

## Review

# Laboratory tests in children undergoing ambulatory surgery: a review of clinical practice and scientific studies

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### Abstract

The drive for cost containment in the United States has lead anesthesiologists to re-assess the benefits of routine pre-operative laboratory and radiological testing. The value of routine tests has been questioned not only by insurance companies but also by physicians. Common pre-operative laboratory and radiological tests are reviewed in the following analysis. Specifically, the use of such tests in children scheduled for ambulatory surgery is discussed. Current clinical practice patterns of pediatric anesthesiologists are included so that physicians may make conclusions on the basis of published literature and clinical practice of peers. © 2000 Elsevier Science B.V. All rights reserved.

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### 1. Introduction

Preoperative evaluation of pediatric patients consists of a history, physical examination and appropriate laboratory and radiological tests. The laboratory tests should not be ordered for all patients scheduled for surgery but must be individualized. Such testing should be based on patient's history, physical examination and objective criteria for laboratory tests. Data from the Mayo Clinic indicate that patients undergoing minimally invasive surgery have little potential to benefit from additional laboratory testing, after a careful medical history was obtained and a physician had decided that no preoperative tests were required [1]. In general, history and physical examination of the patient are far more important than a battery of tests to make a diagnosis. About 85% of diagnosis depend on the history provided by the patient/parents, another 6% diagnosis are made by physical examination and tests add

another 8% to the diagnosis in medical outpatients [2]. The practice of ordering batteries of tests unnecessarily has many disadvantages: it is not cost effective, decreases healthcare funds for others, may lead to inadequate or inappropriate care as a result of the time-consuming follow up of test results, increases risk to the patient and increases medico-legal risk to the healthcare provider [3]. Asymptomatic patients are more likely to be harmed by unwarranted tests and the physician's actions in response to the abnormal results of those tests. In spite of lack of evidence that routine preoperative testing of healthy children before elective surgery is warranted, this practice continues in many health-care facilities. State or institution mandated testing is far less prevalent than reported previously, but physicians recommended testing still comprise a large part of routine tests.

### 2. Indications for testing

Assuming that a history and physical examination have been performed, the possible reasons for preoperative investigations are:

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1. To detect unsuspected conditions: a finding of a new condition may alter the risk of surgery. The previously unidentified condition may be correctable or not correctable. If the condition is corrected preoperatively, it leads to a lower risk of surgery. If the condition is not modifiable, it is simply noted for the sake of completing medico-legal records [4].
2. To obtain baseline results that may be helpful in decision making during and after surgery (e.g. preoperative hemoglobin value to determine allowable blood loss during surgery) [4].
3. Screening for conditions unrelated to the planned surgery.
4. Satisfying institutional or legislative criteria.
5. Habit [5].

However, healthy children who are scheduled to undergo surgical procedures that are not associated with the possibility of extensive blood loss require only minimal preoperative laboratory testing. In some instances, such testing is governed by hospital or state policy.

### 3. Hemoglobin–hematocrit (Hb/Hct)

Until recently the routine measurement of blood hemoglobin concentration or hematocrit prior to elective surgery had been a widely accepted practice. It was assumed that routine preoperative Hb/Hct testing will detect a significant number of anemic children and that the risk of general anesthesia was increased in the presence of even mild anemia. It has been since noted that the incidence of anemia in otherwise healthy children is extremely low in most parts of the North America and Europe and mild degree of anemia does not require therapeutic intervention or modification of the anesthetic technique [6]. Most anesthesiologists now accept hematocrits in the mid-20's for elective surgical procedures, provided there are no other systemic problems. The most common reason to obtain a pre-operative Hb/Hct is to assess allowable blood loss during surgery.

The usefulness of routine preoperative hemoglobin and hematocrit determinations has been evaluated and the value of this test has been questioned [7–10]. Baron

et al. on a retrospective review noted that only 1.1% of the 1863 children had Hct values of less than 30% or greater than 50% [11]. Roy et al. studied 2000 patients ages 1 month to 18 years scheduled for minor surgery [7]. Eleven patients (three < 1 year, and eight 1–5 years old) had a Hb less than 10 g%. Of these, three patients had their surgery postponed and rescheduled following oral iron therapy; while the remaining eight underwent anesthesia and surgery without complications. These authors concluded that healthy pediatric patients 5 years and older scheduled for minor surgery do not require routine Hb determinations. Furthermore, the low incidence of anemia and low rate of deferral of surgery in anemic children, 1–5 years of age, lead them to question the value of routine preoperative Hb testing in this age group [7]. Hackmann, et al. noted anemia in 0.5% of the 2648 pediatric day-surgery patients studied [9]. Only two of the anemic patients had their surgery postponed (one of them also had a respiratory infection).

These authors made three observations from their study:

1. the incidence of anemia is rare but is more likely to occur in those < 1 year of age
2. the presence of a mild degree of anemia does not alter the decision to proceed with day surgery, and
3. physicians could not reliably detect anemia clinically [9].

There are three groups of patients who are at increased risk of having anemia:

1. infants < 1 year,
2. adolescent menstruating females,
3. children with chronic disease [12,13]

One of the common causes of anemia in adolescent females is heavy menstrual bleeding. The precise incidence of anemia in the pre-surgical patients of this age group is not known. Preoperative Hb/Hct may be indicated in such patients and those undergoing surgical procedures associated with considerable blood loss. A recent survey of more than 600 pediatric anesthesiologists of United States, indicated that, only 27% of pediatric anesthesiologists order routine hemoglobin/hematocrit [14] in healthy children between 1 and 12 years of age (Table 1). Less than 50% order routine Hb/Hct in infants < 1 year of age and only 33% require routine Hb/Hct in adolescents [14] (Table 1).

Table 1  
Hb/Hct stratified by age and ordering pattern [14]

	< 1 year (n = 610)	1–12 year (n = 613)	Female > 12 year (n = 602)
Routinely required	292 (47.9%)*	166 (27.1%)	199 (33.1%)
By anesthesiologist/surgeon	264	139	177
By State/hospital	28	27	22
Not routinely required	318 (52.1%)	447 (72.9%)	403 (66.9%)

\*  $P < 0.001$  (< 1 year vs. older patients).

Table 2  
PT/PTT prior to T&A [14]

(a)*	Teaching	Non-teaching	Total
Routine	135 (38.7%)	142 (49.7%)	277 (43.6%)
Non-Routine	214 (61.3%)	144 (50.3%)	358 (56.4%)
Total	349 (100%)	286 (100%)	635 (100%)
(b)**	Urban	Non-urban	
Routine	110 (41.2%)	167 (45.4%)	227 (43.6%)
Non-Routine	157 (58.8%)	201 (54.6%)	358 (56.4%)
Total	267 (100%)	368 (100%)	585 (100%)

\*  $\chi^2 = 7.69$ ;  $P = 0.006$ .

\*\*  $\chi^2 = 1.1$ ;  $P = 0.29$

#### 4. Complete blood count (CBC)

The possible benefits of performing a CBC test routinely would be the detection of leukopenia or leukocytosis reflecting hematological malignancies or infection [4]. O'Connor and Drasner noted abnormal WBC in 13 of 486 (2.7%) patients [8]. None of the children in the study had their surgeries canceled. One instance of elevated WBC was thought to be secondary to a chronic otitis media. The remaining 12 elevated WBC were unexplained with no documented follow-up. CBC is now rarely ordered before ambulatory surgery. Only ~20% of pediatric anesthesiologists order CBC as a routine pre-operative test [14].

#### 5. Urine analysis: (U/A)

The rationale for performing routine urinalysis before surgery includes detecting, and treating children with unsuspected renal disease and urinary tract infections. However, O'Connor and Drasner noted clinically abnormal results of UA in 36/453 (8%) of the pre-surgical patients [8]. Of these abnormal results, 12 were related to known conditions and repeat studies in another 12 patients revealed normal UA. The remaining 12 patients had no documented follow-up. Surgeries were canceled in two children. One infant came back a week later for emergency surgery and the second infant was operated upon after treatment of urinary tract infection. They concluded that a routine U/A adds little to the preoperative evaluation of a healthy child and should be omitted. The survey of pediatric anesthesiologists indicates that the practices of most institutions reflect this recommendation in that routine U/A is ordered by only 15% of the physicians [14].

#### 6. Coagulation testing

Intra-operative and postoperative bleeding is a concern during any surgery, but post-operative bleeding

following adeoidectomy and/or tonsillectomy is particularly worrisome. The American Academy of Otolaryngology-Head and Neck surgery has recommended coagulation studies only in patients with positive histories and physical examinations [15]. In spite of this recommendation, ~45% of respondents to the questionnaire on hemostatic labs prior to tonsillectomy continue to obtain PT/PTT prior to tonsillectomy [14]. (Table 2a and b) The hemostatic evaluation of patients undergoing surgery, especially tonsillectomy has not been uniform because of the conflicting results of the studies and individual clinical experiences.

The incidence of post-tonsillectomy bleeding ranges from 0.28 to 2.15% [16,17]. It is arguable whether routine preoperative hemostatic (PT/PTT) tests should be performed in all children scheduled for tonsillectomy. Even if the hemostatic tests are performed for all such children, there is evidence that it will not predict all cases of post-tonsillectomy bleeding. Excessive bleeding associated with tonsillectomy is usually not a result of an identifiable coagulation disorder [16]. Close, et al. suggested that routine measurement of the activated partial thromboplastin time and prothrombin time in asymptomatic patients undergoing tonsillectomy is not useful for predicting postoperative bleeding [15]. Houry, et al. prospectively compared the results of four standard preoperative hemostatic screening tests (PT, APTT, platelet count and bleeding time) with history and clinical data in a multicenter study of 3242 patients [18]. Their results suggested that preoperative hemostatic screening tests should not be performed routinely, but only in patients with abnormal clinical data. Bolger et al. [19], however, reported that 21% of patients undergoing tonsillectomy had an abnormality of the activated partial thromboplastin time (APTT), prothrombin time (PT), or bleeding time (BT) and they suggested that these tests be performed in all patients to detect possible coagulation disorders.

#### 7. Pregnancy test

Even though the overall pregnancy rate in the pre-surgical patient may be low, there are great social, ethical and medico-legal concerns when an adolescent scheduled for outpatient surgery is noted to have a positive pregnancy test just before surgery. Therefore, it is not surprising that pregnancy test is routinely required by ~45% of anesthesiologists [14] (Table 3).

The rate of teenage pregnancies in the United States is high, not only in urban populations, but also in non-urban areas. Teenage pregnancy represents 13–23% of total pregnancies in the United States [20]. Potential concerns over teratogenicity and miscarriages have led to the recommendation that elective surgery be postponed until the second trimester of pregnancy.

Therefore, it is important to know whether a patient scheduled for surgery is pregnant. An accurate history is often not obtained because adolescents may not believe that they could be pregnant and are reluctant to disclose their sexual behavior or pregnancy.

Azzam et al., retrospectively examined the results of 2 years of mandatory pregnancy testing in 412 adolescent surgical patients [21]. Pregnancy testing was performed without patient's or their parents' specific consent, as it was deemed a component of the preoperative evaluation and the practice had been approved by the medical staff bylaws. The overall incidence of positive tests was 1.2%. Five of 207 patients who were older than 15 years tested positive for pregnancy test, an incidence of 2.4% in that group. None of the 205 patients under the age of 15 years had a positive pregnancy test. In three subjects, the surgical procedure was postponed, in one it was performed under local anesthesia, and in another a general anesthesia without nitrous oxide was administered. The authors concluded that mandatory pregnancy testing is advisable in adolescent surgical patients aged 15 years and older [21]. In an editorial comment in response to the Azzam study, Duncan and Pope questioned the ethical, financial and legal grounds of performing pregnancy test without consent from each individual patient or her parents [22].

In contrast, Malviya et al., prospectively evaluated the reliability of the preoperative history obtained from adolescent patients in ruling out pregnancy [23]. Four hundred and forty-four adolescent patients who underwent 525 procedures were questioned preoperatively regarding the possibility of pregnancy. Regardless of the history, a urine pregnancy test was ordered. In 514 cases, patients or the parents denied the possibility of pregnancy. Seventeen patients were not tested due to patient/parental refusal. Eight patients stated that they might be pregnant. All pregnancy tests were negative. There was not a single patient who was pregnant. They concluded that adolescents educated about the potential risks of anesthetics might provide a reliable history regarding the possibility of pregnancy [23].

At Children's National Medical Center, we do not perform routine pregnancy testing in adolescent patients. Instead, we rely on the history provided by the patient. On the morning of surgery, the nursing staff of

the outpatient surgical admissions unit escorts the adolescent away from the parents and confidentially elicits the history of sexual activity and the possibility of pregnancy. The patient is informed of the risks of anesthesia and surgery for a pregnant patient. The anesthesiologist or the operating room nursing staff again try to confirm the history just before induction of anesthesia. Whenever the history is suggestive of pregnancy or if the history is inconclusive, a urine pregnancy test is obtained. If this test is negative, no further action is necessary and the surgery proceeds without further delay. However, if the urine pregnancy test is positive, then, a blood pregnancy test is ordered with parental approval to verify the results of the urine test. If the blood test is positive, then the adolescent and the parents are informed and the plan for elective surgery modified.

## 8. Sick cell disease

Routine preoperative sickle cell testing is not performed. The incidence of sickle cell disease is estimated to be 0.2–0.5% among the African American population. The incidence of sickle cell trait is ~8% in the same population. Routine testing for sickle cell disease is often done by the neonatologist/pediatrician. The diagnosis is usually made in the first year of life and it is rare for an undiagnosed child to be scheduled for routine surgery. African/American children with low Hb/Hct should also be tested. We order Hemoglobin/Hematocrit and Hb-SS electrophoresis for children known to have sickle cell disease. Frequently, the diagnosis of sickle cell disease is known prior to surgery but the child does not have any preoperative preparation. It is crucial that the severity of the sickle cell disease is known and that the hematologist has adequately prepared the child for the general anesthesia and surgery.

## 9. Chest radiograph

Of all the preoperative tests, the chest radiograph has been most objectively studied in adults. This was never a routine test in children prior to surgery. The American Academy of Pediatrics recommended elimination of

Table 3  
Pregnancy testing [14]

	Teaching (n = 354)	Non-teaching (n = 273)	Total (n = 627)
Routinely required	151 (43%)	120 (44%)	271 (43%)
By anesthesiologist/surgeon	144	117	261
By State/hospital	7	3	10
Not routinely required	203 (57%)	153 (56%)	356 (57%)

this test as part of routine preoperative assessment as early as 1983. However, the increasing incidence of infections such as HIV and tuberculosis raises the question of protection of other patients who share the same playroom/holding area and health care workers.

## 10. Legislative mandate

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) which is responsible for accreditation of healthcare facilities in the United States only requires that any indicated laboratory or X-ray examination be completed preoperatively. There are no specifically mandated tests before surgery. Similarly the American Society of Anesthesiologists, the American College of Surgeons and the American Academy of Pediatrics do not have any guidelines recommending any specific routine preoperative laboratory tests [4]. Individual states and local requirements may vary.

In conclusion, routine laboratory tests and radiological should not be ordered. Tests should be ordered on the basis of history and physical examination of the patient and the results of such tests then should be followed and necessary action taken prior to ambulatory surgery.

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