
GYNECOLOGY

Appropriateness of Preoperative Screenings in Patients Undergoing Elective Gynecologic Surgery at Srinagarind Hospital, Khon Kaen University, Thailand: An Observational Study

Pol Likitdee, M.D.*,
Pisake Lumbiganon, M.D.*,
Cattleya Thongrong, M.D.**,
Chumnan Kietpeerakool, M.D.*,
Kiattisak Kongwattanakul, M.D.*,

* Department of Obstetrics and Gynecology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

** Department of Anesthesiology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

ABSTRACT

Objectives: To evaluate the appropriateness of routine preoperative screening for patients who undergoing elective major gynecologic surgery at a tertiary care university hospital, Khon Kaen Province based on the hospital guideline.

Materials and Methods: This retrospective descriptive study reviewed 808 medical records of gynecologic patients undergoing elective surgery in 2014.

Results: The mean age of the patients was 44.2 years. Approximately 36% of patients had associated co-morbidity. Almost 90% of the patients had inappropriate screening tests. Complete blood count and chest x-ray were the two most appropriate screening test. The most inappropriate tests were urinalysis and fasting blood sugar. Patients were classified into 4 groups: 1) patients < 45 years old with no underlying conditions; 2) patients < 45 years old with at least one underlying conditions; 3) patients \geq 45 years old with no underlying conditions and 4) patients \geq 45 years old with at least one underlying conditions. The first group had highest rate of performing inappropriate preoperative tests with blood urea nitrogen/creatinine as the most overuse test. The costs of inappropriateness preoperative tests were 39.8% of the total costs of preoperative assessment.

Conclusion: Almost 90% of the patients had inappropriate screening tests which increased the cost by about 40%. Hospital administrators should find appropriate mechanisms to reinforce doctors to strict their requests for only tests that are necessary.

Keywords: preoperative tests, preoperative screenings, appropriateness, unnecessary cost

Correspondence to: Pisake Lumbiganon, M.D., Department of Obstetrics and Gynecology, Faculty of Medicine, Khon Kaen University, 123 Mitrabarp Highway, Muang District, Khon Kaen 40002, Thailand, Email pisake@kku.ac.th Tel +66 818 719 039

ความเหมาะสมของการตรวจคัดกรองในผู้ป่วยที่มารับการผ่าตัดแบบไม่เร่งด่วน แผนกนรีเวช โรงพยาบาลศรีนครินทร์ มหาวิทยาลัยขอนแก่น ประเทศไทย: การศึกษาวิจัยเชิงสังเกต

พล ลิขิตดี, ภิเศก ลุมพิกานนท์, คัทลียา ทองรอง, ชำนาญ เกียรติพิรกุล, เกียรติศักดิ์ คงวัฒนกุล

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความเหมาะสมของการตรวจคัดกรองในผู้ป่วยนรีเวชที่มารับการผ่าตัดแบบไม่เร่งด่วนในโรงพยาบาลมหาวิทยาลัย ระดับตตดิยุภี จังหวัดขอนแก่น โดยอ้างอิงตามแนวทางการตรวจคัดกรองของโรงพยาบาล

วัสดุและวิธีการ: เป็นการศึกษาเชิงพรรณนาแบบข้อมูลง โดยการทบทวนวรรณเวชระเบียนผู้ป่วยนรีเวชที่มารับการผ่าตัดแบบไม่เร่งด่วนในปี พ.ศ. 2558 จำนวน 808 ราย

ผลการวิจัย: อายุเฉลี่ยของผู้ป่วยอยู่ที่ 44.2 ปี ประมาณ 36 เบอร์เซ็นต์ของผู้ป่วยมีโรคประจำตัว อย่างน้อย 1 โรค พบร่วมกับร้อยละ 90 ของผู้ป่วยได้รับการตรวจคัดกรองที่ไม่เหมาะสม โดยการส่งตรวจ complete blood count และ chest x-ray เป็นการตรวจที่ปฏิบัติได้เหมาะสมที่สุด 2 อันดับแรก ขณะที่การส่งตรวจที่ไม่เหมาะสมมากที่สุด ได้แก่ การส่งตรวจปัสสาวะ และ fasting blood sugar เมื่อแบ่งผู้ป่วยออกเป็น 4 กลุ่มดังนี้ 1.) กลุ่มผู้ป่วยอายุ < 45 ปี และไม่มีโรคประจำตัว 2.) กลุ่มผู้ป่วยอายุ < 45 ปี และมีโรคประจำตัวอย่างน้อย 1 โรค 3.) กลุ่มผู้ป่วยอายุ ≥ 45 ปี และไม่มีโรคประจำตัว 4.) กลุ่มผู้ป่วยอายุ ≥ 45 ปี และมีโรคประจำตัวอย่างน้อย 1 โรค พบร่วมผู้ป่วยในกลุ่มแรกมีอัตราการส่งตรวจที่ไม่เหมาะสมสูงที่สุด โดย blood urea nitrogen/creatinine เป็นการส่งตรวจที่เกินความจำเป็นมากที่สุดในผู้ป่วยกลุ่มนี้ ค่าใช้จ่ายจากการส่งตรวจที่ไม่เหมาะสม พบร่วมมูลค่าคิดเป็นร้อยละ 39.8 ของค่าใช้จ่ายในการส่งตรวจคัดกรองก่อนการผ่าตัดทั้งหมด

สรุป: เก็บร้อยละ 90 ของผู้ป่วยได้รับการตรวจคัดกรองที่ไม่เหมาะสม ส่งผลให้เกิดค่าใช้จ่ายเพิ่มขึ้นประมาณร้อยละ 40 ฝ่ายบริหารของโรงพยาบาลควรหาวิธีการที่เหมาะสมเพื่อส่งเสริมให้แพทย์ส่งตรวจคัดกรองเฉพาะที่จำเป็นเท่านั้น

คำสำคัญ: การตรวจก่อนผ่าตัด, การตรวจคัดกรองก่อนผ่าตัด, ความเหมาะสม, ค่าใช้จ่ายที่ไม่จำเป็น

Introduction

Routine preoperative tests are defined as any laboratory tests performed before surgery in the absence of clinical symptoms⁽¹⁾. The aim of the preoperative medical assessment is to evaluate and prepare patients before surgery to reduce morbidity and mortality from surgery⁽²⁾. Moreover, pre-operative medical evaluation can decrease length of hospitalization and minimize postponed or cancel surgeries⁽³⁾.

Preoperative assessments are based on clinical history and physical examination⁽⁴⁾. Factors influencing preoperative assessment include patient's age, underlying conditions and types of surgical procedure which reflect the risk of anesthesia and surgery⁽⁴⁻⁶⁾. The Royal College of Anesthesiologists of Thailand has established guidelines on preoperative assessment to enhance patient's safety. Srinagarind Hospital has also implemented preoperative assessment guideline according to the Royal College of Anesthesiologists with slight modification by including chest x-ray (CXR) in all patients age ≥ 15 years.

Over-investigated preoperative test not only increases health care cost but also delays in treatment if surgeries were to be postponed due to reevaluation⁽⁷⁻⁹⁾. Appropriateness of preoperative assessment therefore should be based on patient's history and physical examination findings and clinical judgment which might affect the abnormality of the test⁽¹⁰⁻¹¹⁾.

The cost of routine preoperative assessment is considered a health care problem in many countries. For instance, the US has paid approximated 3 billion dollars annually⁽¹²⁾; the United Kingdom has paid 11.2 million dollars annually in which up to 30% were inappropriate assessment and the abnormal results needed no management⁽¹³⁾.

This study was conducted to evaluate the appropriateness of routine preoperative screenings in patients undergoing major elective gynecologic surgery and to assess the cost associated with unnecessary investigations.

Materials and Methods

Study design and setting

This retrospective descriptive study was conducted at Srinagarind Hospital, Khon Kaen Province, Thailand. Srinagarind Hospital is a 1200-bed university hospital serving as a supra-tertiary referral center in Northeast Thailand.

Patients

We reviewed the medical records of all patients who underwent elective major gynecologic surgery including either laparotomy or laparoscopic procedures. We excluded patients who underwent emergency surgery and minor surgery (i.e. excisional biopsy, wound debridement, wound suture, fractional curettage, and hysteroscopy).

Data collection

We identified the patients who underwent elective major gynecologic surgery in 2014 from operating room log books. After receiving the patient's hospital number, we electronically searched for the patient's medical records that had been scanned to review and collected the relevant data including age, pre-operative diagnosis, associated conditions, medical history, classifications of surgical procedure and results of preoperative screenings including complete blood count (CBC), blood urea nitrogen (BUN)/creatinine (Cr), electrolytes, liver function tests (LFTs), fasting blood sugar (FBS), CXR, electrocardiogram (EKG) and urinalysis (UA).

We analyzed the appropriateness of each preoperative screening against hospital guideline. This guideline classifies the risk of patients on the basis of four characteristics including types of operation (minor versus major), patients' age (< 15 , 15-44, and ≥ 45 years), associated conditions, and current medications (Table 1). In addition, we evaluated whether these inappropriately prescribed tests had abnormal results and whether further managements were required, based on these abnormal results. All data were recorded in Case Record Forms (CRFs) and then transferred to Microsoft Excel 2007.

Sample size

This study included all gynecologic patients

undergoing major elective surgery in 2014.

Data analysis

The primary outcome was number and percentage of the appropriateness of preoperative assessment. Inappropriate preoperative assessments were defined as preoperative tests which were not in accordance with

the hospital guideline. The costs of the unnecessary test were calculated to represent the cost that could be saved.

Ethical Consideration

The study was approved by Khon Kaen University Ethics Committee in Human Research (HE581091).

Table 1. Modified Royal Thai College of Anesthesiologists guideline for preoperative tests.

Characteristic	CBC	Electrolytes	BUN/Cr	FBS	LFTs	CXR	EKG
Type of operation:							
Minor							
Major	+						
Age (year)							
< 15	+						
15 – 44*	+					+	
≥ 45	+		+	+		+	+
Associated conditions:							
CVS				+		+	+
Pulmonary						+	+
Malignancy	+					+	
Hepatobiliary		+	+		+		
Renal	+	+	+				
Bleeding disorder	+						
DM		+	+	+			+
CNS		+	+	+			+
Medication							
Diuretics		+	+				
Digoxin		+	+				+
Steroids		+			+		
Anticoagulants	+						

Abbreviations: CBC, complete blood count; BUN, blood urea nitrogen; Cr, creatinine; FBS, fasting blood sugar; LFTs, liver function tests; CXR, chest radiograph; EKG, electrocardiogram; CVS, cardiovascular system; DM, diabetes mellitus; CNS, central nervous system.

*Original Thai Royal College of Anesthesiologists guideline recommended CXR in all patients age ≥ 45 but in the modified hospital guideline recommended CXR in all patients age ≥ 15

Results

Medical records of 808 patients were reviewed. The mean age was 44.2 years. Approximately 50.2% of patients were ≥ 45 years of age. One-third (35.5%) of patients had associated

co-morbidity. Table 2 displays the baseline characteristics of the patients. Approximately 75.1% of the patients were diagnosed with benign diseases including myoma uteri (26.2%), endometriosis (22.3%), and ovarian cyst (9.5%). The remaining

patients (24.9%) were diagnosed with gynecologic malignancy including ovarian cancer (14.7%),

endometrial cancer (6.1%), and cervical cancer (4.1%).

Table 2. Patients' characteristics.

Characteristic	n	Percent
Overall	808	100
Age (years)		
Mean	44.2	
< 45	403	49.8
≥ 45	405	50.2
Associated Conditions		
None	521	64.5
At least 1 co morbidity	287	35.5
CVS	162	20
DM	71	8.8
Thyroid disorder	35	4.3
Pulmonary	28	3.5
Hepatobiliary	18	2.2
Renal	16	2
Bleeding disorder	13	1.6
Malignancy	13	1.6
CNS	5	0.6
Medication		
Anticoagulants	20	34.5
Steroids	18	31
Diuretics	17	29.3
Digoxin	3	5.2
Diagnosis		
Gynecologic malignancy	201	24.9
Ovarian cancer	119	14.7
Endometrial cancer	49	6.1
Cervical cancer	33	4.1
Benign disease	607	75.1
Myoma uteri	212	26.2
Endometriosis	180	22.3
Ovarian cyst	77	9.5
Infertile	34	4.2
Others	104	12.9

Abbreviations: CVS, cardiovascular system; DM, diabetes mellitus; CNS, central nervous system.

Seven hundred and eighteen (88.9%) patients had inappropriate screening test. CBC was the most appropriate screening test (100%). The three most common inappropriate (overuse) preoperative tests were UA (88.7%), electrolytes (64.1%) and BUN/Cr (43.9%), respectively. For UA, there was 717 tests (88.7%) overuse and 42 (5.9%) had abnormal results. Twenty-one (50%) patients who had abnormal UA received treatment as asymptomatic bacteriuria without confirming urine culture.

For electrolytes, there was 514 tests (63.6%) overuse. Of these, 28 (5.4%) had only minor deviation from normal range and eight patients (28.6%) who had abnormal electrolyte results

required treatment before elective surgery. For BUN/Cr, there was 354 tests (43.8%) overuse and none of these tests were abnormal.

In contrast, the most inappropriate (under use) preoperative test was FBS that were not investigated in 172 out of 808 (21.3%) patients. The details are shown in Table 3.

According to the hospital guideline, CXR was also the most appropriate screening at 100%. When applying the Royal Thai College of Anesthesiologists guideline, 370 tests out of 808 (45.8%) patients were considered as overuse. Only 4 (1%) of patients who were considered as having overused CXR had abnormal findings but did not require any further management.

Table 3. Inappropriateness of results and management of preoperative tests in elective surgical patients.

Test	Inappropriate preoperative tests				
	Overall investigation rate	Under investigation rate	Over investigation rate	Abnormal result among over investigated tests	Changed or Additional management
	N (%)	N (%)	N (%)	N (%)	N (%)
BUN/Cr	355 (43.9)	1 (0.1)	354 (43.8)	0	0
Electrolytes	518 (64.1)	4 (0.5)	514 (63.6)	28 (5.4)	8 (28.6) ¹
LFTs	226 (28)	3 (0.4)	223 (27.6)	26 (11.8)	0
FBS	281 (34.8)	172 (21.3)	109 (13.5)	2 (1.9)	0
CXR ²	0	0	0	0	0
EKG	159 (19.7)	14 (1.7)	145 (17.9)	8 (5.6)	0
Urinalysis	718 (88.9)	1 (0.1)	717 (88.7)	42 (5.9)	21 (50) ³

Abbreviations: BUN, blood urea nitrogen; Cr, creatinine; LFTs, liver function tests; FBS, fasting blood sugar; CXR, chest radiograph; EKG, electrocardiogram.

¹ Electrolyte imbalance (hypo or hyperkalemia) were treated with medication.

² If the original Royal Thai College of Anesthesiologists guideline were used, there were 370 tests overuse for CXR. Among these 4 (1%) had abnormal results but did not require further management.

³ Abnormal urinalysis was treated as asymptomatic bacteriuria without confirmation by urine culture.

The appropriateness of routine preoperative tests by patients' age and underlying conditions are shown in Table 4 and 5. Patients were classified by age and underlying conditions into four groups. The first group was patients under 45 years of age with no underlying conditions. The second group was

patients under 45 years of age with at least one underlying conditions. The test with the highest appropriateness (100%) in these two groups was CBC and CXR. In contrast, the three most common inappropriate (overuse) preoperative tests in the first group were BUN/Cr (90.4%), urinalysis (90.1%)

and electrolytes (69%) respectively. The most inappropriate (underuse) preoperative test in the second group was FBS (14.8%) (Table 4).

The third group was patients 45 years or older with no underlying conditions. The last group was patients 45 years or older with at least one underlying conditions. CBC and CXR were the two tests with the highest appropriateness (100%). The most inappropriate (underuse) preoperative test was FBS (47.5% and 34.4% for group 3 and 4,

respectively). The most overused test in both groups was UA (Table 5).

The total costs of preoperative assessment per year in this study were 698,650 Bahts (US\$ 20,524.1) of which 278,280 Baht (US\$ 8,180.2) or 39.8% were considered as unnecessary cost. The main unnecessary costs were from LFTs at 91,430 Bahts (US\$ 2,676), electrolytes at 82,240 Bahts (US\$ 2,415.8), and UA at 35,850 Bahts (US\$ 1,075.5).

Table 4. Appropriateness of preoperative tests in patients aged < 45 by underlying conditions.

	No underlying condition (342)			With underlying condition (61)		
	Appropriate		Inappropriate	Appropriate		Inappropriate
	Under investigation	Over investigation	Under investigation	Over investigation	Under investigation	Over investigation
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
CBC	342 (100)	0	0	61 (100)	0	0
BUN/ Cr	33 (9.6)	0	309 (90.4)	16 (26.2)	0	45 (73.8)
Electrolyte	106 (31)	0	236 (69)	23 (37.7)	2 (3.3)	36 (59)
LFTs	266 (77.8)	0	76 (22.2)	49 (80.3)	1 (1.6)	11 (18)
FBS	249 (72.8)	0	93 (27.2)	36 (59)	9 (14.8)	16 (26.2)
CXR*	342 (100)	0	0	61 (100)	0	0
EKG	213 (62.3)	0	129 (37.7)	38 (62.3)	7 (11.5)	16 (26.2)
Urinalysis	34 (9.9)	0	308 (90.1)	12 (19.7)	0	49 (80.3)

Abbreviations: CBC, complete blood count; BUN, blood urea nitrogen; Cr, creatinine; LFTs, liver function tests; FBS, fasting blood sugar; CXR, chest radiograph; EKG, electrocardiogram.

*If the original Royal Thai College of Anesthesiologists guideline were used, there were 342 and 28 CXR tests overuse in group 1 and 2 respectively. Among these 4 (1%) had abnormal results but did not require further management.

Discussion

Almost 90% of the patients had inappropriate screening tests. CBC and CXR were the most appropriate screening tests (100%). In contrast, the most inappropriate (either overuse or underuse) preoperative tests were UA and FBS respectively. Patients younger than 45 years with no underlying conditions had the highest rate of inappropriate preoperative tests in which the most overused test was BUN/Cr. The costs of inappropriate preoperative tests

per year in this study were 39.8% of the total costs used for preoperative assessment.

CXR was not recommended by the Royal Thai College of Anesthesiologists guideline for patients aged between 15 to 45 years old. However, the Department of Anesthesiology, Srinagarind Hospital recommends to perform CXR in patients aged ≥ 15 years because of the high prevalence of tuberculosis (TB) in South-East Asia⁽¹⁴⁾. However, almost all CXRs were normal and those with abnormal findings required no further

management. Routine preoperative CXR in patients aged between 15 and 45 years therefore should not be recommended.

Improving glycemic control prior to surgery in patients with DM reduces postoperative complication⁽¹⁵⁾.

Table 5. Appropriateness of preoperative tests in patients by aged ≥ 45 by underlying conditions.

	No underlying condition (181)			With underlying condition (224)		
	Appropriate		Inappropriate	Appropriate		Inappropriate
	Under investigation	Over investigation	Under investigation	Over investigation		
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
CBC	181 (100)	0	0	224 (100)	0	0
BUN/ Cr	180 (99.4)	1 (0.6)	0	224 (100)	0	0
Electrolyte	28 (15.5)	0	153 (84.5)	133 (59.4)	2 (0.9)	89 (39.7)
LFTs	123 (68)	0	58 (32)	144 (64.3)	2 (0.9)	78 (34.8)
FBS	95 (52.5)	86 (47.5)	0	147 (65.6)	77 (34.4)	0
CXR	181 (100)	0	0	224 (100)	0	0
EKG	175 (96.7)	6 (3.3)	0	223 (99.6)	1 (0.4)	0
Urinalysis	13 (7.2)	1 (0.6)	167 (92.3)	31 (13.8)	0	193 (86.2)

Abbreviations: CBC, complete blood count; BUN, blood urea nitrogen; Cr, creatinine; LFTs, liver function tests; FBS, fasting blood sugar; CXR, chest radiograph; EKG, electrocardiogram.

Previous studies have shown that preoperative tests are often performed non-adherently to the guideline. One observational study of patients underwent elective general surgery in NHS England and Wale found that the proportion of inappropriate tests against the 2003 NICE guidelines was 31.3%⁽¹³⁾. Also in the United States, approximately half of patients had at least one unnecessary test⁽¹⁷⁾. Similarly, previous prospective study conducted in 1,363 patients scheduled for elective surgery in Austria showed that the prevalence of non-adherence to standard guidelines for LFTs, EKG and CXR were 98.1%, 84.1%, and 83.7% respectively⁽¹⁸⁾. The notably high rate of inappropriate preoperative tests used in this study (88.9%) was secondary to overuse of UA (88.7%), electrolytes (64.1%), BUN/Cr (43.9%), and underuse of FBS (21.3%).

The strengths of our study were worthy of note.

However, FBS was under-investigated (21.3%) in this study. Our hospital guideline was in accordance with the American Diabetic Association (ADA) which recommends that overweight adults or all adults aged ≥ 45 years should be screened for diabetes⁽¹⁶⁾.

Firstly, an evaluation was carried out over the one-year period thus precluding the possible variation over the time of each year. Secondly, we considered all dimensions of inappropriate screening including overuse and underuse of the tests. Finally, we also reported the unnecessary cost associated with inappropriate preoperative investigations. We have reported the results of this study to our Department Chair and the Administrative Committee. A software program are planned to be developed in our hospital IT system to automatically prescribe the appropriate preoperative screening tests based on patients' age and underlying conditions to reduce the unnecessary costs associated with inappropriate preoperative screening. However, this study did not determine the impact of inappropriate appropriate preoperative screening tests on the patients' perioperative outcomes particularly among those who had underuse of some screening

tests which became the limitation of this study.

We would like to make the following recommendations based on the results of this evaluation: (1) CXR should not be routinely performed in patients < 45 years of age; (2) Hospital administrators and heads of the departments should evaluate the appropriateness of their current preoperative tests; and (3) Mechanisms to regulate the appropriate use of pre-operative tests e.g. create awareness among physicians, using IT program to limit the tests based on baseline characteristics of the patients, etc. should be implemented. There is a need to conduct implementation research to evaluate strategies to reduce inappropriate use of pre-operative screening tests.

Acknowledgement

This work was supported by the Thailand Research Fund (Distinguished Professor Award) [DPG5780003].

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Apfelbaum JL, Connis RT, Nickinovich DG, Pasternak LR, Arens JF, Caplan RA, et al. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology* 2012;116:522-38.
2. Roizen MF. Preoperative laboratory testing: necessary or overkill? *Can J Anesth* 2004;51:R53-8.
3. Macpherson DS, Lofgren RP. Outpatient internal medicine preoperative evaluation: a randomized clinical trial. *Med Care* 1994;32:498-507.
4. Zambouri A. Preoperative evaluation and preparation for anesthesia and surgery. *Hippokratia* 2007;11:13-21.
5. Gupta A. Preoperative screening and risk assessment in the ambulatory surgery patient. *Curr Opin Anaesthesiol* 2009;22:705-11.
6. Pasternak LR. Preoperative laboratory testing: general issues and considerations. *Anesthesiol Clin N Am* 2004;22:13-25.
7. Udomthavornsuks B, Lumbiganon L. Routine preoperative screening. *Srinagarind Med J* 2009;24:278-82.
8. Johansson T, Fritsch G, Flamm M, Hansbauer B, Bachofner N, Mann E, et al. Effectiveness of non-cardiac preoperative testing in non-cardiac elective surgery: a systematic review. *Br J Anaesth* 2013;110:926-39.
9. National Guideline Centre (UK). Preoperative tests (update): routine preoperative tests for elective surgery. London: National Institute for Health and Care Excellence (UK); 2016.
10. Böhmer AB, Wappler F, Zwissler B. Preoperative risk assessment—from routine tests to individualized investigation. *Dtsch Arztsbl Int* 2014;111:437-45.
11. Feely MA, Collins CS, Daniels PR, Kebede EB, Jatoi A, Mauck KF. Preoperative testing before noncardiac surgery: guidelines and recommendations. *Am Fam Physician* 2013;87:414-8.
12. Fischer SP. Cost-effective preoperative evaluation and testing. *Chest* 1999;115:96S-100S.
13. Phoenix GK, Elliott T, Chan JK, Das SK. Preoperative blood tests in elective general surgery: cost and clinical implications. *J Perioper Pract* 2012;22:282-8.
14. World Health Organization. Global tuberculosis control 2009: epidemiology, strategy, financing. Report. Geneva, Switzerland: WHO; 2009.
15. Guzman JZ, Iatridis JC, Skovrlj B, Cutler HS, Hecht AC, Qureshi SA, et al. Outcomes and complications of diabetes mellitus on patients undergoing degenerative lumbar spine surgery. *Spine* 2014;39:1596-604.
16. Kirkman MS, Briscoe VJ, Clark N, Florez H, Haas LB, Halter JB, et al. Diabetes in older adults. *Diabetes Care* 2012;35:2650-64.
17. Katz RI, Dexter F, Rosenfeld K, Wolfe L, Redmond V, Agarwal D, et al. Survey study of anesthesiologists' and surgeons' ordering of unnecessary preoperative laboratory tests. *Anesth Analg* 2011;112:207-12.
18. Flamm M, Fritsch G, Seer J, Panisch S, Sönnichsen AC. Non-adherence to guidelines for preoperative testing in a secondary care hospital in Austria: the economic impact of unnecessary and double testing. *Eur J Anaesthesiol* 2011;28:867-73.