

# Continuous Improvements of a Clinical Pathway Increased Its Feasibility and Improved Care Providers' Perception in TKA

Tae Kyun Kim, MD<sup>1</sup>, Moon Jong Chang, MD<sup>2</sup>, Seok Jin Kim, MD<sup>3</sup>, Young Dong Song, MD<sup>1</sup>, and Sei Kyoung Kim, RN<sup>1</sup>

<sup>1</sup>Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Seongnam; <sup>2</sup>Department of Orthopaedic Surgery, Samsung Medical Center, Seoul; <sup>3</sup>Department of Orthopaedic Surgery, Sinwoo Hospital, Seongnam, Korea

**Purpose:** We aimed to determine 1) whether dropout rate decreased and 2) whether health care providers' perceptions were changed with continued improvements of contents of clinical pathway (CP) for total knee arthroplasty (TKA).

**Materials and Methods:** This retrospective study included two separate analyses of patients and health care providers. In the analysis of patients, dropout rates and reasons were evaluated in two cohorts of patients who underwent TKA with CP applied at two different time periods (384 patients from 2009 to 2010 and 242 patients from 2012 to 2013). Contents of CP were continuously improved during the 3-year interval. Self-administered questionnaire surveys targeted to health care providers were carried out twice (2010 and 2013) and compared.

**Results:** Dropout rate decreased from 19.1% in the first time period to 10.4% in the second time period. Although overall satisfaction of care providers was high at both time-points, doctors had more favorable perceptions than nurses; most positive changes of perception were noted in nurses. The health care providers' perceptions for potential concerns of CP were improved while the perceptions for potential benefits and satisfaction were maintained.

**Conclusions:** Continuously improved CP has increased feasibility for TKA patients and reduced health care providers' concern about its value. We propose that CP can be implemented and actively used to improve the outcomes and efficacy of patient care for TKA, regardless of the rotation of care providers.

**Keywords:** Knee, Arthroplasty, Clinical pathways, Health care providers

## Introduction

A clinical pathway (CP) is a structured care plan that indicates the sequence and timing of care actions necessary to achieve goals with optimal efficiency<sup>1-3</sup>. CPs have been found to be ef-

ficient and have advantages for high volume procedures that lack substantial unexpected events<sup>4,5</sup>. It was previously revealed that implementation of a CP could reduce hospital stay, cost and complication rate when applied to relevant indications in various fields of medicine<sup>1,6-25</sup>. For patients undergoing total knee arthroplasty (TKA), an increase in functional outcome and a decrease in pain after implementing the CP were reported<sup>6,25</sup>.

However, there are also concerns about CPs. CPs inherently have limited flexibility for patients' individual conditions. Thus, a CP may not be an optimal approach for a patient and/or disease with great variability during treatment. Under such circumstances, frequent unexpected events during the treatment may lead to the frequent changes of the care plan or dropouts from the CP. These dropouts can negatively affect patient outcomes and the efficiency of patient care. Because TKA is primarily performed in elderly patients with frequent comorbidities, a concern about unexpected events related to these comorbidities has led to the

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Correspondence to: Tae Kyun Kim, MD

Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, 82 Gumi-ro 173beon-gil, Bundang-gu, Seongnam 463-707, Korea

Tel: +82-31-787-7196, Fax: +82-31-787-4056

E-mail: osk@snubh.org

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question of whether TKA is an ideal procedure for the application of a CP.

Nonetheless, it is possible to establish an advanced CP system that enables us to cope with individual differences among TKA patients and unexpected events that arise during their care, based on various perioperative management methods for TKA patients reported by recent studies and the accumulated experience of health care providers. It is expected that this improved CP can reduce the dropout rate of TKA patients and improve the health care providers' perception about the CP. If these were accomplished, the CP would become a more optimal, standardized care system for TKA patients by continuous improvement of the contents of the CP for TKA. However, no previous studies have rigorously studied these issues of a CP for TKA.

We, therefore, aimed to determine 1) whether the dropout rate decreased and 2) whether health care providers' perceptions were changed with continued improvements of the contents of our CP for TKA. We hypothesized that the continued improvements of the CP contents would reduce the dropout rate and improve the health care providers' perceptions about the CP for TKA.

## Materials and Methods

This observational study was performed using medical chart review and self-administered questionnaires, and involved two separate analyses: 1) analysis of the patients who underwent primary TKA and 2) analysis of the health care providers. Each analysis comprised two cohorts from two different time periods. This study was approved by Institutional Review Board of the authors' hospital.

### 1. Subjects for Analysis of Dropout Rate from the CP

Since December 2007, a CP was applied to all the patients undergoing primary TKA in our institute, without exception. Analysis of dropout rate from the CP included 626 patients who underwent primary TKA with application of the CP. The patients comprise two time period groups. The first time period group

consisted of 384 patients who underwent primary TKA from April 2009 to March 2010 at our institution. The second time period group included 242 patients who underwent primary TKA from April 2012 through March 2013. The time period groups did not differ in sex distribution; however, they differed in terms of age, height, weight and body mass index (BMI) (Table 1).

### 2. Subjects for Analysis of Health Care Providers' Perception

In total, 98 health care providers were included; they comprised the residents and the nurses who had experiences with both the CP care and non-CP care in the Department of Orthopedic Surgery at our institution. There were 11 residents and 21 nurses who completed the survey of 2010; 15 residents and 51 nurses completed the survey of 2013.

Between the two periods, we improved the CP in terms of medical and non-medical contents. For preemptive pain management, one hour before surgery, multimodal oral analgesic drugs were administered in addition to celecoxib 200 mg on as-needed basis<sup>26</sup>. To manage blood loss, the use of tranexamic acid (TNA) was added. In unilateral TKAs, patients were given a 10 mg/kg of body weight dose of TNA 30 minutes before tourniquet deflation, and the same dose was repeated 3 hours after the commencement of the first injection. In simultaneous bilateral TKAs, the same dose of TNA was administered 30 minutes before tourniquet deflation for the 1st operation, then 30 minutes before tourniquet deflation for the 2nd operation, and finally, the same dose was repeated 3 hours after the commencement of the second injection<sup>27</sup>. To prevent postoperative emesis, patients received 10 mg intravenous dexamethasone 1 hour before surgery<sup>26</sup>. For deep vein thrombosis prophylaxis, postoperative rivaroxaban was added. Patients started rivaroxaban 10 mg on the second day after surgery. For the non-medical contents of the CP, we made convenient icons to add an order in the electron medical record system, made a CP for diabetes mellitus patients, and had regular meetings so that it was easier to operate in terms of selection of the CP, reporting problems about the patients, and communication among health care providers.

**Table 1.** Patient Demographics of Two Different Time Period Groups

Parameter	First time period (n=384)	Second time period (n=242)	p-value
Age (yr)	70 (6.6)	72 (6.2)	<0.001
Female (%)	90	92	0.501
Height (cm)	154 (7.3)	152 (7.1)	0.036
Weight (kg)	65 (10.0)	62 (8.9)	<0.001
Body mass index (kg/m <sup>2</sup> )	27.4 (3.6)	26.6 (3.0)	0.007

Data are presented as mean (standard deviation).

The dropout rate and the reasons for dropout were investigated by reviewing the medical records. The patients were classified as 'completion' of the CP or 'dropout' from the CP. According to the CP protocol, all elective patients undergoing primary TKA are admitted the day before surgery, the patients undergoing unilateral primary TKA are discharged 7 days after surgery, the patients undergoing staged bilateral primary TKA are discharged 7 days after the second knee surgery (i.e., 14 days after the first knee surgery), and the patients undergoing simultaneous bilateral primary TKA are discharged 9 days after surgery in our hospital. This schedule for discharge was not changed during study period. The outcome was defined as 'dropout' if the patient failed to complete the CP for any reason, including a prolonged hospital stay of >2 days. Otherwise, the outcome was defined as 'completion' of the CP. The reasons for dropout were classified into non-medical reasons and 8 medical reasons. The non-medical reasons included earlier or later discharge attributable to the patients' desire. Medical reasons were classified into the following 8 categories: 1) delayed rehabilitation, 2) wound complication, 3) acute postoperative infection, 4) minor systemic problem, 5) major systemic problem, 6) other management problem not related to the knee joint, 7) intraoperative complication, and 8) mortality. Delayed rehabilitation was defined as withdrawal from the CP because of the problems related to ambulation and/or range of motion of the knee joint. Wound complication was defined as a persistent discharge from the wound during hospitalization. Cardiopulmonary complication was classified as a major systemic problem, while the other systemic complications were classified as a minor systemic problem. If a medical problem unrelated to the operated knee joint, such as voiding difficulty, required management, this reason was classified as other management not related to knee joint. In addition, complications such as neurovascular injury or additional ligament injury that occurred during the operation were classified as intraoperative complication. A death associated with the operation, either directly or indirectly, was classified as mortality.

Health care providers' perceptions about the CP were evaluated using a self-administered questionnaire that consisted of 16 questions (Appendix). It had the following three sections: 9 questions about potential benefits, 4 questions about potential concerns, and 3 questions about valuation. The question about satisfaction with CP in the valuation section was evaluated using visual analog scale that graded 11 steps from 0 to 10, and the remaining 15 questions were assessed by the Likert scale (5: strongly agree, 4: agree, 3: neutral, 2: disagree, 1: strongly disagree).

The same survey was carried out twice, in April 2010 and in April 2013. All responders were blinded to the purpose of this

study.

Statistical analyses were conducted using SPSS ver. 20.0 (IBM Corp., Armonk, NY, USA), and p-values of <0.05 were considered significant. To compare the dropout rate between the two time-period groups, the proportions of the dropout patients were cross-tabulated across the time-period groups, and statistically significance differences were determined using the chi-square test. To compare the frequencies of the dropout reasons between the two time-period groups, the proportions of each reason were calculated for each time-period group, and analyzed using the chi-square test. To compare the perceptions of health care providers about the CP between two time-period groups, the answers for the questions assessed by the Likert scale were dichotomized into 'agree' and 'disagree' ('agree'; strongly agree, agree and 'disagree'; neutral, disagree, strongly disagree), and the proportions of the responders who were in the agree category were cross-tabulated across the time-period groups, and the proportions were compared using the chi-square test or Fisher-exact test. To compare the residents and nurses regarding perceptions of health care providers about the CP, the answers for the questions assessed by the Likert scale were also dichotomized into 'agree' and 'disagree'; the proportions of the responders who were in the agree category were cross-tabulated across the health care provider groups, and analyzed using the chi-square test or Fisher-exact test. To compare health care providers' satisfaction with the CP between the two time-periods, the means and standard deviations of the scores were calculated and analyzed using student's t-test.

## Results

Dropout rate decreased from 19.1% in the first time period to 10.4% in the second time period ( $p=0.004$ ). The reduction in overall dropout rate was largely attributable to the reduction in dropouts caused by medical reasons (from 12.8% to 5.4%,  $p=0.003$ ): decreases in delayed rehabilitation and wound complications were the major reasons (Table 2).

There was no change in overall satisfaction with the CP between the first and second periods; however, residents had a more favorable perception than nurses in both time periods (Table 3). The health care provider's perceptions of the potential concerns about the CP were improved. In contrast, the perceptions on potential benefits, except for economic perspectives, and the levels of satisfaction with CP were maintained. All significant changes in the perceptions of potential benefits between two time periods were observed in nurses. After continued improvement of the CP contents, nurses agreed that the CP facilitates the trans-

**Table 2.** Comparison of Reasons for Dropout from the Clinical Pathway between the First and Second Time Period Groups

Dropout reason	First time period (n=84)	Second time period (n=242)	p-value
Non-medical reason	24 (6.3)	12 (5.0)	0.499
Medical reason	49 (12.8)	13 (5.4)	0.003
Delayed rehabilitation	11 (2.9)	1 (0.4)	0.029
Wound complication	15 (3.9)	4 (1.7)	0.110
Acute postoperative infection	3 (0.8)	0 (0.0)	0.168
Minor systemic problem	7 (1.8)	6 (2.5)	0.575
Major systemic problem	2 (0.5)	0 (0.0)	0.261
Other management problem	9 (2.3)	1 (0.4)	0.061
Intraoperative complication	1 (0.3)	1 (0.4)	0.741
Mortality	1 (0.3)	0 (0.0)	0.427

Data are presented as counts (%).

**Table 3.** Comparison of the Overall Satisfaction with the Clinical Pathway between Residents and Nurses according to the Study Period

Time of survey	Overall satisfaction		p-value
	Residents	Nurses	
2010	7.7	6.2	0.040
2013	8.2	6.5	<0.001
p-value	0.444	0.538	

Data are presented as means of visual analog scale (0–10).

fer of a duty (43% vs. 71%,  $p=0.027$ ). The perceptions of whether the CP can improve quality of care and safety were not changed. The perceptions on potential economic benefits, namely reducing hospital cost and length of stay, were changed negatively (Table 4). Regarding the potential concerns about the CP, the negative perceptions of the CP were reduced in the second time period: only 18% of the health care providers responded that the CP inhibited creative thinking as a trainee in the second time period compared to 41% in the first time period ( $p=0.017$ ). This reduction was largely due to the reduction in negative perception of the residents (from 55% to 7%,  $p=0.021$ ) (Table 5). The perceptions about the CP regarding valuation showed no difference between in 2010 and in 2013. However, 83% of the health care providers included in this study were willing to use the CP if they were given a choice (Table 6).

## Discussion

The CP is optimal for routine procedures without substantial unexpected events and has some inherent limitation in flexibility to adjust to patient's individual conditions. Therefore, the typical

characteristics of TKA patients, i.e., elderly individuals frequently with medical comorbidities, have raised concerns about whether TKA is an ideal procedure for applying a CP. In addition, health care providers may have negative perceptions about the application of a CP to TKA patients. However, continued improvements of the CP contents, which enables coping with individual differences in TKA patients, may reduce dropout rates or health care providers' negative views about the CP. To address these issues, we investigated changes in dropout rates in patients who underwent TKA and health care providers' perceptions between two time-periods over an interval of 3 years during which continued improvements of the CP contents for TKA were made.

There were several limitations that should be noted when interpreting our findings. First, this study was conducted using heterogeneous patient groups. In the analysis of dropout rate from the CP, two cohorts had somewhat different demographics in terms of age and BMI. The characteristics of more aged patients in more recent time-period group corresponded to our national trend of TKA candidates<sup>28</sup>, consistent with the extremely rapid increase of the elderly in our country. These differences in demographics could have introduced a bias. However, considering that the rate of dropout was reduced in the second time period group despite their older age, we believe that the integrity of our study was not jeopardized by demographic differences. Second, we did not examine the changes in health care providers' perceptions among the same providers that worked during the time periods of the two patient cohorts. Instead, we included the residents and the nurses who were available at the time of the each survey. However, we only included the residents and the nurses who had been trained with the same program under the same environment, and thus, the bias originating from different study cohorts

**Table 4.** Changes of Health Care Providers' Perceptions about the Clinical Pathway from 2010 to 2013 (Potential Benefits)

Question	2010 (n=32)	2013 (n=66)	p-value
<b>Quality and safety</b>			
Improved quality of care	22 (69)	43 (65)	0.724
Residents	10 (91)	14 (93)	1.000
Nurses	12 (57)	29 (57)	0.983
Reduced order input	22 (69)	45 (68)	0.955
Residents	11 (100)	15 (100)	N/A
Nurses	11 (52)	30 (59)	0.616
Reduced error	18 (56)	39 (59)	0.789
Residents	9 (82)	11 (73)	1.000
Nurses	9 (43)	28 (55)	0.353
<b>Economical perspective</b>			
Reduced hospital cost	25 (78)	34 (52)	0.012
Residents	10 (91)	11 (73)	0.356
Nurses	15 (71)	23 (45)	0.042
Reduced length of stay	28 (88)	45 (68)	0.040
Residents	9 (82)	14 (93)	0.556
Nurses	19 (91)	31 (61)	0.013
<b>Communication</b>			
Facilitates transferring a duty	18 (56)	50 (76)	0.049
Residents	9 (82)	14 (93)	0.556
Nurses	9 (43)	36 (71)	0.027
Improved communication with patients	25 (78)	48 (73)	0.565
Residents	7 (64)	11 (73)	0.683
Nurses	18 (86)	37 (73)	0.232
Improved communication among health care providers	27 (84)	47 (71)	0.155
Residents	11 (100)	14 (93)	1.000
Nurses	16 (76)	33 (65)	0.342
<b>Education</b>			
Recognized educational benefits	29 (91)	54 (82)	0.256
Residents	9 (82)	15 (100)	0.169
Nurses	20 (95)	39 (77)	0.060

Data are presented as numbers (%) of the subjects who replied 'agree'.

N/A: not available.

would be minimal.

Our results support the hypothesis that continued improvements of CP contents would decrease the dropout rate. In the literature related to the CP for TKA, most studies excluded the patients with American Society of Anesthesiologists Physical Status Score 3 and 4<sup>12)</sup>, chronic opioid use or chronic pain syndrome<sup>29)</sup>, high comorbidities, severe cardiac/respiratory disease, and severe multiple joint involvement<sup>30)</sup>. This restrictive strategy could reduce dropout, but also reduce the application rate of the

CP. In contrast, we applied the CP to the patients undergoing primary TKA without exception. Even with the 100% application, the dropout rate was reduced to a reasonable level after continued improvement of CP contents. Moreover, the rate of dropout due to medical reasons markedly decreased in the more recent time-period group (12.8% in the first time-period group vs. 5.4% in the second time period group) while the dropouts due to non-medical reasons were not significantly changed. Thus, we believe that a contemporary CP, when its contents have been continu-

**Table 5.** Changes of Health Care Providers' Perceptions of the Clinical Pathway from 2010 to 2013 (Potential Concerns)

Question	2010 (n=32)	2013 (n=66)	p-value
Inhibits coping with diverse situations	19 (59)	26 (39)	0.063
Residents	6 (55)	7 (47)	0.691
Nurses	13 (62)	19 (37)	0.056
Inhibits creative thinking as a trainee	13 (41)	12 (18)	0.017
Residents	6 (55)	1 (7)	0.021
Nurses	7 (33)	11 (22)	0.295
Inhibits additional order insertion	24 (75)	28 (42)	0.002
Residents	6 (55)	5 (33)	0.279
Nurses	18 (86)	23 (45)	0.002
Has higher risk of malpractice	21 (66)	22 (33)	0.003
Residents	5 (46)	5 (33)	0.530
Nurses	16 (76)	17 (33)	0.001

Data are presented as numbers (%) of the subjects who replied 'agree'.

ously improved, would be valuable for systematic perioperative care of TKA patients. Findings of our study affirm the hypothesis that the continued improvements of CP contents would improve the health care providers' perceptions about the CP for TKA. Health care providers' perceptions were substantially improved in the potential concerns category. In contrast, the health care providers' perceptions became worse in economic perspective in terms of the hospital cost and length of hospital stay. These are somewhat discordant with the result of previous studies that revealed that a CP was an effective method to reduce hospital cost and length of stay without compromising quality of patient care and safety<sup>8,20,30</sup>. It can be explained by the fact that we did not change the discharge plans of the CP during the study period although we changed the contents of the CP to add new drugs and/or interventions for pain and postoperative emesis control. Thus, health care providers might have thought that the hospital cost was increased because of the additional orders for drugs and interventions.

## Conclusions

This study demonstrates that, with continuing improvements in the contents of the CP, this CP has increased feasibility for TKA patients and reduced health care providers' concern about its value. Our findings suggest that CP can be safely implemented and actively used as an optimal perioperative care strategy for patients undergoing TKA, regardless of the rotation of care providers.

**Table 6.** Changes of Health Care Providers' Perceptions of the Clinical Pathway from 2010 to 2013 (Valuation)

Question	2010 (n=32)	2013 (n=66)	p-value
Improves general medical process	25 (78)	47 (71)	0.467
Residents	8 (73)	15 (100)	0.063
Nurses	17 (81)	32 (63)	0.132
Willing to use clinical pathway	24 (75)	55 (83)	0.328
Residents	10 (91)	15 (100)	0.423
Nurses	14 (67)	40 (78)	0.295

Data are presented as numbers (%) of the subjects who replied 'agree' and proportions in parentheses.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Appendix

This questionnaire was designed for the health care providers who cared for patients who underwent total knee arthroplasty with application of the clinical pathway (CP) to research the benefits of the CP and complement the CP. The data collected through this survey will be used to improve the CP. Please answer all questions as sincerely as possible.

■ Questions about the Responders

A1. Jobs and work period

- Resident
  - 1st year                       2nd year                       3rd year                       4th year
- Nurse

How long have you worked as a nurse?

- Less than 1 year       1–3 years                       3–5 years                       More than 5 years

■ Items below are the known benefits of a CP. What do you think of each item described below? How much are these associated with the currently used CP?

- B1. The CP improves quality of medical service.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B2. The CP decreased the costs of medical care.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B3. The CP reduced the workload i.e., decreased time for entering the order.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B4. The CP facilitates transferring a duty over to another provider.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B5. The CP reduced medical errors, i.e., reduced faulty orders.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B6. The CP has educational benefits, i.e. understanding the standardized process for TKR patient care.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B7. The CP improved communication with the patients/guardians.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B8. The CP improved communication between medical staff.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- B9. The CP reduced length of stay.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree

■ Items below are the known weaknesses of CP. What do you think of each item described below?

- C1. The CP inhibits coping with the diverse situations of individual patients.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- C2. The CP inhibits creative thinking as a trainee.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- C3. The CP inhibits additional insertion/performance of an order.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- C4. The CP has a higher risk of malpractice when the compliance of the patient with the CP is low or a complication occurs.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree

■ Items below are description of your general feelings about the CP. What is your feeling?

- D1. The currently used CP improves general medical process.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- D2. If you had the right to choose whether to use the CP, you would choose to use the CP.
  - 5. Strongly agree       4. Agree                       3. Neutral                       2. Disagree                       1. Strongly disagree
- D3. What is your satisfaction level with the CP? (0: very dissatisfied, 10: very satisfied)

