# Effects of enhanced recovery after surgery practices on postoperative recovery and length of stay after unilateral primary total hip or knee arthroplasty in a private hospital

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## ABSTRACT

**Introduction:** Enhanced recovery after surgery (ERAS) practices improve postoperative recovery and reduce postoperative length of stay (LOS) in patients undergoing primary total hip arthroplasty (THA) or total knee arthroplasty (TKA). Our study investigated whether these promising results could be reproduced in a private hospital setting.

**Methods:** In total, 228 patients were included in the study cohort: the conventional group comprised 117 patients from 2012 to 2014, while the ERAS group comprised 111 patients from 2017 to 2018. All patients had undergone unilateral primary THA or TKA at a private hospital in Hong Kong. The outcome was postoperative LOS; factors affecting LOS were also investigated.

**Results:** No significant differences were found in any baseline parameters between the two groups of patients. The mean LOS was significantly shorter in the ERAS group than in the conventional group (3.28 ± 1.04 vs 5.16 ± 2.06 days, P<0.001). Moreover, a significantly greater proportion of patients could be discharged on or before postoperative day 3 in the ERAS group, compared with the conventional group (77.5% vs 13.7%, P<0.001). A significant difference in LOS was observed between general ward and private ward patients (3.06 ± 0.59 vs 3.66 ± 1.46 days, P=0.003). Sex, age, and nature of surgery (TKA vs THA) did not have significant effects on LOS.

**Conclusions:** The ERAS practices yielded a significant improvement in postoperative LOS, compared to conventional practices, among patients who underwent unilateral primary THA or TKA in a private hospital.


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**New knowledge added by this study**

- Enhanced recovery after surgery (ERAS) practices in total joint arthroplasty improve postoperative length of stay in the private hospital setting, similar to previous findings in public joint replacement centres.
- Among patients who underwent unilateral primary total hip or knee arthroplasty in a private hospital, postoperative length of stay was lower for patients in general wards than for patients in private wards.

**Implications for clinical practice or policy**

- Standardised ERAS practices could be implemented as a protocol by private hospitals in Hong Kong.
- Although full ERAS implementation may be difficult to achieve in a short period of time, gradual addition of ERAS components could improve patient outcomes in private hospitals.

## Introduction

Enhanced recovery after surgery (ERAS) practices were developed in the 1990s whereby multiple modalities of intervention[1] were introduced perioperatively to improve postoperative recovery,[2] reduce length of stay (LOS),[3] and lower the incidence of perioperative morbidity.[4] These practices have been widely adopted in many surgical fields,[5-7] including orthopaedics.[8] Further enhancements of postoperative pain management, venous thromboembolism prophylaxis, and early mobilisation have led to encouraging results in primary total hip arthroplasty (THA) and total knee arthroplasty (TKA); such results have included earlier recovery,[9] LOS reduction,[10] improved function,[11] and lower venous thromboembolism incidence[12] without declines in patient satisfaction, postoperative complication rate,[13] or cost.[14] The development of

  

## 術後加速康復療程對私家醫院全髖及全膝關節置換手術後復元及住院時間之影響

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**引言：**術後加速康復療程（ERAS）能促進全髖及全膝關節置換手術後復元及減少住院時間。本研究旨在評估ERAS能否在私家醫院達到相同效果。

**方法：**共有228名患者被納入研究，其中117名患者於2012-2014年間接受常規手術，111名患者於2017-2018年間接受ERAS療程。全部患者均在同一間香港私家醫院接受單邊全髖或全膝關節置換手術。常規手術及ERAS療程患者之住院時間將進行比較。

**結果：**兩組患者的基本因素沒有顯著分別。ERAS顯著縮短住院時間（3.28 ± 1.04天比5.16 ± 2.06天，P<0.001），令更多患者能於術後3天內出院（77.5%比13.7%，P<0.001）。普通病房患者比私家病房患者的住院時間略低（3.06 ± 0.59天比3.66 ± 1.46天，P=0.003）；而性別、年齡和關節種類則沒有顯著分別。

**結論：**ERAS能於私家醫院促進全髖及全膝關節置換手術後復元及減少住院時間。


ERAS practices has matured with the progressive introduction of standardised clinical pathways for all patients receiving THA or TKA,[15] also referred as fast-track hip and knee arthroplasty.[16] These ERAS practices have become the standard of care in most joint replacement centres.[17,18]

Because of the ageing population and increasing incidence of degenerative joint disease,[19] the wait time for elective TKA in a public joint replacement service can reach 5 years in Hong Kong[20]; thus, many patients visit private orthopaedic surgeons for earlier surgery. Despite the presence of robust joint replacement options in the Hong Kong orthopaedic community, there remain differences between public and private hospital settings in terms of the environment, perioperative medical care, and service availability. To our knowledge, no studies have been published regarding the effects of ERAS practices on LOS after lower limb total joint arthroplasty, or whether ERAS practices could be implemented as a standardised protocol by private hospitals in Hong Kong.

Therefore, this study investigated whether the promising results of ERAS practices could be reproduced in private hospitals by comparison of LOS among patients who underwent unilateral primary THA or TKA by a single surgeon at Hong Kong Sanatorium & Hospital, a private hospital in Hong Kong, before and after the implementation of ERAS.

# Methods

## Patients

Patients who had undergone unilateral primary THA or TKA by the senior author (KYC) at Hong Kong Sanatorium & Hospital, Hong Kong, were included in the study cohort. Patients with revision arthroplasty, one-stage bilateral arthroplasty, and unicompartmental knee arthroplasty were excluded. Because ERAS practices were progressively implemented from 2015 to 2016, we allocated patients who were treated from 2012 to 2014 into the conventional group and patients who were treated from 2017 to 2018 into the ERAS group.

## Similarities between enhanced recovery after surgery and conventional practices

Our ERAS practices were generally similar to conventional practices. Most patients underwent surgery on the morning after an evening admission. Most patients received spinal anaesthesia unless contra-indicated (eg, ankylosing spondylitis, severe spinal deformity, coagulopathy, or fixed cardiac output state); routine sedation (using intravenous midazolam and propofol) was also conducted to improve patient comfort. Cementless THA systems, either a Pinnacle acetabular cup with a Summit femoral stem (DePuy, Warsaw [IN], US) or an R3 acetabular cup with a Synergy femoral stem (Smith & Nephew, Auckland, New Zealand), were implemented by means of a posterolateral approach. Total knee arthroplasty was performed using a medial parapatellar approach with thigh tourniquet and conventional instruments. Cemented rotating platform TKA systems were used: either a Legacy Posterior Stabilised Flex Mobile prosthesis (Zimmer, Warsaw [IN], US) or an Attune prosthesis (DePuy). A Foley urinary catheter was inserted only on urinary retention with bladder volume of >800 mL.[21] Prophylactic antibiotics were administered on the induction of anaesthesia, then continued for 2 days after surgery. Prophylaxis against venous thromboembolism, both pharmacological (with subcutaneous enoxaparin) and mechanical (with a sequential compression device), was routinely implemented. Patients were discharged home when they could safely exit their beds without assistance and stably walk using an assistive device without any sign of complications.

## Differences between enhanced recovery after surgery and conventional practices

### *Steroid administration*

When using ERAS practices, a higher dose of intravenous steroid is administered on the induction of anaesthesia for both THA and TKA. In the conventional group, 4 to 8 mg of dexamethasone was administered; in the ERAS group, 125 mg of methylprednisolone (equivalent to 25 mg of dexamethasone) was administered instead.[22] Notably, high-dose glucocorticoids before arthroplasty are

reportedly safe and recommended for routine use.[23]

### *Management of pain, nausea, and vomiting*

In the conventional group, no standard pain control regimen was established. Pain medications were prescribed at the discretion of anaesthetists or surgeons, including the use of femoral nerve block and postoperative patient-controlled analgesia pump. Pain management was standardised and optimised in the ERAS group, particularly for patients undergoing TKA. Pre-emptive analgesia was implemented, such that patients routinely began oral pregabalin and transdermal buprenorphine patch treatments before surgery. Preventive analgesia was also employed both intra- and post-operatively. A periarticular "cocktail" injection of local infiltrative analgesia[24]—consisting of ropivacaine, ketorolac, and 1:1000 adrenaline—was injected into the posterior joint capsule before implantation of the prosthesis; it was also injected into the subcutaneous layer anteriorly and intra-articularly during wound closure. After surgery, patients received multimodal oral analgesia including regular cyclooxygenase-2 inhibitors or non-steroidal anti-inflammatory drugs, pregabalin, and paracetamol. Buprenorphine patch treatment was maintained for 5 to 7 days. Patient-controlled analgesia was omitted when using ERAS practices. In contrast, the pain control requirement was lower for patients undergoing THA. In both conventional and ERAS groups, local anaesthetic (bupivacaine) was injected into the subcutaneous plane before skin closure, while oral paracetamol was prescribed after surgery. After discharge from the hospital, patients who underwent TKA were administered non-steroidal anti-inflammatory drugs, pregabalin, and paracetamol for up to 5 weeks after surgery; most patients undergoing THA were prescribed paracetamol alone.

Prophylactic intravenous palonosetron was routinely administered to prevent postoperative nausea and vomiting; intravenous metoclopramide was used to manage breakthrough symptoms.

#### *Blood management*

Tranexamic acid was routinely used in the ERAS group to minimise bleeding and the need for transfusion. For patients undergoing TKA, 1 g of tranexamic acid was injected intra-articularly after deep layer closure. No routine use of tranexamic acid was adopted in conventional practices. A deep drain was used when adhering to conventional practices but not when adhering to ERAS practices. For patients undergoing THA, intravenous tranexamic acid was administered at the same time as induction of anaesthesia; a deep drain was also used and removed the next morning.

#### *Sleep management*

While hypnotics were only administered on request when in the conventional group, patients in the ERAS group were routinely prescribed hypnotics the night before surgery and the first 2 to 3 days after surgery. This helped patients in the ERAS group to comply with the rehabilitation programme after surgery.

#### *Same-day rehabilitation*

Same-day or day-zero rehabilitation was implemented in the ERAS group. Patients in the conventional group had bed rest on the day of surgery, then began mobilisation on postoperative day 1. Conversely, patients in the ERAS group who underwent morning surgery were encouraged to mobilise in the afternoon or evening on the same day, under physiotherapist supervision.

### Outcomes

The outcome was postoperative LOS, which was denoted by the number of days after surgery when the patient was discharged from the hospital. The day of surgery was regarded as postoperative day 0. Discharge criteria remained consistent throughout the study period (ie, safe exit from bed without assistance and stable walking using an assistive device), as described above. The proportion of patients discharged on or before postoperative day 3 in each group was compared. We also investigated the effects of age, sex, nature of surgery (THA versus TKA), and class of hospital bed (general versus private ward) on LOS.

### Statistical analysis

Patient data were anonymously entered into an encrypted file to ensure privacy. Data analysis was performed using SPSS (Window version 26.0; IBM Corp, Armonk [NY], US). The Chi squared test, independent samples *t* test with two-tailed significance, and one-way analysis of variance were used for comparisons. A P value of $<0.05$ was considered statistically significant.

## Results

### Baseline parameters

In total, 228 patients were included: 117 in the conventional group and 111 in the ERAS group. The mean and median ages did not significantly differ between the conventional and ERAS groups (Table 1). Most patients were aged between 50 and 89 years (89.7% in the conventional group and 97.2% in the ERAS group); however, the distribution of ages did not significantly differ between groups. The distributions of sex, nature of surgery, and class of hospital bed also did not significantly differ between the conventional and ERAS groups (Table 1).

TABLE 1. Baseline parameters

| | Conventional (n=117) | ERAS (n=111) | P value |
|---|---|---|---|
| Age, y | | | |
| Mean (± SD) | 67.9 ± 12.4 | 69.6 ± 9.2 | 0.253* |
| Median (range) | 68 (26-100) | 69 (46-92) | - |
| Sex (%) | | | |
| Female | 66.7 | 60.4 | 0.323† |
| Male | 33.3 | 39.6 | |
| Nature of surgery (%) | | | |
| TKA | 57.3 | 53.2 | 0.533† |
| THA | 42.7 | 46.8 | |
| Class of hospital bed (%) | | | |
| General | 62.4 | 63.1 | 0.917† |
| Private | 37.6 | 36.9 | |
| Age-group (%) | | | |
| 20-29 | 1.7 | 0 | 0.366† |
| 30-39 | 0.9 | 0 | |
| 40-49 | 6.8 | 1.8 | |
| 50-59 | 9.4 | 11.7 | |
| 60-69 | 34.2 | 37.8 | |
| 70-79 | 29.9 | 35.1 | |
| 80-89 | 16.2 | 12.6 | |
| 90+ | 0.9 | 0.9 | |

Abbreviations: ERAS = enhanced recovery after surgery; SD = standard deviation; THA = total hip arthroplasty; TKA = total knee arthroplasty

* Independent-samples *t* test

† Pearson Chi squared test

TABLE 2. Comparison of postoperative length of stay

| | Conventional (n=117) | ERAS (n=111) | P value |
|---|---|---|---|
| Length of stay, d | | | |
| Mean (± SD) | 5.16 ± 2.06 | 3.28 ± 1.04 | <0.001* |
| Median (range) | 5 (3-16) | 3 (2-10) | - |
| Discharged on or before postoperative day 3 (%) | 13.7 | 77.5 | <0.001* |

Abbreviations: ERAS = Enhanced recovery after surgery; SD = standard deviation

* Independent-samples *t* test

## Outcome

The mean LOS significantly improved from 5.16 ± 2.06 days to 3.28 ± 1.04 days (P<0.001) after ERAS implementation (Table 2). Patients discharged on or before postoperative day 3 comprised 13.7% of the conventional group and 77.5% of the ERAS group (P<0.001).

TABLE 3. Factors affecting length of hospital stay after THA or TKA

| | Length of stay (days) | |
|---|---|---|
| | Conventional (n=117) | ERAS (n=111) |
| Sex | | |
| Female | 5.35 ± 2.25 | 3.27 ± 1.23 |
| Male | 4.79 ± 1.59 | 3.30 ± 0.67 |
| P value | 0.174* | 0.895* |
| Nature of surgery | | |
| TKA | 5.40 ± 2.18 | 3.27 ± 0.76 |
| THA | 4.84 ± 1.87 | 3.29 ± 1.29 |
| P value | 0.145* | 0.931* |
| Class of hospital bed | | |
| General | 5.03 ± 1.89 | 3.06 ± 0.59 |
| Private | 5.39 ± 2.34 | 3.66 ± 1.46 |
| P value | 0.364* | 0.003* |

Abbreviations: ERAS = enhanced recovery after surgery; THA = total hip arthroplasty; TKA = total knee arthroplasty

* Independent-samples *t* test

## Factors affecting postoperative length of stay

Subgroup analysis was performed to examine the effects of sex, nature of surgery, class of hospital bed (Table 3), and age-group (Fig) on LOS.

In the conventional group, there were no significant differences in mean LOS between female and male patients, patients receiving TKA and patients receiving THA, or general ward and private ward patients (Table 3). One-way analysis of variance showed a significant difference in mean LOS among age-groups (F [7, 109]=2.58, P=0.017) [Fig]. The mean LOS generally increased as age increased from the third decade (3 days) to the ninth decade (7 days); however, two patients in the 20-29 age-group had exceptionally long hospital stays.

In the ERAS group, there were no significant differences in mean LOS between female and male patients or between patients receiving TKA and patients receiving THA (Table 3). One-way analysis of variance showed that age did not have a significant effect on the mean LOS (F [5, 105]=1.13, P=0.348) [Fig]. However, the mean LOS significantly differed between general ward and private ward patients (3.06 ± 0.59 vs 3.66 ± 1.46 days, P=0.003) [Table 3].

## Complication and re-admission

No postoperative complications or instances of 30-day re-admission were observed among patients who underwent TKA. Among patients who underwent THA, three (two from the conventional group, one from the ERAS group) had complications. In the conventional group,

one patient with spondyloepiphyseal dysplasia experienced dislocation during in-patient stay, which required closed reduction; one patient experienced dislocation during postoperative week 3, which required re-admission and revision to offset the liner and a longer neck hip ball to improve soft tissue tension. In the ERAS group, one patient had periprosthetic femoral fracture after an accidental fall on postoperative day 13, which required re-admission with revision to the long cementless stem, as well as cable fixation. No patients in either group experienced postoperative wounds or periprosthetic infections.

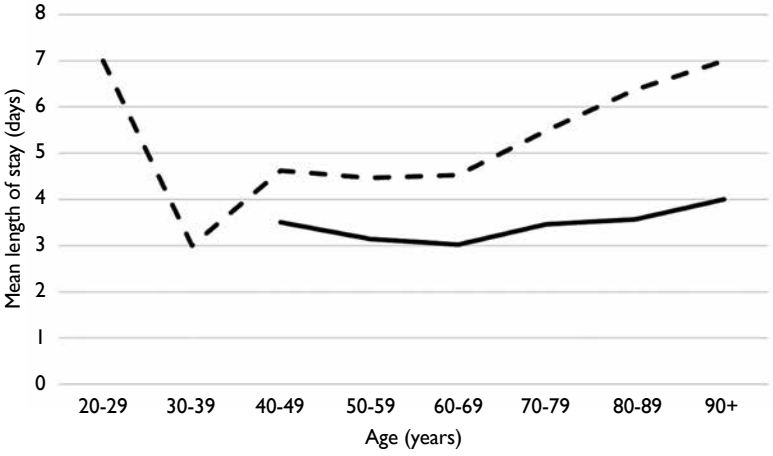


FIG. Postoperative length of hospital stay according to age-group for conventional recovery (dashed line) and enhanced recovery after surgery (solid line)

## Discussion

Despite more efficient service provision, postoperative LOS in private hospitals might be limited by confounders that surgeons cannot control (eg, patient preference and financial factors).[25] Nevertheless, it was unsurprising that our results were consistent with previous literature: ERAS practices are effective for reducing the LOS after unilateral primary arthroplasty.

Regarding factors that affect postoperative LOS, a significant difference in the mean LOS was observed between general ward and private ward patients in the ERAS group. In public hospitals, the LOS among patients with worse socio-economic backgrounds is often limited by inadequate social support from family after discharge[26] or a suboptimal home environment (eg, non-lift landing flats in older urban buildings).[27] While placement issues are rarely problematic for patients in private hospitals,[28] a possible explanation for the difference in LOS between general ward and private ward patients, where the cost difference is on average 5 times higher, is that patients with better socio-economic backgrounds may have higher expectations for surgical outcomes[29]; thus, they may tolerate longer hospital stays for rehabilitation, despite the higher costs of such stays. Private insurance is also reportedly an independent predictor of discharge delay despite objective readiness for discharge[30]; however, we presumed that the effect of insurance was not applicable in the present study because fewer than 10% of patients in our cohort had no insurance coverage. Furthermore, no significant differences in the mean LOS were noted with regard to the nature of surgery, sex, or age in the ERAS group. These findings may be related to the use of standardised ERAS practices and perioperative protocols, which have minimised variation in patient management.[31]

The implementation of ERAS practices in private hospitals is potentially beneficial to all stakeholders (including hospital administrators) because it facilitates hospital bed availability, while reducing costs via shorter convalescence duration and reduced morbidity.[32] However, there are some important challenges for surgeons who wish to initiate ERAS practices in private centres. These challenges include occasional requirements for minor alterations in ward environments, changes in anaesthesia technique, rapid turnover of in-house surgical staff, and noncompliance with ERAS practices.[33] Furthermore, a large caseload might be necessary to attract a dedicated multidisciplinary team for the sustainable development of ERAS practices in private centres. While it may be challenging to achieve full ERAS implementation in a short period of time, the stepwise addition of ERAS components might improve patient outcomes in private hospitals.[34]

There were some limitations in this study. First, this study used a retrospective design without randomisation, which may have led to imbalance and bias in the results. Second, this study only involved patients from a single surgeon; thus, the sample size was small. Third, differences in functional status and co-morbidities were not considered in the analysis, as the electronic health record sharing system between public and private hospitals was only established in 2016 so complete acquisition of patient's parameters was not possible. Finally, other clinical outcome parameters and patient satisfaction were not investigated; these will be examined in a future study, where a thorough documentation in patient reported outcome measure and clinician-based outcome measure will improve the validity of results.

In conclusion, ERAS practices produced significant improvement in mean postoperative LOS, compared to conventional practices, for patients who underwent unilateral primary THA or TKA in a private hospital. Specifically, a significantly greater proportion of patients in the ERAS group were able

to return home on or before postoperative day 3. The findings indicate that the good outcomes of ERAS practices in public joint replacement centres can be reproduced in private hospitals with sufficient caseloads and consistent implementation of ERAS practices.

### Author contributions

Concept or design: KY Chiu.
Acquisition of data: MMT Chung.
Analysis or interpretation of data: MMT Chung.
Drafting of the manuscript: MMT Chung, JKF Ng, FY Ng, PK Chan.
Critical revision of the manuscript for important intellectual content: KY Chiu.

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

### Conflicts of interest

All authors have disclosed no conflicts of interest.

### Declaration

The results of this study were presented in the Hong Kong Orthopaedic Association 40th Annual Congress in Hong Kong (31 October to 1 November 2020).

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### Ethics approval

This study was approved by the Hong Kong Sanatorium & Hospital Medical Group Research Committee (Ref RC-2019-25). The requirement for patient consent was waived for this retrospective study.

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