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Original Paper

Pre-operative Over-investigation of Routine Tests Prior to Elective Surgeries

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Abstract

Background: *Previous studies stressed on the burden raised by routine pre-operative test ordering, which should be based on the assessment of patient physical status. In a tertiary hospital in Jordan, we aim to study the compliance with guidelines regarding pre-operative routine testing prior to an elective surgery, cholecystectomy, and calculate the estimated cost from non-compliance with the guidelines.*

Methods: *We included laparoscopic cholecystectomy (through ICD-9 code) to represent an elective surgery. For each surgery done from the period 1/1/2016 to 31/12/2016, data regarding preoperative investigations, admission history note, operative and discharge note were obtained. Tests that are considered routine investigations are Complete blood count (CBC), kidney function tests (KFT), electrolytes, chest X-ray, electrocardiogram, coagulation studies, and urine-analysis. We classified patients who underwent cholecystectomy according to the latest version of the American Society of Anesthesiologists (ASA) physical status system to assess the need for routine tests, then we calculated the number and cost of excess tests.*

Results: *A total 382 routine, non-emergent laparoscopic cholecystectomy surgeries were performed. 319 (83.5%) of patients were classified as ASA-1, 60 (15.7%) were classified as ASA-2, and only 3 (0.8%) were classified as ASA-3. Age was a significant determinant in obtaining chest X-ray ordering*

and findings (p< 0.001) and electrolytes ordering and findings (p= 0.001). Total routine tests cost for elective cholecystectomy during 2016 was 16,021$. Regarding operative compilations, only 14 (3.7%) complication occurred, all of which were bleeding related.

Conclusion: *Oversighting routine preoperative test ordering before elective cholecystectomy will significantly reduce the cost without increasing post-operative complications.*

Keywords

Cholecystectomy, Elective surgery, routine investigation, pre-operative test

1. Introduction

Generally, routine tests are those tests ordered in the absence of a specific clinical indication or purpose (ASA, 2012), an example of routine tests are those ordered preoperatively for screening purposes without clinical indication. Two main guidelines globally accepted to define the indications of preoperative routine tests before elective (non-emergent) surgeries; the practice advisory for pre-anesthesia evaluation developed by American Society of Anesthesiologists (ASA) (ASA, 2012), and the National Institute for Health and Care Excellence (NICE) guidelines (NICE, 2016).

The rationale behind routine pre-operative test ordering should be based on the assessment of patient's physical status, which can be classified based on the ASA physical status classification system (Doyle, 2020), and the invasiveness of the surgical procedure, which can be graded according to the NICE grading system into minor, intermediate, and major or complex surgery (NICE, 2016). Previous studies defined some of the problems arose from pre-operative over-investigation, mostly due to not following the guidelines for test ordering, leading to an increased burden on the hospital and the patient, and an unexpected cancellation (Vogt, 1997; Flamm, 2013). In a tertiary hospital in Jordan, we aim to study the compliance with guidelines regarding pre-operative routine testing prior to an elective surgery, cholecystectomy, and calculate the estimated cost from non-compliance with the guidelines.

2. Methods

2.1 Overview

Cholecystectomy is performed as either laparoscopic (mostly) or open, but we only included laparoscopic cholecystectomy (through ICD-9 code) to represent an elective surgery. During data retrieval from hospital's system archive, we didn't include emergent cholecystectomy, we also didn't include canceled surgeries. For each surgery done from the period 1/1/2016 to 31/12/2016, data regarding preoperative investigations, admission history note, operative and discharge note were obtained. We included routine (non-emergent) laparoscopic cholecystectomy done on patients who are above 16 of age (in which, the NICE guidelines apply), so 4 patients were excluded as they were less than 16 years of age. We also didn't include pregnant women.

At the University of Jordan Hospital, the practice of preoperative investigation (i.e., routine or indicated) is performed by the treating surgeon's team, up to one week before operation, most of the

time after consulting an anesthetist. Test ordering can be done by residents without consulting the surgeon, which results in pre-operative routine over-investigation. Tests that are considered routine investigations are:

- Complete blood count (CBC)
- Kidney function tests (KFT)
- Electrolytes
- Chest X-ray
- Electrocardiogram
- Coagulation studies
- Urine-analysis

We assessed if chest X-ray was ordered along with its result if abnormal findings were detected or not, abnormal findings on chest X-ray were determined based on the radiological reports written by radiologists. Each of the previous tests are ordered as a "panel", where each panel consists of the following:

- CBC: Hemoglobin (Hb), Hematocrit, White blood cell count (WBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), red blood cells (RBC), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), Neutrophils, Eosinophils, Basophils, Lymphocytes, Monocytes, Platelets.
- Electrolytes: Calcium (Ca), chloride (Cl), magnesium (Mg).
- KFT: Creatinine (Cr), Urea, potassium (K), sodium (Na).

We ensured that the full panel was ordered by data screening first, we analyzed the test most likely be abnormal from the panel including; Hb and WBC from CBC, Cr and Na from KFT, and Cl only from electrolytes. Thresholds between normal and abnormal for each test were obtained according to machine standards. As the previously cited guidelines state that data were not enough to recommend with or against coagulation studies, we didn't assess it in this study. Moreover, urine-analysis is not routinely ordered in cholecystectomy, where we only found less than 10 tests ordered, so it was not included in this study. We were not able to assess for ECG (not computerized or archived electronically).

2.2 Compliance with Guidelines

First, we classified patients who underwent cholecystectomy according to the latest version of the American Society of Anesthesiologists (ASA) physical status system (Doyle, 2017). Three groups resulted from our sample according to ASA classification:

ASA 1 where patients were normal and healthy without co-morbidities (as found in ASA 2).

ASA 2 where patients have mild systemic disease (e.g., treated hypertension, obesity, social smoker or drinker).

ASA 3 where patients have systemic disease, but is not life threatening (e.g., congestive heart failure, chronic kidney disease, severe COPD).

None of us included patients satisfy the criteria for ASA 4 or beyond, or had an emergency surgery.

Second, the grade of surgery (i.e., minor, intermediate, and major or complex) was adopted from NICE guidelines and its most recent update (NICE, 2016; O'Neill, 2016). According to these guidelines, elective cholecystectomy was classified as an intermediate surgery.

Accordingly, the following testing strategy is the most consistent with both NICE and ASA guidelines for preoperative testing

Table 1. The Panels (Group of Tests) Routinely Ordered Prior to Elective Cholecystectomy (Intermediate Risk Surgery) and the Tests and Costs for Each Panel, and the Recommendations for Each ASA Grade

Panel	Tests in the panel	Cost of the panel	ASA	Recommendation
CBC	Hemoglobin, hematocrit, white blood cell count and differential, and platelet count	13$	ASA-1	✖
			ASA-2	✖
			ASA-3	✖
KFT	Creatinine, blood sugar, potassium, sodium, urea.	30$	ASA-1	✖
			ASA-2	✖
			ASA-3	✔
electrolytes	Calcium, chloride, phosphorous, and magnesium	35$	ASA-1	✖
			ASA-2	✖
			ASA-3	✔
Chest X-ray	Chest X-ray	20$	ASA-1	✖
			ASA-2	✖
			ASA-3	✔

ASA: American Society of Anaestheiologists.

2.3 Statistical Analysis

We used SPSS 21.0 (Chicago, USA) in our analysis. We used mean (± standard deviation) to describe age. We used frequency (percentage) to describe the presence of complications and if lab and imaging were done or not, and if they were normal or abnormal (i.e., if done).

We used one-way ANOVA to investigate the mean difference in age between ordering investigations their results. We used Chi-square tests to find if there was a gender difference in test ordering. P value of less than 0.05 was taken as significant.

3. Results

A total 382 routine, non-emergent laparoscopic cholecystectomy surgeries were performed at Jordan University Hospital in the period 1/1/2016 to 31/12/2016 on patients aged more than 16 years of age,

with a mean age was 43.6 years (±14.2). They were 90 (23.6%) men and 292 (76.4%) women. 319 (83.5%) of patients were classified as ASA-1, 60 (15.7%) were classified as ASA-2, and only 3 (0.8%) were classified as ASA-3.

Age was a significant determinant in obtaining investigations, as a significant relation between age and both chest X-ray and electrolytes as shown in Table 2.

Table 2. Mean Age (Standard Deviation) for Patients whom Chest X-ray and Electrolytes were not Done, Done but were Normal, and Done but Abnormal

	p value	not ordered	done-normal	done-abnormal
chest X-ray	< 0.001	42.4 years (±13.8)	43.1 years (±12.6)	56.3 years (±14.2)
electrolytes	0.001	42.0 years (±13.7)	47.1 years (±13.9)	57.4 years (±14.2)

Age was not a significant determinant in neither CBC, nor KFT. We also didn't find significant differences between gender and test ordering. Table 3 detail the percentage of tests done (both normal and abnormal) and tests not done from each panel. Table 4 detail the percentage of panels done for each ASA class.

Table 3. Each Test Studied and Its Status; not Done, Done with Normal Results, and Done with Abnormal Results

Test	Not done	Done-Normal	Done-Abnormal
CBC-Hb	22%	54.2%	22.9%
CBC-WBC	22%	63.6%	14.4%
KFT-Cr	25.1%	42.2%	32.7%
KFT_Na	25.1%	74.3%	0.5%
electrolytes-Cl	70.7%	28%	1.3%
Chest X-ray	89.3%	7.1%	3.7%

Table 4. Number of Patients in each ASA Grade for each Panel and if the Tests were Done or not Followed by the Percentage of Tests Done without Compliance with the Guidelines

Test	ASA	Recommendation	Number of patients	% Done
CBC	ASA-1	✖	319	77.1%
	ASA-2	✖	60	75%
	ASA-3	✖	3	100%
	Overall not indicated	✖	382	77%
KFT	ASA-1	✖	319	75.2%
	ASA-2	✖	60	75%
	ASA-3	✔	3	100%

	Overall not indicated	✖	382	74.6%
electrolytes	ASA-1	✖	319	27.6%
	ASA-2	✖	60	36.7%
	ASA-3	✔	3	66.7%
	Overall not indicated	✖	382	28.8%
Chest X-ray	ASA-1	✖	319	7.8%
	ASA-2	✖	60	25%
	ASA-3	✔	3	33.3%
	Overall not indicated	✖	382	10.5%

The cost of tests (panels) ordered without compliance with guidelines for elective cholecystectomy during 2016 was as following:

CBC, 217 tests * 13$ = 2821$

KFT, 285 tests * 30$ = 8550$

Electrolytes, 110 tests * 35$ = 3850$

Chest X-ray, 40 tests * 20$ = 800$

Total routine tests cost for elective cholecystectomy during 2016 was 16,021$.

Regarding operative compilations, only 14 (3.7%) complication occurred, all of which were bleeding related.

4. Discussion

In this study, we showed that CBC is the most common test ordered (77% overall) as a routine pre-operative testing against guidelines indication, followed by KFT which was ordered in 74.6% of all cholecystectomies, followed by electrolytes ordered in 28.8%, and finally chest X-ray ordered in 10.5% overall. The total costs of routine tests for elective cholecystectomy during 2016 was 16,021$. Whereas age shouldn't be considered in pre-operative test ordering, we found a significant difference in age for both chest X-ray and electrolytes ordering.

In its most recent practice advisory paper, the ASA stated that pre-operative tests should not be ordered routinely (ASA, 2014). Although recent guidelines restricted the indication for routine pre-operative testing, compliance with these guidelines still below optimum (Brown, 2011). Reasons behind non-compliance was found to be: practice tradition, belief that other physicians want the test done, medicolegal worries, concerns about surgical delay or cancellation, and lack of awareness of evidence and guidelines (Brown, 2011). In a detailed analysis of the outcome of pre-operative testing, a study found that 70% of the tests ordered were abnormal, but management peri-operatively changed in only 0.2% (Johnson, 2002). In our study, abnormal test results in ordered pre-operative tests ranged from 0.5% to 32.7%, and surgical procedure were carried out despite these results without any operative complication that is related to the ordered tests.

Different factors affect test ordering, including patient's demographics, health status, anesthesia used,

and surgical invasiveness (Benarroch-Gampel, 2012; Mancuso, 1999). In our study, we found that age is a significant factor that affects pre-operative testing. According to both ASA and NICE guidelines, age per se should not be considered in test ordering.

Compliance with guidelines alone can reduce the direct cost of routine tests ordered pre-operatively by 15% (Flamm, 2013). For cholecystectomy alone in our hospital during one year, a total of around 16,000$ can be saved by selective test ordering according to the guidelines. The total savings can be higher when extrapolated on all routine surgeries. As an example, compliance with guidelines alone can reduce the cost of routine tests ordered pre-operatively in one center in UK by 70,000$ (Johnson, 2002). Keeping in mind that Jordan is considered a Upper-middle income country according to the recent World Bank report (World Bank), the value of saving these suggested costs is more pronounced.

Several approaches suggested to reduce the cost and burden from pre-operative over investigation:

- Preanaesthesia clinics, where it was developed and implemented in several countries and their systems is widely studied (Kerridge, 1995; van Klei, 2002; Lew, 2004).
- Implementation of an electronic decision support tool (Flamm, 2013).
- Developing and implementing a reliable history and physical exam forms that physicians can reliably rely on to replace investigations (Böhmer, 2014).
- Eliminating “panel” testing and replacing it with a test by test ordering.

The present study has several limitations that we believe should be considered in future works. First, more elective surgeries should be studied to generalize and reliably calculate the cost of pre-operative tests, and this should include other tests that are routinely ordered in other surgeries (e.g., urine-analysis). Other factors that can affect test ordering should be considered, including the insurance status of the patient. Finally, there are indirect costs and burden that should be discussed, which include the workforce and machines that do the testing, and the costs of surgery cancellation and patient admissions resulted from pre-operative over-investigation.

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