

Brief communication (Original)

The prevalence of inappropriate blood tests in pediatric patients scheduled for elective surgery in Thailand: a retrospective chart review

Naiyana Aroonpruksakul, Thaniya Stimanont, Pattira Pianchob

Department of Anesthesiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand

Background: Laboratory blood tests rarely detect any abnormalities in apparently healthy patients. Moreover, unnecessary testing may not only upset pediatric patients and their parents, but may harm patients because of overtreatment of borderline or false-positive results.

Objectives: To determine the prevalence and factors correlated with inappropriate preoperative testing of pediatric patients scheduled for elective surgery.

Methods: We conducted a 6-month retrospective chart review of all children <15 years of age who underwent elective surgery at Siriraj Hospital in Bangkok, Thailand. Demographic and clinical data were recorded, including age, sex, physical status class according to the American Society of Anesthesiologists (ASA), underlying diseases, diagnosis, operation, service unit, and grade of surgery. The requested preoperative laboratory tests were based on the surgeon's decision. We assessed whether each test was appropriate based on the recommendations for preoperative testing from our Department of Anesthesiology.

Results: We included data from 130 patients. The overall prevalence of inappropriate preoperative testing was 55%. Grade of surgery and service unit significantly affected inappropriate testing ($P = 0.01$ and $P = 0.001$ respectively). The highest prevalence of inappropriate test requests was for a complete blood count (37%), and all the risk factors, including ASA class I ($P = 0.015$), minor operation ($P < 0.001$), and nonpediatric surgery unit ($P < 0.001$), were significantly associated with this test.

Conclusions: The prevalence of inappropriate preoperative testing was high, especially for healthy patients who underwent minor operations. Therefore, we recommend that surgical staff be educated to request laboratory tests only when indicated.

Keywords: Healthy pediatric patients, inappropriate preoperative order, minor surgery, pediatric anesthesia, preoperative testing

The benefits of routine preoperative laboratory blood testing in the general surgical population have been evaluated and questioned for many years. Several studies demonstrated that performing tests in healthy patients rarely detected abnormalities, and when abnormalities were detected, patient management was not altered significantly [1]. Unnecessary testing may be harmful for some patients because overtreatment of borderline or false-positive results and can substantially increase the cost of perioperative care [2]. Therefore, preoperative laboratory testing should be performed only when indicated.

Anesthesiologists often witness unnecessary preoperative laboratory testing that pediatric patients undergo when being scheduled for elective surgery. Blood sample collection is an unpleasant experience for children, and it not only produces immediate anxiety, fear, distress, and pain, but also has long-term detrimental effects on neuronal development, pain threshold and sensitivity, coping strategies, emotionality, and pain perceptions [3, 4]. Several studies suggest that children with history of negative medical experiences often showed high levels of anxiety before venipuncture and were distressed and uncooperative during the procedure. Childhood pain has also been linked to fear, pain, and avoidance of medical care in adulthood, which lead to poor compliance with medical appointments [3-6].

Correspondence to: Naiyana Aroonpruksakul, Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand. E-mail: naiyana.aro@mahidol.ac.th

Additionally, unnecessary laboratory tests substantially increase health care costs.

Our objective in this study was to determine the prevalence of inappropriate laboratory testing, according to the recommendations from the Department of Anesthesiology, Siriraj Hospital, in pediatric patients scheduled for elective surgery at Siriraj Hospital (**Supplementary Table**), and determine the factors that correlated with the prevalence of inappropriate laboratory testing.

Materials and methods

This study was approved by the Institutional Review Board at Siriraj Hospital (021/2554(EC4)). The medical records of children <15 years old, who were admitted to the surgical ward for elective surgery between May and October 2010, were reviewed retrospectively.

We recorded patient demographic and clinical data including age, sex, their physical status class according to the American Society of Anesthesiologists (ASA), medical history (previous underlying diseases and the present indication for surgery), diagnosis, operation, service unit (categorized by the subspecialty of attending physician and according to nonpediatric or pediatric surgery, which included operations only for pediatric patients), and grade of operation (major surgery was classified as thoracic or abdominal surgery). The preoperative laboratory tests performed for each patient were recorded, including complete blood count (CBC), urinalysis, electrolytes, coagulation studies, and liver function tests (LFT). Results of chest radiographs (CXR) and electrocardiograms (EKG) were also recorded. Each test was determined to be appropriate or inappropriate based on the recommendations listed from the Department of Anesthesiology, Siriraj Hospital, as shown in the **Supplementary Table**.

We conducted a pilot study to estimate the sample size. According to the pilot study, the prevalence of inappropriate laboratory test requests being made was about 60%. Therefore, based on 95% confidence interval (CI) of prevalence of inappropriate test requests of approximately 60% + 8.5%, a sample of 130 subjects was required. Demographic data were analyzed using descriptive statistics. A Fisher exact test was employed to determine factors associated with inappropriate laboratory tests. $P < 0.05$ was considered significant.

Results

The reviewed medical records were classified according to surgery service units as pediatric ($n = 65$) and nonpediatric ($n = 65$). Patient demographic and clinical data are shown in **Table 1**.

Most patients were aged between 1 and 8 years (62%), ASA class I (60%), and undergoing elective minor surgery (87%).

The overall prevalence of inappropriate requests for testing was 55.4% (158 out of 285 tests ordered). The prevalence of inappropriate preoperative laboratory test requests is shown in **Figure 1**. The most frequent inappropriate preoperative investigations were CBC (36.9%), electrolytes (20%), CXR (15.4%), blood urea nitrogen (BUN)/creatinine (Cr) (14.6%), and coagulogram (13.8%). The LFTs were the only laboratory tests that were ordered appropriately.

The prevalence of inappropriate investigations in healthy patients (ASA classifications I and II) was higher than in those with ASA classification III (approximately 50% vs 0%) as shown in **Table 2**.

Table 1. Demographic and clinical data

Characteristic	Number (%)
Age (years)	
0 to <1	22 (17)
1 to <8	81 (62)
8 to <15	27 (21)
American Society of Anesthesiologists classification	
I	78 (60)
II	49 (38)
III	3 (2)
Grade of surgery	
Minor	113 (87)
Major	17 (13)
Service unit	
Pediatric surgery	65 (50)
Nonpediatric surgery	65 (50)
Plastic	12 (9)
Orthopedics	13 (10)
Ear, nose, throat	12 (9)
Eye	11 (9)
Urogenital	6 (5)
Radiograph	11 (9)

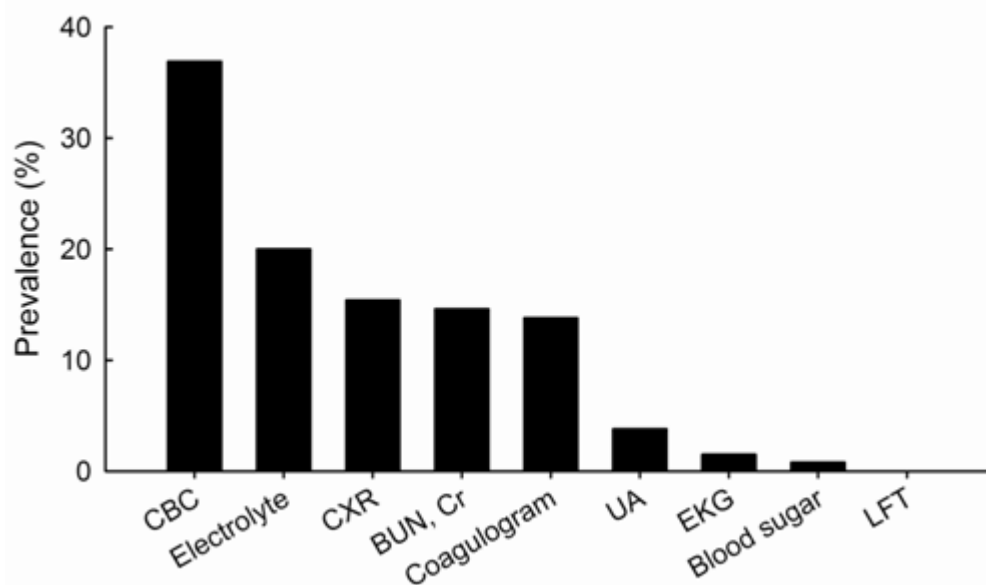


Figure 1. Prevalence of inappropriate preoperative laboratory investigations

CBC = complete blood count, CXR = chest radiograph, BUN = blood urea nitrogen, Cr = creatinine, UA = urinalysis, EKG = electrocardiogram, BS = blood sugar, LFT = liver function tests

Table 2. Prevalence of inappropriate laboratory investigation by ASA, age, grade of surgery, and service unit

Possible factors	Inappropriate	Total (n)	Prevalence (%)	P
ASA classification				
1	41	78	53	0.19
2	28	49	57	
3	0	3	0	
Age (years)				
0 to <1	11	22	50	0.13
1 to <8	39	81	48	
8 to <15	19	27	70	
Grade of surgery				
Minor	55	113	49	0.01
Major	14	17	82	
Service unit				
Pediatric surgery	25	65	39	0.001
Nonpediatric surgery	44	65	68	

ASA = American Society of Anesthesiologists

Although the prevalence of inappropriate investigations was the highest among children aged between 8 and 15 years (70%, $P = 0.13$), the prevalence of inappropriate laboratory test requests in the other 2 age groups were also approximately 50%. The prevalence of inappropriate preoperative laboratory investigations increased significantly where patients were to undergo major operations (82%, $P = 0.01$) and in patients assessed in nonpediatric

surgery service units (68%, $P = 0.001$).

Considering each possibly related factor, CBC was the most frequently ordered inappropriate test, and it correlated significantly with ASA classification I (46%, $P = 0.02$), minor operation (43%, $P < 0.001$), and nonpediatric surgery unit (59%, $P < 0.001$). The prevalence of inappropriate laboratory test orders is shown in **Table 3**.

Table 3. Prevalence of each inappropriate laboratory test request and the possible related factors

Possible factors	CBC		Electrolyte		Chest X-ray		BUN, Cr		Coagulogram	
	Inapp. n (%)	P	Inapp. n (%)	P	Inapp. n (%)	P	Inapp. n (%)	P	Inapp. n (%)	P
ASA classification										
I	36 (46)	0.02	18 (23)	0.83	17 (22)	0.92	15 (19)	0.34	10 (13)	0.75
II	12 (25)		9 (18)		12 (25)		5 (10)		8 (16)	
III	0		0		0		0		0	
Age (year)										
0 to <1	5 (23)	0.10	3 (14)	0.55	4 (18)	0.01	2 (9)	0.48	7 (32)	0.02
1 to <8	29 (36)		17 (21)		3 (16)		12 (15)		7 (9)	
8 to <15	14 (52)		7 (26)		12 (44)		6 (22)		4 (15)	
Grade of surgery										
Minor	48 (43)	<0.001	22 (20)	0.35	20 (18)	0.003	19 (17)	0.47	10 (9)	0
Major	0		5 (29)		9 (53)		1 (6)		8 (47)	
Service										
Pediatric surgery	10 (15)	<0.001	9 (14)	0.08	9 (14)	0.03	7 (11)	0.22	13 (20)	0.07
Nonpediatric surgery	38 (59)		18 (28)		20 (31)		13 (20)		5 (8)	

ASA = American Society of Anesthesiologists, BUN = Blood urea nitrogen, Cr = creatinine, Inapp. = inappropriate

The prevalence of testing, except for CXR, was not different among patients in the different age groups. Most frequently, CXRs were ordered inappropriately for patients aged between 8 and 15 years (44%, $P < 0.01$) and in the nonpediatric surgery service units (31%, $P = 0.03$). Surprisingly, CXR was not performed in half of the patients undergoing major operations in the pediatric surgery unit (53%, $P = 0.003$). Coagulograms were ordered inappropriately for the group undergoing major operations (47%, $P < 0.001$). The cost of unnecessary laboratory investigations in this study is shown in **Table 4**. It was approximately 19,000 Thai baht for 158 tests of 130 patients.

Table 4. Total cost estimates of inappropriate laboratory investigations

	Fee (baht)	Total cost (baht)
Complete blood count	90	4,320
Urinalysis	50	250
Blood urea nitrogen	50	950
Creatinine	50	950
Electrolyte	160	4,160
Glucose	40	40
Coagulogram	190	3,420
Liver function tests	350	0
Chest radiograph	220	4,400
Electrocardiogram	200	400
Total		18,890

Discussion

Preoperative laboratory testing is generally requested to obtain more information about the patient to optimize the preoperative clinical conditions and avoid perioperative complications. However, several investigators demonstrated that in the absence of clinical indications, routine testing rarely detects abnormalities; when abnormal findings are detected, they rarely alter surgical or anesthetic management [7-12].

To evaluate preoperative testing for elective surgery, Turnbull and Buck [8] reviewed charts of 2,570 patients and found that only 2% of the tests were significantly abnormal and only 4 patients benefited from routine laboratory testing. Ideal practice should include selective testing of children after taking a careful history and physical examination [1, 2, 7-13]. The nonselective ordering of preoperative tests leads to higher costs, patient discomfort, and a large number of false-positive results [3].

When comparing the recommendations of our hospital for pediatric preoperative laboratory testing with the review by Kumar and Srivastava [13] and the U.K. National Institute for Health and Care Excellence (NICE) guidelines [14], all three state that no laboratory investigations are needed in healthy children scheduled for elective minor surgery. NICE guidelines recommend preoperative examinations only for children classified as ASA I who are scheduled to undergo either minor or major surgery. For patients with kidney disease, lung disease, or cancer, our

recommendations and the report by Kumar et al. [13] suggest to assess CBC, BUN, Cr, electrolyte, and CXR. However, there are some discrepancies between the guidelines, such as a lack of comorbid severity grading.

In this study, we found the most frequently and inappropriately ordered test was CBC, which was ordered most for healthy patients (ASA class I and II) scheduled to undergo minor operations. According to the recommendation of our hospital, it is reasonable to check CBC if the patient's history is suggestive of underlying anemia, renal failure, cardiac or pulmonary disease, history of bleeding disorder, patients undergoing surgery with expected major blood loss, and if the patient is a former preterm infant with postconceptual age (PCA) < 55 weeks. Roy et al. assessed the cases of 2,000 infants and adolescents <18 years old who underwent minor surgery. The incidence of anemia was less than 2%, and the procedures in 73% of these patients were not cancelled with uneventful anesthesia and surgery [15]. Meneghini et al. also showed that, in healthy children undergoing minor operations, the value of the routine determination of hemoglobin concentration is negligible. The prevalence of severe leukopenia, leukocytosis, and thrombocytopenia were extremely low in healthy patients scheduled to undergo elective surgery [16].

The second most inappropriate laboratory test request was for electrolyte quantification; nevertheless, we recommend that electrolytes be evaluated in patients with renal disease, heart disease, liver disease, and children who have received chemotherapy.

CXR is recommended for patients with underlying heart or respiratory diseases and patients with expected major blood loss. The present results showed that in half of the patients in the surgery group, CXR was not requested. A study by Sane et al. [17] suggested that the routine preoperative CXR should be performed, whereas Cot [18] and the NICE guidelines [14] do not recommend ordering CXR for major surgery. However, LFT was indicated appropriately for patients with liver disease or those who received chemotherapy.

The prevalence of inappropriate laboratory investigations increased significantly with the severity of operation and in the nonpediatric surgery service unit (unfamiliar with pediatric patients). The coagulogram was the most frequently ordered test before major operations. Suchman and Mushlin [19] and Asaf et al. [20] showed that in healthy patients, without a history of bleeding, diathesis, activated partial

thromboplastin time, and prothrombin time (PT), bleeding time did not predict the risk of perioperative bleeding and was not recommended for routine preoperative screening.

Patel et al. [21] sent 1,200 questionnaires to anesthesiologists and surgeons who were members of the Society for Pediatric Anesthesia. They showed that testing for hemoglobin levels was routinely ordered in 27%–48% of patients depending on their age. Compared with our study, the prevalence of inappropriate requests to determine CBC in the pediatric surgery unit was lower, yet it still occurred in 15% of the cases. A possible explanation may be insufficient training of new staff. However, CBC was requested inappropriately more frequently and significantly in the nonpediatric surgery units than in the pediatric surgery unit. Unfamiliarity is a possible reason why physicians did not follow the recommendation of the Department of Anesthesiology, or that ordering routine laboratory tests was easier. Another explanation is that surgeons often worried about procedures being delayed or cancelled if some test results were not obtained [22].

The main limitation of our study was the use of recommendations formulated specifically and solely for Siriraj Hospital. We recognize that a number of guidelines are available and data would differ based on the guidelines chosen. Our data represent findings from a single institution and may not be generalizable to populations in other hospitals and health care systems. The cost analysis was performed based on local hospital billing rates.

Conclusion

In conclusion, the prevalence of inappropriate preoperative testing was high, especially for healthy children scheduled to undergo minor operations. Therefore, it is important to train the surgical staff so that inappropriate preoperative laboratory tests are not requested for healthy pediatric patients who will undergo minor operations.

Acknowledgments

The authors were supported by a Research Development Grant from the Faculty of Medicine, Siriraj Hospital.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Supplementary Table. The recommendation of preoperative laboratory investigation for pediatrics from Siriraj Hospital knowledge management website

	CBC	CXR	EKG	Electrolyte	Bun/Cr	Glucose	Coagulogram	LFTs
1. Age ≤ 15 y, healthy, no underlying disease, minor operation, no further lab investigation	–	–	–	–	–	–	–	–
2. Preterm PCA < 55 wks (PCA = gestational age + age)	✓	–	–	–	–	–	–	–
3. Underlying disease e.g. diabetes, heart disease, lung disease, kidney disease, hormone therapy, cancer	✓	✓	✓ (Heart disease)	✓	✓	✓ (DM)	–	–
4. Major operation, risk of bleeding	✓	✓	–	–	✓	–	–	–
5. History of bleeding tendency (e.g. purpura, ecchymosis), on anticoagulant	✓	–	–	–	–	–	✓	–
6. Liver disease, jaundice, History of chemotherapy	✓	✓	–	✓	✓	✓	✓	✓

DM = diabetes mellitus, PCA = postconceptual age.

References

- Sarayrah MA, Habaibeh E. Pre-operative blood testing in the pediatric age group – Is it necessary? *Mid East J Family Med.* 2009; 7:15-7.
- Mallick MS. Is routine pre-operative blood testing in children necessary? *Saudi Med J.* 2006; 27:1831-4.
- Cohen LL. Behavioral approaches to anxiety and pain management for pediatric venous access. *Pediatric.* 2008; 122:s134-9.
- Bijttebier P, Vertommen H. The impact of previous experience on children's reactions to venepunctures. *J Health Psychol.* 1998; 3:39-46.
- Blount R, Piira T, Cohen L. Management of pediatric pain and distress due to medical procedures. In: Roberts MC, ed. *Handbook of pediatric psychology.* 3rd ed. New York: Guilford Press. 2003; 216-33.
- Uman LS, Birnie KA, Noel M, Parker JA, Chambers CT, McGrath PJ, et al. Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane Database Syst Rev.* 2013; 10:CD005179.
- O'Connor ME, Drasner K. Preoperative laboratory testing of children undergoing elective surgery. *Anesth Analg.* 1990; 70:176-80.
- Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. *Arch Intern Med.* 1987; 147:1101-5.
- Kaplan EB, Sheiner LB, Boeckmann AJ, Roizen MF, Beal SL, Cohen SN, et al. The usefulness of preoperative laboratory screening. *JAMA.* 1985; 253: 3576-81.
- Mantha S, Roizen MF, Madduri J, Rajender Y, Shanti Naidu K, Gayatri K. Usefulness of routine preoperative testing: a prospective single-observer study. *J Clin Anesth.* 2005; 17:51-7.
- Roizen MF. More preoperative assessment by physicians and less by laboratory tests (Editorial). *N Engl J Med.* 2000; 342:204-5.
- Munro J, Booth A, Nicholl J. Routine preoperative testing: a systematic review of the evidence. *Health Technol Assess.* 1997; 1:i-iv; 1-62.
- Kumar A, Srivastava U. Role of routine laboratory investigations in preoperative evaluation. *J Anaesthesiol Clin Pharmacol.* 2011; 27:174-9.
- National Institute for Clinical Excellence (NICE). The use of routine preoperative tests for elective surgery: NICE Clinical Guidance No 3. London: National Institute for Clinical Excellence. 2003; 6-23.
- Roy WL, Lerman J, McIntyre BG. Is preoperative haemoglobin testing justified in children undergoing minor elective surgery? *Can J Anaesth.* 1991; 38:700-3.
- Meneghini L, Zadra N, Zanette G, Baiocchi M, Giusti F. The usefulness of routine preoperative laboratory test for one-day surgery in healthy children. *Pediatr Anaesth.* 1998; 8:11-5.
- Sane SM, Worsing RA, Wiens CW, Sharma RK. Value of preoperative chest X-ray examinations in children. *Pediatrics.* 1977; 60:669-72.
- Cot CJ. Preoperative preparation and premedication. *Br J Anaesth.* 1999; 83:16-28.
- Suchman AL, Mushlin AI. How well does the activated partial thromboplastin time predict postoperative hemorrhage? *JAMA.* 1986; 256:750-3.
- Asaf T, Reuveni H, Yermiahu T, Leiberman A, Gurman G, Porat A, et al. The need for routine pre-operative coagulation screening tests (prothrombin time PT/partial thromboplastin time PTT) for healthy children undergoing elective tonsillectomy and/or adenoidectomy. *Int J Pediatr Otorhinolaryngol.* 2001; 61:217-22.

21. Patel RI, DeWitt L, Hannallah RS. Preoperative laboratory testing in children undergoing elective surgery: analysis of current practice. *J Clin Anesth.* 1997;9:569-75.
22. St Clair CM, Shah M, Diver EJ, Lewin SN, Burke WM, Sun X, et al. Adherence to evidence-based guidelines for preoperative testing in women undergoing gynecologic surgery. *Obstet Gynecol.* 2010; 116: 694-700.