

Assessment of pre-operative investigation cost and associated factor on surgical patients at Gondar university hospital, Gondar, Ethiopia, 2019

Abstract

Background: Pre-operative investigations are performed before any surgical intervention under anesthesia. Many are considered as routine. However, there are no clear guidelines regarding these in Gondar University general comprehensive specialized hospital. We aimed to investigate the relevance of the laboratory investigations ordered routinely and their cost implications and associated factor compared with the National Institute of Clinical Excellence (NICE) guidelines.

Methods: Institutional based cross-sectional study was carried out at University of Gondar general comprehensive specialized hospital. A total of 300 patients scheduled for elective surgical procedures included in this study. Neither the surgeons nor anesthetists involved were aware of the study. The laboratory investigations of the patients who underwent surgery were noted and the prescriber and site of the investigation done was also noted. All values were categorized as normal or abnormal and they were assessed as indicated or unindicated based on NICE guidelines.

Results: A total of 688 laboratory tests and 172 instrumental tests were done. Out of 688 laboratory tests 639 was indicated as per NICE guideline and 49 was unindicated; from those investigations 600 was ordered by surgical teams and the rest 88 was ordered by anesthetists. And from 172 instrumental tests 152 was indicated as per NICE guideline 20 was unindicated, out of those instrumental tests 140 was ordered by surgical team and the rest 12 was ordered by anesthetists. In instrumental tests chest X-ray and ECG accounts the majority (82.89%). The additional cost incurred towards unindicated tests was 13.89% of the total cost for the tests.

Conclusion: Pre-operative laboratory investigations add to cost with large amount. Patient pre-morbid conditions and surgical grade should guide the clinician to request for the relevant laboratory tests.

Keywords: cost, laboratory tests, pre-operative, associated factor, Gondar

Volume 8 Issue 3 - 2020

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Received: June 13, 2020 | **Published:** August 17, 2020

Abbreviations: NICE, national institute of clinical excellence; PAC, pre-anesthetic check-up; TDF, theoretical domains framework; GUH, Gondar university hospital; ECHO, echocardiogram; ECG, electrocardiogram; CXR, chest X-ray; CBC, complete blood count; RBS, random blood sugar; INR, international normalized ratio; BG, blood grouping

Background

In the mid-19th century clinician's elicited thorough history and physical examination for preoperative assessment and only selective laboratory tests were ordered to confirm or refute clinical diagnosis. The ease of ordering and low cost of obtaining many laboratory tests made this new method of evaluation attractive. This practice evolved from the assumption that early and frequent testing could detect disease in their pre-clinical stage to allow early and less costly treatment.¹ This thinking was accepted as dogma and rapidly made its way into medical mindset of all health care workers such that excessive testing was equated with efficient care. Many hospitals made rather arbitrary rules to perform a series of laboratory tests prior to any operative procedure with the assumption that voluminous information would enhance the safety of surgical patients and reduce the liability for adverse events. The practice continued for years without any scientific basis of the usefulness and with little consideration of cost.² The cost-benefit ratio of routine pre-operative investigations is not favorable,

and the traditional practice of ordering routine pre-operative tests before elective surgery is not recommended. Evidence suggests that pre-operative tests are not associated with decreased mortality or better outcomes. However, the practice of routine pre-operative tests before elective surgery has remained widely prevalent. Health-care practices not only depend on practitioners' knowledge but also on the local laws, protocols, administrative policies, etc. The present study was aimed to assess the reasons behind this continued practice and its cost effect on elective surgical patients.³

Pre-anesthetic check-up (PAC) is a basic element in anesthetic care. It is defined as the process of clinical assessment that precedes the delivery of anesthesia care for surgical and non-surgical procedures. The PAC needs the consideration of information from multiple sources including pre-operative investigations. 'Routine investigations' are quite routine practice though there are negative recommendations and clear note in the guidelines that routine investigations are not needed in all patients.⁴ Routine pre-operative tests for anesthesia management are often ordered by both anesthetists and surgeons for healthy patients undergoing low-risk surgery. The Theoretical Domains Framework (TDF) was developed to investigate determinants of behavior and identify potential behavior change interventions. In this study, the TDF is used to explore anesthetists' and surgeons' perceptions of ordering routine tests for healthy patients undergoing low-risk surgery. They identified key factors that anesthetists and surgeons believe influence whether they order pre-operative tests routinely for anesthesia

management for a healthy adult undergoing low-risk surgery. These beliefs identify potential individual, team, and organization targets for behavior change interventions to reduce unnecessary routine test ordering.⁵

Methods and materials

Institution based, analytic cross-sectional, study design was conducted from February to June 2019 E.C. The study was conducted at University of Gondar Hospital, North West Ethiopia. It is located in Central Gondar administrative zone, Amhara National Regional state, which is far from about 730 km Northwest of Addis Ababa (the capital city of Ethiopia). All surgical patients going to operate during the study period were included and Patients come for emergency surgeries were excluded from the study.

Sample size and sampling technique

The actual sample size for the study was determined by using single population proportion

Formula for single proportion population,

$$n = \frac{(z_{\alpha/2})^2 \cdot pq}{d^2}$$

Where n= Initial estimated sample size

Z = Confidence level (alpha, α)

P = prevalence from previous study

S = marginal error

where p=0.62 and 1-p =0.38 from previous study and d=0.05(5%)

n=1.96*1.96*0.62*0.38/0.05*0.05 where n is minimum sample size for a single population proportion formula

n=363 and we add 5% of non-respondent rate =363*5/100=18 so,

n=363+18=381. But due to inadequate patient numbers for this much sample size we have had done it with a sample size of 300. Non-probability convenience sampling technique was used.

Data collection, quality control and analysis procedures

The data was collected at University of Gondar comprehensive specialized hospital by data collector, the data collectors was group members of anesthesia students with structured questionnaire containing questions. The data collector gives information to the participants about the objective of the study and give orientation about how to fill and answer the questionnaire. The question contains socio demographic factor, laboratory tests, imaging radiologic investigations, coexisting disease, generally about the surgery and who order those investigations. Short term training for the data collector had been given a week before data collection. Its accuracy was checked daily by investigator under direct supervision. The data have been analyzed by using SPSS 20th version software using frequency distribution table and percentage regression.

Operational definitions

- **NICE:** a guideline which makes recommendations to help guide the appropriate use of routine preoperative tests for patients before elective surgery.⁶
- **Investigation:** the action of investigating something or someone; formal or systematic examination or research. (late Middle English: from Latin investigation (n-),)

- **Cost:** (of an object or action) require the payment of (a specified sum of money) before it can be acquired or done. (oxford dictionary)
- **Instrumental testes:** imaging modalities which used to identify or diagnose a disease entity.¹
- **ASA physical status:** Operation was considered in the development or as components of risk classification irrespective of anesthesia and surgery.⁷

Ethical consideration

The ethical consent was obtained from ethical council of college of medicine and health science. After explanation of aim and benefit of study written and verbally informed consent have been obtained from each study participant and their Confidentiality have been guaranteed throughout the study.

Result

Socio-demographic distribution

The use of routine laboratory investigations before elective surgery is widespread. It is considered a part of pre-anesthetic evaluation to determine fitness for anesthesia and identify patients at high risk of postoperative complications. So pervasive is the thinking that surgeons, anesthetists, and even patients expect “battery of laboratory tests” prior to surgery.² In our study total of 300 patients were scheduled for elective surgical procedures and prospectively evaluated with a response rate of 78.9%. There was no data loss or inappropriate data. The majority of the patients were adults age above 16 years 254(84.7%) in number and 46(15.3%) are under 16 year. Their ASA physical status majorly distributed between I (56%) and II (42.3%) and the other 1.7% (5) are ASA III. The nature of surgical procedures performed were distributed between Grades 1(62) (20.7); 2(183) (61%) and Grades 3 and 4 (13%). The remaining 5.3% were neurosurgical procedures. This has been separately considered as per the NICE guidelines. The demographic data and nature of procedure are outlined in Table 1.

Specific results

A total of 688 laboratory tests and 172 instrumental tests were done. Out of 688 laboratory tests 639 was indicated as per NICE guideline and 49 was unindicated. From those investigations 600 was ordered by surgical teams and the rest 88 was ordered by anesthetists. And from 172 instrumental tests 152 was indicated as per NICE guideline 20 was unindicated, out of those instrumental tests 140 was ordered by surgical team and the rest 12 was ordered by anesthetists. The number of laboratory tests and instrumental tests done is shown in Table 2. Chest x-ray which was done in 63(23%) patients and not done in 237(77%) patients. From patients which had chest x-ray; 55(18.3%) was indicated and 8(2.7%) was unindicated. Out of 63 patients with Chest x-ray 57(19%) was ordered by surgeons and 6(2%) ordered by anesthetists. The site where chest x-ray done were 28(9.3%) from private and 35(11.7%) from in hospital. For the unindicated tests, the total cost amounted was 1020 ETB (16.19%). ECG which was done in 63(21%) patients and not done in 237(79%). From patients which had ECG; 55(18.3%) was indicated; 8(2.7%) was unindicated and 6(2%) was investigations not done-indicated. Out of 63 patients with ECG; 45(15%) was ordered by surgeons and 18(6%) by Anesthetists. The site where ECG done were 36(12%) in private and 27(9%) in hospital. For the 8 (2.7%) unindicated tests, the total cost mounted was 810 ETB (11.5%). Echocardiography which was

done in 23(7.7%) patients and not done 277(92.3%). From patients which had Echo; 21(7%) was indicated and 2(0.7%) was unindicated and 6(2%) was Investigations not done-indicated. Out of 23 patients with Echo 17(5.7%) was ordered by surgical team and 5(1.7%) was ordered by Anesthetists. The site where Echo done were 15(5%) in private and 7(2.3%) in hospital. For the 6 (2%) unindicated tests, the

total cost amounted was 300 ETB (13.08%). Computed topography which was done in 4(1.3%) patients and not done in 296(98.7%). From patients which had CT; 2(0.7%) was indicated; out of 4(1%) with CT all are ordered by surgical teams. The site where CT done were; 2(0.7%) in private and 2(0.7%) in hospital. No amount of money lost for unindicated tests.

Table 1 Socio-demographics of elective patients scheduled for surgery from April to June, 2019 in GUH, Gondar, North West Ethiopia (N=300, and frequency n and percent n (%))

Variable		n (%)
Age (years)	<16	46(15.3)
	>16	254(84.7)
Sex	Male	149(49.7)
	Female	151(50.3)
ASA	I	168(56)
	II	127(42.3)
	III	5(1.7)
	IV	...
Surgical grade	1	62(20.7)
	2	183(61)
	3	34(11.3)
	4	5(1.7)
	Neurosurgical procedures	16(5.3)

ASA, American society of anesthesiologists

Table 2 Laboratory and instrumental tests done for elective surgical patients from April to June, 2019 in GUH, Gondar, North West Ethiopia

Investigation	Number of patients where investigations done	Investigations not done	Investigations done as per guidelines	Investigations done-unindicated	Surgeon	Anesthetist	Private	In hospital
CXR	63	237	55	8	57	6	28	35
ECG	63	237	55	8	45	18	36	27
ECHO	23	277	21	2	17	5	15	7
CT	4	296	4	...	4	....	2	2
(n=299)								
CBC	296	4	281	15	287	9	19	277
Electrolytes	60	239	51	9	49	11	29	31
(n=299)								
RFT	48	252	43	5	42	6	14	34
TFT	27	273	25	2	22	5	15	12
HFT	35	265	25	10	32	3	15	12
INR	23	277	18	5	11	12	12	11
BG	147	153	136	11	115	31	1	145
(n=296)								
RBS	40	256	39	1	36	3	38	....
Other's	19	278	17	2	18	1	9	10
(n=297)								

ECHO, echocardiogram; ECG, electrocardiogram; CXR, chest X-ray; CBC, complete blood count; RBS, random blood sugar; INR, international normalized ratio (coagulation profile), BG, blood grouping

Complete blood count which was done in 296(98.7%) patient and was not done in 4(1.3%) patients. From patients which had CBC; 15(5%) was not indicated. Out of 296(98.7%) patients with CBC 287(95.7%) was ordered by surgeons and 9(3%) was ordered by Anesthetists. The site where CBC done was; 19(6.3%) in private and 277(92.3) in hospital. For the 15(5%) unindicated tests, the total cost amounted was 666 ETB (6.33%). Electrolyte which was done in 60(20%) patient and not done in 239(79.7%) patients. From patients which had electrolyte; 51(17%) was indicated and 9 was unindicated. Out of 60 patients with electrolyte 49(16.3%) was ordered by surgeons and 11(3.7%) was ordered by Anesthetist. The site where electrolyte done was 29(9.7%) in private and 31(10.3%) in hospital. For the 9(3%) unindicated tests, the total cost amounted was 2530 ETB (18.65%). Renal function test which was done in 48(16%) and not done in 252(84%). From patients which had RFT; 43(14.3%) are indicated and 5(1.7%) was not indicated. Out of 48(16%)

patients with RFT; 42(14%) was ordered by surgeons and 6(2%) was ordered by Anesthetist. The site where RFT done was 14(4.7%) in private and 34(1.3%) in hospital. For the 5(1.7%) unindicated tests, the total cost amounted was 320 ETB (8.37%). Thyroid function test which was done in 27(9%) patients. From patients which had TFT; 25(8.3%) are indicated and 2(0.7%) was unindicated. Among those investigations 22(7.3%) was ordered by surgeon and 5(1.7%) was by Anesthetists. And the site which was done where 15(4%) in private and 12(5%) in hospital. For the 2(0.7%) unindicated tests, the total cost amounted was 1200 ETB (8.96%). Hepatic function test which was done in 35(11.6%) patients; of them 10(3.3%) was unindicated and in 265(88.3%) patients was not done. Among those investigations 32(10.7%) was ordered by surgeon and 3(1%) was by Anesthetists. And the site which was done where 15(4%) in private and 12(3.7%) in hospital. For the 10(3.3%) unindicated tests, the total cost amounted was 820 ETB (25.78%) Table 3.

Table 3 The cost analysis considered as indicated and unindicated tests for investigations done from April to June, 2019 in GUH, Gondar, North West Ethiopia

Laboratory tests	Unindicated Tests		Number of Indicated tests		Cost per unit (ETH Birr)		Actual cost (ETH Birr)	Cost inquired On unindicated tests
	In hospital	private	In hospital	Private	In hospital	Private		
	CXR	2	6	33	22	60			150	6300	1020
ECG	1	5	26	31	60	150	7020	810
ECHO	...	2	7	13	60	150	2292	300
CT scan	...	...	4	...	800	...	3200	...
CBC	12	3	255	16	33	90	10521	666
Electrolyte	2	7	22	29	40	350	13560	2530
RFT	4	1	30	13	30	200	3820	320
TFT	...	2	12	13	366	600	13392	1200
HFT	7	3	5	12	40	180	3180	820
Coagulation profile	1	4	10	8	250	700	11150	3050
Blood group	10	1	135	...	10	30	1480	130
RBS	1	....	38	...	15	40	585	15
Other's	2	...	17	...	...	...	4265	360
Total							80765	11221
Cost to wards appropriate test								69544
Additional cost (%) spent on unindicated test								13.89

ECHO, echocardiogram; ECG, electrocardiogram; CXR, chest X-ray; CBC, complete blood count; RBS, random blood sugar; INR, international normalized ratio (coagulation profile), BG, blood grouping

Coagulation factor which was done in 23(7.7%) patients; of them 5(1.7%) was unindicated and in 277(92.3%) patients was not done and 3(1%) Investigations was not done-indicated. Among those investigations 11(3.7%) was ordered by surgeon and 12(4%) was by Anesthetists. And the site which was done where 12(4%) in private and 11(3.7%) in hospital. For the 7 (1.7%) unindicated tests, the total cost amounted was 3050 ETB (27.35%). Blood grouping which was

done in 147(49%) patients; of them 11(3.7%) was unindicated and in 153(51%) patients was not done and 15(5%) Investigations was not done-indicated. Among those investigations 115(38.3%) was ordered by surgeon and 31(10.3%) was by Anesthetists. And the site which was done where 1(0.3%) in private and 146(48.3%) in hospital. For the 11(3.7%) unindicated tests, the total cost amounted was 130 ETB (8.78%). Blood glucose level which was done in 40(13.3%) patients;

of them 1(0.3%) was unindicated and in 256(85.3%) patients was not done and 12(4%) Investigations was not done-indicated. Among those investigations 36(12%) was ordered by surgeon and 3(1%) was by Anesthetists. And the site which was done where null in private and 38(12.7%) in hospital. For the 1(0.3%) unindicated tests, the total cost amounted was 15 ETB (2.56%). From other specific tests 19 investigations was done (five urinalysis, twelve ultrasound, one hematocrit and one cytology); two was not indicated (ultrasound), Among those investigations 18 was ordered by surgeon and one was by Anesthetists. And the site which was done where 10 in private and 9 in hospital. For the 2(0.6%) unindicated tests, the total cost amounted was 360 ETB (8.44%). Their distribution is described with pie chart on Figure 1.

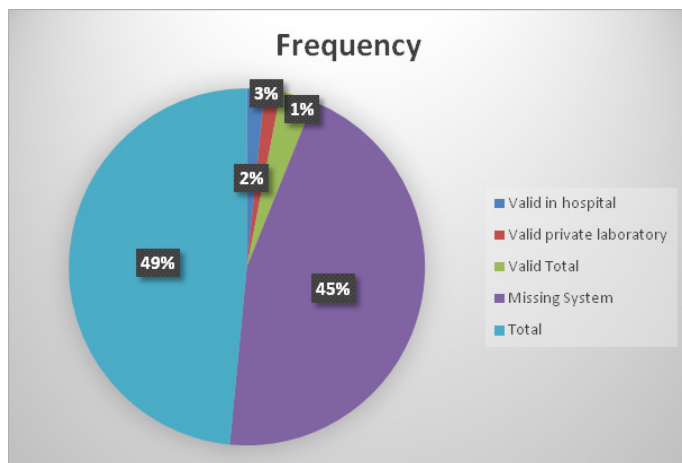


Figure 1 Distribution of other specific tests which where they have been done, in GUH, Gondar, North West Ethiopia.

Discussion

Numerous subsequent studies involving ambulatory or inpatient surgery demonstrated that the frequency of abnormal laboratory test results in asymptomatic patients was very low and 60-75% of patients would not have required any test if guided by clinical evaluation.⁵ Although there was a good agreement between anesthetists and surgeons for the different reasons cited for continued routine practice, the most common reasons for practicing routine pre-operative testing were different among anesthetists and surgeons.⁴ The routine screening of full blood count contributes little in patient's management.⁸ In our study, routine blood examinations were done in 97.7% patients, and 5% of measurements were actually not required. Evidence does not support routine CXR for patients aged below 70 years without risk factors as it does not decrease morbidity or mortality.⁹ In the present study, 21% of the patients had undergone CXR and out of these more than 2.7% were unnecessary. The present study also reveals similar findings for ECG, ECHO, electrolyte and blood sugar measurements. With the majority of the test ordered by surgical teams (87.9%) and 12.1% by Anesthetists. The present study results indicate that unnecessary investigations could be reduced significantly by good pre-operative evaluation of patients, with no loss of clinically relevant information and patient care. It is necessary to identify the risk factors and request for investigations based on the patient comorbid conditions and nature of surgery. Guidelines help to have a structured, patient directed, evidence-based approach for

workup of these patients scheduled for surgery. The reduction in costs following patient directed investigations have been reported by earlier studies.¹⁰⁻¹² A cost analysis study showed a reduction of 63% of cost per patient by applying their institute guidelines.¹³ Similarly, in another study, selective ordering of investigations by the anesthesiologists significantly reduced the number of tests and the cost by almost 25% and reduced by 41% if consultant assessed and ordered for the tests.¹²

The present study had estimation of 13.83% cost reduction by applying the NICE guidelines. The estimated saving in costs that was calculated refers to the application of the NICE guidelines in our patient population. However, this may not be an ideal way of interpreting our data and draw conclusions. Because compared to the developed countries, developing countries have limitations with respect to the access to health care. In a large study involving 6111 patients undergoing elective surgery, the usefulness of routine chest radiographs and its influence on anesthetic management was evaluated.⁶ They found 18.3% were abnormal out of which only 5.1% (313 patients) were considered as useful which altered anesthetic management. Similarly, routine ECG screening for patients with no cardiovascular risk added very little to predict perioperative cardiac complications.⁸ The present study shows near similar findings as compared to the study done in Srilanka.^{6,8,14} The mentioned study found very poor compliance to the local recommendations for CXRs, coagulation profiles, liver enzymes and ECHO. Another retrospective review found that 100% of the patients had many routine investigations done, but there was no change in the plan of anesthesia in any of these cases despite having 32.5% abnormal test results for some of the tests.¹⁴ We observed that many patients were referred to the cardiologists for cardiac evaluation in patients scheduled for surgical procedure based on the age and nature of the procedure. The need for this instrumental investigation (ECG, Echo) was determined by the nature of the clinical status of the patient and also the severity of the existing comorbidities as per NICE guideline. In our study participates; out of 23 patients who had ECHO, 2(8.69%) were not clinically indicated. This accounted for 2.67% of the total additional cost incurred towards unindicated investigations.

Our study also found that only 5.18% of the practitioners did not prescribe routine pre-operative tests for the patient population what we evaluate, despite the existence of recommendations to the contrary being available for nearly 15 years.¹⁰ This indicates that the guidelines have failed to convince the practitioners. One of the reasons may be the practitioner's apprehensions and practice environment, even though in our setup patient to health care provider is not one to one. In a retrospective cost analysis study, total cost towards the laboratory tests was calculated.¹⁵ However, cost incurred towards indicated and unindicated tests was not done. It is necessary that the guidelines should be pertinent to the population at large addressed. The laboratory tests should be patient centered and need-based which should add to the pre-operative preparation, intraoperative modification of anesthesia care and post-operative management.^{11,13} All the current guidelines reported are based on the meta-analysis studied in the developed nations. In Ethiopia, where more than 85% is rural population with awareness and literacy rate in health care is low, presentation to the hospital will always be at the advanced stage of the disease. This precludes the use of these standard guidelines in our patient population. Thus, there is a need for developing guidelines to suit our population considering the socio-economic status, time of presentation and the nature of the disease being treated.

To our knowledge, this is first prospective study looking at the cost implications of pre-operative laboratory testing both indicated and unindicated and costs savings in our population.¹⁶

Strength of the study

The study is the first in its kind in our setup and could generate new ideas about pre-operative investigation ordering guide to be developed.

Limitation of the study

- Lack of similar study in the country to compare the result.
- The study subjects in this study only included government hospital (GUH) hence the result may not be representative for private hospitals.
- The finding of this study might have been influenced by subject response bias because self-reporting nature of the questionnaire for the site of investigations which were done.
- The study design used was a cross sectional quantitative method because of time constraint. However, it was better to conduct a qualitative design especially observation.

Conclusions and recommendations

Conclusion

The routine screening of full blood count contributes little in patient's management.⁸ In our study, routine blood examinations were done in 97.7% patients, and 5% of measurements were actually not required. In the present study, 21% of the patients had undergone CXR and out of these more than 2.7% were unnecessary. The present study also reveals similar findings for ECG, ECHO, electrolyte and blood sugar measurements.¹⁷ With the majority of the test ordered by surgical teams (87.9%) and 12.1% by Anesthetists. The present study had estimation of 13.83% cost reduction by applying the NICE guidelines. The estimated saving in costs that was calculated refers to the application of the NICE guidelines in our patient population. However, this may not be an ideal way of interpreting our data and draw conclusions. Because compared to the developed countries, developing countries have limitations with respect to the access to health care. Anesthetists were more use the current updated recommendations. Practice of the current recommendations of cost effectiveness was greater among anesthetists than surgeons. What our study found is that only 5.18% of the practitioners did not prescribe routine pre-operative tests for the patient population what we evaluate, despite the existence of recommendations to the contrary being available.¹⁸

Recommendations

- **For the hospital administrators:** We recommend for the administrator to make the all the laboratory apparatus available in the governmental hospital.
- **For health care provider:** To order those tests based on guidelines and not to prescribe routinely; and better to develop and use guidelines which is applicable in our set up. The reason why routine testing ordered should be justified and as per the most recent updated guidelines.

- **For future researchers:** To include the reason why practitioner do in such away and how they are look for the trend.

Acknowledgments

None.

Conflicts of interest

The author declares that there is no conflict of interest.

Funding

None.

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