Effect of the White Blood Count on the Clinical Management of the Febrile Infant

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Background. The white blood count is commonly used in the evaluation of the febrile infant without a focal source of infection. This study describes the physician's use of diagnostic tests in this clinical situation and also evaluates the effect of an elevated white blood count (WBC) on diagnostic test ordering and patient management.

Methods. A case scenario describing a febrile infant was mailed to all 294 pediatric, family, general, and emergency physician members of the Academy of Medicine of Cleveland. Questions about test ordering and case management were asked, both before and after the patient's WBC was known. Physicians were randomly assigned to receive a case scenario with either a normal or an elevated WBC.

Results. Of the 294 physicians contacted, 196 (67%) returned usable questionnaires. Physicians ordered an average of 1.4 tests in the initial management of the case, for an average cost of $82. Emergency physicians ordered more tests than other physicians (2.4 vs 1.2 tests, $P = .001$). Once the WBC was known, physicians in the high WBC group ordered more additional tests than the normal WBC group (0.89 vs 0.33 tests, $P < .001$), and were more likely to change to a more aggressive therapeutic management strategy ($P < .001$).

Conclusions. The cost of physician-ordered laboratory testing is significant for the clinical scenario of a febrile infant without a localizing source. An elevated WBC affects physician management by causing more tests to be ordered and by influencing some physicians to choose more aggressive management strategies.

Key words. Decision making; leukocytosis; fever; infant. *J Fam Pract 1991; 33:465-469.*

The complete blood count (CBC) and the white blood count (WBC) and differential are among the most commonly ordered tests in an outpatient setting.[1,2] In spite of this, the clinical utility of the white blood count in physicians' decision making has been questioned.[1–9] Ordering a WBC and differential is often used as an adjunct to help make decisions concerning infants and children presenting with an acute febrile illness. These tests are considered to be simple and relatively inexpensive by many physicians.

Fever in infants and children is a common reason for telephone calls and office visits to physicians.[10–12] The clinical scenario of a febrile child under the age of 2 years without other manifestations of disease or localized physical findings is common and often anxiety provoking for parents and physicians.[12] The physician's task of determining which children are at high risk for meningitis or bacteremia is difficult.[8,9] Clinical observation of the child has been shown to be the best single predictor of serious illness.[13,14] Febrile infants less than 2 months of age and severely ill-appearing children are commonly hospitalized. For children over 2 months of age who are febrile and look mildly or moderately ill, however, there is little consensus about diagnostic evaluation or management.[1,8–10,12,15,16]

We conducted a clinical trial involving a case scenario to evaluate physician use of laboratory tests in the management of a febrile infant without a focal source of infection. The initial management of the case is of interest in light of two recent decision analyses[8,9] that call into question the usefulness and cost-effectiveness of diagnostic testing in febrile infants. In addition, we hypothesized that physicians confronted by an elevated WBC would order more diagnostic tests and be more likely to choose more aggressive therapeutic management plans. We also hypothesized that emergency physicians and physicians working in emergency rooms and urgent care centers would order more laboratory tests.

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Methods

A current listing of Cleveland area general practitioners, family physicians, pediatricians, and emergency physicians was obtained from the Academy of Medicine of Cleveland. A case vignette describing a 10-month-old infant with a 2-day history of fever (temperature 38.8°C, rectal), nonspecific symptoms, and no focal findings on physical examination was mailed to all 294 physicians (Appendix). A postcard reminder was sent 1 week later. A second mailing with a personalized cover letter was sent to nonrespondents 4 weeks after the first mailing. Physicians were asked to answer questions about how they would initially manage the patient. Then, with the knowledge of the WBC and differential, they were asked to answer the same questions. Physicians were randomly assigned to one of two separate versions of the vignette. In one version, the WBC was 9000, and in the other, it was 18,000. Both had the same normal differential count. Demographic data about each physician's age, year of graduation from medical school, specialty, and type of practice were also obtained.

Analyses were performed on an IBM PC microcomputer, using the SPSS-PC statistical software package.[17] Summary variables were created for the number of tests ordered before and after the WBC was known. The costs of the tests ordered were calculated from the charges for these tests at University Hospitals of Cleveland. A change in management score was created for each respondent by subtracting the rank order score for the initial management question from the response to the management question after the WBC was known. Thus, a higher management change score represented a change toward more aggressive management based on the additional information of the WBC.

Statistics descriptive of the study sample were calculated and compared for the normal and high WBC groups to assess the effectiveness of randomization and to determine any evidence of selective return rates for the two groups. For these and all subsequent comparisons, chi-square tests were used for categorical variables, *t* tests were calculated for continuous variables, and the Wilcoxon matched-pairs signed-ranks test performed for ordered categorical variables assessing change before and after the WBC count was known. Because of differences between the two WBC groups in ordering tests even before the WBC was known, the percentage of respondents ordering particular tests after the WBC was known was compared between the two groups using an analysis of variance, with the initial number of tests ordered used as a covariate, thus controlling for the initial differences.

Table 1. Characteristics of Physician Study Sample (N = 196) Randomized to Two Versions of Case Vignette*

Variable	Physicians Assigned to Normal WBC Group (n = 105)	Physicians Assigned to High WBC Group (n = 91)	*P* Value for Difference
Age, mean (y)	52	49	.14
Years since graduation from medical school, mean	23	22	.55
Specialty (%)			.50
Pediatrics	44	49	
Family practice	33	23	
General practice	12	14	
Emergency medicine	10	11	
Other	1	3	
Practice type (%)			.45
Solo	38	28	
Group	34	32	
HMO	8	14	
Urgent care	1	2	
Emergency	5	11	
Full-time teaching	7	7	
Not practicing	2	2	
Other	5	5	

**In one version, the WBC was 9000, and in the other, it was 18,000.*
WBC denotes white blood count; HMO, health maintenance organization.

Results

One hundred ninety-six physicians returned usable questionnaires, for a response rate of 67%. No data were available on the nonresponders. The characteristics of the study sample are depicted in Table 1. The sample represents a mature group of physicians, with a mean age of 51 years. Most physicians are either in solo or group practice. Demographically, the two study groups appear to be comparable.

The initial management of the case before the WBC was known is shown in Table 2. Physicians ordered an average of 1.4 tests, for a mean cost of $82. Slightly over half of the physicians ordered a CBC, while 39% of physicians ordered no laboratory tests. Even though the results of the WBC were not known to the physicians at this point, physicians in the normal WBC group ordered more tests, being significantly more likely to order a CBC. Initial management by the majority of physicians consisted of reassurance, antipyretics, and fluids on an outpatient basis.

Table 3 shows the management of the case for the two groups after the results of the WBC were known. The elevated WBC group was significantly more likely to order additional tests, specifically blood cultures, chest radiographs, and urine tests. The average costs of these additional tests were $60 for the high WBC group and

Table 2. Management of the Case Before White Blood Count (WBC) Is Known

Test/Plan	Whole Physician Group (N = 196)	Physicians Assigned to Normal WBC Group* (n = 105)	Physicians Assigned to High WBC Group† (n = 91)	*P* Value for Difference
Laboratory tests ordered (%)‡				
None	39	31	47	.02
CBC and differential	52	60	43	.02
Blood culture	16	19	13	.23
Chest radiograph	8	7	9	.62
Urinalysis and/or culture	33	39	27	.08
Sedimentation rate	6	9	2	.053
Throat culture	19	21	17	.48
Lumbar puncture	4	3	4	.56
Other	2	1	2	.50
Number of tests ordered, mean	1.4	1.6	1.1	.02
Cost of tests ordered mean ($)	82	92	68	.08
Initial management (%)				.75
Reassurance	11	11	13	
Antipyretics and fluids	83	86	82	
Outpatient antibiotics	4	4	4	
Hospitalization	2	2	1	

**WBC = 9000.*
†WBC = 18,000.
‡Some physicians ordered more than one test.
CBC denotes complete blood count.

Table 3. Management of the Case After White Blood Count (WBC) Is Known

Test/Plan	Physicians Assigned to Normal WBC Group* (n = 105)	Physicians Assigned to High WBC Group† (n = 91)	*P* Value for Difference
Additional laboratory tests ordered (%)			
None	43	23	.004
Blood culture	7	22	.002
Chest radiograph	8	18	.04
Urinalysis and/or culture	2	20	<.001
Sedimentation rate	2	4	.31
Throat culture	7	9	.58
Lumbar puncture	4	11	.052
Other	5	3	.61
Number of tests ordered, mean	.33	.89	<.001
Cost of tests ordered mean ($)	19	60	.001
Management (%)			.02
Reassurance	12	11	
Antipyretics and fluids	83	70	
Outpatient antibiotics	3	12	
Hospitalization	2	7	
Change in management after WBC is known (%)			<.001
One step less aggressive	8	3	
No change	90	76	
Next more aggressive step	2	16	
Two steps more aggressive	0	5	

**WBC = 9000.*
†WBC = 18,000.

$19 for the low WBC group. By analysis of variance, controlling for differences in initial test ordering, the adjusted cost ($50 vs $25) and higher number of tests ordered (mean of 0.90 vs 0.32) remained significantly higher ($P < .001$) in the elevated WBC group. The high WBC group was also significantly more likely to choose one of the more aggressive management strategies (outpatient antibiotics or hospitalization) compared with the normal WBC group ($P = .02$). In addition, the high WBC group changed to a more aggressive management from baseline more often than the low WBC group ($P < .001$). Interestingly, for more than three fourths of the physicians in both groups, knowledge of the WBC did not alter management.

After the WBC was known, physicians in different specialties and types of practice showed no significant differences in patient management or in ordering additional tests. In initial test ordering, however, emergency physicians requested an average of 2.4 tests, compared with a mean of 1.2 tests ordered by other physicians ($P = .001$). The average cost of initial laboratory tests was $139 for emergency physicians vs $73 for other physicians ($P = .03$). Emergency physicians were significantly more likely than other physicians to obtain blood cultures (41% vs 13%, $P < .001$), chest radiographs (27% vs 5%, $P < .001$), and sedimentation rates (18% vs 3%, $P = .003$). Similar findings were found when physicians working in emergency rooms or urgent care centers, regardless of specialty, were compared with physicians working in other practice settings. When the behavior of pediatricians was contrasted with other physicians, a trend toward pediatricians ordering fewer tests (mean of 1.1 vs 1.6, $P < .05$) emerged. Pediatricians were less likely to order throat cultures (9% vs 28%, $P < .001$) than other physicians.

Discussion

It has been estimated that a primary care pediatrician would encounter a febrile child under 2 years of age without an identified source once in every 1½ days of practice.[15] The problem is similarly common in family practices. The possibility that a serious bacterial infection

such as bacteremia, pneumonia, or meningitis may be present often leads physicians to use the white blood count as an aid to diagnosis and management. Indeed, Stein[6] found that fever in an infant was the most common reason for ordering a WBC in a suburban pediatric practice. The WBC is simple and easy to order, but has been shown to have a limited value in distinguishing between viral and bacterial infections.[1–3,8,9,18] Moreover, the WBC has significant costs in terms of patient discomfort, the need for trained personnel to obtain the blood, additional test ordering, and more aggressive management if an elevated WBC is found.

The study findings support our hypothesis that an elevated WBC affects management of such cases by causing the physician to be more likely to order additional tests and to change the therapeutic plan. For most physicians in either the high or normal WBC group, however, knowing the WBC did not alter the therapeutic plan. It would be wise for physicians to consider how the results of the WBC will affect the management of the patient, and to abstain from ordering the test if patient management will not be altered by either a normal or elevated count. Indeed, only half of the physicians in our sample would have ordered a WBC in the first place. The difference in *initial* test ordering between the normal and high WBC groups is likely a chance phenomenon. Controlling for this did not alter the findings.

A recent review[19] of the value of the written case scenario for predicting physician behavior in actual clinical encounters found that there is little empirical data to support or refute the criterion validity of this research approach. The case scenario approach may be particularly suspect for research that assesses multiple aspects of patient care over time or that involves multiple types of patient scenarios. The authors conclude that "written simulations are probably an effective research instrument for . . . elucidating the decision-making process."[19] Using the case scenario in a clinical trial involving physician decision making about one particular clinical situation has the advantage of allowing the researcher to isolate the effect of a particular finding on the physician's clinical management decisions. The case vignette methodology does limit the physician's ability to use clinical judgment in making decisions about the case. This may have led to an increased reliance on laboratory tests for decision making, and could thus lead to overreporting of the importance of laboratory tests.

Test ordering for similar illness presentations has been shown to vary by specialty and practice settings. For patients presenting with cough and upper respiratory tract symptoms, fewer tests were ordered in health maintenance organizations than in urgent care centers.[10] Our results confirm these findings and additionally suggest that pediatricians may be more conservative in test ordering. Because pediatricians and family and general physicians are able to use follow-up to aid in diagnosis and management, they are able to order fewer tests than physicians working in emergency rooms or urgent care centers. This may diminish the cost of care for this common clinical presentation. Further research is warranted on teaching physicians how to selectively use laboratory tests such as the WBC to aid in decision making.[20]

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For editorial comment, see page 453.

Appendix

Case Presentation

A 10-month-old infant is brought in by his mother to see you. His mother reports a two-day history of her infant "feeling warm," having decreased appetite, and being irritable. There is no history of rash, respiratory symptoms, cough, vomiting, diarrhea, or recent exposure to illness. Past medical history is noncontributory.

Physical examination reveals a well-developed, well-nourished infant who is crying. He appears fussy, but is easily consoled by his mother. Temperature is 38.8°C (101.8°F) rectally, pulse 130 bpm, and respirations 20/min. No focal abnormalities are found.

With only this information available, please indicate how you would probably manage this patient by responding to the questions below:

What laboratory tests would you order?

_____ None
_____ CBC with differential
_____ Blood culture
_____ Chest X-ray
_____ Urinalysis and/or culture
_____ Sedimentation rate
_____ Throat culture
_____ Lumbar puncture
_____ Other: _____
_____

Assume that any laboratory tests you ordered are normal, and any cultures pending. What would be your management plan?

_____ Reassurance. Follow-up if worse or not improving
_____ Antipyretics and fluids at home with close follow-up
_____ Antibiotics as an outpatient with close follow-up
_____ Admit to the hospital

Your assistant has already obtained a WBC and differential, which shows:

WBC 18,000* 22% Segs 8% Bands 65% Lymphs 5% Monos

With this additional information available, please indicate how you would probably manage the patient by responding to the questions below:

What additional laboratory tests would you order?

_____ None
_____ Throat culture
_____ Blood culture
_____ Chest X-ray
_____ Urinalysis and/or culture
_____ Sedimentation rate
_____ Lumbar puncture
_____ Other: _____
_____

Again, assuming that any laboratory tests you ordered are normal, and any cultures pending, what would be your management plan?

_____ Reassurance. Follow-up if worse or not improving
_____ Antipyretics and fluids at home with close follow-up
_____ Antibiotics as an outpatient with close follow-up
_____ Admit to the hospital

*WBC = 9,000 for half of the study sample.