



Cost-Benefit Analysis of a Simulated Institution-Based Preoperative Smoking Cessation Intervention in Patients Undergoing Total Hip and Knee Arthroplasties in France*

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Background: The literature on preoperative smoking cessation indicates that smoking patients are more likely to have postoperative complications. However, the economic implications of such complications are unclear. In particular, the balance between the cost of a preoperative intervention for smoking cessation (PISC) and the benefit resulting from the potential decrease in hospitalization costs is not known.

Methods: Only one previous study, a randomized trial involving smokers scheduled for hip or knee replacement surgery, provides sufficient data to simulate the hospital course of patients subjected or not subjected to a PISC. We used a multistate Markov-type model and official French hospital costs for 2008 to simulate this situation. The cost-benefit analysis adopted the payer's perspective.

Results: The mean benefit, corresponding to the decrease in the cost of the hospital stay for a reference case patient having followed a PISC, was estimated at €313, with a corresponding mean cost of the PISC estimated at €196. Therefore, the PISC was associated with a cost saving of €117 per patient. The results were most sensitive to the cost of ICU care as a proxy for cost of smoking-related complications, and to the relative risk of complication between patients with and without a PISC.

Conclusion: Under the conditions simulated by this cost-benefit model, potential modest cost savings may accrue with implementation of an institution-based smoking cessation program through reduced total hospitalization costs that exceed the cost of the intervention.

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Key words: arthroplasty, replacement, hip; arthroplasty, replacement, knee; costs and cost analysis; smoking cessation; perioperative care

Abbreviations: BPISC = short-term benefit of PISC; CPISC = mean cost of PISC per patient; LOS = length of stay; ORTHO = Orthopaedic Department; OTHER = other medical or surgical wards; PISC = preoperative intervention for smoking cessation

Approximately eight million persons are anesthetized in France each year, of whom approximately two million are smokers.^{1,2} Most relevant

reports³⁻⁶ suggest that smokers are more likely than nonsmokers to have postoperative complications, and this has led to growing interest in preoperative cessation programs.

Surprisingly, although the economics of smoking cessation in the general population and in patients

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with respiratory diseases are widely documented,^{7–10} studies^{4,5,11} of smoking cessation prior to hospitalization never take economic issues into account. A particular issue concerns patients with scheduled surgeries. Considering such patients, it is not known whether the cost of a preoperative intervention for smoking cessation (PISC) is offset by lower hospitalization costs that may result from consequence of a lower rate of complications. We therefore conducted a medicoeconomic study in which we estimated the cost of a PISC and its impact on hospitalization costs.

MATERIALS AND METHODS

Smoking patients subjected to the PISC are referred to as patients from the intervention group, and smoking patients not subjected to such an intervention are referred to as patients from the control group.

Statement of Objective, Perspective, and Time Horizon

The type of medicoeconomic analysis^{12–14} of our study is a cost-benefit analysis conducted from the institutional payer's perspective, and it focuses on the potential short-term cost benefit for a given health-care institution investing in a PISC. Let $CPISC$ denote the mean cost of the PISC per patient, and $BPISC$, the potential short-term benefit of the PISC considered as the mean cost of the hospital stay per patient in the control group and mean cost of the hospital stay per patient in the intervention group. We estimated the balance between the cost $CPISC$ and the benefit $BPISC$. The question posed may be summarized thus: assuming that the French Social Security would be willing to recommend and pay for a PISC for smokers scheduled for surgery, what would be the balance between the cost of the PISC and the resulting potential change in the cost of the hospital stay, also paid for by Social Security?

Search for Primary Studies

We sought original articles on preoperative smoking cessation in three systematic review articles,^{4,5,11} including two from the evidenced-based medicine Cochrane Database.^{4,11} Only one study³ gave details of a PISC and in-hospital courses. This randomized trial³ involved 120 smokers scheduled for elective hip or knee replacement 6 to 8 weeks later, of whom 60 smokers followed a PISC. The intervention was significantly associated with smoking cessation (as 64% patients stopped smoking, compared to only 7.7% in the control group); median length of stay (LOS) in the Orthopaedic Department (ORTHO) was 11 days and 13 days, respectively (no significant difference), and the sum of the number of days spent in intensive care was 2 days and 32 days, respectively. The smoking status of patients who had required intensive care was not mentioned. We also looked at all articles that cited this randomized trial,³ using the Web of Science databases (Thomson Reuters, New York, NY), but no supplementary data were found.

Patient Simulation

We based the cost-benefit study on a multistate Markov-type model (Fig 1). Using TreeAge Pro Suite software (TreeAge Software; Williamstown, MA), we simulated the hospital course of one million patients. In our study, average figures may be

derived from theoretical cohorts, but in order to guarantee the absence of any unexpected border effect, the current standard in medicoeconomic approaches is to perform Monte Carlo simulations, as we did. The simulation of a given patient's hospital stay can be viewed as a four-step process (Fig 1); the underlying process is detailed in Appendix 1. All parameter values were fixed according to the values reported by Møller et al.³

The hospital course of each patient was expressed as the sum of the ORTHO LOS (in days), ICU LOS, and LOS in any other medical or surgical wards (OTHER). These three stays that composed the hospital course were then translated in terms of costs to determine the cost of the hospital stay.

Costs

All costs and benefits were based on direct costs, estimated and expressed in 2008 euros. The PISC was considered to begin 6 to 8 weeks before the scheduled date of surgery. This corresponded to a short-term horizon, and the cost-benefit analysis did not therefore include a discounting correction.

Cost of Hospital Stay

The cost of the hospital stay was calculated by applying the official rates used in January 2008 in French hospitals: (1) The sum of ORTHO stay and OTHER stay was translated in terms of cost by applying the official price corresponding to the diagnosis-related group "hip replacement without comorbidities": a fixed value of €5,978.62 for any stay ranging from 5 to 31 days, with an additional cost of €354.78 per supplementary day for stays > 31 days; (2) we applied a daily cost of €628.87 for ICU stay, corresponding to the average of the daily rates applied for ICU patients (€838.16/d) and for patients in high-dependency units (€419.58/d).

Cost of the PISC

The type of PISC considered had to be similar to that described by Møller et al³ because this article was the source of the patient outcome data. Accordingly, we considered that the cost of the PISC included two components, both completely free of charge for the patient. First, the costs of management by a specialized nurse (initial interview and brief weekly contacts) and of tests (Fagerström test, evaluation of smoking status through carbon monoxide measurement in expired air) were estimated at €120. Second, the cost of nicotine replacement therapy for 6 weeks was estimated through a personal survey on January 29, 2008, of 30 pharmacies located in five areas of Paris (northwest, northeast, center, southwest, southeast): the price of nicotine patches ranged from €53.80 to €98 (median, €77.35) and was normally distributed, with a mean and SD of €76.16 and €10.00, respectively. The total cost of the PISC, $CPISC$, was therefore estimated at €120 + 76.16, approximately €196 per patient.

Reference Case Analysis and Sensitivity Analysis

The parameter values used in the simulations of the reference case are all listed in Table 1. We performed a sensitivity analysis that explored various situations around a reference case (Table 2). We studied the impact of identical distributions of ORTHO LOS in the intervention and control groups (scenario A), and considered patients from other diagnosis-related groups (hip replacement with associated comorbidities, and knee replacement, scenarios G and H, respectively). We allowed the daily rate for intensive care to vary from €419.58 (scenario I) to €838.16 (scenario J). We studied the impact of a global decrease in the consequences of complications, allowing the parameter value of the Poisson distribu-

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