Pre-operative Investigations: Yield and Conformity to National Guidelines

H Juliana, BMedSc*, T A Lim, FRCA*, K Inbasegaran, FANZCA**

*Anaesthesiology Unit, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Hospital Kuala Lumpur, Jalan Masjid, 50586, Kuala Lumpur, **Department of Anaesthesiology and Intensive Care, Hospital Kuala Lumpur, Jalan Pahang, Kuala Lumpur

Summary

Routine ordering of pre-operative investigations yields a low true positive rate and is not cost effective. In this study, case notes of 251 adults who underwent elective surgery were reviewed. Pre-operative investigations were classified as 'indicated' or 'not indicated', based on the national guidelines. Only 56% of all tests done were indicated. The overall rates of expected and unexpected abnormal values from pre-operative blood investigations were 51.1% and 34.4% respectively. This study found that selective testing based on guidelines was beneficial. However, the results also suggest that the local guidelines need to be reviewed.

Key Words: Pre-operative investigations, Clinical Practice Guidelines, Cost-effectiveness

Introduction

Pre-anaesthetic evaluation is the initial step in preparing a patient for surgery. At the conclusion of the evaluation, the anaesthetist would have developed a plan for anaesthesia and peri-operative management. Generally, the task is to have the patient in the best possible condition prior to surgery, with an ultimate goal of reducing peri-operative morbidity and mortality[1].

Laboratory investigations are part of the pre-anaesthetic evaluation. They complement history and physical examination in detecting and assessing diseases that may be present in a patient prior to surgery. The most common pre-operative laboratory investigations are the full blood count (FBC), serum electrolytes, blood urea nitrogen (BUN) and serum creatinine, blood glucose, prothrombin time (PT), partial thromboplastin time (aPTT), chest x-ray (CXR), electrocardiograph (ECG) and urinalysis[2].

During the 1970s, the practice of routinely ordering pre-operative laboratory investigations by doctors world-wide proceeded relatively without question. In the 1980s, many assessments of medical technology concluded that routine pre-operative investigations without suspected or known patient disease yield an extremely low rate of true positive test results and were not cost-effective.

Studies have shown that the usefulness of selectively ordered pre-operative tests is high compared to the practice of routine testing[3,4]. In response, several guidelines for ordering pre-operative laboratory investigations have been produced. For example, University Hospital Consortium (UHC) of the United States, a non-profit alliance of leading academic medical centres, proposed a strategy for pre-operative testing based on the work by Kaplan and Blery[3,5].

In Malaysia, similar guidelines have been produced for local use[6]. These guidelines have been available in Hospital Kuala Lumpur (HKL) since 1998. However, no study has been carried out to see whether the guidelines have been followed, and whether the guidelines have any role in improving cost-effectiveness.

This study was designed to determine the yield of commonly ordered pre-operative blood investigations in patients undergoing elective surgery in Hospital Kuala Lumpur. The study also looked at whether the practice of ordering pre-operative investigations followed the recommendations of the national guidelines.

Materials and Methods

A hospital-based, descriptive cross sectional study was conducted over ten weeks from June 5 to August 10, 2001. The study was conducted at the Urology, Mobile and Accident & Emergency Operation Theatres (OT) in Hospital Kuala Lumpur (HKL).

Study Population
Patients above 12 years old, having elective surgical procedures under general, spinal or epidural anaesthesia, were eligible for inclusion into the study. Patients were sampled from five different surgical disciplines: General Surgery, Orthopaedics, Urology, Gynaecology and Ophthalmology. Within each surgical discipline, 20 morning OT lists were sampled, giving a total of 100 OT lists sampled during the study period.

Data Collection
A standardised pro forma sheet (Appendix 1) was used to obtain all the required information. Data collection was carried out in the OT on the day of surgery. Relevant information was obtained from the admission forms, the patients' medical records, the anaesthetic forms and the laboratory result slips. Whenever possible, patients were interviewed to confirm the correctness of the data. The investigations reviewed were:
1. Full blood count (FBC)
2. Blood urea, serum electrolytes and creatinine (BUSEC)
3. Random Blood Sugar (RBS)
4. Prothombin time and activated partial thromboplastin time (PT/aPTT)
5. Liver function tests (LFT)
6. Electrocardiograph (ECG) and
7. Chest x-ray (CXR).

Data Analysis
Blood test results were considered abnormal if values obtained were outside the normal range used in HKL. For investigations that consist of more than one component (FBC, BUSEC, LFT and PT/aPTT), the investigation was considered abnormal when at least one abnormal value was present in the cluster of results.

Investigations done were first classified as indicated or not indicated based on the guidelines for pre-operative laboratory investigations at HKL (Appendix 2). For blood tests, it was then determined whether the result was normal or abnormal. Expected abnormal results were abnormal results obtained when the test was indicated, whereas unexpected abnormal results were abnormal results obtained from tests which were not indicated (Figure 1). The decision to assign a test as indicated or not indicated, and a result as normal or abnormal was made by one of four specialist anaesthetists. The following ratios were then calculated:

$$\text{Proportion of expected abnormal results} = \frac{\text{No. of expected abnormal results}}{\text{Total no. of indicated blood tests done}}$$

$$\text{Proportion of unexpected abnormal results} = \frac{\text{No. of expected abnormal results}}{\text{Total no. of not indicated blood tests done}}$$

Conformity to the National Guidelines was determined using the decision algorithm shown in Figure 2. The medical notes of every patient were checked to see whether any of the above 7 tests were done. The National Guidelines was then checked to determine whether any particular test should have been done. If any test was done and was indicated, then that test was considered a test done which conformed to guidelines. Similarly, if a test was not done and was not indicated, that test was considered a test not done which conformed to guidelines. Tests done which were not indicated and tests not done which were indicated were considered tests which did not conform to the guidelines.

Data were analysed using Statistical Packages for Social Science (SPSS) Version 10.0. Differences between proportions were compared using the χ^2 test, with Yates' correction where appropriate. Differences between means were compared using Student's t-test. A value of p < 0.05 was considered significant. Total deviation rate was calculated using the ratio:

$$\text{Total Deviation rate} = \frac{\text{Number of tests that did not confirm} \times 100\%}{\text{Total number of tests (none \& not done)}}$$

Results

There were 251 patients who fulfilled the inclusion criteria, 140 males and 111 females. The mean (SD) age was 45.5 (17.8) years. Table I shows the distribution of respondents by age and sex. A total of 214 concurrent diseases were reported by 129 respondents. The most common diseases encountered were cardiovascular disease (29.1% of all patients), renal disease (22.3%) and diabetes mellitus (17.1%).

Yield of Pre-operative Blood Investigations
Figure 3 shows the frequencies of the 7 pre-operative investigations ordered among the respondents. Out of 1117 pre-operative investigations, 816 were blood tests, of which 751 were available for analysis (Table II). Of 375 tests that were not indicated, 129 (34.4%) had abnormal results. The highest percentage of unexpected abnormal results was seen in FBC, where there were 71 (68.9%) abnormal results out of 103 tests that were not indicated. This was followed by LFT (55.0%), PT/aPTT (28.6%), BUSEC (27.1%) and RBS (0.9%). The proportions of unexpected abnormal values in the individual components of the blood tests are shown in Table III.

Out of 230 Hb concentration tests available for analysis, 94 (40.9%) were outside the normal range. All abnormal values were lower than normal, ranging from 5.4 to 11.9 g dL^{-1}. Expected abnormal concentrations were detected in 56 patients (44.1%) out of 127 in whom the test was recommended. The mean (SD) Hb level when the abnormal value was expected was 10.1 (1.2) g dL-1, while the corresponding value when it was unexpected was 10.6 (1.4) g dL^{-1}. This difference was not significantly different (t = 1.97, df = 92, p = 0.05). The difference in proportions of patients with expected and unexpected abnormal levels was also not statistically significant (χ^2 = 1.22, df = 1, p = 0.27).

The mean (SD) Hb level in female patients was 11.7 (1.6) g dL^{-1}, while the corresponding value in males was 12.9 (2.3) g dL^{-1}. This difference was significantly different (t = 4.219, df = 228, p < 0.01). Furthermore, it was also found that 54.1%

of female patients presented with abnormal Hb levels compared to more 31.1% of male patients. This difference was also significantly different (χ^2 = 12.3, df=1, p < 0.01).

The proportion of expected abnormal BUSEC results was significantly higher than the proportion of unexpected abnormal results (Table II). Out of 224 blood urea concentration tests available, 17 (7.6%) were abnormal, all of which were expected. Thirty-seven patients had expected elevated serum creatinine concentrations while only one patient had an unexpected elevated serum creatinine concentration. Significantly different proportions of patients had expected and unexpected abnormal serum creatinine values (χ^2 = 15.9, df=1, p < 0.01).

The proportion of abnormal RBS values was 20.3% when the test was indicated. However, only 0.9% of unexpected abnormal RBS results were found out of 106 tests that were not indicated. This difference in proportions was statistically significant (χ^2 = 18.0, df=1, p < 0.01).

Conformity to National Guidelines
Of the 1117 pre-operative investigations done, 625 (56.0%) conformed to the guidelines (Table IV). The highest conformity was the ECG, where 80% of 148 ECGs done followed the guidelines. On the other hand, the most overused test was the PT/aPTT, where only about 9.4% of 64 tests done followed the guidelines (Figure 4a).

Conformity to the guidelines, however, includes not only tests done following the guidelines, but also tests not done because no indications for ordering the tests was present in the guidelines. With regards to the latter, 575 (90%) of 640 pre-operative tests not done conformed to the guidelines (Table IV). Indications were actually present in 65 (10%) instances where the tests were not done. Among tests not done, the highest conformity occurred in PT/aPTT (99%), followed by LFT (92%), and the lowest occurred in ECG (75%) (Figure 4b).

The proportion of tests done which conformed to the guidelines (56.0%) was significantly lower than the proportion of test not done which conformed (89.8%; x^2 = 215.8, df = 1, p < 0.01). Total deviation rate was 31.7%.

Table I: Distribution of Respondents by Age and Sex

Age (years)	Male	Female	Total
< 20	14	5	19
20 - 29	26	13	39
30 - 39	18	23	41
40 - 49	23	30	53
50 - 59	16	18	34
60 - 69	22	15	37
70 - 79	18	6	24
> 79	3	1	4
Total	140 (56%)	111 (44%)	251 (100%)

Table II: The Yield of Pre-operative Blood Investigations

Blood Investigation	Done			Results			
	Indicated	Not indicated	TOTAL	Normal	Abnormal		Comparing proportions of expected and unexpected abnormal results
					Expected	Unexpected	
FBC	127	103	230	64	95	71	$\chi^2 = 0.98$, df = 1, p = 0.32
BUSEC	154	70	224	131	74	19	$\chi^2 = 8.67$, df = 1, p < 0.01
LFT	10	40	50	24	4	22	$\chi^2 = 0.25$, df = 1, p = 0.62
PT/aPTT	6	56	62	43	3	16	$\chi^2 = 0.38$, df = 1, p = 0.54
RBS	79	106	185	168	16	1	$\chi^2 = 18.0$, df = 1, p < 0.01
TOTAL	376	375	751	430	192	29	

Table III: Proportion of unexpected abnormal values seen in this and previous studies

Blood Investigation	Proportion of unexpected abnormal values seen in this study	Proportion of unexpected abnormal values seen in previous studies [8,9,10,12]
FBC:		
Hb	36.9%	0 - 10%
TWBC	19.4%	0.1 - 9.5%
Platelet count	9.7%	0 - 11.8%
RBC count	55.3%	
BUSEC:		
Blood Urea	0%	1.0%
Serum Sodium	17.1%	n/a
Serum Potassium	10.0%	n/a
Serum Creatinine	1.4%	0.2% - 2.4%
LFT		
Total Protein	15.0%	n/a
Serum Albumin	47.5%	n/a
Total Bilirubin	15.0%	n/a
Coagulation Studies		
PT	19.6%	0% - 2.9%
APTT	5.4%	1.4%
RBS	0.9%	1.8% - 5.5%

n/a = not available

Table IV: Number of pre-operative investigations done according to guidelines recommendations

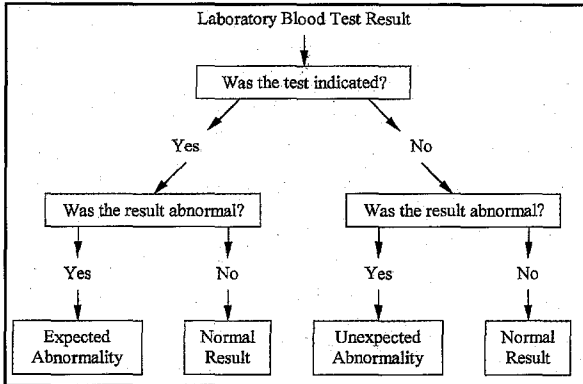|	Conform to guidelines	Did not conform to guidelines	TOTAL
Tests done	625	492	1117
Tests not done	575	65	640
TOTAL	1200	557	1757

Fig. 1: Algorithm for classifying a blood investigation result
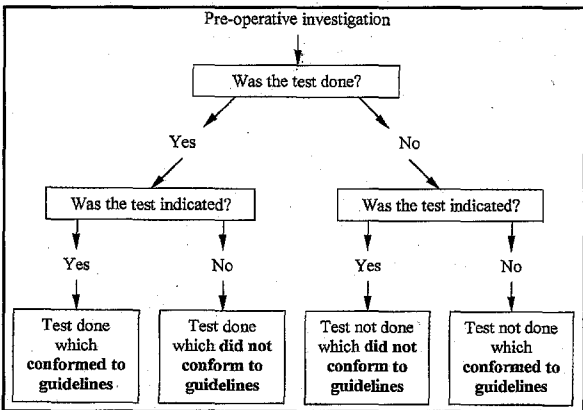

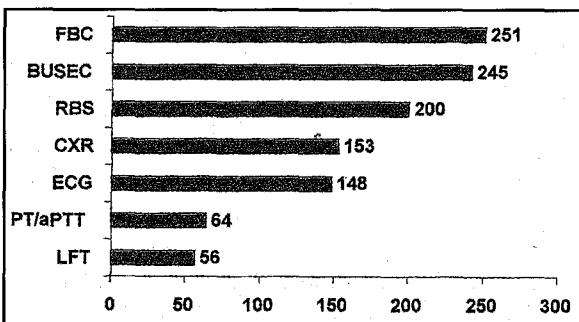**Fig. 2: Algorithm for classifying pre-operative investigations**

Fig. 3: Common pre-operative investigations done in HKL
Total number of patients = 251
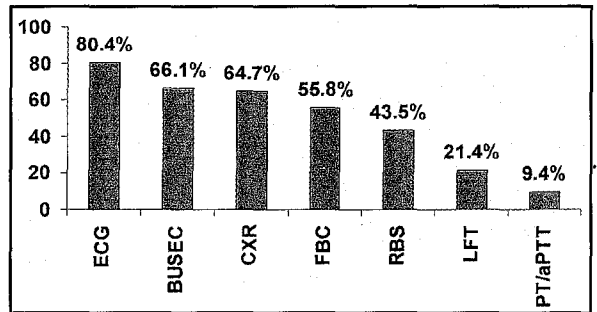**Total number of investigations done = 1117**

Fig. 4a: Percentage of laboratory blood tests which were done that conformed to the National Pre-anaesthetic Investigations Guidelines
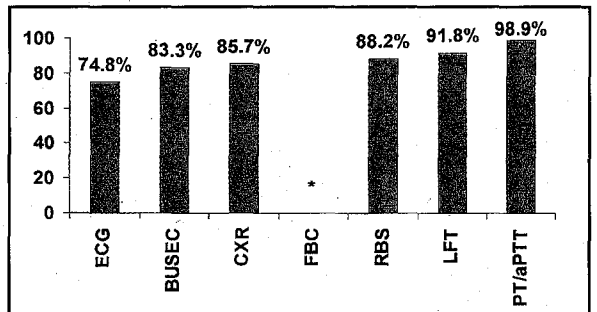

Fig. 4b: Percentage of laboratory blood tests which were not done that conformed to the National Pre-anaesthetic Investigations Guidelines.
***All patients had a pre-operative FBC.**

Discussion

This study revealed quite a high percentage of unexpected abnormal values (34.4%) when compared to other studies. McKee and Scott reported 16% while Turnbull and Buck reported only 4.5%[7,8]. A comparison between percentages of unexpected abnormal values in this and previous studies is shown in Table III. The percentages of unexpected abnormal values found in the FBC components were high compared to other studies[8,9,10]. However, similar to other studies, female patients were more likely to have abnormal Hb values compared to male patients. This supports the suggestion that the

need for pre-operative Hb measurement in both sexes may differ[11].

The percentages of unexpected abnormal blood urea and serum creatinine values found in this study were within the range previously reported[8,9]. Similar to previous studies, only a small percentage of unexpected abnormal values was found in RBS[8,9,12]. However, higher percentages of unexpected abnormal PT and aPTT values were recorded in this study[8,9].

The higher percentages of unexpected abnormal values found in the present study may be because of how 'indicated' and 'abnormal values' were defined. While most researchers defined a test as indicated only after the patient has been seen and assessed clinically, laboratory tests done in the present study were assigned as indicated when recommended by the guidelines. This could have lead to instances where laboratory tests that were required clinically being classified 'not indicated' according to the guidelines. This in turn would have lead to a higher percentage of unexpected abnormalities. However, it is by using this definition that an evaluation of the guidelines was possible.

'Normal' values in this study referred to the reference range used in HKL. This may differ from the wider reference range used in some of the other studies. Such a range can be widened by including not only values found in the normal population, but also all values where no therapeutic intervention was needed. The narrow range of values used in this study may have contributed to the high percentage of abnormal values. In addition, up to 5% of normal individuals can have test results that fall outside the 'normal' range[13].

The proportion of tests done which conformed to the guidelines was lower than the proportion of tests not done which conformed. This is because many of the tests ordered were not recommended by the guidelines, and suggests that there is a greater tendency to investigate patients even when it is not recommended. The guidelines

suggest that for healthy patients undergoing short, minimally invasive procedures, investigations may not be necessary.

Compared to similar studies, the conformity of tests done in the present study was low (56%). Blery et al. found a 70% conformity of tests done while Adams et al., found a 96% conformity to the protocol at County / UH and 88% at the private / Community Hospital[5,14].

Although most recommended tests were actually done and most non-recommended tests were not done, a 32% deviation from the guidelines was still seen. This deviation rate is high when compared to a study done about 15 years ago where a deviation rate of 18% was reported[5].

Guidelines should only serve as a guide and never as substitute for the doctors' own clinical judgement. This could be one of the reasons why doctors deviate from guidelines. The low conformity in the present study could also be caused by the doctors not being aware that such guidelines exist, or because the guidelines were not adequately circulated. It must be appreciated that the guidelines being evaluated are for tests recommended for administration of anaesthesia and are not intended for surgical management. As such, certain tests may be deemed necessary from the surgeon's point of view, but may have been excluded from the guidelines. This emphasises the need for co-operation between disciplines when developing Clinical Practice Guidelines.

The pre-operative investigations guidelines aim to maximise the detection of abnormal values. A low percentage of unexpected abnormalities mean that the guidelines are able to discriminate between patients who require certain laboratory tests from those who do not.

In this study, the discriminatory ability of the guidelines was well demonstrated by the BUSEC and the RBS. Following the guidelines, almost all patients who had impairment of renal function

required a pre-operative BUSEC. Similarly, almost all patients with high blood sugar required a RBS. Unfortunately, the number of patients in this study with LFT and PT/aPTT results were too small to make a useful comparison. Assuming an expected abnormality rate of 50%, unexpected abnormality rate of 35% and a power of 80%, the number of samples needed for each blood test is 167. The results of this study also suggest that many patients with anaemia would not have been detected if the guidelines were rigidly followed. Two reasons could account for this. Clinical anaemia, which is one of the recommended criteria for carrying out a FBC, could have been noticed but not documented in the patient's notes. Secondly, there is always an element of subjectivity in clinical examination and pallor could have been missed in a number of patients. This is not surprising as low Hb levels are quite common in the population of a developing country. For Clinical Practice Guidelines to remain relevant, they need to be reviewed periodically when new evidence is discovered[15]. The findings of this study suggest that the guidelines available in HKL might not be effective enough in detecting abnormal FBC test results, and therefore require review.

Several limitations of this study may have contributed to the present findings. While other studies looked into the percentages of unexpected abnormalities as well as beneficial changes in patient management, this study only addressed the unexpected abnormalities encountered. Any action taken in response to the abnormal results was not documented. This means that abnormal results encountered in the present study may or may not be clinically important.

All patients recruited into the study were already seen pre-operatively by the attending anaesthetist and the decision to proceed with operation was already made. Patients who had their operation cancelled by the surgeon or anaesthetist when the blood investigations were grossly abnormal were not included in this study. While this would have determined the yield of clinically significant abnormal pre-operative test results, logistic requirements for such a study was beyond the resources available. In any case, there would have been little effect on the calculation of the yield and rate of conformity. One of the objectives of the study was to determine whether the yield of expected abnormal results was higher than the yield of unexpected results. Showing this to be true in patients who are clinically fit for surgery supports the need for rational pre-operative laboratory testing.

This study found that the overall rate of expected and unexpected abnormal values from pre-operative blood investigations to be 51.1% and 34.4% respectively. Selective testing based on guidelines is beneficial as shown by the BUSEC and RBS. However, the list of indications in the present guidelines may need to be modified as many abnormal values were still left undetected. In addition, low conformity to the guidelines might be reflective of disagreement between doctors involved in pre-operative care and the presently available guidelines.

Acknowledgements

References

1. Traber KB. Preoperative evaluation. In: Longnecker DE, Murphy FL (eds) Introduction to Anaesthesia. London : WB Saunders Company, 1997.

2. Fildes JJ, Robin AP. Preoperative and postoperative care. In: Condon RE, Nyhus LM (eds) Manual of surgical therapeutics. New York: Lippincott Williams & Wilkins, 1996: 212-54.

3. Kaplan EB, Sheiner LB, Boeckmann AJ, et al. The usefulness of preoperative screening. JAMA 1985; 253: 3576-81.

4. Charpak Y, Blery C, Chastang C, et al. Usefulness of selectively ordered preoperative tests. Med Care 1988; 26: 95-104.

5. Blery C, Charpak Y, Szatan M, et al. Evaluation of a protocol for selective ordering of preoperative tests. Lancet 1986; 1: 139-41.

6. Chapter of Anaesthesiologists, Academy of Medicine of Malaysia. Recommendations on Pre-anaesthetic Assessment. Kuala Lumpur, 1998.

7. McKee RF, Scott EM. The value of routine preoperative investigations. Ann Roy Coll Surg Eng 1987; 69: 160-62.

8. Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. Arch Intern Med 1987; 147: 1101-05.

9. Sanders DP, McKinney FW, Harris WH. Clinical evaluation and cost effectiveness of preoperative laboratory assessment on patients undergoing total hip arthroplasty. Orthopedics 1989; 12: 1449-53.

10. Macpherson DS. Preoperative laboratory testing: Should the test be "routine" before surgery? Med Clin of North Am 1993; 77: 289 - 307.

11. Roizen MF, Cohn S. Preoperative evaluation for elective surgery: What laboratory tests sre needed? In: Stoelting RK, Barash PG, Gallagher TJ (eds). Advances in Anaesthesia. Chicago: Mosby, 1993.

12. Narr BJ, Hansen TR, Warner. Preoperative laboratory screening in healthy Mayo patients: Cost-effective elimination of tests and unchanged outcomes. Mayo Clinic Proceedings 1991; 66: 155-59.

13. Stoelting RK, Miller RD. Basics of Anaesthesia. London: WB Saunders Company, 2000.

14. Adams JG, Weigelt JA, Poulos E. Usefulness of preoperative laboratory assessment of patients undergoing herniorrhaphy. Arch Surg 1992; 127: 801-5.

15. Shekella P, Eccles MP, Grimshaw JM, Woolf SH. When should clinical guidelines be updated? BMJ 2001; 323: 155-57.

APPENDIX 1
PROFORMA SHEET FOR COLLECTION OF DATA

Date:

Reference no:

DEMOGRAPHIC DATA AND SOCIAL HISTORY:

Name: Sex:

Registration No:

I/C No:

Address:

Race: Malay / Chinese / Indian/ Others (specify)

Age:

Weight:

Marital Status:

Smoking status: Never / Ex-smoker / Current smoker / Others

Use of Alcohol: Yes / No

SURGICAL INFORMATION:

Type of surgery:

Concomitant Diseases: Cardiovascular Disease   Diabetes Mellitus

Renal Disease   Respiratory Disease

Haematological Disease   Clinical Anemia

Liver Disease   Hepatobiliary Disease

Others (specify):

Medication: Yes / No

If Yes:

1.

2.

3.

4.

PRE-OPERATIVE INVESTIGATIONS:

	Laboratory Investigation	Performed	Value
1	**ECG**		N/A
2	**FBC:**		
	Hb		
	TWBC		
	Platlet count		
	RBC count		
	MCH		
	MCV		
3	**Coagulation Profile:**		
	PT		
	APTT		
4	**LFTs:**		
	Total Protein		
	Serum Albumin		
	Total Bilirubin		
	Enzymes - AST		
	ALT		
	LDH		
5	**CXR**		N/A
6	**Renal Profile:**		
	Blood Urea		
	Serum Na$^+$		
	Serum K$^+$		
	Serum Creatinine		
7	**RBS / FBS**		

APPENDIX 2
GUIDELINES FOR PRE-ANAESTHETIC LABORATORY INVESTIGATIONS

<u>Recommended Pre-anaesthetic Investigations</u>

These tests are recommended for administration of anaesthesia and are not intended to limit those required for issues specific to their surgical management.

Full Blood Count
Age above 60
Clinical anaemia
Haematological disease
Renal disease
Chemotherapy
Procedures with blood loss >15%

Blood Urea, Serum Electrolytes and Creatinine
Age above 60
Renal disease
Liver disease
Diabetes Mellitus
Cardiovascular disease
Procedures with blood loss >15%

Random Blood Sugar
Age above 60
Diabetes Mellitus
Liver dysfunction

Liver Function Tests
Hepatobiliary disease
Alcohol abuse

Prothombin Time and activated Partial Thromboplastin Time
Haematological disease
Liver disease
Anticoagulation
Intrathoracic/ Intra-cranial procedures

Electrocardiogram
Age above 50
Cardiovascular disease
Diabetes Mellitus
Renal disease

Chest X-ray
Age above 60
Significant Respiratory disease Cardiovascular disease

Note: for healthy patients undergoing short, minimally invasive procedures, investigations may not be necessary.