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ARTHROPLASTY

Are postoperative blood tests always required after lower limb arthroplasty?

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Aims

It is common practice for patients to have postoperative blood tests after total joint replacement (TJR). However, there have been significant improvements in perioperative care with arthroplasty surgery, and a drive to reduce the length of stay (LOS) and move towards day-case TJR. We should reconsider whether this intervention is necessary for all patients.

Methods

This retrospective study included all patients who underwent a primary unilateral TJR at a single tertiary arthroplasty centre during a one-year period. Electronic medical records of 1,402 patients were reviewed for patient demographics, LOS, and American Society of Anesthesiologists (ASA) grade. Blood tests were examined to investigate the incidence of postoperative anaemia, electrolyte abnormalities, and incidence of acute kidney injury (AKI).

Results

For total knee arthroplasties, preoperative (R = –0.22) and postoperative haemoglobin (R = 0.2) levels were both negatively correlated with LOS ($p < 0.001$). For all patients who had undergone a TJR, 19 patients (0.014%) required a blood transfusion postoperatively due to symptomatic anaemia. Risk factors identified were age, preoperative anaemia, and long-term aspirin use. Significant abnormal sodium levels were found in123 patients (8.7%). However, only 36 patients (2.6%) required intervening treatment. Risk factors identified were age, preoperative abnormal sodium level, and long-term use of non-steroidal anti-inflammatory drugs, angiotensin receptor blockers, and corticosteroids. Similarly, abnormal potassium levels were evident in 53 patients (3.8%), and only 18 patients (1.3%) required intervening treatment. Risk factors identified were preoperative abnormal potassium level, and long-term use of angiotensin-converting enzyme inhibitors and diuretics. The incidence of AKI was 4.4% (61 patients). Risk factors identified were age, increased ASA grade, preoperative abnormal sodium, and creatinine level.

Conclusion

Routine blood tests after primary TJR is unnecessary for most patients. Blood tests should only be performed on those with identifiable risk factors such as preoperative anaemia and electrolyte abnormalities, haematological conditions, long-term aspirin use, and electrolyte-altering medications.

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Introduction

Total joint replacement (TJR) is a common and successful surgical intervention. There are approximately 160,000 TJRs performed annually in England and Wales, with high patient satisfaction scores and improved patient health outcomes.[1] As a result of the COVID-19 pandemic, there has been a substantial increase in waiting times for TJR.[2] This has led to an increase in popularity of day-case TJR, as it is more efficient, cost-effective, and most importantly, does not compromise patient safety.[3,4] Day-case TJR is not common practice in the UK and the average length of stay (LOS) for patients undergoing a TJR in the UK is four days.[5] However, there have been significant improvements in postoperative recovery from major surgery following

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Table I. Patient demographic data (total n = 1,402).

Variable	Value
Total cohort	
Mean age, yrs (range)	68 (25 to 95)
M:F, n	622:780
Operation, n	
TKA	776
THA	626
Male: Female, n	
TKA	338:438
THA	284:342
Mean age, yrs (range)	
TKA	71 (25 to 92)
THA	77 (25 to 95)
ASA grade 1, n (%)	
TKA	38 (4.9)
THA	54 (8.6)
ASA grade 2, n (%)	
TKA	490 (63.1)
THA	377 (60.2)
ASA grade 3, n (%)	
TKA	244 (31.4)
THA	191 (30.5)
ASA grade 4, n (%)	
TKA	4 (0.5)
THA	3 (0.5)

ASA, American Society of Anesthesiologists; THA, total hip arthroplasty; TKA, total knee arthroplasty.

the principles of enhanced recovery after surgery (ERAS). ERAS techniques have greatly improved perioperative care pathways of TJR.[6] There is evidence that enhanced perioperative management reduces complications, shortens hospital stays, and improves patient satisfaction.[7,8] In the context of ERAS principles, the necessity of ordering routine postoperative laboratory tests has been questioned. The National Institute of Health and Care Excellence (NICE) does not detail guidelines on routine postoperative blood investigations following TJR. This responsibility lies with the clinician to decide whether such an intervention is in the patient's best interests.

It is currently common practice for patients to have postoperative blood tests after TJR. This requires a healthcare provider's time and an additional cost to process. The routine postoperative blood tests consist of a full blood count (FBC) and urea and electrolytes (U&E), and cost approximately £12 per patient.[9,10] Therefore, as healthcare providers move towards a more efficient process and day-case TJR, we must consider whether such an intervention is necessary for all patients. Studies have suggested that postoperative blood tests after TJR may not routinely be required.[11,12] This study aimed to assess the necessity of routine postoperative blood tests following primary TJR by determining the incidence of abnormal postoperative blood results and whether any intervention was required. We also aimed to assess whether we can identify risk factors for abnormal postoperative blood results, and therefore target healthcare resources more appropriately.

Methods

This retrospective study included all patients who underwent a primary unilateral total hip arthroplasty (THA) or total knee arthroplasty (TKA) at a tertiary arthroplasty centre (Nottingham University Teaching Hospitals NHS Trust, Nottingham, UK) during 2019. No patients were excluded from the study. As per local protocol, all patients underwent routine preoperative assessment. Anticoagulant and antiplatelet medications are routinely stopped for the recommended duration before surgery. All patients undergoing TJR were given 1 g tranexamic acid intravenously at induction. TKAs received 2 g intra-articular tranexamic acid (TXA) and THAs a further 1 g intravenous TXA. Postoperative blood tests were regularly taken on the day after surgery.

The following patient data were collected from their electronic medical records: demographics, LOS, American Society of Anesthesiologists (ASA) grade,[13] and blood test results including pre- and postoperative haemoglobin, electrolytes (sodium and potassium), and creatinine levels. Risk factors for anaemia and electrolyte abnormalities were recorded. Normal values for haemoglobin were determined as > 130 g/l in males and > 120 g/l in females; sodium 134 to 145 mmol/l; potassium 3.5 to 5.3 mmol/l; and creatinine 50 to 98 µmol/l in males and 45 to 84 µmol/l in females. Acute kidney injury (AKI) was measured by the increase in creatinine level from the patient's baseline. A creatinine increase of 1.5× to 2× the baseline level was AKI grade 1, an increase of 2× to 3× was AKI grade 2, and an increase of greater than 3× was AKI grade 3. Any treatment for abnormal results was recorded. Local guidelines from Nottingham University Hospitals NHS Trust defining a threshold for treatment were followed. Packed red blood cells were warranted if haemoglobin levels were < 70 g/l or the patient was symptomatic. Treatment was warranted for sodium levels < 130 mmol/l or > 145 mmol/l, potassium levels < 3.5 mmol/l or ≥ 6 mmol/l, and AKI level 1 or greater.

ASA and LOS. A total of 1,402 patients were included in this study. 776 patients underwent a TKA and 626 patients underwent a THA. ASA grades for both cohorts are summarized in Table I. The mean LOS for the TKA and THA cohort was 4.3 days (1 to 33) and 4.5 days (1 to 35), respectively. For both the TKA and THA groups, ASA grades were positively correlated with LOS, Pearson R = 0.3132 and R = 0.2874, respectively ($p < 0.001$).

Statistical analysis. Preoperative variables were tested with simple logistic regression to assess the relationship with postoperative blood test abnormalities. Statistical

Table II. Mean pre- and postoperative haemoglobin levels, with ranges in brackets.

TKA			THA		
Preop Hb	**Postop Hb**	**Postop reduction in Hb**	**Preop Hb**	**Postop Hb**	**Postop reduction in Hb**
135 (96 to 176)	117 (85 to 164)	18 (-31 to 56)	135 (86 to 174)	112 (70 to 155)	23 (-12 to 64)

THA, total hip arthroplasty; TKA, total knee arthroplasty.

Table III. Regression coefficients and odds ratios for risk factors associated with anaemia.

Factor	Odds ratio (95% CI)	p-value
Age	1.022 (1.011 to 1.034)	< 0.001
ASA grade	1.147 (0.9241 to 1.425)	0.215
Preoperative anaemia	8.777 (4.847 to 17.89)	< 0.001
Warfarin	0.4828 (0.2199 to 1.112)	0.074
DOAC	0.9569 (0.5972 to 1.588))	0.859
Clopidogrel	0.7391 (0.4392 to 1.289))	0.269
Aspirin	1.874 (1.172 to 3.149))	0.012

ASA, American Society of Anesthesiologists; CI, confidence interval; DOAC, direct oral anticoagulants.

analysis was performed using SPSS v22 (IBM, USA). A p-value < 0.05 was considered significant.

Results

Haemoglobin levels. Pre- and postoperative levels for the TKA and THA groups are summarized in Table II.

In the TKA group, preoperative Hb (R = –0.22) and postoperative haemoglobin (R = 0.2) were both negatively correlated with LOS (p < 0.001). However, there was no statistically significant correlation between pre- or postoperative haemoglobin and LOS in the THA group. In the TKA group, one patient (0.12%) required a blood transfusion postoperatively due to symptomatic anaemia (pre- and postoperative haemoglobin 103 and 78, respectively). This patient underwent a complex primary TKA and had a drain for 24 hours.

In the THA group, 18 (2.9%) patients required a blood transfusion postoperatively for symptomatic anaemia. Two of those patients underwent complex primary THA and two others had prior haematological issues. Ten (56%) of the 18 patients who required a blood transfusion were anaemic before surgery. Risk factors identified for postoperative anaemia were age, preoperative anaemia, and long-term aspirin use (Table III).

Sodium levels. There were no patients with postoperative hypernatraemia (> 145 mmol/l) in either the TKA or the THA groups. The number of patients with hyponatraemia is summarized in Table IV.

In the TKA group, of the 71 patients who had significant postoperative hyponatraemia (< 130), 29 (40.8%) had hyponatraemia preoperatively, 60 (84.5%) were on medication(s) that cause hyponatraemia, and eight (11.2%) had no identifiable risk factors for hypotraemia. Overall, 21 (26.6%) required treatment for their hyponatraemia.

Table IV. Patients with hyponatraemia.

Variable	TKA	THA
Hyponatraemia, n (%)	234 (30.1)	179 (28.6)
Significant hyponatraemia (sodium < 130), n (%)	71 (9.1)	52 (8.3)
Symptomatic hyponatraemia (sodium < 125), n (%)	11 (1.4)	8 (1.3)

THA, total hip arthroplasty; TKA, total knee arthroplasty.

In the THA group, of the 52 patients who had significant postoperative hyponatraemia (< 130), 23 (44.2%) had hyponatraemia preoperatively, 38 (73.1%) were on medication(s) that cause hyponatraemia, ten (19.2%) had no identifiable risk factors for hyponatraemia, and 15 (28.8%) required treatment for their hyponatraemia.

Risk factors identified for postoperative abnormal sodium levels were age, preoperative abnormal sodium level, long-term use of non-steroidal anti-inflammatory drugs (NSAIDs), angiotensin receptor blockers (ARBs), and corticosteroids (Table V).

Potassium levels. Postoperative potassium levels are summarized in Table VI.

In the TKA group, of the 29 patients who had abnormal potassium levels, five (17.2%) had an abnormal preoperative potassium level, 19 (65.5%) were taking medications that affect potassium levels, five (17.2%) had no risk factors for hypo/hyperkalaemia, and 11 (38.9%) required treatment.

In the THA group, of the 24 patients who had abnormal potassium levels, one (4.2%) had abnormal preoperative potassium levels, 13 (54.2%) were taking medications that affect potassium levels, eight (33.3%) had no risk factors for hypo/hyperkalaemia, and seven required treatment.

Risk factors identified for postoperative abnormal potassium levels were preoperative abnormal potassium level, long-term use of angiotensin-converting enzyme inhibitors (ACEi), and diuretics (Table V).

Renal function. The frequency of postoperative AKI is summarized in Table VII. Risk factors identified for postoperative AKI were age, ASA grade, and preoperative abnormal sodium and creatinine levels.

Discussion

Patients waiting for elective TJR are severely affected by the increasing waiting times. The solution inevitably requires improved cost-effectiveness and efficiency with already stretched resources. LOS after TJR is correlated with a significant increase in procedure cost,[14]

Table V. Regression coefficients and odds ratios for risk factors associated with electrolyte abnormalities.

	Postop abnormal sodium levels		Postop abnormal potassium levels		Postop AKI	
Risk factor	OR (95% CI)	**p-value**	OR (95% CI)	**p-value**	OR (95% CI)	**p-value**
Age	1.035 (1.024 to 1.047)	< 0.001	1.016 (0.9903 to 1.043)	0.239	1.040 (1.014 to 1.069)	0.003
ASA grade	1.134 (0.9290 to 1.386)	0.216	0.8557 (0.5289 to 1.378)	0.523	1.850 (1.189 to 2.893)	0.007
Preop abnormal sodium	12.33 (7.44 to 21.51)	< 0.001	1.210 (0.4807 to 3.314)	0.476	2.764 (1.286 to 5.410)	0.005
Preop abnormal potassium	0.7063 (0.3274 to 1.396)	0.342	4.430 (1.619 to 10.32)	0.001	1.301 (0.580 to 3.209)	0.524
Preop creatinine	0.9961 (0.9904 to 1.001)	0.167	0.9968 (0.9819 to 1.006)	0.642	0.9613 (0.9431 to 0.9787)	0.001
ACEi	1.138 (0.8584 to 1.500)	0.369	1.811 (0.9795 to 3.225)	0.049	0.9013 (0.4527 to 1.659)	0.752
NSAID	0.6786 (0.4997 to 0.9121)	0.011	0.8920 (0.4187 to 1.727)	0.749	0.5564 (0.2423 to 1.117)	0.128
Diuretics	1.290 (0.9316 to 1.773)	0.120	5.174 (2.911 to 9.091)	< 0.001	1.044 (0.4742 to 2.050)	0.908
SSRI	0.8553 (0.5533 to 1.292)	0.469	0.6374 (0.1534 to 1.770)	0.455	1.375 (0.5600 to 2.899)	0.441
PPI	0.9796 (0.7747 to 1.237)	0.863	1.006 (0.5698 to 1.748)	0.983	0.8330 (0.4851 to 1.399)	0.497
TCA	0.9095 (0.6040 to 1.343)	0.641	0.7700 (0.2299 to 1.927)	0.621	1.219 (0.4972 to 2.563)	0.631
B-blocker	1.176 (0.8587 to 1.599)	0.306	0.8080 (0.3294 to 1.702)	0.605	1.315 (0.6585 to 2.432)	0.407
ARB	1.664 (1.178 to 2.336)	0.004	1.201 (0.4880 to 2.543)	0.659	1.737 (0.8429 to 3.286)	0.108
Corticosteroids	2.099 (1.002 to 4.349)	0.046	2.884 (0.6735 to 8.524)	0.090	1.540 (0.2453 to 5.294)	0.561
Aspirin	0.9797 (0.6583 to 1.434)	0.917	0.7740 (0.2222 to 1.861)	0.576	0.4546 (0.1099 to 1.250)	0.188

ACEi, angiotensin-converting enzyme inhibitor; AKI, acute kidney injury; ARB, aldosterone receptor blocker; ASA, American Society of Anesthesiologists; CI, confidence interval; NSAID, non-steroidal anti-inflammatory drug; OR, odds ratio; PPI, proton pump inhibitor; SSRI, selective serotonin receptor inhibitor; TCA, tricyclic antidepressants.

Table VI. Postoperative potassium levels.

Potassium level	TKA	THA
Postop hypokalaemia, n (%)	23 (3.0)	22 (3.5)
Postop hyperkalaemia, n (%)	6 (0.8)	2 (0.3)

THA, total hip arthroplasty; TKA, total knee arthroplasty.

Table VII. Incidence of acute kidney injury.

AKI grade	TKA	THA
1, n (%)	29 (3.7)	21 (3.4)
2, n (%)	4 (0.5)	4 (0.6)
3, n (%)	1 (0.1)	2 (0.3)

AKI, acute kidney injury; THA, total hip arthroplasty; TKA, total knee arthroplasty.

therefore decreasing LOS will improve the procedure's cost-effectiveness.[15] Notably, without compromising safety, day-case TJR has been proven to benefit patients and healthcare systems due to reduced cost.[16] In this study, we have shown that ASA grade was positively correlated with LOS, which has also been found in other studies.[17,18] This is likely due to patients with a higher ASA grade requiring more significant input after surgery before being deemed safe to leave the hospital. ASA grade could potentially determine the day of surgery, as in most centres there is reduced inpatient healthcare provider coverage over weekends. Consequently, it may be beneficial to match patients with high ASA grades, who require more input and resource, with the period of the week when more healthcare providers and thus more input are available.

With an ageing population and increasing need for TJR, it appears essential that continuous improvement of perioperative pathways and possibly a move towards day-case surgery will be required to meet the demand for TJR. ERAS has already proved to reduce the rate of mortality, transfusion, complications, and LOS of inpatients undergoing TJR.[8] Our study has found that for patients undergoing TKA, preoperative haemoglobin levels are statistically correlated with LOS. A similar study has also shown that preoperative anaemia independently increases LOS for patients undergoing TKA.[19] This modifiable risk factor is easily identified preoperatively; greater emphasis should be placed on correcting preoperative anaemia in TKA patients. Perioperative blood management protocols have already been shown to reduce transfusion rates and LOS.[18,20]

Blood loss during arthroplasty surgery has always been a concern. However, with improvements in surgical technique, shorter operating times, and the introduction of tranexamic acid, there have been significant reductions in blood loss.[21] Of a total of 1,402 patients in this study, only 19 (0.014%) required postoperative transfusion, all due to symptomatic anaemia. Similar low transfusion rates have been shown in previous studies.[22] It is essential to check haemoglobin levels postoperatively if the patient is symptomatic. However, this study highlights that most patients are not symptomatic and therefore do not require this test. All symptomatic patients had at least one risk factor for requiring a blood transfusion preoperatively: complex primary TJR, prior haematological conditions (multiple myeloma and autoimmune haemolytic anaemia), or preoperative anaemia. These are in keeping with risk factors found in previous studies.[12] Identifying and managing these patients preoperatively could have avoided or at least reduced the requirement for postoperative blood transfusions, as these have associated risks such as infection, transfusion reactions, embolism, and

anaphylaxis.[23] Additionally, postoperative blood transfusion has been shown to prolong LOS.[24] The impact of postoperative anaemia cannot be underestimated, especially in orthopaedics, as it is associated with impeded functional mobility and poorer outcomes.[25]

Electrolyte levels are frequently altered after surgery due to a multitude of factors. This study found no patients with hypernatraemia, but significant hyponatraemia was found in 123 (8.7%) patients. However, only 36 (2.6%) patients required intervening treatment for their abnormal sodium levels. Similarly, abnormal potassium levels were evident in 53 patients (3.8%) patients, and only 18 (1.3%) patients required intervening treatment. With minimal numbers requiring any intervention, routinely obtaining electrolyte results cannot be cost-effective. A total of 140 out of the 176 (79.5%) of patients with postoperative electrolyte abnormalities had either abnormal preoperative electrolytes, or were routinely taking at least one medication which could have caused the electrolyte abnormality. This suggests that only certain patients with such risk factors should require postoperative blood tests. Previous studies have shown that abnormal preoperative laboratory results and certain medications are risk factors for postoperative electrolyte disturbance.[26] Patients are also at risk of AKI after major surgery. However, postoperative AKI was found in only 61 (4.4%) of all patients in this study. This implies that postoperative renal function testing is normal in the majority of patients and so should not be routinely tested.

We emphasize that blood tests provide useful information in the management and surveillance of TJR patients.[27–29] They can aid in the identification of postoperative complications.[30,31] Furthermore, postoperative laboratory tests should be ordered in symptomatic patients to avoid missing complications and clinical problems. However, abnormal postoperative laboratory results and subsequent intervention rates are low, and most postoperative blood results are normal. This study adds to the growing evidence that suggests that routine postoperative laboratory tests are unnecessary in the majority of patients, and that only patients with risk factors should undergo such tests after surgery.[32] This study also highlights that identifiable risk factors can predict abnormal postoperative blood tests. Moving forward, it is possible that a risk scoring system could be created to aid clinical decision-making about the necessity of postoperative blood tests.[33,34] Wu et al[33] have developed a risk scoring system based on preoperative, intraoperative, and perioperative risk factors to aid decision-making. This could help decide which patients are suitable for day-case surgery, or whether they need to be admitted for further monitoring and postoperative laboratory tests. Other studies have found specific comorbidities that could also guide postoperative blood tests.[35] The routine use of postoperative blood tests is a significant financial burden to healthcare providers,[36] and previous studies have suggested that this is not a cost-effective practice.[37] It is also essential that patients with these risk factors be managed and optimized preoperatively to avoid postoperative interventions. As perioperative care, surgical technique, instruments, and implants improve, so must all patient interventions. Further studies are required to better risk-stratify patients to prevent unnecessary blood tests.

This study had the following limitations: first, it is a retrospective study performed at a single centre. Second, the risk factors we focused on were preoperative blood results and medication; we did not look at intraoperative factors such as intravenous fluids or medications.

In patients undergoing TJR, most of the postoperative blood tests are normal. Our study has highlighted that the intervention rate for postoperative blood results is low, even in the presence of an asymptomatic abnormal result. Also, most patients with abnormal postoperative blood results have a preoperative risk factor. Therefore, routine postoperative blood results should not be performed on every patient. Only those with identifiable risk factors such as preoperative anaemia, haematological conditions, preoperative electrolyte abnormalities, and use of aspirin and certain electrolyte-altering medications need to have postoperative blood tests routinely.

Take home message

- This study highlights that postoperative blood tests are unnecessary in the majority of patients undergoing lower limb arthroplasty.
- There are certain risk factors for abnormal blood tests; further studies should focus on a risk scoring system to identify patients who require postoperative blood tests.

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