

Anemia in Pediatric Day-surgery Patients: Prevalence and Detection

Thomas Hackmann, M.D., F.R.C.P.(C.),* David J. Steward, M.B., F.R.C.P.(C.),†
Samuel B. Sheps, M.D., M.Sc., F.R.C.P.(C.)‡

A prospective study was conducted to determine the prevalence of anemia in pediatric day-surgery patients, and a single-blinded study was conducted to evaluate the anesthesiologist's capability to detect preoperative anemia clinically. The subsequent management of children with anemia was noted. During the preoperative examination the anesthesiologist completed a questionnaire and predicted the preoperative hemoglobin concentration based on the history and physical examination. The preoperative hemoglobin concentration was measured for all of the patients, but the results were withheld until after completion of the questionnaire. Documentation was complete in 2,649 patients, and these comprised the final study group. Fourteen patients (0.5%) were anemic (hemoglobin concentration < 100 g/l), but of these, only 5 had been predicted to be anemic based on clinical examination. Seven of these 14 anemic patients were less than 1 yr of age. Only 2 of the anemic patients had surgery postponed, and 1 of these also had a respiratory infection. Forty-four patients were incorrectly predicted to be anemic (*i.e.*, their actual hemoglobin concentration was greater than 100 g/l). We conclude that in our patients, anemia is rare but is more likely to occur in those less than 1 yr of age. The presence of mild degrees of anemia does not alter the decision to proceed with day surgery. The anesthesiologists participating in this study could not reliably detect anemia clinically. (Key words: Anesthesia, pediatric; anemia; preoperative preparation.)

ROUTINE MEASUREMENT of blood hemoglobin concentration or hematocrit prior to elective pediatric surgery has been a widely accepted practice.¹ This is based on the assumption that knowledge of the preoperative value may influence the decision to proceed with general anesthesia or affect intraoperative patient management. It has been suggested that anemia may increase the risk of general anesthesia in pediatric patients,² although a clear association between anemia and risk has not been established.

Retrospective studies have documented the prevalence of anemia in different populations of pediatric surgical

patients³ and also have examined the influence that this diagnosis has had on patient management.^{4,5} However, the value of preoperative hemoglobin testing for every child is still uncertain.

To examine the necessity for preoperative hemoglobin measurement, we assessed the capability of the anesthesiologist to predict, without access to laboratory testing, the likelihood of anemia in pediatric patients. We also reexamined the influence of the confirmed diagnosis of anemia on the subsequent management of the patient.

Materials and Methods

Appropriate institutional ethical review was obtained, and a series of consecutive patients scheduled for day surgery or for "admit day of surgery" procedures were studied prospectively. All patients were less than 18 yr of age and ASA physical status 1-3 and were having minor surgical procedures or investigations under general anesthesia or sedation. Patients who had had recent blood tests performed were excluded from the study, since they would not require a repeat hemoglobin concentration estimation and since the previous results would be available to the anesthesiologist. A health questionnaire for each patient was completed by a parent and was available to the anesthesiologist at the time of the preoperative examination, as was the surgical history. Hemoglobin concentration was measured in each patient, but the result was concealed until the anesthesiologist had completed the preoperative evaluation and also answered the following questions.

- Is the preoperative history suggestive of anemia?
 - Does the preoperative examination suggest anemia?
 - I predict the preoperative Hb to be: <70 g/l <100 g/l >100 g/l
- If surgery is cancelled please state reason for cancelling:

Descriptive statistics⁶ were used to describe the results by examining the anesthesiologists' clinical assessment against the laboratory result of the hemoglobin concentration.

Results

A total of 3,309 consecutive patients were studied over a period of 7 months: documentation was complete in

* Fellow in Anesthesia, British Columbia's Children's Hospital.

† Professor, Department of Anesthesia, University of British Columbia.

‡ Associate Professor and Head, Department of Health Care and Epidemiology, University of British Columbia.

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Address reprint requests to Dr. Steward: Department of Anesthesia, British Columbia's Children's Hospital, 4480 Oak Street, Vancouver, British Columbia, Canada, V6H 3V4.

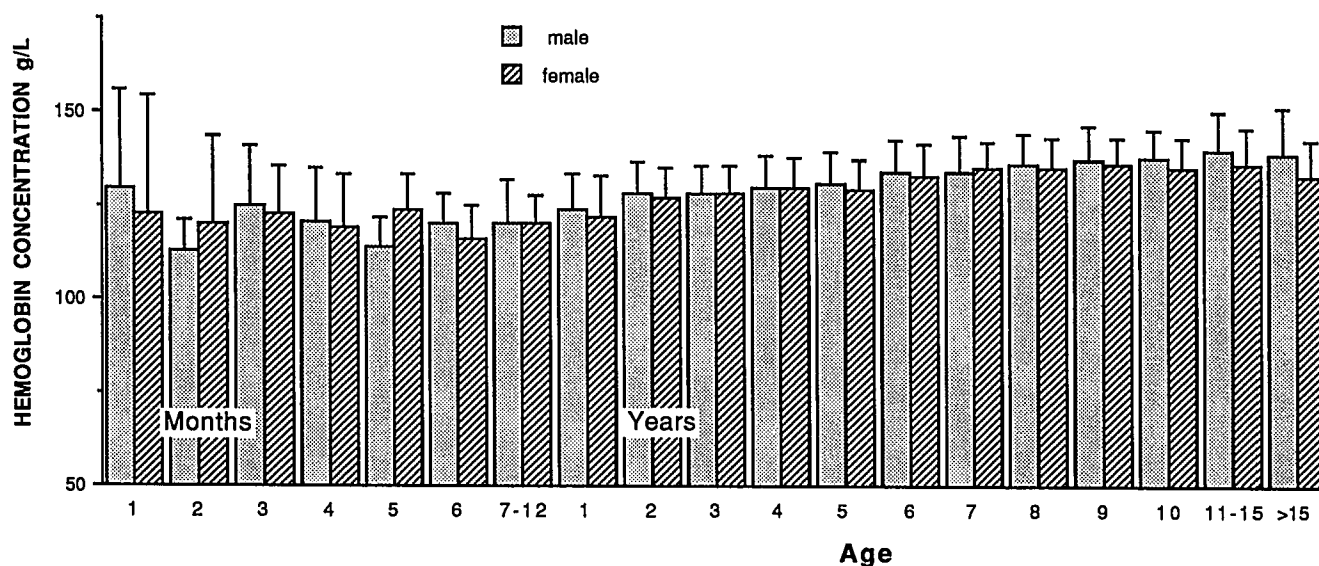


FIG. 1. Measured hemoglobin concentrations in the study group by age and sex.

2,649 patients (80%), and these comprised the final study population. Only 3.3% were less than 6 months of age. More boys than girls were included, reflecting the overall preponderance of male patients in our outpatient surgical unit. The measured hemoglobin concentration of all patients by age and sex are shown in figure 1.

Anesthesiologists predicted the presence of anemia in 44 patients when the true hemoglobin was greater than 100 g/l. A total of 14 patients were anemic as defined by a hemoglobin concentration < 100 g/l, yielding an overall prevalence of 0.52%. Five of these patients (36% of all anemic patients) were correctly identified by the anesthesiologists based on history and/or physical examination (patients 1-5, table 1). In 9 patients the low hemoglobin concentration was not recognized clinically by the anesthesiologist. (patients 6-14, table 1). Based on these results the anesthesiologists' clinical assessment as a test for anemia was described with regard to sensitivity and positive and negative predictive value (table 2). The prevalence of anemia in the population studied was low (0.0053). The sensitivity also was low (0.36), as was the positive predictive value, indicating the anesthesiologist's inability to detect anemia reliably given only the history and clinical examination. The high negative predictive value is a result of the large size of the study group and the low prevalence of anemia. Thus, because anemia is rare, it is very likely that an anesthesiologist will be correct in predicting that a patient is not anemic.

The results were studied to identify any specific patient group prone to be anemic. The findings indicate that mild anemia is more common in children less than 1 yr of age. Of the entire study population of 2,649 children, 269

were younger than 1 yr. Of this patient subgroup, 7 (2.6%) had a hemoglobin of less than 100 g/l (see table 3). It also was noted that 2 of the older children with abnormally low hemoglobin had active juvenile rheumatoid arthritis (table 1).

Surgery was cancelled in one patient (table 1, number 4) because of a low hemoglobin concentration and in one patient (table 1, number 10) because of the presence of respiratory tract infection as well as a low hemoglobin. During the study period, surgery was cancelled in 34 other patients for other reasons unrelated to their hemoglobin concentration.

Discussion

The results of this study show that the prevalence of anemia in the studied population of infants, children, and adolescents presenting for outpatient surgery is low (0.5%). This is similar to the findings of two previous studies,^{6,7} which documented preoperative hematocrit values less than 30% in 0.7% of children who were to undergo inpatient elective surgery. These studies were reported almost 10 yr ago, and it is likely that we now perform similar surgical procedures in the day-surgery unit. Our finding of a slightly lower prevalence of anemia may reflect the fact that children are preselected to undergo outpatient surgery and are otherwise generally healthy. Thus, the patient population studied does not necessarily reflect the prevalence of anemia in the overall pediatric population but rather reflects it in a selected group.

TABLE 1. Description of Patients With a Hemoglobin Concentration Less Than 100 g/l

Patient Number	Age	Weight (kg)	Hb (g/l)	Anemia Predicted Preoperatively	Type of Surgery	Associated Conditions
1	2 months	4.3	91	Yes	Hernia repair	Prematurity, 35 weeks, jaundice at birth, postoperative periodic breathing
2	7 months	8.2	96	Yes	Manipulation of club feet	Previous history of anemia available from old chart
3	1 yr, 5 months	8.8	88	Yes	Hernia repair	Past history of chest infection, associated with anemia, previously treated for anemia
4	1 yr, 7 months	9.2	70	Yes	Examination under anesthesia, anal dilatation	Hirschsprung's disease, history of amebiasis and anemia; surgery cancelled
5	3 yr, 2 months	15.9	74	Yes	Cardiac catheterization	Severe rheumatoid arthritis; preoperative consultation had been obtained
6	1 month	4.5	87	No	Closed reduction of congenital dysplasia of hip	Congenital hyperinsulinism, seizures and cyanotic spells on 4th day of life, no previous documentation of low Hb
7	3 months	6.0	98	No	Hernia repair	Negative history
8	7 months	8.4	98	No	Strabismus repair	Jaundice at birth; baby breastfed
9	11 months	7.7	81	No	Strabismus repair	Prematurity, 32 weeks, history of apnea
10	1 yr, 2 months	10.9	76	No	Circumcision	Recent history of pharyngitis, coryza, rhonchi on auscultation; surgery cancelled
11	1 yr, 3 months	13.4	98	No	Circumcision	History of pyloric stenosis with vomiting and aspiration
12	1 yr, 10 months	12.4	96	No	Hernia repair	History of gastroenteritis at age 8 months
13	2 yr, 11 months	15.0	96	No	Dental restorations	Negative history
14	14 yr	53.4	97	No	Injection of rheumatoid joints	Rheumatoid arthritis, previous anemia documented in chart

In our type of practice patients initially are referred by the family practitioner to the surgeon and thus receive some preliminary screening before they attend for surgery. Therefore, one must assume that severe degrees of anemia may be discovered and treated before patients

are scheduled for elective outpatient surgery. A greater prevalence of anemia may be expected in areas where different referral practices prevail or where the population is composed of a different racial or socioeconomic background. A recent study from another institution⁴ reported

TABLE 2. Test of the Ability of the Anesthesiologist to Detect Anemia Clinically

Anesthesiologist's Preoperative Assessment	Actual Status on Laboratory Results	
	Anemic (Hb < 100 g/l)	Not anemic (Hb > 100 g/l)
Anemia predicted on history or physical	5 (true positive) a	44 (false positive) b
Anemia not predicted	9 (false negative) c	2,591 (true negative) d
Totals	14	2,635

Prevalence of anemia: $(a + c)/(a + b + c + d) = 0.0053$.

Sensitivity of the test: $a/(a + c) = 0.36$.

Positive predictive value of test (posttest likelihood of anemia in

those predicted anemic): $a/(a + b) = 0.10$.

Negative predictive value of test: $d/(c + d) = 0.99$.

TABLE 3. Relationship Between Anemia and Age

	Age < 1 yr	Age > 1 yr	Total
Hb < 100 g/l	7 (2.6%)	7 (0.29%)	14
Hb > 100 g/l	262	2,373	2,635

Corrected chi-squared-20.3.
1 degree of freedom.
 $P < 0.0001$.

an incidence of 11.9% anemia in children undergoing elective surgery. Therefore, the results reported here may not apply to patients at other centers.

What constitutes anemia in each child is not easy to define, especially for the infant who undergoes a period of physiologic anemia. We arbitrarily chose a concentration of 100 g/l of hemoglobin, which has traditionally been considered clinically important and has influenced additional therapeutic decisions, *i.e.* the initiation of diagnosis and treatment and/or the postponement of surgery. Had we selected a hemoglobin concentration of 90 or 80 g/l, only 0.18 or 0.09% respectively of our entire study population would be classified below these levels, which are clinically more important.

From our findings it is apparent that surgery is very rarely postponed because of a hemoglobin concentration less than 100 g/l. Only two patients with an abnormally low hemoglobin had their surgery postponed. One of these patients also had a concurrent active respiratory tract infection with wheezing on auscultation, which was the principal reason for postponing elective surgery (patient 10, table 1). The other patient whose surgery was postponed had a hemoglobin concentration of only 7 g/l (patient 4, table 1). His severe anemia was detected by the anesthesiologist on clinical evaluation, and the decision was made that he should have a complete investigation and treatment of this anemia before his elective surgery. The remaining 12 patients with an abnormally low hemoglobin concentration received general anesthesia as planned without any apparent ill effects. Similar practices have been reported by Rossello *et al.*⁷ and by Wood and Hoekelman.⁸ The former studied 690 patients and found 5 (0.7%) who had a hematocrit of less than 30%, but only 1 had surgery postponed.

Thus, it appears that there is increasing willingness among anesthesiologists to provide anesthesia in children for elective surgery despite hemoglobin concentrations of less than 100 g/l. Anemia is an infrequent finding in preoperative pediatric patients, and serious adverse perioperative events such as cardiac arrest or death fortunately are even rarer. Thus it would be very difficult to establish an association between mild anemia and adverse outcomes.

The question remains as to whether routine preoperative testing for anemia still is necessary for all outpatient infants and children. It has been suggested that the history and physical examination should serve as guidelines in the decision to order additional laboratory tests.[§] This study was undertaken primarily to determine whether the anesthesiologist, during a brief preoperative examination, can reliably identify patients who might be anemic and in whom further investigation was indicated. The anesthesiologists participating in this study could not do so; they incorrectly labeled 44 patients as anemic and were unable to detect anemia in 9 others. In these 44 cases with false positive results, little harm would have been done by drawing blood, and the expense certainly would have been less compared to that of testing the entire group of 2,649 patients. Of greater concern is that anemia was not correctly diagnosed in nearly two thirds of the truly anemic patients. This result is expressed by the low sensitivity and low positive predictive values of the anesthesiologists' performance as a test (table 3). This confirms the difficulty of diagnosing anemia using the clinical appearance of the patient.

It was expected that this study would heighten the participating anesthesiologists' awareness to the possibility of anemia. A limitation may be that the anesthesiologists were not provided with a more elaborate protocol or checklist as a means of screening for anemia. It is not known how extensively the participating anesthesiologist looked for the signs and symptoms of mild anemia, which may be rather vague and may not be readily detected during a brief preoperative examination in a busy setting. It is noteworthy that, on closer examination of their history, several patients whose anemia was not properly diagnosed had conditions that should have alerted the anesthesiologist. This suggests that the history obtained at preoperative examination is not always complete and emphasizes the importance of obtaining the history carefully.

Eight of the nine children in whom anemia was not diagnosed by their anesthesiologist until the blood test result was available underwent anesthesia without complication. It is not known whether this added knowledge of the patient's anemia caused the anesthesiologist to modify the anesthetic management in any way.

The results of our study confirm that it is difficult to diagnose mild degrees of anemia by clinical evaluation of children. However, the results also suggest that there may

§ Roizen MF, Kaplan EB, Schreider BD, Lichtor LJ, Orkin FK: The relative roles of the history of physical examination, and laboratory testing in preoperative evaluation for outpatient surgery: The "startling" curve of preoperative laboratory testing. *Anesthesiol Clin North Am* 5:15-34, 1987.

be little justification for continuing routine universal preoperative testing for anemia in all pediatric outpatients when the results of these tests have little influence on patient management. The potential cost-savings of eliminating many preoperative complete blood counts each year is significant, as is the potential benefit to the child of omitting an unpleasant and uncomfortable procedure. Our study also confirms that anemia is more common in children less than 1 yr of age. This may be a subgroup in whom preoperative testing should be continued although, as stated above, it is uncertain whether this will affect anesthetic management or the outcome of anesthesia in any patient.

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