

Evaluation of a point-of-care hematology analyzer for use in dogs and cats receiving chemotherapeutic treatment

Ana Lara-Garcia, DVM, PhD, DACVIM; Kenji Hosoya, DVM, MSc, DACVR; Cristina Iazbik, DVM; Nicole Westendorf; Stacey Gallant; Guillermo Couto, DVM, DACVIM

Objective—To compare WBC, neutrophil, and platelet counts and Hct values obtained with a point-of-care hematology analyzer with values obtained by a reference method for dogs and cats receiving chemotherapy.

Design—Cross-sectional study.

Animals—105 dogs and 25 cats undergoing chemotherapy.

Procedures—Blood samples were analyzed with a point-of-care hematology analyzer and with an impedance- and laser-based analyzer with manual differential WBC counts. Results for WBC, neutrophil, and platelet counts and Hct were compared. Sensitivity and specificity of the point-of-care analyzer to detect leukopenia, neutropenia, and anemia were calculated.

Results—554 canine and 96 feline blood samples were evaluated. Correlation coefficients for dogs and cats, respectively, were 0.92 and 0.95 for total WBC count, 0.91 and 0.88 for neutrophil count, 0.95 and 0.92 for Hct, and 0.93 and 0.71 for platelet count. Sensitivity and specificity, respectively, of the point-of-care analyzer to detect leukopenia were 100% and 75% for dogs and 100% and 68% for cats; to detect neutropenia were 80% and 97% for dogs and 100% and 80% for cats; to detect anemia were 100% and 80% for dogs and 100% and 66% for cats; and to detect thrombocytopenia were 86% and 95% for dogs and 50% and 87% for cats.

Conclusions and Clinical Relevance—The point-of-care analyzer was reliable for monitoring CBCs of dogs and cats receiving chemotherapy. It had good to excellent correlation for WBC and neutrophil counts and Hct and accurately detected leukopenia, neutropenia, and anemia. Sensitivity of the analyzer for detecting thrombocytopenia was lower but acceptable. (*J Am Vet Med Assoc* 2008;232:1488–1495)

An easy-to-use, point-of-care hematology analyzer should be a useful tool in a veterinary practice, particularly at practices that routinely administer chemotherapy to dogs and cats. A point-of-care hematology analyzer provides CBC results in a short time, and it allows clinicians to make rapid treatment decisions and to detect hematologic complications from cancer or chemotherapeutic treatments without the delay involved when samples are sent to an outside reference laboratory.

Because most veterinarians are accustomed to submitting samples for CBCs to outside reference laboratories, it is imperative that they be secure with the fact that a point-of-care hematology analyzer would provide similar and reproducible results to those of reference laboratories. The brief amount of time it requires to obtain results with a point-of-care analyzer is valuable for oncology patients, where most treatment decisions are made on the basis of results of a CBC performed during a particular visit.¹

Currently, some veterinary practices require that a patient visit their clinic 1 or 2 days before a scheduled

chemotherapy administration to enable clinicians to obtain a blood sample, which is then submitted to a reference laboratory for a CBC. The patient is subsequently treated on the basis of the CBC results. However, this adds inconvenience and expense for the owners. Some veterinary practices perform a rapid semiquantitative evaluation of a blood film, which can be sufficiently sensitive to reveal neutropenia or thrombocytopenia,² but a full differential cell count is still preferable. Therefore, a point-of-care analyzer that provides reliable and reproducible results and that can accurately identify hematologic abnormalities that would preclude chemotherapy administration and lead to appropriate prophylactic or palliative medical management should be of value.

One particular point-of-care hematology analyzer^a has been widely used in veterinary practices since 2003. Preliminary experiments^b have revealed a good correlation between results for this analyzer and results for other hematology analyzers; however, correlations with results of manual WBC differential counts, especially neutrophil counts, are contradictory.^{3,4} To our knowledge, there are no published studies in which investigators evaluated the agreement between results for this point-of-care analyzer and results for a reference method for detecting cytopenia when the ranges provided by the manufacturer of the point-of-care analyzer are used.

From the Department of Veterinary Clinical Sciences, College of Veterinary Medicine, The Ohio State University, Columbus, OH 43210. Presented in part at the 25th Annual Conference of the Veterinary Cancer Society, Huntington Beach, Calif, October 2005. The authors thank James Russell for technical assistance. Address correspondence to Dr. Lara-Garcia.

Information provided by the manufacturer is typically used for interpretation of CBC results by private practitioners who use a particular point-of-care analyzer.

This point-of-care hematology analyzer used a flow-cytometry system designed to classify blood cells by evaluating a stream of cells and particles with laser light and determining the number, size, and complexity of the cells. The mixing and sampling system of the device are designed to reduce operator-related variation, and results are obtained within 8 to 12 minutes.⁵

The objective of the study reported here was to compare the WBC, neutrophil, and platelet counts and the Hct obtained with a point-of-care hematology analyzer in samples collected from dogs and cats receiving chemotherapy with results obtained by use of a standard instrument and a manual WBC differential count. In addition, the ability of this point-of-care analyzer to detect leukopenia, neutropenia, anemia, and thrombocytopenia in patients receiving chemotherapy was evaluated.

Materials and Methods

Animals—Dogs and cats with various types of neoplasia that were receiving chemotherapeutic treatment at The Ohio State University Veterinary Teaching Hospital Oncology Service were included in the study. Blood samples were obtained from animals as part of a regularly scheduled hematologic analysis during the course of treatment. The study was performed in compliance with the guidelines of animal use for clinical investigation established by The Hospital Executive Committee of The Ohio State University Veterinary Teaching Hospital.

Evaluations were performed on 105 dogs that ranged between 3 and 14 years of age (median, 8.32 years). There were 45 spayed females, 51 castrated males, 3 sexually intact females, and 6 sexually intact males. Dogs represented 41 breeds; the most commonly represented were mixed-breed dogs ($n = 25$), Labrador Retrievers (8), Golden Retrievers (7), and Shetland Sheepdogs (5).

Dogs had lymphoma, acute lymphoblastic leukemia, chronic lymphocytic leukemia, osteosarcoma, hemangiosarcoma, soft tissue sarcoma, melanoma, mast cell tumor, malignant histiocytosis, multiple myeloma, plasma cell tumor, or carcinoma. The most common neoplasm was lymphoma ($n = 46$ dogs), followed by osteosarcoma (21), carcinoma (11), and mast cell tumor (10). Dogs were receiving 1 or more drugs administered systemically, which included prednisone, dexamethasone, cyclophosphamide, vincristine, cytosine arabinoside, doxorubicin, L-asparaginase, chlorambucil, methotrexate, actinomycin D, melphalan, suramin, carboplatin, gemcitabine, lomustine, and flurouracil. A subset of the dogs with carcinoma received intralesional or intravesical treatments (for dogs with transitional cell carcinoma of the urinary bladder) with α -interferon, fluorouracil, or paclitaxel.

Evaluations were performed on 25 cats that ranged between 3 and 16 years of age (median, 8.72 years). There were 14 spayed females and 11 castrated males. Breeds most commonly represented were domestic shorthair ($n = 17$), domestic longhair (3), and domestic medium hair (2). Cats had lymphoma, acute lymphoblastic leukemia, chronic lymphocytic leukemia, fibrosarcoma, histiocytic sarcoma, mast cell tumor, or carcinoma. The most com-

mon neoplasm was lymphoma ($n = 13$ cats), which was followed by fibrosarcoma (5) and chronic lymphocytic leukemia (2). Cats were receiving 1 or more drugs administered systemically, which included prednisone, dexamethasone, vincristine, cyclophosphamide, doxorubicin, actinomycin D, cytosine arabinoside, L-asparaginase, lomustine, chlorambucil, and carboplatin.

Sample collection and analysis—Blood samples were obtained by jugular venipuncture from dogs and cats with cancer that were receiving chemotherapeutic treatments. Between 3 and 4 mL of blood was collected. One milliliter of blood was placed in a vacuum tube containing EDTA,^c and the remainder of the sample was placed in another similar vacuum tube containing EDTA. The 1-mL blood sample was analyzed by use of a point-of-care hematology analyzer,^a and the other sample was submitted to The Ohio State University Veterinary Teaching Hospital Hematology Laboratory for routine analysis. Samples were stored at 22°C (72°F) and processed within 4 hours after collection.

Samples were evaluated with the point-of-care hematology analyzer in accordance with the manufacturer's instructions and appropriate software settings, depending on the species (ie, dog or cat).⁵ Samples that yielded error messages for the results were not reevaluated because of a lack of sufficient amounts of blood. The analyzer did not require calibration by the operators. Quality-control beads were analyzed along with the sample during each analysis to ensure the quality of the analysis. The analyzer was continuously on (24 h/d), and it provided a printout (24 variables) with cell count results and dot plots for RBCs, WBCs, and platelets for each sample. Results were classified as normal or abnormal on the basis of the reference ranges provided by the manufacturer.⁵

Personnel at the Veterinary Teaching Hospital Hematology Laboratory used an automated hematology analyzer.^d The automated analyzer used principles of electrical impedance, laser-light scatter, and multivariable flow cytometry with specific adjustments for veterinary samples to perform routine CBCs.⁶ The device was calibrated daily.

Reference ranges used for the samples analyzed with the reference method were those established by the Hematology Laboratory staff. Because differential WBC counts obtained with the automated hematology analyzer have not been validated for veterinary use, they were performed manually by use of a 100-cell differential count. Manual platelet counts were performed for samples obtained from dogs and cats only when abnormal platelet algorithms were detected with the reference method or when the platelet count obtained with the automated hematology analyzer was $< 100 \times 10^9$ cells/L.

Leukopenia, neutropenia, anemia, and thrombocytopenia were defined as cell counts less than the reference range for each specific cell type. Reference ranges provided by the manufacturer were used for counts obtained with the point-of-care hematology analyzer, and reference ranges established at the Veterinary Teaching Hospital Hematology Laboratory were used for counts obtained with the automated hematology analyzer (Appendix).

Statistical analysis—For statistical purposes, samples that yielded error messages were not included in any

of the calculations related to the variables affected by the specific error type. Because the point-of-care hematology analyzer only provided absolute neutrophil counts (ie, it included the number of band cells within the mature neutrophil count), for statistical calculations, neutrophil counts obtained with the point-of-care hematology analyzer were compared with the total number obtained for the reference method, which was determined by adding the segmented neutrophil and band cell counts. A statistical software package^e was used for calculations. Normality of the data was assessed with the Kolmogorov-Smirnoff test, and nonparametric tests were used to analyze data that did not have a normal distribution. Correlations between the data obtained with each analyzer were performed with the Spearman method. An objective classification system used with the point-of-care hematology analyzer and other automatic analyzers was used to characterize the degree of correlation with the reference method.^{3,4,7-9} The *r* values were categorized as excellent (0.93 to 0.99), good (0.80 to 0.92), fair (0.60 to 0.79), or poor (< 0.59).^{3,4,7-9} Median values for each variable were compared by use of the Wilcoxon matched-pair test. Results were considered significant at values of $P < 0.05$.

To assess the degree of agreement between techniques, Bland-Altman plots with 95% confidence intervals were used.^{10,11} Agreement was considered good when the bias was small, the 95% confidence intervals for the bias were narrow, and there were < 10% outliers. Outliers were defined as those values that were outside the limits of agreement (bias \pm 2 SD). There was no real bias when the 95% confidence interval included zero.

Sensitivity and specificity—Sensitivity and specificity for the point-of-care hematology analyzer were calculated for detection of leukopenia, neutropenia, anemia, and thrombocytopenia.¹² Sensitivity was calculated as the percentage of cytopenic samples (as determined by results for the reference method) that were also identified as cytopenic by the point-of-care hematology analyzer by use of the following equation:

$$\text{Sensitivity} = (\text{true positive results} \times 100) / (\text{true positive results} + \text{false negative results})$$

Specificity was calculated as the percentage of noncytopenic samples (as determined by results for the reference method) that were also identified as noncytopenic by the point-of-care hematology analyzer by use of the following equation:

$$\text{Specificity} = (\text{true negative results} \times 100) / (\text{true negative results} + \text{false positive results})$$

Results

Blood samples—Blood samples were collected between March and September of 2005. Samples were collected weekly or every 2 or 3 weeks, depending on the chemotherapeutic protocol for each dog or cat. There were 554 CBCs performed in dogs and 96 CBCs in cats. Mean number of CBCs per patient was 4 in dogs and 3.8 in cats.

WBC counts—The point-of-care hematology analyzer yielded error messages for WBC counts on 50 (9%)

canine and 10 (10%) feline samples; therefore, results for 504 canine and 86 feline samples were included in the statistical analysis. The correlation between WBC counts for the point-of-care hematology analyzer and the automated analyzer was significant ($P < 0.001$) and was categorized as good for dogs ($r = 0.92$) and excellent for cats ($r = 0.95$); however, the median WBC counts for the point-of-care hematology analyzer were significantly ($P < 0.001$) lower than median WBC counts for the automated analyzer for both dogs and cats (Figures 1 and 2).

The mean difference in WBC counts between the point-of-care hematology analyzer and automated analyzer was small (-1.13×10^9 cells/L), and the SD of the differences was 3.22×10^9 cells/L. A plot of the differences between canine WBC counts for both devices against their means revealed good agreement and a 95% confidence interval of -7.45 to 5.19×10^9 cells/L with 2.6% outliers (Figure 3). There was also good agreement for feline WBC counts, with a small mean difference of -0.53×10^9 cells/L and an SD of the differences of 4.63×10^9 cells/L (Figure 4). The 95% confidence interval was -9.61 to 8.56×10^9 cells/L, with only 1 outlier that accounted for 1.2% of the samples.

Prevalence of leukopenia in dogs was 35% for the point-of-care hematology analyzer and 14% for the automated analyzer (Table 1). Prevalence of leukopenia in cats was 50% for the point-of-care hematology analyzer and 27% for the automated analyzer. Sensitivity of the point-of-care hematology analyzer to detect leukopenia was 100% for dogs and cats, and specificity was 75% for dogs and 68% for cats (Table 2).

Neutrophil counts—The point-of-care hematology analyzer yielded error messages for differential WBC counts in 84 of 554 (15%) canine samples and in 18 of 96 (19%) feline samples; therefore, results for 470 canine and 78 feline samples were included in the statistical analysis. The correlation for neutrophil counts between the point-of-care hematology analyzer and reference method was significant ($P < 0.001$) and was categorized as good for both dogs ($r = 0.91$) and cats ($r = 0.88$). However, median neutrophil counts for the point-of-care hematology analyzer were significantly ($P < 0.001$) lower than median counts for the reference method for both dogs and cats (Figures 1 and 2).

Analysis revealed good agreement between both methods for neutrophil counts in dogs and cats. The mean difference in the canine neutrophil count between the point-of-care hematology analyzer and manual differential count was small (-1.60×10^9 cells/L), and the SD of the differences was 2.20×10^9 cells/L. A plot of the differences between canine neutrophil counts for both techniques against their means revealed a 95% confidence interval of -5.93 to 2.72×10^9 cells/L and 4.5% outliers (Figure 3). The mean difference for feline neutrophil counts was small (-1.12×10^9 cells/L), and the SD of the differences was 2.5×10^9 cells/L (Figure 4). Thus, the 95% confidence interval (-6.02 to 3.78×10^9 cells/L) was similar to that for canine samples, with only 1 outlier (1.5% of feline samples).

Prevalence of neutropenia in dogs was 16% for the point-of-care hematology analyzer and 17% for the reference method. Prevalence of neutropenia in cats was 51% for the point-of-care hematology analyzer and 40% for the reference method (Table 1). Sensitivity of the

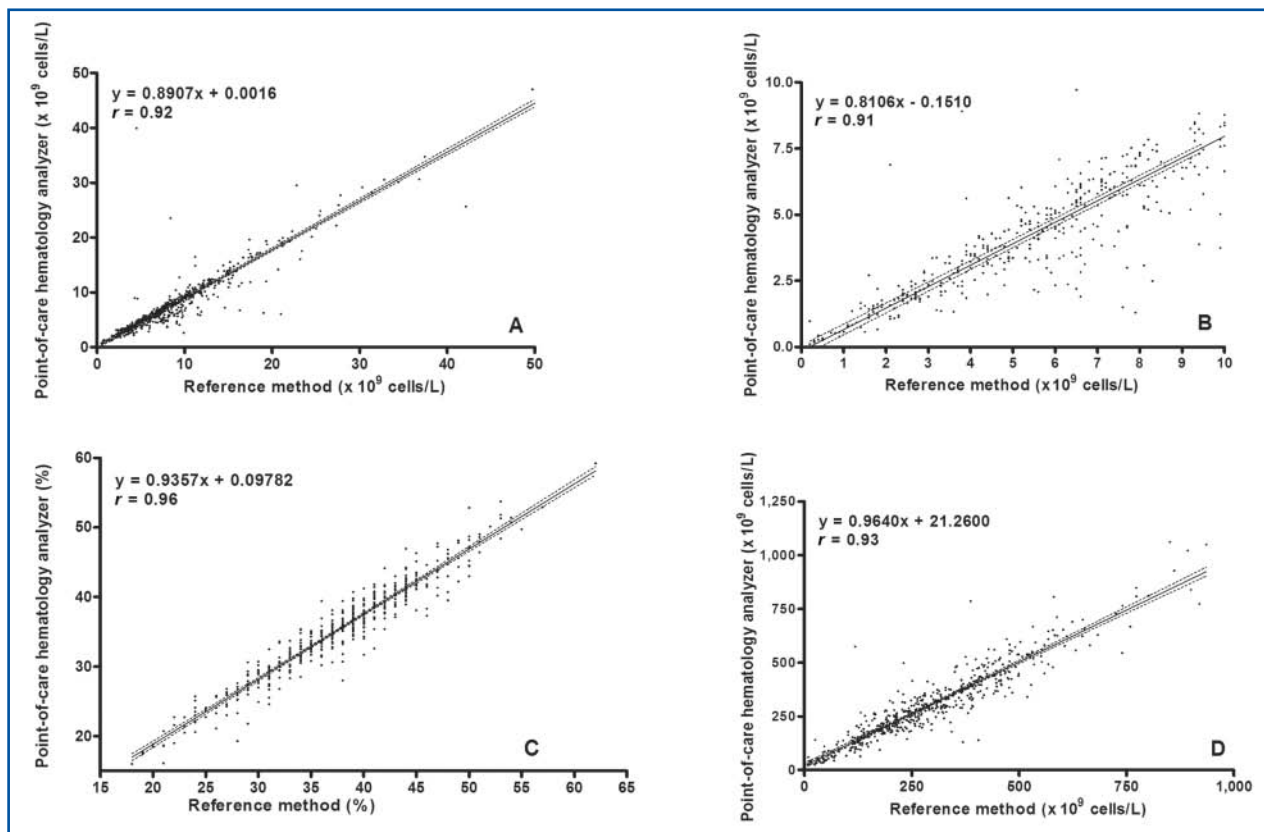


Figure 1—Scatterplots of WBC counts (A), neutrophil counts (B), Hct (C), and platelet counts (D) obtained with a point-of-care hematology analyzer^a and a reference method on samples obtained from 105 dogs receiving chemotherapeutic treatments. The median (solid line) and 95% confidence intervals (dotted lines) are indicated for each plot. The reference method was an automated hematology analyzer^d used by personnel at The Ohio State University Veterinary Teaching Hospital Hematology Laboratory.

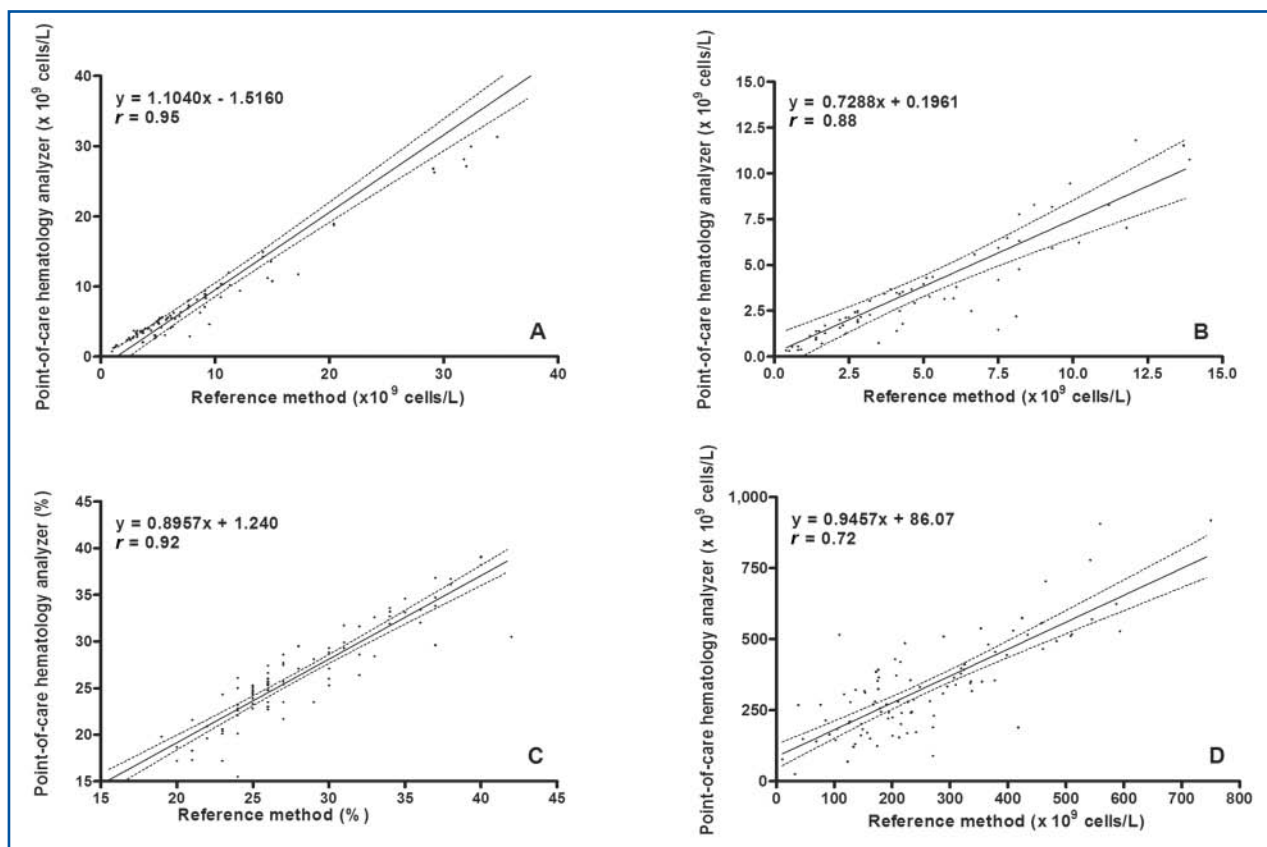


Figure 2—Scatterplots of WBC counts (A), neutrophil counts (B), Hct (C), and platelet counts (D) obtained with a point-of-care hematology analyzer and a reference method on samples obtained from 25 cats receiving chemotherapeutic treatments. See Figure 1 for remainder of key.

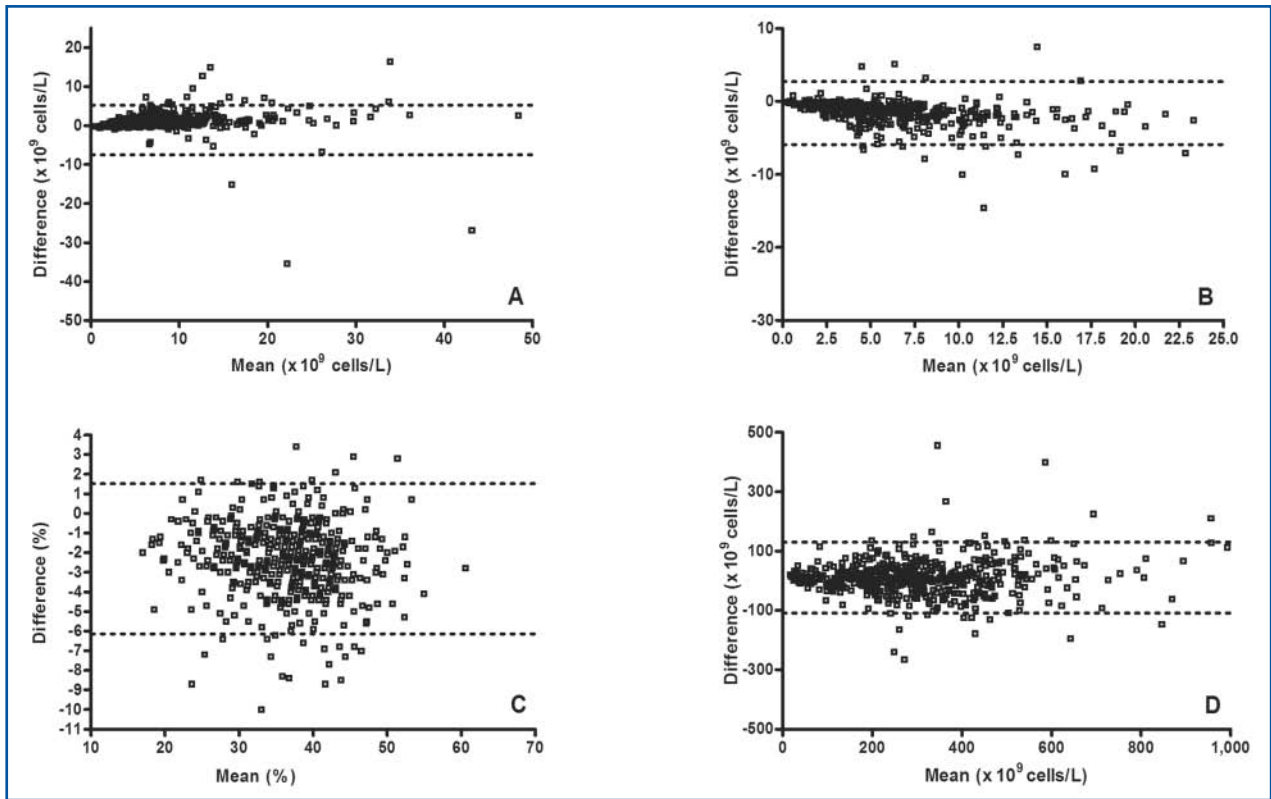


Figure 3—Bland-Altman plots for WBC counts (A), neutrophil counts (B), Hct (C), and platelet counts (D) obtained with a point-of-care hematology analyzer and a reference method on samples obtained from 105 dogs receiving chemotherapeutic treatments. Differences between results for the point-of-care hematology analyzer and reference method are plotted on the y-axis, and the mean value of the measurements for both methods is plotted on the x-axis. See Figure 1 for remainder of key.

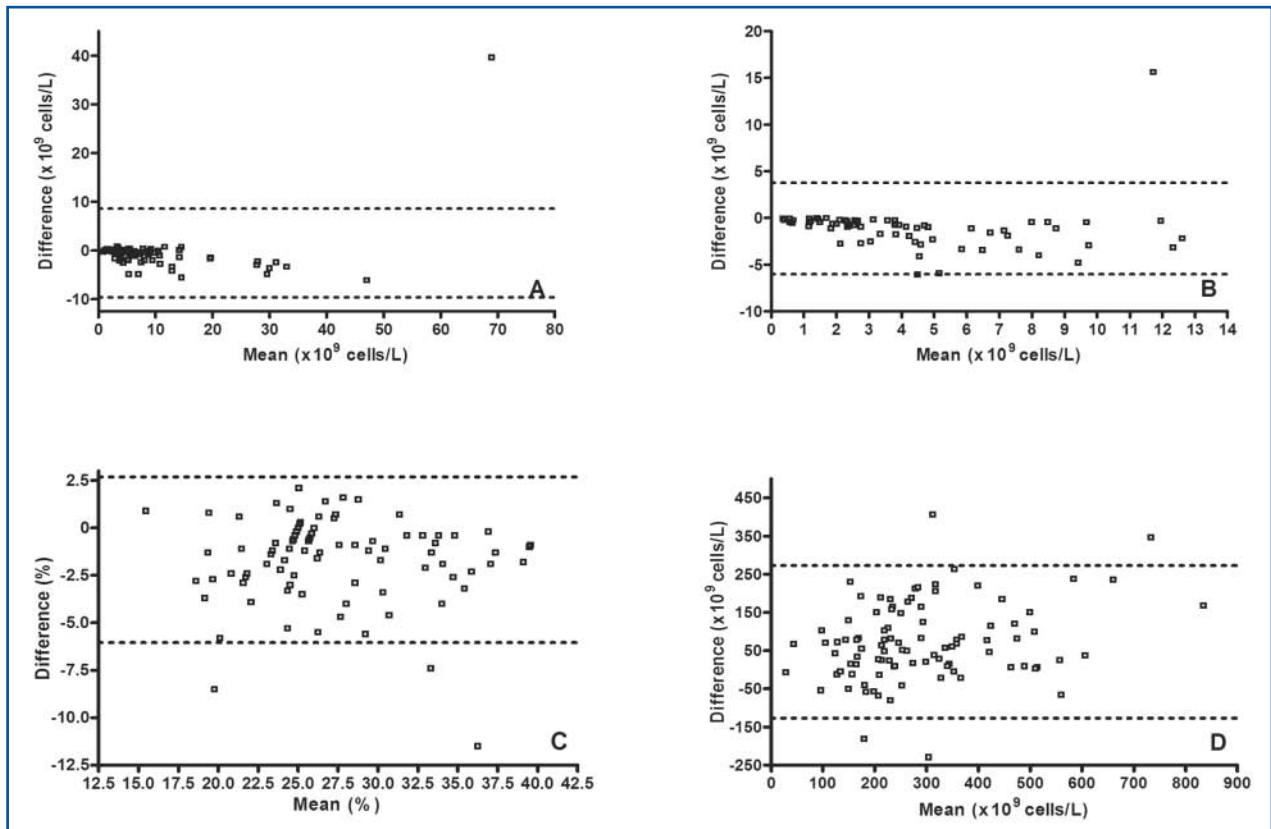


Figure 4—Bland-Altman plots for WBC counts (A), neutrophil counts (B), Hct (C), and platelet counts (D) obtained with a point-of-care hematology analyzer and a reference method on samples obtained from 25 cats receiving chemotherapeutic treatments. Differences between results for the point-of-care hematology analyzer and reference method are plotted on the y-axis, and the mean value of the measurements for both methods is plotted on the x-axis. See Figure 1 for remainder of key.

Table 1—Prevalence of leukopenia, neutropenia, anemia, and thrombocytopenia as determined on the basis of results for a reference method (RM)* and a point-of-care (POC) hematology analyzer^a on samples obtained from 105 dogs and 25 cats receiving chemotherapeutic treatments.

Variable	Species	Cutoff value		Prevalence (%)	
		RM	POC	RM	POC
Leukopenia ($\times 10^9$ cells/L)	Dog	< 4.1	< 5.5	14	35
	Cat	< 4.1	< 5.5	27	50
Neutropenia ($\times 10^9$ cells/L)	Dog	< 3.0	< 2.0	17	16
	Cat	< 3.0	< 2.5	40	51
Anemia (Hct %)	Dog	< 36	< 37	36	57
	Cat	< 25	< 30	28	77
Thrombocytopenia ($\times 10^9$ cells/L)	Dog	< 106	< 175	10	13
	Cat	< 150	< 175	21	19

*The reference method was an automated hematology analyzer^d used by personnel at The Ohio State University Veterinary Teaching Hospital Hematology Laboratory.

Table 2—Sensitivity and specificity* for detection of leukopenia, neutropenia, anemia, and thrombocytopenia with a point-of-care hematology analyzer for samples obtained from dogs and cats receiving chemotherapeutic treatments.

Variable	Species	Sensitivity (%)	Specificity (%)
Leukopenia	Dog	100	75
	Cat	100	68
Neutropenia	Dog	80	97
	Cat	100	80
Anemia	Dog	100	66
	Cat	100	31
Thrombocytopenia	Dog	86	95
	Cat	50	87

*Results for an automated hematology analyzer^d were considered the criterion-referenced standard.

point-of-care hematology analyzer to detect neutropenia was 80% for dogs and 100% for cats, and the specificity was 97% for dogs and 80% for cats (Table 2).

Hct—The point-of-care hematology analyzer yielded error messages related to RBC variables for 95 (17%) canine and 6 (6%) feline samples; therefore, results for 459 canine and 90 feline samples were included in the statistical analysis. The correlation between Hct values for the point-of-care hematology analyzer and automated analyzer was significant ($P < 0.001$) and was categorized as excellent for dogs ($r = 0.96$) and good for cats ($r = 0.92$). The median Hct for the point-of-care hematology analyzer was significantly ($P < 0.001$) lower than the median for the automated analyzer for both dogs and cats (Figures 1 and 2).

A plot of the difference between Hct results for the point-of-care hematology analyzer and automated analyzer for dogs against their means revealed good agreement (Figure 3). The mean difference in Hct between the point-of-care hematology analyzer and automated analyzer was small (-2.31%), and the SD of the differences was 1.95%. Thus, the 95% confidence interval was -6.14% to 1.51% with 5.7% outliers. There was also good agreement between both devices for feline Hct results, which revealed a small mean Hct difference (-1.67%) and an SD of the differences of 2.22% (Figure 4). The 95% confidence interval was -6.04% to 2.69% with 3.3% outliers.

Prevalence of anemia in dogs was 57% for the point-of-care hematology analyzer and 36% for the

automated analyzer. Prevalence of anemia in cats was 77% for the point-of-care hematology analyzer and 57% for the automated analyzer (Table 1). Sensitivity of the point-of-care hematology analyzer to detect anemia was 100% for both dogs and cats, and specificity was 66% for dogs and 31% for cats (Table 2).

Platelet counts—The point-of-care hematology analyzer yielded error messages for platelets in 10 of 554 (1.8%) canine samples and in 1 of 96 (1%) feline samples; therefore, results for 544 canine and 95 feline samples were included in the statistical analysis. The correlation between the point-of-care hematology analyzer and reference method for platelet counts was significant ($P < 0.001$) and was categorized as excellent for dogs ($r = 0.93$) and fair for cats ($r = 0.72$). The median platelet count for the point-of-care hematology analyzer was significantly ($P < 0.001$) higher than the median platelet count for the reference method for both dogs and cats (Figures 1 and 2).

A plot of the difference between the platelet counts for the point-of-care hematology analyzer and reference method against their means revealed good agreement (Figure 3). The mean difference in platelet counts between the point-of-care hematology analyzer and reference method was 10.65×10^9 cells/L, and the SD of the differences was 60.84×10^9 cells/L. Thus the 95% confidence interval was -108.6 to 129.9×10^9 cells/L with 4.6% outliers. The Bland-Altman plot for feline platelet counts revealed a large mean difference of 72.72×10^9 cells/L, and the SD of the differences was 102×10^9 cells/L. The 95% confidence interval was wide (-127.2 to 272.65×10^9 cells/L) but with only 4.2% outliers (Figure 4).

Prevalence of thrombocytopenia in dogs was 13% for the point-of-care hematology analyzer and 10% for the reference method. Prevalence of thrombocytopenia in cats was 19% for the point-of-care hematology analyzer and 21% for the reference method (Table 1). Sensitivity of the point-of-care hematology analyzer to detect thrombocytopenia was 86% for dogs and 50% for cats, and specificity was 95% for dogs and 87% for cats (Table 2).

Discussion

The study reported here revealed that results for the CBC variables evaluated with the point-of-care

hematology analyzer had good agreement with those for the reference method and good to excellent correlation for total WBC count, neutrophil count, and Hct in dogs and cats and for platelet counts in dogs. The percentage of error messages was > 10% only for neutrophil counts in cats and dogs and for the Hct in dogs. The number of samples with error messages was similar to or lower than that reported in other studies^{3,4} in which this point-of-care hematology analyzer was evaluated. Furthermore, considering that a substantial number of the patients in our study had hematologic abnormalities (ie, cytopenia, circulating neoplastic cells, and RBC fragments) as a result of their disease or secondary to their chemotherapeutic treatment, a higher prevalence of error messages was expected. For comparison, the automated analyzer used as the reference method in this study will reportedly yield error messages for the WBC differential in 52 of 100 randomly selected samples.[†] As mentioned earlier, the study design necessitated that samples receiving an error message for a certain variable were not reevaluated because of an insufficient volume of blood and were therefore not included in the statistical calculations for that specific variable. Thus, the only categoric change in the correlation resulted when all samples were analyzed together (data not shown) for WBCs in cats, which changed from excellent to good ($r = 0.92$ with error messages vs $r = 0.95$ without error messages). In fact, r values improved for neutrophil counts in cats ($r = 0.91$ vs $r = 0.88$ without error messages), although the correlation remained good.

The amount of blood used in each CBC performed with the point-of-care hematology analyzer was 0.8 mL, and the results were available within 8 to 12 minutes. Therefore, in a veterinary practice, it typically should not pose a problem to collect a subsequent blood sample and repeat the CBC for those patients in which sample errors were reported. Alternatively, a clinician could evaluate a blood film or send an additional sample to a referral laboratory when the duplicate results are markedly abnormal.

We determined that the total WBC count, neutrophil count, and Hct for the point-of-care hematology analyzer were significantly lower than those obtained with the reference method in both dogs and cats. This may have been related to the differences in techniques used to count cells or attributable to WBC and neutrophil lysis by the reagents used; however, the significant differences in Hct cannot be explained by this mechanism. These results, plus the fact that the low end of the reference ranges for WBC count and Hct were lower for the automated analyzer than for the point-of-care hematology analyzer, likely contributed to the higher number of leukopenic and anemic classifications obtained for the point-of-care hematology analyzer. Consequently, although the sensitivity for detecting leukopenia, neutropenia, and anemia in dogs and cats and thrombocytopenia in dogs ranged from 80% to 100%, specificity for these variables was much lower. This was especially noticeable for the Hct in cats in which the lower end of the reference range for the point-of-care hematology analyzer was 30%, whereas it was 25% for the automated analyzer, which led us to classify more samples as anemic for the point-of-care hematology analyzer than for the reference method. How-

ever, most of the samples that were classified as anemic with the point-of-care hematology analyzer but not the automated analyzer in dogs and cats had Hct values that corresponded with mild anemia; thus, the higher prevalence of anemia when results are obtained with the point-of-care hematology analyzer could falsely cause concern for clinicians (ie, a patient may be bleeding or have hemolysis as a result of the treatment or as a result of the disease).

The potential overinterpretation of these differences is difficult to predict in a new patient; however, in a patient receiving chemotherapy in which several CBCs have been conducted with the same point-of-care analyzer over time, it would be easy to identify a pattern toward abnormality that needs to be addressed. The software of the point-of-care hematology analyzer used in the study reported here also provided a graphic depiction of changes in these variables over time, thus facilitating visual interpretation of the data.

Clinically, differences in the results between both methods did not markedly affect the decisions made with regard to chemotherapeutic administration in these patients because although the prevalence of leukopenia for the point-of-care hematology analyzer was almost twice as high as for the automated analyzer for dogs and cats, the prevalence of neutropenia, which has a direct impact on treatment decisions of clinicians, was similar for both methods. Moreover, the guidelines for treatment of a dog or cat with chemotherapeutics are typically based on absolute numbers of neutrophils, rather than on the WBC count¹³ and other factors, such as the clinical status of the patient and the aggressiveness of the disease.

The point-of-care hematology analyzer yielded higher platelet counts than did the reference method for both species. In humans, RBC fragments are a primary reason that spuriously high platelet counts are obtained with automated counters.¹⁴ In the study reported here, blood samples from each patient were divided and placed into 2 EDTA-containing tubes to be analyzed with the point-of-care hematology analyzer or the automated analyzer under the same conditions; therefore, there was no reason that there would have been more RBC fragments in 1 aliquot than in the other, but it is possible that the point-of-care hematology analyzer was more sensitive in detecting small particles (ie, platelets) than was the automated analyzer. As discussed previously, blood films of the samples analyzed with the point-of-care hematology analyzer were not evaluated, and RBC fragments were reported only in a few of the samples submitted to the Hematology Laboratory and analyzed with the automated analyzer, especially samples from dogs with hemangiosarcoma (only 4.8% of the canine patients).

In cats, there was a fair correlation for platelet counts between the point-of-care hematology analyzer and reference method, and sensitivity for detecting thrombocytopenia in this species was also fair. We considered it acceptable because, in general, platelet counts in cats are highly variable when obtained by use of automated counters or hemacytometers (which is the criterion-referenced standard). The correlation between instrument-derived counts and manual counts in cats is usually fair to poor; therefore, independent of the instrument used,

it is always recommended to evaluate the number of platelets in a freshly prepared blood film.^{15–17}

It is obvious that reference laboratories should establish their own reference ranges when a specific device is used on the basis of the fact that there are inherent variations of the healthy pet population of the area and, ideally, every private practice would do the same. However, the reality is that private practitioners often use the ranges provided by the manufacturer of a device. For that reason and on the basis of the results of the study reported here, we suggest that the lower limits of the reference ranges for total WBC counts in dogs and cats and for Hct in cats for the point-of-care hematology analyzer should be reevaluated. The ranges provided by the manufacturer have not been reviewed since the device was placed on the market in 2003 and have been used as a reference by veterinarians throughout the United States.

When compared with results of other studies,^{4,b} we detected good to excellent correlations for Hct, WBC counts, and neutrophil counts in dogs and cats and for platelet counts in dogs. The correlation for platelet counts in cats in our study was higher than that reported in 1 study^b but similar to that reported in another study.⁴ The correlation between the neutrophil counts for the point-of-care hematology analyzer and manual determinations was good for dogs and cats; it remained good (data not shown; $r = 0.86$ for dogs and $r = 0.91$ for cats) when the data analysis included all samples with error messages. These results differ from those reported in another study³ in which investigators obtained a poor correlation for neutrophil counts for the point-of-care hematology analyzer versus a manual differential count in 44 canine blood samples and a fair correlation in 42 feline samples. In that study, it was proposed that counting only 100 cells, versus counting 200 cells, could have been a limitation of the study. The method used for our manual differential count was based on counting 100 cells, so we do not have a good explanation for differences in results between that study and the study reported here.

The point-of-care hematology analyzer was easy to manage, required a small amount of blood, and provided results after only a brief period. On the basis of our results, we believe that the point-of-care hematology analyzer is clinically reliable for assisting clinicians when making treatment decisions for dogs and cats receiving chemotherapeutic treatment. The patients would have been treated the same, as determined on the basis of total neutrophil count for either method, although the ranges for the point-of-care hematology analyzer could lead to an excessive number of animals classified as anemic and leukopenic.

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Appendix

Reference ranges for feline and canine blood samples analyzed by use of a point-of-care hematology analyzer^a or by use of an automated hematology analyzer^d with manual differential WBC counts at The Ohio State University Veterinary Teaching Hospital Hematology Laboratory.

Species	Variable	Point-of-care hematology analyzer	Hematology laboratory
Dog	WBCs ($\times 10^9$ cells/L)	5.5–16.9	4.1–15.2
	Total neutrophils ($\times 10^9$ cells/L)	2.0–12.0	3.0–10.7
	Hct (%)	37–55	36–54
	Platelets ($\times 10^9$ cells/L)	175–500	106–424
Cat	WBCs ($\times 10^9$ cells/L)	5.5–19.5	4.0–14.5
	Total neutrophils ($\times 10^9$ cells/L)	2.5–12.5	3.0–9.2
	Hct (%)	30–45	25–46
	Platelets ($\times 10^9$ cells/L)	175–600	150–600

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