Development of a clinical pathway for total knee arthroplasty and the effect on length of stay and in-hospital functional outcome

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The goal of reducing the length of a patient's hospital stay after orthopaedic surgery has recently gained much interest from surgeons and hospital administrators. The influence of hospital stay reduction on qualitative outcome is not always documented. The purpose of this study was to investigate this relationship in more detail. We report our experience with patients undergoing total knee arthroplasty. In 2000, an in-hospital clinical pathway for patients undergoing total knee arthroplasty was instituted at the University Hospitals Pellenberg, Belgium. We evaluated this pathway in 103 patients by using a pre-experimental, interrupted, time-series design. This pathway significantly decreased length of stay by 33% without negatively affecting functional outcomes during hospitalisation. In further research also the long term effects have to be studied.

Keywords : knee ; arthroplasty ; clinical pathway.

INTRODUCTION

Total knee arthroplasty (TKA) is a commonly performed orthopaedic procedure. In 2000, about 9200 total knee replacements were performed in Belgium (*3*). The aims of TKA are to reduce pain and to restore a close to normal knee function. To attain these aims, TKA requires an interdisciplinary team approach. A clinical pathway (defined as a set of methods and tools underlying a multidisciplinary programme of care for a specific patient population) provides the interdisciplinary team with a tangible plan that ensures qualitative and efficient patient care and can help to achieve these aims (*11*).

Kim *et al* studied the recent literature on the effects of clinical pathways on hip and knee arthroplasty, and concluded that clinical pathways effectively reduce costs and length of stay in acute care hospitals without compromising patient outcomes (*6*). Of the 11 studies discussed in this review, nine measured complications : five studies found that pathway implementation did not affect the number of complications, whereas four studies found that pathway implementation reduced the number of complications. Although three of the

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studies reviewed by Kim *et al* compared functional outcome in patients that had undergone knee arthroplasty in the presence or absence of clinical pathways, their findings were inconclusive because these studies used a wide range of measures (6). Moreover, interpretation of their findings was difficult because of substantial methodological limitations, particularly the use of historical controls and failure to account for length of stay in rehabilitation facilities (6). Despite these limitations, Kim *et al* concluded that overall clinical pathways have a positive impact. At odds with this conclusion, however, are the findings of Mauerhan *et al* who reported a significantly higher rate (p = .015) of dislocations after hospital discharge in patients undergoing total hip arthroplasty after introduction of their clinical pathway. Their pathway did decrease the length of stay from 6.6 days to 3.9 days (8).

The aim of the present study was to determine how the implementation of a clinical pathway for TKA affects length of stay and in-hospital functional outcome in a large teaching hospital in Belgium.

PATIENTS AND METHODS

Sample

The study was carried out at the Pellenberg University Hospital, which is part of the University Hospitals Leuven in Belgium, a large system of teaching hospitals with 1850 beds. The more than 400 knee arthroplasty procedures performed annually within the Department of Orthopaedics provided us with a great opportunity to test the efficacy of our clinical pathway for TKA. The clinical pathway project began in September 2000. A total of 103 patients participated in our study ; all gave informed consent to participate. All participants were Dutch-speaking patients who had never undergone a TKA procedure prior to admission to our hospital. Before implementing this pathway, a baseline measurement was performed from October 2000 to December 2000 on one group of patients (n = 26 ; mean age = 69.3 y, SD = 9.43 ; 9 men and 17 women). We did an initial evaluation of the efficacy of the first version of the pathway from September 2001 to October 2001 on a second group of patients (n = 32 ; mean age = 66.8 y, SD = 11.24 ; 11 men and 21 women). After implementation of the second version of the pathway, a second

evaluation was done from January 2003 to March 2003 on a third group of patients (n = 45 ; mean age = 64.5 y, SD = 9.76 ; 9 men and 36 women). Exclusion criteria included revision of the arthroplasty, mental retardation, or severe co-morbidity. We found no statistical differences between the three patient cohorts with regard to sex, age, work situation, training, or marital status.

Implementation of the clinical pathway

The clinical pathway under study in this report was developed, implemented, and evaluated according to the 30-step method developed by the Belgian-Dutch Clinical Pathway Network (www.nkp.be) (1, 11, 12). The project team is lead by the senior orthopaedic knee surgeon and includes the head nurse, the physiotherapist, the social worker, and the clinical pathway facilitator. The development of this pathway took nearly 6 months.
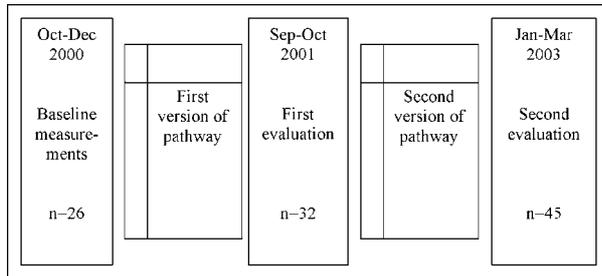
The Clinical Pathway Intervention

The following key interventions and outcomes were defined : (1) preoperative checklist on functional and social status ; (2) prophylactic antibiotics ; (3) knee replacement procedure ; (4) pain medication ; (5) thrombo-embolic prophylaxis ; (6) postoperative lab tests ; (7) postoperative radiographs ; (8) start of physiotherapy on postoperative day 1, including discussion of follow-up exercises ; (9) pain management ; (10) postoperative knee flexion ; (11) patient's ability to walk various distances ; (12) patient's ability to climb/descend stairs ; and (13) wound status.

Two versions of this clinical pathway were used in this study (fig 1). The first version was not integrated into the patients' records, but was used as a checklist to assess the patients during each day of their hospital stay. The second version was developed after evaluating the first version of the clinical pathway. The evaluation included results on functional outcome and practical experiences. The team discovered that the amount of administrative work had doubled ; thus, we attempted to integrate the clinical pathway into the patients' records in a more practical way. We also included new key interventions on pain management.

Design

A pre-experimental, interrupted, time-series design was used (fig 1). Measurements were taken three times : a baseline measurement, a second measurement taken one month after implementation of the pathway, and a

Fig. 1. — The clinical pathway intervention process

Fig. 2. — Kaplan Meier plots showing the day on which patients first walked 60 meters following total knee arthroplasty surgery. Three different groups of patients were assessed : one before implementation of the clinical pathway, one after implementation of the first version, and one after implementation of the second version of the pathway (n = 103).

third measurement taken 15 months after implementation of the pathway. The design is an extension of a one-group pre-test versus post-test design for situations having more than two observations.
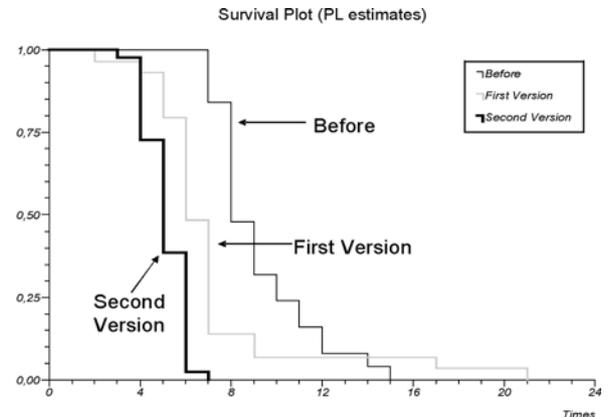
Measurements

To measure the effect of the clinical pathway, six variables were defined : (1) the postoperative day 90° knee flexion was attained, (2) the postoperative day the patient could perform a straight leg raise, (3) the postoperative day the patient could walk 60 meters, (4) the postoperative day the patient could walk 200 meters, (5) the first day the patient was pain free, and (6) length of hospital stay. Pain free was defined as a pain score of less than 3 on the 0-to-10 Visual Analogue Scale, persisting for two consecutive days. The project team members scored these outcomes daily and noted these in the patients' records.

Statistical analysis

Because the data were time dependent, we used a survival analysis. The significance level was set at $p < 0.05$.

RESULTS

As shown in table I, the implementation of the pathway had a significant impact on the postoperative day on which the patient could perform straight leg raises as well as on the first day patients could walk 60 and 200 meters (figs 2 and 3). Implementation of the first version of the pathway did not affect the mean postoperative day on which 90° knee flexion was attained. We noticed, however, that patients experienced a slight increase in pain intensity, but this was not significant. On

average, it took more than 9.8 days before pain intensity levels dipped below the pain score of 3 for two consecutive days. Implementation of the first version of the pathway decreased the length of hospital stay from 15.3 to 12.1 days (fig 4).

Implementation of the second version of the pathway significantly advanced the mean postoperative day 90° knee flexion as well as straight leg raising and walking 60 and 200 meters was reached. The length of stay also decreased significantly. The pain score decreased to levels measured before the implementation of the pathway (table I).

Following implementation of both versions of the pathway, the mobility indicators (i.e., ability to walk 60 and 200 meters) were significantly advanced. After the implementation of the second version, all patients were able to walk 60 meters by postoperative day 7 (fig 2) and 200 meters by postoperative day 10 (fig 3). The length of stay decreased significantly from an average of 15 days before the implementation of the clinical pathway to an average of 10 days after implementation of the second version of the pathway. All of these patients were discharged 15 days after surgery ; 15 days was the average length of stay of patients before the pathway was implemented (fig 4).
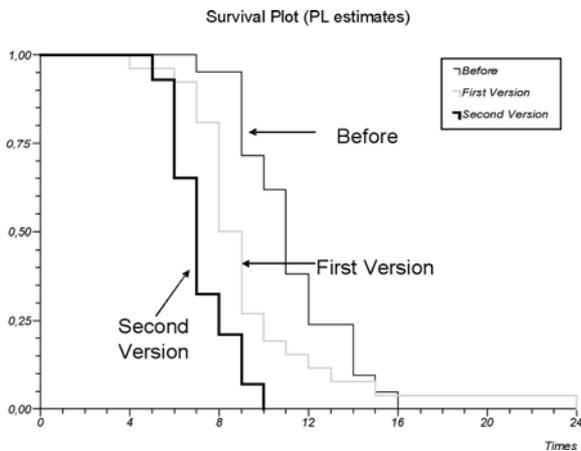
Fig. 3. — Kaplan Meier plots showing the day on which patients first walked 200 meters following total knee arthroplasty surgery (n = 103). All conventions are as in fig 2.
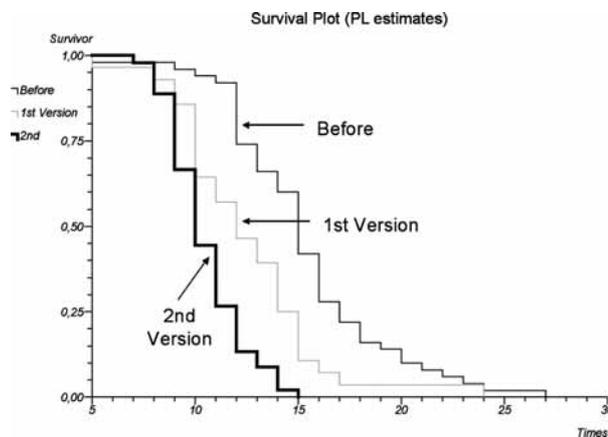
Fig. 4. — Kaplan Meier plots showing the length of hospital stay of patients following total knee arthroplasty surgery (n = 103). All conventions are as in fig 2.

Table I. — Implementation of two versions of a clinical pathway for total knee arthroplasty :
effect on clinical indicators and length of stay

Indicator	Baseline* (n = 26)	First evaluation[†] (n = 32)	Second evaluation[‡] (n = 45)	Log-Rank test
90° Knee flexion	9.5[§]	9.5	8.0	$p < 0.05$
Straight leg raise	6.6	6.2	3.4	$p < 0.05$
60-meter walk	9.2	7.1	5.1	$p < 0.05$
200-meter walk	11.2	9.4	7.2	$p < 0.05$
Pain score < 3 for two days[‖]	7.9	9.8	7.4	$p > 0.05$
Length of stay	15.3	12.1	10.5	$p < 0.05$

*Assessment performed before implementation of pathway ; [†]Assessment performed after implementation of the first version of the pathway ; [‡]Assessment performed after implementation of the second version of the pathway ; §Data represented in terms of Kaplan Meier mean survival days (i.e., postoperative days) ; [‖]Pain measure was based on the 0-to-10 Visual Analogue Scale.

DISCUSSION

The present study involved the development, implementation, and evaluation of two versions of an in-hospital clinical pathway for TKA patients. Implementation of this pathway decreased length of hospital stay by 33%. Although the length of stay decreased in our study, it is still longer than that of knee arthroplasty patients that participated in previous pathway studies, mainly in the U.S.A. (*2, 4-7, 9*). The length of stay of patients subjected to our second pathway is comparable to that of patients treated at 13 other hospitals within the Belgian-Dutch Clinical Pathway Network

(www.nkp.be) (mean length of stay : 13.2 days ; n = 294) (*13*).

Improvement of the in-hospital functional outcomes was the most important result of our study. In hospital mobility indicators improved significantly after the introduction of the pathway. Our findings are in line with those of Kim *et al* (*6*). The methods we used in the present study are now being examined further by other hospitals within the Belgian-Dutch Clinical Pathway Network that are in the process of developing and evaluating their own pathways for knee arthroplasty patients.

In the literature we found that in-hospital clinical pathways tend to decrease total hip and knee

patients' length of stay (6). This in-hospital positive effect, however, can lead to negative effects such as long-term complications. This means that we have to be very careful with the interpretation of this result. The ultimate goal of clinical pathways is optimal quality and certainly not the decrease in length of stay. For example, Mauheran *et al* found that implementation of a clinical pathway decreased length of stay but increased the rate of dislocations following hip replacement surgery (8), underscoring the need to consider the long-term effects of clinical pathways. Given the potential of negative long-term effects associated with the implementation of clinical pathways, we will have to evaluate the long-term effects of our in-hospital TKA pathway in future studies. This was not possible within this study due to practical reasons. The use of both length of stay and clinical indicators to evaluate the efficacy of a clinical pathway could help in defining an appropriate length of stay for our patients in our healthcare organisation.

Our study has some inherent limitations. A risk for bias exists in the type of study design we used. First, our patient sample was small. It would have been better to have a larger sample size and to assess more patients before implementation of the first version of the pathway. The multidisciplinary team decided, however, that a pathway needed to be implemented as soon as possible. Second, because the first version of the pathway was being developed by the TKA team members at the same time that these same team members cared for the control patients, how team members cared for these patients may have been influenced, in part, by their ongoing discussions about the pathway. This type of bias could have been avoided if one TKA team developed the pathway and a different team cared for the patients. The development and implementation of clinical pathways is inherently a continuously changing process in which all team members must participate. Furthermore, to utilise our team most efficiently, as well as considering our setting, we could not foresee a more appropriate study design. Because we used the data from patients examined before pathway implementation as the control group for the first version of the pathway, randomisation was not possible.

CONCLUSIONS

The introduction of this in-hospital clinical pathway for TKA in our teaching hospital reduced length of stay by 33% without affecting the short-term functional outcomes. We were not able to evaluate the long-term effect of this pathway within this study. By assessing both length of stay and functional outcome, we can better determine the effectiveness of a care programme, both from the clinicians' and the hospital administrators' point of view.

Based on the findings of this clinical pathway study and the benchmarking of similar pathways by other hospitals within the Belgian-Dutch Clinical Pathway Network, our TKA team is currently examining the possibility of developing a short-stay pathway, which would be designed for a length of stay of 5 to 7 days. To develop this pathway the team will work closely together with the homecare teams (general practitioners, nurses and physiotherapists). In this way we will be able to evaluate the important long-term effects of the clinical pathway.

We conclude that this project on the development, implementation, and evaluation of this in-hospital clinical pathway for TKA had a positive impact on our hospital, our multidisciplinary TKA team, and on our patients during their acute hospitalisation.

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