

Preoperative testing at a university hospital in a developing country: are the requested tests indicated?

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Declaration

I, Iwan van der Nest declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature

Signed at: University of the Witwatersrand, Johannesburg

On this date: 26 May 2014

Abstract

Background: At Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) preoperative tests are mostly requested directly by the surgeons and this is not done according to national or international standards or guidelines. The preoperative tests are often not appropriate for the particular patient and could cause patients additional discomfort, lead to cancellation or postponement of the planned surgery and generate unnecessary financial expenditures. CMJAH is a resource limited hospital and the preoperative test practice at this hospital is unknown.

Aim: The aim of this study was to audit and evaluate preoperative tests requested for adult patients scheduled for elective surgery at CMJAH.

Method: Data was collected utilising a preoperative assessment form, designed for the purpose of this study, completed by different anaesthetists during their preoperative visits.

Each preoperative assessment form was considered individually. It was determined which preoperative tests were requested, by whom and if it was appropriate according to the National Institute for Health and Clinical Excellence (NICE) Guidelines for preoperative testing. The results for the laboratory investigations were obtained from the National Health Laboratory Service (NHLS) at CMJAH. The results were then analysed to determine if there was an association between the NICE Guidelines' recommendation and the detection of abnormal results.

Results: A total of 1093 preoperative tests were requested for the 277 patients included in this study (3,95 tests per patient). The test that was requested most frequently was the chest X ray (CXR) (n=240, 21,96%). The anaesthetists requested a total of 53 (4,85%) additional preoperative tests. In this group of tests the electrocardiograph (ECG) was requested most frequently (n=16, 30,12%).

Ten different clinical departments requested a total of 1093 tests. Of these, 346 (31,66%) would not have been recommended by the NICE Guidelines. It was found that

general surgery requested the greatest number of unnecessary tests (n=112, 32,37%) and Ophthalmology requested the least number of unnecessary tests (n=7, 2,02%).

When one considers the number of unnecessary tests requested as a percentage of the tests requested by each particular discipline it was found that the greatest percentage of unnecessary tests were requested by Urology (46,67%) with Vascular surgery (11,11%) requesting the smallest percentage of unnecessary tests.

In an attempt to determine if there were any statistically significant associations ($p < 0,05$) between the NICE Guidelines' recommendation and the detection of abnormal results, no statistically significant association could be established except for the urea results ($p = 0,0027$).

Conclusion: The abundance of unnecessary preoperative tests identified with this study illustrates the need for the development and implementation of a multifactorial strategy for the reduction of unnecessary preoperative tests at CMJAH.

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List of abbreviations

ABG	Arterial blood gas analysis
ASA	American Society of Anesthesiologists
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
CT	Computed Tomography
ECG(s)	Resting electrocardiography(-ies)
FBC(s)	Full blood count(s): Including haemoglobin, white cell count and platelet count
Hb(s)	Haemoglobin(s)
INR(s)	International Normalised Ratio(s)
NHLS	National Health Laboratory Service
NICE	National Institute for Health and Clinical Excellence
PLT(s)	Platelet count(s)
PT(s)	Prothrombin time(s)
PTT(s)	Activated partial thromboplastin time(s)
SASA	The South African Society of Anaesthesiologists
UCE(s)	Renal function tests: Including measurement of sodium, chloride, potassium, urea and creatinine
WCC(s)	White cell count(s)
CXR(s)	Chest x-ray(s)

Chapter 1: Overview of the study

1.1 Introduction

An overview of the study is given in this chapter and will include: the background to the study, the problem statement, aim and objectives, research assumptions, demarcation of the study field, ethical considerations, research methodology, significance of the study, validity and reliability summary and study outline.

1.2 Background to the study

The practice of ordering a battery of routine preoperative tests for patients scheduled for a surgical procedure still appears to be the standard at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH). Goal-directed preoperative testing should rather be the norm as routine testing is counter efficient and not cost effective (1). Preoperative tests are indicated when it is likely that they correctly identify abnormalities or change the diagnosis, the management plan or the patient's outcome (2). The discovery of an unsuspected condition that could change the anaesthetic, surgical or medical management of the patient is possibly an advantage of routine preoperative testing. The incidence of this is however very low and it rarely changes the anaesthetic management of the patient (3-5).

Routine preoperative testing is not without consequence and may put the patient at risk of unnecessary further investigation. This may result in significant financial expenses and could impact on the operating theatre schedule. With an increased use of preoperative tests there is an increased yield of false positive test results. This occurs as normal results are considered to fall within two standard deviations of the mean for a particular population, which translates to 5% of healthy people having abnormal results. (4) For the patient this could mean further consultations with physicians, further investigations with a possible risk of injury from these investigations and an overall unpleasant experience(6, 7).

Narr et al (8) estimated, based on data from 1988, that a annual cost saving of between \$3 billion and \$4 billion could be achievable in the United States of America if preoperative tests were limited to those indicated by history and examination. Review of the literature revealed no similar data for South Africa. This cost is compounded by the possible medico-legal implications of not reacting to abnormal results and by the interference with the operating theatres' schedule (1). There is also the ethical principle of distributive justice to consider when faced with limited resources.

Various strategies have been employed to minimise unnecessary preoperative testing. This includes the use of standardised guidelines, the use of preoperative assessment clinics, anaesthetist driven requesting of tests and the total omission of preoperative testing (9-14).

Various attempts at developing evidence-based practice guidelines for preoperative testing have been made. Due to inconsistencies in the literature, the American Society of Anesthesiologists (ASA) opted to publish a practice advisory (15). In the United Kingdom the National Institute for Health and Clinical Excellence (NICE), an independent organisation that produces evidence-based guidelines for the promotion of good health and treatment of disease, published guidelines for preoperative testing in 2003 (16). The South African Society of Anaesthesiologists (SASA) recommends that the choice of preoperative investigation be guided by findings of the preoperative assessment (17). The use of guidelines for preanaesthetic tests is by no means a silver bullet as compliance with these guidelines seems to be a challenge (5, 18).

A further strategy to decrease unnecessary testing is to improve the preoperative evaluation by the utilisation of preoperative assessment clinics (14). One of the aims of the preoperative assessment clinic is to avoid unnecessary investigations through thorough history taking and physical examination. It also serves the purpose of optimising the patients' medical condition, which reduces their perioperative risk (19). This helps to streamline the perioperative process and reduce the number of patients being cancelled or rescheduled on the day of the surgery (20, 21).

Anaesthetist-driven requesting of preoperative testing also seems to have an impact in reducing unnecessary testing. Katz et al (13) demonstrated that anaesthetists were between 53% and 67% less likely than surgeons to order unnecessary preoperative tests.

The omission of routine preoperative testing for low risk surgery has also been proven not to pose an increased perioperative risk to the patient (12, 22, 23).

The problem of unnecessary requesting of preoperative tests is a global phenomenon. A review of the literature revealed very little work published from the developing world. Pal et al (24), working in Pakistan, indicated that, except for a higher incidence of anaemia, there was no significant increase in abnormal test results.

With limited data related to the developing world and specifically South Africa, there is a void in the knowledge on our patterns of requesting preoperative tests.

1.3 Problem statement

At Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) preoperative tests are mostly requested directly by the surgeons and this is not done according to national or international standards or guidelines. The preoperative tests requested are often not appropriate for the particular patient and could cause patients additional discomfort, lead to cancellation or postponement of the planned surgery and generate unnecessary financial expenditures. CMJAH is a resource limited hospital and the preoperative test practice at this hospital is unknown.

1.4 Aim of the study

The aim of this study was to audit and evaluate preoperative tests requested for adult patients scheduled for elective surgery at CMJAH.

1.5 Objectives of the study

The primary objectives of this study were to:

- document all requested preoperative tests;
- determine the number of preoperative tests requested by the anaesthetist;
- determine the number of requested preoperative tests that were not recommended according to the NICE Guidelines for preoperative testing;
- determine each clinical department's contribution to the unnecessary preoperative tests that were requested

The secondary objective of this study was to determine if there is an association between the NICE recommendation for preoperative testing and the detection of abnormal results in laboratory tests.

1.6 Research assumptions

The following definitions shall apply in this study:

Adult: An individual of the age 18 years or older.

ASA grade: the ASA grade is a simple scale describing fitness to undergo an anaesthetic.

ASA grade 1: a normal healthy patient with no systemic disease

ASA grade 2: a patient with mild to moderate systemic disease

ASA grade 3: a patient with severe systemic disease imposing functional limitations on the patient

ASA grade 4: a patient with severe systemic disease that is a constant threat to life

ASA grade 5: a moribund patient who is not expected to survive without the operation

ASA grade 6: a patient declared brain-dead whose organs are being removed for donor purposes (25).

Routine testing: Testing carried out indiscriminately on all patients as part of the preoperative assessment that is not directly related to the planning of the surgical

procedure e.g. computed tomography (CT) scans for staging of cancer (16). In accordance with the NICE guidelines the following tests will be considered:

- Chest x-ray (CXR)
- Resting electrocardiography (ECG)
- Full blood count: Including haemoglobin, white cell count and platelet count (FBC)
- Haemostasis tests: Prothrombin time (PT), activated partial thromboplastin time (PTT) and international normalised ratio (INR)
- Renal function tests: Including measurement of sodium, chloride, potassium, urea and creatinine (UCE)
- Blood glucose test
- Urine 'dipstick' test
- Pregnancy test
- Blood gases: arterial and venous blood gas analysis
- Pulmonary function tests/ flow-volume-loop: Measurements of peak expiratory flow rate, forced vital capacity and forced expiratory volume.

Unnecessary testing: Testing that is not indicated by preoperative testing guidelines.

Abnormal results: Results that do not fall within the normal range of the particular test as determined by the National Health Laboratory Service (NHLS).

Surgical grading: The surgical grading system as used in the NICE Guideline for preoperative testing. The grade increases with the severity of the surgery. The grading with examples of surgeries is:

Grade 1 (minor): Excision of lesion of skin; drainage of breast abscess

Grade 2 (intermediate): Primary repair of inguinal hernia; excision of varicose veins of leg; tonsillectomy/adenotonsillectomy; knee arthroscopy

Grade 3 (major): Total abdominal hysterectomy; endoscopic resection of prostate; lumbar discectomy; thyroidectomy

Grade 4 (major+): Total joint replacement; lung operations; colonic resection; radical neck dissection; neurosurgery; cardiac surgery.(16)

1.7 Demarcation of the study field

CMJAH is a 1066 bed hospital affiliated to the University of the Witwatersrand. It is centrally located in the city of Johannesburg and offers mainly tertiary level care consisting of inpatient services and specialist outpatient clinics. It functions as a referral hospital for numerous secondary hospitals surrounding the city of Johannesburg in the province of Gauteng. The hospital has 23 operating theatres in its main theatre complex. An estimated 20 000 patients receive surgical treatment of various types at this complex annually.

1.8 Ethical considerations

Approval to conduct the study was obtained from the relevant authorities (Appendices A, B and C). Participation in the research was voluntary. Written informed consent was obtained from patients (Appendices D and E). Where patients were incompetent or incapable of giving consent it was obtained from a legally authorised representative.

Confidentiality was maintained in the study. The study was conducted according to Good Clinical Practice and in adherence to the World Medical Association's Declaration of Helsinki (26).

1.9 Research methodology

1.9.1 Research design

A prospective, contextual, descriptive research design was used in this study.

1.9.2 Study population

The study population was adult patients, of ASA grade 1 to 3, scheduled for elective surgery at the CMJAH main theatre complex.

1.9.3 Study sample

The minimum sample size for this study was calculated at 267 patients based on the number of elective surgeries performed in 2010, an expected prevalence of unnecessary tests of 50%, a confidence level of 90% and precision of 5%. This was done in consultation with a biostatistician and with the aid of Statcalc a function of the program Epi Info 7.

In this study a convenience sampling method was used. The inclusion and exclusion criteria were as follow.

1.9.4 Inclusion and exclusion criteria

Inclusion criteria:

- adult patients 18 years and older;
- ASA Grade 1 to 3;
- scheduled for elective surgery.

Exclusion criteria:

- patients scheduled for cardiothoracic- or neurosurgery;
- patients who did not consent to take part in the study.

1.9.5 Description of data collection

The data were collected from the preoperative assessment forms (Appendix F) designed for the purpose of this study. Anaesthetists were requested to complete the preoperative assessment forms, after obtaining signed informed consent from the patients, at the time of their preoperative visits. The forms and consent forms were then placed in boxes at various points in the main theatre complex at CMJAH for collection by the researcher.

Each collected preoperative assessment form was then processed to determine if a signed informed consent form accompanied it and if the patient met the inclusion criteria.

Using the data obtained from preoperative assessment forms the researcher determined if the requested preoperative tests were indicated according to the NICE Guidelines for preoperative testing (Appendix G). After considering the patient's age, ASA grade, existing comorbid conditions and the surgery severity grade it was determined whether a particular preoperative test:

- was not recommended,
- should have been considered, or
- was recommended according to the NICE Guidelines for preoperative testing.

The results for the laboratory investigations were then requested and provided by the NHLS at CMJAH. It was then determined if the results were normal (within the NHLS' normal range) or abnormal (outside of the NHLS' normal range).

1.9.6 Statistical Analysis

The raw data was captured using Excel 2011 version 14.3.9 by Microsoft and analysis was done using both Excel and StatCalc version 7.3.3, a program by AcaStat software.

1.10 Significance of the study

Routine preoperative testing is not only inefficient, but also costly (1) and CMJAH is a resource limited hospital. No standard guideline for preoperative testing is, to the best of the researcher's knowledge, consistently used at CMJAH. The number of unnecessary preoperative tests performed at CMJAH is unknown. The literature does not reveal data specific for South Africa except for limited work done on ECGs, CXRs and clotting tests (27, 28). This study can possibly identify the need for the development and implementation of institution-specific guidelines for preoperative testing.

1.11 Validity and Reliability

Measures were put in place to ensure validity and reliability of the study.

1.12 Study report outline

The outline of the study is as follows.

- Chapter 1: an overview of the study.
- Chapter 2: a comprehensive literature review of the various components related to preoperative tests.
- Chapter 3: a detailed explanation of the research methodology.
- Chapter 4: the presentation of the results and the discussion thereof.
- Chapter 5: summary of the research, limitations, recommendations and the conclusion of the study.

1.13 Summary

This chapter provided an overview of this study. It included the background to the study, the problem statement, aim and objectives, research assumptions, demarcation

of the study field, ethical considerations, research methodology, significance of the study, validity and reliability and the study outline.

In the next chapter a review of the relevant literature is presented.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter preoperative testing will be examined with a review of the literature. The aim of preoperative testing will be discussed first, followed by routine preoperative testing, looking at the risks of and reasons for routine preoperative testing. Next, possible solutions and alternatives to routine preoperative testing will be discussed, including history taking and physical examination and the use of standardised guidelines, with a closer look at the ASA and NICE Guidelines for preoperative testing. The effect of anaesthetist-driven requesting of preoperative tests and the utilisation of preoperative clinics as ways of reducing the number of preoperative tests will be dealt with next. Lastly the complete omission of preoperative testing and its effects will be considered.

2.2 The aim of preoperative testing

In preparation for surgery many patients are admitted prior to the actual day of surgery to facilitate their preoperative evaluation. This would include history taking, physical examination and the performance of preoperative tests. It is important to consider what one wishes to achieve by performing any sort of preoperative test. The aims of the preoperative assessment, and of preoperative testing, are to reduce the surgical and anaesthetic morbidity and mortality, to increase the quality of perioperative care, to return the patient to his/her optimum level of functioning and to provide enough information to enable the patient to give informed consent for the procedure(1, 2).

In order for a preoperative test to render a useful contribution towards achieving the goal of restoring the patient to the optimum level of functioning it needs to meet the following criteria:

- diagnostic efficacy- does the test correctly identify abnormalities?
- diagnostic effectiveness- would the test change your diagnosis?

- therapeutic efficacy- would the test change your management?
- therapeutic effectiveness- would the test change the patient's outcome?

Tests meeting none or only one of these criteria would not be useful, whereas tests meeting three or four of the criteria would be considered very useful (2).

2.3 Routine preoperative testing

Unfortunately preoperative testing is often done routinely and not according to standard guidelines (5). In studies conducted in Europe and Canada the rate of preoperative testing was between 1,95 and 4,63 tests per patient (29-32). Klein and Arrowsmith (33) humorously point out that one could be forgiven for thinking that there is therapeutic value in preoperative testing if one observes the rate at which it is done.

Studies conducted mainly in Northern America and Europe concluded that performing preoperative studies routinely is not only counter-efficient but also not cost effective (3-5, 22). There is limited evidence available about the usefulness of routine preoperative testing in developing countries including South Africa (24, 27, 28). As the functioning of health systems in the developing world are not always optimal, one would expect that routine preoperative testing would have a higher yield of previously undiagnosed conditions that could possibly affect the perioperative outcome. The limited available literature, however, indicates that trends in the developing world are not dissimilar to those of the developed world (24, 27). Sommerville and Murry (27), looking at preoperative CXRs and ECGs, showed a greater yield of abnormal results, however the groups where the tests were indicated had the highest yields, as was found with the studies in the developed world. In Pakistan, Pal et al (24) concluded that, except for the high proportion of anaemia found in the female population, the results of the preoperative tests found with their study was in general agreement with those found in other studies.

2.3.1 Risks of routine preoperative testing

In performing routine preoperative tests the possibility arises of exposing the patient and the health system to a number of risks. For the patient there is the risk of unnecessary further testing in reaction to abnormal test results yielded by the initial routine test. In establishing the normal reference range of a test, two standard deviations from the mean on a Gaussian curve are normally taken. This would then mean that 5% of people tested would have abnormal test results even though they have no disease. Therefore, with the practice of routine testing an increased number of falsely abnormal results will be yielded. (3)

These falsely abnormal tests may introduce a whole array of problems. Firstly the patient might be exposed to further preoperative tests or additional consultations with physicians. This could cause the patient unnecessary injury, additional distress and is in general an unpleasant experience (6, 7).

Routine preoperative testing has financial implications for both the patient and the health system. The cost is generated in several ways: the cost of the initial test, the cost of additional follow-up tests or consultations to determine the validity of any abnormal results and delays in the surgery schedule(1). Narr et al (8) estimated, based on data from 1988, that an annual cost saving of between \$3 billion and \$4 billion could be achievable in the United States of America if preoperative tests were limited to those indicated by history and examination. No similar data could be found in the literature related to South Africa. Sommerville and Murray (27) however estimated in 1992 that at RK Khan Hospital, in Kwa-Zulu Natal, costs could be reduced if routine chest X-rays be limited to patients over the age of 60 and ECGs to those aged over 40 without increasing the patients perioperative risk significantly. These costs increase significantly when one considers the expenditure on increased bed occupancy, possible delays in the operating theatre schedule and the possible medico-legal implications.

The medico-legal implication of routine testing could place the health system and the physician at significant risk should the abnormal results not be acted on. The literature suggests that between 30% and 60% of unexpected abnormal results detected by

preoperative laboratory tests are ignored by clinicians and not documented or investigated further (34). Routine preoperative screening with inadequate history and physical examination could put the clinician at increased risk of missing an important perioperative condition, especially when an inappropriate diagnostic test is requested or if a result is responded to incorrectly (35).

A further risk that needs consideration is the risk of breaching the ethical principle of distributive justice. Distributive justice can be defined as "fair, equitable, and appropriate distribution determined by justified norms that structure the terms of social cooperation" (36). In a limited resource setting like South Africa the balance of equity and efficiency of resource use is important (29), as it does not benefit society to spend valuable resources on preoperative tests that do not necessarily change the management or outcome of the patient.

2.3.2 Reasons for requesting routine preoperative tests

There are various reasons behind requesting routine preoperative tests. These can be divided into two groups: those done with specific intentions and those done due to tradition, out of a belief that other physicians might desire the tests, due to fear of medico-legal action, out of concern for surgical delay or cancellation and due to a lack of knowledge (37). Junior doctors are often left with the task of requesting preoperative tests and they are prone, due to their lack of knowledge, to seek the relative safety of routine batteries of tests. This tradition is passed on from one generation to the next. Katz et al (13) found that, among anaesthetists, the only statistically significant predictor for requesting at least one unnecessary preoperative test was year of training. Anaesthetists who qualified after 1979 were 45% less likely to request at least one unnecessary preoperative test, indicating the need for continued education.

Routine tests are often done with clear intentions, which may encompass: hope, fear, and defensive medicine. A prominent intention is the hope to discover a previously undiagnosed condition that could have an effect on the perioperative outcome (3). The literature reveals that the rate of detecting abnormalities that could not be detected

through thorough history taking and physical examination is very low and routine testing is not an effective way of detecting these conditions (3, 4). Bryson et al. (5) found that the results of preoperative tests influenced the patient management in only 2,6% of cases.

A certain proportion of routine preoperative tests are ordered on the basis of fear. One of these fears is that another physician might need the results of the test when they are consulted about the patient. The fear that the anaesthetist might cancel the surgery if the results to the tests are not available is prominent. (37) In a center where there is no compliance with standard guideline for preoperative testing, this fear could be valid, though it has been that for patients undergoing minor surgery without having routine preoperative tests done there was no increased risk of cancellation (12, 23).

Defensive medicine, due to the fear of litigation, also motivates many physicians to request routine preoperative tests but, as indicated earlier, this practice might increase the physician's risk of being sued (35). Gandhi et al (35) indicated that Reason's "Swiss cheese" model of accident causation still holds true, where the alignment or chain of multiple system breakdowns leads to diagnostic errors that lead to harm to the patient. The most frequent breakdown, at a rate of 55%, was the incorrect ordering of diagnostic tests. Routinely requesting preoperative tests as opposed to requesting specifically indicated tests could trigger a chain of events causing the patient discomfort and could lead to litigation processes against the health care provider. The results of preoperative tests with high rates of falsely abnormal results could act as a red herring distracting the physician from more important issues (7).

2.4 Possible solutions to the problem of routine preoperative testing

A combination of various strategies is needed to solve the problem of routine preoperative testing. It is complex and no silver bullet solution exists. These strategies might include: thorough history taking and physical examination, the use of preoperative testing guidelines, anaesthetist-guided requesting of tests, the use of preoperative assessment clinics and possibly complete omission of preoperative testing in certain situations.

2.4.1 History taking and physical examination

One needs to return to one of the fundamental basics of medicine, namely history taking and physical examination. The best measure of screening for disease is history and examination (38). In a study by Delahunt and Turnbull (9), only 63 abnormalities were discovered out of 1972 tests performed in patients where history and physical examination did not indicate the need for the test. And in none of the instances did the discovery of the abnormal results influence the management of the patient (9).

The work of Thomas Bayes illustrates the importance of history taking and physical examination. Thomas Bayes (1702-1761), an English Presbyterian minister, formulated a theorem bearing his name, Bayes' Theorem, on "inverse probability" which was published posthumously (39). This theorem cannot be ignored in clinical medicine as it can be applied to describe the relationship between a diagnosis of a disease, the patients' prior probability of having the particular disease and the likelihood (population prevalence) of having the disease (40).

The theorem can be simplified as follows and explained in Table 2.1 (39):

$$P(A/B) = \frac{P(B/A)P(A)}{P(B)} \text{ provided that } B \neq 0$$

Table 2.1 Explanation of variables in Bayes' theorem

P(B/A)	the likelihood or the conditional probability of B given A
P(A)	the prior probability of A (it is prior because it exists independently from B but B needs not to occur after A)
P(B)	the prior probability of B
P(A/B)	the conditional probability of A given B (it is also known as the posterior probability as it is dependent on B)

In order to understand the relevance to history taking and physical examination the following example can be considered (39):

A specific disease condition has a prevalence of 0.5% in the general population. If a specific test has 99% sensitivity and 99% specificity for this particular disease it would seem that the test would predict the presence of the disease very accurately. By using Bayes' theorem the high probability of this test of incorrectly identifying healthy individuals for having the particular disease (false positives) can be illustrated.

Consider D as having the disease and H as not having the disease. Let + be the event of testing positive for the disease using the particular test. The other variables are listed in Table 2.2.

Given this information one can now calculate $P(D/+)$ or $P(A/B)$.

$$\begin{aligned}
 P(D/+) &= \frac{P(+/D)P(D)}{P(+)} \\
 &= \frac{P(+/D)P(D)}{P(+/D)P(D)+P(+/H)P(H)} \\
 &= \frac{0,99 \times 0,005}{0,99 \times 0,005 + 0,01 \times 0,995} \\
 &= 0,3322
 \end{aligned}$$

Table 2.2 Explanation of variables in example of Bayes 'theorem

<p>P(D) or P(A)</p>	<p>The probability of the patient having the disease: this is independent of any other information. This is, for the purpose of this example, 0,5% or 0,005 as this is the prevalence of the disease in the general population.</p>
<p>P(H)</p>	<p>The probability that the patient doesn't have the disease. This is $1 - P(D)$, or 0.995.</p>
<p>P(+/D) or P(B/A)</p>	<p>The probability that the test is positive if the patient has the disease. This is 0,99 as the test is 99% accurate.</p>
<p>P(+/H)</p>	<p>The probability that the test is positive if the patient actually doesn't have the disease. This is 0.01 as this test will produce false positives in 1% of patients that doesn't have the disease.</p>
<p>P(+) or P(B)</p>	<p>The probability that the test will be positive independent of any other information. This is calculated by adding the probability of true positives appearing ($99\% \times 0,5\% = 0,495\%$) to the probability that false positives will be appearing ($1\% \times 99,5\% = 0,995\%$). This gives 1,49% or 0.0149.</p>

Even though this particular test is highly sensitive and specific for the particular disease, it only detects the true positive 33% of the time. In order to yield more true positive values for this particular test the prior probability ($P(A)$) that the patient being tested has the disease needs to increase. This can be done by careful selection of patients that are tested. By selectively testing a specific portion of the population in which the prevalence of the disease is known to be increased, the tests will yield more true positive results. This illustrates the value of thorough history taking and physical examination.

Charpak et al. (41) found that in patients with suspected abnormal results, based on history taking and physical examination, the prevalence of abnormal results was much higher (41).

2.4.2 Preoperative testing guidelines

A further strategy to decrease the number of preoperative test requested is the implementation of preoperative testing guidelines. The number of individuals, of different levels of experience, involved in the preoperative preparation of patients justifies the use of standard guidelines. The utilisation of standard guidelines can reduce the number of unnecessary tests done and curb the expenses involved (10, 11). This is only beneficial when the guidelines are adhered to. Adherence to guidelines is institution dependent, with some studies finding compliance to available guidelines to be poor (5, 18, 30, 32) and others finding high levels of compliance (42). Phoenix et al (31) found that 31,3% of tests performed at their institution did not adhere to the NICE Guidelines for preoperative testing, whilst Pastides et al (30) found only a 5% adherence. In Austria Flamm et al (32) found that that 81,7% of tests done did not adhere to their guidelines.

Developing guidelines is often difficult or even impossible due to inconsistencies in the available literature (15, 16). Many studies have insufficient sample sizes as large sample populations are required, such as in the landmark study of Schein et al. (12) which had study population of 18 183. The literature often lacks sufficient evidence to

support a decision on whether a test is recommended or not. Consensus committees are then used in an attempt to reach a conclusion (15, 16).

Various international institutions have developed guidelines or advisories for preoperative testing. SASA recommends that preoperative tests should be requested after taking the history, physical examination and information in the patient's medical record into consideration (17). More focused recommendations regarding ECGs, CXRs, and Hb is provided and for further guidance they recommend that one consults the ASA webpage (17).

The ASA published their practice advisory on preoperative blood tests in 2002, and in 2003 NICE published a guideline that was found, with review of the literature, to be the most comprehensive to date (15, 16). The Institute for Clinical Systems Improvement published a guideline in 2010 but this only considers a very limited number of preoperative tests (six in total) and considers specific guidance on preoperative testing as beyond its scope (43). The ASA and NICE Guidelines will be discussed next with emphasis on the NICE Guidelines.

2.4.2.1 The ASA advisory for preanesthesia evaluation

The ASA opted, in 2002, to publish a practice advisory instead of a guideline for preoperative testing due to the challenge of inconsistencies in the data. The latest update to this advisory was published in 2012 (15). Practice advisories are systematically developed reports in areas where the scientific evidence is insufficient to develop an evidence-based model. The advisories draw conclusions from various sources, including available literature but they are not supported by the literature to the same extent as an evidence-based guideline would be. Other sources included expert opinion and public forums (15).

The ASA advisory set out to achieve the following aims:

- to assess the currently available evidence pertaining to the healthcare benefits of preanesthesia evaluation;

- to offer a reference framework for the conduct of preanesthesia evaluation by anaesthesiologists; and
- to stimulate research strategies that can assess the healthcare benefits of a preanesthesia evaluation. (15)

For the ASA advisory the evidence related to the content and timing of the preanaesthetic evaluation was taken into account but not that of the interaction between the preoperative evaluation, preoperative testing nor the influence of perioperative care (15). In developing the advisory various factors were considered. The first considerations were the preanaesthetic history and physical examination, including the evaluation of the patient's medical record and patient interviews. Secondly, the timing of the initial assessment and of the preanaesthetic interview and physical examination related to the severity of the surgical invasiveness. Thirdly, the different preoperative tests requested routinely or with specific indication were evaluated. These tests included: ECG, other cardiac evaluations (angiography, echocardiography or stress test), chest X-ray, pulmonary evaluation (i.e. pulmonary function test and spirometry), haemoglobin and haematocrit, coagulation studies, serum chemistry (potassium and glucose), urinalysis and pregnancy testing (15).

The task force concluded that routine preoperative testing does not make a significant contribution to the perioperative assessment or to the anaesthetic management of the patient. They stated that selective preoperative testing, after consideration of the information gained from the medical record review, interviews and physical examination, may be of use to anaesthetists in perioperative decision-making and management. Specific decision-making parameters for the various tests were not provided, as evidence for this could not unequivocally be supported by the available literature. It was further advised that the individual specific tests and their timing be individualised to the specific patient and the invasiveness of the specific procedure (15).

It is appreciated that the interaction between the various components taken into account in this advisory is beyond their mandate. In formulating a standard guideline for preoperative testing for an institution these interactions become increasingly

important. As a tool to guide the preoperative testing by individuals with various levels of experience, this advisory is of limited use. It however highlights the importance of the fundamental steps in the preoperative evaluation which include history taking and physical examination leading up to the preoperative testing (15).

2.4.2.2 The NICE Preoperative tests: The use of routine preoperative tests for elective surgery

The NICE is an independent organisation based in the United Kingdom that produces evidence-based guidelines for the promotion of good health and treatment of disease. They published guidelines for preoperative testing in 2003. With review of the literature it was found to be the most comprehensive guideline available.

When the NICE developed the guideline for preoperative testing the following aims were set:

- to evaluate the evidence relating to the 'value' of routine preoperative testing in elective surgical patients and in selected groups of patients with comorbid conditions by carrying out a systematic review of the literature;
- to develop guidance for clinicians on the use of preoperative tests in normal healthy adults and children (ASA grade 1), and in adults with mild (ASA grade 2) and severe (ASA grade 3) systemic disease arising from selected comorbid conditions; and
- to produce an illustrative economic model investigating plausible rates of abnormal results, rates of changes in management, rates of postoperative complications avoided by preoperative tests and the subsequent costs of preoperative investigations and of adverse events and their sequelae (16).

The guideline was developed through the collaboration of various professional and lay group members, which included staff from the NICE National Collaboration Centre for Acute Care, The Royal College of Surgeons of England's Clinical Effectiveness Unit and the London School of Hygiene and Tropical Medicine's Department of Public Health and Policy (16).

In developing the guideline the preoperative tests considered were those relevant to patients receiving secondary level care, although some of the tests carried out could have relevance for patients at primary care level (16). Further, preoperative tests that would be carried out as part of the preoperative evaluation of ASA grade 1 (children and adults) and ASA grade 2 and 3 (adults) patients undergoing elective surgery were considered. Listed in Table 2.3 are the tests that were considered by the guideline-developing group with a description of the content of each specific test.

Certain tests were not included in the development of the guideline, as they did not fulfill the criteria of routine or generic preoperative tests. Some of these included computed tomography (CT) scans of the thorax, echocardiography (ECHO), stress ECG and nuclear cardiology screening (e.g. Technetium screening). Blood group testing was excluded as it is not a diagnostic test and does not yield any abnormal test results.

Table 2.3 The preoperative tests considered in developing the NICE Guidelines (16).

Test	Description
Chest x-ray	Plain chest x-ray (radiograph).
Resting ECG	Resting electrocardiography (ECG).
Full blood count	Full blood count includes haemoglobin measurement, white blood cell count and platelet count. Using current laboratory automated analysers it is not possible to obtain only a haemoglobin measurement. It is possible to measure only haemoglobin with point of care testing, but this form of testing was excluded from the development of the guideline.
Haemostasis tests	Haemostasis tests include prothrombin time (PT), activated partial thromboplastin time (APTT) and international normalised ratio (INR; derived from the patient's PT and normative data).
Renal function tests	Renal function tests include measurement of potassium, sodium and creatinine and/or urea levels.
Blood glucose test	Blood glucose test is a measurement of glucose from a blood sample, as opposed to measurement in the urine using a urine 'dipstick' test.
Urine 'dipstick' test	Urine dipstick tests are manufactured to test for different conditions separately and together. Urine dipsticks test for pH, protein, glucose, ketones and blood/haemoglobin.
Sickle cell test	Testing for sickle cell disease/trait usually takes place in two stages. First a test is used to detect sickle cell disease/trait (for example the Sickledex test). More detailed (and more expensive) tests are then carried out if the first test is positive.
Pregnancy test	Biochemical testing for pregnancy. In most cases this would be a urine test.
Blood gases	Arterial blood gas analysis or venous blood gas analysis in combination with pulse oximetry (to measure the oxygen and carbon dioxide content, and acid-base status of the blood) may be used to evaluate patients with severe respiratory or cardiovascular disease.
Pulmonary function test	Measurements of peak expiratory flow rate, forced vital capacity and forced expiratory volume.

The guideline considers various comorbid diseases in the selection of the preoperative tests that are performed: these include cardiovascular disease (including diabetes), respiratory disease and renal disease. The degree of surgical intervention also influences the selection of preoperative tests required and was graded according to severity of the intervention as illustrated in Table 2.4. (16)

Table 2.4 Severity grading of surgery with explanatory examples (16)

Grade	Example
Grade 1 (minor)	Excision of a skin lesion or drainage of a breast abscess
Grade 2 (intermediate)	Primary repair of an inguinal hernia; excision of varicose veins on a leg; tonsillectomy/adenotonsillectomy or knee arthroscopy
Grade 3 (major)	Total abdominal hysterectomy; endoscopic resection of the prostate; lumbar discectomy or thyroidectomy
Grade 4 (major+)	Total joint replacement; lung surgery; colonic resection or radical neck dissection

The development of the guideline involved numerous steps. After assembly of the guideline development group and defining the aims of the guideline, a systematic review of the available literature was conducted. From the systematic review of the literature carried out for the Health Technology Assessment (HTA) in 1997, assessing the evidence for the use of preoperative testing in healthy patients admitted for elective

surgery, it was known that the literature addressing the value of preoperative testing was lacking (16, 44).

In the areas where evidence from the literature was lacking, it was decided to use formal consensus methods for the development of the guideline. The modified nominal group technique was chosen for the consensus, as this is the most commonly used method in consensus development in health care. Two parallel consensus panel groups comprising an equal distribution of different health care professionals from various interested groups were selected. After informal testing of the assumptions made for the consensus a consensus questionnaire was drafted and sent, with a summary of the available evidence, to the panelists. The panelists were asked to rate their agreement with the statements, taking into account the evidence presented to them and their clinical expertise. (16)

The next step in the consensus formation was a meeting held with the two different consensus panels where possible reasons for disagreements pertaining to the statements made in the questionnaire were discussed. After discussion, each statement was re-rated by the panelists and only ratings from the second round were considered for the development of the guideline. Consensus was reached only if both the groups agreed on the statement. (16)

The guideline was drafted based on the consensus opinion and the literature review. In the areas where no consensus was reached and where the literature was lacking in evidence it is advised that the physicians used their clinical discretion in deciding on the appropriateness of the test for their particular patient. As a final step, the draft guideline was distributed to stakeholders, collaborators and interested parties for commenting. These comments were considered in the final draft of the guideline. (16)

In the final guideline the recommendations regarding the preoperative tests were arranged into user friendly “look-up” tables arranged according to the severity of the surgery intervention, the ASA grading, the age and the comorbid diseases of the patient (16). The recommendations were colour coded in a similar way to traffic lights, where red indicates that a test is not recommended, amber indicates that the test should be

considered according to the clinician's own discretion and green indicates that the test is indicated (16). The guidelines were published in both booklet and practical wall poster format.

Various challenges regarding the NICE Guidelines have been raised. Firstly, the presentation format of the guideline was criticised, as there were 38 "look-up" tables and one flow diagram. Considering the amount of variables that needed to be considered, it is difficult to envision a simpler format. Secondly, large areas in the tables are coloured amber as consensus could not be reached for these particular scenarios and the decision regarding these scenarios is left up to the discretion of the clinician. Thirdly, there are very few instances where there is a difference in the tests indicated for ASA grade 1 and ASA grade 2 patients. This is considered an inconsistency and not an error. The inconsistency arose because different panels considered the two different groups of patients, and these panels had slightly different compositions and beliefs. A fourth challenge arose with the difficulty in classifying co-morbidity and surgical complexity, as the scales used are not tightly defined. The ASA grading scale, for example, has rules for how certain scenarios should be categorised. Lastly, the NICE Guidelines are not comprehensive, as they do not consider every aspect of the preoperative evaluation as many of the specialised cardiac examinations are omitted. (45) After review of the literature it does however appear to be the most comprehensive guideline currently available.

2.4.3 Anaesthetist driven requesting of preoperative tests

In a hospital setting the onus for requesting preoperative test mostly rests with the surgical teams. This situation is not optimal as the literature suggests that surgeons are more likely to request unnecessary preoperative tests than their anaesthetic colleagues (13, 46). Katz et al. (13) developed four different scenarios related to different surgical disciplines. The scenarios were sent to surgeons (n=537), each surgeon receiving the scenario related to their discipline. The surgeons were then asked to indicate which preoperative tests they would request for the particular scenario. The same scenarios were distributed to 175 anaesthetists, each anaesthetist receiving all four scenarios. The anaesthetists were given the same instructions. It was found that the anaesthetists

were between 53% and 67% less likely than the surgeons to request an unnecessary preoperative test depending on the surgical discipline concerned (13).

Macario et al. (47) found that after educating surgeons regarding preoperative testing the number of unnecessary tests requested decreased by 20% but there was a concomitant decrease of 13% in the number of indicated tests. It would seem that education would not be the sole solution to the problem of unnecessary testing. The direct involvement of the anaesthetist has been shown to decrease the number of unnecessary preoperative blood tests ordered. The preoperative assessment clinic is the ideal setting to realise this.

2.4.4 Preoperative assessment clinics

Preoperative assessment clinics synchronise preoperative surgical, anaesthetic, nursing and laboratory care. At the preoperative assessment clinic the patients are seen well in advanced of the scheduled surgery. The medical history, records, previous tests and specialist consultations are reviewed and a physical examination is conducted. Preoperative tests are then requested if indicated and it is determined if the patient needs further optimisation prior to the planned surgery. (19)

Preoperative assessment clinics have been proven to reduce the number of unnecessary preoperative test requests (14, 46, 48). In 1994, at Stanford University Hospital in California, Fischer (14) indicated that the preanaesthetic assessment clinic managed to decrease the number of preoperative test requests by 55% and reduce costs by 59%. The cost reduction translated to \$112,09 per patient. This saving is relatively small but when the cumulative cost is considered it amounts to a substantial saving.

The benefit of the preoperative assessment clinic stretches beyond the reduction in preoperative test requests. Ferschl et al. (20) indicated that the preanaesthetic assessment clinic can have a significant impact on case cancellations on the day of the surgery. The patients that did not attend the preoperative assessment clinic were 0.38

(95% CI, 0,29-0,49; $P < 0,001$) times more likely to be cancelled on the day of surgery than patients who attended the clinic (20).

2.4.5 Omission of preoperative testing

Complete omission of preoperative tests in certain settings has been proven not to influence patient safety or perioperative outcome (12, 22, 23). In the landmark study by Schein et al. (12), 18 189 patients undergoing elective cataract operations were randomly assigned to two groups. The patients were either assigned to a group receiving, in addition to history and physical examination, a routine battery of preoperative tests or to a group with complete omission of the preoperative tests. The patients were then monitored for adverse medical events and interventions on the day of the surgery and for seven days post-surgery.

The cumulative rate of events was found to be the same in both groups at 31 events per 1000 operations. The most frequently observed events in both groups were treatment for hypertension and arrhythmias (mostly bradycardia). This accounted for 61% of events in the no-testing group and 68% of events in the routine testing group. There were also no significant difference found between the two groups in the number of cancellations or postponement of surgery with 2,5% in the no-testing group and 2,3% in the routine testing group. As cataract surgery poses minimal surgical risk and is mostly performed under local anaesthetic and sedation one should be careful of extrapolating these findings to all types of surgery, but in surgery with similar risk it is reasonable to apply the findings. (12)

In a pilot study by Chung et al. (23) the omission of indicated preoperative testing was investigated to determine if there is an increased incidence of perioperative adverse events in patients undergoing day-case-surgery. There was no significant difference in the incidence of perioperative adverse events between the testing and the no-testing groups within 30 days after surgery. A larger sample size is however needed to demonstrate that indicated testing could be eliminated in certain circumstances without increasing the risk of perioperative complications. (23)

2.5 Summary

In this chapter a review of the literature related to the different aspects of preoperative testing was presented. Firstly the aim of preoperative testing was discussed followed by an in-depth scrutiny of routine preoperative testing. The possible solutions to routine preoperative testing concluded the chapter. In the next chapter the research methodology of this study will be discussed.

Chapter 3: Research Design and Methodology

3.1 Introduction

In this chapter detailed discussion of the problem statement, aim and objectives, demarcation of the study, ethical considerations, research design and methodology, data analysis and validity and reliability of the study is presented.

3.2 Problem statement

At Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) preoperative tests are mostly requested directly by the surgeons and this is not done according to national or international standards or guidelines. The preoperative tests requested are often not appropriate for the particular patient and could cause patients additional discomfort, lead to cancellation or postponement of the planned surgery and generate unnecessary financial expenditures. CMJAH is a resource limited hospital and the preoperative test practice at this hospital is unknown.

3.3 Aim

The aim of this study was to audit and evaluate preoperative tests requested for adult patients scheduled for elective surgery at CMJAH.

3.4 Objectives

The primary objectives of this study were to:

- document all requested preoperative tests;
- determine the number of preoperative tests requested by the anaesthetist;
- determine the number of requested preoperative tests that were not recommended according to the NICE Guidelines for preoperative testing;

- determine each clinical department's contribution to the unnecessary preoperative tests that were requested

The secondary objective of this study was to determine if there is an association between the NICE recommendation for preoperative testing and the detection of abnormal results in laboratory tests.

3.5 Demarcation of the study field

CMJAH is a 1066 bed hospital affiliated to the University of the Witwatersrand. It is centrally located in the city of Johannesburg and offers mainly tertiary level care consisting of inpatient services and specialist outpatient clinics. It functions as a referral hospital for numerous secondary hospitals surrounding the city of Johannesburg in the province of Gauteng. The hospital has 23 operating theatres in its main theatre complex. An estimated 20 000 patients receive surgical treatment of various types at this complex annually.

3.6 Ethical considerations

Approval for the conduct of this study was obtained from the Postgraduate Committee and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (Appendices A and B). The CEO of CMJAH also granted permission to conduct the study (Appendix C).

Participation in the research was voluntary. Patients were given the option of withdrawing their consent to participate in the research at any time. The privacy of the patients was respected and confidentiality of their personal information (name and hospital number) was observed by not including this information in the captured data. Written informed consent was obtained from the patients with the use of an information letter (Appendices D and E). If a patient was incompetent or incapable of giving consent it was obtained from a legally authorised representative.

Confidentiality of the anaesthetists was ensured as only the researcher had access to the completed preoperative assessments forms.

The study was conducted according to good clinical research practice and in adherence to the World Medical Association Declaration of Helsinki (26).

3.7 Research methodology

3.7.1 Research design

A prospective, contextual, descriptive research design was used in this study.

A prospective study is defined as a study in which the variables are measured at the time at which the study takes place (49). In this study the anaesthetists completed a preoperative assessment form at the time of their preoperative visit.

A contextual study is one that takes place in a specific location (49). This study is contextual as it was conducted at one hospital only – CMJAH.

Descriptive study designs are used to explain certain characteristics within a field of study as they occur naturally. Variables are not manipulated but rather described, enabling the interpretation of the theoretical meanings of the findings, providing knowledge of the variables and the study population for use in future research. (50) A descriptive study design best served the purpose of this study.

3.7.2 Study population

The study population was adult patients, of ASA grade 1 to 3, scheduled for elective surgery at the CMJAH main theatre complex.

3.7.3 Study sample

When calculating the sample size with quantitative research various factors need to be taken into consideration. These include: the research design; the sampling method; the degree of precision required; the variability of the factors being investigated and the incidence of a particular variable in the population. The greater the sample size the higher the probability will be that the findings will represent the population accurately by lowering the sample error. The sample error is the concept of extrapolating population characteristics from data collected from a sample of the population. Sample size calculations with quantitative studies are based on the level of precision and confidence required from the results. Confidence intervals are used and these are a range of values around a value obtained from a sample with a known probability that the true value for a population is contained within that range. The interval width is determined by the clinical significance of the precision of knowing the occurrence of a particular phenomenon. (51)

The minimum sample size for this study was calculated at 267 patients based on the number of elective surgeries performed in 2010, an expected prevalence of unnecessary tests of 50%, a confidence level of 90% and precision of 5%. This was done in consultation with a biostatistician and with the aid of Statcalc, a function of the program Epi Info 7.

This translates to: if 50% of preoperative tests are requested unnecessarily in a population of roughly 20 000 and we were to investigate 267 patients this study would find that 90% of the time between 45% and 55% of preoperative tests were done unnecessarily.

3.7.4 Sampling method

In this study a convenience sample was used to obtain the desired information regarding preoperative tests done at CMJAH. Convenience sampling is a form of non-

random sampling where the most readily accessible individuals are used in obtaining an estimate of a particular element of interest (51).

3.7.5 Inclusion and exclusion criteria

Inclusion criteria:

- adult patients 18 years and older;
- ASA Grade 1 to 3;
- scheduled for elective surgery.

Exclusion criteria:

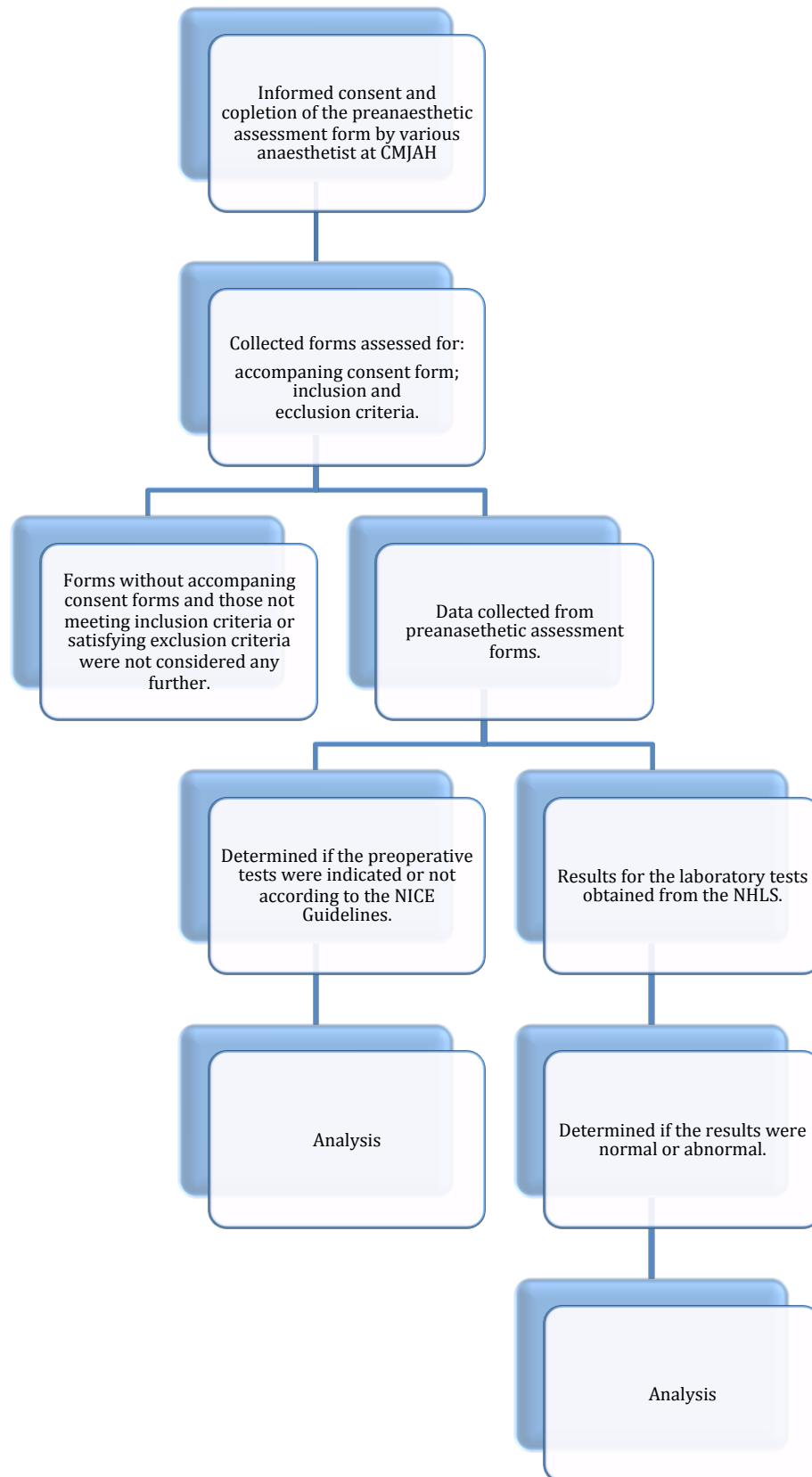
- patients scheduled for cardiothoracic- or neurosurgery;
- patients who did not consent to take part in the study.

3.7.6 Description of data collection

Data was collected with the assistance of fieldworkers - the anaesthetists who did the routine preoperative assessment during the study period. An information session was held where the anaesthetists were informed about the study and what was expected of them. The researcher was available throughout the study period should the anaesthetists have any questions.

The data collection process is depicted in Figure 3.1.

Figure 3.1 Data collection flow diagram



The data was collected from the preoperative assessment forms (Appendix F) that were designed for the purpose of this study and completed by anaesthetist during their preoperative assessment of patients. The anaesthetists were requested to complete a preoperative assessment form, after obtaining signed informed consent from the patients, at the time of their preoperative visits. The forms and consent forms were then placed in boxes at various points in the main theatre complex at CMJAH for collection by the researcher.

The collected preoperative assessment forms were then processed to firstly determine if the signed informed consent form accompanied it and if the patients met the inclusion criteria. The preoperative assessment forms that were unaccompanied by informed consent forms, those that did not meet the inclusion criteria and those that satisfied the exclusion criteria were not considered any further during the research process.

The following data was collected from the forms included in the research:

- patient age;
- gender;
- scheduled surgical procedure;
- surgical disciplines involved in the surgery;
- comorbid diseases;
- ASA grading;
- preoperative tests performed;
- results of the preoperative tests; and
- additional tests requested by the anaesthetist at the time of evaluation.

Using the abovementioned data the researcher determined if the requested preoperative tests were indicated according to the NICE Guidelines for preoperative testing (Appendix G). By using the patient's age, ASA grade, existing comorbid conditions and the surgery severity grade, it was determined whether a particular preoperative test:

- was not recommended,
- should have been considered, or

- was recommended according to the NICE Guidelines for preoperative testing.

The results for the laboratory investigations were then requested and provided by the National Health Laboratory Service at CMJAH. It was then determined if the results were normal (within the NHLS' normal range) or abnormal (outside of the NHLS' normal range).

3.7.7 Statistical analysis

The raw data was captured using Excel 2011 version 14.3.9 by Microsoft and analysis was done using both Excel and StatCalc version 7.3.3, a program by AcaStat software. Descriptive statistics (frequency and percentages) were done to describe the characteristics of the sample and the preoperative tests. Further analysis using a chi-square was used to determine if there was an association between the NICE recommendation and the detection of abnormal results. Where $n < 5$ Fisher's exact test was applied. A statistically significant association was taken as $p < 0,05$. The Bonferroni post hoc test correction was applied where a statistically significant result was detected.

3.8 Validity and Reliability

Validity refers to the extent to which a measurement represents the true value of a phenomenon. The validity can be threatened at any point in the research method as well as by external factors to the study. (52)

Reliability represents the consistency of the achieved measure. This would mean that should the same measuring instrument be applied to a different sample under circumstances it should produce the same results. (52)

Validity and reliability in this study were ensured in the following manner:

- A preoperative assessment form specific to this study was designed and utilized.
 - Various anaesthetists completed these forms during their preoperative visits.
- The researcher carried out a 10% quality control of the sample by performing a

repeat preoperative assessment comparing the findings with the original preoperative assessment.

- Using the NICE Guidelines for preoperative testing it was determined by the researcher if a particular preoperative test was indicated or not. To determine the degree of reliability the clinical supervisor performed a 10% quality control and level of correspondence was determined.
- Knowledgeable fieldworkers, anaesthetists working in the Department of Anaesthesiology, collected data.
- An appropriate study design and sample size was used in the study.

3.9 Summary

This chapter provided a detailed discussion of the problem statement, aim and objectives, demarcation of the study, ethical considerations, research design and methodology, data analysis, and validity and reliability of the study.

In the next chapter the results and the discussion thereof will be presented.

Chapter 4: Results and Discussion

4.1 Introduction

This chapter includes the results and will be reported as per the study objectives set out in the first chapter. Demographic characteristics of the study population will be presented as an introduction to the analysis. A discussion of the results concludes the chapter.

The primary objectives of this study were to:

- document all requested preoperative tests;
- determine the number of preoperative tests requested by the anaesthetist;
- determine the number of requested preoperative tests that were not recommended according to the NICE Guidelines for preoperative testing;
- determine each clinical department's contribution to the unnecessary preoperative tests that were requested

The secondary objective of this study was to determine if there is an association between the NICE recommendation for preoperative testing and the detection of abnormal results in laboratory tests.

4.2 Data analysis

4.2.1 Demographic characteristics of the study sample

A total of 360 anaesthetic assessment forms were returned during the five-month study period (October 2011 to February 2012). Of these 277 (76,9%) forms were included in the study and 83 (23,1%) were excluded. The majority of the exclusions, 74 (89,2%), were due to the anaesthetic assessment forms being returned without an accompanying consent form. One (1,2%) form was excluded, as the patient was too young to be included in the study, four (4,8%) forms were excluded as the patients were of ASA grade 4, five (6%) forms were excluded as the patients were scheduled for

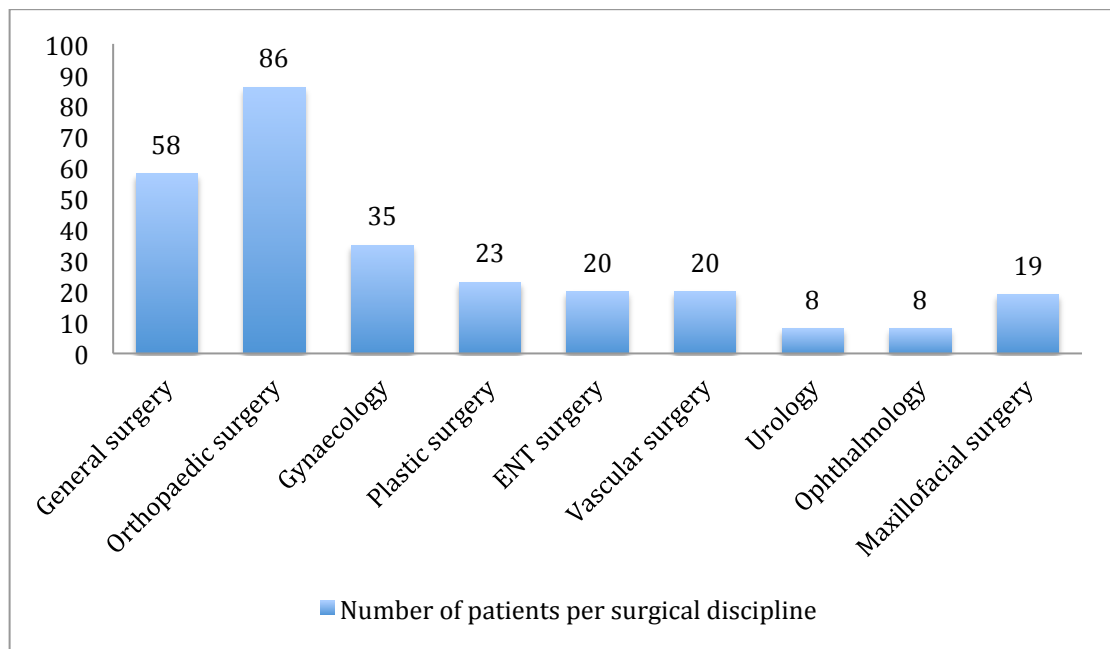
cardiothoracic- or neurosurgery and one (1,2%) form was excluded because it did not contain sufficient information.

The ages of patients ranged from 18 to 88 years with a mean age of 45,33 years. The characteristics of these patients are described in Table 4.1. Patients from nine surgical disciplines were included in the study and are shown in Figure 4.1. A total of 31 different anaesthetists completed the anaesthetic assessment forms.

Table 4.1 Patient characteristics

Characteristics		Number	%
Gender	Male	115	41,52%
	Female	162	58,49%
ASA Grade	ASA 1	96	34,66%
	ASA 2	137	49,46%
	ASA 3	44	15,88%
Grade of surgery	Grade 1	10	3,61%
	Grade 2	152	54,87%
	Grade 3	79	28,52%
	Grade 4	36	13,00%

Figure 4.1 Number of patients per surgical discipline

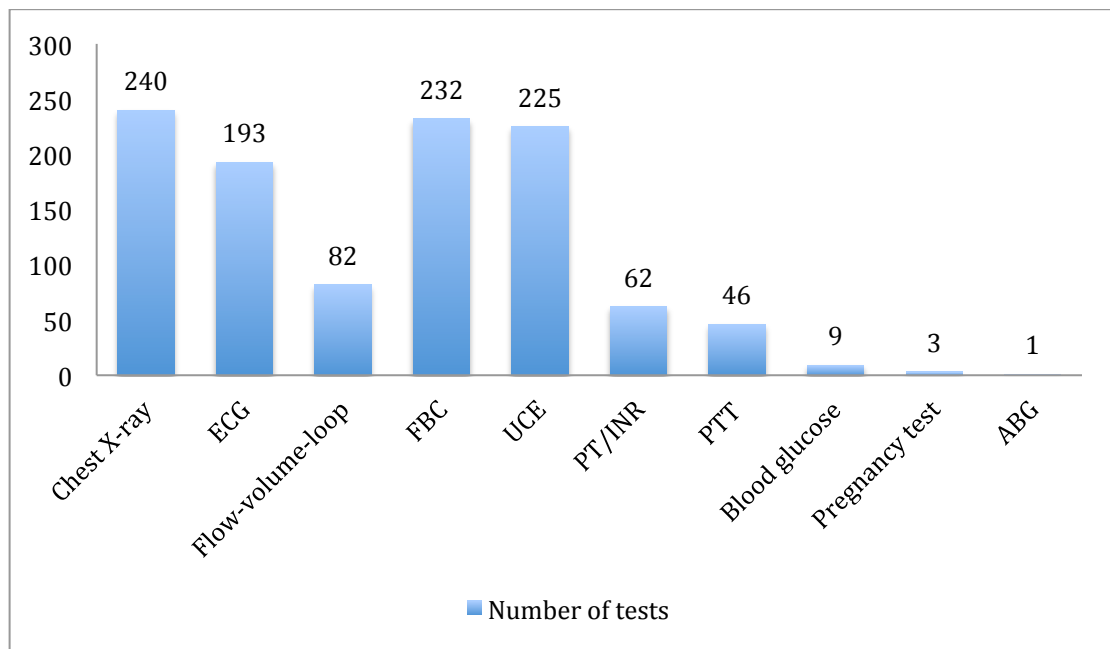


4.2.2 Primary objectives:

- **to document all requested preoperative tests**

A total of 1093 preoperative tests were requested for the 277 patients included in this study (3,95 tests per patient). These are shown in Figure 4.2.

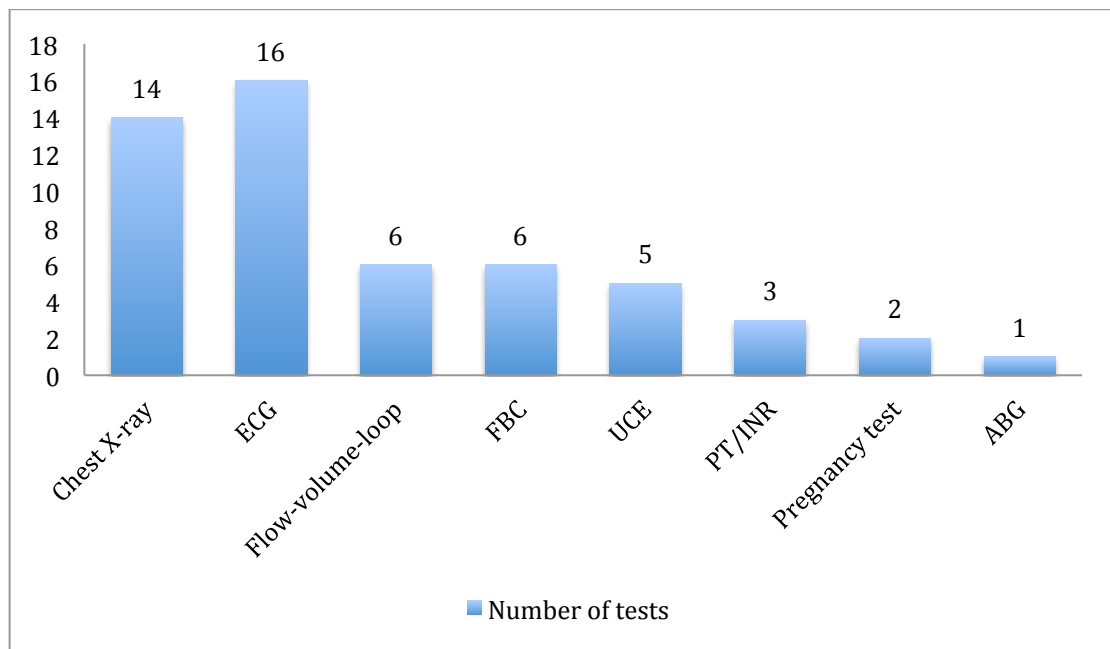
Figure 4.2 Total number of preoperative tests requested



- **to determine the number of preoperative tests requested by the anaesthetists.**

The anaesthetists requested a total of 53 (4,85%) preoperative tests. These are shown in Figure 4.3.

Figure 4.3 Preoperative tests requested by the anaesthetists



- **to determine the number of requested preoperative tests that were not recommended according to the NICE Guidelines for preoperative testing**

Each patient's surgery grade, age, ASA grade and existing comorbid conditions were considered. It was then determined if a specific preoperative test:

- was not recommended,
- should be considered or
- was recommended according to the NICE Guidelines for preoperative testing.

Ten different clinical departments requested a total of 1093 tests; 346 (31,66%) of these would not have been recommended by the NICE Guidelines.

These are shown in table 4.2.

Table 4.2 Requested tests not recommended according to the NICE Guidelines

Test	Number of tests not recommended (total requested)	Percentage of test total
Chest X-ray	78 (240)	32,50%
ECG	31 (193)	16,06%
Flow-volume-loop	53 (82)	64,63%
FBC	43 (232)	18,53%
UCE	56 (225)	24,89%
PT/INR	48 (62)	77,42%
PTT	32 (46)	69,57%
Blood glucose	3 (9)	33,33 %

- **to determine each clinical department's contribution to the unnecessary preoperative tests that were requested**

Of the 346 unnecessary tests each clinical department requested a median of 66,50 tests. When one considers the percentage of unnecessary tests requested by each discipline as a total of the tests requested by that discipline the median was 28,46%. These are shown in Table 4.3.

Table 4.3 Unnecessary preoperative tests per clinical discipline

Discipline	Total number of tests requested (%)	Number of unnecessary tests requested (%)	Unnecessary tests requested as a % of the discipline's total requests
General Surgery	298 (27,26%)	112 (32,37%)	37,58%
Orthopaedic Surgery	284 (25,98%)	80 (23,12%)	28,17%
Gynaecology	131 (11,89%)	46 (13,29%)	35,11%
Plastic surgery	80 (7,31%)	23 (6,65%)	28,75%
ENT surgery	50 (4,57%)	14 (4,05%)	28,00%
Vascular surgery	90 (8,23%)	10 (2,89%)	11,11%
Urology	45 (4,12%)	21 (6,07%)	46,67%
Ophthalmology	26 (2,38%)	7 (2,02%)	26,92%
Maxillofacial surgery	36 (3,29%)	9 (2,60%)	25,00%
Anaesthesiology	53 (4,85%)	24 (6,94%)	45,28%
Median	66,50 (6,08%)	22,00, 6,36%	28,46%

4.2.3 Secondary objective:

To determine if there was an association between the NICE recommendation for preoperative testing and the detection of abnormal results in laboratory tests.

The results of the preoperative laboratory tests that were requested were provided by the NHLS at CMHAH. These were analysed to determine the number of abnormal results detected according to the NHLS's normal ranges. The results were further subdivided according to the NICE recommendation's groups that are:

- not recommended test,
- tests that should be considered and
- tests that were recommended.

A chi-square was used to determine if there was an association between the NICE recommendation and the detection of abnormal results. Where $n < 5$ Fisher's exact test was applied.

The first group of tests that were considered was the FBC. This consists of three sub components namely the haemoglobin, the white cell count and the platelet count.

When the haemoglobin results were considered it was found that 131 (56,47%) out of the 232 results were outside of the normal range. Of the 131 results that were abnormal, 126 (96,18%) were below the lower limit of the normal range and 5 (3,82%) were above the upper limit of the normal range.

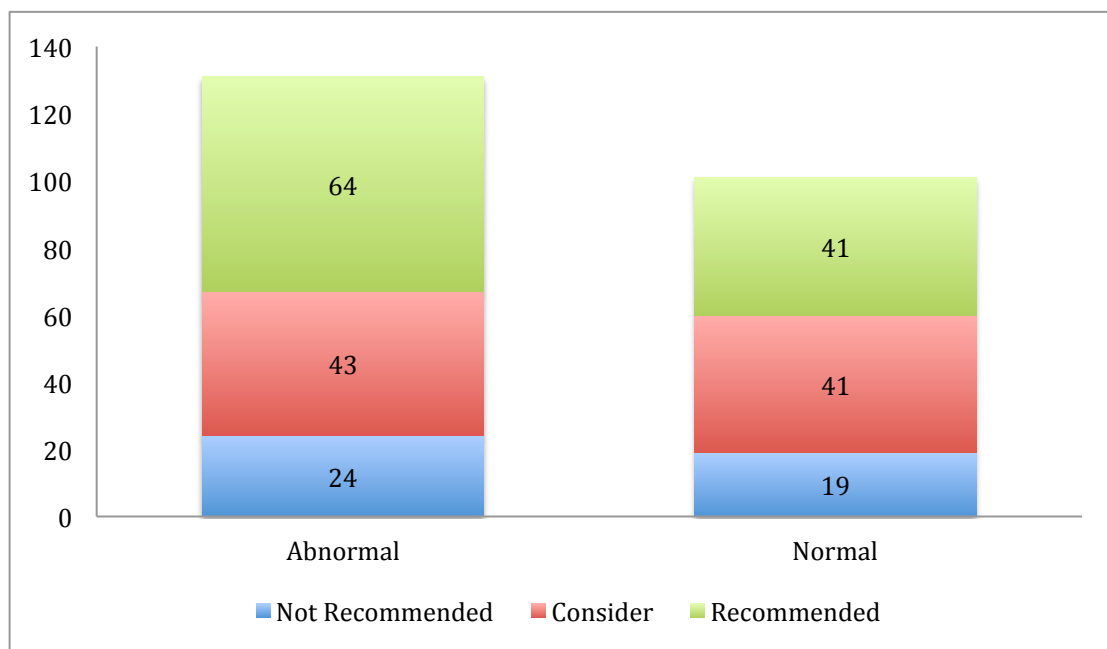
When the abnormal haemoglobin results were considered according to the NICE groupings it was found that 24 of the 43 (55,81%) tests not recommended, 43 of the 84 (51,19%) tests that should be considered and 64 of the 105 (60,95%) of the tests that were recommended were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,4029$). These results are shown in Table 4.4 and Figure 4.4.

Table 4.4 Hb results according to the NICE recommendation

Hb	NICE Recommendation				
		Not recommended	Consider	Recommended	Total (%)
Results	Abnormal				131 (56,47%)
	Number	24	43	64	
	Row %	18,32%	32,82%	48,85%	
	Column %	55,81%	51,19%	60,95%	
	Total %	10,34%	18,53%	27,59%	
	Normal				101 (43,53%)
	Number	19	41	41	
	Row %	18,81%	40,59%	40,59%	
	Column %	44,19%	48,81%	39,05%	
	Total %	8,19%	17,67%	17,67%	
Total (%)		43 (18,53%)	84 (36,21%)	105 (45,26%)	232

p=0.4029

Figure 4.4 Hb results according to the NICE recommendation



When the white cell count results were considered it was found that 52 (22,41%) out of the 232 results were outside of the normal range. Of the 52 results that were abnormal 14 (26,92%) were below the lower limit of the normal range and 38 (73,08%) were above the upper limit of the normal range.

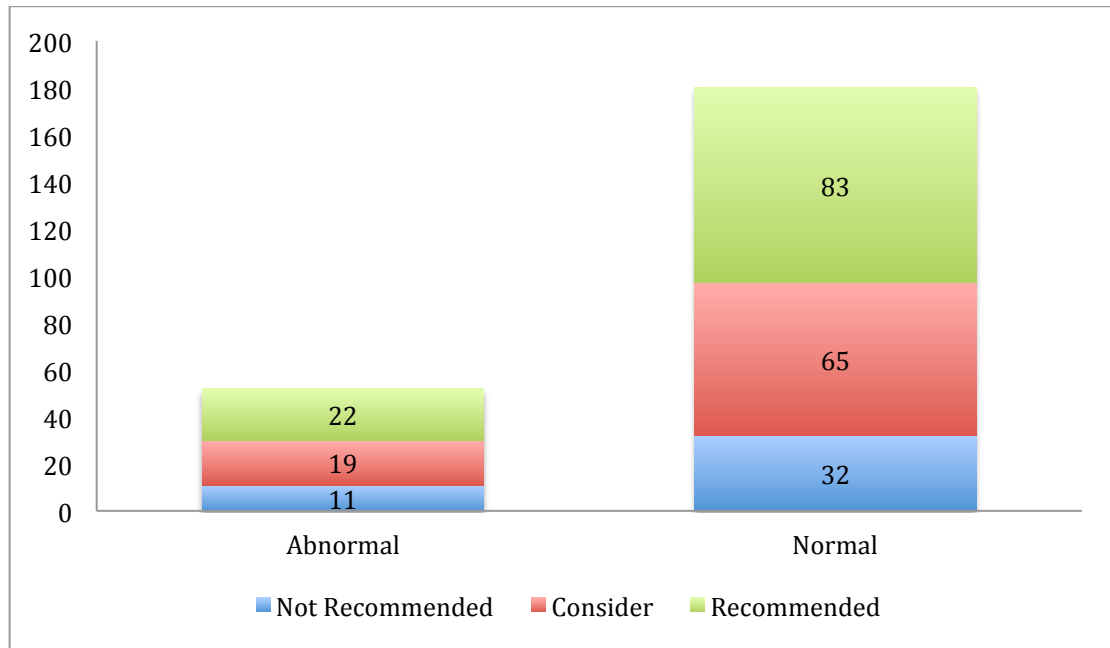
When the abnormal white cell count results were considered according to the NICE groupings it was found that 11 of the 43 (25,58%) tests not recommended, 19 of the 84 (22,62%) tests that should be considered and 22 of the 105 (20,95%) of the tests that were recommended were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,8273$). These results are shown in Table 4.5 and Figure 4.5.

Table 4.5 WCC results according to the NICE recommendation

WCC	NICE Recommendation				Total (%)
		Not recommended	Consider	Recommended	
Results	Abnormal				52 (22,41%)
	Number	11	19	22	
	Row %	21,15%	36,54%	42,31%	
	Column %	25,58%	22,62%	20,95%	
	Total %	4,74%	8,19%	9,48%	
	Normal				182 (78,45%)
	Number	32	65	83	
	Row %	17,78%	36,11%	46,11%	
	Column %	74,42%	77,38%	79,05%	
	Total %	13,79%	28,02%	35,78%	
Total (%)		43 (18,53%)	84 (36,21%)	105 (45,26%)	232

$p=0,8273$

Figure 4.5 WCC results according to the NICE recommendation



When the platelet count results were considered it was found that 88 (37,93%) out of the 232 results were outside of the normal range. Of the 88 results that were abnormal 17 (19,32%) were below the lower limit of the normal range and 71 (80,68%) were above the upper limit of the normal range.

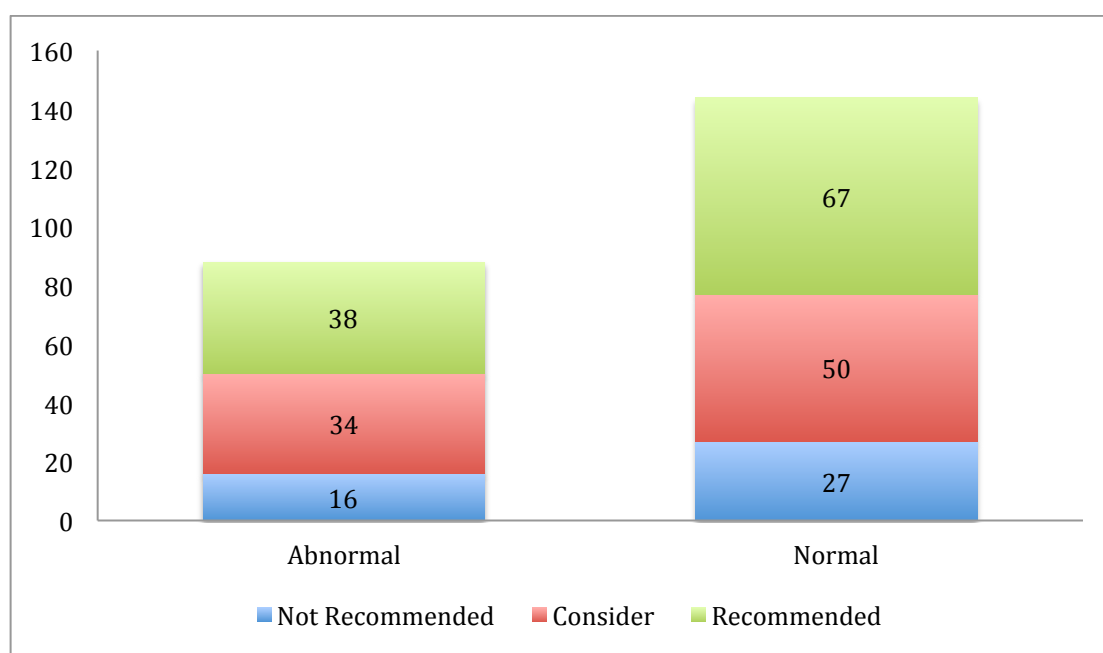
When the abnormal platelet results were considered according to the NICE groupings it was found that 16 of the 43 (37,21%) tests not recommended, 34 of the 84 (40,48%) tests that should be considered and 38 of the 105 (36,19%) of the tests that were recommended were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,8287$). These results are shown in Table 4.6 and Figure 4.6.

Table 4.6 Platelet results according to the NICE recommendation

PLT	NICE Recommendation				
		Not recommended	Consider	Recommended	Total (%)
Results	Abnormal				88 (37,93%)
	Number	16	34	38	
	Row %	18,18%	38,64%	43,18%	
	Column %	37,21%	40,48%	36,19%	
	Total %	6,90%	14,66%	16,38%	
	Normal				144 (62,07%)
	Number	27	50	67	
	Row %	18,75%	34,72%	46,53%	
	Column %	62,79%	59,52%	63,81%	
	Total %	11,64%	21,55%	28,88%	
Total (%)		43 (18,53%)	84 (36,21%)	105 (45,26%)	232

p=0,8287

Figure 4.6 Platelet results according to the NICE recommendation



The next group of tests that was considered is the UCE. This consists of the electrolytes (sodium, potassium and chloride), urea and creatinine. The results were considered in two groups, firstly the electrolytes and secondly urea and creatinine combined, as was done in the review by NICE.

When the electrolyte results were considered it was found that 125 (18,52%) out of the 675 results were outside of the normal range. Of the 125 results that were abnormal 50 (40,00%) were below the lower limit of the normal range and 75 (60,00%) were above the upper limit of the normal range.

When the abnormal electrolyte results were considered according to the NICE groupings it was found that 25 of the 165 (14,88%) tests not recommended, 48 of the 240 (20,00%) tests that should be considered and 52 of the 267 (19,48%) of the tests that were recommended were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,3708$). These results are shown in Table 4.7 and Figure 4.7.

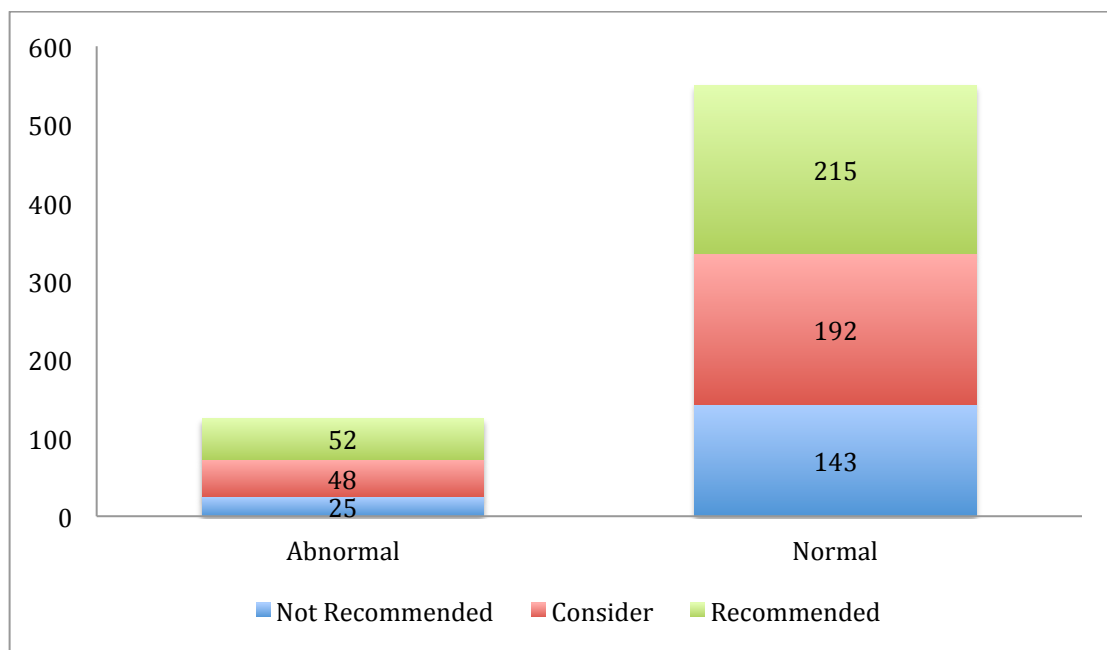
When considering each electrolyte individually no statistically significant association between the NICE recommendation and the detection of abnormal results could be detected with sodium ($p=0,2894$), potassium ($p=0,1740$) and chloride ($p=0,8102$). These results will not be presented.

Table 4.7 Electrolyte results according to the NICE recommendation

Electrolytes	NICE Recommendation				Total (%)
		Not recommended	Consider	Recommended	
Results	Abnormal				125 (18,52%)
	Number	25	48	52	
	Row %	20,00%	38,40%	41,60%	
	Column %	14,88%	20,00%	19,48%	
	Total %	3,70%	7,11%	7,70%	
	Normal				550 (81,48%)
	Number	143	192	215	
	Row %	26,00%	34,91%	39,09%	
	Column %	85,12%	80,00%	80,52%	
	Total %	21,19%	28,44%	31,85%	
Total (%)		165 (24,89%)	240 (35,56%)	267 (39,56%)	675

p=0,3708

Figure 4.7 Electrolyte results according to the NICE recommendation



When the urea and creatinine results were considered it was found that 108 (24,00%) out of the 450 results were outside of the normal range. Of the 108 results that were abnormal 39 (36,11%) were below the lower limit of the normal range and 69 (63,89%) were above the upper limit of the normal range.

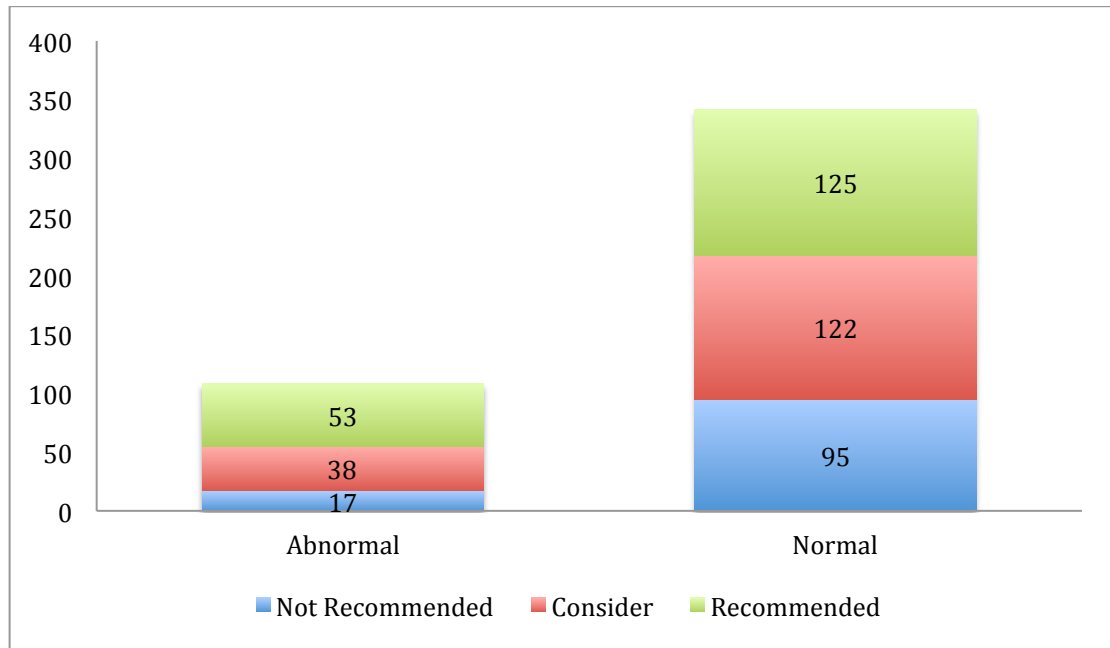
When the abnormal results were considered according to the NICE groupings it was found that 17 of the 112 (15,18%) tests not recommended, 38 of the 160 (23,75%) tests that should be considered and 53 of the 178 (29,78%) of the tests that were recommended were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,0180$). These results are shown in Table 4.8 and Figure 4.8.

Table 4.8 Urea/Creatinine results according to the NICE recommendation

Urea/ Creatinine	NICE Recommendation				Total (%)
		Not recommended	Consider	Recommended	
Results	Abnormal				108 (24,00%)
	Number	17	38	53	
	Row %	15,74%	35,19%	49,07%	
	Column %	15,18%	23,75%	29,78%	
	Total %	3,78%	8,44%	11,78%	
	Normal				342 (76,00%)
	Number	95	122	125	
	Row %	27,78%	35,67%	36,55%	
	Column %	84,82%	76,25%	70,22%	
	Total %	21,11%	27,11%	27,78%	
Total (%)		112 (24,89%)	160 (35,56%)	178 (39,56%)	450

$p=0,0180$

Figure 4.8 Urea/Creatinine results according to the NICE recommendation



When considering the urea and creatinine results individually no statistically significant association between the NICE recommendation and the detection of abnormal results could be detected with creatinine ($p=0,3429$), and these results will not be presented. However with the urea results a statistical significant association between the NICE recommendation and the detection of abnormal results was found and will be presented next.

When the urea results were considered it was found that 34 (15,11%) out of the 225 results were outside of the normal range. Of the 34 results that were abnormal 2 (5,88%) were below the lower limit of the normal range and 32 (94,12%) were above the upper limit of the normal range.

When the abnormal urea results were considered according to the NICE groupings it was found that 3 of the 56 (5,36%) tests not recommended, 9 of the 80 (11,25%) tests that should be considered and 22 of the 89 (24,72%) of the tests that were recommended were abnormal. With a p value of 0,0032 an association between the NICE recommendation and the detection of abnormal results could be established. These results are shown in Table 4.9 and Figure 4.9.

With further analysis of the results, by applying the Bonferroni post hoc test correction, an association between the NICE recommendation and the detection of abnormal results was found between the groups where testing was recommended and where testing was not recommended ($p = 0,0027$). This is shown in Table 4.10 and Figure 4.10.

Table 4.9 Urea results according to the NICE recommendation

Urea	NICE Recommendation				
		Not recommended	Consider	Recommended	Total (%)
Results	Abnormal				34 (15,11%)
	Number	3	9	22	
	Row %	8,82%	26,47%	64,71%	
	Column %	5,35%	11,25%	24,72%	
	Total %	1,33%	4,00%	9,78%	
	Normal				191 (84,89%)
	Number	53	71	67	
	Row %	27,75%	37,17%	35,08%	
	Column %	94,64%	88,75%	75,28%	
	Total %	23,56%	31,56%	29,78%	
Total (%)		56 (24,89%)	80 (35,56%)	89 (39,56%)	225

$p=0,0032$

Figure 4.9 Urea results according to the NICE recommendation

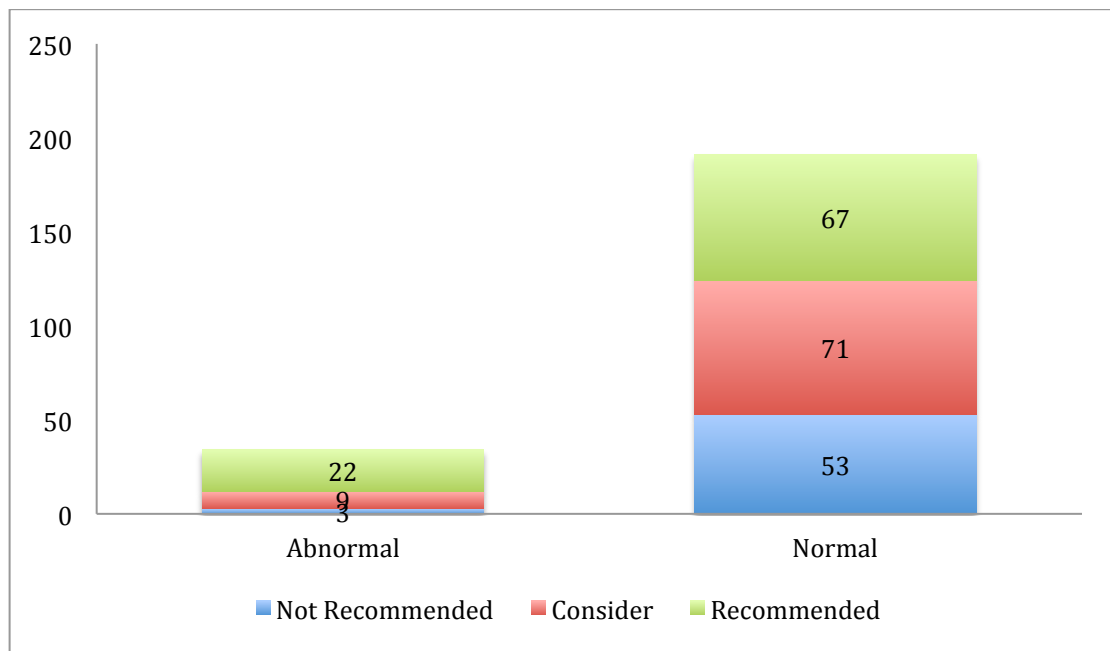
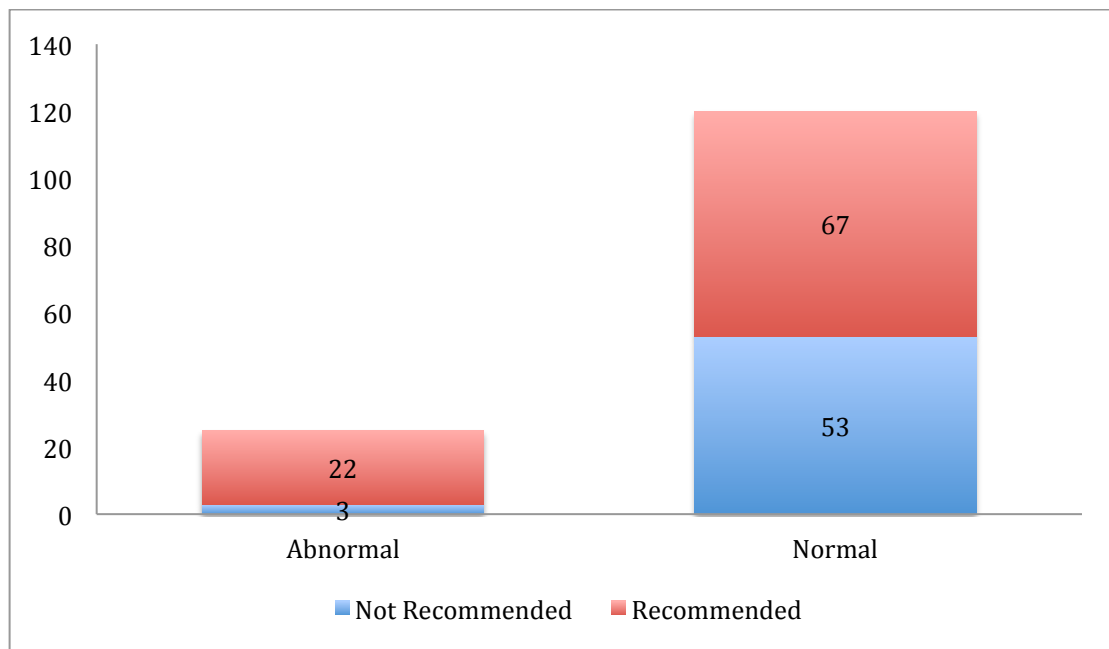


Table 4.10 Urea results according to the NICE recommendation groups: Not recommended and Recommended

Urea	NICE Recommendation				
		Not recommended	Recommended	Total (%)	
Results	Abnormal				
	Number	3	22	25 (17,24%)	
	Row %	12,00%	88,00%		
	Column %	5,36%	24,72%		
	Total %	2,07%	15,17%		
	Normal				
	Number	53	67	120 (82,76%)	
	Row %	44,17%	55,83%		
	Column %	94,64%	75,28%		
	Total %	36,55%	46,21%		
	Total (%)		56 (38,62%)	89 (61,38%)	145

p= 0,0027

Figure 4.10 Urea results according to the NICE recommendation groups: not recommended and recommended.



The next group of tests that was considered is the coagulation studies consisting of the PT/INR and the PTT.

When the PT/INR results were considered it was found that 1 (1,61%) out of the 62 results was outside of the normal range. The normal range for the INR was taken as an INR greater than 1,5.

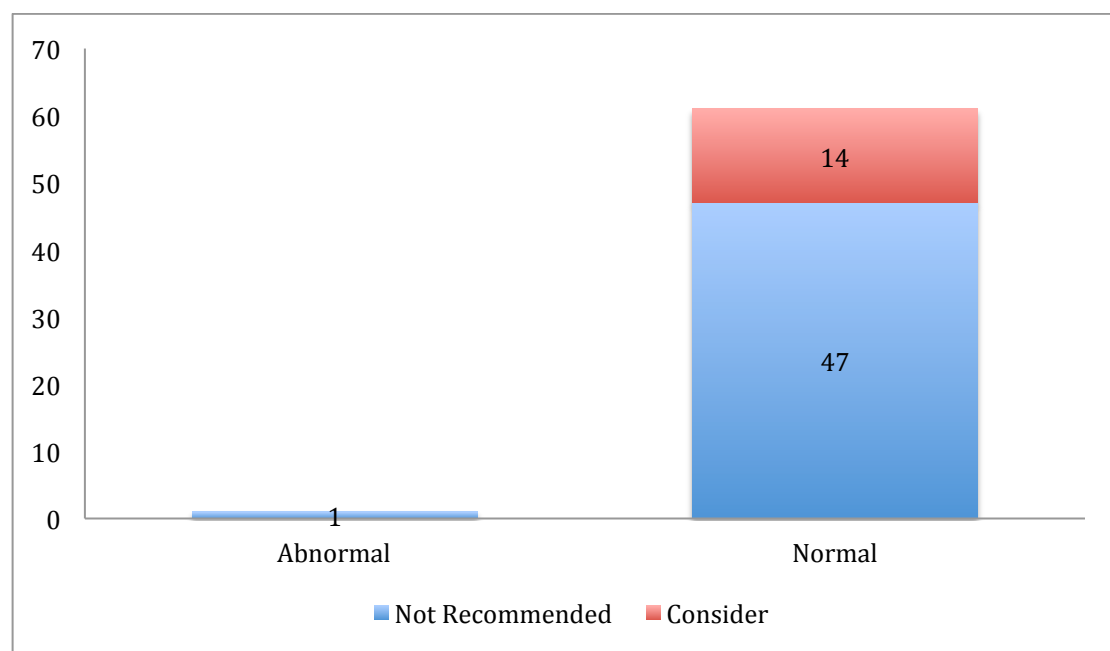
When the abnormal PT/INR results were considered according to the NICE groupings it was found that 1 of the 48 (2,08%) tests not recommended and none tests that should be considered were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,5861$). These results are shown in Table 4.11 and Figure 4.11.

Table 4.11 PT/INR results according to the NICE recommendation

PT/INR	NICE Recommendation			Total (%)
		Not recommended	Consider	
Results	Abnormal			
	Number	1	0	1 (1,61%)
	Row %	100,00%	0,00%	
	Column %	2,08%	0,00%	
	Total %	1,61%	0,00%	
	Normal			
	Number	47	14	61 (98,39%)
	Row %	77,05%	22,95%	
	Column %	97,92%	100,00%	
	Total %	75,81%	22,58%	
Total (%)		48 (77,42%)	14 (22,58%)	62

p= 0,5861

Figure 4.11 PT/INR results according to the NICE recommendation



When the PTT results were considered it was found that 10 (21,74%) out of the 46 results were outside of the normal range.

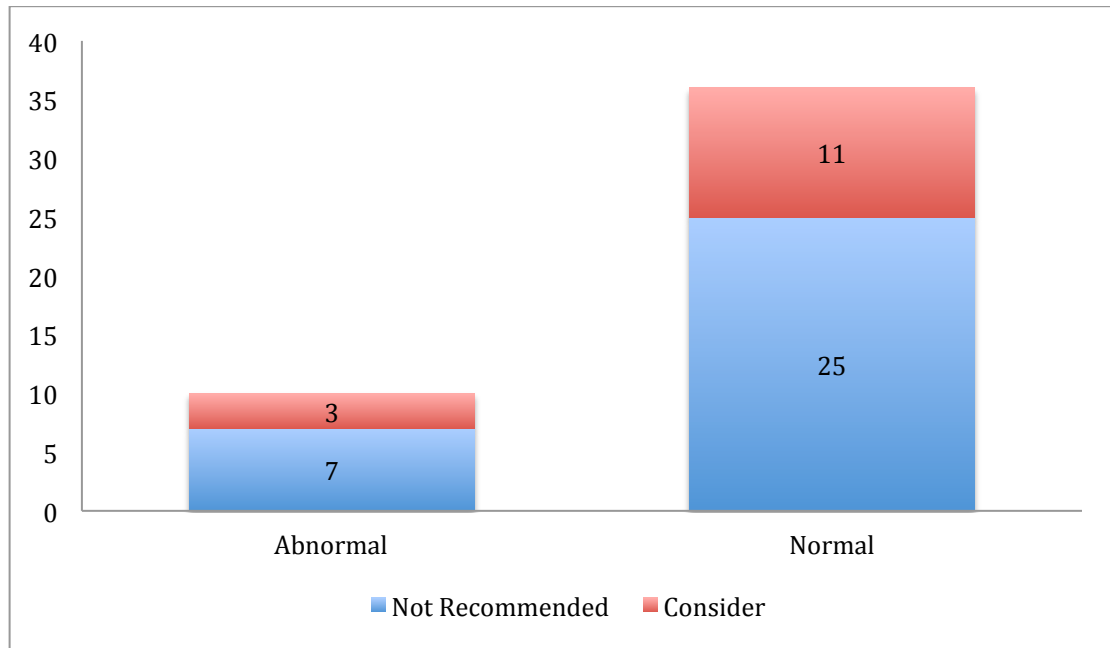
When the abnormal PTT results were considered according to the NICE groupings it was found that 1 of the 32 (21,88%) tests not recommended and 3 of the 14 (21,43%) tests that should be considered were abnormal. No association between the NICE recommendation and the detection of abnormal results was found ($p=0,9731$). These results are shown in Table 4.12 and Figure 4.12

Table 4.12 PTT results according to the NICE recommendation

PTT	NICE Recommendation			
		Not recommended	Consider	Total (%)
Results	Abnormal			
	Number	7	3	10 (21,74%)
	Row %	70,00%	30,00%	
	Column %	21,88%	21,43%	
	Total %	15,22%	6,52%	
	Normal			
	Number	25	11	36 (78,26%)
	Row %	69,44%	30,56%	
	Column %	78,12%	78,57%	
	Total %	54,35%	23,91%	
Total (%)		32 (69,57%)	14 (30,43%)	46

$p= 0,9731$

Table 4.12 PTT results according to the NICE recommendation



4.3 Discussion

Requesting preoperative tests without the use of guidelines for preoperative testing is still practiced at CMJAH.

In an attempt to clarify the use of preoperative tests, the aim of this study was to describe the preoperative tests requested by the different clinical disciplines and then to determine to what extent this differs from what would be recommended by the NICE Guidelines for preoperative testing. Lastly it was determined if there was an association between the NICE recommendation and the detection of abnormal laboratory results found in this study.

A total of 1093 preoperative tests were requested for the 277 patients included in this study (3,95 tests per patient). This correlates well with studies done in Europe and Canada where on average between 1,99 and 4,63 tests per patient were done (5, 30-32, 42). The most frequently requested preoperative test, of the ten tests considered for this study, was the CXR (n=240, 21,96%) and the least frequent requested test was the

ABG (n=1, 0,09%). These requests were made by ten different clinical disciplines including nine surgical disciplines and anaesthesiology.

In this study there were 31 anaesthetists who participated by completing the preoperative assessment forms. They were mostly registrars or medical officers. The anaesthetists requested a total of 53 (4,85%) preoperative tests, of which ECGs were requested most frequently (n=16, 30,19%) and least frequently arterial blood gas analysis (n=1, 1,89%).

After considering each patient's surgery grade, age, ASA grade and existing comorbid conditions, it was determined whether a specific preoperative test, according to the NICE Guideline for preoperative testing:

- was not recommended,
- should be considered or
- was recommended.

Of the 1093 tests that were performed 346 (31,66%) would not have been recommended according to the NICE Guidelines. It was further noted that 27 (8,71%) tests that would be recommended were not requested. Following a review of the literature three studies were found looking at compliance with the NICE Guidelines. These however only considered blood tests and did not include ECG, CXR and Flow-volume- loops (30, 31, 42). When these three tests are omitted from the results found in our study 184 (31,83%) of tests would not have been recommended. This compares well with results found in a similar study, conducted in London, where 31,3% of tests conducted were found to be inappropriate according to NICE (31). The compliance with the NICE Guidelines are however institution dependant. In another audit performed at a district general hospital in Britain, Putnis et al (42) found a 90,6% compliance with the NICE Guidelines. It is possible that the reason for requesting the preoperative test need not always have been for the anaesthetic workup but there was a reason related to the surgery for requesting a specific test.

Of the 346 unnecessary tests in our study the CXRs were requested most frequently (n=78, 22,54%) and glucose tests least frequently (n=3, 0,87%).

However if one considers the number of unnecessary tests requested per total requested for each particular tests it was found that with 48 out of 62 (77,42%) the PT/INR were requested the most frequently and at 31 out of 193 (16,06%) the ECGs were requested least frequently. This correlates with the results found with both studies done in Britain where the coagulation studies were done inappropriately most frequently at 65,9% (31) and 17,8% (42). With review of the literature no studies specific to South Africa could be found.

The data was further analysed to determine what each clinical discipline's contribution to the number of unnecessary preoperative tests. It was found that general surgery requested the greatest number of unnecessary tests (n=112, 32,37%) and Ophthalmology requested the least number of unnecessary tests (n=7, 2,02%).

When one considers the number of unnecessary tests requested as a percentage of the tests requested by each particular discipline it was found that the greatest percentage of unnecessary tests were requested by Urology (46,67%) with Vascular surgery (11,11%) requesting the smallest percentage of unnecessary tests. It should be taken into consideration that, even though according to the NICE Guidelines the tests would not have been recommended, there might have been a surgical indication for requesting a specific preoperative test. With a review of the literature no specific studies could be found describing which clinical discipline is most likely to request unnecessary preoperative. In a study by Katz et al (13) it was found, with a simulated patient scenario and questionnaire based study, that anaesthetists were up to 67% less likely than the surgeons to request an unnecessary preoperative test.

The results of the different laboratory tests were analysed to determine if there is an association between the NICE recommendation for preoperative testing and its subdivisions and the likelihood of detecting abnormal results.

The FBC with its different subcomponents, haemoglobin, white cell count and platelet count, was considered first.

In this study a total of 131 (56,47%) of abnormal haemoglobin results were detected of which 126 (54,31%) were low, with the lower limit of normal taken as 12,1g/dl for females and 14,3g/dl for males. This is relatively high compared to the 10,7% of abnormal haemoglobin results found in the prospective non-consecutive sampling studies included in the review presented by NICE (53). Pal and Safdar (54), in their efforts to determine the preoperative workup requirement in a developing country, found a prevalence of 19,4% of a low haemoglobin. With review of the literature the only available data in South African was study by Nojilana et al (55) determining the burden of disease of iron deficiency anaemia in South Africa in 2000, where it was found that 9-12% of pregnant women between the ages of 15 and 45 had iron deficiency anaemia. This is still significantly lower than the results found in this study.

In a study published in 2009 by Lawrie et al (56), conducted in Johannesburg, it was found that the reference ranges for haemoglobin used by the NHLS for Gauteng remain valid when considering ethnicity and gender differences. And thus the high number of abnormal results cannot be attributed to inappropriate reference ranges for this patient population.

As haemoglobin level was tested in 232 (81,23%) and not on all patients the pattern of requesting does not seem to be purely routine but rather by utilising some form of selection. This could contribute to a higher level of abnormal values being detected. In 24 (55,81%) of the abnormal tests the haemoglobin test would not have been recommended according to the NICE Guidelines. As such a high percentage of abnormal haemoglobin levels were detected it could indicate that the NICE recommendation for testing haemoglobin is inappropriate in the setting of CMJAH.

It was noteworthy that the group where the NICE Guidelines recommended testing had the highest percentage of abnormal results (n=64, 60,95%). There was however no statistically significant association between the different NICE subdivisions and the detection of abnormal haemoglobin results (p= 0,4029).

In our study a total of 52 (22,41%) abnormal white cell counts were detected of which 38 (73,07%) were high. This is higher than the 0,1% of abnormal results found in the

prospective non-consecutive sampling studies included in the review performed by NICE (53).

In a study by Amaranto et al (57) it was shown that a white cell count at the upper limit of normal was an independent predictor for complications, major adverse events and death in patients going for endovascular procedures. A review of the literature failed to elucidate if this holds true for all types of surgery. The reason as to why the number of abnormal white cell counts detected in our study is increased is unclear and could indicate the need for further research.

The group where the NICE Guidelines did not recommend testing had the highest percentage of abnormal results (25,58%, n=11). There was however no statistically significant association between the different NICE subdivisions and the detection of abnormal white cell counts (p= 0,8273). As such a high number of abnormal white cell counts were detected it could indicate that the NICE Guidelines for preoperative testing are inappropriate for our population.

In our study a total of 88 (37,39%) abnormal platelet counts were detected, of which 71 (80,68%) were above the upper limit of normal. This higher than the 2,7% of abnormal results found in the prospective non-consecutive sampling studies included in the review performed by NICE (53). A literature review failed to detect specific data for South Africa. In a study on medical patients, thrombocytosis was found to be a biomarker for pyogenic infection in particular, empyema, abscesses and soft tissue infection (58). These patients had longer periods of admission, higher rates of infection, sepsis, in-hospital complications and death. The increased level of thrombocytosis in our study could, in conjunction with the high level of leucocytosis, indicate the presence of infective processes. This is of concern as these were elective procedures and, unless the reason for surgery was to address the infective process, this could increase the risk of morbidity and mortality for the patients. Further investigation would be needed to determine if this level of thrombocytosis and leucocytosis impacts negatively on patient outcome at CMJAH. The group where the NICE Guidelines recommended that testing should be considered had the highest percentage of abnormal results (n=84, 40,48%). There was however no statistically significant association between the different NICE

subdivisions and detection of abnormal platelet counts ($p=0,8287$). This could indicate that the NICE Guidelines are inappropriate for CMJAH regarding the requesting of platelet counts and the need for the development of an institution specific guideline. The UCE is considered next, subdivided into the electrolytes, urea and creatinine.

In our study a total of 125 (18,82%) abnormal electrolyte results were detected. This is higher than the 1,0% found in the prospective studies and 1,6% found in the retrospective studies in the NICE review (53). The reason for the increased number of electrolyte abnormalities found with this study is unclear and could indicate the need for further investigation. A review of the literature did not yield results specific to South Africa. At 52 (7,70%), the group where the NICE Guidelines recommended testing had the highest number of abnormal results. No statistically significant association between the different NICE subdivisions and detecting abnormal electrolyte results could be found ($p=0,3708$). When considering each electrolyte individually no statistically significant association between the NICE recommendation and the detection of abnormal results could be found with sodium ($p=0,2894$), potassium ($p=0,1740$) and chloride ($p=0,8102$). This could indicate that the NICE Guidelines are inappropriate for CMJAH regarding the requesting of electrolytes and the need for the development of institution specific guidelines.

In our study a total of 108 (24,00%) abnormal urea and creatinine results were detected. This is higher than the 1,0% found in the prospective studies and 9,7% found in the retrospective studies in the NICE review (53). The reason for the increased number of urea and creatinine abnormalities found with our study is unclear and could indicate the need for further investigation. Review of the literature failed to yield data specific to South Africa. At 53 (11,78%), the group where the NICE Guidelines recommended testing had the highest number of abnormal results. No statistically significant association between the different NICE subdivisions and the detection of abnormal urea and creatinine results could be found ($p=0,0180$). However when considering the urea and creatinine results individually the chi-square found a statistical significant association between the NICE recommendation and the detection of abnormal urea results ($p=0,0032$) and this will be discussed next.

In our study a total of 34 (15,11%) abnormal urea results were detected. The group where the NICE Guidelines recommend testing had the highest percentage of abnormal results (n=22, 9,78%). With a p value of 0,0032 there was a statistically significant difference between the different NICE subdivisions for detecting patients with abnormal urea results. On further analysis of the results it was found that there is an association between the NICE recommendation and the detection of abnormal urea results between the groups where testing was recommended and where testing was not recommended (p=0,0027). This could indicate that the NICE Guideline is appropriate for detecting abnormal urea results and that these recommendations could be incorporated in an institution-specific guideline for CMJAH.

The next group of tests that were considered were the coagulation studies consisting of the PT/INR and the PTT.

In this study a total of 1 (1,61%) abnormal PT/INR results was detected. This is less than the rate of detecting abnormal results found with the NICE review where the studies where tests done routinely detected 3,2% abnormal results (53). The group where the NICE Guidelines did not recommend testing had the highest percentage of abnormal results (n=1, 1,61%). No statistically significant difference between the different NICE subdivisions for detecting patients with abnormal PT/INR results could be found (p=0,5861). This could indicate that the NICE Guidelines are inappropriate for CMJAH regarding the requesting of PT/INR and the need for the development of institution-specific guidelines.

In this study a total of 10 (21,75%) abnormal PTT results were detected. This is higher than the rate of detecting abnormal results found with the NICE review where the studies where tests done routinely detected 4,9% abnormal results (53). The group where the NICE Guidelines did not recommend testing had the highest percentage of abnormal results (n=7, 15,22%). No statistically significant difference between the different NICE subdivisions for detecting patients with abnormal PTT results could be found (p=0,9731). This could indicate that the NICE Guidelines are inappropriate for CMJAH regarding the requesting of PTT and the need for the development of institution specific-guidelines.

4.4 Conclusion

The rate of requesting preoperative tests at CMJAH was found to be 3,95 tests per patient with a total of 1093 tests requested. The most frequently requested test was the CXR at 21,96%. The anaesthetists requested a total of 53 (4,85%) preoperative tests with the ECGs being requested most frequently (n=16, 30,19%). Of the requested tests 346 (31,66%) would not have been recommended by the NICE Guidelines for preoperative testing. The PT/INRs were requested inappropriately most frequently at 77,42%, which correlates with the results found with similar studies (31, 42). It was found that general surgery requested the greatest number of unnecessary tests (n=112, 32,37%), however when one considers the number of unnecessary tests requested per total tests requested by each particular discipline it was found that Urology requested the greatest percentage of unnecessary tests (46,67%). With the results found with our study no statistically significant association between the NICE Guidelines' recommendation and the detection of abnormal laboratory results could be established, except for the urea results where there was an association between the NICE recommendation groups where testing was recommended and where testing was not recommended (p=0,0027).

The detection of a normal test result could in some instances be of importance and influence the further treatment of the patient. However the high rate of abnormal results detected with this study in combination with the lack of a statistically significant association between the detection of abnormal results and the NICE Guidelines' recommendations, indicates the need for the development of an institution-specific guideline for preoperative testing for CMJAH.

4.5 Summary

In this chapter the statistical analysis and discussion of the results found with the data collection were addressed. The results were presented and discussed according to the primary and secondary objectives of this study. The data presented included a demographic description of the study population, the number of requested preoperative tests, the number of preoperative tests requested by the anaesthetists, the

number of tests that would not have been recommended according to the NICE Guidelines for preoperative testing, each clinical department's contribution to the unnecessary tests were calculated and lastly it was determined if there is an association between the NICE Guidelines' recommendation and the detection of abnormal laboratory test results. The data were presented with the aid of descriptive and inferential statistics.

The final chapter will provide a summary of the study, including its limitations, recommendations and conclusions.

Chapter 5: Summary, Limitations, Recommendations and Conclusion

5.1 Introduction

In this chapter a summary to the study will be provided followed by a discussion on the possible limitations of the study. The clinical recommendation and recommendations for future research that became apparent during this study will be discussed. Lastly the conclusion of this study will be presented.

5.2 Summary of the study

5.2.1 Aim of the study

The aim of this study was to audit and evaluate preoperative tests requested for adult patients scheduled for elective surgery at CMJAH.

5.2.2 Objectives of the study

The primary objectives of this study were to:

- document all requested preoperative tests;
- determine the number of preoperative tests requested by the anaesthetist;
- determine the number of requested preoperative tests that were not recommended according to the NICE Guidelines for preoperative testing;
- determine each clinical department's contribution to the unnecessary preoperative tests that were requested

The secondary objective of this study was to determine if there is an association between the NICE recommendation for preoperative testing and the detection of abnormal results in laboratory tests.

5.2.3 Summary of the methodology of the study

The study design was that of a prospective descriptive clinical survey investigating the use of preoperative tests at CMJAH. The data was collected utilising a preoperative assessment form, designed for the purpose of this study, completed by different anaesthetists during their preoperative visits. The data included demographic information and data pertaining to the preoperative tests requested for each patient.

A minimum sample size for this study was calculated at 267 forms based on the number of elective surgeries performed in 2010.

The anaesthetists completed the preoperative assessment forms after obtaining written informed consent from the patients. Each preoperative assessment form was considered individually and it was determined which preoperative tests were requested, by whom and if it was appropriate according to the NICE Guidelines for preoperative testing. The results for the laboratory investigations were obtained from the NHLS at CMJAH. The results were then analysed to determine if there was an association between the NICE Guidelines' recommendation and the detection of abnormal results.

5.2.4 Main findings of the study

A total of 1093 preoperative tests were requested for the 277 patients included in this study (3,95 tests per patient). The test that was requested most frequently was the CXR (n=240, 21,96%). The anaesthetists requested a total of 53 (4,85%) additional preoperative tests. In this group of tests the ECG was requested most frequently (n=16, 30,12%).

Ten different clinical departments requested a total of 1093 tests and 346 (31,66%) of these would not have been recommended by the NICE Guidelines. It was found that general surgery requested the greatest number of unnecessary tests (n=112, 32,37%) and Ophthalmology requested the least number of unnecessary tests (n=7, 2,02%).

When one considers the number of unnecessary tests requested as a percentage of the tests requested by each particular discipline it was found that the greatest percentage of unnecessary tests were requested by Urology (46,67%) with Vascular surgery (11,11%) requesting the smallest percentage of unnecessary tests.

In an attempt to determine whether there were any statistically significant associations ($p < 0,05$) between the NICE Guidelines' recommendations and the detection of abnormal results no statistically significant association could be established except for the urea results ($p = 0,0027$).

5.2.5 Limitations of the study

The generalisability of this study should be viewed with certain limitations in mind. This study was done contextually at CMJAH and the results may not be generalisable to other South African hospitals. The results found with this study do however illuminate the manner in which preoperative tests were requested at CMJAH during the study period.

The quality of the data may have been affected as data was collected from preanaesthetic assessment forms completed by field workers (anaesthetists) and not through review of the patients' records and patient interviews by a single researcher. However, an information session was held where the anaesthetists were informed about the study and what was expected from them. The researcher was available throughout the study period should the anaesthetists have any questions. A quality control was performed on 10% of the sample to determine the extent of this limitation. And a correspondence of 93,75% was found between the data on the preanaesthetic assessment forms and that found by the researcher.

A further limitation could be that the different individuals involved in requesting preoperative tests adjusted their practice as they became aware that preoperative testing was being audited.

Another limitation to the study is that, due to the limited time during which the study was conducted, one cannot extrapolate the data to be relevant for all periods of time as the circumstances might differ during another time period. It might be that a particular group of physicians who were requesting preoperative tests had certain habits or beliefs or they might have been less or more knowledgeable than another group that might request preoperative tests. The study can thus only describe the appropriateness of the requested preoperative tests at the time that the study was conducted.

The assumption that was made by the researcher, for the purpose of this study, that all preoperative test that were requested pertained to the anaesthetic preoperative workup, could place a limitation on the data collected for this study. The request of a specific preoperative test could have been justified by a surgical reason. The extent to which this assumption has affected the generalisability of the finding of this study is not known.

A single researcher determined the appropriateness of the preoperative tests that were requested using the NICE Guidelines for preoperative testing. In an attempt to quantify the extent of this limitation the clinical supervisor assessed 10% of the sample and a correspondence of 95,24% was found between the findings of the researcher and that of the supervisor.

The validity of the NICE Guidelines for preoperative testing as an instrument for determining whether a specific preoperative test was indicated or not for a particular patient could be a limitation. This guideline was not developed with a specific institution in mind and the needs of each institution might differ. The extent of this limitation became apparent with the high number of abnormal laboratory results that were detected in this study.

5.3 Recommendations from this study

5.3.1 Clinical recommendations from this study

The effect of requesting unnecessary preoperative tests is extensive. Other than causing unnecessary discomfort to the patient it may have an effect on the logistical running of the theater schedule by causing time delays or cancellation of surgeries. Additional issues are the financial, medico-legal and ethical implications. A high number of unnecessarily requested preoperative tests were found with this research (n=346, 31,66%). As CMJAH is a resource-limited environment, in a developing country, the need for a strategy to restrict the number of requested preoperative tests is accentuated by this study. The strategy could include:

- the implementation of an institution specific guideline for preoperative testing;
- a sustainable education program for all physicians involved in requesting of preoperative tests;
- the enforcement of a restriction, in collaboration with the NHLS, on the number and the type of laboratory investigations being requested; and
- the establishment of a preoperative assessment clinic.

The need for the development of an institution-specific guideline for preoperative testing was reiterated by the findings in this study. The combination of the number of abnormal laboratory results detected and the lack of a statistically significant association between the NICE Guidelines' recommendations and the detection of abnormal results, found with this study, stressed this need.

5.3.2 Recommendations for further research

Since the time that this study was conducted the NHLS at CMJAH has implemented a gate-keeping system. This restricts the number and type of preoperative tests that are allowed per patient. Only senior members of staff are allowed to request certain preoperative tests. The effect this has had on the number of unnecessarily requested preoperative laboratory tests needs to be examined with periodical audits.

Should any of the remaining recommendations mentioned above be implemented it is suggested that their implementation process and impact be audited.

The large number of abnormal preoperative laboratory tests detected with this research could also indicate the need for further research. This study was not designed or sufficiently powered to suggest possible reasons for this finding. A study specific to this purpose would need to be conducted to fully illuminate this finding.

5.4 Conclusion

The abundance of unnecessary preoperative tests identified with this study illustrates the need for the development and implementation of a multifactorial strategy for the reduction of unnecessary preoperative tests at CMJAH.

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Appendices

Appendix A: Permission from Postgraduate Committee



Dr I Van der Nest
1420 Starkey Avenue
Waverley
Pretoria
0186
South Africa

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2076

Reference: Ms Salamina Segole
E-mail: salamina.segole@wits.ac.za
10 July 2012
Person No: 587674
PAG

Dear Dr Van der Nest

Master of Medicine (in the specialty Anaesthesia): Approval of Title

We have pleasure in advising that your proposal entitled "*Preoperative testing at a university hospital in a developing country: Are the requested tests indicated?*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

A handwritten signature in cursive script, appearing to read 'S Benn', with a horizontal line underneath.

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix B: Permission from Ethics Committee

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Iwan van der Nest

CLEARANCE CERTIFICATE

M110704

PROJECT

Preoperative Testing at a University Hospital in a
Developing Country: Are the Requested Tests

Indicated?

INVESTIGATORS

Dr Iwan van der Nest.

DEPARTMENT

Department of Anaesthesiology

DATE CONSIDERED


29/07/2011

DECISION OF THE COMMITTEE*

Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 29/07/2011

CHAIRPERSON 
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Ms Juan Scibante

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix C: Permission from the CEO at CMJAH



**health and
social development**
Department: Health and Social Development
GAUTENG PROVINCE

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Office of the CEO
Enquiries: L. Mngomezulu
(011) 488-3793
(011) 488-3753
28 September 2011

Dr. Iwan van der Nest
Department of Anaesthesiology
Charlotte Maxeke Johannesburg Hospital

Dear Dr. Van der Nest

RE: "Preoperative testing at University hospital in a developing country: are the requested tests indicated"

Permission is granted for you to conduct the above research as described in your request provided:

1. Charlotte Maxeke Johannesburg Academic hospital will not in anyway incur or inherit costs as a result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the Head of Department and Unit Manager or Sister in Charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

Yours sincerely

A handwritten signature in cursive script, appearing to read 'Barney Selebano'.

Dr. Barney Selebano
Chief Executive Officer

Appendix D: Participant information letter

Participant information letter

Preoperative testing at a university hospital in a developing country: are the requested tests indicated?

Dear Sir/Madam

Hello, my name is Iwan van der Nest and I am a doctor in the Anaesthetic Department at the University of the Witwatersrand (Wits) and Charlotte Maxeke Johannesburg Academic Hospital (CMJAH). I am doing research on the special tests that are done before you come to theatre for an operation. Research is the process through which we collect information to help us to answer some questions we have. In this study I want to look at the tests (like the blood tests and X-rays) that were done on you before you come for your operation, and would therefore like to invite you to take part in this study.

For this study I do not need you have any extra tests done, I simply want to look at the tests that have already been done to prepare you for this operation. I also want to have a look at the results of the tests that were done. I will be looking at the tests of about 400 people that come for operations at this hospital. I will get this information from the form that the anaesthetists (the doctors that see that you have no pain and/or make you sleep during the operation) will fill out.

It is your own choice to take part or not take part in the study and nobody will force you if you do not want to. If you do not want to be part of the study the treatment you will get will not change in any way. If you decide during any time in the future that you do not want to be part of the study anymore you are welcome to contact us. There is no direct benefit (reward) for you when you take part in my research but it may help us to help other people in the future.

I will do everything that I can to keep your personal information (name and hospital number) anonymous. This study was approved by the Human Research Ethics Committee (Medical) and participants may contact the Chairman should they have any queries, complaints, and questions regarding their rights as research participants.

For any further information you are welcome to contact us.

Contact details of researchers:	Chairman of the Ethics Committee:
Dr Iwan van der Nest 011- 488 4343	Prof Cleaton-Jones 011-717 2301

Thank you for taking the time to read this letter.

Dr Iwan van der Nest

Appendix E: Consent Form

Consent Form

Preoperative testing at a university hospital in a developing country: are the requested tests indicated?

I, _____ (name and surname) fully understand the information letter. I have been give a chance to ask any questions I might have and I am happy with the answers I have been given.

I hereby give consent/permission to be included in this study.

Or

As legal representative of _____

I, _____ hereby give consent/permission for him/her to be included in this study.

(Signature)

(Date)

(In case of assent)
I hereby agree to be included in this study.

(Signature)

Appendix F: Preoperative assessment form

Anaesthetic Assessment Charlotte Maxeke Johannesburg Academic Hospital

Patient Name: _____

Hospital Number: _____ Ward: _____

DoB: _____ Age: _____ Gender: _____

Y	Y	Y	Y	M	M	D	D
---	---	---	---	---	---	---	---

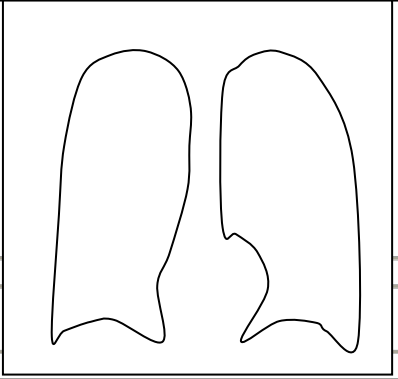
Planned Surgical Procedure: _____

Date: _____ Anaesthetist: _____

Y	Y	Y	Y	M	M	D	D
---	---	---	---	---	---	---	---

History	Physical Examination
Presenting Hx: _____ _____ _____	HR: _____ BP: _____ SpO ₂ : _____ Resp: _____ Temp : _____ Weight: _____ General: _____ _____
Medical Hx/ Co-Morbidities: _____ _____ _____ _____	Cardiovascular: _____ _____ _____
Surgical and Anaesthetic Hx: _____ _____ _____	Respiratory: _____ _____ _____
Family Hx/ Social habits: _____ _____	Head/ Neck/ Airway: _____ _____
Effort tolerance: _____	Other: _____ _____
Medication: _____ _____ _____	_____ _____ _____
Allergies: _____ _____	_____ _____

Special Investigations:



CXR:

ECG:

Hb		Na ⁺		Alb		AST	
Wcc		K ⁺		Ca ²⁺		GGT	
Plt		Cl ⁻		PO ₄ ⁻		pH	
INR		CO ₂ ⁻		Mg ²⁺		pCO ₂	
PTT		Urea		T.Bili		pO ₂	
Glucose		Creat		D.Bili		HCO ₃ ⁻	
				ALP		BE	
				ALT		Lactate	

Pregnancy test: Pos: () Neg:()
 Floop: Pre: FEV₁: (%) FEV₁/FVC: (%) Post: FEV₁: (%) FEV₁/FVC:
 (%)
 Other:

Assessment and Plan:

ASA grade:

Assessment/ Problem list:

Plan/ additional recommendations/ requests:

Signature:
