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ORIGINAL STUDY

Socioeconomic aspects of total hip arthroplasty
A one-year survey in a Belgian university hospital

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We prospectively analysed hospital stay, discharge policy, hospital cost and postoperative recovery of 102 consecutive total hip arthroplasties performed in a Belgian university hospital during a one-year period starting in October 2001.

Of the independent patients, 87.4% regained independence after 6 weeks and 19.6% used rehabilitation units. Preoperative residence, hip function and mental scores were the best predictors for postoperative independence.

Average hospital stay was 14.4 days and hospital cost 9,500 Euros. Hospitalisation represented over 50% of hospital cost and hip implants between 16.1 and 25.6% depending on prosthesis type. Complications and discharge to a rehabilitation unit increased hospital stay and cost.

Six months after surgery, functional hip scores as well as WOMAC, mental and physical SF-12 scores improved significantly.

Surgical techniques and faster rehabilitation programs, reducing needs for rehabilitation units and allowing earlier return to independence, are probably the best ways to control the cost of total hip arthroplasty in Belgium.

INTRODUCTION

From implant sales figures in the Benelux, the number of total hip arthroplasties (THA) performed in 2001, has been estimated at 40,000/year (1.52 THA/1,000 inhabitants/year) (*10*). In Belgium alone, in 1998, about 16,000 THAs were performed (1.57 THA/1,000 inhabitants/year) (*4*). The total hospital cost for elective THA has been estimated at 152 million Euros/year (*4*). This is mainly financed by the Belgian social security system based on risk adjustment and solidarity (*12, 13*). Belgium has a well-developed compulsory health insurance system covering 98.3% of the population. This system pays for costs related to all aspects of THA (hospitalisation, surgery, anaesthesia, rehabilitation and medication) during hospitalisation and afterwards (*11*). Only a small fee (approximately 10%) is charged directly to patients.

The health insurance reimbursement rate for each type of orthopaedic implant is confined within small margins. The reimbursement of health care

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is mainly based on a retrospective fee-for-service system and allows (up to now) the medical profession to control, to a large extent, indications, implant choices, hospital stay and the discharge policy from the hospital. This medically controlled, fee-for-service system, combined with a high physician/population ratio (34.4 doctors/10,000 inhabitants in 1995) and quality competition between health providers, has led to high quality medicine. Overall the Belgian health care system has been working well, leading to a high degree of patient satisfaction and the absence of a waiting list for THA or other major interventions (*12*).

The purpose of this study is to assess and identify factors influencing the hospital cost, the hospital stay and the hospital discharge policy related to the implantation of THA in a Belgian university hospital.

PATIENTS AND METHODS

Patient population and evaluation protocol

During a one-year period starting October 1, 2001, all patients scheduled for an elective primary THA at the Academic Hospital of the Vrije Universiteit Brussel were registered prospectively. Revisions, acute fracture cases and patients treated with a bipolar hip arthroplasty were excluded.

Before surgery, data were collected regarding the patient's general health status (SF-12 (*14*) and WOMAC score (*2*)), hip function (Harris Hip score (HHS) (*6*) and Merle-d'Aubigné-Postel score (MDPS) (*7*)) and social status (residence and dependence on family or outsiders). The discharge destination, length of hospital stay and factors leading to a prolonged stay (> 16 days) were registered at the time of discharge from the orthopaedic ward. To evaluate in-hospital cost, all hospital invoices were collected and subdivided into ten categories : hospitalisation, surgery, anaesthesia, imaging, laboratory tests, physiotherapy, medication, material (including implants), surveillance and medications and "miscellaneous costs".

Hip function (HHS and MDPS) and social status were re-evaluated six weeks and three months postoperatively. Final evaluation took place between 6 months and one year after surgery and included the patient's general health status (SF-12 and WOMAC score), hip function (HHS and MDPS) and social status.

Statistical analysis was performed with SPSS 11.5.1 (SPSS Inc., Chicago, Illinois, USA). Interval and ratio level data were compared with a one-way analysis of variance (ANOVA) if homogeneity of group variance was confirmed by a Levene test. In case of unequal variances or ordinal data, comparisons were made with the nonparametric Kruskal-Wallis-ANOVA or the Wilcoxson rank test. Nominal data were compared with the chi-square test. Factors that could influence the discharge policy were analysed with a discriminant analysis. Factors that could influence hospital stay or hospital cost were analysed with a multiple linear regression.

Implant choices and discharge policy

During the study period three femoral implants were routinely in use : one uncemented stem (Image, Smith & Nephew, Memphis, Tennessee, USA) and two cemented stems (CPT, Zimmer, Warsaw, Indiana, USA and Vectra-III, Biomet, Warsaw, Indiana, USA). On the acetabular side three implants were routinely in use : two uncemented cups (Dacup and Duraloc (Sector or Option), DePuy, Leeds, UK) and one cemented cup (ZCA, Zimmer, Warsaw, Indiana, USA).

Guidelines for the use of primary THA at the Academic Hospital of the Vrije Universiteit Brussel were introduced to rationalise implant choices. These guidelines were adopted by consensus within the orthopaedic department and are reconsidered regularly in the light of new developments. They are found useful for teaching purposes, giving trainees the opportunity to have hands-on experience with different surgical techniques and implant philosophies. During the study period, these guidelines were not altered and were interpreted in the light of the patients' specific requirements and general health.

Active patients with a physiological age below 60 or 65 years were treated with an uncemented Image stem in combination with a Dacup or Duraloc Option cup and an alumina-alumina bearing surface (group I). Less active patients, between 60 and 75 years of age, were generally treated with a cemented CPT stem combined with an uncemented Duraloc Sector or Duraloc Option cup and a standard metal-polyethylene bearing surface (group II). Patients above 75 years of age were treated with a cemented Vectra-III stem, a ZCA cemented cup and a standard metal-polyethylene bearing surface (group III). One 41-year-old lady was treated with a Birmingham Hip Resurfacing (MMT, Birmingham, UK). In another patient a Contour Reinforcement Ring (Smith & Nephew, Memphis, Tennessee, USA) was

Table I. — Hip implants, demographics and preoperative general health and hip function scores

Implant groups	N	Side L/R	Sex M/F	Age in years Mean (min-max, SD)	SF-12 Ph. Med. (IQR)	SF-12 M. Med. (IQR)	Womac Med. (IQR)	HHS Med. (IQR)	MDPS Med. (IQR)
Image/Duraloc-Dacup	18	10/8	9/9	55.2 (27.2-62.9, 7.8)	28.3 (11.1)	50.5 (17.9)	56.0 (23.2)	41.5 (28.8)	8.5 (3.5)
CPT/Duraloc	40	24/16	20/20	69.9 (64.6-75.7, 3.0)	31.2 (14.0)	49.1 (19.7)	59.0 (20.0)	50.0 (30.0)	10.0 (4.0)
Vectra/ZCA	37	10/27	10/27	78.4 (68.0-84.9, 3.9)	34.0 (9.8)	42.8 (19.9)	59.0 (13.0)	36.0 (28.5)	9.0 (3.5)
Other implants	7	3/4	2/5	68.1 (42.3-75.1, 11.6)	25.5 (14.1)	45.8 (24.2)	62.1 (11.5)	56.0 (15.5)	9.0 (2.5)
Total	102	47/55	41/61	70.3 (27.2-84.9, 9.6)	31.7 (11.1)	47.0 (18.9)	59.0 (14.0)	44.0 (31.0)	9.0 (3.0)

Med. : Median, SD : Standard Deviation, IQR : Interquartile Range.

used to reconstruct a post-radiotherapy acetabular insufficiency fracture. These patients and those treated with other miscellaneous implant combinations were allocated to group IV.

The discharge policy was not altered during the survey. A social nurse assessed all patients on admission. In case of doubt about the possibility of return to a preoperative environment after surgery, a standard form was filed for a rehabilitation unit. Discharge from the orthopaedic ward was decided by consensus between the head nurse, the physiotherapist and the surgeon in charge. In general the aim of discharge is the 10th day postoperatively. This is an improvement compared to the period before 2000 when the target date of discharge was on the 14th post-operative day on removal of the sutures.

RESULTS

Demographics and evolution of housing

Between October 1, 2001 and September 30, 2002, 102 elective primary THA's were performed in 101 patients at the Academic Hospital of the Vrije Universiteit Brussel. The patients' demographic and preoperative data in relation to implant groups are shown in table I. Between groups, the sex distribution, preoperative hip scores and preoperative general health scores are not statistically different (p-value of chi-square test for sex : 0.146 ; p-value of Kruskal-Wallis test for HHS : 0.321, MDPS : 0.103, SF-12-Mental : 0.895, SF-12-Physical : 0.213, WOMAC : 0.465). However patients' ages differ significantly between groups (Kruskal-Wallis test : $p < 0.001$), reflecting the department's guidelines for implant choices.

Figures 1 and 2 show the preoperative housing, the hospital discharge policy and evolution of housing up to 6 months after THA for the whole population and for those patients coming from their own home. On admission, 93.14% of patients lived in their own home either with a partner or alone. After THA, 68.63% were able to return home but 19.61% were discharged to a rehabilitation unit or convalescence centre. Of those patients living together with a partner in good general health, 88.52% were discharged directly back home. However, of those patients living alone at home, only 48.27% were discharged directly back home, 30.48% used a rehabilitation unit and 10.34% went to live with family. Of those patients living at home before surgery, 87.37% went home after 6 weeks. This number increased to 94.74% after 6 months. However, none of the seven patients who lived with family or were institutionalised prior to surgery became independent after THA.

Complications

"Major complications" are reported in table II. In this unselected population, 13.7% of patients suffered "major complications" during hospitalisation and 9.8% after discharge from the orthopaedic ward. Early complications include THA dislocation (4.90%) and cardiovascular or respiratory

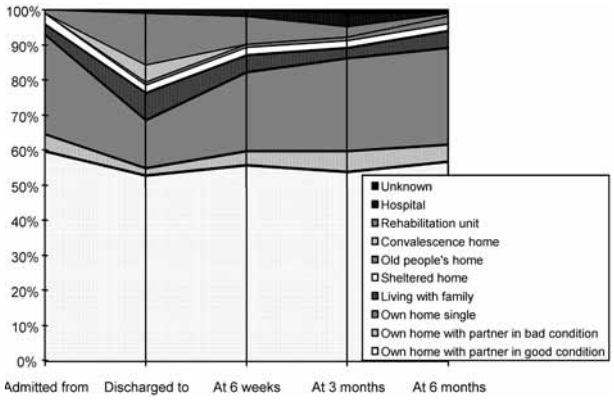

***Fig. 1.* —** Lundadiagram of all patients treated with a THA

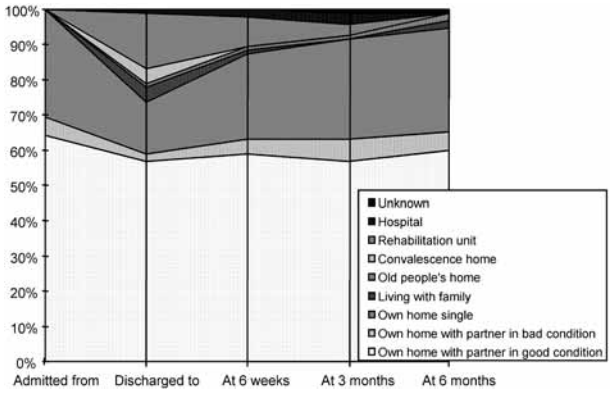

Fig. 2. — Lundadiagram of patients living at home and treated with a THA.

Table II. — "Major complications" during initial hospitalisation on the orthopaedics ward and after discharge (n (% of THA))

All prostheses n = 102	Complications during hospitalisation	Complications after hospitalisation
Hip dislocation	5 (4.90%)	1 (0.98%)
Fracture greater trochanter	1 (0.98%)	3 (2.94%)
Haematoma/superficial infection	2 (1.96%)	0 (0.00%)
Deep venous thrombosis	1 (0.98%)	5 (4.90%)
Pulmonary embolism	1 (0.98%)	3 (2.94%)
Cardiovascular disease	3 (2.94%)	2 (1.96%)
Gastroduodenal bleeding	1 (0.98%)	1 (0.98%)
Urinary calculus	1 (0.98%)	0 (0.00%)
Renal failure	1 (0.98%)	0 (0.00%)
Pneumonia	1 (0.98%)	1 (0.98%)
No complications	88 (86.27%)	92 (90.20%)

problems (4.9%). However, in only 4 cases (3.9%) was a complication identified as a cause of prolonged hospitalisation beyond 16 days. Complications occurring after discharge from the orthopaedic ward include secondary fractures of the greater trochanter (2.9%) and deep venous thrombosis (4.9%). A pulmonary embolism complicated three out of five deep venous thromboses.

Hospital cost and hospital stay

Figure 3 shows the hospital cost of THA for different implant groups. The average total hospital cost for the whole group was 9,495.52 Euros (SD : 2,178.38). Hospitalisation costs represent 53.8%, implants and material 21.3%, surgery 7.7%, anaesthesia 4.1% and laboratory tests 4.0%. Medication, in-hospital physiotherapy, radiology and other costs represent together only 9.1% of the overall hospital cost.

To compare hospital cost of different implants, data were analysed with a one-way ANOVA or a nonparametric Kruskal-Wallis test if a Levene test revealed significant differences in variances. Results were similar for the whole population and also for those patients who did not suffer "major complications". Overall hospital cost did not differ significantly between groups ; however significance was almost reached (p-value for one-way ANOVA : 0.052 for all patients and 0.053 for those without "major complications"). Two cost components differed significantly between implant groups : the cost of implants and material and the

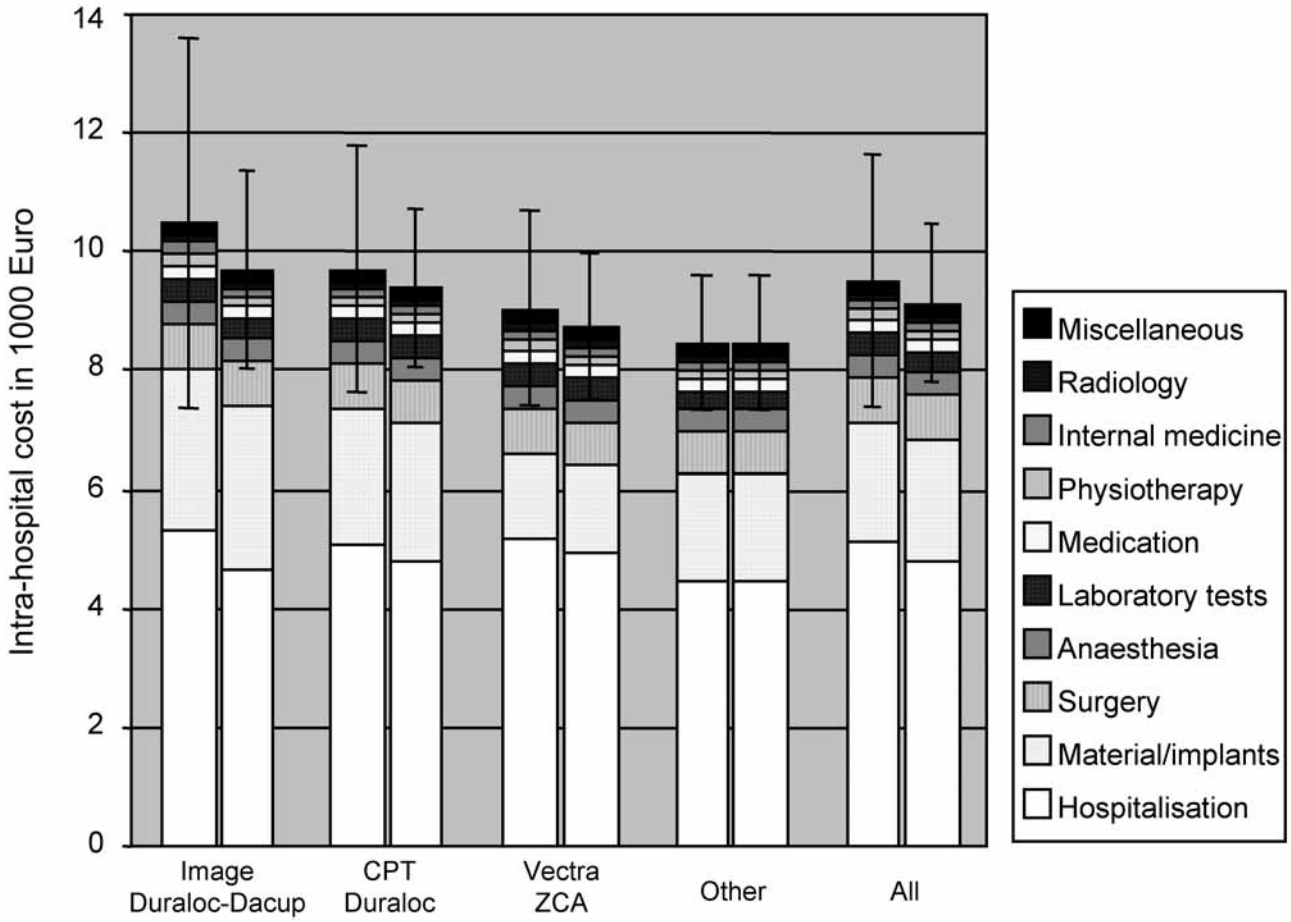

Fig. 3. — Hospital cost of different types of THA in use in this study. Left bar graph : all patients. Right bar graph : patients without major complications.

cost for radiology (p-value of Kruskal-Wallis test : < 0.0001 and 0.038 respectively). The average implants and material cost for an "uncemented THA with alumina-alumina bearing surfaces" (Image-Dacup/Duraloc), was 2,685.71 Euro compared to 1,444.05 Euro for an "all-cemented THA with metal-polyethylene bearing surface" (Vectra-ZCA). In the first group, implants and material represent 25.6% of the total cost compared to 16.1% in the second group.

For the whole population, average hospital stay (including preoperative admission) and hospital cost were respectively 14.4 days (SD : 4.96) and 9,495.52 Euros (SD : 2 178.38). If no "major complications" occurred during hospitalisation (88 cases), hospital stay and cost were respectively 13.6 days (SD : 3.08) and 9,125.20 Euros (SD : 1 399.04). On the other hand, if "major complications" occurred during hospitalisation (14 cases), both hospital stay and costs increased significantly to 19.4 days (SD : 9.82) and 11,823.17 Euros (SD : 4,123.82) (p-value for Kruskal-Wallis test : 0.014 and 0.003 respectively). In the whole population as well as for those patients who did not suffer any "major complication", no significant differences were found in hospital stay between implant groups (p-value for Kruskal-Wallis test : 0.206 and 0.119 respectively).

Table III. — Relation between the discharge destination (postop residence : home alone, home with partner, rehabilitation, other) and possible influencing factors (chi-Square test (Chi^2) or Kruskal-Wallis-ANOVA (K-W)). Discriminant analysis taking into account each influencing factor separately : percent successful predictions from the model.

Possible influencing factors	Postop residence p-values	% of correctly classified cases for discharge to all postop residences	% of correctly classified cases for discharge to a rehabilitation unit
Age in years	0.099 (K-W)	38.2%	6.7%
Preop SF-12 Physical	0.511 (K-W)	16.9%	53.3%
Preop SF-12 Mental	*0.024** (*K-W*)	40.4%	6.7%
Pre-op WOMAC	*0.047** (*K-W*)	33.7%	60.0%
Preop HHS (0-100 points)	*0.044** (*K-W*)	40.4%	60.0%
Preop MDA (3-16 points)	*0.044** (*K-W*)	41.6%	73.3%
Duration of hospital stay	*0.028** (*K-W*)	48.3%	13.3%
Preop residence (home alone, home with partner, rehabilitation, other)	*< 0.001** (Chi^2)	77.5%	0.0%
Preop activity (strenuous, ADL, independent, dependent)	0.133 (Chi^2)	15.7%	0.0%
Aetiology (osteoarthritis, necrosis, rheumatoid arthritis, other)	0.366 (Chi^2)	19.1%	40.0%
Charnley classification (group A, B, C)	0.985 (Chi^2)	14.6%	40.0%
Prosthesis (group I, II, III, IV)	0.129 (Chi^2)	44.9%	0.0%

* level of significance reached ($p < 0.05$).

Factors influencing discharge policy, hospital stay and hospital cost

The items listed in table III were identified as possible influencing factors for the discharge destination after surgery. For each item a chi-square or Kruskal-Wallis test was performed. Significant differences in preoperative mental SF12, WOMAC, HHS and MDP scores as well as in preoperative residence and duration of hospitalisation were found between the discharge groups (home alone, home with partner, rehabilitation unit, other). In 89 instances no data were missing and these cases were subjected to a discriminant analysis containing all factors identified in table III. A model based uniquely on the residence before surgery could predict postoperative destination in 77.5% of cases. The duration of hospitalisation, the prosthesis type, the preoperative hip function (HHS, MDPS) and the mental status (SF-12 mental) could predict the discharge destination in only 40 to 50% of cases. Preoperative functional hip scores (HHS, MDPS) and preoperative general health scores (WOMAC, SF-12 Physical) were the best predictors for the need of a rehabilitation unit after surgery.

A multiple linear regression analysis was performed to identify factors (age, pre-operative hip function (HHS, MDPS), Charnley score, aetiology, general health status (SF-12 Physical, SF-12 Mental, WOMAC), preoperative residence and activity, prosthesis type and occurrence of “major complications” during hospitalisation) that influence hospital stay and hospital cost. For all patients with no missing data (89 cases) the only factor related, with a significant regression coefficient, to a prolonged hospital stay and higher cost was the occurrence of a “major complication” during hospitalisation. This factor can be excluded by considering only patients who did not sustain any severe complications during hospitalisation (80 cases). In this group, the only factor related, with a significant regression coefficient, to the duration of hospitalisation was discharge destination after surgery. In the same group, two factors (the discharge destination and implant type) were related, with a significant regression coefficient, to intra-hospital cost. On average, patients being discharged to a rehabilitation unit remained longer on the orthopaedics ward and were more costly (mean : 16.5 days (SD : 4.90) and 10,422.23 Euros (SD : 2,610.37)) compared to those being discharged to their home, family or any other place (mean : 13.4 days (SD : 2.35) and 9,056.60 Euros (SD : 950.84)). This difference is significant for the

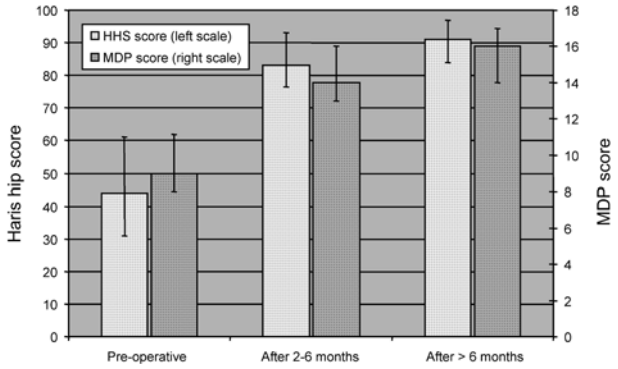

Fig. 4. — Evolution of functional hip scores prior to and after THA (median and inter-quartile range).

duration of hospitalisation but not for hospital cost (Kruskal-Wallis : $p = 0.035$ and $p = 0.132$).

Recovery after THA

Patients were followed for a period six months to one year after THA. Figures 4 and 5 show the evolution of hip function scores (HHS and MDPS) and general health parameters (SF-12 and WOMAC score) over time. A significant improvement of all scores was noted between preoperative and postoperative visits (Wilcoxon ranks test : $p < 0.001$). Both hip function scores also improved significantly during consecutive post-operative visits (Wilcoxon ranks test : $p < 0.001$).

DISCUSSION

This study analyses the hospital cost, the hospital stay, the discharge policy and the postoperative recovery after THA in a Belgian university hospital. In contrast to most other Belgian hospitals, doctors in university hospitals are not paid on a fee-for-service basis but are employees working for a fixed remuneration. The university hospital itself is payed by the National Health insurance system on a fee-for-service basis but the reimbursement rates for hospital costs are slightly higher. These higher reimbursement rates are justified by educational and research duties performed by university hospitals. For these reasons, not all aspects of this study may be applicable to other Belgian institutions.

The patient's profile in this study was similar to that of a typical Belgian THA population (*4*) in which 60% are female, on average 70 years old, living independently in their own homes, either alone or with a partner, and most of them are in

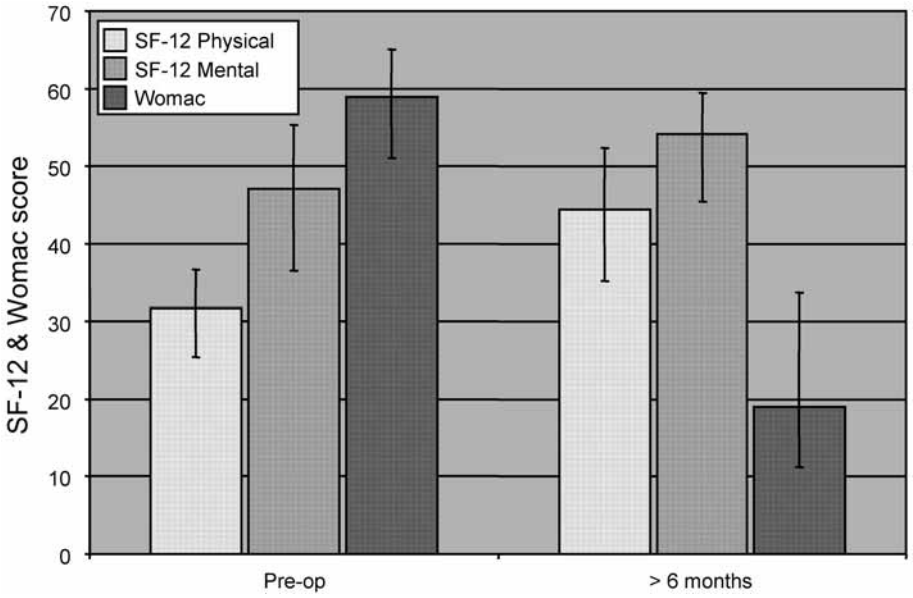

Fig. 5. — Evolution of general health scores prior to and after THA (median and inter-quartile range)

quite good health. This contrasts with a hip fracture population analysed some years earlier in the same hospital (*11*) in which 75% of the population were female, on average 10 years older, 40% living in institutions and less than 10% had no concomitant diseases. This could explain the longer hospital stay (18.7 to 29 days (*1, 11*) versus 14.4 days) and higher needs for rehabilitation facilities in the fracture group. Of those patients living at home prior to surgery, 35.9% were discharged directly back home after a hip fracture (*11*) compared to 73.7% after elective THA. Although most osteosynthesis or arthroplasty implants for fracture treatment are cheaper than those for THA, hospital costs, within the same hospital, were quite similar for both groups (hip fracture treatment : 8 667 Euros in 1995-96 (*1*) compared to 9,496 Euros in 2001-2002 for THA). Similarly, a study performed by a major health insurance contractor in 1998 (*4*), found the treatment of hip fractures with a hip arthroplasty more expensive than elective THA (11,118 versus 8,738 Euros).

The average hospital cost of THA in this study (9,496 Euros) is slightly higher than in other Belgian hospitals (Belgian average 1998 : 8,738 Euros (*4*)). This can be explained by the higher reimbursement rate per hospitalisation day in a university hospital. Despite a shorter average hospital stay compared with the national average (14.4 versus 18 days), the proportional cost of hospitalisation in our study is higher than the national average (53.8% versus 45.1%) (*4*). Average hospital stay and cost of THA in this study are both similar to those in Finland (1998 : 14.2 days, 10,500 US$ = ± 10,500 Euros (*9*)) and in Ireland (2002 : 16.4 days, 6,472 £ = ± 9,350 Euros (*8*)). However, they are both higher than in England (1998 : 12 days, 4,052 £ = ± 5,820 Euros (*3*)). On the other hand, and despite a very aggressive early discharge policy, hospital costs in the US remain in general higher than in Europe (1997 : 7.2 days, 13,352 US$ = ± 13,352 Euros and 4.1 days, 10,153 US$ = ± 10,153 Euros (*5*)).

The difference in implant price is the main cause of hospital cost variation between different types of THA that were used. Because of the implant price regulation system in Belgium, the cheapest THA in this study (all cemented, metal-polyethylene) is about 1,500 Euros or 14.3% cheaper than the most expensive THA (all cementless, ceramic-ceramic). This difference represents only 15.8% of the average cost of a THA and seems justified in young patients if revision surgery can be delayed or facilitated. However, in the elderly, all-cemented THA is likely to outlive the patient and seems most adequate.

Not surprisingly, patients living on their own prior to surgery have the highest need for postoperative rehabilitation units. However, if no major complications occurred, those patients discharged to a rehabilitation unit stayed significantly longer on the orthopaedics ward and were more expensive compared to those discharged elsewhere. A similar finding was observed for hip fracture patients some years ago in the same institution (*11*). This can be attributed to a chronic shortage of rehabilitation units in the Brussels region where volunteer and familial aid are less available. Both hospital stay and cost could be reduced by shortened waiting lists for rehabilitation facilities. This could be achieved not only by increasing the number of rehabilitation units but also by enhancing the collaboration between these units and the orthopaedics department. Improved communication, together with a better awareness of all team members regarding expenses related to prolonged hospitalisation, reduced the goal for hospital discharge from the 14th to the 10th postoperative day since 2000. Further improvement could be achieved through a faster postoperative rehabilitation program. Such a program could lead to an earlier return to independence, reduce the need for rehabilitation units and further decrease hospital stay. This is probably the best way to continue to reduce the cost of THA in our health system. From this point of view “less invasive” surgical techniques in THA might be of some interest as long as similar long-term results could be achieved.

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