
Cost-Effectiveness Analysis			
Persson et al. 1999	Combinations of prophylaxis against infection in THR	Costs of THR, infection, revision, antibiotics	Relation between cost of revision and rate of revision
Cummings et al. 2009	Antibiotic impregnated bone cement (ABC) vs no ABC	Costs of THR (literature studies)	Revision rate Mortality rate Costs per QALY
Merollini et al. 2013	No antibiotics vs antibiotic prophylaxis vs antibiotic impregnated cement vs laminar air operating room	Costs of prevention of infection and treatment of infection	Costs per QALY gained
Cost-Benefit Analysis			
No studies found		Monetary units	Monetary units

DOI 10.3109/17453674.2014.913227

tries, there are special guidelines created by the authorities on how to perform adequate health economic evaluations. In Sweden, such guidelines have been created by the Swedish Council on Health Technology Assessment (SBU 2013).

In the cost benefit analysis, not only the costs but also the outcomes are measured in monetary units. This kind of evaluation is rare because of the difficulties in transposing physical units and outcomes into monetary units. The method allows direct comparisons of costs and benefits, which is an advantage.

Since the early 1980s, the discipline of health economics has developed and nowadays advanced sophisticated simulation models are frequently used. Cost-of-illness studies prevailed during the 1980s and cost-effectiveness studies have become more common, especially since the beginning of the 1990s. Modeling and the use of Markov decision models in cost-utility analyses have been more frequent during the last decade, and the cost-effectiveness in these studies has often been expressed as the cost per QALY gained.

An advantage of modeling is the possibility of obtaining quick results regarding which methods are most cost-effective. Data put into the models often come from different sources, which is a drawback and a limitation. Sensitivity analysis is therefore often performed and used to evaluate how the outcome of a model might change when costs and benefits are varied over a range of plausible values.

Health economic thinking has increased economic awareness, and is becoming an important factor when making decisions in a financially choked healthcare organization. Economic thinking permeates people's actions at different organizational levels. Healthcare organizations have a hierarchical structure, which may create conflicts between the goals for cost-effectiveness set up at different levels. Positive effects in one public sector may create higher costs in another sector, e.g. a particular surgical procedure may give a better outcome but may be more expensive. At the same time, the expensive technique may result in shorter sick leave and therefore be cost-effective from the point of view of society as a whole. The medical literature contains a limited number of adequate economic evaluations related to treatment and prevention of PJI. Although the economic evaluations of preventive methods in this field are few, they represent a range of different types of methods (see Table).

The results from studies may differ depending on differences in costs, outcomes, type of study, and medical interventions in preventing deep infections after joint replacement surgery.

Such differences are observed even in well-performed studies. Hence, the findings of Merollini et al. (2013) can be compared with the results from the study by Cummins et al. (2009). The cost-effectiveness of antibiotic cement in the study by Cummins et al. led to an incremental cost-effectiveness ratio of US $37,355/QALY gained. When testing different scenarios, the cost-effectiveness of this technology was highly dependent on costs of cement and baseline patient age; its use was only recommended for a relatively young patient cohort (< 71 years) and low costs of cement (< US $650). In comparison, the results from Merollini et al. (2013) showed a better value for money when antibiotic cement was used (AU $3,909 saved/QALY gained). One important difference between the two studies was the lower additional cost of cement employed in the analysis by Merollini et al. (AU $90 vs. US $600).

Even more importantly, the main outcome variable in the study by Cummings et al. was revision due to deep infection whereas in the study by Merollini et al. it was surgical site infection (SSI). This explains the higher initial infection rate reported by Merollini, and makes comparisons between the studies complicated.

Cost analysis dominates the studies that have been published on economic evaluations related to prosthetic joint infections. A few cost-effectiveness studies can be found, and only a couple of complete health economic studies have reported health utilities as outcome in their cost-effectiveness analyses. Data used in the studies are often derived from different sources, and it is not possible to make any generalizations.

It is difficult to obtain adequate information from the studies to make decisions concerning cost-effectiveness in the prevention and treatment of PJI. Comprehensive cost data is lacking and can be improved. Outcomes should be expressed in both quality of life and in relevant functional measures for this kind of health state. Homogenous data related to the same patient population and organizational settings with relevant follow-up periods are needed.

An increase in the rate of revision due to infection has been experienced during the last 10 years in the Scandinavian countries. Rapid economic evaluations such as simulations and decision models may be used in order to give rapid feedback to clinical decision-makers. However, no model can depict the numerous possibilities in clinical practice. Large series of patients are required from homogeneous geographical settings. A clear and commonly used definition of deep infection is needed (International Consensus Group on Prosthetic Joint Infection 2013).

There is a need for better design in future limited longitudinal prospective studies in this field. This should be supported by use of larger cohorts derived from the well-kept knee and hip registries, where patient-specific information including outcome measures is registered—as well as revision rates.

Lars Borgquist[1], Annette W-Dahl[2], Håvard Dale[3], Lars Lidgren[2], and Anna Stefánsdóttir[2]
[1]*Department of Medical and Health Sciences, Faculty of Health Sciences, Linköping University, Sweden,*
[2]*Department of Orthopaedics, Clinical Sciences Lund, Lund University, Sweden,*
[3]*Department of Orthopaedic Surgery, Haukeland University Hospital, Bergen, Norway.*

Bengtson S, Borgquist L, Lidgren L. Cost analysis of prophylaxis with antibiotics to prevent infected knee arthroplasty. BMJ 1989; 299 (6701): 719-20.

Cummins J S, Tomek I M, Kantor S R, Furnes O, Engesaeter L B, Finlayson S R. Cost-effectiveness of antibiotic-impregnated bone cement used in primary total hip arthroplasty. J Bone Joint Surg (Am) 2009; 91 (3): 634-41.

Dale H, Fenstad A M, Hallan G, Havelin L I, Furnes O, Overgaard S, Pedersen A B, Kärrholm J, Garellick G, Pulkkinen P, Eskelinen A, Makela K, Engesaeter L B. Increasing risk of prosthetic joint infection after total hip arthroplasty. Acta Orthop 2012; 83 (5): 449-58.

International Consensus Group on Prosthetic Joint Infection, 2013. http://www.msis-na.org/international-consensus/

Lidgren L. Joint prosthetic infections: a success story. Acta Orthop Scand 2001; 72 (6): 553-6.

Merollini K M, Crawford R W, Whitehouse S L, Graves N. Surgical site infection prevention following total hip arthroplasty in Australia: A cost-effectiveness analysis. Am J Infect Control 2013; 41 (9): 803-9.

Persson U, Persson M, Malchau H. The economics of preventing revisions in total hip replacement. Acta Orthop Scand 1999; 70 (2): 163-9.

SBU. Utvärdering av metoder i hälso- och sjukvården: En handbok. Version 2013-05-16 Stockholm: Statens Beredning för Medicinsk Utvärdering (SBU). www.sbu.se/metodbok