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## The Utility of Basic Metabolic Panel Tests After Total Joint Arthroplasty

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## ABSTRACT

**Background:** Routine laboratory studies are often obtained daily after total joint arthroplasty (TJA) regardless of medical management. The purpose of this study was to investigate the utility of routine basic metabolic panel (BMP) tests after TJA. Furthermore, the goal was to identify factors that may predispose patients to abnormal laboratory values that require medical intervention.

**Methods:** A retrospective review was performed on 767 patients who underwent primary TJA at a single institution. Preoperative and postoperative potassium, sodium, creatinine, and glucose values were collected along with demographic data, comorbidities, and procedural characteristics. Multivariable logistic regression models were used to determine independent risk factors for abnormal postoperative laboratory values.

**Results:** Diabetes was associated with abnormal glucose (odds ratio [OR] 23.4, 95% confidence interval [CI] 10.7–51.0,  $P < .001$ ), while chronic kidney disease was associated with abnormal creatinine (OR 3.1, 95% CI 1.7–5.8,  $P < .001$ ) and potassium (OR 1.8, 95% CI 1.1–2.8,  $P = .014$ ) requiring medical intervention. An abnormal preoperative laboratory value was also associated with medical treatment for each of sodium, potassium, and creatinine (all  $P < .001$ ). Average number of BMP tests collected for patients who did not receive medical intervention was 2.8. This equated to \$472,372.56 in total hospital charges.

**Conclusion:** Cost containment while maintaining high-quality patient care is critical. Routine postoperative BMP tests in patients with normal preoperative values without major medical comorbidities do not contribute to actionable information. Patients with diabetes, chronic kidney disease, or with abnormal preoperative values should obtain a BMP after TJA.

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The total number of total hip and total knee arthroplasties is expected to significantly grow within the next decade primarily due to the aging baby boomer generation [1,2]. As a result, the health-care expenditure will increase accordingly. In this era focusing on cost containment, reducing medical cost while providing quality patient care is paramount for total joint arthroplasty (TJA). Currently, emphasis has been placed on reducing

implant costs and length of hospital stay, as well as on the number discharged to acute rehabilitation or skilled nursing facilities [3–8]. For primary TJA, index hospital costs have been recently estimated between \$13,862 and \$14,675 [3,9]. This cost includes entities such as operating room fees, anesthesiology, room and board, pharmacy, physical and occupation therapy, radiology, and laboratory fees. In 2008, the estimated cost for laboratory studies was \$249 per index hospitalization per patient [10]. More recently, inpatient laboratory costs were reported to be an average of \$1033 following laparoscopic cholecystectomy [11].

It is not uncommon for routine laboratory tests such as complete blood count and basic metabolic panel (BMP) to be ordered throughout an entire hospitalization after TJA, regardless of medical intervention. To date, the utility of postoperative routine laboratory tests has been evaluated after colorectal [12], spinal [13,14], and outpatient partial knee arthroplasty [15]. However, to our

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This study was approved by the institutional review board at our institution.

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knowledge, there have been no studies evaluating the utility of BMP tests after inpatient TJA. The purpose of this study was to investigate utility and hospital charges of routine BMP tests after TJA. Furthermore, the goal was to identify factors that may predispose patients to abnormal laboratory values that require medical intervention. We hypothesized that patients with major medical comorbidities would likely need medical intervention secondary to an abnormal laboratory value and that routine BMP tests would not contribute to actionable information in healthy patients with normal preoperative laboratory values.

## Methods

This retrospective review was performed on patients who underwent primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) from January of 2012 to September of 2014 at a single institution. This study was approved by this institution's human subject review board. Exclusion criteria included all patients who underwent revision surgery, partial knee arthroplasty, those without preoperative laboratory studies, and patients without record of hospital charges.

All patient charts were manually reviewed to analyze the following data from electronic medical records: patient age, gender, procedure type, American Society of Anesthesia (ASA) score, length of procedure, preoperative and postoperative laboratory values included in a BMP, and the number of laboratory tests collected throughout hospital admission. Medical comorbidities evaluated included diabetes controlled with diet (DMD), diabetes controlled with oral medication, insulin-dependent diabetes mellitus (DMI), chronic kidney disease (CKD), coronary artery disease, history of pulmonary embolism/deep vein thrombosis, and chronic steroids. Laboratory values that were analyzed included potassium (K), sodium (Na), creatinine (Cr), and glucose (Glu). An abnormal postoperative or preoperative laboratory value was identified if recorded outside of the following corresponding ranges: potassium (3.5–5.0 mmol/L), sodium (135–145 mmol/L), creatinine (>1.1 mg/dL, and >0.2 mg/dL increase from previous value), and glucose (>140 mg/dL).

Outcomes that were analyzed included 90-day readmission, in-hospital myocardial infarction (MI), stroke, delirium, seizure, and death. All patients identified with an abnormal postoperative laboratory value were evaluated for potential medical intervention which included the following: hospitalist/endocrinologist consultation, fluid bolus, fluid restriction, electrolyte supplementation, addition or withdrawal of medication, addition of sliding scale insulin, or additional scheduled glucose laboratory tests.

The monetary charge for a BMP was provided by the medical financial department at this institute that was broken down as hospital charge and Medicare reimbursement. Total hospital charge of a single BMP test is \$297 with Medicare reimbursement of \$11. Direct hospital savings were determined by subtracting the total charge of all laboratory tests ordered from the charge of laboratory tests that resulted in a medical intervention.

Data are presented using the mean and standard deviation or median and interquartile range for continuous variables and counts with percentages for nonmissing categorical data.

Multivariable regression models were used to determine which baseline characteristics were independently associated with a postoperative laboratory value for each of sodium, glucose, creatinine, and potassium. Covariates considered for each model were age, gender, length of surgery, renal disease (CKD), diabetes (diet, insulin, and oral), history of pulmonary embolism/deep vein thrombosis, coronary artery disease, chronic steroids, procedure type (TKA or THA), as well as the associated preoperative laboratory

**Table 1**  
Patient Demographics.

	Number (Range)	Percentage
Male	310	40.4%
Female	457	59.6%
Hip	323	42.1%
Knee	441	57.5%
Age	70.87 (22–94)	
<65	85	11.1%
65–75	451	58.7%
>75	233	30.3%
ASA 1	5	0.7%
ASA 2	254	33.1%
ASA 3	500	65.2%
ASA 4	8	1.0%
DM diet	34	4.4%
DM orals	90	11.7%
DM insulin	46	6.0%
CKD	108	14.1%

ASA, American Society of Anesthesia; CKD, chronic kidney disease; DM, diabetes mellitus.

value. Results are presented using the odds ratio (OR) and 95% confidence interval (CI).

A *P* value <.05 was considered statistically significant. Statistical analyses were completed by the Duke Department of Biostatistics (Durham, NC) using SAS version 9.4 (SAS, Institute, Inc., Cary, NC).

## Results

A total of 767 patients with TJA were identified including, 310 (40.4%) male and 457 (59.6%) female patients. The mean age was 70.9 years (range 22–95). Three hundred twenty-three procedures were THA (42.2%) and 441 were TKA (57.8%) (Table 1). A complete demographic profile is provided in Table 1. Diabetes, CKD, and an abnormal preoperative laboratory value were the common risk factors identified using multivariate regression models (Fig. 1). The overall complication rate was 4.4% with 2 intensive care unit transfers and 65 (8.5%) 90-day readmissions (Fig. 2). Fourteen (1.8%) patients who sustained a complication had an abnormal BMP value that required medical management. Only 2 (0.3%) patients who sustained a complication (1 MI, 1 delirium) did not have an abnormal preoperative laboratory value, diabetes, and CKD. Both intensive care unit transfers had multiple medical comorbidities (ASA = 4) and abnormal preoperative laboratory values. Twenty-seven of the 90-day readmissions were patients who had an abnormal postoperative laboratory value that required medical management. Only 3 of these patients did not have any risk factors and were readmitted for manipulation under anesthesia, mechanical fall, and pain control (Table 2). Abnormal postoperative laboratory values had no correlation to postoperative complications. There were a total of 241 patients (31.4%) who received medical management overall, with 40 patients having more than 1 abnormal value. In total, 51 abnormal values were treated with medical management in 34 patients (4.43%) without identified risk factors (22 patients had >1 abnormal value).

Of the 767 patients who underwent primary TJA, 193 (25.2%) had an abnormal postoperative potassium value with 63/193 (32.6%) requiring medical management. Of those patients who required medical management, 26/63 (41.3%) did not have any risk factors. Five of these patients were transfused (average K level of 3.1 [range: 2.8–3.3]), one became delirious with value at 3.3, and one had a rheumatologic flare with value at 3.2. Nineteen of the 26 patients were asymptomatic and supplemented with no adverse events (average 3.2 [range: 3.1–3.4]) (Fig. 3). Multivariable logistic regression analysis found that female gender (OR 2.0, 95% CI

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