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The Utility of Preoperative Blood Screening Before Hip and Knee Arthroplasty

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ABSTRACT

Purpose

It is engrained in medical training that routine blood screening prior to arthroplasty is necessary for optimal patient care. There is little evidence to support their utility and the aggregate cost to the health system. The purpose of this study was to evaluate preoperative blood screening by identifying the frequency of an abnormal result and to examine the influence of age, gender and body mass index (BMI) on the frequency of abnormal blood pathology.

Method

This is a retrospective review of 1000 patients from a single centre who underwent elective primary hip or knee arthroplasty from 2015-2017. Abnormal blood results were identified and clinically relevant intervals were created for routine markers.

Results

939 patients had available pathology results with 84% identified as having an abnormal result and 43% having a clinically important factor. Abnormal liver function tests (LFT) and ferritin were most common. There was no significant difference by age for any abnormal result, however there was an increase in renal dysfunction, abnormal haemoglobin and ESR with increasing age. Males and patients with BMI > 40 had an increased rate of abnormal results, particularly LFTs.

Conclusion

The ordering of preoperative investigations prior to lower limb arthroplasty is recommended by NICE guidelines, alleviating concern of post-operative complications and covering medicolegal issues. Our study determined a high frequency of abnormal results, justifying routine blood screening is recommended prior to surgery, particularly for the elderly, males and obese patients.

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Keywords: Arthroplasty, Preoperative, Screening, Pathology

BACKGROUND

The numbers of hip and knee replacements is increasing in line with an aging and increasingly active population. In Australia, there has been a 139.8% increase in primary total knee replacement from 2003-2016 [1]. Preoperative management for patients undergoing major surgery, including hip and knee replacements, traditionally involves a full medical assessment including chest radiograph (Xray), electrocardiogram (ECG) and routine blood tests. The NICE guidelines recommend the minimum investigation for any patient undergoing joint replacement surgery is a full blood count (FBC). However, with American Society of Anesthesiologists Physical Status Classification System (ASA) Grade II or above, the number of recommended investigations increases to identify patients at risk, optimize perioperative morbidity, direct anaesthetic choice and guide postoperative management.

Turnbull et. al. determined in over 5000 patients undergoing elective surgery, an abnormal blood result was detected in 5%. An abnormal result was considered clinically relevant in 2% and only 0.4% of patients actually benefitted from the investigation [2]. Similar results have been found in several studies with <1% of patients having a change in management due to abnormal pathology results [3-5].

Pathology investigations incur a fee. The aggregate cost can be an enormous financial burden to the health system with unnecessary, routine and clinically irrelevant investigations.

It is engrained in medical training that these investigations are necessary for optimal patient care, however there is little evidence to support their utility. The purpose of this study is to evaluate preoperative blood screening by identifying the frequency of an abnormal result and to examine the influence of age, gender and body mass index (BMI) on the frequency of abnormal results. It is hypothesised that routine blood screening may not be required in younger, otherwise healthy patients prior to undergoing hip or knee replacement.

METHODS

Retrospective review of a prospective database of arthroplasty surgery at one Australian centre identified 1000 consecutive patients undergoing elective primary total hip replacement (THR) or total knee replacement (TKR). Four surgeons performed all surgeries at one private hospital from July 2015 to June 2017. Ethical approval for the database has been received from St Vincent's Human Research Ethics Committee (SVH 13/073).

Routine blood tests returned 59 separate markers. Clinically important factors (CIF) were selected from the panel of routine blood investigations. Selected factors that were considered most clinically relevant were creatinine (Cr), haemoglobin (Hb), sodium, white cell count (WCC), erythrocyte sedimentation rate (ESR), platelets, Estimated Glomerular Filtration Rate (eGFR), albumin, ferritin and liver function tests (LFT). Normal range and clinically important factors are shown in Table 1.

Statistical Methods

The frequency of abnormal results is expressed as a percentage of subjects. Differences in the percentage of abnormal results were compared between genders, age brackets in 10-year intervals, ASA grade, and BMI using chi square tests. Statistical significance was set at $p<0.05$. SPSS version 24 was used for the statistical analysis.

RESULTS

Of the 1000 patients identified, 939 had available pathology results. There were 552 THR and 387 TKR. There were 504 women and 435 men. The mean age was 67 years (24-96 years) and the mean BMI was 28.5 (16-58). 848 patients had recorded ASA classification. There were 147 grade 1, 482 grade 2, 216 grade 3 and 3 grade 4 ASA.

An abnormal result was identified in 84% of patients with an abnormal CIF identified in 404 patients (43%). By far the most common abnormality was LFT which was present in 21%, followed by ferritin at 18%. The remaining abnormalities are listed on Table 2.

There was not found to be any significant difference when correlated CIF to the patient's age (p=0.07). However, the frequency of abnormality did significantly increase with age in regards to renal function (Cr and eGFR), Hb and ESR (Figure 1). The greatest percentage being in those patients over the age of 80. No patients displaying abnormal renal function under the age of 60, whereas 24% of patients over 80 years had abnormal eGFR. Similarly, 9% of patients over 80 had an abnormality in Hb, compared to 1-2% in each of the other age groups. Abnormalities in LFT were found to be more frequent in the younger demographic with the highest rate occurring in those under 50 (31%) and the lowest in those over 80 (9%).

In regards to gender, for any CIF there was a significantly increased rate of abnormal blood results in males (48% vs.39%) (p=0.006). This was particularly true for LFT with 28% having an abnormal result compared to 15% of women. (Figure 2)

High BMI was also found to have an influence, with 68% of patients with a BMI over 40 identifying as having an abnormal CIF (p<0.001). ESR, platelets and LFT were abnormal in a significantly greater percentage of patients with BMI >40. (Figure 3)

The proportions of patients with abnormal results was not significantly influenced by ASA classification (p=0.942). Interestingly there was a significantly higher proportion of patients with abnormal renal function (Cr and eGFR) in the ASA 1 group compared to other ASA grades (p=0.01 and p=0.004). (Figure 4)

DISCUSSION

With rising healthcare costs, responsible clinical practice includes developing strategies to reduce expenses without compromising patient care. The purpose of this study was to identify a possible area in preoperative management in which cost could be reduced for patients undergoing hip and knee replacement. The results from this study show a surprisingly high percentage of patients with abnormal pathology results. The frequency of an abnormal result is increased with older age, higher BMI and is more common in males. Interestingly in our study ASA grade did not seem by influence frequency of abnormal results.

Kaplan et. al. determined that of 2785 patients having routine preoperative investigations only 3.4% had a result which exceeded the action limit and only in 0.22% of patients did this result in further investigations or cancellation of surgery[3]. Similarly, a study from the Mayo Clinic found that in healthy adults, preoperative abnormalities were identified in 4.2% [5]. This is strikingly different from our study with 84% of patients found to have any abnormal result and 43% with abnormal clinical important factor. One possible reason for this is that Kaplan did not specify his patient population, while the Mayo patients were classified as ASA I. At the time of review, no other studies have been specifically conducted on patients undergoing joint replacements. The Joint Registry of Australia reports that 85.7% of patients undergoing THR and 92% of TKR patients have ASA II or III [1]. This indicates the vast majority of patients have mild to severe systemic disease which would almost certainly be reflected in pathology results. In our study the mean age was 67 years and 57% were ASA II, with mild systemic medical disease and 25% ASA III with severe medical disease. It is possible that with an older cohort of patients we would expect to see a greater frequency of abnormal investigations. In fact, we did determine that the frequency of abnormal renal function and anaemia does increase with age, particularly in those over 80 years. Although it would be beneficial to evaluate patients based on specific medical comorbidities this is a limitation of the registry data; in our study overall ASA grade did not appear to influence the frequency of abnormal results. As the arthroplasty procedures performed in this study were elective, those with more serious medical comorbidities, or those with poorly controlled disease would not have undergone surgery, perhaps reflecting the lack of significant difference in this study.

Abnormal blood results were also significantly more common with increasing BMI. This is intuitive that obese or morbidly obese patients will likely have greater medical comorbidities. They are generally recognized as being at greater risk during surgery and of experiencing more complications, including increased risk of post-operative kidney injury [6-8]. Obesity is recognized as a state of low grade inflammation and thus may be the cause of elevated ESR and platelets in the BMI >40 group [9]. The relevance of this result in joint replacement surgery is yet to be determined.

There was also found to be a significant difference in regards to gender, with males being more likely to have an abnormal result. This was particularly true for LFT with 28% of men having abnormal LFT. In general, the most commonly abnormal pathology test was LFT (21%), particularly in younger male patients and primarily GGT. GGT is a sensitive indicator of hepatobiliary pathology, but it is not specific. GGT is known to be elevated with alcohol abuse but also diabetes, pancreatic disease and myocardial infarction. It has been reported that sensitivity of elevated GGT for detecting excessive alcohol consumption may be as high as 94% [10]. Alcohol ingestion may affect a patient under anaesthetic, post-operatively and throughout their rehabilitation. It is important to recognize in our patients this common abnormality and question accordingly.

More in agreement with the results of our study, Yazici et. al found a blood result out of normal range in 93.4% of patients undergoing elective septal surgery [11]. Despite the large percentage of abnormal results, all but 0.8% were deemed to be minimally out of range and could be ignored based on history and examination. Thus, perhaps the difference between an abnormality as determined by laboratory ranges and a clinically significant result needs to be better defined. Although we attempted to be more specific in determining what is an abnormal range, it is difficult to identify at which range a result becomes clinically significant. By identifying clinical important factors (CIF) in our study the percentage of abnormal results nearly halved. It would be prudent and possibly cost effective to take a detailed medical history and examination and order patient specific investigations rather than a battery of routine tests. It has previously been found that with a detailed review of the patient's history and examination up to 75% of patients would not require any tests [12].

Given the high frequency of abnormal pathology results, it may also be important to recognize what is baseline for the patient. A mildly elevated ESR or LFT may not be a concern in isolation, however, irregularities are more alarming if they are new, and a suddenly low Hb is more

concerning than persistent anaemia. It has previously been reported that 75% of patients have an increase in LFT following surgery, with GGT having the greatest rise of 38% [13]. Thus, in a patient with an already elevated LFT it may be of benefit to know their baseline rather than concern for liver pathology secondary to the surgery, new medication or post-operative care. It has also been found that inflammatory markers may be elevated in arthroplasty patients prior to surgery with 46% found to have elevated ESR and 25% CRP [14]. As these are important markers for prosthetic joint infection it may improve sensitivity to know the patients baseline level. Kildow et. al, found that in patients with a normal pre-operative Hb there was no added value in ordering FBC post-operatively, however those patients with a low pre-operative Hb had a transfusion rate of 15% [15]. Thus, a preoperative evaluation of what is baseline for the patient may identify high risk individuals, counsel them appropriate and likewise prevent multiple post-operative investigations and delay discharge.

Bernstein et. al reported on the value of a pre-operative optimization protocol for patients leading into arthroplasty surgery [16]. This protocol, which included routine blood screening, determined that pre-operative investigations resulted in decreased length of stay, fewer post-operative investigations and lower direct cost. In our patient cohort with a high frequency of abnormal results we support a method to identify patients at risk and intervene as required to optimize them for surgery. As most arthroplasty patients have modifiable risks, pre-operative screening allows for opportunity to improve outcomes.

Due to the nature of registry data, our study was limited in that we were not able to identify if action had been taken on an abnormal result. Although previously referenced studies have reported low rates of intervention, in an arthroplasty population this may not be the case. Saleh et.al found that 20% of major arthroplasty patients were anaemic on preoperative investigation and 42% of those patients required a transfusion [17]. The transfusion rates reported for the orthopaedic ward at our hospital over the time of the study and for primary total knee and hip patients operated on by the four surgeons in this trial was only 20 patients for THA and 16 for TKA. This low rate of transfusion out of the large cohort of patients suggests that abnormal results were identified on pre-operative assessment and intervention may have occurred prior to surgery. It is also difficult to standardize intervention as it is based on surgeon preferences and is often carried out by other health care specialists, such as the general practitioner or internal medicine specialist. The addition of data relating to any changes in treatment that was actioned as a results

of abnormal blood tests would certainly strengthen this study, and it is unfortunate that this was not possible to reliably ascertain in this cohort. Further investigation would be warranted in future prospectively designed studies.

The ordering of preoperative investigations is recommended by NICE guidelines as well as several surgical and anaesthetic organizations. It is also ingrained in habit, alleviates concern of post-operative complications and covers medicolegal issues. We also feel it to be justified given the high frequency of abnormal results. In our practice, pre-operative blood screening remains standard of practice to identify at risk patients, to avoid potential complications and to identify a patient's baseline to prevent unnecessary post-operative investigation and prolonged length of stay. Although other studies have identified low rates of abnormal results, no study has focused on a large cohort of patients undergoing hip or knee replacements. Based on our results, routine blood screening is recommended prior to arthroplasty surgery, particularly for the elderly, males and obese patients.

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Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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TABLES

TABLE 1: Normal range of selected blood markers with clinically important factor

Test	Normal range	CIF
Creatine	Females age <70 (45-85) Females age >70 (45-95) Males age <70 (60-110) Males age >70 (60-120)	Females >100 Males >125
Haemoglobin	Females age <70 (119-160) Females age >70 (110-160) Males age <70 (130-180) Males age >70 (128-175)	Females <110 Males <120
Sodium	135-145	<130
White Cells	4-11	<3.5
ESR*	Females <35 Males <30	>30
Platelets	150-450	<140
eGFR**	>59	<55
Albumin	Females age <50 (37-48) Females age 50-80 (36-47) Females age >80 (34-45) Males age <50 (39-50) Males age 50-80 (36-47) Males age >80 (34-45)	<34
Ferritin	Females age <50 (15-200) Females age >50 (30-300) Males (30-300)	Females <15, >250 Males <30, >350
Liver Function Tests **AST** **ALT** **GGT**	 10-40 5-40 <35 females, <50 males	 >40 >40 >50

Range identified by Douglass Hanly Moir

*Erythrocyte sedimentation rate

**Estimated Glomerular Filtration Rate

322 TABLE 2: Frequency of abnormal results from Clinically Important Factors

Test	% of patients
Total	43
Liver Function Tests	21
Ferritin	18
Erythrocyte sedimentation rate	9
Estimated Glomerular Filtration Rate	6
Creatine	4
Haemoglobin	2
Platelets	1
White Cell Count	1
Sodium	1
Albumin	0

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FIGURES