



# Introduction of an innovative day surgery pathway for unicompartmental knee replacement: no need for early knee flexion

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## Abstract

**Objectives** To evaluate the introduction of an innovative rehabilitation protocol, delaying knee flexion, for patients receiving unicompartmental knee replacement.

**Design** Longitudinal cohort.

**Setting** Specialist Orthopaedic Unit within an NHS Foundation Trust.

**Participants** 669 consecutive patients undergoing unicompartmental knee replacement.

**Intervention** An innovative rehabilitation protocol, delaying knee flexion.

**Main Outcome Measures** Length of stay, range of movement, Surgical Satisfaction Questionnaire.

**Results** There were 669 consecutive primary unilateral unicompartmental knee replacements from September 2016 to February 2018. In total 264 patients (39%) went home on the day of surgery, 253 (38%) on day 1 and 152 (23%) stayed in 2 or more days (range 2 to 28 days). The mean length of stay reduced from 2.6 to 1.2 days (median 1 day). Mean flexion was 110° (range 30 to 140) at 6 weeks. The surgical satisfaction questionnaire showed that 90% of patients discharged on day 0 were very satisfied with the results of surgery.

**Conclusion** Many components of traditional care were altered to introduce this protocol. The most important factors were delayed knee flexion providing benefits in terms of early mobilisation with no short term detriment, physiotherapists working late shifts, a consistent message and patient education. It was safe, effective and patient satisfaction was high.

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**Keywords:** Day surgery; Knee arthroplasty; Knee flexion; Length of stay; Unicompartmental knee replacement

## Introduction

Current practice following knee replacement is to commence flexion promptly in an attempt to limit post-operative stiffness. This can result in increased pain and swelling which in turn limits and delays mobility and discharge. We have observed that following minimally invasive Oxford unicompartmental knee replacement (UKR)<sup>1</sup> patients recover good flexion [1] whether they start flexion early or late. This has led to a belief that rehabilitation should commence slowly [2] and delaying flexion should encourage early mobilisation without compromising function.

Reducing the number of days patients spend in hospital is a priority in the NHS with a need to perform more short stay procedures. Bradley *et al.* [3] reported their experience of day-case UKR with 130 consecutive patients over 46 months

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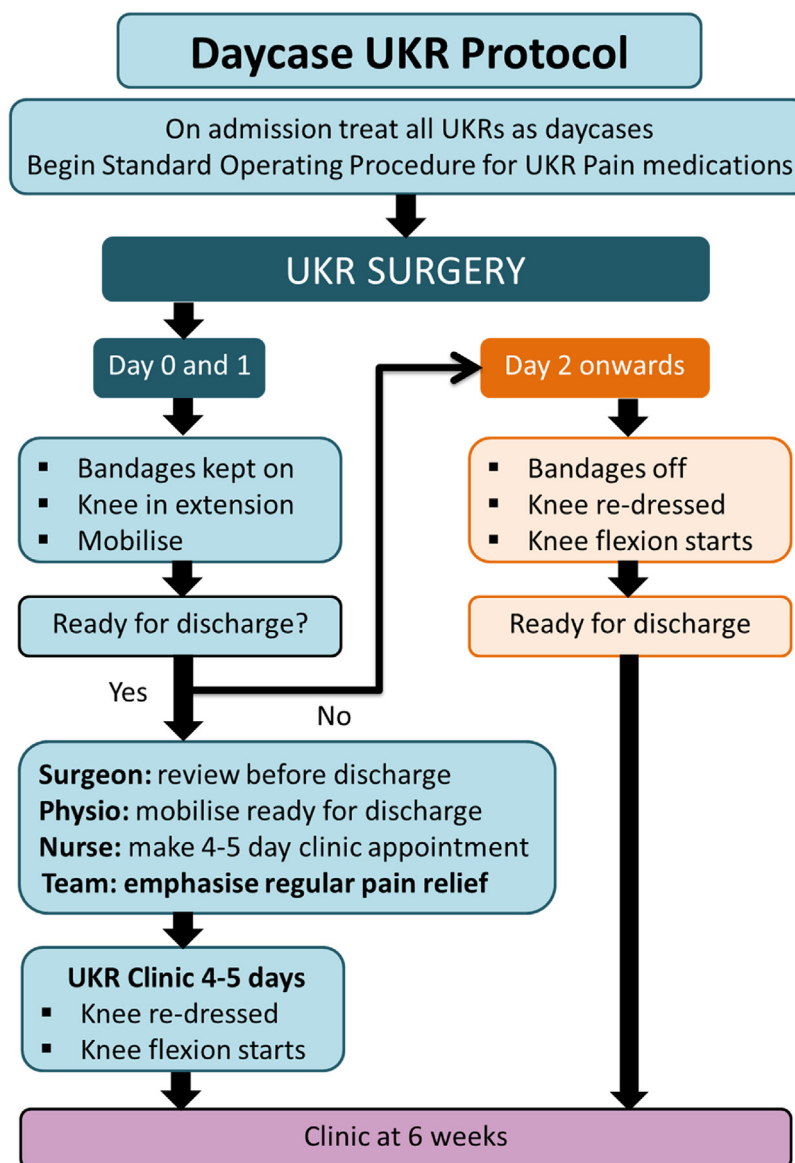


Fig. 1. Day-case clinical protocol.

however only 72 patients met the inclusion criteria. The USA, Denmark and The Netherlands have also reported successful day-case UKR surgery [4–7] on highly selected cohorts of patients.

Our aim was to introduce an innovative rehabilitation protocol, delaying knee flexion, for all patients receiving UKR. This, when added to our existing enhanced recovery programme, would give all patients the opportunity to mobilise early and go home on the day of surgery. The UKR is suited to an accelerated protocol with minimally invasive surgery [8], faster recovery [9] and fewer major complications compared to total knee replacement [10]. We recognised that same day discharge would be unrealistic for everyone due to the diverse population in terms of comorbidities, age and home town. We report the results of the first 18 months implementing this new protocol.

## Methods

The project was reviewed by the hospital's governance committee and deemed to be a service improvement audit not requiring approval from an ethics committee.

In September 2016 the protocol was introduced (Fig. 1). All UKR patients attended pre-operative assessment. If a screening questionnaire revealed they lived alone or had concerns about discharge, they were assessed by an occupational therapist. Every patient was given consistent advice by all clinicians and written information instructing them to prepare themselves, their family and home for same day discharge.

On admission, patients were seen by a nurse, surgeon and anaesthetist. Theatre lists were arranged allowing UKRs to be first where possible. A standard minimally invasive surgical technique was used with a general or spinal anaesthetic

**1. Pre-Medication:**

- 1.1 Routine pre-medications to be prescribed by the the anaesthetist at their discretion
- 1.2 Paracetamol 1000mg PO, Ibuprofen 400mg PO+/- Omeprazole 20mg PO  
{If no contraindications exist: See Appendix}

**2. Intra-operatively:**

- 2.1 Anaesthetic discretion (avoiding femoral/sciatic blocks)

**3. Post-Operatively to start in recovery and written as TTO:**

- 3.1 Once only in recovery
  - Gabapentin 300mg PO single dose Postop in recovery
- 3.2 Regular Analgesia
  - Paracetamol – 1000mg 6 hourly PO - (reduce dose to 500mg if patient is under 50Kg) to continue as needed for 2/52
  - Ibuprofen 400mg 8 hourly PO - (if not contraindicated) total of 3 days
  - Oxycodone MR (Oxycontin) 10mg 12 hourly for 5 doses then stop (first dose to be given in recovery, patient will need x4 doses in TTO)
  - Codeine Phosphate 60mg QDS PO **OR** Tramadol 50-100mg PO QDS  
Only to start **after** Oxycodone MR (Oxycontin) is stopped- continue up to 2 weeks depending upon patient's experience of pain.
- 3.3 Analgesics for Breakthrough Pain
  - Oxynorm 5mg PO 6 hourly (maximum of 20mg in one day) for 5 days
- 3.4 Antiemetic
  - Cyclizine 50mg PO 8 hourly PRN max of 150mg in one day (also to be available in TTO for 3 days)
- 3.5 Laxatives
  - Senna tablets 2 at night for up to 1 month
  - Laxido 1-2 sachets BD regularly (also to be available in TTO for 5 days)
- 3.5 PPI
  - Omeprazole 20mg OD (also to be available in TTO for 7 days)
- 3.6 Thromboprophylaxis
  - As per Trust Guidelines

**\*\* All TTO medicine will be available as PowerPlan for E-Prescribing. \*\***

**APPENDIX:****CONTRAINDICATIONS TO NSAID USE**

- Pre-existing structural kidney disease
- Stage 4 or 5 CKD (eGFR < 30ml/min)
- CCF
- Hepatic failure
- History of GI bleed or perforation
- Symptomatic peptic ulcer
- Allergy to NSAID's (including aspirin)
- Asthma with known exacerbation by NSAIDs
- Clotting/platelet abnormalities
- \* Patients already taking regular NSAID's or proton pump inhibitors at admission should continue with their normal medication

Fig. 2. Standard Operating Procedure for UKR day-case medications.

and peri-articular local infiltration. Femoral or sciatic nerve blocks were discouraged and no wound drains were used. At the end of surgery a compression bandage was applied to the knee.

Patients ate and drank promptly and returned to a ward for physiotherapy assessment of sensation and motor power. If these were adequate static quadriceps and foot and ankle exercises commenced. Patients were instructed to keep their knee straight and mobilised weight bearing as tolerated with crutches along with stairs practice. Instruction was given to keep their compression bandage intact and maintain knee extension until they returned to a designated UKR clinic 4 to 5 days later. X-ray and assessment by the surgical team was required before discharge with advice on the impor-

tance of resting the leg in elevation to reduce swelling and, when at home, to walk around inside using crutches. There were detailed instructions on the importance of taking all prescribed pain medications, laxatives and anti-emetics (Fig. 2). Safety netting advice and telephone numbers were given if there were concerns in the first 4 to 5 days. If for social, medical or geographic reasons patients were unable to go home on day 0 they stayed overnight. If the reason resolved they were discharged on day 1 with the same instructions as those discharged on day 0.

If patients remained in hospital until day 2, the compression bandage was removed, knee flexion started and they were discharged when well and mobilising safely. Out-patient physiotherapy was arranged to improve range of

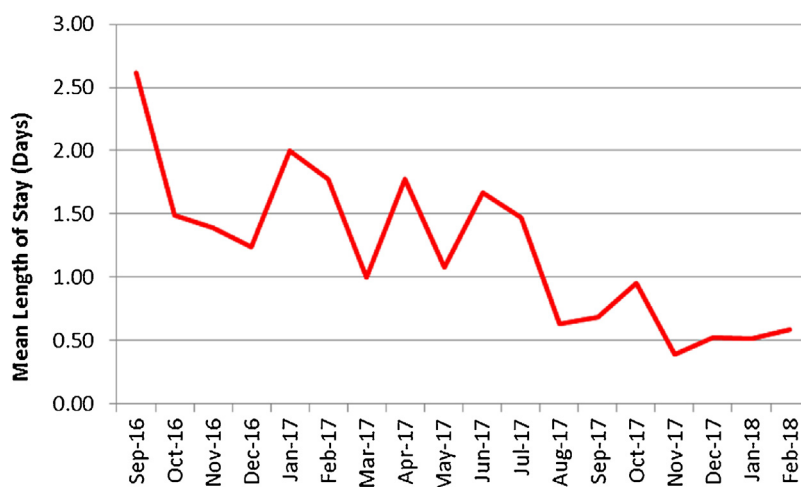


Fig. 3. Length of stay.

motion (ROM) or mobility, if required, but was not routine.

All patients discharged on day 0 or 1 returned to the UKR clinic on the closest weekday to the 5th post-operative day. Nurses re-dressed the wound and patients had a single physiotherapy session of gentle knee flexion and extension along with a comprehensive booklet of exercises and advice. Surgical team review or referral to out-patient physiotherapy was possible on the day if there were concerns but these were not routine. There were also details of a physiotherapy out-patient drop-in clinic for those concerned about their progress within the next three months.

Every patient was routinely seen by a surgeon or specialist physiotherapist at six weeks and completed the Surgical Satisfaction Questionnaire [11]. ROM and any complications were recorded and patients were discharged from routine follow up if there were no outstanding issues.

## Results

### Demographics

There were 329 male and 340 female patients. The mean age was 69 (range 38 to 93). Of these 94 were 80 years or over and 7 were 90 or over.

### Length of stay

In 18 months 669 consecutive primary UKRs were performed. Of these, 264 (39%) were discharged on day 0, 253 (38%) on day 1 and 152 (23%) stayed in 2 or more days (range 2 to 28 days). In the month following the introduction of the protocol 34 patients underwent UKR with a mean length of stay (LOS) of 2.6 days. Six patients were discharged on day 0 and 10 on day 1. Seventeen months later 34 patients underwent UKR with a mean LOS of 0.59 days, 17 were

discharged on day 0 and 15 on day 1. The average LOS for the entire 18 months was 1.2 days (range 0–28 days, median 1 day) (Fig. 3). Men and women had a mean LOS of 1.0 and 1.3 days respectively.

### Reasons for delayed discharge on day 0

The most common reason for delay was reduced sensation or muscle strength, 66 patients (16%). Fifty four (13%) were delayed for medical reasons and 51 (13%) for dizziness or nausea. Only 30 (8%) stayed due to their past medical history and 32 (8%) for pain. Thirty four (8%) returned late from theatre. Thirty three (8%) had a failure of the protocol (delays in the medication package, X-ray or physiotherapy). Patient choice or social reasons (caring responsibilities, living alone or a long journey home) accounted for 44 (11%) patients. Twenty six (6%) were slow to mobilise, 16 (4%) had post-operative instructions delaying mobilisation and 19 (5%) had wound concerns.

### Range of motion

On day 4 to 5 the mean fixed flexion was 2.9° (range 0 to 40) and flexion 78° (range 30 to 115). At six weeks mean fixed flexion was 2.5° (range 0 to 20) and flexion 110° (range 30 to 140).

### Re-admissions

All re-admissions within the first six weeks were evaluated for those 264 patients discharged on day 0 (Table 1).

### Patient satisfaction

Patient satisfaction at six weeks was assessed using the Surgical Satisfaction Questionnaire [11] and showed that 90% of patients discharged on day 0 were very satisfied

Table 1

Patients discharged on day 0 – reasons for readmission.

Age	Gender	Re-admission length of stay	Reason for re-admission
<b>Minor Concerns</b>			
65	Male	1	Haematoma
71	Male	1	Wound bleed
74	Male	1	Haemarthrosis
49	Female	2	Wound bleed
<b>Minor Complications</b>			
45	Male	1	Superficial wound infection requiring oral antibiotics
54	Male	1	Superficial wound infection requiring intravenous then oral antibiotics
68	Female	1	Stitch abscess and cellulitis requiring oral antibiotics
66	Male	3	Pain Relief
<b>Complications</b>			
67	Female	2	Tibial plateau fracture diagnosed at 6 weeks required internal fixation
55	Female	2 + 1	Haemarthrosis day 2 + Manipulation under Anaesthesia at 9 weeks
66	Male	4	Pneumonia
68	Male	4 + 1	Pulmonary Embolus with Deep Vein Thrombosis + Angina
65	Male	6	Debridement And Implant Retention 5 weeks post-op for infection

with the results of surgery and 92% would “do it all over again”.

#### Cost saving

In 18 months, mean LOS reduced by 1.4 days with a reduction in bed occupancy of 937 days. Assuming a cost of £300 per bed day, £281 100 was saved.

#### Discussion

In an unselected consecutive cohort of 669 UKRs we have shown that early mobilisation with delayed knee flexion does not adversely affect knee ROM at 6 weeks. Same day discharge was possible in 264 (39%) patients with a further 253 (38%) discharged on day 1 following the same protocol. In the last 6 months of evaluation length of stay consistently averaged under 1 day.

The innovation of delaying knee flexion played an important part in the protocol's success. In a combined attempt to reduce post-operative pain and swelling, mobilise early and go home on the day of surgery we asked patients to initially avoid any formal flexion exercises. No rigid knee splint was used as we wanted to allow gentle knee flexion during daily activities. Little difficulty was observed regaining ROM and at the 4–5 day appointment mean flexion was 78°. Indeed many patients were observed sitting in the waiting room with their knee in 90° claiming to have kept their knee straight. Flexion seems to have been regained with functional tasks as comfort allowed [12]. At six weeks mean flexion was 110° which compares favourably to another study using the same implant and similar surgical technique before this protocol was introduced [13]. The main factor to have changed was the rehabilitation.

To promote early mobilisation and discharge, many hospital practices were altered. The core working hours of the physiotherapy team were changed to enable an extended working day to 19:30 including on-call until 22:00. This was achieved by restructuring the existing rota and was cost neutral but provided cover over a longer day. Occupational therapists had a change of emphasis with increased staffing in pre-operative assessment clinics to plan and facilitate discharge, resourced through re-deployment from in-patients. The aim was to prepare patients and their families more fully for early discharge and make them aware of the new protocol. Our experience being that front loading the occupational therapy input meant less involvement during patients' hospital stay.

Introducing this innovative protocol required a multidisciplinary approach [14], a change in mind set of patients and clinicians [7] and dissemination to all team members. Hospital processes were streamlined and numerous small changes made in many departments to maximise efficiency; surgical teams reviewed patients and ordered home medications promptly allowing delivery from pharmacy. Nurses required familiarity with the entire protocol. Refinements were made to the pre-admission processes and patient information and X-rays could be taken in theatre. All changes required continuous monitoring.

Following the protocol introduction we evaluated the reasons for re-admission in the first six weeks (Table 1). Of the 264 patients discharged on day 0, 13 (5%) were readmitted. Four (1.5%) were classified as minor concerns, admitted with wound problems and monitored without treatment for 24 to 48 hours. A cautious approach if infection was suspected. Four (1.5%) were classified as minor complications requiring a short medical intervention, such as short term intravenous or oral antibiotics or pain relief. Five (2%) admissions were classified as complications. Of these; 2 (0.8%) required longer hospital admissions and treatment for pneumonia and a pul-

monary embolus with a deep vein thrombosis, and 3 (1%) returned to theatre for i, internal fixation of a tibial plateau fracture, ii, MUA and iii, debridement for infection. As this protocol is a new concept we have no historical data for comparison. However, the re-admission rate of 5% and return to theatre rate of 1% compares favourably to other unselected enhanced recovery series [15].

Throughout this process we educated patients, encouraging them to make early discharge plans with realistic expectations. In spite of consistent patient education, 11% of patients stayed in for social reasons. Some lived alone, had no transport or a long journey home. In this study 34% of women and 45% of men went home on day 0. Barker [12] noted that women are reluctant to have early discharge due to the care they may receive from their partner. Social issues are difficult to address; perhaps we need stricter pre-operative guidelines.

We set out to describe the implementation of an innovative day surgery pathway. It is not possible to compare this with other similar studies; as this is the only pathway that does not rely on a pre selected patient cohort. Having an unselected cohort is the biggest strength of this study. It removes the time consuming process of screening and allows all patients the opportunity for early discharge. However the absence of a control group makes it difficult to compare it to other studies on accelerated discharge

Many components of traditional care were altered ultimately, the success was the result of marginal improvements in all areas. We feel the most important factors were delayed knee flexion which provided benefits in terms of early mobilisation with no short term detriment, physiotherapists working an extended day allowing patients to mobilise later into the evening, a consistent team message and patient education. The protocol resulted in a marked reduction in LOS and cost. It was safe, effective and patient satisfaction was high resulting in The National Orthopaedic Alliance recommending it's adoption to its members [16].

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**Ethical approval:** The project was reviewed by the hospital's governance committee and deemed to be a service improvement audit not requiring approval from an ethics committee.

**Conflict of interest:** The author or one of more of the authors have received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article. In addition, benefits have been or will be directed to a research fund, foundation, educational institution, or other non-profit organisation with

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## References

- [1] Pandit H, Jenkins C, Barker K, Dodd CA, Murray DW. The Oxford medial unicompartmental knee replacement using a minimally invasive approach. *J Bone Jt Surg Br* 2006;88:54–60.
- [2] Goodfellow J, O'Connor J, Pandit H, Dodd C, Murray D. Unicompartmental arthroplasty with the Oxford knee. Oxford: Goodfellow Publishers Limited; 2015.
- [3] Bradley B, Middleton S, Davis N, Williams M, Stocker M, Hockings M, et al. Discharge on the day of surgery following unicompartmental knee arthroplasty within the United Kingdom NHS. *Bone Jt J* 2017;99B:788–92, <http://dx.doi.org/10.1302/0301-620X.99B6.BJJ-2016-0540.R2>.
- [4] Cross MB, Berger R. Feasibility and safety of performing outpatient unicompartmental knee arthroplasty. *Int Orthop* 2014;38:443–7, <http://dx.doi.org/10.1007/s00264-013-2214-9>.
- [5] Gondusky JS, Choi L, Khalaf N, Patel J, Barnett S, Gorab R. Day of surgery discharge after unicompartmental knee arthroplasty: an effective perioperative pathway. *J Arthroplasty* 2014;29:516–9.
- [6] Munk S, Dalsgaard J, Bjerggaard K, Andersen I, Hansen TB, Kehlet H. Early recovery after fast-track Oxford unicompartmental knee arthroplasty. *Acta Orthop* 2012;83:41–5, <http://dx.doi.org/10.3109/17453674.2012.657578>.
- [7] Kort N, Bemelmans Y, Schotanus M. Outpatient surgery for unicompartmental knee arthroplasty is effective and safe. *Knee Surg Sport Traumatol Arthrosc* 2017;25(9):2659–67.
- [8] Pandit H, Hamilton TW, Jenkins C, Mellon SJ, Dodd CAF, Murray DW. The clinical outcome of minimally invasive Phase 3 Oxford unicompartmental knee arthroplasty: a 15-year follow-up of 1000 UKAs. *Bone Jt J* 2015;97-B:1493–500, <http://dx.doi.org/10.1302/0301-620X.97B11.35634>.
- [9] Price AJ, Webb AJ, Topf H, Dodd CAF, Goodfellow JW, Murray DW. Rapid recovery after oxford unicompartmental arthroplasty through a short incision. *J Arthroplasty* 2001;16:970–6.
- [10] Liddle AD, Judge A, Pandit H, Murray DW. Adverse outcomes after total and unicompartmental knee replacement in 101330 matched patients: a study of data from the National Joint Registry for England and Wales. *Lancet* 2014;384:1437–45, [http://dx.doi.org/10.1016/S0140-6736\(14\)60419-0](http://dx.doi.org/10.1016/S0140-6736(14)60419-0).
- [11] Murphy M, Sternschuss G, Haff R, van Raalte H, Saltz S, Lucente V. Quality of life and surgical satisfaction after vaginal reconstructive vs obliterative surgery for the treatment of advanced pelvic organ prolapse. *Am J Obstet Gynecol* 2008;198:1–7, <http://dx.doi.org/10.1016/j.ajog.2007.12.036>.
- [12] Barker KL, Reilly KA, Lowe CM, Beard DJ. Patient satisfaction with accelerated discharge following unilateral knee replacement. *Int J Ther Rehabil* 2006;13:247–53.
- [13] Jenkins C, Barker KL, Reilly KA, Pandit H, Dodd CAF, Murray DW. Physiotherapy management of minimally invasive Oxford medial compartment knee arthroplasty: an observational study of 100 patients following an accelerated treatment protocol. *Physiotherapy* 2006;92:214–8, <http://dx.doi.org/10.1016/j.physio.2006.05.007>.

- [14] Pearson S, Moraw I, Maddern G. Clinical pathway management of total knee arthroplasty: a retrospective comparative study. *Aust N Z J Surg* 2000;351–4.
- [15] Malviya A, Martin K, Harper I, Muller SD, Emmerson KP, Partington PF, *et al.* Enhanced recovery program for hip and knee replacement reduces death rate: a study of 4,500 consecutive primary hip and knee replacements. *Acta Orthop* 2011;82:577–81, <http://dx.doi.org/10.3109/17453674.2011.618911>.
- [16] National Orthopaedic Alliance. NOA Quarterly Meeting 1st Aug – Review 2018. <http://nationalorthopaedicalliance.co.uk/noa-quarterly-meeting-1st-aug-review/>. [Accessed 16 November 2018].

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