Cost-Effectiveness of Accelerated Perioperative Care and Rehabilitation After Total Hip and Knee Arthroplasty

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Background: Accelerated perioperative rehabilitation protocols following total hip and knee arthroplasties are currently being implemented worldwide, but the cost-effectiveness of these protocols from a societal perspective is not known. We compared the cost-effectiveness of an accelerated perioperative care and rehabilitation protocol with that of a more standard protocol for patients treated with total hip and knee arthroplasty.

Methods: A cost-effectiveness study was undertaken as a study piggybacked on a randomized clinical trial comparing early outcomes of an accelerated and intensive postoperative rehabilitation regimen with those of a more standard rehabilitation protocol. We assessed eighty-seven patients (forty-two who received the standard protocol and forty-five who received the accelerated protocol) for a total of twelve months. Costs from the time of the patient's visit immediately before the operation to one year postoperatively were calculated with use of activity-based costing analysis. Postoperative quality-adjusted life-years (QALYs) were calculated from validated patient diaries and questionnaires at fifteen time points. The primary objective was to determine whether one intervention was dominant over the other during a twelve-month period or, if neither was dominant, to determine the incremental cost-effectiveness ratio.

Results: The result of the randomized clinical trial showed the accelerated intervention to be effective, with a reduction in the length of the hospital stay and a gain in health-related quality of life at the three-month follow-up time point. The cost-effectiveness study showed the accelerated protocol to be significantly less expensive than the standard protocol ($p = 0.036$), with an average reduction in cost of 18,880 Danish kroner (95% confidence interval, 1899 to 38,152) (approximately US $4000). Patients treated with the accelerated protocol following hip arthroplasty had an additional average gain of 0.08 QALY (95% confidence interval, 0.02 to 0.15) compared with the patients who received the standard protocol ($p = 0.006$); this led to a 98% dominance of the accelerated protocol over the standard protocol. No significant or clinically relevant difference in the numbers of QALYs associated with the two protocols was observed for the patients treated with knee arthroplasty.

Conclusions: An accelerated perioperative care and rehabilitation protocol can be both cost-saving and clinically more effective after total hip arthroplasty, whereas it can be cost-saving with no observed significant difference in effect, from a societal perspective, after knee arthroplasty.

Level of Evidence: Economic and decision analysis Level I. See Instructions to Authors for a complete description of levels of evidence.

In Denmark, 12,000 total hip and knee arthroplasties are performed each year[1]. The total hospital costs for those procedures were approximately 700 million Danish kroner (DKK) (110 million U.S. dollars) in 2005[2]. New protocols designed to optimize perioperative care and rehabilitation have been given several different names, such as "accelerated in-

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tervention" or "clinical pathway." An accelerated intervention is defined as a multimodal intervention taking place in a multidisciplinary or interdisciplinary organization in order to shorten the time to recovery[3-7]. In contrast, clinical pathways have been implemented in the United States in an effort to reduce the length of the hospital stay and thereby control hospital costs, with less focus placed on consequences for patients and society[8].

While clinical pathways for hip and knee replacement have been shown to reduce the length of the hospital stay and costs[9], their major impact is from a hospital perspective. However, to establish the cost-effectiveness of these interventions, they should be assessed from a societal perspective[10]. The efficacy of accelerated perioperative care and interventions has recently been established[11], but to our knowledge there is no evidence regarding their cost-effectiveness. We therefore investigated, from a societal perspective, the cost-effectiveness of an accelerated perioperative care and rehabilitation intervention, compared with a more standard protocol, following total hip and knee arthroplasty.

Materials and Methods

A cost-utility study was piggybacked on a randomized clinical trial performed at the Orthopedic Clinic in the Regional Hospital Holstebro, Denmark, from August 2005 to February 2007[11]. The randomized clinical trial was performed to study the effect of accelerated intervention, defined as specialized proactive care and early intensive mobilization and exercise, compared with that of a regimen that was less personalized and less intensive. The randomized clinical trial included eighty-seven patients treated with total hip arthroplasty or with unicompartmental or total knee arthroplasty. The outcome measures of the randomized clinical trial were the length of the stay in the hospital, gain in health-related quality of life from baseline to three months postoperatively, and adverse effects within the first three months postoperatively. The main results of that study were a reduction in the mean length of the hospital stay from eight days (95% confidence interval, 7.1 to 8.4) in the standard-protocol group to five days (95% confidence interval, 4.2 to 5.6) in the accelerated-protocol group ($p < 0.001$). This was accompanied by a larger gain in the health-related quality of life of 0.08 (95% confidence interval, 0.004 to 0.16) in the accelerated-protocol group ($p = 0.03$). No significant or clinically relevant differences in adverse effects were observed.

In the current cost-effectiveness study, we followed all eighty-seven patients for an additional nine months and focused on both costs and cost-effectiveness in the first year postoperatively. The procedures followed in this study were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. The study protocol was approved by the Medical Ethics Committee of Ringkoebing and Southern Jutland Counties, and The Danish Data Protection Agency.

Patients

All patients who were scheduled to undergo elective primar total hip arthroplasty, total knee arthroplasty, or unicom partmental knee arthroplasty at our center were consecutivel invited to participate in the study. All patients meeting th inclusion criteria were provided written and oral informatio about the study at the initial visit, and interested patients gav written consent. The inclusion criteria were a planned electiv primary total hip arthroplasty, total knee arthroplasty, o unicompartmental knee arthroplasty. Exclusion criteria wer neurological impairment to a degree that the patient could no understand the instructions for participation and a lack o written consent prior to hospitalization.

We determined that a cost saving resulting from a two day reduction in the length of the hospital stay would b clinically relevant. We performed a power analysis and deter mined the need for at least forty patients in each group witl alpha set at 0.05 and beta set at 0.80. Altogether, 117 patient were eligible for the study (Fig. 1). Twenty-three patients re fused to participate, and those twenty-three patients had ar average age (and standard deviation) of 67 ± 10.4 years, a female-to-male ratio of 14:9, and a total hip arthroplasty-to-total knee arthroplasty ratio of 10:13. An additional fou patients did not meet the inclusion criteria. This left ninet patients for randomization. Forty-five patients were allocate to each group. Three patients in the standard-protocol grou (two scheduled to be treated with total hip arthroplasty and one scheduled to be treated with knee arthroplasty) were ex cluded after randomization. One patient was excluded becaus the surgery was cancelled as a result of an infection, and two were excluded because they wanted the surgery to be per formed outside of the inclusion period. This left eighty-seven patients to receive the allocated intervention. The patients were randomized to either a standard-intervention group or a new accelerated-intervention group by a secretary who was not otherwise involved in the study and who drew an opaque envelope from a box. After randomization, the patients filled in a baseline questionnaire to establish their preoperative health-related quality of life. Other data on patient characteristics were drawn from hospital registers. The patient characteristics of both groups are presented as an electronic appendix.

Protocol: Both Groups

The patients in both groups were treated with identical surgical and anesthetic procedures according to Danish guidelines, one of which is the use of cemented implants for total hip arthroplasties performed in patients over sixty-five years of age[12,13]. Five experienced surgeons performed all of the operations. Three surgeons performed total hip and total knee arthroplasties at a ratio of 2:1, the fourth surgeon performed only total hip arthroplasties, and the fifth surgeon performed total knee and total hip arthroplasties at a ratio of 9:1. The surgeons were equally represented in both intervention groups. Medications for pain relief were identical in the two groups and consisted of OxyContin or OxyNorm (oxycodone) and paracetamol; Zofran (ondansetron) was used for

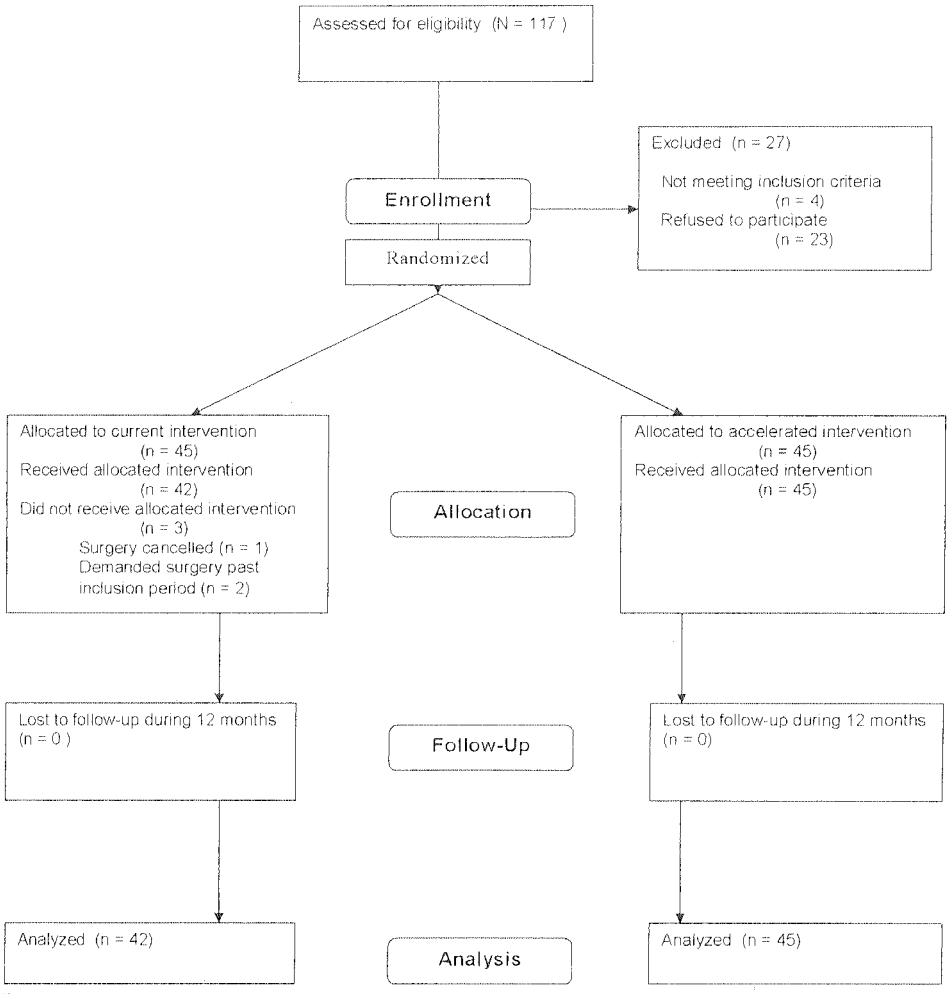

Fig. 1

Flow chart of patients in the two intervention arms.

nausea reduction, and magnesia tablets were given for bowel regulation.

The standard and accelerated protocols are summarized in Table I. A detailed description of the accelerated protocol has been published previously[14].

Discharge

All patients were discharged to home. The discharge criteria were the same for both groups: absence of any signs of wound problems; the patient's willingness to be discharged; satisfactory pain control; awareness of procedures for safely discontinuing the use of medication; knowledge of restrictions; the ability to walk safely with or without walking aids, to walk up and down stairs, and to perform home exercises; knowing how to increase home exercises; the ability to perform personal care; and, in the group treated with knee arthroplasty, achievement of at least 90° of knee flexion. Surgeons who were not otherwise involved in the study determined, in agreement with the patients, when the discharge criteria were fulfilled; no patient asked to postpone discharge after having fulfilled the other discharge criteria.

Attempts to Reduce Bias in the Study

The standard-protocol patient group and health-care staff were separated from the accelerated-protocol patient group and health-care staff during the study period, and the health-care staffs were not allowed to discuss the interventions with each other. Two newly employed therapists, a physiotherapist and an occupational therapist, blinded to the standard protocol were mainly responsible for the rehabilitation in the accelerated-protocol group. Health-care personnel carrying out the standard protocol were not aware of the procedures in the accelerated-protocol group. Because the length of the hospital stay was related to both the intervention and the outcome, surgeons who were not otherwise involved in the study decided when the discharge criteria were fulfilled. We used validated questionnaires[15], diaries[16], and registers[17] for all data collection.

Economic Evaluation

The analysis was based on a societal perspective, and the time frame was fixed to one year per patient. The analysis was a marginal analysis (investigating only areas that were different). The cost-effectiveness of the accelerated intervention was esti-