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 in 123 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.

Cite this article: Bone Jt Open 2023;4-5:357–362.

Keywords: Hip, Knee, Arthroplasty

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
the principles of enhanced recovery after surgery (ERAS). ERAS techniques have greatly improved perioperative care pathways of TJR. There is evidence that enhanced perioperative management reduces complications, shortens hospital stays, and improves patient satisfaction. 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 ordering of postoperative laboratory tests. 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. Antiplatelet and anticoagulant 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, 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
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 hyponatraemia (> 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 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. 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
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 patients undergoing TJR. 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.

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

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Postop abnormal sodium levels</th>
<th>Postop abnormal potassium levels</th>
<th>Postop AKI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>p-value</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Age</td>
<td>1.035 (1.024 to 1.047)</td>
<td>&lt; 0.001</td>
<td>1.016 (0.9903 to 1.043)</td>
</tr>
<tr>
<td>ASA grade</td>
<td>1.134 (0.9290 to 1.386)</td>
<td>0.216</td>
<td>0.8557 (0.5289 to 1.378)</td>
</tr>
<tr>
<td>Preop abnormal sodium</td>
<td>12.33 (7.44 to 21.51)</td>
<td>&lt; 0.001</td>
<td>1.210 (0.4807 to 3.314)</td>
</tr>
<tr>
<td>Preop abnormal potassium</td>
<td>0.7063 (0.3274 to 1.396)</td>
<td>0.342</td>
<td>4.430 (1.619 to 10.32)</td>
</tr>
<tr>
<td>Preop creatinine</td>
<td>0.9961 (0.9904 to 1.001)</td>
<td>0.167</td>
<td>0.9968 (0.9819 to 1.006)</td>
</tr>
<tr>
<td>ACEi</td>
<td>1.138 (0.8584 to 1.500)</td>
<td>0.369</td>
<td>1.811 (0.9795 to 3.225)</td>
</tr>
<tr>
<td>NSAIID</td>
<td>0.6786 (0.4997 to 0.9121)</td>
<td>0.011</td>
<td>0.8920 (0.4187 to 1.727)</td>
</tr>
<tr>
<td>Diuretics</td>
<td>1.290 (0.9316 to 1.773)</td>
<td>0.120</td>
<td>5.174 (2.911 to 9.091)</td>
</tr>
<tr>
<td>SSRI</td>
<td>0.8553 (0.5333 to 1.292)</td>
<td>0.469</td>
<td>0.6374 (0.1534 to 1.770)</td>
</tr>
<tr>
<td>PPI</td>
<td>0.9796 (0.7747 to 1.237)</td>
<td>0.863</td>
<td>1.006 (0.5698 to 1.748)</td>
</tr>
<tr>
<td>TCA</td>
<td>0.9095 (0.6040 to 1.343)</td>
<td>0.641</td>
<td>0.7700 (0.2299 to 1.927)</td>
</tr>
<tr>
<td>B-blocker</td>
<td>1.176 (0.8587 to 1.599)</td>
<td>0.306</td>
<td>0.8080 (0.3294 to 1.702)</td>
</tr>
<tr>
<td>ARB</td>
<td>1.664 (1.178 to 2.336)</td>
<td>0.004</td>
<td>1.201 (0.4880 to 2.543)</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>2.099 (1.002 to 4.349)</td>
<td>0.046</td>
<td>2.884 (0.6735 to 8.524)</td>
</tr>
<tr>
<td>Aspirin</td>
<td>0.9797 (0.6583 to 1.434)</td>
<td>0.917</td>
<td>0.7740 (0.2222 to 1.861)</td>
</tr>
</tbody>
</table>

AKI, acute kidney injury; CI, confidence interval; NSAIID, non-steroidal anti-inflammatory drug; OR, odds ratio; PPI, proton pump inhibitor; SSRI, selective serotonin receptor inhibitor; TCA, tricyclic antidepressants.

This modifiable risk factor is easily identified preoperatively; greater emphasis should be placed on correcting preoperative anaemia in TJK patients. Perioperative blood management protocols have already been shown to reduce transfusion rates and LOS. 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. 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. 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. 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.\textsuperscript{23} Additionally, postoperative blood transfusion has been shown to prolong LOS.\textsuperscript{24} The impact of postoperative anaemia cannot be underestimated, especially in orthopaedics, as it is associated with impeded functional mobility and poorer outcomes.\textsuperscript{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.\textsuperscript{24} 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.\textsuperscript{27–29} They can aid in the identification of postoperative complications.\textsuperscript{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.\textsuperscript{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.\textsuperscript{33,34} Wu et al\textsuperscript{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.\textsuperscript{35} The routine use of postoperative blood tests is a significant financial burden to healthcare providers,\textsuperscript{36} and previous studies have suggested that this is not a cost-effective practice.\textsuperscript{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.

\textbf{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.

\textbf{References}

9. Czoski-Murray C, Lloyd-Jones M, McCabe C, et al. What is the value of routinely testing full blood count, electrolytes and urea, and pulmonary function tests before elective surgery in patients with no apparent clinical indication and in subgroups of


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Funding statement:
- The authors received no financial or material support for the research, authorship, and/or publication of this article.

ICMJE COI statement:
- B. Bloch reports consulting fees and payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events from DePuy Synthes, ZimmerBiomet, and Ethicon, all of which are unrelated to this study.

Ethical review statement:
- Ethics approval was not required for this study.

Open access funding:
- The open access fee for this study was provided by Nottingham Hospital charities.

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